SOTICS 2011

The First International Conference on Social Eco-Informatics

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SOTICS 2011 Editors

Nima Dokoohaki, Royal Institute of Technology (KTH) - Stockholm, Sweden

Lynne Hall, University of Sunderland, UK

SOTICS 2011

Foreword

The First International Conference on Social Eco-Informatics [SOTICS 2011], held between October 23 and 29, 2011 in Barcelona, Spain, constituted the inaugural event on social eco-informatics, bridging different social and informatics concepts by considering digital domains, social metrics, social applications, services, and challenges. Academic and industrial contributions on algorithms, mechanisms, models, services dealing with challenges in social eco-systems were submitted.

The systems comprising human and information features form a complex mix of social sciences and informatics concepts embraced by the so-called social eco-systems. These are interdisciplinary approaches on social phenomena supported by advanced informatics solutions. It is quit intriguing that the impact on society is little studied despite a few experiments. Recently, also Google was labeled as a company that does not contribute to brain development by instantly showing the response for a query. This is in contrast to the fact that it has been proven that not showing the definitive answer directly facilitates a learning process better. Also, studies show that e-book reading takes more times than reading a printed one. Digital libraries and deep web offer a vast spectrum of information. Large scale digital library and access-free digital libraries, as well as social networks and tools constitute challenges in terms of accessibility, trust, privacy, and user satisfaction. The current questions concern the trade-off, where our actions must focus, and how to increase the accessibility to e-Social resources.

We take here the opportunity to warmly thank all the members of the SOTICS 2011 Technical Program Committee, as well as the numerous reviewers. The creation of such a broad and high quality conference program would not have been possible without their involvement. We also kindly thank all the authors who dedicated much of their time and efforts to contribute to SOTICS 2011. We truly believe that, thanks to all these efforts, the final conference program consisted of top quality contributions.

Also, this event could not have been a reality without the support of many individuals, organizations, and sponsors. We are grateful to the members of the SOTICS 2011 organizing committee for their help in handling the logistics and for their work to make this professional meeting a success.

We hope that SOTICS 2011 was a successful international forum for the exchange of ideas and results between academia and industry and for the promotion of progress in the area of Social Eco-Informatics.

We are convinced that the participants found the event useful and communications very open. We also hope the attendees enjoyed the historic charm of Barcelona, Spain.

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Mobile Applications for Ethical Consumption - Metrics and Frameworks

Stephanie Watts
Dept. of Information Systems
Boston University School of Management
Boston, MA
swatts@bu.edu

***Abstract*—Mobile smartphone applications are becoming available in the service of ethical consumption. Ethical consumption occurs when consumers are empowered with sufficient information about firm behavior to make their purchases in consonance with their own ethics. Such tools vary in the transparency of the data they rely on to deliver ethical information to users, from those based on rich, complex but proprietary data sets, to those based on parsimonious but transparent, public-domain data sets. This paper presents a theoretical framework for understanding the potential impacts of these differences, and provides an example of what the metrics in a transparent, public-domain data set might look like. Such applications have the potential to substantially increase the role of the public in supporting ecology and social justice.**

Keywords- mobile computing, smartphones, transparency, ethical consumption, corporate social responsbility.

I. INTRODUCTION

Consumer citizenship [1] is becoming increasingly important as individuals seek to consider the impact of their purchasing choices on wider society and the environment [2]. The 2008 ethical purchasing index published by the U.K.'s co-operative bank reports both growing support for ethical products and services, and also large losses to brands due to consumer boycotts. The ethical consumption movement is growing, perhaps not coincidentally at a time of high levels of distrust in business. In the U.S., a 2008 Gallup survey found that 47% of consumers say they have "very little or no" trust in business [3]. A 2009 survey by AccountAbility in the U.K. found that over half the public (56%) say businesses themselves must be accountable for their own behavior, but only 6% of people trust them to do so. This is problem for business, since good stakeholder relations enable firms with superior financial performance to sustain this for longer and help poorly performing firms recover more quickly [4]. Large consumer product organizations have spent billions on branding over the past decade, the primary purpose of which is to build consumer trust. For a public distrusting business, the possibility of collective engagement through ethical consumption offers an alternative path: A market-based approach to achieving the benefits of socially responsible commerce, such as better environmental stewardship and a strong middle class. Fundamentally, the more that companies practice corporate social responsibility (CSR), the more they will reap the documented benefits of CSR, such as fostering consumer and employee engagement [5], enhancing corporate reputation [6], and increasing profits [7][8].

The increased accessibility of information about global concerns has amplified consumer activism [9]. Controversies surrounding business practices are increasingly disseminated via the internet, resulting in better informed consumers [10]. The Internet enables consumers to overcome many of the information asymmetries that characterize traditional consumer markets, and to obtain high levels of market transparency. Communication technologies enable consumers to more easily act collectively to impose sanctions on firms via exit and voice, and to play an active role in influencing business practices [11]. As a result, increasing numbers of consumers are seeking to engage and influence corporate behavior through their actions in the marketplace, responding to reports of questionable practices such as environmental pollution, child labor, and/or animal welfare abuse. This reflects consumers' understanding that their collective buying power is significant and can exert economic pressure. In one modeling study, economic pressure from consumers on companies and brand owners was found more likely to lead to improved workplace conditions than socio-political pressure [12], and there is no reason to believe this does not extend to other ethical business practices. One of the reasons that there is little research in this area is that until very recently, even the Internet had not made it easy and convenient for consumers to shop with their consciences. Information on corporate behavior available on the Internet is vast, complex, and can be of questionable validity. Such information is rarely easy or convenient to use at the point of purchase, and many areas of consumer concern are characterized by a lack of effective labeling and the "greenwashing" of negative activities by firms themselves. The inconvenience to consumers of applying CSR information to their everyday purchasing behavior has been cited as the cause of the 'values-action' gap, wherein 30% of consumers report that they are very concerned about ethical issues, yet the market for ethically-produced foods remains at 5% [13]. The advent of mobile smartphones is changing this situation, providing convenient, easily accessible information about business practices to consumers at the point of purchase. Smartphones such as Apple's iPhone and Google's Android are poised to significantly alter information asymmetries in consumer markets more effectively than the Internet has been able to thus far. Smartphone users downloaded 2.4 billion applications in 2009, and are predicted to download 7

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billion in 2013 [14]. There are currently over 50 iPhone applications in distribution that address the needs of green consumers. For example, Greenopia by Geodelic Systems and GreenMap by Green Map Systems utilize GPS technology such that users can locate green businesses when traveling. Applications such as CarbonCalc by Carbon Harmony, and ClimateCounts provide tools to help users reduce their carbon footprint. What's on My Food by the Pesticide Action Network, Shop No GMO by Mark Rainbow, and Cruelty Free by Symbiotic Software enable consumers to identify which products are free of pesticides, genetically modified ingredients, and animal testing during development, respectively. Such applications are distinguished by the industries, products and practices they provide information about, and by the consumer markets they aim to serve. Almost all are available for free or a nominal fee on the iPhone and will soon be available on other platforms. We refer to these applications as Mobile Technology-enabled Ethical Consumption (MTEC) tools.

Armed with a smartphone and free software downloads, consumers can now swipe the barcode of a product in a store and quickly and easily find out information about the product and the company that produced it. In this way consumers can choose to buy products produced by companies whose practices are consonant with their values. Used en masse, these tools give consumers the power to reward good companies and punish bad ones, using their collective purchasing power to create market mechanisms that motivate ethical corporate practices. In a 2009 BBC News poll of 14,500 people in 15 countries, more than half said they were "active ethical consumers". In the hands of large numbers of consumers, smartphone applications are making previously private information public and altering companies' ability to exploit information asymmetries. Business leaders are noticing this trend: The April, 2010 issue of the Harvard Business Review explains how the new transparency is changing the landscape of business [15]. The impacts of this new technology-enabled consumer phenomenon on society and business are potentially very positive, yet largely unknown. Such positive impacts – public empowerment, increased profits, environmental stewardship, less worker exploitation, sustainable development, etc. – depend on the widespread adoption of the information delivered by these technologies, and the validity of that information. It takes large numbers of ethical consumers to alter market share through ethical consumption. However, the movement is small right now and it is not clear how or whether it will succeed in motivating companies to practice more ethically. This research presents a theoretical framework for understanding differences among MTEC tools, on the basis of the type of data they use to present information to consumers. It then presents an example of a data index that illustrates the potential role that data transparency might play in the adoption of ethical consumption.

This paper is structured as follows: We begin by reviewing prior research in the domain of ethical consumption, and make the case that dual-process theories of human cognition can increase our understanding of this phenomenon. Next we present our theoretical model, followed by a description of the index that we are working to embed in our MTEC application. We conclude with a discussion of the importance of such applications for furthering ecology and social justice.

II. REVIEW OF PRIOR RESEARCH

The bulk of the empirical research on the impacts of the ethical consumption phenomenon comes from the marketing departments of business schools. These researchers investigate the effect of corporate social responsibility (CSR) information on consumers' intent to purchase and willingness to buy products produced ethically. Using survey methods, marketing researchers have established that what consumers know about a company can influence their beliefs about and attitude toward new products manufactured by that company [16]. Consumers' positive perceptions of a company's social responsibility have a positive impact on their purchase intent for products produced by that company [17]. Consumers' intention to buy a product increases when the product complies with ethical and social requirements (Fair trade products in this case) and the company has an acknowledged commitment to protect consumer rights and interests [18]. The question of how CSR information affects consumer purchase intent is an important one, and these results are encouraging. However, these studies do not take into account the role of MTEC tools on this process. By making ethical consumption information available at the point of purchase in the grocery store, well-designed MTEC tools can provide accurate, transparent information to consumers in a convenient form – with a swipe of the bar code. This capability is what is *new* about ethical consumption, and why new approaches to understanding this phenomenon are called for. Further, CSR affects both consumers' intent to purchase and their intent *not* to purchase. The marketing research in this domain does not investigate the impact of CSR on non-purchasing, and collective non-purchasing behavior is an important driver for motivating ethical business practices.

For these reasons, and because of the potential for important widespread impacts of MTEC tools on the ecological and social justice practices of corporations, non-marketing-based theoretical approaches to this phenomenon are called for. Our theoretical model applies the widely accepted body of dual-process cognitive theory to the problem of understanding consumer adoption of CSR information via MTEC tools. Dual-process cognitive theories describe the conditions and processes that take place when people accept new information as valid or discount it as invalid. These theories distinguish between two basic ways that individuals' process information: systematically and heuristically. *Systematic processing* involves scrutinizing the argumentation of new information and analyzing it in the context of what is already known, in order to judge its validity. Performing this detailed analysis

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demands and consumes cognitive capacity [19], [20]. *Heuristic processing* is defined as the application of learned procedural knowledge structures –heuristics– to informational cues during assessment of received information [20], [21]. In general, both processing modes occur concurrently and exert interdependent effects on judgment [21], [22]. The dual-process paradigm evolved out of the early attitude change research of social psychologists such as McGuire [23]. The Heuristic Systematic Model (HSM) [20], [21] and the Elaboration Likelihood Model (ELM) [19] are the most renowned variants of this perspective. ELM has been widely adopted by marketing researchers in order to understand what makes information most persuasive. However, because the paradigm also applies to validity-seeking processes in general, the dual-process theories have been used to investigate a wide variety of phenomena. Examples include studies of risk perception [24], auditor performance [25], and price search behavior [26]. For understanding adoption of computer-mediated information, Watts-Sussman has investigated information adoption when it is mediated by email [27], [28], online communities [29], voicemail [28], decision support systems [30], and videoconferencing [31]. This research extends this work to the phenomenon MTEC tools.

III. THEORETICAL MODEL

HSM was developed to apply to validity seeking settings in which people are primarily motivated to attain accurate views consonant with relevant facts [21]. In this study we are interested in knowledge adoption in the context of ethical consumption, and because this is a validity-seeking context, we utilize the theory and terminology of HSM throughout this paper. Such models are particularly appropriate for investigating how people process mediated information, as follows: Systematic processing is relatively unaffected by information delivery medium, since people are able to access argument content regardless of how it is delivered (i.e., email and face-to-face do not differ significantly in their ability to deliver *explicit* content). However, available heuristics can vary widely across mediated communication modes. Heuristics are informational indicators other than the content itself that people use to assess content. A potentially infinite number of these heuristics exist in interpersonal communication contexts [32]. For instance, in groups people are influenced by consensus cues and attributes of the group leader such as charisma. Individually, people often use heuristics pertaining to an information source, and can be influenced by an information source's attractiveness, likeability, and credibility [19]. While face-to-face interaction provides the many peripheral cues that enable us to establish a shared context [33], we know that peripheral cues do operate in computer-mediated contexts [34]. For example, people use cues to delete e-mails they receive without scrutinizing the arguments they contain or even reading them at all. Because it is a widely accepted body of cognitive theory that has been successfully applied to computer-mediated communication contexts in the past, this research uses the HSM to investigate information adoption processes in the context of ethical consumption. The model in Figure 1 below from Sussman and Seigal [27] was used to show that the process of email-mediated information adoption follows the dual process paradigm, such that source credibility functions as a peripheral cue and affects the perceived relationship between argument quality and information usefulness, ultimately affecting information adoption.

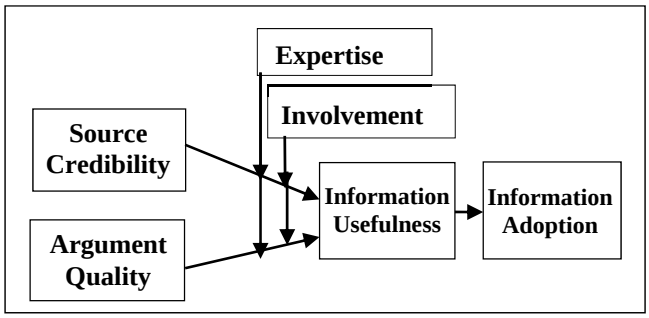

Figure 1. Information adoption of email-mediated advice

This theoretical framework is appropriate for understanding the process of how people adopt the information delivered to them via MTEC tools:

- Information adoption is positively associated with information usefulness.
- Perceived information usefulness is a function of both the systematic processing of argument quality and the heuristic processing of source credibility cues.
- The relative influence of argument quality and source credibility is moderated by both the information recipient's domain expertise and his involvement in the information topic, consistent with the dual-process theories.

However, this model does not help us distinguish between tool designs. It is important to do so, since the design of these tools embeds in them availability of certain heuristics, which in turn affects how the information they provide is processed by the user. In order to adapt this body of theory to technology-mediated ethical consumption, we propose that the construct of data transparency is particularly important in this context, providing a means for distinguishing among different designs of these tools, and therefore should be included in the validated model of information adoption above. *Data transparency* – the degree that the user is able to self-validate the information provided by the tool – increases source credibility. Data transparency is a technical design factor that designers can optimize in the tool, or not. To the extent that the user is able to independently confirm the validity of the information provided by the tool, the source of the information is more credible than if the user is not able to independently confirm its validity. Thus:

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P1. Higher data transparency is associated with higher source credibility, which is in turn associated with higher information usefulness and adoption.

P2. Information provided by MTEC tools with higher data transparency is more likely to be adopted by users than information provided by tools with lower data transparency.

P3. This effect is likely to be more pronounced among users that are less trusting of online information validity.

The dominant MTEC tool in the United States is GoodGuide. For its data source, GoodGuide uses the output of research and analysis firms produced for the purpose of socially responsible investing. The data sets created by these companies are extremely thorough; many are based on over 600 indicators. Such extensive research and analysis is expensive, and the companies that create them sell these data to institutional investors who can afford to pay high subscription fees. Because they are expensive to create and maintain, these data sets are proprietary, which reduces the data transparency of the MTEC tools delivering information based on these data. In order to produce MTEC tools with high data transparency, we propose the creation of metrics based on non-proprietary data, analogous to the concept underlying the United Nation's Human Development Index (H.D.I). The H.D.I. ranks countries according to only three simple indices: a nation's G.D.P., its citizens' education, based on adult literacy and school-enrollment data, and its citizens' health, based on life-expectancy statistics. The advantage of the H.D.I. is its transparency, parsimony and corresponding simplicity, but this simplicity comes at a sacrifice of data richness and nuance, a limitation that H.D.I. researchers are working to address. We suggest that a parsimonious, transparent index of CSR behavior can be developed that will increase user adoption of the information provided by MTEC tools. Below we propose one such index based entirely on data in the public-domain. Note that it applies to publicly held corporations only, since privately held companies are not required to disclose some of the metrics that the index is based on.

IV. TRANSPARENT CSR INDEX

On the basis of data availability, we suggest three sub-metrics for this index: unproductive spending, environmental sustainability, and local job creation. First, corporate spending patterns indicate the capacity of a corporation to internalize costs that it has externalized to society and the environment. Companies that spend their earnings wisely have more funds available for improving environmental and social performance than do spendthrift companies. For this reason we identify four categories of large business expenses that are widely accepted in the corporate world, but that common-sense and history suggest are unproductive use of funds: excessive advertising, excessive long-term debt, high executive salaries and bonuses, and government lobbying. In most developed countries, these data are publicly available in financial reports that public corporations are required by law to file. Most large corporations are headquartered in these countries, since they tend to have stable economies. For example, according to this sub-metric described in detail below, the Kraft Corporation spent $1.5B in 2009 on unproductive spending in these four categories, but only made $3B profit on $40.4B in sales revenue. Thus for this company, unproductive spending amounted to about one half of its 2009 profits, and suggests that if companies were to cut back on these unproductive expenses they could afford to do the right thing by their workers, communities, and the environment.

A. Metrics of Unproductive Spending

While all companies need to advertize, a number of corporations spend more than half their profits on advertising. Socially responsible companies of the future will choose to spend less on advertising and PR, choosing instead to spend these dollars on things like good wages and benefits for their workers, environmental management systems, philanthropy, etc. This has the direct effect of doing good works, and also the indirect effect of generating positive perceptions of the company, which in turn drives sales. Nor does advertising get high grades for its impact on society in general and on children in particular. Advertising affects our cultural understanding of what is valuable and can fuel materialism, consumption, superficiality, and insecurity [35]. Advertising to children can create frequent conflicts for families when children pressure their parents into buying things that they can't afford, exacerbating the debt burdens of working families. For these reasons we contend that spending *excessively* on advertising and PR is an unproductive use of corporate earnings, relative to the environmental and social good that could come out of spending those funds more wisely. Thus one metric of this proposed spending index is the amount that a corporation spent on advertising the previous year as listed on their 10K, above an amount equal to 20% of the profit they reported that year. This is an arbitrary designation reflecting the value judgment that spending more than 20% of profits on advertising is unproductive relative to other potential uses of those funds.

Another area that U.S. companies spend trillions on annually is debt financing. Corporations take out loans to finance things like new buildings and production facilities, company acquisitions, and stock buy-backs, and then pay interest on these loans. Clearly, such borrowing is necessary and desirable, to a point. However, companies that borrow *too much* spend unproductively on interest payments. High levels of debt financing constrain managerial choice because interest on this debt must be repaid on a contractual schedule. Companies with high levels of debt do not have the financial flexibility to react effectively to unforeseen costs, for example the costs of an environmental accident or new labor demands. Socially responsible companies keep their debts to a reasonable level so that they can pay them

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off without having to cut spending in other important areas. Consumers and governments work to practice restraint in accumulating debt, and well-governed corporations do likewise. The value of limiting to a reasonable level the amount of debt a corporation takes on seems self-evident to those outside of the financial industry: if consumers and governments are expected to practice such fiscal restraint, it seems reasonable to expect corporations to practice it as well. Thus the second metric of our index uses the ratio of long-term-debt to capitalization. Capitalization refers to how much the company is worth on the stock market and so is an indicator of net worth. For the purposes of this index, and based on conversations with financial experts at ethical investing firms, we suggest this ratio shouldn't be higher than 20%. Clearly startup companies naturally need higher debt margins, but this metric is for large established corporations that have already grown to a massive size. Thus we count 5% of the long-term debt that exceeds this ratio, as an approximation of the costs to finance this excessive debt. Note that this figure does not include funds spent on research and development, so this metric should not impede the corporate capacity to innovate.

It is widely acknowledged that many companies spend large sums paying their top executives disparately large salaries and bonuses. This occurs regardless of whether the firm is currently laying-off workers, cutting benefits, or paying subsistence wages. Clearly top executives should be paid well, but there are negative consequences to the organization when they are paid hundreds of times more than their employees. High levels of executive compensation are associated with high employee cynicism, which in turn reduces employees' organizational citizenship behaviors and increases the chances that they will agree to engage in unethical behavior such as workplace sabotage (Andersson & Bateman, 1997). Indeed, wide disparities in corporate pay scales can directly and adversely affect the value of the firm (Thomas, 2003), due to a variety of effects such as lower employee productivity, higher turnover, and higher absenteeism. Thus companies that pay their executives disproportionally not only incur the direct costs of paying these high sums, but also a variety of indirect costs that can have a negative effect on the bottom line. For these reasons, we suggest that companies that pay *unreasonably* high levels of executive compensation are spending this money unproductively, since this money could be more productively and responsibly spent in other ways. Thus the third metric of our spending index is total the amount paid out to top executives in compensation and bonuses the prior year, above $3M for each executive, as listed on the Summary Compensation Table of the DEF 14A Proxy statement that corporations are required by law to disclose. This is an arbitrary designation: Many executives may view $3M as a paltry salary, but their employees earning $15 per hour would probably find it acceptable. More research needs to be conducted on what an optimal amount would be, one that is high enough to attract and retain leadership talent, but not so large as to incur the negative effects on employees and firm value discussed above.

The final area of unproductive corporate spending that we propose for this index is government lobbying. Corporate revenues exceed the GDP of most governments. In the U.S., companies spent $3.49 billion on Federal lobbying in 2009 [36], an average of over $6.5 million per congressperson. Clearly this gives corporations a lot more power to influence what legislation gets implemented than most individuals have. The governments of the European Union, Scandinavia, Brazil and Japan all do a better job of protecting their citizens from the effects of cost externalization than the U.S. government does [37], partly because they have stricter controls on lobbying. Companies that spend excessively on lobbying are using their financial power to influence legislation, a practice that Adam Smith and many other organizational theorists since are against. Lobbying is not a productive use of earnings relative to other socially responsible spending opportunities. Thus the final element of our proposed spending index is the total amount a firm spent on Federal lobbying the prior year, which companies are required by law to disclose. This has the disadvantage of not accounting for the size of the company. However, when politicians vote in congruence with lobbying efforts, it is the total dollars spent that are influential, regardless of company size.

According to this proposed metric of corporate spending, the 2009 Kraft corporation example above breaks down to $1.04 billion spent on excessive advertising, $431 million spent to finance excessive long-term debt, $37.1 million on excessive executive compensation, and $3.39 million on Federal lobbying, for a total of $1.52 billion dollars. This is a lot of money, relative to the $3,021 million in profit they made the same year, and certainly could have been spent in more socially and environmentally productive ways.

B. Non-financial Indices in the Public Domain

Public-domain indicators of a corporation's environmental record and sustainability initiatives are obvious candidates for such an index, although they vary according to local regulatory requirements. The U.S. government-mandated Toxic Release Inventory – toxic releases plus toxic wastes – reflects a transparent indicator of corporate environmental behavior that is in the public domain in the United States. Another indicator we might include in this index addresses the issue of job off shoring and the deleterious effects it is having on the economies of more advanced countries. As the economies of many wealthier countries become increasingly bifurcated due to reductions in the size of their middle classes, fewer and fewer citizens have the financial resources to use anything other than price to inform their purchasing decisions. This situation supports and maintains those companies that produce cheap products by taking advantage of lax

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regulatory oversight in lessor developed countries (LDCs). It also has deleterious consequences within the economies of developed countries as increasing rates of poverty give rise to higher levels of crime, domestic violence, underground economies, and corruption. We use the United States to describe a proposed metric comprised of two ratios, but it is applicable to any country: For every million dollars spent by Americans and recorded as U.S. sales by a corporation (i.e., U.S. sales), that corporation supports X jobs in the U.S. For every million dollars spent by non-Americans as reflected in non-U.S. sales reported, this corporation supports Y jobs. The ratio of X to Y shows the extent that the company supports more jobs overseas than they are in the U.S., for the same sales dollars spent by consumers, where the lower this number is the better. The higher this number, the fewer U.S. jobs the company supports per dollar of U.S. sales. For example, companies whose sales are primarily generated in the U.S. and who locate their jobs primarily in the U.S. will have a very low score for this. Companies whose sales are generated in the U.S. but who rely heavily on foreign labor will have a very high score on this. This data is publicly available since corporations are required to release it for tax reporting purposes.

A final metric that we would like to see in this index would be a measure of supply chain transparency. This is an extremely important issue for development policy, since most of the environmental and human rights violations by businesses in LDCs are perpetrated not by large corporations themselves but by their smaller local suppliers. Often we have accurate information about what local companies are doing, but since transnational corporations are not required to disclose their supply chain partners, they cannot be held accountable for these violations. And while many of the large multinational corporations have policies that ostensibly prohibit them from trading with unethical suppliers, it is very difficult and expensive to monitor supply chains effectively. For this reason, until we have mandated disclosure of supply-chain partners, we lack a public-domain metric in this important area.

V. CONCLUSIONS

The emergent phenomenon of MTEC tools have the potential to fuel widespread ethical consumption, where consumer choices in aggregate provide a market-based mechanism for motivating corporate social responsibility. But, the achievement of this potential depends on widespread adoption and use of the information provided by these tools. This research contributes a theoretically-driven model for understanding the important role that data transparency can play in designing MTEC tools for optimal adoption. In service of this model, we propose a parsimonious, non-proprietary index of corporate social responsibility that consists of three sub-metrics – unproductive spending, environmental sustainability, and local job creation. We hope to encourage debate and discussion about both the idea of such an index, and what an optimal form of it would look like. We hope that, over time, firms will see the value in improving their performance in areas measured by this index. In this way, MTEC tool-supported ethical consumption can become a significant driver supporting the needs of civil society.

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Why Numbers, Invites and Visits are not Enough: Evaluating the User Experience in Social Eco-Systems

Lynne Hall, Colette Hume
Department of Computing, Engineering and Technology
University of Sunderland
Sunderland, SR6 0DD, United Kingdom
{lynne.hall, colette.hume} @sunderland.ac.uk

Abstract — **Social eco-systems are often evaluated through quantitative data that is automatically logged and analysed. However, where the user's experience of social eco-systems is evaluated, more explicit intervention approaches are typical, with questionnaires, focus groups and user testing widely used, directly asking the user about their experience. User experience evaluation thus ruptures the social eco-system, occurring as a separate, discrete activity outside of that system. In this paper, we propose that evaluation should be part of the social eco-system adding value to the user experience. We outline an evaluation approach that has been applied within games-based learning environments where the evaluation is seamlessly embedded. We briefly outline our approach to generating and analyzing data highlighting its potential for social eco-system evaluation.**

Keywords-evaluation; user experience; analysis of user-generated content.

I. INTRODUCTION

It is widely recognized that the impact of social eco-systems requires further consideration, with relatively few studies or empirical investigations. Social eco-systems typically involve enjoyable and often affective interactions within a user-chosen context. The user's interaction focus is primarily recreation, enjoyment or problem solving in relation to a social need. Yet, how can we evaluate or understand the impact of that interaction on an individual or societal level? And more, if we do try to evaluate it, can we do this without having an experimenter effect, even if that "experimenter" is an anonymous on-line survey.

Users are only vaguely aware and in general don't seem to care about the collection of usage statistics. Thus, statistics can be endlessly calculated relating to the number and frequency of visits, invites, postings and so on, without any impact on the user. However, evaluating the user experience is more challenging, requiring conscious user input, rather than logging of actions.

Unlike the integrated usage data collection, the user experience evaluation of social eco-systems is typically a separate, discrete activity to the main use of the system, with questionnaires, focus groups and user testing widely used. User experience evaluation thus changes the dynamic of the social eco-system, placing the user in the role of evaluator rather than social network member.

In this paper, we propose an alternative to this discrete, separate approach to user experience evaluation. Instead of separating out evaluation and changing the role of the user, we have developed an approach that enables us to evaluate the user experience without users being aware that they are taking part in an evaluation. This approach has considerable relevance to the evaluation of social eco-systems, meeting two key success factors for social networks:

- Evaluation should be invisible and should have no (as achieved with usage statistics) or a positive impact on user activities
- Add-ons (e.g. evaluation instruments) to the social eco-system must be integrated and add value to the user experience

In this paper, we briefly outline our approach to the generation of evaluation content and discuss our proposed approach to the analysis of this content. Our key focus is how to mask the evaluation experience so that the user is unaware of their evaluation input whilst generating data useful to an interdisciplinary research and design team. This approach has been successfully applied and we believe that it offers potential for other developers and researchers to evaluate social eco-systems. Section 2 briefly discusses social eco-system evaluation, highlighting the focus on commercial factors and the relevance of these to user experience evaluation. Section 3 discusses our approach to user experience evaluation, outlining our approach and its application to two systems. Section 4 discusses our approach and considers its potential for evaluating social eco-systems. Section 5 concludes that this approach has considerable relevance to supporting and improving the user experience of evaluation.

II. EVALUATING SOCIAL ECO-SYSTEMS

There has been a massive growth in commercially supported social eco-systems. The marketers, quite rightly, recognize that supporting an on-line community will increase brand loyalty and sales. Through allocating significant resources to on-line activity, some companies have established high quality, effective social eco-systems, with significant user presence. The purpose of these social eco-systems is to enable companies to achieve their business

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goals. Thus, in the evaluation of such commercially derived social eco-systems the evaluation issue is not really user experience and social impact, rather it is the company's Return On Investment (ROI). This ROI includes the social eco-systems impact on: developing brand loyalty, thought leadership, reducing operating costs, optimizing marketing budgets, and increasing profits [1].

With the aim of demonstrating ROI, much of the evaluation in social eco-systems is achieved using logged user interactions. For example, the number of invites made by a user; frequency of postings; and number and type of interactions within the social eco-system. There are many tools available to log and analyse user interactions, with such functionalities increasingly provided as standard in site development products. However, whilst tools can be used as a basis to calculate a range of quantitative measures such as visits, social graph, social surface area, etc. their insight into the direct user experience is limited. Whilst such numerical data can enable us to determine the strength, sustainability and growth potential of the social eco-system, it does not allow us to explore the user experience itself.

There are considerable challenges for user experience evaluation of social eco-systems, with users often geographically dispersed and having limited real world interactions. In response to this, techniques have been developed for both virtual and real world evaluations. However, the majority of these require additional user input, often with the user role changing from member, player, commentator, etc. to a critic, tester or evaluator.

Whilst engagement in user experience evaluation can offer positive benefits to participants, for example, early access to new features, input to development, status within the network, etc., many users choose not to participate in evaluations. Thus, unless participation in evaluation activities is mandated (e.g in a fiat system [2]), the participants self-select thus providing only a partial view of the user experience of the social eco-system. Further, where participation in evaluation activities is mandated, users can view evaluation as a burden [3].

In considering the evaluation of the user experience in a social eco-system, it is not the issue of usability that is key. There are a whole variety of half-hearted attempts by companies and organisations to create social eco-systems. From these, we know that if the usability is poor that unless the environment is incredibly compelling, then users will go elsewhere. Instead, it is the user's personal, social and emotional experience that requires evaluation to enable us to explore the impact of social eco-systems.

III. EMBEDDING EVALUATION IN THE USER EXPERIENCE OF SOCIAL ECO-SYSTEMS

Our approach to evaluation has been developed within the EU FP6 eCIRCUS [4] and FP7 eCUTE [5]. Both projects have focused on technology enhanced learning for significant social issues, including bullying and intercultural conflict. In this paper, we discuss our evaluations with the ORIENT [5] and MIXER [6] showcases, outlining our approach and highlighting the potential for its use with other social eco-systems.

Our research has focused on evaluating a specific type of social eco-system: technology enhanced learning through interaction in intelligent computer assisted role-play environments. In our experiences of designing, developing and evaluating our showcase applications, we have dramatically changed our approach to evaluation. Rather than evaluation being conducted as a discrete, separate activity to the interaction, we now add value through seamlessly embedding evaluation into the user experience. The impact of this is that users are unaware they are taking part in an evaluation. In addition, the results from this evaluation have been of considerable use to the interdisciplinary development team.

To enable us to evaluate our showcases, users are actively engaged in the individual and communal generation of real world artefacts and digital assets. Critical to the success of our approach is for users to be aware of, and participate in the social eco-system provided through our environment. We artificially create a temporary social eco-system for a specific showcase and its participating users. Whilst we have to stimulate users into creating assets, in many social eco-systems a plethora of such user-generated content exists or could easily and enjoyably be developed meeting the requirements of the evaluation and improving the user experience.

However, having extensive data or content is insufficient without a viable analysis approach. Analysing the content is complicated by a multiplicity of formats and the challenges offered by non-textual assets. Our evaluation approach uses a range of techniques and tools for content analysis, with approaches derived from information retrieval research transforming the content into usable data.

The following examples briefly outline our approach to generating and analyzing user experience data.

A. ORIENT: Seamlessly embedding evaluation into the user experience

ORIENT provides users with an intelligent computer assisted, semi-immersive, graphical role play environment depicting an imaginary culture, the 'Sprytes.' It is aimed at teenagers and young adults who interact in groups of 3, taking roles in Space Command (a benevolent United Nations type of organization with a galactic focus) with the goal of helping the Sprytes to save their planet from imminent destruction. ORIENT's learning focus is cultural understanding and sensitivity.

The characters, the Sprytes, inhabiting this world are autonomous agents, based on an extension of the FAtiMA agent architecture [7]. Emotional appraisal is based on the OCC cognitive theory of emotions [8] extended by incorporating aspects of a needs driven architecture, PSI [9]. To enable cultural adaptation of the agents, Hofstede's cultural dimension values were added to the agent minds for the culture of the character; cultural specific symbols; culturally specific goals and needs, and the rituals of the culture [10].

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Users interact with the Sprytes using a Wiimote to provide gestures and speech recognition of character names. They interact with the ORIENT world using a scanner phone with an RFID reader. Additionally, the users are provided with the ORA-CLE (Onboard Resource Agent - Cultural and Liaison Engagement), a mobile phone based embodied conversational agent whose role is to support the users in their interaction. Figure 1 provides an overview of ORIENT's main components. At the core of the system is the virtual world model that is presented to the user as 3D graphics on a large screen, in front of which the users interact with ORIENT as a group.

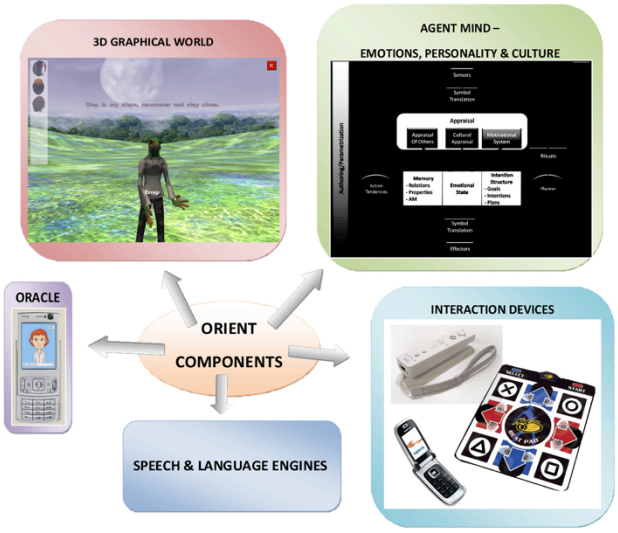

Figure 1. ORIENT Overview

Developed as part of an interdisciplinary project, the evaluation aimed to investigate the effectiveness of ORIENT in fostering cross-cultural acceptance through the promotion of collaborative practices and the appreciation of similarities and differences between cultures. From the technical perspective, evaluation focused on the coherence and comprehensibility of the narrative; the believability and credibility of the agents that underpin the characters; and participant engagement with the cultures of ORIENT and the Sprytes themselves. With the interaction approach, we focused on evaluating the participant's views of the impact of unusual interaction devices and mechanisms, focusing on device usability and user satisfaction with unusual interaction mechanisms. This resulted in a wide range of purposes and instruments required for the evaluation.

Even though we needed users to participate in an extensive evaluation, our goal was for players to have only one consistent experience that of being a player in a role play game. To achieve this we transformed traditional and/or well established data gathering instruments into 'in role' counterparts. These were then embedded into the role play and reinforced with supporting artifacts. Each instrument was given archetypal branding (adding value to the role play context) and an age appropriate format and aesthetic (meeting user expectations), see figure 2. The resulting battery of piloted instruments aimed to add maximum value to the over-arching role playing game while collecting key evaluation data to help developers assess the user experience from a number of theoretical perspectives.

Figure 2. Evaluation Instruments

This approach was very successful in generating data from users about their experience, with the interesting side-effect that users were completely unaware where the game stopped and the evaluation started. The evaluation instruments and activities are effectively seamless and thus data captured in a way that is invisible for the user. Rather than the evaluation instruments and supporting artifacts adding a burden to the user, they seemed instead to enhance the game, actually increasing the immersion and enjoyment of the users. The data and content produced through the user interactions was analysed using qualitative and quantitative analysis techniques and are further discussed in [11].

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B. *MIXER: Opinion and sentiment: approaches to analyzing user generated content*

With ORIENT, the majority of the user-generated content was achieved through specially prepared instruments many of which were hard copy. With the ongoing development of our evaluation approach, we are focusing on the generation of digital assets. Our exploration of the generation and analysis of digital assets is currently focused on MIXER [6]. This application aims to provide 9-11 year olds with classroom-based, technology enhanced learning experiences related to cultural conflict. This context for MIXER is provided by Hide & Seek where participants may be characters or other users and where conflict is typically a result of rule misunderstandings, based on Hofstede's cultural dimensions [10]. Figure 3 provides some frames outlining the MIXER narrative.

Our evaluation is focused both at children and teachers as achieved through their interactions with MIXER and their discussing of these experiences. The evaluation is seamlessly embedded into the experience of the application, right from the initial design stage. For example, the frames in figure 3 have been generated as a comic book. Into this comic book (which represents the application for the users) we have embedded traditional questionnaires that have been morphed into quizzes and mini-games.

In addition, the comic book is supplemented by an on-line experience, where the users will engage in the generation of blogs, digital AV & photo albums and participation in a tailored social network. Two complementary social networks are used, one for the teachers and the other for the child users of MIXER.

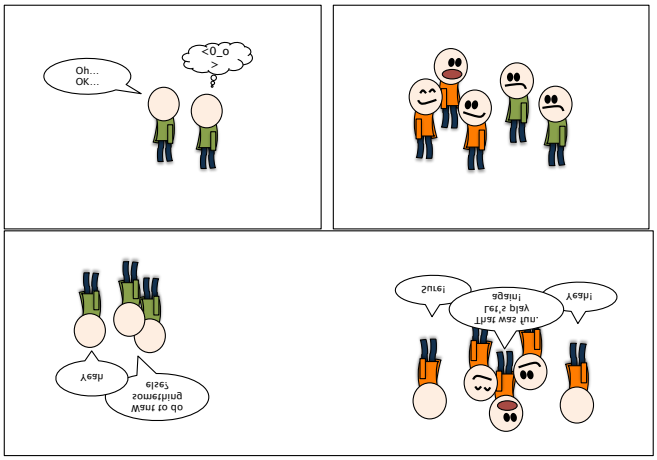

Figure 3: Frames from the MIXER storyboard

During the user interaction, a main focus is gaining an appreciation of the user's Theory of Mind with users prompted with a range of questions which result in the user producing freeform text in the interaction. In addition to this direct input during the interaction users are also involved in generating content in relation to their experience.

An initial study, involving three groups of 9-11 year old children (10 in each group) has recently been conducted to establish user responses to embedding evaluation in MIXER. The three conditions were provided in separate locations. This separation was to ensure that children of one group were not aware of the other conditions' activities. The three evaluation conditions were:

- **Direct evaluation**: children were provided with a non-interactive comic book (just for reading); a work book composed of a series of activities related to the comic book and specifically activities related to Theory of Mind; and a set of questionnaires related to the comic book, attitudes to culture, in-group / out-group, understanding of cultural dimensions
- **Hybrid evaluation**: children were provided with an interactive comic book and asked to write / draw responses (thus incorporating Theory of Mind activities). The workbook (without the Theory of Mind activities) and questionnaires were given as a single item, with the questionnaires embedded in the workbook.
- **Seamless evaluation**: children were provided with a single artefact incorporating the interactive comic book, the workbook activities and the questionnaires. The questionnaires were modified and presented as quizzes and activities using age appropriate aesthetics. The activities and questionnaires were placed throughout the comic book, replicating the approach of magazines for 9-11 year olds.

Observations during the use of MIXER highlighted that children in the Seamless Evaluation condition engaged for longer and were highly engrossed in the workbook and evaluation activities. Children in this condition required very little input or encouragement from the adults present and worked steadily through the entire artefact. More questions and issues were raised in the other conditions, particularly in relation to completion of the questionnaires. In the direct evaluation condition, children were not particularly interested in completing the questionnaires and spent significantly less time with the comic book and Theory of Mind activities, then those in the Hybrid or Seamless Evaluation conditions.

We are currently engaged in analyzing the data generated during this initial MIXER study. Early results indicate that the results from using different versions of the questionnaires are relatively similar across the conditions. This is an expected outcome illustrating that although instruments are modified they are essentially collecting the same data. However, in line with their greater engagement, children in the Seamless Evaluation condition wrote and drew more within the comic book (and the embedded Theory of Mind activities) than the other conditions. Our initial results appear to indicate that improving the user experience of evaluation results in greater user engagement. Current work focuses on further analyzing our data, particularly in relation to the impact of embedding the Theory of Mind within the Comic book.

With MIXER, we are now focusing on the analysis of freeform text and digital (e.g., audio, video, photos)

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contributions. Our key aim in evaluating these user-generated content is to determine personal, social and emotional user experience. As such, we are particularly looking for opinions and affective views within user-generated content.

There is current considerable interest in the evaluation of "opinionated content" such as discussion groups, blogs, tweets, video postings and other methods where people express their views online. Through evaluating relevant user-generated content, it is obvious that companies can gain consumer feedback about their own and competitor's products, thus avoiding the need to conduct surveys, organise focus groups or employ external consultants [12].

A considerable number of statistical measures can help analyse text and automation tools. Through the use of semi-automated methods, we will be analyzing user generated content provided in the MIXER social eco-system. We are currently investigating a range of methods, aiming to find the most appropriate analysis approach for our evaluation purposes. These interdisciplinary evaluation purposes are quite broad, relating to educational, psychological, socio-cultural, interaction and technical goals. Methods we are investigating include:

- Use of base and comparative polar words (e.g., base: "bad", comparative: "worse") enabling the use of statistical measures (e.g., [13]) .
- Seed words and connectives such as AND, OR, BUT, or HOWEVER are being used to find related or contrasting words, as in [14].
- Clustering techniques, such as Factor Analysis are being used to identify word and opinion clusters.
- Named entity recognition (as applied in ontology generation) will be applied, aiming to support co-reference resolution, for example – a pronoun such as "it" might refer to "the game", "MIXER", "the computer," etc.
- Synonym grouping will be facilitated using SenitWordNet (as used by [15])

A key benefit of using sentiment analysis is that it can be used to convert natural language texts into structured data, that can then be stored and manipulated in a database. We will use Liu's approach [12] and store user generated content as a quintuple:

- Object (product, person, event, organisation, topic),
- Feature of that object
- Polarity of the opinion of the holder on that feature of that object
- Opinion holder
- Time when the opinion made by opinion holder

This data can be both analysed statistically and represented visually, supporting a greater understanding of the data. Although we have just begun applying this approach to our analysis of MIXER, early investigations suggest that this will provide a powerful addition to our evaluation approach.

IV. DISCUSSION

The Six Benchmarks for Digital Marketing Strategy [16] have been developed to evaluate the potential effectiveness of social media on ROI:

1. Goal - What is the targeted goal of your advertisement, social media program or campaign?
2. Engage – How effective is the message in attracting or involving your target market?
3. Relationship – Did the message stimulate the target to feel trust or common interests?
4. Value –Does the product or service and related message communicate added benefit for the individual, organization or company?
5. Action- Does the message move you to act?
6. Synergize- Is the tool an add-on to current marketing efforts or is it integrated into the campaign?

Although such benchmarks identify plentiful questions and issues, there is little information about how systems can be evaluated against them. Whilst usage stats will answer some issues, clearly, user experience data has to be both generated and analysed to permit evaluation against these benchmarks.

In this paper, we have proposed an approach to the generation and analysis of user generated content. Our approach differs from many current user experience evaluation approaches. Through focusing both on reducing the visibility of evaluation participation and on adding value through evaluation our approach gains useful data whilst either having no or a positive affect on the user.

Our approach to gathering user experience data involves the use of existing user input formats (e.g. blogs, postings, tweets) and the creation of add-ons (e.g., questionnaires represented as quizzes, mini-games, etc.). Our users are consistently unaware that they are taking part in an evaluation. Results have highlighted that users view the evaluation experience positively, seeing it as a value add rather than a negative. In addition, the interdisciplinary project team have gained results and evaluation data that have been relevant and useful.

Within our approach, we are gathering data in two ways. Firstly, through crafting customized quizzes and embedding questions (from existing traditional questionnaires) in interactions and entertaining activities. And secondly, through viewing user generated content as a primary source of evaluation material. Where possible we avoid technology learning and thus use popular formats, Facebook has already trained most of our users.

Sentiment analysis and opinion mining offer considerable potential for the analysis of user generated content in the evaluation of any social eco-system. Semi-automated approaches can greatly increase the speed of data refinement and analysis. The use of such approaches also provides the data in a format that is relatively easy to visualize, thus allowing greater understanding by development teams and stakeholders.

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Related work focuses on the evaluation of AV and photographic content. With photography we are exploring indexicality to support evaluation [17]. With both photographs and AV content, the critical issue is how to transform the content into analyzable outputs. Initial results suggest that the labels and descriptions frequently generated by users along with non-textual postings may contain sufficient content to analyse the AV without requiring additional data refinement. To further investigate we are exploring the use of meta-tagging, to enable us to compare results from further content refinement with the use of user generated labels and descriptions.

V. CONCLUSIONS

It is possible to create a user experience evaluation that can be completely embedded within a social eco-system. Evaluation instruments and approaches can be crafted to enhance rather than detract from the social eco-system experience. Sentiment analysis and opinion mining transform user generated content into a highly valuable and analyzable data source. The use of this approach allows user experience evaluation data to be gained and analysed as invisibly as usage statistics.

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Agricultural Knowledge Transfer Via Talking Planter

Yosei Isoe
Graduate School of Science and Engineering
Ritsumeikan University
Shiga, JAPAN
cc001071@ed.ritsumei.ac.jp

Yoshio Nakatani
College of Information Science and Engineering
Ritsumeikan University
Shiga, JAPAN
nakatani@is.ritsumei.ac.jp

***Abstract*—The succession of agricultural knowledge has recently grown in importance because of a decrease in the number of agricultural workers in Japan. To aid in solving that problem, this study suggests a framework for use in the succession of agricultural knowledge via a system. More concretely, it involves a method that planter communicates with users and other planters. The content of the communication includes failure information, which has been confirmed to be effective in a previous study.**

Keywords- Knowledge transfer; agriculture; tacit knowledge; explicit knowledge; SECI model.

I. INTRODUCTION

Knowledge Transfer is currently a very important theme and it has been gaining a great deal of attention. The transfer of knowledge issue is being tackled in a variety of scenes, for example, system engineering, artificial intelligence, and so on. However, these approaches involve a number of problems.

This particular research tackles the problem of transferring agricultural knowledge. Agriculture does not involve any corporatization and hence has typically been communicated from parents to their children or person to person over long periods of time. In recent years, however, the number of people who have been changing jobs from corporate employees to farmers has been increasing. As a result, the need for agricultural knowledge to be transferred to them has increased as well. In addition, with the increase of home gardens allowing crops to grow, gardening boom have taken place among young people, and the need for agricultural knowledge to be transferred to them is also increasing[3]. However, as lacking of experience, the transfer of newly increased agricultural knowledge has been taken place via the trial and error process until now. Recently, the possibility of knowledge being shared on a global scale through the new ubiquitous network society has also risen. This study suggests a framework by which novice agricultural workers can access to the knowledge of experienced agricultural workers via the network mentioned above. This study uses, in particular, knowledge gained from past failures and provided by the planters and novice agricultural workers can then share that knowledge. Through the conversation with planters, the novice agricultural workers can gain the knowledge while they are doing the agricultural work. There have been a number of studies and support systems on enabling objects to provide information to the user but this study suggests a new support system specifically concerning the transfer of agricultural knowledge.

Section 2 explains about associated concept of this study. Then, we introduce the previous study in Section 3. Finally, we explain the proposed system in Section 4, and present conclusion and future works in Section 5.

II. ASSOCIATED CONCEPT

A. *Tacit knowledge*

Nonaka defined tacit knowledge to be "knowledge gained from individual experiences or specific situations, which can include intangible elements such as beliefs, views, value systems, and so on" [4]. This concept was a refinement of Michael Polanyi's concept of tacit knowledge [5]. Agricultural knowledge regarding the necessary chores, know-how, and experience gained from failures could be classified as tacit knowledge.

B. *SECI model*

The SECI model was defined by Nonaka and Takeuchi as a knowledge acquisition process used to share tacit knowledge inside a company. This model repeats 4 processes, which are given below.

i . Tacit to Tacit (Socialization)
ii . Tacit to Explicit (Externalization)
iii . Explicit to Explicit (Combination)
iv . Explicit to Tacit (Internalization)

Figure 1 shows the flow of the SECI model.

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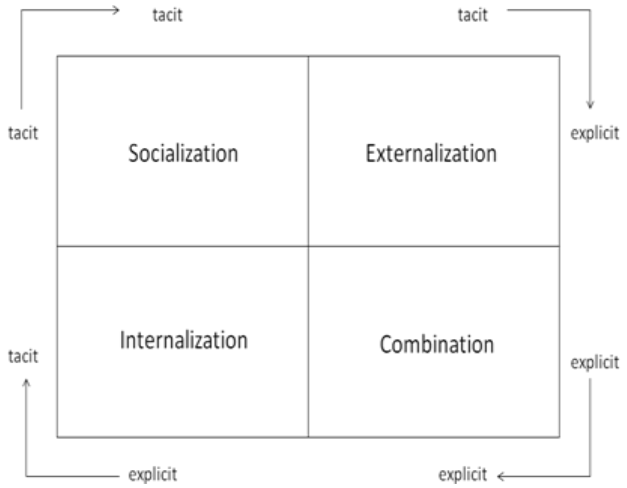

Fig.1 Flow of SECI model

These four processes lead to the creation of new knowledge. The succession of agricultural knowledge can also be classified into the four steps of the SECI model, with examples of each step being as follows.

i . Socialization

Novice agricultural workers work together with experienced agricultural workers. Novice agricultural workers can thus observe them, and then imitate them, learn the techniques of experienced agricultural workers.

ii . Externalization

Novice agricultural workers and experienced agricultural workers note down what they have noticed during agricultural work.

iii . Combination

Novice agricultural workers summarize what they have noted down. In addition, novice agricultural workers also transcribe what was noted down by experienced agricultural workers.

iv . Internalization

Novice agricultural workers work alone without the help of the experienced agricultural workers.

Several studies have been made on transferring knowledge using the SECI model, but have been inadequate. Examples include a "Knowledge Management Support System That Uses Fond Memories in Peer Support Communities of Universities" [6] and "Supporting Knowledge Transfers and Task Scheduling via Use of Ontology" [7]. Some research has also taken place on supporting agriculture. However, there has been almost none on support from the aspect of "Objects that can provide information to people".

III. PREVIOUS STUDY

A. Agricultural Knowledge Transfer

This research is based on the previous research called "Agricultural Knowledge Transfer Based on Experience from Failures" [8]. The previous study supports the transfer of the knowledge that should be transferred as the failure experience through the SECI model. The four processes of the SECI model were used in the system as follows.

STEP1: Socialization

Novice agricultural workers learn the experience gained in failure using the system.

STEP2: Externalization

Experienced agricultural workers or novice agricultural workers with experience gained from failures input the experience they gained from failures into the system.

STEP3: Combination

The rules are made according the failure experience and the time and stored in the system. The system then informs novice agricultural workers using those rules.

STEP4: Internalization

Novice agricultural workers carry out the actual work using the above rules or their own thinking.

The transfer of knowledge has been attempted by repeating the above 4 steps according to the SECI model.

B. System Construction of Previous Study

The flow of the system involves 5 main functions, with an explanation on each and the corresponding SECI model process being given below.

i. Retrieval Failure Experience function (Socialization)
ii. Recommendation of Relevant Failure Experience function (Socialization)
iii. Registration of Failure Experience function (Externalization)
iv. Make rules function (Combination)
v. Information function (Combination)

The system does not actually implement Internalization of the SECI model and instead, novice agricultural workers have to select the right choice before doing the actual work, which therefore plays the role of Internalization in the SECI model.

Figure 2 shows an image of the system and Figure 3 is the main screen of the previous system.

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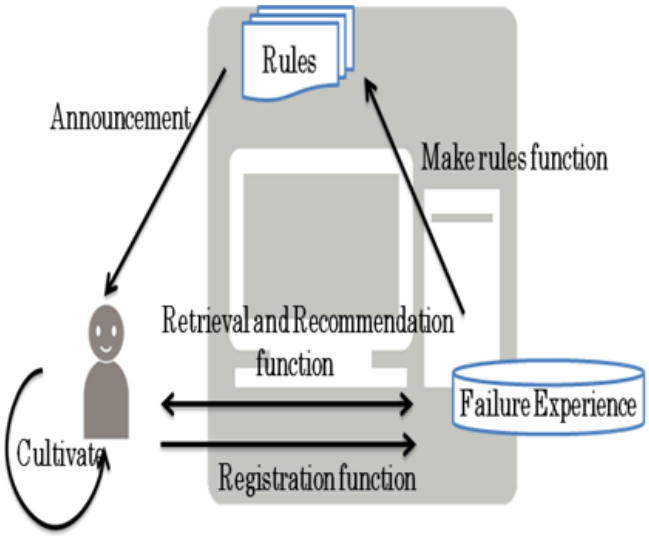

Fig. 2 Image of the previous system

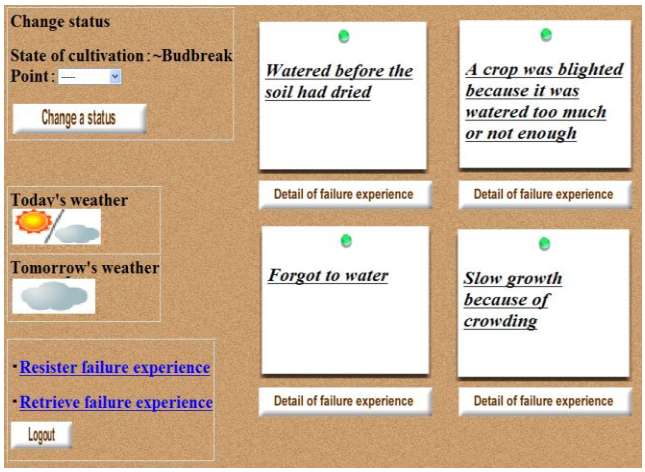

Fig.3 Main screen of the previous system

C. *Evaluation of Previous Study*

The previous study was evaluated using the system. The purpose is confirming whether the subjects did actually learn from experienced agriculture workers and their own experiences. In addition, the system also confirms whether or not the subjects were able to gain individual knowledge. The evaluation involved the method of cultivation being classified into 3 patterns, the results of which were then compared. The 3 patterns were as below.

i. Pattern where nothing was utilized
ii. Pattern where a manual was utilized
iii. Pattern where this system was utilized

The subjects cultivated Mizuna for a month, then they were interviewed, and the results of the 3 patterns were then compared.

D. *Experimental subjects*

Before the evaluation the subjects were provided with a questionnaire on their knowledge of agriculture, with 29 university students from the Social Communication Laboratory completing the questionnaire forms. 6 of the subjects that gave the same answers in the questionnaire were then selected as it was assumed that their knowledge of agriculture would be approximately the same. Table 1 shows the assignment of the method of cultivation.

TABLE I. ASSIGNMENT OF METHOD OF CULTIVATION

	Group A	Group B
Use nothing at all	Subject K	Subject T
Use a manual	Subject I	Subject H
Use the system	Subject O	Subject Y

E. *Results of interviews*

The results of interviews were classified into three different types of knowledge and experience as below.

i . Knowledge the subjects learned from the system or a manual
ii . Knowledge the subjects learned via experience
iii . Chores the subjects experienced

Some of the results of the interviews are given below, and are based on the above classification. Table 2 shows the results of "Pattern where nothing was utilized", Table 3 "Pattern where a manual was utilized", and Table 4 "Pattern where this system was utilized".

TABLE II. RESULT OF "PATTERN WHERE NOTHING WAS UTILIZED"

< Knowledge the subjects learned from the system or a manual>
Nothing in particular
< Knowledge the subjects learned via experience >
Don't plant too many seeds at one time
< Choices the subjects experienced >
Plant a little less seeds
Water the crop everyday
Water the crop using a glass container and tap

TABLE III. RESULT OF "PATTERN WHERE A MANUAL WAS UTILIZED"

< Knowledge the subjects learned from the system or a manual>
Water the crops carefully
Don't overwater
< Knowledge the subjects learned via experience >
Nothing in particular

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< Choices the subjects experienced >
Plant seeds in a line
Water the crop carefully
Water the crop using the right amount

TABLE IV. RESULTS OF "PATTERN WHERE THIS SYSTEM WAS UTILIZED"

< Knowledge the subjects learned from the system or a manual>
Narrowly-spaced planting results in slow growth
The crop can be blighted because of being watered too many times or not watered enough
< Knowledge the subjects learned via experience >
Mizuna seeds are very small
Take care not to plant seeds too close to each other
Mizuna leaves are not very big
< Choices the subjects experienced >
Plant seeds with appropriate spacing
Don't plant one seed per space but instead two

The results led to the following discoveries:

<Pattern where nothing was utilized>
Subjects experienced gaining knowledge from experience.

<Pattern where a manual was utilized>
Subjects experienced gaining knowledge from the system or a manual.

<Pattern where the system was utilized>
Subjects gained knowledge not only from the system or a manual but also actual experience.

The traditional transfer of agricultural knowledge has involved the method that experienced agriculture workers provide novice agriculture workers with knowledge and experience, and the novice agriculture workers then gain individual knowledge via actual experience. These steps are typically used to transfer agricultural knowledge. The pattern that uses the system is thus fairly similar to these steps when compared to the other 2 patterns.

The system can therefore be used to efficiently transfer agricultural knowledge.

F. Problems

In the previous study, transferring agricultural knowledge has been proved to be effective through the use of failure experience and the SECI model. However, agricultural work is assumed to be done after referring the failure experience information in front of a computer. In the succession of agricultural knowledge, it is typical that the knowledge is shared and exchanged between people. Using the system via a computer therefore appears slightly unnatural and using the computer and doing the agricultural work will be recognized as two no-related things. Moreover, it will be difficult for users to relate knowledge acquired during agricultural work to knowledge acquired from the system because they would appear to be separated processes. This study therefore suggests a framework that users can use to help succeed agricultural knowledge face-to-face during actual agricultural work.

IV. PROPOSED SYSTEM

A. Media Equation

The Media Equation involves a "Person corresponding unconsciously and socially to the treatment of an object" [9]. This suggests that user can treat object in the same way as treating a person.

Example of study by using Media Equation include a "Clothes Which Propose Fashion Coordinate Based on the Previous Experience"[10]. This study uses that theory in aspiring to aid in knowledge transfers.

B. Approach of the system

This study attempts to rectify problems in the previous study through a "Media Equation". In addition, this study suggests a framework to help user gain knowledge with the same feeling as when the user work with a real person. The method "a planter provides information while talking to the user during agricultural work", in particular, is used. This results the user feeling that they are working together with another person, because, the planter provides a form of communication. In addition, the user can do according to the information provided by the planter. Thus, the user can learn know-how from the planter and do the agricultural work at the same time.

C. Summary of the system

In this study, the planter used grows crops while managing all the crops through communicating with the user. The user can thereby decide what to do in the next step by communicating with the manager planter.

This study mainly involves three conditions wherein the planter communicates.

i. The same work as the failure experience of another person.
ii. The same work as the failure experience of user.
iii. The different planter with the planter the user works with.

In pattern i, the planter tell user about the failure possibility according to the failure experience of the other worker. The same as pattern i, in pattern ii, the planter also talk to users about the possible failure. In pattern iii, the different planters communicate with each other, because, the agricultural work with each planter differs. In any other situation, the planter communicates if the content of the agricultural work is somewhat irregular, for example, the work of the day before and the work that the day greatly differs.

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The system using various sensors to recognizes the type of agricultural work. For example, a sensor can be installed to measure the volume of water and another sensor to monitor the temperature.

Users can thereby obtain and share knowledge during agricultural work via communicating with the planters. Figure 4 shows an image of the system and Figure 5 shows the composition of the system.

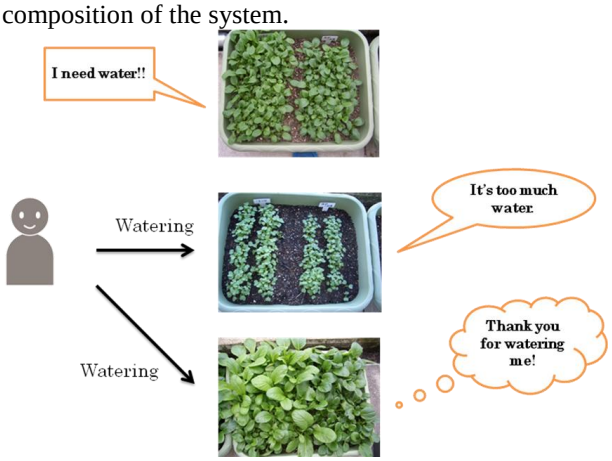

Fig. 4 Image of this system

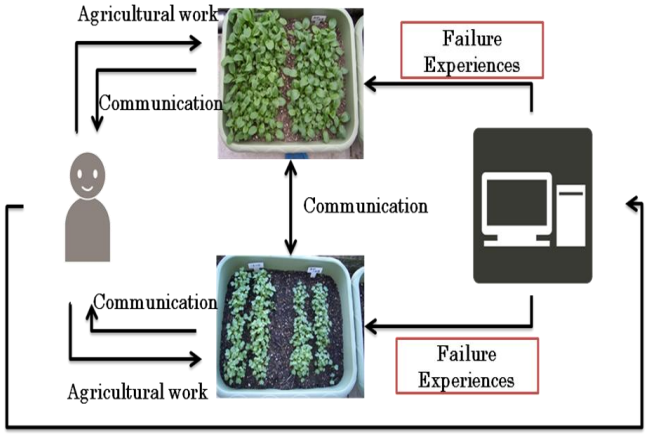

Fig. 5 Composition of this system

V. CONCLUSION AND FUTURE WORK

This paper suggested a framework to help the transfer of agricultural knowledge via communication with the planters. And a prototype is under development according the method mentioned in the study. Especially the "watering" is an essential part in agricultural work and this part will also be develop in this study. In the next step, add the possibility of choose a crop and state of cultivation and collect failure experiences. Moreover, the system will be evaluated and the efficiency of the method be confirmed.

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Clothes that Coordinate Your Fashion Based on Previous Choices

Mio Fukuda
Graduate School of Science and Engineering
Ritsumeikan University
Shiga,Japan
cc010072@ed.ritsumei.ac.jp

Yoshio Nakatani
College of Information Science and Engineering
Ritsumeikan University
Shiga, Japan
nakatani@is.ritsumei.ac.jp

Abstract — This paper concerns research on "Talking Closet" system that support coordination of your everyday fashion. It involves fashion coordination via the "Clothes communicating, and making fashion proposals" when clothes are in your hand in front of the closet, making the act of choosing clothes when the system is used more enjoyable. Experiments took place with subjects and the feel of the operation and significance of the system verified. The significant nature of this system was proved as a result of the experiment.

Keywords - fashion coordination; recommendation system; feeling; IC tag; multi-agent system.

I. INTRODUCTION

Nowadays fashion not only involves clothing but is also used in a broader sense. For example, fashion is involved in a lot of things of our lives, including hairstyles, footwear, makeup, recreation, housing, ways of thinking, food, art, and so on. Fashion can reflect the age, society, and lifestyle modifications with reality. In addition, fashion is now used to emphasize self-expression a lot more than ever before. Fashion is now also focusing on tools that can use one's own sensibility and intellect. Moreover, when you put on your favorite clothes you can improve the way you feel, or by putting on clothes that differ what from you always wear, too. Choosing clothes to put on can help you in recognizing your own possibilities and can be a form of control, both also quite significant matters.

The variety of fashion is extremely diverse throughout the world, with the combinations being basically infinite. People's choice of fashion is in reality, however, influenced by the cost, trends, culture, society, and religion, etc. Making that choice can involve internal communication and enrich your self-awareness, being based on fresh discoveries and failures. However, it can also involve psychological stress for some people now. People nowadays can find it difficult to find the time to coordinate their fashion within a limited time in the morning and when they need to take into consideration the various abovementioned elements. Moreover, a vicious circle can occur in that case the onus of your fashion coordination can ever increase, along with the conditions that should be considered if the target situation is important, thus making it impossible to determine very easily. Young people also generally don't have many clothes, thus making it even more difficult to coordinate new styles of clothing.

This study therefore proposes an unprecedented system wherein the coordination of clothing is assisted through quasi-interactions of the clothing and guidelines from past experiences in solving the abovementioned problems, being intended for use in assisting with coordination of clothing.

This paper describes the related research in Section 2, and states the outline of this system in Section 3. Details of the trial production built system are given in Section 4. Section 5 reports an experimental result and interpretation.

II. ASSOCIATED STUDY

An extremely large number of fashion coordination support systems have taken place to date [1][2][3].

This research was first directed to a system and method of providing a virtual fashion closet [1]. The system coordinates clothing by combining two or more fashion items via a Virtual Closet on a computer. In some embodiments the Virtual Closet system can recommend outfits based on the weather, season, or the user's calendar. In addition, a Virtual Closet social network site can be made available. The Virtual Closet social network can be used to allow friends to view each other's Virtual Closets, recommend outfits to one another, recommend fashion items to buy, recommend fashion items to get rid of, recommend outfits to wear at a particular event, share and borrow each other's fashion items, or otherwise provide an appropriate social networking environment via the Virtual Closet.

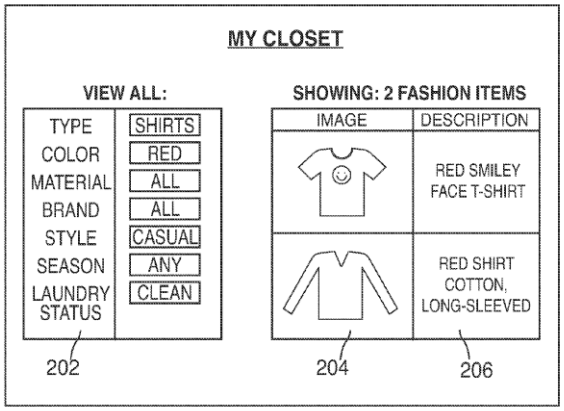

Figure 1. Illustration of fashion items displayed

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This research then involves garments being presented to the user via a computer and a database of garments, wherein the database of garments includes parameters for at least some of the garments represented by records in that database, with the parameters including at least the type of garment, data on any plurality of garment types, on each type of plurality of garments, a set of tolerance ranges for that garment type, the user's measurements, as obtained from the consumer or a source derived from the consumer, the measurements of garments in the database, comparing the user's measurements to the garment measurements, giving the garments a score from the database of garments based on their measurements, the user's measurements and a set of tolerance ranges for each garment based on its type, and the presentation to the user with a computer generated filtered list of garments from the database in order, or at least approximately, according to those scores [2].

However, the act of choosing clothes while considering the computer system gives the user the interval separated from daily life, and it doesn't become the one to look forward to coordination though these existing fashion coordination support systems are convenient to support the acquisition of the dissemination and the skill for the user to choose clothes. There is also a psychological sense of resistance to accepting fashion coordination that a system has one-sidedly decided upon. The user making their own choice is necessary, and, if possible, the act of doing so enjoyable. It is necessary to achieve a process wherein the system enables a situation in which clothes are chosen very naturally in daily life in ensuring that the user is not psychologically affected by the system, with no resulting burden and the person making the final decision. This approach therefore involves each of the individual clothing plugging itself to the person.

III. OUTLINE OF SYSTEM

This system supports the user making judgments in real time and interactively by each of the clothes wishing to be selected and based on variety of knowledge concerning fashion coordination and its own particular features, past history of being worn, and the day's schedule, etc.

A. Operational procedure

Figure 2 shows the system configuration. The user first registers their feelings and purposes of the day into the system. The registration of feelings is achieved by choosing a color from a palette. The user then needs to stand in front of the closet. At this time the clothes that best matches the chosen color image and purpose insist that they be chosen because of their uniqueness. It also starts to insist that it be chosen**,** if the different clothing is touch. The user therefore needs to feel, after having picked some specific clothing, gratitude for choosing the clothing. At this point, and if the user has selected the top clothes the clothing at the bottom start to insist from the viewpoint of compatibility with the top. Finally, the user makes a decision that is based on the insistence of the various clothing. The coordination then finally decided upon is then stored in the data base with information input that includes the date and the purpose, etc. (Figure 2).

B. Mounting tool

Figure 3 shows IC tag and IC tag Reader which the user has it strapped to his hand. Specified clothing is then recognized by the IC tag on the pertinent hanger. The IC tag reader of "Yubitan" of AP-REFINE INC. Co. and key ring type IC tags of WATADA PRINTING CO., LTD were used. The clothing was thereby identified with that equipment and the clothes "Touched" in daily life recognized, and cooperation within the system thus achieved. The intention to equip with the reader in hand mentioned is that this device is available to use in a wide area, not just the closet. In addition, the shape of clothes not ruined by adding the IC tag that is not added directly to clothes it set in suspenders and individual information can be prevented from leaking. The aim with the system was to create an enjoyable feeling after having chosen some clothing, thus making communication important. The data was managed by a terminal PC. A prototype system for trial purposes was constructed using Java on a Windows PC.

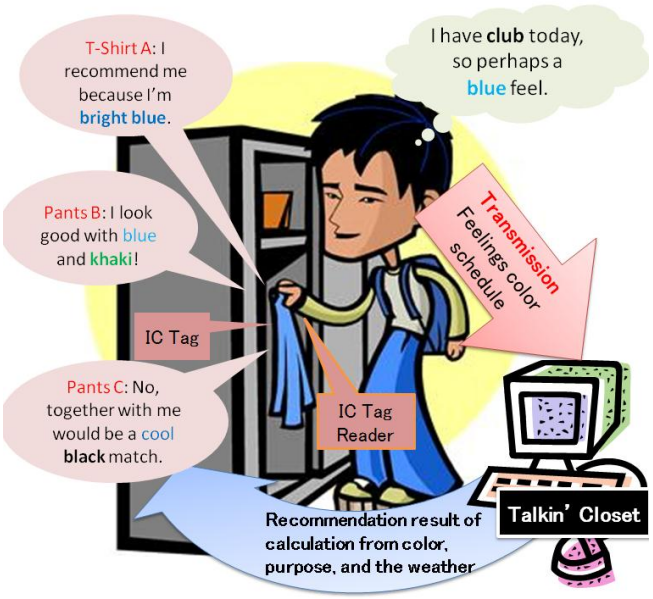

Figure 2. Image of system utilization

Figure 3. IC tag and IC tag Reader

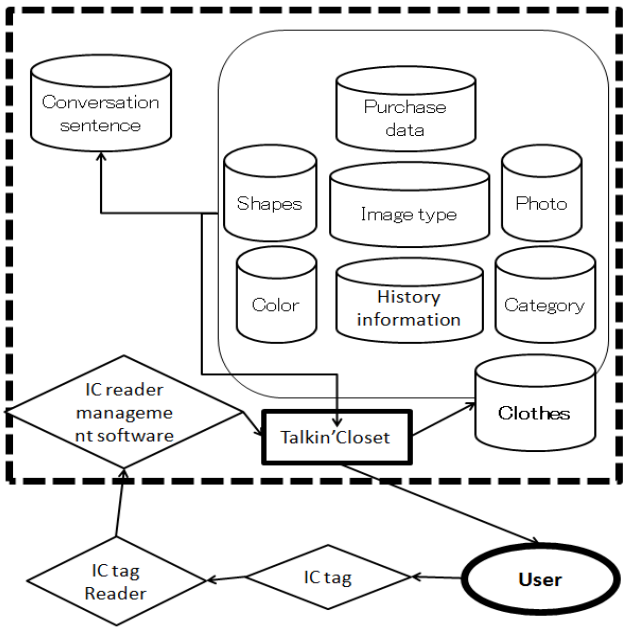

Figure 4. System configuration chart

C. System configuration

Figure 4 shows the system configuration. The temperature on the day acquired from the data base from the associating feeling and color, the user's schedule, and the Internet for the clothing data base and coordination knowledge database and weather information etc. were all used. A template must be referred to from the conversational data base for the content of what the clothes insists.

D. Recommendation flow

First any candidate clothing from the color and purpose of the feeling input by the user are selected from the data base. The candidates from the color based on the same and the contrast of hue and the tone include three color choices that match the color of the input feeling clothing or input feeling. Moreover, the color image is considered by defining using 14 image words. The one that the color image is corresponding to the image of clothes made a candidate. (Figure 5). The attributes of clothing (It is pants and T-shirt in case of sports. If it is an announcement, the blouse and skirt, etc.) that are considered appropriate for the schedule of the day are also candidates because of the purpose. The features of clothing that is touched when first being decided upon (color, image, and attribute) are then analyzed, and candidates selected by it that have been frequently touched given priority, and are then recommended by the system from candidates selected by the user in past recommendation situations. When the first clothes are decided, the clothes appropriate for the purpose are recommended as a candidate.

The self-recommendation from clothes output by the voice, and the content is elected from the conversation template according to the condition of arriving at the candidate.

IV. PROTOTYPE SYSTEM

Because the system was made for trial purposes this time registers author's wardrobe was used, ten kinds of colors that are appropriate for the college woman were able to be set into the color palette, and to select a target item from six. The screen was divided into three fields, (with) from the left being the input field, the candidate display field, and a detailed information display field. Six or less pieces of candidate clothing are displayed on the screen in the center once the user has specified a color and purpose (Figure 6). The process can be restarted again by pushing the lower right UP button if there are no suitable clothes. Clothes that are touched start self-insistence when they are displayed in the center, and detailed information on the clothes displayed in the detailed information field on the screen. The user listens to the insistence of clothes to which a voice has been output, and thus can visually decide upon the clothing. Clicking the FIX button at the bottom of the detailed information field stops it. Once the top half of your clothes have been decided upon, the bottom suitable for the top is elected a candidate field. However, it becomes a coordination decision at that time when it is chosen. In the same way the coordination is completed by deciding upon the second set of clothes, the combination, date and input information are registered in the data base, and it is reflected in the future (Figure 7).

V. EVALUATION AND CONSIDERATION

The utility of the system was evaluated via experiments and a questionnaire. Author's 38 clothes were used for ten college women and the system was used. The operation and significance of the system were then considered using the results.

A. Evaluation result

With operability the answer "It was easy to use" was received from all the experimental subjects and the opinion that using it was enjoyable was also received.

The answer "Would use it once it is put to practical use" was received from all the experimental subjects with regard to its significance. However, there were many that answered, although not by all members, that they "Used it every day", but found it "Embarrassing" or "Had no time", etc. In addition, the act of coordinating clothing can be understood and demand high with anyone who finds coordinating their clothes every day annoying but understands the system, and thus happy with it. In addition, the opinion of "The lack of hesitation can be recommended with anyone not confident about their fashion sense" was also obtained.

B. Consideration

The direction of the system will not be changed because of the above-mentioned results in the future, and the aim of

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a system that can be naturally operated in choosing clothing and an interface pursued. Moreover, it turned out that "The interested parties would be both men and women who are insecure about their fashion sense", which is a significant result.

VI. POSTSCRIPT

This papers proposed a system that supports fashion coordination in everyday life, used it for trial purposes, and then evaluated it. The system involved research and development with the aim at creating it and thus supporting fashion coordination in an original, enjoyable way. Experiments involving a prototype system and subjects revealed its significance. The following views will be achieved to assume it to the system that specializes in the user or more in the future.

1) Creation of user's preference learning function

2) Introduction of trends

3) Changed into the multi agent.

Moreover, to correspond to a more complex condition, the enhancement of the following functions is aimed at**.**

4) Diversification of retrieval function (expansion of weather information and vital information, addition of priority, figures, and consideration of balance)

5) Recommendation routine made perpetual (increase in volume of data and variation in the conversations).

6) Increase in number of combinations (heavier clothing, accessories, and shoes)

Now, to clear these problems, the research is advanced, and the inducement of the action is enabled by analyzing the user's behavior and doing modeling and it will develop with the system where the fashion coordination is felt happier in the future.

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Figure 5. Color image scale [5]

Figure 6. Screen displaying candidate clothes

Figure 7. Screen displaying coordination decisions

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Discovering Dynamic Logical Blog Communities Based on Their Distinct Interest Profiles

Guozhu Dong
Department of Computer Science and Engineering
Wright State University
Dayton, OH 45435, USA
guozhu.dong@wright.edu

Neil Fore
Department of Computer Science and Engineering
Wright State University
Dayton, OH 45435, USA
neilfore@gmail.com

***Abstract* — This paper addresses the problem of identifying dynamic logical blog communities based on the distinct interests shared by blogs in the communities. This paper is motivated by the facts that the blog space is highly dynamic both in the participating bloggers and in the interests/issues of concern to them in their blogs, and that many organizations are interested in identifying the evolution/emergence of various blog communities and the current interests/issues of concern to the blogs of those communities. Using dynamic shared distinct interests to define logical blog communities allows us to better identify and track the issues of concern to the bloggers than using statically chosen keywords or statically defined blog communities. The paper discusses algorithms to solve the above problem, which attempt to maximize discriminativeness and diversity of the distinct interests of the blog communities. Experiments are reported to evaluate the performance of the algorithms and to demonstrate their utility.**

Keywords-distinct interest; clustering with description; weblog community discovery; community description; contrast pattern.

I. INTRODUCTION

Weblogs are a popular and easily accessible avenue for individuals and social communities to express their opinions and to interact with each other on matters of interest. The ability to quickly understand the evolution of, including the formation of new, blog communities, and the ability to quickly identify the current interests and issues of concern to various communities of bloggers, are important to various social organizations. The purpose of this paper is to study the problems associated with providing such abilities. It presents algorithms for solving those problems and reports an experimental evaluation on those algorithms.

The blog space is both large (containing a large number of blogs written by a large number of bloggers) and fast-changing. Moreover, the issues/interests of concern to bloggers are dynamic and fast-changing, reflecting what is happening in the real world. As a result, static blog communities and static blog community descriptions are not adequate to best provide the two abilities discussed in the previous paragraph. We need to identify logical blog communities, based on the distinct interests/issues shared by blogs in those communities, in a dynamic manner.

Distinct interests of blogs play a significant role in solving those problems discussed above. A distinct interest of a blog is a combination of a (small) number of words that occur in the given blog but rarely occur in other blogs. Distinct interests of a blog capture highly distinguishing focuses of the blog when compared against the other blogs. A logical blog community is one in which the blogs have significant shared distinct interests. (We will provide precise criteria used to determine logical blog communities below.)

In general, a distinct interest corresponds to a *contrast pattern* (CP). For this, it will be convenient to use the term "cluster" (of blogs) as a synonym of blog community. A pattern is a small set of words. A CP (a.k.a. emerging pattern) [3] for a given clustering (corresponding to number of blog communities) is a pattern that occurs much more frequently in blogs of one (its home) cluster than in the other clusters. This difference in frequency makes a CP a highly discriminative pattern to describe its home cluster and distinguish that cluster against the other clusters.

In this paper, we will use distinct interests as the basis to form logical blog clusters, and to identify the shared distinct interests of the formed blog clusters. To that end, we use a recently proposed Contrast Pattern based Clustering algorithm, called CPC [6]. Intuitively speaking, in the blog community discovery context, the CPC algorithm aims to form blog clusters whose associated distinct interests have high quality and high diversity (as CPs of the clusters). A CP's quality is defined in terms of its support in its home cluster and the length ratio of its closed pattern over its minimal generator patterns; the diversity of CPs is defined in terms of their shared items and shared matching data (tuple sets). CPCQ is a clustering quality index introduced in [7], based on the quality/diversity of CPs; that paper also demonstrated that CPCQ consistently prefers expert-given clusterings to other generated clusterings. CPC aims to form clusters to maximize the CPCQ score.

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Since CPCQ and CPC automatically discover the most important distinct interests of the dynamically formed blog clusters of the dynamic collections of blogs posted recently (e.g., in the last hour), they are well suited to the dynamic nature of blog communities. The results they produce are more desirable than those blog communities (and their descriptions) that correspond to static communities of bloggers who write blogs of interest or correspond to a static set of keywords. Those two static approaches are often based on what were known about the past, and may not be able to capture what is happening now.

Table I illustrates some of these ideas using 7 short weblogs. The best clustering (indicated in column 1) is mostly suggested by the distinct interests (CPs) present in the blogs. The patterns {disease}, {diet}, {suffer}, {suffer, treatment}, etc. are distinct interests (CPs) of blogs in cluster 1, and the patterns {music}, {song}, and {music, song} are distinct interests (CPs) of blogs in cluster 2. (A minimum support threshold of 25%, i.e., 2 weblogs, is used here.)

TABLE I. CPC CLUSTERING OF SYNTHETIC WEBLOGS

Cluster	Weblogs
1	disease, diet, exercise
1	disease, suffer, treatment
1	best, diet, help, weight
1	help, suffer, treatment
2	album, artist, music, song
2	best, music, popular, song
2	band, music, release, song

The contrast patterns {music} and {song} are high-quality distinct interests of blogs in cluster 2 because each occurs in all 3 weblogs of cluster 2. These two patterns do not share common words and hence are very diversified. The pattern set {{music}} (of one pattern) makes a distinct interest set/profile of cluster 2 (since its matching data covers the entire cluster 2). The patterns {treatment} and {diet} do not occur together in any given weblog, but together they cover the entire cluster 1. Each of these two patterns is a distinct interest of cluster 1. Moreover, the pattern set {{treatment}, {diet}} is a diversified set (profile) of the distinct interests of cluster 1.

Since no other clustering is better than the given clustering in terms of quality, diversity, and total coverage of CPs, the given clustering maximizes the CPCQ score. Moreover, the clustering is also considered high-quality since it has two diversified distinct interest profiles for each cluster: {{disease}, {help}} and {{treatment}, {diet}} for cluster 1, and {{music}} and {{song}} for cluster 2.

TABLE II. DISTINCT INTEREST PROFILES OF BLOG CLUSTERS

DIPs (2) for Cluster 1	{{diet},{treatment}}}, {{disease, help}}
DIPs (2) for Cluster 2	{{music}}, {{song}}

In practice, the blogs collected are often not clustered, and/or they are clustered but the clusters do not have known blog collection descriptions. The blog cluster profiles can help users get a sense of the main issues of interest in the blog cluster, and get a feel on what the blogs are roughly about.

Related Work: (A) Our work is related to weblog analysis and tracking (e.g., [1]). Reference [1] presented a tool for tracking and analyzing blogs, which can identify frequent terms used in blogs, and the influential bloggers and relationship among bloggers in given blogs. However, it did not consider forming blog clusters together with their distinct interest profiles, as is done in this paper.

(B) This work is also related to [4], which presented methods to discover descriptions of weblog clusters/communities using sets of single-word patterns, but it did not consider how to form blog clusters and did not consider using multi-word patterns. Regarding distinct interest profile formation, this paper generalizes [4] by using multi-word contrast pattern descriptions, which are more general and are capable of capturing more subtle distinct interests for blog clusters, and also gives methods to discover high-quality clusters (or communities) in given weblog collections. Experiments confirm that the approach of this paper is more effective.

(C) This work is also related to document collection summarization (e.g., [8,9]), and multiple document collection summarization (e.g., [2,4]). Document summarization can be divided into three types, namely sentences-based (where a summary consists of sentences extracted from the original documents), templates-based (where predefined templates are filled as summaries), and term-based (where a set of carefully selected terms is used to form the summaries). This work is novel in its use of the quality and diversity of the contrast patterns, which can contain multiple terms, to form the clusters and to describe the clusters.

(D) To some extent, this paper is also related to frequent pattern based clustering [5]. While [5] used frequent patterns in the formation of clusters, it did not consider using the quality and diversity of the contrast patterns of the clusters in the clustering process.

Organization of the Paper: Section II formally defines the problems to be studied in the paper. Section III presents the CPC clustering algorithm and the CPCQ clustering quality index. (Their details can be found in [6] and [7].) Section IV

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reports an experimental evaluation of the algorithms on real blog data. Section V concludes the paper.

II. PROBLEM DEFINITION

In this paper, we consider two technical problems for dynamic weblog-based community analysis. The first problem is for producing distinct interest profiles for weblog data with a known community/cluster structure. The second is for clustering and describing the found communities (clusters) using their distinct interest profiles, for weblog data without a known community structure.

Below, we use "distinct interest" (DI) and "contrast pattern" (CP) as synonyms. (However, only carefully selected CPs are included in the distinct interest profiles (DIPs).) Preliminaries on CPs are given in Section III.

Definition: Given k (≥2) (blog) collections (communities) $D_1,\ldots, D_k$, a *distinct interest profile* (DIP) consists of k sets $S_1,\ldots, S_k$ of distinct interests for the collections.

Problem 1 (Distinct Interest Profile): Given k (≥2) (blog) collections (communities) $D_1,\ldots, D_k$, find a succinct and informative DIP to describe the collections.

The "succinct" requirement on the descriptions ensures that low processing load is required when users examine a DIP. The "informative" requirement ensures that users can quickly estimate the main themes/concerns/interests/issues of the blogs in given collections. Technically, we can measure the informativeness by the F-score of clusterings induced by the DIP on data with known classes. (The F-score measures the agreement between the DIP-induced clustering and the original collections viewed as classes.)

Problem 2 (Distinct Interest Based Community Discovery and Description): Given a (blog) collection D and natural number $k \geq 2$, form a high-quality clustering of D having k clusters $C_1,\ldots, C_k$ together with a succinct and informative DIP to describe the clusters.

The "high quality of formed clustering" requirement will be measured by the F-score and the CPCQ value (discussed in the next section). Earlier studies [6] show that clusterings maximizing the CPCQ value often are highly similar to expert-given classes (on datasets with known classes).

III. CONEPTS AND TECHNIQUES OF CPCQ AND CPC

In this section, we provide high-level descriptions of our technical approaches to solve the two problems listed in Section II. Specifically, after first providing some technical preliminaries, we describe the CPCQ clustering quality measure and the CPC clustering algorithm. Roughly speaking, CPC attempts to discover clusters that maximize the quality and diversity of the CPs within each cluster. Similarly, CPCQ evaluates the quality of a given clustering by finding optimal groups of high-quality, diversified CPs in each cluster.

A. Preliminaries

As discussed in Section I, a contrast pattern (CP) for a given clustering (a set of collections) is a pattern that occurs much more frequently in blogs of one (its home) cluster than in the other clusters.

For a pattern P, we will use |P| to denote its item length (cardinality) and mt(P) to denote its matching tuple set -- mt(P) is the set of blogs in a dataset (or cluster, which can be clear from the context) that contain the pattern P.

Each pattern P is associated with an equivalence class (EC) of patterns defined as EC(P)={P' | mt(P') = mt(P)}. In a sense, all patterns in a common EC have the same practical "meaning", since they match the same set of blogs/objects. Each EC can be concisely described by a closed pattern Pmax and a set of minimal generator (MG) patterns. The closed pattern is the unique longest pattern in the EC and the MG patterns are those minimal (under the set containment relation) in the EC. An EC contains precisely those patterns X satisfying "X is a superset of at least one MG pattern" (of the EC) and "X is a subset of the closed pattern". The MGs of an EC can be viewed as different minimal descriptions of the mt(P) dataset.

For example, for the data given in Table I, the EC of CPs containing {music} consists of the following CPs: {music}, {song}, and {music, song}. {music} and {song} are the MGs, and {music, song} is the closed pattern. Moreover, mt(P) is equal to the entire cluster 2 for each CP P in the EC.

Both the MGs and the closed patterns of such ECs will be important for quality and diversity evaluation of clusters and for cluster descriptions. Below, when we say "pattern" P, we refer to any MG pattern in the EC of P.

Thinking of patterns in terms such equivalence classes (determined by the patterns' matching tuple sets) is an important aspect of both CPC and CPCQ.

B. The CPCQ Clustering Quality Measure

For the CPCQ cluster quality measure [7], a high-quality clustering is one having a large number of high-quality, diversified CPs in each of its clusters.

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A CP P is considered to have high quality if it is short, its closed pattern is long, and its support in its home cluster is high.

- If P is short, its home cluster is more easily distinguishable from the other clusters by using P. For blog data, a short P can be viewed as a short distinct interest of the blogs in the home cluster of P.
- If its closed pattern is long, its matching blogs (i.e., mt(P)) are more coherent. All of the words in the closed pattern of P are coincident distinct interests of the home cluster of P.
- If P's support in its home cluster is high, it will account for a large number of blogs in that cluster.

Technically, given a MG pattern P, we use the term *length ratio* to denote the ratio of P's closed pattern length to P's length, or |Pmax|/|P|. We prefer higher length ratios. For example, for the CP (of the EC of) {music}, the length ratio is 2.

The diversity requirement of CPCQ is motivated by the fact that natural concepts (captured by clusterings) (e.g., the gender, male/female, concepts) often can be easily distinguished/characterized in many highly different ways. The diversity of CPs is measured by the average of diversity between CP pairs. Two CPs are considered diversified if they two CPs share few items/blogs (i.e., their item/data overlap is low, and their item/data diversity is high). To measure the abundance/diversity of CPs in each cluster, CPCQ builds a number of diversified CP groups for each cluster. Ideally, the average pairwise data- and item-overlap among CPs should be low within each CP group, and each CP group should cover its entire cluster. Among CP groups, the average pairwise item overlap among CPs from different CP groups should be low; however, data overlap among CP groups is not considered since each CP group can cover its home cluster. The high-quality CP groups of high-quality, diversified CPs found for the clusters can be used to describe/represent the clusters.

A DIP can be formed by taking one CP group from each cluster in a clustering.

More details on CPCQ are given in [7], including a greedy algorithm to search for the multiple high-quality, diversified CP groups to assess the CPCQ value.

In this paper, we use the CP groups constructed by the CPCQ group-building algorithm [7] as the DIPs to describe/characterize the clusters.

C. The CPC Clustering Algorithm

The CPC algorithm constructs clusters on the basis of patterns to maximize the CPCQ score of the resulting clustering. A main challenge for CPC is that it only has access to the frequent patterns, since CPs are only determined after the clusters are known. Hence the CPC algorithm must guess and evaluate which frequent patterns should become CPs and which of such CPs should be put into the same cluster.

To address the challenge, a relationship is defined between CPs to measure their suitability of belonging to the same cluster. This relationship, termed *Mutual Pattern Quality* (MPQ), measures the number and quality of *other* CPs that can be gained by assigning two diversified CPs to the same cluster. Specifically, given two patterns P_1 and P_2 sharing few blogs/tuples, MPQ(P_1,P_2) is high if a relatively large number of (mutual) patterns share many matching blogs with both P_1 and P_2. If MPQ(P_1,P_2) is high, then patterns P_1 and P_2 are likely to belong to be CPs of the same cluster; if MPQ(P_1,P_2) is low, P_1 and P_2 are likely to be CPs of separate clusters. The MPQ formula will be given below.

Using MPQ, the CPC algorithm constructs clusters bottom-up by first finding a set of weakly-related seed patterns (having low MPQ values among the CPs in the set) to initially define the clusters, and then repeatedly adding diversified patterns that have high MPQ values with CPs of a certain cluster to that cluster. Once clusters are completely defined in terms of CPs, blogs (and other CPs) can be assigned to clusters based on their matching CPs. The details are given in [6].

MPQ Formulae: Given two patterns P_1 and P_2 sharing very few blogs/tuples, MPQ(P_1,P_2) is defined as

$$MPQ(P_1, P_2) = \frac{PQ2(P_1,P_2)}{PQ1(P_1) * PQ1(P_2)}. \quad (1)$$

In (1), PQ2(P_1,P_2) is the *Joint Overlap-Weighted Pattern Quality* of P_1 and P_2, given by

$$PQ2(P_1, P_2) = \quad (2)$$

$$\sum_X \left(\frac{|mt(P_1) \cap mt(X)| * |mt(P_2) \cap mt(X)|}{|mt(X)|} * \left(\frac{|X_{max}|}{|X|}\right)^2 \right).$$

In (2), X is any pattern except P_1 or P_2. PQ2(P_1,P_2) is high if X shares many blogs/tuples with P_1, it shares many blogs/tuples with P_2, and it matches few blogs/tuples elsewhere in the dataset. These properties indicate that X is a CP alongside P_1 and P_2 if, and only if, P_1 and P_2 are CPs of

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the same cluster. Additionally, $PQ2(P_1,P_2)$ is high if X has a high length ratio.

To favor the most exclusive connections between P_1 and P_2, $PQ2(P_1,P_2)$ is normalized by the *Overlap-Weighted Pattern Quality* (PQ1) of each argument. PQ1 for a pattern Q is given below:

$$PQ1(Q) = \sum_P \left\{ |mt(P) \cap mt(Q)| * \left(\frac{|P_{max}|}{|P|}\right)^2 \;\middle|\; P \neq Q \right\}. \quad (3)$$

A high PQ1(P) value indicates that many high-quality patterns share many blogs/tuples with P. Normalizing $PQ2(P_1,P_2)$ by $PQ1(P_1)*PQ1(P_2)$ is necessary since more mutual patterns (i.e., patterns contributing non-zero values to PQ2/MPQ) are likely to be found between two patterns P_1 and P_2 if their PQ1 values are high. Conceptually, this normalization is analogous to calculating the correlation between two events A and B, which is strong if Prob(AB)/(Prob(A)*Prob(B)) >> 1.

Unlike most clustering algorithms, CPC constructs clusters on the basis of patterns before assigning blogs/tuples. That is, CPC-produced clusters are completely determined/described by DIs/CPs when applied to weblogs. The accuracy of these clusters, then, reflects of the utility of DIs and DIPs for discovering blog communities as well as describing them.

IV. EXPERIMENTAL EVALUATION ON WEBLOG DATA

This section reports our experimental evaluation of CPC for the discovery of blog communities in real weblog data, and of CPCQ for the discovery of the associated DIPs.

Specifically, we report CPCQ scores, which are used as an internal quality measure by CPC, and F-scores, for various settings. (F-score measures agreement between CPC-generated clusters and the given categories; it has a maximum value of 1.0.) We also show the DIPs found by CPCQ for given communities and for CPC-produced clusterings.

These experiments were performed on weblog collections extracted from four categories of the BlogCatalog dataset [10]: health, music, sports, and business. Each dataset was preprocessed by stemming, removing duplicate weblogs, and tokenizing (i.e., words were treated as items).

A. Succinctness and Informativeness of DIPs

As stated earlier, the DIP-based community descriptions are generated by the CPCQ algorithm. For consistency, all CPCQ results (scores and DIPs) use a minimum support threshold (minS) of 3% and two CP groups (and hence two DIPs). This leads to brief descriptions while allowing informative CP groups (DIPs) to be found.

Table III shows the DIP based descriptions and CPCQ scores for the health and music collections treated as given clusters C_1 and C_2, and for the clusters created by CPC (k=2, minS=10%) from the union of health and music. One can clearly estimate the themes of the clusters from the DIPs. Moreover, given the similarity of the DIPs in the two cases, the high F-score for the CPC clustering suggests a high degree of informativeness for the DIPs of the health/music collections (as a given clustering). In each case, the CPCQ score is relatively low, mostly because the DIPs do not cover the majority of their home clusters.

TABLE III. CLUSTER DESCRIPTIONS FOR HEALTH AND MUSIC CATEGORIES

	Categories, as given CPCQ: 0.53		**CPC clusters (minS=10%)** F-score: 0.901, CPCQ: 0.71	
	DIP 1	**DIP 2**	**DIP 1**	**DIP 2**
C_1	{diseas}, {help, hair}	{diet}, {treatment, suffer}, {peopl, insur}	{diseas}, {dai, drink}	{diet}, {treatment, suffer}
C_2	{music}	{song}	{song}	{album}

To evaluate DIP based descriptions for a larger number of weblog collections, we repeated the above using four collections. Table IV shows the DIPs generated from the original categories, and Table V shows those generated for the clusters created from the union of the four collections by CPC (k=4, minS=3%).

TABLE IV. CLUSTER DESCRIOTIONS FOR HEATH, MUSIC, SPORTS AND BUSINESS CATEGORIES

Category	**CPCQ-generated CP groups (minS=3%)**, CPCQ: 0.247	
	DIP (CP group) 1	**DIP (CP group) 2**
Health	{health, diet}, {treatment, suffer}	{disord}, {health, heart}
Music	{releas, song}	{guitar}, {releas, post, music}
Sports	{season, team}	{final, win}, {am, sport}
Business	{busi, monei, market}	{busi, monei, internet}

TABLE V. CLUSTER DESCRIPTIONS FOR CPC-GENERATED CLUSTERS, k=4, minS=3%

Cluster	**CPCQ-generated CP groups (minS=3%)** F-score: 0.77, CPCQ score: 0.325	
	DIP (CP group) 1	**DIP (CP group) 2**
1	{bodi, food}, {suffer, medic}	{symptom}, {health, fit}
2	{band, song}, {youtub, music}	{releas, song}
3	{team, game}	{season, team}
4	{busi, market}	{busi, monei}

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Again, it is clear that one can estimate the cluster themes from the DIPs. Moreover, the DIPs are similar for the two cases, and the F-score for the CPC clustering is reasonably high. The DIPs shown in Table IV for health and music are not identical to those in Table III, due to the presence of two new clusters.

B. CPC Clustering Quality

To measure the quality/accuracy of blog clusters created by CPC, we use the CPCQ measure as well as the F-score of the CPC clusterings. Tables VI and VII show these values for various CPC clusterings for k=2, 3, and 4. For brevity, not all results are shown, but the cases with the highest and lowest F-scores are included.

TABLE VI. CPCQ AND F-SCORE FOR CPC CLUSTERINGS, k=2

	heath, music		health, business		sports, business	
minS	**CPCQ**	**F-score**	**CPCQ**	**F-score**	**CPCQ**	**F-score**
10%	0.71	0.901	0.36	0.853	0.407	0.858
5%	0.535	0.893	0.33	0.74	0.38	0.882
3%	0.664	0.89	0.355	0.77	0.352	0.826
2%	0.664	0.899	0.338	0.704	0.347	0.794

TABLE VII (a). CPCQ AND F-SCORE FOR CPC CLUSTERINGS, k=3

	health, music, sports		health, music, business	
min S	**CPCQ**	**F-score**	**CPCQ**	**F-score**
5%	0.393	0.827	0.33	0.76
3%	0.552	0.849	0.334	0.806
2%	0.404	0.824	0.35	0.723
1%	0.452	0.843	0.397	0.743

TABLE VII (b). CPCQ AND F-SCORE FOR CPC CLUSTERINGS, k=4

	health, music, sports, business	
minS	**CPCQ**	**F-score**
5%	no clusters at minS=5%	
3%	0.325	0.77
2%	0.229	0.767
1%	0.247	0.742

The F-score of CPC varies significantly based on the dataset, which may indicate more similarity between certain weblog collections. CPC's F-score also decreases with increasing k. This is partly due to the same reason, but is also expected since fewer CPs can be expected to exist among a larger number of clusters. Nonetheless, the F-scores achieved here demonstrate consistently high accuracy, confirming the usefulness of DIPs (i.e., CPs) in discovering weblog communities.

Notice that in three of the five cases, the highest F-score coincides with the highest CPCQ score, indicating that CPCQ can be used to estimate the optimal minS value for CPC when categories (and hence F-scores) are not known. However, the results show no clear trend in F-scores or CPCQ scores as minS is varied for any case; therefore, a range of minS values should be tried to estimate an optimal minS value.

C. Comparison against DCR-induced Clusterings

Below, we compare the F-score of CPC-produced clusterings to those induced by discriminative collection representatives (DCR) [4]. Note that DCRs are created from known blog collections (that paper builds a very simple DCR-based classifier to recover the blog categories) while CPC attempts to discover the blog clusters/collections together with the DIP-based descriptions. In other words, F-score of the approach of [4] is supervised class recovery (classification) accuracy, whereas F-score given by our CPC approach here gives unsupervised class recovery accuracy.

To make the comparison, we constructed three datasets as described in [4]; each set contains the first 1000 weblogs from a weblog collection C_1 (shown in column 1 of Table VIII) and 100 weblogs from each of 10 other categories (of BlogCatalog [10]). For each dataset, we selected the CPC clustering (k=2) having the highest CPCQ score among minS in {10%, 5%, 3%, 2%}.

TABLE VIII. F-SCORE COMPARISON: DCR AND CPC

C_1	F-score (C_1)		F-score (total)	
	DCR	**CPC**	**DCR**	**CPC**
Sports	0.772	0.734	0.713	0.78
Music	0.785	0.846	0.727	0.83
Health	0.756	0.733	0.668	0.765

Interestingly, overall (total) F-scores are higher for CPC clusterings in all 3 cases, while F-scores for C_1 are higher for DCR-induced clusterings in 2 of the 3 cases. This suggests that CPC's ability to dynamically discover/utilize the DIPs for the remaining 10 categories gives it an advantage over DCR-induced clustering, despite the fact that CPC is unsupervised.

We note that F-scores for these CPC clusterings are lower, on average, than for the k=2 clusterings reported in the previous section. A possible explanation is that more patterns may be shared between C_1 and the union of 10 categories (and hence fewer high quality CPs exist) than between C_1 and a single other category.

V. CONCLUDING REMARKS

This paper addressed the problem of identifying dynamic logical blog communities based on the distinct interests shared by blogs in the communities. Using dynamic shared distinct interests to define logical blog communities allows us to better identify and track the issues

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of concern to the bloggers than using statically chosen keywords or statically defined blog communities. The paper discusses a Contrast Pattern based Clustering (CPC) algorithm to solve the above problem, which attempts to maximize discriminativeness and diversity of the distinct interests of the blog communities. Experiments over real weblog data indicate that the contrast pattern based clustering quality measure and the contrast pattern based clustering methods can help discover natural weblog communities/clusters, and can discover succinct and informative distinct interest profiles to describe the communities/clusters. Potential future research topics include improving the CPC algorithm by considering the history of blog communities, their distinct interest profiles, and the blogger themselves, in the process of forming new blog communities and their distinct interest profiles.

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Restatement of Subjects of Design in Engineering as a Contribution to the Training of Engineers with a Sustainable Approach

José Bernardo Parra-Victorino
División de Estudios de Posgrado e Investigación
Instituto Tecnológico de Puebla
Puebla, México
bernardoparra@hotmail.com

Misael Murillo-Murillo
premi168@yahool.com.mx

María Leticia Ramírez-Castillo
Universidad Politécnica de Puebla
Puebla, México
letyram@unam.mx

Abstract—**This paper proposes a new methodology for the training of engineers in Mexico. The authors propose that engineering courses incorporate the process of recovery management and waste management for the design of new products. This methodology contributes toward improving ecological justice because many factories make products without evaluating the use of recycled materials. If every new product incorporated the processes associated with waste management and recovery in question, future engineers, whom these new skills develop, may think about products not only in terms of utility, but also in terms of reuse or recycling. According to Reverse Logistics, we will be able to create quality standards in productive process based on a sustainable model. In Information Technologies, we make use of several tools such as AutoCad, CAM, Databases, agents and mobile technologies for making decisions. This methodology has been effectively tested in a classroom, using mobile technologies and agents.**

Keywords- Reverse Logistics; sustainable approach to engineering; Recovery Management; Waste Management; agents and mobile technologies

I. INTRODUCTION

Currently, there exists a problem in engineering education in Mexico, and other countries, because the curriculum does not have an approach to evaluate production including reduction, recycling and reuse. If the public policies of the state government had established these kinds of ecological engineering plans, many enterprises could have evaluated other production alternatives. Within the current paradigm of the professional engineer with the tools to solve technical problems by applying scientific and technological knowledge, several important functions are referred to. These are designing and making process designs and prototypes for industry. We seek to optimize all processes by using different ICT (Information and Communication Technologies) and to design tests to verify that these processes and prototypes accomplish performance standards established in both domestic and international regulations, taking into account that we are engaged in commercial globalization [1]. This means that design is identified as a central and distinctive element of the activities of an engineer.

In this regard, when a design is carried out, the importance of teamwork is highlighted combining efforts on a specific objective can include, for example, team members working together on forms, features or materials that are included in new products.

In addition to the cited substantive function, we now have the obligation of proposing, especially in developed countries, sustainable production projects, i.e., those which ensure, through good use of existing natural resources, the survival of future generations of human beings.

Thus, the need to start the formation of ecologically conscious engineers is crucial. Universities must encourage students to focus, from the design stage and prototyping stage of industrial products to production processes, on a sustainable approach.

We propose that a sustainable engineer be able to create and manage new materials, and analyze designs and proposals for improvement. The engineer must contemplate the use of color, create designs that improve space utilization and consumption of energy, and give priority to designs inspired by nature.

Some of the objectives that should arise in the context of the functions of "sustainable engineer" are as follows:

- To conceive, create and characterize composite materials, plastics or meta-materials with new properties, different from their original components.
- To analyze specific designs as a starting point for the detection of engaging experiences not yet offered.
- To learn to deal with the current trends of color and shape, its application in product manufacturing, the psychology of color in its use and consumption.
- To create designs which improve the use of space and energy.
- To create designs for everyday items that are inspired by nature, in their form and functionality.

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Within this new approach, solutions to minimize environmental impacts should extend to methods of production and packing materials and shipping. To accomplish this task, the use of recycled or biodegradable materials should be a priority. All of this represents a conceptual and technical basis as a starting point for proposing innovative designs. We must now focus our attention on the tools needed to lead to efficient designs.

There are some commonly used software tools, e.g., Solid Works, EDCAM Professional, and uPrint Plus, among others [2] that facilitate the achievement of the posed objectives, at least in regard to conception, design of parts, accessories or complete products.

One way to evaluate if the new scopes of engineering education are showing results is by comparing the costs, time and advantages in the production of prototypes made by any engineering student with a sustainable formation. In our university, we did some tests in a new course, which will be shown in this paper.

This new course proposal, which has been incorporated into engineering education in the Master of Engineering at the Instituto Tecnológico de Puebla, must be evaluated by other university professors who will assess the success of the program in order to make it a requirement.

II. State of the art

The integration of sustainability issues into a regular industrial engineering product design course is a challenge. Experiences at Delft University of Technology show that in course development, one of the most important aspects is credibility in written and spoken form.

Additionally, by putting sustainability in a wider scope to include social issues like safety, it is likely both students and staff without sustainability backgrounds will feel enthusiastic about the new approach, which is likely to result in better learning processes and assignments, with a higher credibility and more acceptance.

According to [3], Delft University has proposed the following elements to foster sustainability:

- Agreements between organizations (such as ANUIES in Mexico) and government institutions,
- Professors at institutions of higher education that develop coursework focused on this area, and
- Some higher education institutions must implement sustainable development processes to support teaching.

However, no one has proposed a methodology that covers a deeper level, which is the aim of our evaluation of prototype development under a sustainable approach. We propose a model of engineering education that seeks to improve the manufacturing processes.

This model has a great advantage over operations previously carried out:

a) The master of engineering program at Instituto Tecnológico de Puebla has established an innovation course, with the sustainable approach, that involves the development of products under this approach; so far a product with the sustainable approach has been developed in partnership with Universidad Politécnica de Puebla.
b) There is a learning process for all engineering programs, not only for those that include the sustainable approach.

At Instituto Tecnológico de Puebla, knowledge of sustainable developing and design is applied when students create innovative products; we have gone beyond teaching ecological culture [4].

III. Theoretical framework

Based on the model proposed by [6], which is explained below, we propose a model that includes several additional aspects such as management of how inputs will react, energy and production time. This model will be implemented in the areas of product design for engineering students at the Instituto Tecnológico de Puebla.

Additionally, we are hoping for improved production yields, based on the new engineering education. It seeks to promote good, sustainable practice and to take the first step in creating high added value from low cost materials. And, in addition, the new education seeks to aid in the future the creation of patents and self-employment. Some background in RL management is listed below.

Europe has been the continent where RL has been most developed. RL arose during the '80s from the concern, over rising levels of electronic wastes and the return needs of defective products. This led to the European Directive 2002/95/EC on electrical waste and electronic equipment collection.

In 2005, member countries of the European Union established a plan for collecting this type of waste and determined that the manufacturers would be responsible for financing the collection and processing of them. In the United States (U.S.), this practice spread during the '90s. In Mexico, the electronics industry is investing in RL.

Different authors agree to some extent on the activities of RL that are applied in industry. To carry out this work, the cited activities in Figure 1 were done. They are briefly explained below.

Let us define some of the terms considered in the scheme shown in Figure 1.

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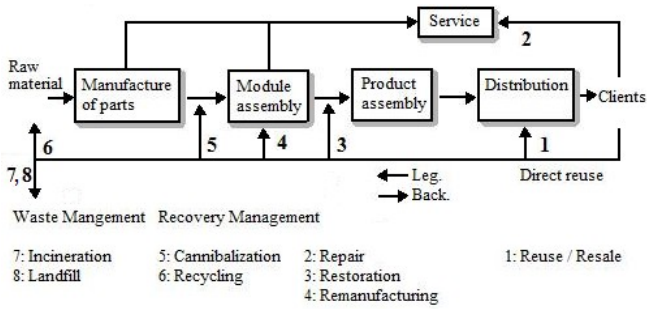

Figure 1. Activities of RL [5].

A. *Reuse*

This term means to recover a full product to give it a new use. It is difficult to apply widely, largely because of the fast obsolescence of products in an age of strong technological evolution.

B. *Repair, Remanufacturing and Cannibalization*

These three options involve an overhaul and improvement of product quality. Repair options differ in the complexity of treatment, so that means less effort than restoration, but this option is less desirable than remanufacturing. Cannibalization is based on the recovery of certain components to be incorporated into other products.

C. *Recycling*

Recycling is commonly understood as a reuse of materials, i.e., recovery of materials for reuse as raw material in another manufacturing process.

D. *Energy Recovery*

This alternative consists of removing, by combustion, the energy content of certain parts of the products. This option is not recommended because obtaining energy from the combustion of these wastes could be a new source of emissions that must be strictly controlled.

E. *Discharge*

Although it really would not be a valid recovery alternative this would be the last resort in the disposal of products at the end of their useful life.

It should be noted that all these activities of RL, constitute a development and adaptation to the concept of the so-called strategy of the three "R's" (Reduce, Reuse, and Recycle) considered within the so-called recycling logistics.

IV. RL STRATEGIES

A. Approaches

The RL strategy is a coherent model, unifying and integrating decisions that determine and reveal the purpose of the organization in terms of long-term objectives. The RL strategy focuses on prioritizing the allocation of resources and selecting the current or future products of the business, in order to achieve a long term sustainable advantage [6]

In developing a strategy, it is very important to have the reasons for implementing such a strategy clearly defined. In the literature about RL, possible reasons why companies around the world use RL strategies are cited. Among the reasons listed in [5], we are particularly interested in the following ones:

- Legal and environmental problems of landfills
- Retriving the value of the product and/or resources

B. Strategic Aspects of RL

The implementation of RL strategies, along with considerations of the environmental impact of disposal and recycling products, at the end of their useful life, lead to a change in design criteria and manufacturing processes.

RL strategies are characterized by practical production needs. These strategies can generate significant differences, especially in the cost-effectiveness of a production process because using recycled material is cheaper, in addition to being more sustainable. However, we do need to think about the cost of collecting the recycled material. It is also necessary to define the time requirements for transporting the materials to the production site.

For the reason that they satisfy the RL strategy, pure generic strategies and their hybrids can be implemented.

1) *Environmental Strategy*

This strategy is aimed at minimizing the negative environmental impact of waste, for which reason it can be costly [5] [7].

2) *Recovery Strategy*

This strategy is focused on recovering all that can be reused in order to reduce production costs. According to [8], "RL is the last frontier for reducing costs". According to the designed RL strategy, different objectives will be present, which may be present either in one or another strategy, so that the corresponding target-strategy will depend on the importance accorded to them. Listed below are some objectives that may be present in the strategies of RL [5] [9].

a) Maximize the value added to products and materials that have returned to the company, making maximum use of recycled resources.
b) Minimize the cost of returning the goods and materials, i.e., the network to operate efficiently.
c) Minimize the negative impact of these products and materials on the environment.
d) Increase customer service.
e) Reduce the cost of production.

V. REVERSE LOGISTICS IN ENGINEERING EDUCATION

A. Subjects Involved

According to what has been stated so far, it is obvious that RL is a methodology that can have wide applications in industry due to the benefits it represents. However, Mexican institutions of higher education have not included it in their curriculum as a compulsory subject or optional, at least.

In this sense, as new generations of engineers must reverse the current paradigm of industrial design, especially

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because of its environmental consequences, universities should incorporate such methodologies in the curriculum of engineering degrees.

To illustrate the changes that must be made in an engineer's education, we have taken as an example the curriculum and syllabus of a course taught in the industrial engineering degree from the Instituto Tecnológico de Puebla.

Synthetically, this proposed change seeks to modify the content of the design subjects for the practices carried out including the development of products that take into account the selection of materials and processes from the point of view of sustainability. The main idea is to always add to the waste and composing parts recovery process, as done in the European electronics industry.

An existing course within an industrial engineering degree, in which certain issues relating to RL are touched, is modified as follows.

B. Courses

Course Title: Marketing
Field: Industrial Engineering
Contribution to Graduate Profile:

Students will learn techniques and qualitative and quantitative methods for decision making related to the conditions set by different markets.

Main Objective of Course:

This course focuses on conceptualizing the role of marketing in order to improve its application in several processes. Students will study market research, product development, pricing decisions and distribution in order to have a basis for decision making in marketing. They can use these skills to provide the customer with the quality, quantity and opportunities her or she needs.

Topics:

1. Overview of Marketing
2. Market research
3. Market Segmentation
4. Design and Product Development
5. Price Allocation
6. Distribution of the Product
7. Promotional Mixture
8. Cases of Successful Marketing

As can be seen in the previous agenda, there are clear areas of opportunity in regard to design and product development, especially in those areas that involve primarily packing materials, packaging and shipping, as product characteristics. Reverse Logistics is also applicable to the life cycle of the product. Our proposal is to incorporate the subject of RL in the training of all engineers, with the aim of fulfilling the objectives outlined in the introduction.

A suggested course, which incorporates the environmental focus mentioned in this paper, would have the following outline.

Course Title: Reverse Logistics
Field: All Engineering Degrees
Main Objective of Course:

This course seeks to analyze the factors which determine the selection of sustainable materials in the manufacture of products. Students will acquire basic skills for managing processes of waste management and material recovery.

Topics:

1. Importance of Reverse Logistics
    - 1.1 Strategic Use
    - 1.2 Barriers to RL
2. Returns Management
    - 2.1 Improving the Returns Process
    - 2.2 Lifecycle
    - 2.3 System Information in Reverse Logistics
    - 2.4 Zero Return
    - 2.5 Remanufacture and Restoration
3. RL and Environment
    - 3.1 Availability and Cost of Landfills
    - 3.2 Packaging
    - 3.3 Returnable Packaging
    - 3.4 Case Study

C. Suggested Practices

- Development of new materials
- Conception and design of new products, including their packing
- Recovery of materials from a product and its packing

The suggested practices are described in Figure 2, where the stage of the manufacturing process of a prototype that a student should perform is observed. Particularly noteworthy is the process of testing the prototype. This is the stage where one makes use of IT to perform and make decisions. As they have to solve difficult implementation problems the students have strong support, from instructors and laboratories.

Although the course was suggested in an industrial engineering degree, it is currently being implemented in the Master of Engineering at Instituto Tecnológico de Puebla.

Students of the pilot RL course created innovative products such as a discrete camera, USB carrying devices, and carrying devices for a professor, among others. To illustrate the creativity of the students, we selected one product which exemplified the use of recycled materials.

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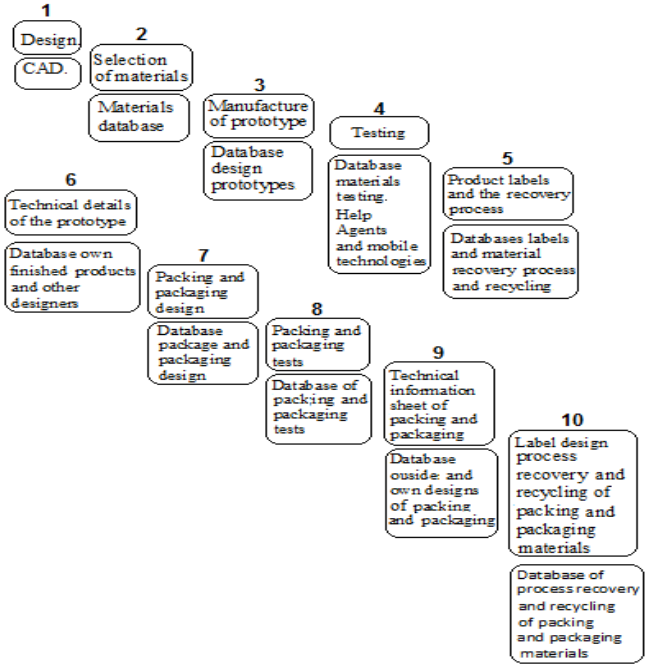

Figure 2**.** Process development of a prototype manufacturing practice and process of reuse and component recovery.

One student invented a unique backpack umbrella, which was named Handy Umbrella. To develop a prototype of the Handy Umbrella, the following skills were applied by the student: Marketing, to determine the market niche, and Reverse Logistics.

For this prototype, various tests were carried out. Three people with different physical characteristics of weight and height used three different Handy Umbrella models. The umbrellas used had the following characteristics:

1. Light weight, thin handle, and pole height of 65 cm.
2. Heavy weight, medium handle, pole height of 78 cm.
3. Average weight, handle, pole height of 53.5 cm.

The Handy Umbrella fits nicely on to, people's backs, but it occasionally needs to be modified to fit the individual. Like clothing or footwear, backpacks have varying sizes for better comfort, though they are perfectly adaptable.

As for the umbrellas, the best adapted to the end product was of average weight.

The product was tested for protection on sunny days and rainy days, showing good performance in both situations. It was also tested on a windy day.

The only drawback the evidence presented is that it becomes a cumbersome umbrella if you are in a very small or crowded place, which could lead to an improvement in future work.

The proposed design at first yielded an ergonomic, adjustable, stable, lightweight, reusable and easy to install product. The product is also hands free because the umbrella is placed in the backpack.

In addition to being practical, the student's umbrella was made from previously processed products. Table 1 shows the product compared to other products on the market. Highlighted are some features of the Handy Umbrella such as cost, average weight, and which materials used.

TABLE I. FEATURE COMPARISON OF DIFFERENT MODELS

Product	Stability	Weight	Recycl.	Handy	Mex.Cost	USD
Shoulder brella	middle	220 gr.	No	Middle	***354***	***30.33***
Nubrella	high	1000 gr.	N o	Low	765.50	65.59
Porbel	high	-	No	Middle	316.20	27.09
Handy umbrella	middle	470 gr.	Yes	Yes	180.0	15.42

As can be seen, by the end of the course the student had created a product that was not only original but also more sustainable and cheaper than other similar products on the market.

Commenting on the reception of the course, we can say that the course was popular among students because for the first time they gave suggestions that will be incorporated next semester.

VI. RESULTS

So far, there have been some laboratory practices which have been able to obtain designs of products that include the 3D model of the product: label design, process design and recovery of waste materials. The latter is aided by creating a database accessible by design. When students require information to design a new product, when they modify a previous design or when they need to find out about the recovery process, they can access the database.

The databases are the repository for agents (software programs that monitor the development of a model meets the specifications) [10] that take the information and report back to the designer about how well the prototype is developing. This reporting happens in real time.

When the designer is making the prototype test of the product, the agent retrieves information from the product of the database server and the user's request is to modify the timely intervention part design or material recovery process. Similarly, when you are doing performance testing of the product, in the laboratory, usually in a workshop, it is best to make inquiries of other materials through access to performance information from the experience of using different components.

Accessing this information is valuable because *in situ* people need to make decision based on experience. Undoubtedly, the crux is this part of the proposal, i.e., discussing the support of mobile technology tools and agents simultaneously to provide support and enrich the experience of an engineering student learning to make decisions. Who, under pressure, can decide how to implement the most appropriate material selection, taking into account the performance of the material, the lifetime of the components, and the recovery cost of the selected material. In short, the students apply the main criteria for deciding how to the manufacture a sustainable product.

Another important part of these courses is the instructors, who must be prepared to evaluate product prototypes

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designed by students. The instructors must also analyze the use of new material, make test for each type of product and reach an agreement with student as to the expected quality of the product.

Once a student has acquired skills in RL, it is clear that this is the fundamental approach to training as a sustainable engineer and, therefore, it will not be difficult to incorporate these experiences in the register of practices of his or her professional life in industry. In order to evaluate the success of this proposal student work can be compared with the items produced under traditional criteria. Companies will appreciate this approach. In a few years it will be a quality standard applied throughout in the country, and employers will choose to hire engineers trained in sustainable production process.

Thus, incorporating this model in universities, for the benefit of future generations, is expected. This method of teaching could even become a state policy in the near future.

VII. Conclusion and Future Work

Because it has been accepted as a model for training students, the process of prototype development is expected to improve and it is expected there will be an external user for each product manufactured.

It is expected that all items proposed in RL will be incorporated in a required course for all the engineering branches in the Instituto Tecnológico de Puebla once a university committee university has evaluated the results of the pilot RL course. We predict that the state government will evaluate the usefulness of RL and thus enact a public policy to mandate all universities in the state to include RL courses.

We conclude that the training of engineers should be modified. For the sake of environmental justice, engineering education should include an assessment of sustainable product elaboration. As has been shown with work in the RL course, students can acquire new skills and designed innovative items that consumers demand from producers.

The use of Information Technology supports all production processes in several ways: i) the use of databases to manage information and materials and products designed, ii) the search for information on the Web through agents, iii) the administration of the reminders of the scheduled dates of project activities by agents [10].

So far there has been one production test in a course, but if this model is extended to all engineering degrees, then there will be benefits to the environment. The RL method can also complement engineering specialties where prototypes are designed based on methods like Learning Based on Problems [11] and Development of Corporate Learning [12], thus amplifying the practice of sustainability in engineering.

We are only beginning to see the positive results of using Reverse Logistics in engineering education. If RL is widely adapted, it has the potential to create a better world for future generations.

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Automatic Question Generation to Determine Roles During a Crisis

Marten Teitsma
University of Amsterdam
The Netherlands
m.teitsma@uva.nl

Jacobijn A.C.Sandberg
University of Amsterdam
The Netherlands
j.a.c.sandberg@uva.nl

Marinus Maris
University of Amsterdam
The Netherlands
m.maris@uva.nl

Bob J.Wielinga
University of Amsterdam
The Netherlands
b.j.wielinga@uva.nl

***Abstract*—Traditional information systems for crisis response and management are centralized systems with a rigid hierarchical structure. Here we propose a decentralized system, which allows citizens to play a significant role as information source and/or as helpers during the initial stages of a crisis. In our approach different roles are assigned to citizens. To be able to designate the different roles automatically our system needs to generate appropriate questions. On the basis of information theory and a restricted role ontology we formalized the process of question generation. Three consecutive experiments were conducted with human users to evaluate to what extent the questioning process resulted in appropriate role determination. The result showed that the mental model of human users does not always comply with the formal model underpinning the questions generation process.**

***Keywords*-Crisis Management, Ontology, Human-Centered Sensing, Theory of Strongly Semantic Information, Situation Theory**

I. INTRODUCTION

When disaster strikes, information gathering is of great importance. During the response phase, when the disaster has just happened, information is most needed but also most scarce. It is during this phase that people and emergency services plan actions in an information twilight. In this paper we describe a formal method to support automatic question generation in an efficient way. This process aims to determine, which roles people can play and how they can help with an adequate response to the disaster. Several experiments with human users were conducted to validate the question generation process and the role determination this results in.

Information technology can be of use to gather information during the so called "golden hour" (i.e., the first sixty minutes after a severe trauma) [11]. But when it comes to information gathering, a focus on a centralized approach has been the usual course [5]. A centralized structure comes along with a strong hierarchical reporting structure, which has been the model for use by the emergency services. Such systems tend to ignore the public as a source of information. Our intended system is (partly) decentralized, i.e., the application runs on a mobile phone, and makes use of ordinary people who happen to be in the disaster area. Until now grassroots participation of citizens during a disaster as a valuable contribution to information gathering has not been fully appreciated by emergency services and other formally involved parties [9]. Due to this lack of appreciation, efforts to develop a technological platform to enable such participation are limited. It has been found however that, even during the most agonizing moments, people tend to help each other and can act rationally [2].

Making use of humans to gather information is the central subject in the new emerging field of Human-Centered Sensing (HCS) [6]. The here proposed application is typified as a participatory sensor because humans are producing information and not just facilitating the gathering of data as in opportunistic sensing e.g., a mobile device recording background noise. By answering questions the human observers can help, making clear what the situation is.

In the context of disasters it is important to be aware of the short time span available. Our assumption is that people do not want to be engaged in a time consuming questionnaire when all around them the world turns upside down. Therefore we designed a very simple ontology, which leads to a limited number of questions. This formalization is needed to automate the question generation process. A non-formalized communication would engage too many people in a call or operation center.

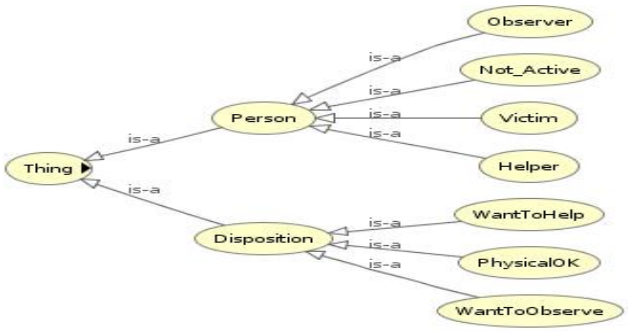

Figure 1. An ontology for roles during a disaster

An example: suppose a hurricane is expected to hit a large urban area. The people in the area already have our application installed on their mobile phone, which guides them through the querying process. After the initial phase of the disaster the users are asked a couple of questions to determine their physical condition as well as their need for

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help and their inclination to help others and their willingness to observe. This information is used in the role determination process. Part of future research will be that when people are classified in different roles, they are asked to perform specific tasks. A *Helper* for example gets the task to go to a place where she can find a *Victim* who is in need of help. Or, a *Victim* is asked to describe the injury he has. Such information will be helpfull to the *Helper* when she is helping this *Victim*. Furthermore, an *Observer* may be asked to give information about his surroundings and tell about the number of people he sees who are hurt.

In this paper, we examine and test the way questions to determine roles can be automatically generated. First, we will provide the theoretical background by discussing some related work. Next, we propose a role determining question generator based on an ontology. Several experiments, conducted to validate the question generation process, are presented and discussed.

II. GENERATING QUESTIONS

Our application strives to determine the role people can have during the response phase of a disaster. Herefore we first have determined, which roles we can discern and define. The definition of roles is done in an ontology. Each concept of a role has certain properties. To avoid a combinatorial explosion we took dependencies into account. These dependencies result in a number of impossibilities, which then can be ruled out in the determination process. To determine which question to ask first, we have developed a specific method, i.e., semantic strengthening based on the Theory of Strongly Semantic Information [4].

A. Ontology

An ontology is a set of concepts and their interrelations, which formally represents objects in a particular domain. Due to the formalism it is possible to reason about the concepts and their properties. To design an ontology we used Protégé-OWL [7]. The semantics of OWL is founded on Description Logic, which is a decidable but still expressive formalism [1].

Because we use properties to generate questions the number of properties per role must be kept to a minimum. Furthermore, they shouldn't be ambiguous. The third requirement for the properties is that they must be maximally subjective, i.e., the answer must rely on the thoughts and feelings of the person herself. Whether people want to help other people or not depends on their disposition to help. The same subjective perspective must be applied to the willingness to observe and even the physical condition of the people who we approach.

After a disaster has struck it is important to quickly distinguish between (groups of) active and non-active people. The non-active people can be victims who are affected by the disaster in such a way that they need help and people who are not physically affected but for some reason don't want to be active. The active people are helping to mitigate the effects of the disaster. They do this by directly helping other people or by observing and generating information useful for emergency services or the mentioned helpers. And thus consists our classification of the roles: *Victim*, *Helper*, *Observer* and *Not-Active* (see also Fig. 1).

Our ontology consists of definitions of the form:

$$\begin{aligned} Observer \equiv Person \\ \cap \exists hasDisposition(PhysicallyOK) \\ \cap \exists hasDisposition(wantToObserve) \end{aligned} \quad (1)$$

which says that *Observer* is equivalent to being a member of the set *Person*, which has the restriction of being member of the two sets of being physically OK and wanting to observe. In the ontology, other concepts like *Gender*, *Age* and Location are also described. These are concepts we want to use in the development of our system where we also use more personnel characteristics.

B. Dependencies

To discuss the information we need and the combination of different pieces of information we use the terminology developed in Situation Theory by Devlin in [3]. In Situation Theory a piece of information is called an infon, which is formally described as a tuple of the form:

$$\langle\langle R, a_1, ..., a_n, 0/1\rangle\rangle \quad (2)$$

where R is a n-place relation, and $a_1, ..., a_n$ are variables representing objects appropriate for R. The last item is the polarity of the infon. When it is "1" the infon is true given a particular situation, otherwise false and "0". We depict a situation as a defined set of infons. This is the minimum number of facts defining the situation.

Trying to determine which situation is the actual situation, one easily creates an enormous amount of possible situations. The number of answers to a question determines how many situations are possible as description of the real situation. A "yes" or "no" as answer gives per question two possible situations and the addition of "I do not know". results in three possible situations. When having more than one question this easily leads to great numbers of possible situations. For example, 4 questions with each 3 possible answers gives 81 possible situations. One has to constrain this combinatorial explosion. In the previous section we discerned four different roles based on four different properties. Each property is a piece of information we want to ask about. Such a property will be formulated as follows:

$$\langle\langle \text{hasDisposition}, wantToObserve, p, t, l, 1\rangle\rangle \quad (3)$$

where p, t and l are parameters for a specific person, time and location. Taken together, such infons can describe a situation of a person. And so having four properties gives

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	σ_1	σ_2	σ_3	σ_4
S_1	0	0	0	0
S_2	0	0	0	1
S_3	0	0	1	0
S_4	0	0	1	1
S_5	0	1	0	0
S_6	0	1	0	1
S_7	0	1	1	0
S_8	0	1	1	1
S_9	1	0	0	0
S_{10}	1	0	0	1
S_{11}	1	0	1	0
S_{12}	1	0	1	1
S_{13}	1	1	0	0
S_{14}	1	1	0	1
S_{15}	1	1	1	0
S_{16}	1	1	1	1

Table I
TABLE WITH POSSIBLE SITUATIONS WHEN HAVING FOUR INFONS

16 (2^4) possible situations as you can see in Table I. Here S_{15} describes an *Observer* when σ_1 is the infon, which says someone is a *Person*, σ_2 describes that someone is *PhysicallyOK* and σ_3 that this person *wantToObserve*. We then restrict the number of possibilities by determining dependencies between the properties.

There are three dependency relations in our ontology: the relation between "being physically OK" and "wanting to observe" and the relation between "wanting to observe" and "wanting to help". Because of transitivity we can detect a third dependency between "being physically OK" and "wanting to help".

This definition of concepts results in sets, which are subsets of other sets:

$$WantingtoHelp \subseteq WantingtoObserve \subseteq PhysicallyOK \subseteq Person \quad (4)$$

This equation says that the set of people who want to help is a subset of the people who want to observe, which is a subset of the people who are physically OK, which is a subset of persons. Here we see that when someone being physically OK implies being a person. And when someone wants to observe it is implied he is physically OK.

Knowing the dependencies in the system would make it the most efficient strategy to ask after whether people want to observe. But then, we suppose these people know that answering "yes" means they want to observe *and* are physically OK, which is a supposition we can not make. In a system with logical dependencies, one should not expect that all the varieties given in Table I do have an even chance of becoming real. It may even be so that some situations are impossible as outcome of a deliberation. The dependencies we formulated determine that situations in our system are possible or impossible. Whether a situation is possible or impossible is not known to the users of the system. Because we know there is a difference between the logic of our system and the mental model of the user, our system has to restrict the situations to possible situations and rule out the impossible ones. How we keep users away from these impossible outcomes is shown in the next section. First the impossible situations have to be determined.

The dependencies we have defined in the ontology restrict all the situations as mentioned in Table I to possible situations. Because all the roles are dependent on σ_1 this infon must necessarily be part of the situation. Looking at Table I, it is obvious which situations are impossible: $S_1 ... S_8$. But also S_{10}, S_{11} and S_{12} are impossible, because in these situations people want to observe or help but are not physically OK. At last, S_{14} is impossible because this person wants to help but not observe, which we also ruled out as possible.

C. Semantic strengthening

Now we know which situations are possible, we can determine after which infon we have to ask first. What we are after is an order of questioning, which leads to the roles as defined in the ontology. The roles are defined by their properties, which are represented as infons in the situations. Dependencies result in restricting the possible situations and excluding the impossible ones. But these restrictions are not known by the persons who use our system. In this section we describe a method to preclude the impossible situations or prohibit the assignment of roles not in line with our definition of these roles.

The order of questions can be found by using a method familiar to semantic weakening as described in [4]. With semantic weakening a series from total vacuity to a minimum vacuity is created. A statement has a minimum vacuity when it refers to the minimum number of situations. Total vacuity for a statement corresponds to a tautology in a specific domain because it is always true. Decreasing the number of situations, which are compatible with the true situation, increases the quantity of informativeness. Semantic weakening is done by connecting the infons, which constitute the situation by more and less disjunctions instead of conjunctions. The number of supported situations divided by the total number of possible situations is called the degree of vacuity. When, in the context of a probability experiment, which resulted in Table I, we make the statement $\sigma_1 \wedge \sigma_2 \wedge (\sigma_3 \vee \sigma_4)$, the situations S_{14}, S_{15} and S_{16} support the statement. The situation S_{13} is not supported because σ_3 and σ_4 are both false in this situation and $\sigma_3 \vee \sigma_4$ does not result in a true statement. Two disjunctions results in the (compound) infon $\sigma_1 \wedge (\sigma_2 \vee \sigma_3 \vee \sigma_4)$. This infon complies with even more situations: first off course S_{14}, S_{15} and S_{16}, and then also with S_{10}, S_{11}, S_{12} and S_{13}. When making the statement $\sigma_1 \vee \sigma_2 \vee \sigma_3 \vee \sigma_4$ all but S_1 is supported.

The method we use, *semantic strengthening*, is keeping the truthfullness when bypassing impossible situations. In

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Number	Hypothetical role	Scenario
1	Victim	During the earthquake you were just drinking coffee in the kitchen. When you noticed the first trembles your ran out of the house but unfortunately a lot of debris was falling down and hit you. You have broken your leg and are not able to move. The telephone rings.
2	Not-Active	You woke up in the middle of night when a police car was riding down the street calling everybody out of bed and warning for an immediate flooding. The police warned not to flee but instead look for a high place and take food and drinks with you. You immediately went to the refrigerator took food and drinks and climbed through the bedroom window to the roof. But now you are sitting there and it is getting colder and darker. The streetlights are not burning anymore, probably because the power is down and you hear water streaming but see nothing. You are getting afraid and what is even worse you lost your glasses so you can't see very clear. After a while the telephone rings.
3	Observer	After the first trembles you and your family ran out of your house. Luckily everybody came out of the house and now you are on the street. Your youngest child is only 3 months old and is sleeping now in your arms. Your 4 year old son is very excited and very wild probably because he is afraid. Your wife has quite a job to handle him. Your house has big cracks in it and you are afraid to go inside. Then the telephone rings.
4	Helper	During the earthquake you were walking in the park with your dog. You saw houses collapse and after five minutes when the earthquake seemed have come to an end you went for your house. But your house wasn't standing any more and collapsed like most of the houses in the street. Now you are in the street and the telephone rings.

Table II
A PART OF THE SCENARIOS FOR THE EXPERIMENTS

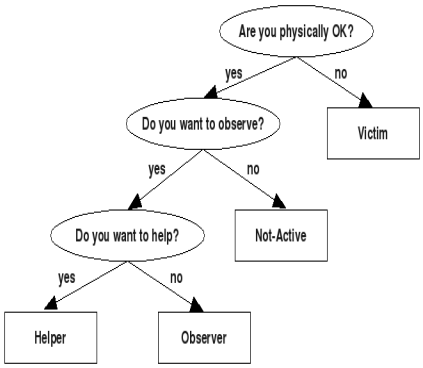

Figure 2. A question tree

our method we place emphasis not on the disjunctions but on the conjunctions. And the conjunctions are placed in such a way that there is no loss of truthfullness and impossibilities are ruled out.

The efficiency of the order of questioning is maximal, i.e., after each answer the total number of situations, as given by Table I is cut in half. It is important to be aware of the order by which the questions are asked. The specific order precludes the impossible situations as an outcome of this questionnaire. With our specific ontology this would result in a question tree as shown in Fig. 2.

III. EXPERIMENTS AND RESULTS

We conducted three experiments to investigate whether the questions we ask to determine the role of the user are indeed self explanatory and lead to appropriate role determination. Different disasters like an earthquake, flooding or a bombing were used to describe a situation where people are involved in, immediately after the occurrence. For each scenario a hypothetical role was envisaged i.e., the specific role, which was implied by the ontology should follow from the scenario. The goal of the experiments was to find out whether human participants answered the questions posed in the same way as hypothesized by our theoretical framework. Examples of the scenarios can be found in Table II.

A. Analysis

For the analysis of the data four measures were computed: the Matthews Correlation Coefficient (MCC) for correlation [8] and the F_1-score for accuracy [12], recall and precision. The MCC (also known as the ϕ-coefficient) is a measure of correlation between what is actual and what is predicted by a system or humans as in this case. Therefore so-called confusion matrices were needed to compute the measures. First is explained how we constructed the confusion matrices, followed by an elaboration on the measures and then the experiments are discussed.

As described in section II, the answers to the questions were used to compute the determination of a role. In the ontology, four roles were defined. To analyse the results as shown in Table III we constructed for each experiment four confusion matrices. An example may be helpfull. Of the four roles each scenario shown to the participants had an expected or actual role, which was envisaged e.g., *Victim*.

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When the participant answered the questions so that the result was that he was a *Victim*, this is marked as "true positive" in *this* confusion matrix. When the participant was determined as being a *Not-Active*, *Observer* or *Helper*, this is marked as "false negative". When another scenario was presented, with another envisaged role e.g., *Helper*, and the participant was determined as *Victim*, this is marked as "false positive" in *this* confusion matrix. When the participant was determined in that scenario as something other than *Victim*, this is marked as "true negative".

We use four measures to interprete the results. MCC is used to tell whether there is a correlation between the actual and predicted values. It is a robust coefficient because it does not deviate when classes of different size are considered. MCC variates between -1 and +1 where -1 indicates a perfect negative correlation and +1 a perfect positive correlation, 0 indicates a random relation. The F_1-score is a measure of accuracy and varies between 0 and 1 where 0 indicates no accuracy at all and 1 a perfect accuracy. The F_1-score is the harmonic mean of the recall and precision. The recall (also called sensitivity or true positive rate) is a measure of how many of the actual situations are determined as such. Precision gives a measure of how many of the predicted situations are actually these situations.

Forty students participated in the first experiment, all of them male and between the age of 18 and 22. Eight scenarios, not very different from the four shown in Table II, were constructed in the english language. Each role was represented twice. The participants were asked to read four of the eight scenarios. These four always represented all four possible roles. As instruction, the participants were told to imagine being in the situation described by the scenario. Each scenario ended with the announcement that the telephone rings and then the participant answered the questions that were subsequently posed in Fig. 2.

The results of the first experiment are summarized in Table III. In this table one can see that actual values were most predicted when the participants were confronted with the *Victim* and *Helper* scenarios. And it shows a bias to the role of *Helper* when reacting on the *Not-Active* and *Observer* scenarios.

When analyzing these figures as in Table IV a very low value for correlation is measured except for the *Victim* scenarios. For the *Victim* scenarios the accuracy is relative high. For the *Not-Active* scenario the correlation is even negative, i.e., it has a reverse correlation. For *Observer* and *Helper* the correlation has a low value. For *Helper* this is a consequence of the high value of "false positive" in the confusion matrix, which is also reflected in the low value for "precision". We then combined the roles of *Victim* and *Not-Active* and *Observer* and *Helper*. The correlation is still low and for *Victim* even declining. But for all other scenarios the correlation is improving. The same can be said of the accuracy.

Experiment 1	Predicted value			
Actual role	Victim	Not-Active	Observer	Helper
Victim	23	4	6	7
Not-Active	2	3	5	30
Observer	2	3	14	21
Helper	1	6	6	27
Experiment 2	Predicted value			
Actual value	Victim	Not-Active	Observer	Helper
Victim	47	1	2	9
Not-Active	11	8	6	34
Observer	3	4	14	38
Helper	5	5	5	44
Experiment 3	Predicted value			
Actual value	Victim	Not-Active	Observer	Helper
Victim	37	0	0	1
Not-Active	1	10	6	21
Observer	1	1	14	22
Helper	0	1	6	31

Table III
RESULTS OF EXPERIMENTS

Experiment 1	MCC	F_1	Recall	Precision
Victim	0,61	0,68	0,58	0,82
Not-Active	-0,05	0,11	0,08	0,19
Observer	0,23	0,39	0,35	0,45
Helper	0,17	0,43	0,68	0,32
Passive	0,28	0,52	0,4	0,73
Active	0,28	0,69	0,85	0,59
Experiment 2	MCC	F_1	Recall	Precision
Victim	0,67	0,75	0,80	0,71
Not-Active	-0,23	0,21	0,14	0,44
Observer	-0,17	0,33	0,24	0,52
Helper	-0,07	0,48	0,75	0,35
Passive	0,44	0,66	0,56	0,79
Active	0,44	0,75	0,86	0,67
Experiment 3	MCC	F_1	Recall	Precision
Victim	0,95	0,96	0,97	0,95
Not-Active	0,39	0,40	0,26	0,83
Observer	0,26	0,42	0,37	0,48
Helper	0,30	0,51	0,74	0,39
Passive	0,63	0,76	0,63	0,94
Active	0,63	0,83	0,96	0,72

Table IV
MCC, F_1, RECALL AND PRECISION FOR THE EXPERIMENTS

Because the first experiment was done with a very homogeneous group of young men we did the second experiment with a more heterogeneous group. Of this group 15.25% was woman and 33.9% of all the participants older than 22 year. In this experiment we also made the scenarios more explicit. Four of these scenarios can be found in Table II. Furthermore, we used a flow diagram per scenario to collect the answers for that scenario. In this experiment the scenarios were read in two groups: the first group read the scenarios 1-4 and the second group read the scenarios 5-8.

The results can be found in Table III. Although the raw results look a lot like those in experiment 1, i.e., the actual role was most predicted for *Victim* and *Helper* and a bias towards

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the role of *Helper*, the analysis is very different as shown in Table IV. The scenario for *Victim* has a relative high value for correlation as in experiment 1 but the other scenarios score a negative value for correlation. When combining the roles as in experiment 1 this negative correlation reverses to a higher correlation than in experiment 1. The number of $0,44$ for MCC is still not high and should be considered "positive" but not "strong positive". The accuracy is also improving as are recall and precision.

In the third experiment 38 students participated, all of them male and between the age of 18 and 22. The third experiment was conducted with a different instruction and a different language. This experiment was in Dutch, which is the native language of most of the people we did the experiment with. We introduced the questions beforehand and gave one example of the dependencies we had defined. The scenarios were the same as in the second experiment (see Table II) but translated of course.

The results can be seen in Table III. As before the actual role was most predicted for *Victim* and *Helper* and the bias towards *Helper* can be seen. In Table IV figures of the MCC F_1, recall and precision are given. As can be seen there is a positive correlation for all the roles and for *Victim* even a very strong correlation and accuracy. When the roles are combined as before this correlation gets stronger for all the roles except for *Victim*. Moreover, the improving of the correlation and accuracy shown in experiment 2 continues.

IV. Discussion and conclusion

Each successive experiment showed an increased correlation between the actual role described in a scenario and the predicted one, which the participants selected after answering the questions. This is shown in Table III, where the predicted role in each column has the highest number of predictions in the third experiment.

As could be expected, adding a flow diagram, using native language and giving an adequate introduction is important for understanding the concepts we use for questioning. Furthermore, we can conclude that there is a difference between the formal definition of the concepts in the ontology and the semantic interpretation people have of these concepts. Morever, the meaning of concepts can, as we have seen, not only vary among people but also between people and systems. This discrepancy is shown in this experiment by different choices people make in answering the questions some of which were formally ruled out by our system. People do not straightforward comply to formal reasoning. This difference is even greater when refering to concepts denoting subjective situations, which intentions such as "the willingness to help" are. Hence, for the sake of disambiguation between such situations, the reasoning that the system does on the basis of the answers of people, ought to be augmented by verifying and confirming the answers provided.

Further research will be done to develop a model of commonsense reasoning in the context of enhancing Situation Awareness. Such a model will consist of basic concepts, which are information-rich and common in use [10]. The system we use will be a "hybrid model", which uses formalized methods to generate questions while incorporating possible mental models.

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Forging Trust and Privacy with User Modeling Frameworks: An Ontological Analysis

Federica Cena
Department of Computer Science
University of Torino
Torino, Italy
cena@di.unito.it

Nima Dokoohaki
Software and Computer Systems (SCS)
Royal Institute of Technology (KTH)
Stockholm, Sweden
nimad@kth.se

Mihhail Matskin
Norwegian University of
Science and Technology (NTNU)
Trondheim, Norway
misha@idi.ntnu.no

***Abstract*—With the ever increasing importance of social networking sites and services, socially intelligent agents who are responsible for gathering, managing and maintaining knowledge surrounding individual users are of increasing interest to both computing research communities as well as industries. For these agents to be able to fully capture and manage the knowledge about a user's interaction with these social sites and services, a social user model needs to be introduced. A social user model is defined as a generic user model (model capable of capturing generic information related to a user), plus social dimensions of users (models capturing social aspects of user such as activities and social contexts). While existing models capture a proportion of such information, they fail to model and present ones of the most important dimensions of social connectivity: trust and privacy. To this end, in this paper, we introduce an ontological model of social user, composed by a generic user model component, which imports existing well-known user model structures, a social model, which contains social dimensions, and trust, reputation and privacy become the pivotal concepts gluing the whole ontological knowledge models together.**

***Keywords*-trust and reputation; privacy; user modeling; ontologies; semantic adaptive social web**

I. INTRODUCTION

Social intelligence according to the original definition of Edward Thorndike is "the ability to understand and manage men and women, [..], to act wisely in human relations" [1]. Some authors have restricted the definition to deal only with knowledge of social situations, where social intelligence is an aggregated measure of social awareness, social progressiveness and interests for new experiences. With the advent of social web, users have the possibility to exploit their social intelligence also in virtual environment, by using available social networking sites and services to maintain contact with other people as well as for sharing contents and experiences. We define "socially intelligent agents" as software agents which are responsible for gathering, managing and maintaining knowledge surrounding individual users in the social web. With the ever increasing significance of social networking sites and services, socially intelligent agents are of increasing value to both computing research communities as well as industries. For these agents to be able to fully capture and manage the knowledge relating to a user's interaction with these social sites and services, a social user model needs to be defined and introduced.

A "social user model" is defined as a generic user model (with generic information about a user [2]), plus social dimensions of users (with social aspects of user, such as social activities, relationships with other users, groups they belong to and social contexts). While existing models (see Section II) capture a portion of such information, they fail to model ones of the most important dimensions of social connectivity: privacy, trust and reputation. To this end, in this paper, we introduce an ontological model of social user, composed by a generic user model component, which imports existing well-known user model structures and captures the basic concepts regarding the user; and a social model, which contains social dimensions. In this model, trust, reputation and privacy become the pivotal concepts gluing the whole ontological knowledge models together. We adopt the definition of "privacy" as defined by Westin [3] as "the right of an individual to determine the amount of information available to other". Privacy is particularly relevant in adaptive systems, since they gather a lot of personal information to provide adaptive services, and in social web, where users share a lot of data to other people. With respect to trust, we consider Golbeck's definition [4]. According to this point of view, trust between two individual exists if the truster executes an action upon understanding that trustee's actions in future will lead to a good outcome or utility for truster. Since our view of trust is reputation-based, it allows us to profile behavior of two individuals in a single relationship. To be able to port such profile across several applications, we have proposed to model reputation separately to profile the behavior or performance of an individual in several contexts.

Our ultimate goal is to propose a model that i) can be used as a reference to model users in the social web context, ii) can be used directly by the adaptive applications, for example, using some mechanism that, given a user, is able to populate such model on the fly according to the user information available on the Web. In this paper, however, we focused on modeling privacy and reputation/trust in social context, and thus in particular we described our models for such concepts. The paper is structured as follows. In Section II, we present existing approaches for modeling users in social web systems, focusing on how they deal with privacy, trust and reputation. Then, in Section III, we describe our application scenario. Sec-

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tion IV briefly describes our framework and all the components involved: user data, domain, context, actions, privacy and trust. Section V focuses on the privacy model, while Section VI focuses on trust and reputation model. Finally, Section VII concludes the paper presenting possible future directions from this work.

II. User Modeling on Social Web: State of the Art

In the user modeling field, there were several attempts to define a generic user model which contains the definition of user features and of his/her physical and social context, expressed with semantic web language and made available for all user-adaptive systems via Internet. In fact, a commonly accepted top level ontology for user and context models is of great importance for the user modeling and context research community. The major advantage is the simplification of using and exchanging user model and context data between different user-adaptive systems. The most known (and adopted) models are the General User Model Ontology (GUMO) [5], the Unified User Context Model (UUCM) [6], and Friend of A Friends (FOAF) [7]. GUMO includes basic user dimensions, such as demographic data, user knowledge, emotional state and personality aspects, user skills, capabilities, user interests, preferences, user goals and plans, etc. Moreover, GUMO also models the environment by representing data like location, time, device, etc. However, the current version lacks of modeling of social data, even if the authors started to work on it [8]. UUCM models several features of the user and his/her situation: cognitive characteristics (area of interest, competence, preference), usage data (current task, task role, task history), social data (relationships the user is involved in), environment data (device, current time, language, location). FOAF focuses more on social data than on user and usage data, since it mainly aims at describing the links between people and the things they create and do over the web. FOAF is weak in defining other user features, such as interests and preferences, knowledge and expertise. Only interests are represented, by means of the ”interest” property, which represents an interest of a user through indicating a document whose topic(s) is of interest for him/her. Describing interests in full is a complex undertaking: FOAF provides no support for characterizing levels of interest.

A recent attempt to model users in the social web has been done by the Grapple project [9]. Within this project, the Grapple User Model Framework (GUMF) is defined for storing, retrieving and sharing information about users between components of the framework. In the framework, the Grapple User Modeling Ontology[10] is proposed, in order to describe all the possible statements about a user, and concepts like creator of the statement, rating of the statement, temporal and spatial dimensions. Most of such existing UM frameworks fail to capture and present privacy policies as well as user's trust statements. GUMO simply has the attribute *gumo:privacy* which defines the default privacy status for each class of user dimensions. UUCM and FOAF do not explicitly model privacy. In GUMF privacy is modeled only with a property (*hasPrivacyPreference*) which expresses the level of privacy concerns of the users. However, privacy in user modeling is a crucial, multidimensional and complex aspect, that cannot be expressed by means of a single property. Personalized interaction and user modeling bear significant implications on privacy, due to the fact that personal information about user needs to be collected to perform personalization [11]. Moreover, Social Web context is particularly challenging for privacy, since social applications gather a lot of data about the user and his/her activities. Thus, the concept of privacy should be decomposed in several dimensions. A first theoretical attempt to define all the privacy dimensions involved in the user modeling process has been made by the Unified Model for Privacy Preferences [12], a formal model which defines the main categories of information in social web context. However, to the authors' knowledge, there are no attempt to integrate such privacy model in a global user model.

At the same time, little attention has been paid to effective incorporation of trust and reputation into user models. Among adaptive Web applications, recommender systems have been quite successful in utilizing and leveraging social trust and reputation. Golbeck first introduced the notion of ontological modeling of trust in semantic social Web [13], [14]. Later on, Golbeck and Ziegler [15] pointed out the importance of profile similarity as a metric to infer reputation-based trust values in a social network and they utilized resulting trust values for improving word-of-mouth style recommendations. Following the Golbeck's ontology, functional models of social trust are proposed. Dokoohaki and Matskin introduce a functional, yet very light-weighted ontology of trust [16]. The semantic model captures the semantics of *relationship* concept, where topic and metric of trust is documented under *MainProperties* of relationship concept, while the context of relationship (e.g. date of relation initiation, goal of it, etc.) is kept under *AuxiliaryProperties* concept. This trust ontology was used later on by Zarghami and Fazeli [17], as the main knowledge model of a trust-based recommendation system. Ontologies of reputation have been proposed as well. Casare and Sichman [18] have introduced a functional ontology of reputation to model reputation of intelligent agents. Since they utilize legal norms, they model social control mechanisms for software agents. As a result, such model becomes suitable for utilization in Social Web as well. Chang et al. [19] propose a basic reputation ontology and an advanced reputation ontology. They also distinguish between the entities towards which reputation is modeled for. Since the major focus is on e-commerce agencies, this model is not entirely suitable for modeling reputation of social users. Main argument for both previous models is lack of quantifiable semantics leading to lack interoperability in between them. Reputation interoperability can be enabled through utilizing semantic technologies [20]. Alnemr et al.[20] propose a functional reputation ontology that can serve as a vocabulary to be utilized in several applications. In this work, reputation is modeled as a complex object *Reputation Object (RO)*. While RO captures the semantics

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of reputation assertions, *ReputationValues* represent the metric for reputation object instances, while the context of reputation is described using the *Criteria* concept, that documents the provenance of the facts surrounding these assertions, such as algorithms used for gathering and computing the values.

Examples of adoption of reputation and trust in user models as pointed out earlier have been limited. Grapple project [9] investigates capturing and utilization of reputation to model the trust between users, by allowing the users to rate each other's opinions and statements, following the eBay model [21]. Adoption of such a plain model of reputation is not successful, nor sufficient in generic and unified models of users, due to several reasons. First of all, rating is an implicit model of reputation, and representing it as a simple form of property-rating or a vector of ratings strips it from its original notion and postulation, according to Alnemr [20]. On the other hand, many systems are already using explicit trust statements to evaluate users, such as Epinions [22]. Second, since trust and reputation convey different semantics on Social Web, then frameworks for modeling users should be capable of describing trust and reputation separately. This difference is pointed out when you introduce a trust model capable of describing trusted peers of a user on a social network, e.g. Facebook or LinkedIn, as well as a reputation model capable of storing and presenting the reputation of user across different communities on-line, such as reputation of a user as a reviewer on Amazon, or reputation of a user as blogger in a blogging community such as Twitter.

III. Understanding Importance of Social User Models in Cross-Systems Personalization

The aim of this section is to better address the advantages of bringing trust and privacy together to improve system's adaptation. We present a brief use case where we describe how our social user model can work in a social web environment. Tom has a strong interest in art and he loves dancing tango. He lives in Turin and he joins iCITY [23], a social community dealing with events and attractions in the city, in order to get suggestion about what to do in the city. Tom use many of the most popular social site, like del.icio.us, Flickr, Facebook and Linked-in. All these social applications collect a lot of data about his current interests, preferences, activities, which make available to other users and other applications. Thus, Tom wants to control the release of such information to other people: for example, he wants that only friends who share the passion for tango with him can see the news about tango he posted on Facebook wall. Furthermore, among such people, he wants that only the people he trusts more can see his score in the latest tango competition, like her friend Jill. Tom is planning a weekend in Florence, and he would like to visit the Institute and Museum of the History of Science in Florence. Smartmusuem application [24] is available for such museum. Smartmusuem is able to collect all the information about Tom the social web applications he interacted with made available and, using them, to build a user model of Tom on the fly. This information can be used to initialize the adaptation process. This model also considers the preferences Tom declared about the release of information to other applications: his personal information can be delivered only to trusted applications which are forbidden to use them for commercial purpose. In particular, the information iCITY maintains about the events Tom has seen, the tags he inserted and the topics he is interested in could be very useful for the museum system to quickly identify his focus of interest and offer him a personalized visit to the museum. Since iCITY agreed on that privacy policy, after the interaction, Smartmuseum will send to iCITY some novel information about Tom that can be used to update the current user model of the application. This scenario can serve as a guideline for re-use of user interaction data generated by one application into another across similar domains. In this way, we illustrated how three user modeling problems can be solved, i.e. (1) cold-start problem in Smartmuseum, that can initialize the user model and start the recommendation from a point closer to user's interests, (2) maintaining an integrated user profile, which reflects larger scope of user interests and activities, (3) the release of information (to other applications and to other people) take the user's preferences for privacy and trust into account. In this paper, we focused on this third advantage. In the current situation, this scenario is far to happen, due to lack of integration among social applications and user data, and due to the lack of policies which integrate trust and privacy.

IV. Our framework for user modeling in the social web

Since modeling the users on the Social Web is a very complex task, an investment is needed for putting these separate pieces together. At the same time, we also aim at bridging the space left by the previous work by considering privacy, reputation and trust, the most crucial concepts within Social Web as the key missing concepts and dimensions surrounding the notion of user on the Social Web. To this end, we have proposed for a user modeling framework within which any user model can be imported and extended with social dimensions and enriched with privacy preferences, reputation and trust assertions. Our model of social web users will contain the following models:

- *User model*, the description of user features according to existing de-facto standards such as GUMO [25], UUCM [6].
- *Domain models* specific for the domain, such as standard domain vocabularies as AAT [26], ULAN [27] for artworks, etc.
- *Context model*, which describes both the physical context (e.g., place, time, etc) and the social context (e.g., relations with other users and roles).
- *User Activities model*, which describes the actions of the users (such as ATOM model [28]).
- *Social data model*, which describes the social data: service data, disclosed data, incidental data, behavioral data, derived data (following Schneier model [29]).

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- *Privacy model*, which describes the main privacy concepts for a user to be able to specify his/her own privacy preferences and policies.
- *Trust and Reputation model*, which describes main trust concepts between two individuals as well as expressing reputation towards a single or a group of individuals.

All such models have been represented as OWL ontologies. In the following, we will describe in more details the Privacy model (see Section V) and the Trust and Reputation model (see Section VI), since they are the main contributions of the paper.

V. Privacy model

According to Kim et al. [30] the most important piece of a privacy-respecting Semantic Web is a privacy ontology that enables agents to exchange privacy-related information using a common language. The privacy ontology should be able to clearly define the various dimensions of privacy (e.g. privacy of personal behavior vs. privacy of communications), and contain enough parameters and index terms to enable specification of a privacy policy in a standard machine-understandable format. It should be descriptive enough to specify the highest known standards of data protection and privacy. Following former suggestions, we have defined a light-weight privacy ontology in OWL-2 which describes the main concepts of privacy in a social context, and the relations among such concepts. We took inspiration from the Unified Model for Privacy Preferences [12] (see Section II).

We also use some of the concepts OWL-S privacy ontology [31], a simple and easy-to-use ontology for expressing privacy policies as well as a protocol to support matching of such policies among Web Services. However, we developed our own ontology, since our point of view is the user in a social context, and not the provided services, as in that case. Our goal was to have a model that is platform independent and can be used in different contexts, able to cross the borders of social platforms (the so called Walled Garden of the Social Web [12]), and expressed by the means of semantic web language to promote interoperability among applications. As we will see, some portion of the ontology has been imported from OWL-s ontology, for re-usability purposes. We have defined the following main concepts[1].:

- **Who** (the recipient of data): individuals (friends, family members, colleagues, companions, etc); agents; organizations*, business*, government agency*
- **What** (the data that are the objects): user model**, context model, domain model (link to some domain ontology), social model***.
- **When** (retention time): week day (working days, week end), day hours (morning, afternoon, evening)
- **Where** (place the data are physically stored): address, location information (link to some geo ontology).

[1]Notice that the dimensions signaled with: * means that they are imported from the OWL-s ontology; ** imported from the GUMO ontology; *** imported from the Grapple model.

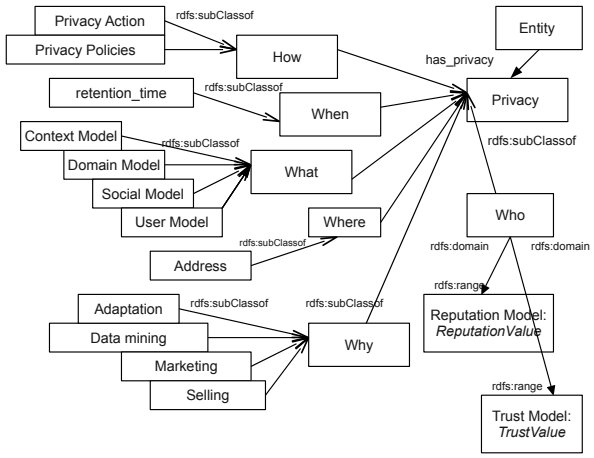

Fig. 1. The privacy ontology

- **Why** (purpose why the data are collected): to be processed (for adaptation purpose, for marketing purpose, for inference purpose, for data mining purpose), to be sold, to be transmitted.
- **How** (process made to the data): data protection techniques; privacy actions*, privacy policies*.

Figure 1 visualizes the privacy ontology representing the taxonomy of the involved concepts.

This ontology model allows then to define privacy policies according to such information. A set of SWRL rules for describing privacy policies can be defined for each specific users; in particular, ”what” and ”who” associations have been chosen as a first domain. An example of rule is the following (we omitted prefixes to enhance readability): it can express the fact that a user can let his/her colleagues see where she is or access her calendar activities only between 8am and 5pm on the weekdays but not over the weekend.

$$\text{Location}(?x) \wedge \text{Tasks}(?y) \wedge$$
$$\text{Day}(?v, \text{Working\_days}) \wedge$$
$$\rightarrow \text{can\_be\_disclosed}(?c, \text{Collegue})$$

The choices about privacy policies are largely subjective, and cannot be defined at priory, but it depends of course on the users preferences and situations conditions. Therefore, privacy policies are not a priority at this stage of the project, and they need further investigation.

VI. Trust and reputation model

Artz and Gil [32] categorize the notion of trust in computer science domain into three main categories: policy-based trust, reputation-based trust and general models of trust. While Semantic Web has benefited from research of all three subcategories, it is well-accepted that a Social Web model of trust is reputation-based. Golbeck first referred to such model as a Web of Trust [13]. A Web of Trust is a directed-edge network between a group of entities (or resources), within which each link carries a trust value and, assuming a transitivity of

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trust, reputation can be collected and inferred for each single individual across such network. Within the context of Web of Trust [13], reputation can be defined as a measure of trust, within which individuals can gather and maintain reputation of other individuals across the network. To express trust and reputation information we have used ontologies allowing for expression and quantification of trust for use in algorithms to make a trust decision about any two entities [16], e.g. Tom trusts Jill highly with respect to dancing. We propose for a combined model of social trust and reputation, bearing in mind the details described previously. To model the trust we adopt the concepts of Dokoohaki's ontology [16], and for reputation we adopt the concepts of Alnemr's ontology [20]. We fuse two sub-ontologies together using a new concept, called *Context* for modeling both trust relations and reputation concepts, through which contextual details of trust and reputation can be captured and stored. While ontologies of trust have allowed for expressing trust between two individuals, it is important to be able to express collective knowledge of trusted opinions about an entity as well. This form of reputation demands a model capable of documenting reputation assertions on its own without pointing to provenance of the assertion of trust [20], e.g. Jill is well-known for her skill in dancing. While trust ontology enables us to model a trust network of social inter-relations, extended ontology of reputation enables us to model assertions of reputation seperately as well. This way we can fully capture the semantics of reputation-based trust on social web. Following previous discussion, we model trust and reputation using concepts below:

- **Trust** (Main concept of trust): Abstract trust (relationship).
- **Relationship** (Connection between two trusting peers): Relationship is the most important concept of our trust model. Relationship always has a sink and a source, which we have described here as *truster* and *trustee* entities. We have used two exact cardinalities on *hasTrustee* and *hasTruster*, in order to state having exactly one truster and one trustee per each relation.
- **Entity(Truster)** (Source of trusted relation): We distinguish between source and target of trust as a trust network is always a directed graph [13]. We distinguish between source and target of trust as a trust network is always a directed graph [13].
- **Entity(Trustee)** (Sink of trusted relation): Same as Truster, the target or sink of trust relationship. We need both entities to be able to determine the credibility of statements issued.
- **Trust Topic and Value** (Main properties of trust): Every trust relation is established surrounding a topic and is quantified using a metric. Following this assumption, we use main properties concept to model the subject and value of trust. Restrictions allow us to assign a single value and subject for each single relation subject to trustworthiness modeling.
- **Context** (Context of trust): Contextual properties of trust is realized using this concept. Defining context for trust relations allows us to specify functional or non-functional auxiliary properties of trust in our model. In the case of functional properties, for instance the algorithms used to gather and compute the trust values can be presented. For instance, we might use spreading activation [33] for gathering trust values, or T-index[17] for computing the trust values. Having context allows us to record the time, date or location that such relationship was established or the type of social network this relation was created, such as business in the case of Linkedin. We use this concept to merge Trust model to Reputation model by defining Context as superclass of Criterion (see figure 2).
- **Reputation** (Reputation assertion): A Reputation assertion about an entity. Using this concept we can assert and define reputation for any entity (person, organization, group). The model adopted here allows us to define completely mention the trust statements used to .
- **ReputationValue** (reputation metric): Reputation of an entity (truster) is quantified and stored using instances of this concept. We can use the *current value* to represent the current reputation score while collection of reputation values asserted can be stored in *history list*. This allows us to gather and store all explicit (trust) or implicit (votes) statements towards an entity. Gathering provenance about an entity's reputation history allows us to later on assess the credibility of statement issuers. concept of *PossibleValues* allows us to define different ranges and values for reputation and store them together.
- **Criterion** (Context of reputation): Contextual properties of reputation is realized using this concept. Defining context for reputation assertions allows us to specify functional or non-functional auxiliary properties of reputation in our model. In the case of functional properties, the algorithms used to gather and compute the trust values can be presented. For instance, we might use a simple web crawler for gathering trust values, or we might utilize *Sum or Bayesian* functions for computing reputation scores [34]. Similar to trust, having criterion allows us to record the time, date or location that reputation was asserted.

Figure 2 visualizes the trust and reputation ontologies, representing the taxonomy of the involved concepts.

We aimed at proposing an interoperable model for embedding trust and reputation into any user-centric adaptive system, as well as sharing statements and assertions of trust and reputation across multiple systems. Thus any model of trust and reputation modeled for social context, should be capable of being aligned with our model. Taking this into account we avoid making choice between metrics for either trust or reputation. This should also be mentioned that choice of metric is also heavily dependent on application, user behaviour as well as data at hand. As a result choices of metric or algorithms are not a priority at this stage, and we will investigate further

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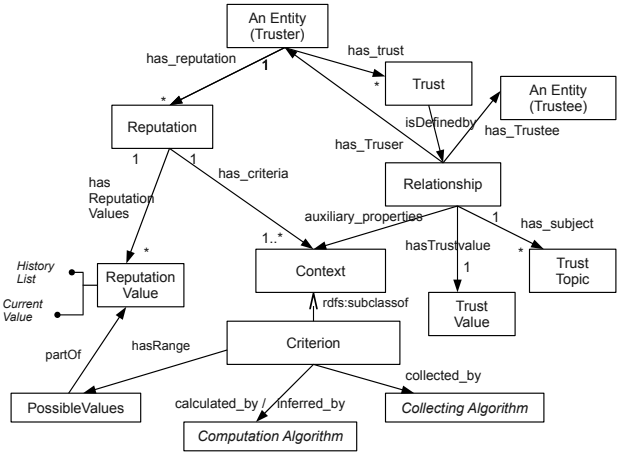

Fig. 2. Trust and reputation ontologies

which metrics or mechanisms suite best for similar scenarios.

VII. Conclusion

In this paper, we have presented an approach for modeling the user in Social Web. The goal of our research work is to study how to put together all the standards and initiatives separately made by different entities in order to provide a complete model of a user which interacts with social web context. More in details, the main contribution of our work is to propose a model of user in a social context:

- that can be used as a reference to model users in social web context;
- which contains explicit modeling of privacy and trust dimensions, that usually existing models do not consider all together;
- that can be directly used by socially intelligent agents and by adaptive systems, populating and consuming it using real user data.

In our future work, we are planning to exploit the model in a existing social recommender systems, and evaluate the impact in recommendations and the final user satisfaction.

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Taking into account Tabbed Browsing in Predictive Web Usage Mining

Geoffray Bonnin, Armelle Brun and Anne Boyer
LORIA – KIWI Team
Campus Scientifique – BP 239
54506 Vandoeuvre-lès-Nancy Cedex, France
{*geoffray.bonnin, armelle.brun, anne.boyer*}*@loria.fr*

***Abstract*—Over the last few years, browser tabs have become a very common tool for web users and have been extensively used to perform parallel navigations. Tabbing facilitates web browsing but results in an imbrication of navigations, which makes it more difficult to understand users' behavior. That is why very recent research has been focusing in analyzing this new kind of usage. This work follows a previous publication in which a new model was proposed to model parallel browsing. In this paper, we propose a new strategy to better take into account tabbing activity. Experiments are performed on an open browsing dataset. Results show that our model provides an accuracy similar to the one of a state-of-the-art model that implicitly takes into account parallel browsing. It thus constitutes a strong basis to estimate tabbing activity. We then present the statistics about parallel browsing that our approach provides.**

Keywords-web usage mining; web predictive modeling; Markov models; tabbing

I. INTRODUCTION

Parallel browsing consists in performing several web navigations at the same time by successively switching from one to another. Until the late 90's, this activity could only be performed by using several browser windows. At that time, studies showed that multiple browsing windows were used less than 1% of the time [9], [27]. Since 2000, when the Opera browser first introduced the *tab* mechanism, it has been possible to perform parallel browsing within one single window. From that time, this feature has progressively been offered by every web browser. Numerous recent studies have shown how much this simple interface changed user behavior, and how much current web users extensively perform parallel browsing [15], [18], [29], [30]. The same conclusion can also be drawn from the Test Pilot data provided in April 2010 by Mozilla Labs [2]. Indeed, we performed a quick analysis of this data and found that every single user had performed tabbing, and that more than half of the users had used more that ten tabs during one session.

It is thus clear that parallel browsing has now become a very common activity. Such an information means that traditional web usage mining approaches [19], [25] can no longer be used in their linear form and that new strategies have to be studied. One of the major application of web usage mining is predictive modeling. Indeed, predictive modeling is useful for many purposes such as web page research [26], latency reduction [23], arrangement of the links in a website [11], web recommendation [20], etc. The most popular techniques used in this domain are association rules [3], sequential patterns [4] and Markov models [22], none of which takes into account parallel browsing. The usual challenge of predictive modeling is to provide a model that is a trade-off between predictive accuracy, coverage, and space and time complexity [5], [7], [13], [22].

When a user performs several parallel navigations using several tabs or several windows, then the resulting session recorded in the logs is an imbrication of linear navigations that cannot directly be identified. This phenomenon is illustrated in Figure 1: a user performs two parallel navigations $\langle A_1, A_2, A_3\rangle$ and $\langle B_1, B_2, B_3\rangle$ using two tabs, which induces the mixed session $\langle A_1, A_2, B_1, B_2, A_3, B_3\rangle$ to be recorded in the logs. Although it is possible to avoid this phenomenon by including tabbing information directly within the logs, as done for instance in the Mozilla Labs Test Pilot data, usual logs do not contain this kind of information. Thus, dealing with the retrieval of linear navigations from such raw logs seems a very promising way to enhance the accuracy of web predictive modeling.

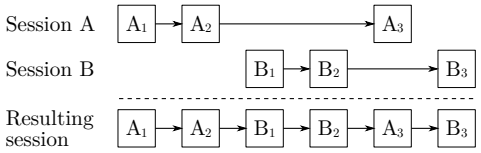

Figure 1. Imbrication of two linear navigations through parallel browsing

In a previous work, we proposed a new model for tabbed browsing called Tabbing-Based All-k^{th}-Order Markov model (TABAKO) [6]. In this paper, we propose a new strategy to extract linear sessions that puts away the concept of tasks. We show that the resulting version of the TABAKO model provides an accuracy comparable to the state-of-the-art and as it explicitely models parallel browsing, it can be used to accurately measure tabbing activity.

The rest of this paper is organized as follows. We are first interested in works related to parallel browsing. We then present our new proposition to model parallel browsing in Section III. Experimental setup is specified in Section IV and the results of our experiments are discussed in Section V.

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Conclusion and perspectives are put forward in the last section.

II. Related Work

In this section, we first present previous works in the field of predictive modeling that take into account parallel browsing. We then turn to the only work, to best of our knowledge, in which tabbing activity is estimated from raw logs.

A. Predictive Modeling for Parallel Browsing

Before the existence of the tabbing mechanism in recent browsers, several approaches had been proposed to discover and refine sessions in web usage data, some of which can be compared to our purpose. For instance, Chen et al. [10] proposed to use a concept called *Maximal Forward Reference* (MFR), *i.e.*, the minimal path from a start page to a target page. More precisely, a MFR is obtained by filtering backward references that are induced by the use of the back button. The major difference with such approaches is that they do not allow to take into account the imbrications induced by the use multiple tabs or multiple windows.

More recently, some works have dealt with approaches that are able to implicitly take into account parallel browsing. In this scope, Jin et al. [17] proposed a web recommendation system able to discover task-level patterns. The authors use probabilistic latent semantic analysis to characterize users' navigational tasks. They then use a Bayesian updating to compute the probability of each task being performed according to a given active session. Then recommendations are computed using a maximum entropy model in which one of the features uses a first-order Markov model. In the same spirit, we proposed in [5] to implicitly take into account parallel browsing by using a skipping-based model. This model is based on a non-contiguous Markov model and computes recommendations based on a weighted combination of subhistories, *i.e.*, small subsequences of user's current session.

In [12], Chierichetti et al. propose to use a simple branching process that captures the opening, switching and closing of tabs to enhance a simple Markov model. The distances from true distributions of this model and PageRank [8] are then compared. Results show that taking in to account tabbing enhances the accuracy of the modeling. However, the data used by the authors contains information about the source node from which users arrive to each page, which allows to deduce information about tabbing activity. Such an information is not commonly available. Also, handling such a branching process induces a large time and space complexity and is not appropriate for common web usage mining applications.

In this paper, we thus focus on the ability to explicitly model parallel browsing and imbrications of navigations without any specific information about tabbing activity.

B. Tabbing Activity Measure

To the best of our knowledge, the work of Viermetz et al. (2006) [28] is the only work in which tabbing activity is estimated from logs with no explicit information about tabbing activity. Such an estimation is obtained by building what the authors call a *clicktree model*, *i.e.*, a tree into which all the possible tabbed paths of user logs are stored. Using this model, the authors estimated that users perform tabbing from 4% to 85% of the time, which is a quite large range. Moreover, as for the work of Chierichetti et al. [12], handling such clicktrees involves huge time and space complexities and is not appropriate for common web usage mining applications.

As will be shown in this paper, the model we propose provides an accurate estimation of tabbing activity while having a low time and space complexity.

III. A New Strategy for the Extraction of Linear Sessions

As mentioned in the introduction, we proposed in [6] a first model for parallel browsing we called Tabbing-Based All-k^{th}-Order Markov model (TABAKO). We first briefly recall the principles on which it is based and then present our new strategy to extract the linear sessions. The rest of the functioning of the TABAKO model remains similar.

A. Overview of the Previous Work

Our previous work was based on a concept we called *tasks* and defined as being a typical sequence of resources that can have several slight variations. We further defined this concept through a global alignment algorithm, *i.e.*, the aforementioned variations correspond to insertions, deletions and substitutions in the sequence of resources. More specifically, we considered that two sessions correspond to a similar task if the score of their best global alignment computed using the Needleman-Wunsch algorithm [21] was greater than a predefined threshold t_1. In the same spirit, we also considered that a session X is a subsession of Y if the score of their best local alignment using a modified version of the Smith-Waterman algorithm [24] was greater than a given threshold t_2. Thus, the basis idea was to say that if a session contains two different tasks, then this session is not a linear session.

The general functioning of the TABAKO model is the following. First, the linear sessions of the training corpus are first extracted using the aforementioned corpus and then stored in order to be used during the prediction step. Second, the model is built exactly as an all-k^{th}-order Markov model [22], except that only the linear sessions are used to train the model. Then, predictions are computed in two steps: (1) the extraction of the best overlapping and the extraction of the corresponding linear sessions, and (2) the creation of the prediction lists by applying the all-k^{th}-order Markov model on the retrieved linear subsessions.

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B. Improvement of the Extraction of Linear Sessions

We focus here on a new strategy for the extraction of the linear sessions within logs. It is based on the following considerations. First, the concept of tasks we defined in our previous work may conflate several different concepts that, while related, are not necessarily comparable. In particular, it is possible that a user performs one single task using several tabs. Also, there is no evidence that the notion of sequence alignment we used does correspond to actual tasks performed by users. Last, such a strategy involves the computation of many sequence alignments and induces a high time complexity.

The strategy we propose here consists in putting away the concept of tasks and thus putting away sequence alignment algorithms. Two important changes are then induced. The first is the replacement of the local alignment algorithm used for the identification of subsessions by a direct matching algorithm. As will be discussed in the following, this reduces the time complexity of the algorithm. The second consists in not performing the task discrimination step, which allows to take into account the situation when a user opens several tabs to perform one single task. Thus all previous considerations are taken into account, and the integration of the resulting algorithm into the TABAKO model should enhance its accuracy.

The general functioning of the extraction of linear sessions can then be summarized as follows: given a session s, we first check whether a session ℓ_1 in the corpus is a subsession of s, *i.e.*, each element of ℓ_1 can be found in s in the same order. If such a session is found, we remove the corresponding elements in s, which results in a new subsession r. We then check whether a session ℓ_2 in the corpus is a subsession of r. If such a session is found, then s in not a linear session. The corresponding algorithm is detailed in Algorithm 1. The idea behind the algorithm is that some of the sessions recorded in the logs correspond to linear navigations, *i.e.*, they are performed using a single window and a single tab. Thus, these sessions can be used to detect the imbrications within the non-linear navigations.

The rest of the functioning of the TABAKO model remains the same, except that subsessions are identified through an exact matching algorithm.

C. Time Complexity

We now focus on the time complexity of the algorithms. We first consider the time complexity of the algorithms used for the identification of subsessions. Recall that the purpose of this process is to determine whether a session ℓ is a subsession of a session s. Using a direct matching algorithm, the time complexity is $\mathcal{O}(|\ell|+|s|)$. Using a sequence alignment algorithm, the time complexity is $\mathcal{O}(|\ell| \cdot |s|)$. Considering that the sessions of the corpus have a maximum size of M, the respective complexities are $\mathcal{O}(M)$ and $\mathcal{O}(M^2)$. Thus, using a direct matching algorithm for the identification of subsessions induces a very smaller time complexity.

Algorithm 1 Extraction of the linear sessions

```
Input: A list of sessions S
Output: The corresponding list of linear sessions
  for all session s in S do
    for all session ℓ1 ≠ s in S do
      if isSubsession(ℓ1, s) then
        r ← s − ℓ1
        for all session ℓ2 in S do
          if isSubsession(ℓ2, r) then
            remove s from S
          end if
        end for
      end if
    end for
  end for
  return S
```

We now consider the time complexity of the general algorithm for the extraction of linear sessions. Using our new proposition, each session s of the corpus is compared to all the other sessions until a matching subsession ℓ_1 is found using a direct matching algorithm. Thus, for each session s, if the training corpus contains N sessions, the corresponding time complexity is $\mathcal{O}(N \cdot M)$. Once such a subsession ℓ_1 has been found, the matching elements are removed from s, and another subsession ℓ_2 is searched in the training corpus, which is also perform in $\mathcal{O}(N \cdot M)$. Thus, the time complexity of the general algorithm is $\mathcal{O}\left(N \cdot (N \cdot M + N \cdot M)\right) = \mathcal{O}(N^2 \cdot M)$. Using our previous proposition, each session s of the corpus is compared to all the other sessions to find all possible subsessions using a local alignment algorithm, and then all such subsessions are compared two by two using a global alignment algorithm until two of them correspond to different tasks. The corresponding time complexity is $\mathcal{O}(N^3 \cdot M^2)$. Thus, our new strategy has a very lower time complexity.

IV. Experimental Setup

A. Evaluation Metric

In order to evaluate the accuracy of our model when our new strategy is integrated, we use the *hit ratio* [14], [16], [22]. For each session of the test corpus and for each browsing step, a prediction list of size m is built, containing the most probable resources according to the model. A hit means that the resource the active user has actually consulted is in the list. In the following experiments we use lists of size 10.

B. Data

Empirical studies are performed on the CTI web server corpus of the DePaul University [1]. It contains 69,471

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consultations of 683 pages by 5,446 users during a two-weeks period in April 2002 (*i.e.*, about 170 consultations per day). The data provided has been cleaned and filtered by eliminating sessions of size 1 and low support page views.

When a session starts, the highest order Markov model that can be used is a Markov model of order 0. As well, after a user has browsed one resource, the highest order Markov model that can be used is a Markov model of order 1. Thus, the differences in predictive ability between more sophisticated models only appear beyond this scope and sessions of size 1 and 2 are not interesting for this purpose. That is why we also eliminated sessions of size 2 from the corpus.

The repartition of session sizes of the resulting corpus is depicted in Figure 2. As it can be seen, most of the sessions (66.0%) have a size between 3 and 5. The corpus has an average session size of 5.9 and a standard deviation of 4.1. Assuming that small sessions are more likely to be linear, we can guess that the proportion of linear session is more than 66.0%.

The corpus has been divided into a training and a test set of 90% and 10% respectively.

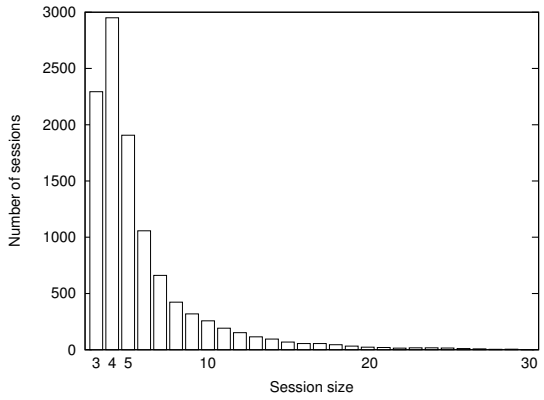

Figure 2. Session sizes of the DePaul university browsing dataset

V. Experimental Results

This section is dedicated to the results of our algorithms. We introduced a new strategy to extract linear sessions from logs, which is one step of the functioning of the TABAKO model. We first study the impact of this change on the accuracy provided by the model. In this frame, we compare the model to the previous proposition and to the state-of-the-art. We then put forward the ability of our model to measure tabbing activity and present the statistics about parallel browsing it provides.

A. Comparison to the State-of-the-art

We are first interested in the accuracy of the TABAKO model when the concept of tasks is put away. We also compare our model to one of the best performing models of the state-of-the-art, the SBR model. This model implicitly takes parallel navigations into account and have already proved its high modeling accuracy [5].

Hit ratios of the old version (with tasks) and of the new version (without tasks) of the TABAKO model, and of the SBR model are presented in Table I. First, we can notice that compared to the previous version of the TABAKO model, the accuracy is enhanced by 12%. This confirms that the concept of tasks we used in our previous proposition is not suited for modeling parallel browsing and puts forward the better relevance of our new strategy.

The most interesting result is that the new version of the TABAKO model provides results similar to the ones of the SBR model. The fact that the model provides similar results is interesting because it explicitly takes into account parallel browsing. This means that this new version of the TABAKO model now constitutes a strong basis to estimate statistics about tabbing activity.

Table I
Comparison to the state-of-the-art

	TABAKO (no tasks)	TABAKO (tasks)	SBR
Hit ratio	**60.1**	54.7	60.1

B. Estimation of the Tabbing Activity

We are now interested in the ability of our algorithms to estimate tabbing activity. Recall that one of the major difference between models like the TABAKO model or the SBR model on one hand, and previous contributions of the state-of-the-art that tried to refine sessions in web usage data on the other hand, is the ability to model imbrications of navigations. However, so far, no information guarantees that such imbrications are contained within the dataset on which we experimented. Thus, we are not only interested in estimating the proportion of non linear sessions, but also the proportion of sessions that contain imbrications. The corresponding results are presented in Table II.

As it can be seen, very few parallel navigations are detected: only 11.7% of the sessions are considered as being non linear, although recent studies show that most of the navigations are not linear [15], [18], [29], [30]. However, this value is plausible for three reasons: first, the data dates back to 2002, and tabbing may not have been much used at that time. Second, studies indicating more than 50% of parallel browsing are based on inter-sites navigation, whereas this corpus contains intra-site navigations, which are less likely to involve parallel browsing. Last, as it can be seen in Figure 2 of Section IV, most of the sessions in this corpus are rather small, and thus may not contain parallel browsing. This last consideration is confirmed by the fact that the

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Table II
STATISTICS ABOUT TABBING ACTIVITY

Proportion of linear sessions	88.3%
Average size of linear sessions	5.0
Standard deviation for linear sessions	2.7
Proportion of non linear sessions	11.7%
Average size of non linear sessions	12.2
Standard deviation for non linear sessions	6.7
Proportion of imbricated sessions	2.0%

extracted linear sessions have an average size of 5.0, while the extracted non linear sessions have an average size of 12.2.

Focusing on the imbrications, we can see that 2.0% of the session do contain such imbrications. As 11.7% of the sessions are not linear, this means that when a user uses several tabs, the corresponding sessions are imbricated linear navigations 17% of the time. This argues in favor that although dating back from 2002, the dataset on which we performed our experiments did contain parallel browsing and that it is necessary to use algorithms able to take into account this phenomenon in order to build accurate predictive models. As parallel browsing was still a new usage in 2002, this proportion should be higher in more recent data. Thus, the difference in accuracy with models that do not take into account imbrications should be higher.

Generally speaking, the statistics provided by the TABAKO model seem likely to correspond to the reality of this particular data, and are further consolidated by the predictive accuracy of the model. Thus, although this model seems to constitute a reasonable tool for measuring tabbing activity, it should be further experimented on a newer dataset.

VI. CONCLUSION AND FUTURE WORK

In this article, we focused on predictive modeling for parallel browsing. We proposed a new strategy for the extraction of linear sessions from logs in which no information about parallel browsing is provided. We then integrated this new strategy into a previous proposition called the Tabbing-Based All-k^{th}-Order Markov model (TABAKO). The new version of the model has a drastically lower time complexity and allows to take into account the case when a user performs one task using several tabs.

Our model was studied on an open browsing dataset, and provided an accuracy similar to one of the best performing state-of-the-art predictive model. We then concluded that it constitutes a strong basis to estimate statistics about tabbing activity. These statistics show that very few parallel navigations are contained in the corpus, which is plausible according to its age. Moreover, the statistics show that imbrications are contained in the navigations, which argues in favor of the necessity to use algorithms able to take into account this phenomenon in order to build accurate models.

In a future work, we plan to enhance the predictive accuracy of the model by investigating two new strategies. The first one is to propose a new incremental algorithm for the extraction of linear sessions, by first considering the smallest sessions as being linear and then moving to larger sessions. The second is to propose a new algorithm that uses a tree structure to determine the best imbrication of linear sessions in each non-linear sessions. We also plan to incorporate other elements in the modeling of web navigation, such as the use of the back button, which was not explicitly taken into account in this work.

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Brave New World? Political participation and new media

Maria João Simões
Department of Sociology
University of Beira Interior, Covilhã
Researcher at Research Centre of Social Sciences (CICS),
University of Minho, Braga
Portugal
e-mail: mariajoaosimoes@sapo.pt

Antónia do Carmo Barriga
Department of Sociology
Researcher at UBI_CES
University of Beira Interior
Covilhã, Portugal
e-mail: acab@ubi.pt

Nuno Amaral Jerónimo
Department of Sociology
Laboratory of Online Communication
University of Beira Interior
Covilhã, Portugal
e-mail: nunoaj@gmail.com

Abstract— **This paper intends to highlight the role played by new social media upon citizens' political participation, their challenges and inequalities, like what has been thoroughly studied for traditional media. New media, also called social networks, like Twitter or Facebook, have been glorified as the universal public sphere, a promising new "café". This paper intends to discuss, in a more realistic and reflexive way, the use of some internet platforms, contradicting the excessive optimism that always arises whenever a new ICT (information and communication technology) emerges. We intend to reposition the social conditions that impact on digital political participations, namely the historical context, the social inequalities and the role of traditional media on political participation. Acknowledging the theoretical proposition stating that political participation (both in real or digital worlds) is stratified, this paper states that there is also a stratification of social media, regarding different levels of uses and goals, and that participation skills needed before social media ever existed are still necessary to participate via new media, an undervalued issue in new media studies. Similarly to other tools, Facebook and Twitter do not change the political situation by themselves. Although this transformation can be enabled by those tools, it all depends on the social, political and historical contexts. Finally, it is recognized that traditional media are also important to make political participation through social networks relevant in the real world.**

Keywords – political participation; new social media; social inequalities

I. INTRODUCTION

When a new technology appears in the field of information and communication, a broaden debate about its democratic potential is inevitable. It happened with the ICTs, the forums, the blogs and it is happening now with the Web 2.0, also designated social media. We face theoretical frameworks with opposite thesis, from optimistic authors, namely Rheingold [1] and Dahlgren [2], who pointed out the transformation of the field of political participation through the use of new technologies, to pessimistic authors, namely Moore [3] and Sunstein [4], who referred that (new) ICTs do not produce significant changes in political participation.

At the empirical evidence level, several researches point out to contradictory results. Thus, within the field of the impacts of (new) ICTs in political participation and democracy it seems that there is a long way to go, either from the theoretical and the empirical point of view. Thus, our contribution intends to discuss in a more realistic way the use of some internet platforms, contradicting the excessive optimism underlying technological deterministic approaches that do not take into account social and power inequalities as well as social and historical environments, both of which contribute to unequal uses of these technologies.

We will focus the analysis upon two levels. First, we will discuss that human societies are structured according to gender, age, income, social and professional category and ethnic group, and we will observe that the interest to participate and the necessary skills for (e-)participation are also unequally distributed. Second, it will be argued that new media are responding to new forms of political participation which are mediated by social and historic environment, clarifying the constraints of these forms of participation in digital environment; also, it shall never be forgotten how traditional media are still decisive to political participation.

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II. POLITICAL PARTICIPATION: FROM OLD TO NEW SOCIAL INEQUALITIES

A crucial issue in political sociology is the inequalities regarding political participation. Therefore, it would be a paradox if this paper did not approach these inequalities also in the virtual political participation field.

A. Social inequalities in political participation

In western democracies, the recognition of political rights and political equality before the law exist together with a structured social hierarchy around several social factors as: gender, age, income, education, social and professional category, ethnic group, residence and so on [5]. The interest, the sense of duty to participate and the political competences and efficiency are also unequally distributed [6].

For Memmy [7], these inequalities can be found in all political activities, reproducing also in political parties themselves and even within the same socioeconomic group. Verba and Nie's studies [8] in the United States, establishing a relationship between political participation and socioeconomic condition, and Bourdieu's [9] in France, focusing in competences and interest for politics, are very illustrative in this matter.

The researches about political (in)competences are influenced, to a large extent, by the crucial role of education in political involvement, very well explicit in the theoretical proposition "all political practice has a character eminently intellectual, it consists, in most part of cases, in the use of words and concepts" [10]. For the author, the political initiative and practice come from a reduced number of individuals and consists in discourse production and reproduction.

This relationship between political skills and political participation variables implies the definition of scales/kinds of political participation that can go from degree zero – the more simple activities as voting – to more complicated – as writing a discourse or a petition or actively participate in a political organization, being the political activities allocated on the top of the scale more skill demanding than the allocated ones on the basis.

Despite the impact of social inequalities in political participation, it would be simplistic not to list other social factors that may influence political participation and reduce, to a certain extent, the referred inequalities. Among those factors are the valued and conscious belonging to a community, the organization of political systems, the stimuli to participate and the citizenship model (liberal or active).

Some authors – the most optimistic towards new technologies – underestimate or do not even take into account in their researches the crucial issue of political skills regarding political participation. According to their technological deterministic approach, new technologies are just enough to create political involvement.

B. From citizens' political participation inequalities to new media segmentation, according to those divisions

Should the unequal distribution of political participation be mitigated or reinforced by the employment of ICTs? For Dijk [11] there are strong probabilities for the second to occur, albeit this thesis can only be tested through researches carried out for several years. Nevertheless, Dijk's doubts are still very optimistic, as no technology can extinguish any major social inequality.

In the top of the scale rests an active political elite, who uses the more advanced electronic tools to improve their political activity, contributing with ideas and solutions, actively participating in decision-making and using different tools, among other activities. A large agglomerate of people is placed in the bottom of the scale, fitting in the last levels and kinds of political participation, which we can name as "mouse click" participation, i.e., voting in electronic polls, which is seldom reflexive and often immediate (Figure nº 1).

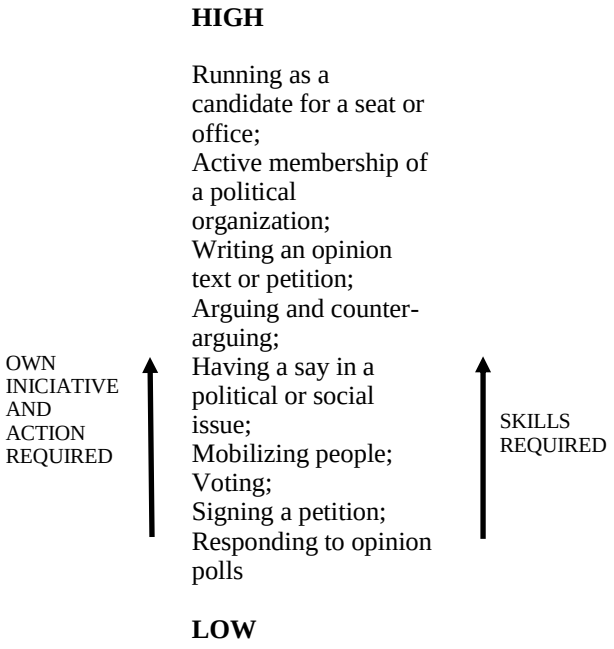

Figure 1. Adapted [12]

Below the latter layer, out of the participation scale, there are the actual excluded: those to whom ICTs are not accessible.

A research on digital political participation in Portugal carried out by Simões [13], between 1998 and 2002, confirms and enlarges Dijk's thesis according to the following propositions.

First, digital political participation is socially stratified, like in real world context, allowing, in the case of digital political participation, to highlight added and more selective processes of social filtering.

Second, social differentiation factors, as gender, academic qualifications and professional category filter citizens who participate both in the real world politics and in the digital one. Those factors are also liable for socially

stratified access to ICTs, thus pointing to a double filtering process regarding digital political participation. The distribution of skills to operate electronic devices is also stratified; the skills of those inquired cybercitizens are higher with common tools, decreasing as technological sophistication increases, idea also stated by Breindl [14].

Third, we should not ignore the filters that have been placed before and after, like the attempts to control speech, the surveillance processes and the increasing trend to paid contents, being the first two a significant threat to autonomy, a fundamental basis to the free expression of ideas [15], and the last one a reinforcement of information access inequalities [16].

To each of the differentiated political uses, which kind of electronic tool do cybercitizens use?

The reflection about the online tools chosen for different types and levels of political participation suggests that, in spite of the multifunctional character of some electronic tools, these are, to a large extent, being placed in a hierarchy according to types and levels of political participation.

At the top of the scale there are the e-NGO's, e.g., Avaaz.org – The World in Action. This is actually a political organization, which implies the involvement and mobilization of its members, with its cognitive resources and skills to engage in political participation. Those resources are crucial to create political discourse, to organize and lead struggles at a global scale using a permanently updated website, which is the basis for mobilizing citizens for concrete actions, often with joint organizations for particular deeds, including drafting petitions or letters in order to send them to international organizations or national governments.

Below that, we find the layer of blogs centred in a more systematic, more argumentative and deeper level of political opinion and discussion [17]. These are tools created and used most of the time by skilled individual users, with expertise in producing and reproducing political discourse, being most of these individual initiatives.

Descending the scale, we find Facebook, Twitter and other social media. As seen in several countries and recently in Northern Africa they might have had an important role for mobilizing and organizing social protests [18]. Facebook, as noted before, might be the most multifunctional tool available on the web. Nevertheless, the most predominant political activity on Facebook has been writing short texts mobilizing and organizing social protests. These short texts do not require the same producing and reproducing skills referred above.

Finally, there are online contexts calling only for "mouse-click participation".

III. CITIZENS' POLITICAL PARTICIPATION IN SOCIAL MEDIA

Some theories alert to the elitist character of representative democracy and to the not fulfilled promises or even the paradoxical character of real democracy [19]. Blumler, cited by Bryant [20] argued that political decisions are largely influenced by how they are represented in the media and understood by the public; that politics is presented like a game, undervaluing the substance of politics; that the personalization of politics is enormous, as personal traits are easier to publicize than serious issues or policies; that media promote the increase of negative messages circulation about politics and its actors, thus resulting in the increase of cynicism and the decrease of political information provided to citizens.

Nowadays, there is a significant enthusiasm with the potentialities that new social media can bring to political participation. Likewise the traditional media, old constraints are still held and new ones emerge, and new hopes arise. Some of these questions are to be discussed in the following paragraphs.

A. Social media facing new forms of political participation

The debate over political participation has seen, in the last three decades, two major sets of thought: those who outline the decrease of participation and those who say that only the classical forms of participation suffer from it, rather than new forms of political engagement, which have been increasing [21]. These new forms of political participation quickly emerged in new ICT.

In the contemporary West, fragmented lives lead to an increasing individualism, as traditional institutions liquefied, which created unprecedented individual pursuits [22]. Thus, citizens are called to reinvent new forms of political and civic participation. As Beck [23] referred, citizenship participation became subpolitical, which differs from the political in two aspects: (i) allowing the access to the public sphere to agents outside the political system and (ii) permitting that people are granted access as individuals, not only as members of organizations. The purpose of action might not therefore be a collective struggle, but a personalised form of intervention [24].

Secondly, the purpose of political action is, in large extent, not embedded in a more general, programmatic and long term action, often having a sporadic and very specific character. People engage with small causes, very often particularistic ones (e.g., defending a single woman against being stoned to death instead of defending equal rights to women).

As an example, on March, the 12th, 2011 around 300,000 people – one of the biggest political protests in the Portuguese contemporary history – marched the streets of Lisbon and Oporto answering to an appeal of a 40,000 members' Facebook page. The idea was born and grown within the Facebook community and nurtured by the national televisions. The immediate cause for this manifestation was "discontentment" and each one of those 300,000 people might have had too many different reasons for being "discontent". This believed political engagement was shown only during this manifestation and the aftermath brought nothing of the sort of a political party or even a collective movement. In the general elections held on June of 2011, this movement did not present itself in either real or virtual contexts, it did not come forward with its goals and reasons for discontentment nor did it contribute to the public debate.

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Thirdly, the action within political parties is now seen as a falsehood; however, without political mediation the singularisation of the political action ends up denying the very purpose of it [25]. The crucial issue about these new forms of political participation is, in fact, their continuity while the intended goals are not achieved. While new ICTs have the potential to perform classical permanent political roles, the new forms of political participation have the opposite characteristics, namely its sporadic form.

B. New public space?

A long way from the "old" public space, as Habermas conceived it, we live nowadays in a "new hyper-mediated public space" that continues to reconfigure, recompose and "contradict" itself, adapting Dominique Wolton's [26] expression. If the contemporary public space has become undoubtedly larger than the classical by the action of traditional media, emerging social media has broadened it even further.

And yet, as Habermas [27] wrote, the echoing of a cultivated social layer has been long gone in the public use of reasoning; the public has become divided, on the one hand, into expertise minorities which use of reason is not public, and another in the great mass of consumers. It should be recognized that the public space has become plural and heterogeneous (Habermas himself recognized it); and that it has been long since the spatial structures of communication are convulsing, as Keane [28] wrote, assisting the dilution of ancient hegemony of public life (limited by territory, structured by the state, mediated only by conventional media). The conventional ideals of a unified public space where citizens struggle for a public cause lead to the overlapping and interconnection of several public spaces.

In this context where public space becomes increasingly fragmented, "virtual communities" have been emerging and strengthening themselves on a daily basis, which can be observed looking to social networks such as Facebook or Twitter. New arenas that, some authors say, have been crucial to the "staging" of mobilizing people to decisive political actions like the ones staged in Northern Africa on February and March 2011.

In this section, this approach intends to confront the dominant excessive optimism with a more realistic analysis of the political participation through social media.

Weblogs have been on the rise as political media for the last decade, but these tools also show the inequalities discussed before. While some bloggers produce highly elaborated discourses, arguing and counter-arguing, most political blog users are just readers or produce nothing more than simplistic and short comments or confidences, which often are not even argumentative.

On the other hand, there might be a reconfiguration of the public sphere as we find a wider interaction between blogs and traditional media. Some recent news have been brought up firstly in the blogosphere (in Portugal, the minor political issue about the Prime Minister's university degree was first discussed within the political blogs); on the other way, the daily discussion on the blogs is centered mainly upon the printed (or published on the web) stories of the traditional media.

Moreover, although the newer social media are in the spotlight, the highly optimistic approaches should not be overrated and may even be criticized as they are somewhat a-historical: most of them try to understand the importance of social networking without considering the social and political history of those using the technology, as well as the profiles of users and those on the leading roles. They also tend to be a-cultural, disregarding the cultural traits of the societies where these new media platforms are being used. Facebook is new in combining several online possibilities, but those who use it are still social and cultural beings, thus making its content a mirror of their representations. This critique regards carefully the political participation in its wider meaning via social networks.

History has shown people uprising against tyrants or undesired social conditions, whether in pre-industrial France, in industrial England or in post-industrial Czechoslovakia, all of which happened before internet. Even the Tiananmen riots, albeit the use of fax and Xerox machines, were mainly set up with face-to-face interaction. The fall of the Berlin Wall, in 1989, had a technology push, as the incidents were started with a televised declaration (by mistake, we understood later), but the people went out of their homes in a completely unorganised way.

We are yet to know exactly how the Egyptian and the Tunisian mobs were organized. But we do know that the major feeders on Tweeter and Facebook were "old" bloggers, protesting against Mubarak regime since back in 2004. The ties between these bloggers might have been stronger than just a Facebook click. If we are to stress the role of online tools, we should regard all of them. The Internet penetration rate in Egypt doesn't surpass 25% [29] and the Facebook users are merely 7.7% of its entire population [30]. People would not take serious risks if they were not committed to each other. Besides, we should not underestimate the involvement of labour unions in these insurrections in Northern Africa.

Social networks provide weak ties between people, as they do not have to seriously engage in any question they are asked to. Facebook has a multiple set of interactive possibilities, but it was not designed with any political aim. Most of the interaction on Facebook is personal and recreational, and the political possibilities of Facebook or Twitter are similar of those presented by blogs, forums or e-mails. "These established social networking sites are not major hotbeds of political activity" [31].

There are also some signs of dissonant attitudes between public opinion, civic participation or electoral behaviour and online political expressions. Certainly, these new media platforms amplify the visibility of one cause, but they do not necessarily make people engage in real causes in the real world. The Facebook page Save Darfur Coalition has almost 1.5 million "friends". And yet, the average amount of money donated to help the refugees in South Sudan was nine cents of dollar [32]. The optimistic view about political participation via new social media must be toned down with the knowledge that online participation does not mean real

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participation, and politics still is a real-world activity [33]. The click of one button is much simpler than protesting on the streets, especially if state powers (police, armed forces) are to impose some violence on the protesters, or even if the action might bring any kind of personal cost.

As another example, in the Portuguese presidential election of 2011, a company made a content analysis study of the internet platforms, to understand what the internet users were saying about all the candidates. Using "Prophesee", the researchers analysed the amount and content of the online dialogue for the electoral campaign period. Fernando Nobre, who came third on the actual ballot, was the candidate with the highest positive feelings towards him and the one with the biggest digital "buzz" of those weeks. He also was "elected" as the Facebook president, as he had 38,584 "likes" opposing Cavaco Silva, the candidate who actually won the election, who only had 28,964 [34].

Anyway, although losing in the digital field, the elected president used as much as eight different platforms during his campaign. These new media, such as Facebook, can up being used as publicity platforms to conventional politics, as they are used almost only during election campaigns or combined with the "old" media that still set the news agenda.

The online social networks provide their members the information about so many civil and political actions at the same time that if they are not filtered by any other medium (usually newspapers or television), the myriad of information and political causes can undermine the ability to significantly adhere to any of them. "The growth and broader dissemination of knowledge paradoxically produces greater uncertainty and contingency rather than providing a resolution of disagreements or the basis for a more effective domination by central societal institutions" [35].

It seems that the outcome of political activities depend, to a large extent, upon the articulation between new social media and traditional ones. On the one hand, these new social media can be used to express opinions, mobilize and organize people for action. They have higher mobilization abilities, as they do not have time and space constraints and are at better odds to faster organize political actions. Thus, new social media introduce some changes in political activity. But, on the other hand, traditional media recount and give visibility to what is happening in the realm of social networks. Hence, traditional media give real existence to new social media.

IV. FINAL REFLECTIONS

The "newer" new media, alike other media and technologies that created similar expectations did not solve "old" social problems. Those new media have been challenging the seductive image of digital citizens who, regardless of their social condition, would be able to use the powerful technological resources, turning them into autonomous citizens, politically active and systematically controlling their political representatives' activities. Therefore, they might not fulfill the democratization and the massification previously promised.

Like political participation in the real world, digital political participation implies political skills. These are also socially stratified, attending to a double filtering process: the same social factors which determine a stratified political participation also promote a stratified use of the ICTs. This stratification is also reinforced by inequalities registered at computer literacy level and by all-pervading inequalities of power.

Our opinion is that these kinds of stratification have lead to the construction of a hierarchy of the different media, according to the different kinds and levels of participation, i.e., some being used more for simpler forms and other to more complex forms of political participation, both being capable of obtaining different levels of efficiency. We do not forget that the participation skills needed before the appearance of the new media are still necessary to participate via new media, which reflexes the frailty of the idea of a brave new world.

And yet, we address traditional media still showing their importance, turning real what happens in the virtual world, revealing much of what is generated in the new media, keeping, at a large extent, their traditional agenda-setting function. The traditional media keep their agenda setting power intact, not only in their own means (printed or broadcasted), but also in the social networks, where those can influence the stories being discussed.

The interconnection between traditional and new media news agendas may indicate we are facing a reconfiguration of the public space rather than the creation of an entirely new one. This reconfiguration might be of interest to further investigations.

Given the recent nature of social manifestations emerging from new media, deeper and more empirical investigations are the next step needed to understand the social context and the goals of these ICTs, the social consequences of their use, the sustainability of online initiatives regarding the reach of the established objectives, separating what is perennial from what is ephemeral; finally it would be useful to create a typology of "participation profiles" that contemplated the multifaceted and more complex nature emerging from these new contexts, helping us repositioning the political participation concept.

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Exploring Security Risks in Virtual Economies

Caroline Kiondo, Stewart Kowalsk, Louise Yngström
DSV SecLab, Stockholm University/Royal Institute of Technology
SE-16440 Kista, Sweden
kiondo@dsv.su.se, stewart@dsv.su.se, louise@dsv.su.se

***Abstract* —A most recent, phenomenon within new socio-eco-systems is the so called Virtual Economies. This paper presents an exploratory study of information security risks that are inherent with the Virtural Economies. A Dynamic Network Analysis Tools (DNAT) was used to perform a risk analysis in the Second life virtual world. The analysis indicates that the currency and user account are the most important assets. User accounts provide access to virtual trading and are critical to the flow of currency within the virtual economy. The removal of both of these from the system will affect the dynamics of the system and defeat the whole purpose of the system. The analysis further identified selling and creation of virtual goods to be important tasks in order to maintain a successful Virtual Economy. If a threat occurs that manipulates the creation of virtual goods then it would affect the trading of virtual goods between the users of the system hence affecting the economy. It is important that users who invest in such an economy to be aware of possible risks associated with this. As the field expands and more internet communities adopt this business model all parties involved need to think of strategies to protect assets that exist within this type of environment.**

Keywords - Virtual Economy; Security Risks; Dynamic Network Analysis; Second Life; Virtual Worlds

I. INTRODUCTION

A Virtual Economy is an emergent economy existing in Virtual Worlds as a result of the exchange of Virtual Goods for real or virtual currency. A Virtual World is an online environment that can be accessed by thousands or millions of users [1]. Not only can these environments be accessed by multiple users simultaneously, but the environment is persistent in the sense that it continues to exist whether or not a user is logged into the system. The Virtual infrastructure allows for inter-connectivity of users through the use of networked computers [2].

The user in this environment is represented by an avatar in the case of MMORPGS (Massively Multi-player Online Role-Playing Games) or a profile in the case of social networks. These entities have the ability to use virtual currency or real currency to obtain virtual goods and services.

Initially, the main purpose of such an economy was purely for entertainment purposes, however the demand for virtual goods and services and the value of these goods to users, has prompted users to either legally or illegally use real money to trade for virtual items. According to the European Network and Information Security Agency, as of 2008, the Real Money Trade (RMT) for virtual items was estimated at about $2 billion [3]. A variety of security risks, threats and attacks have emerged in Virtual Economies because of this. Since virtual items and currencies are only representation of code within a virtual system, there is a real world motivation to manipulate the system in order to obtain real profit.

Virtual Economies are rapidly gaining popularity not only in virtual games such as MMORPGS but also in Social Networking communities. More and more people chose to spend their free time in Virtual Worlds as compared to other forms of entertainment. KZERO an independent research firm has estimated that there are now about 1Billion Virtual World registered users [4]. Due to this popularity most real world organizations and businesses are now ceasing the opportunity to actively participate in Virtual Worlds. Amidst the widespread adoption of Virtual Worlds by various businesses and organizations, the management of risks associated in conducting businesses within such environments has yet to be studied. This paper aims to explore the various security risks inherent in this new emergent Virtual Economy.

This paper is divided into 5 sections. In the next section, we present some background to virtual worlds' economies problems and discuss some of current ongoing research in the area. In section 3, we give more detailed background on the Second life virtual world and outline some of the current security threats and security contra measures used there. In the fourth section we, present a risk analysis of Second Life using the Dynamic Network Analysis Tool. In the last section, we discuss our findings and proposal future research work.

II. VITRUAL WORLD PROBLEMS

Previous research in this area has shown that Virtual World environments are places where users are encouraged to explore new areas, create content and share the content with others. Security related problems that arise within Virtual Economies are also motivated due to the fact that "profit" can be made either within the world or on a secondary black market. Exploitation of bugs and "scamming", are becoming more and more prevalent within Virtual Economies. Obtaining real money from virtually world is a key factor in the increasing attacks experienced within Virtual Economies.

Most of the issues within Virtual Economies are those that are propagated by either sharing of accounts, or selling of advanced user accounts that is to say "power levelling". Power leveling is when one member logs in to another

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members account to play their character so that it can advance in the game. These kinds of problems are also based on permission settings within the systems [5]. Time and state bugs are also a problem in these types of environments because of the underlying architecture [6]. Integration of media and code from third party applications can cause bugs within the system as well. Users can also experience invasion of privacy through surveillance, unwanted marketing and revelation of on-line and off-line identities [7]. There are also issues in regards to trust when it comes to trading within a Virtual Economy. How can one make sure that they will receive a virtual item they are paying for with real money? In a study conducted in China, it was found that Chinese users conduct what is known as FCTs (Face-to-Face Transactions) where they meet in person for example at an internet cafe to perform the transaction [8]. There are users who take advantage of these trust issues present in Virtual Trading. A user purchasing a Virtual good or service can either claim that they have not received the object and ask for a refund or stop payment to their credit card account. Hence the seller incurs the loss; this can also happen in vice versa [9].

Various organized crimes do occur as a result of the value attached to virtual items within Virtual Worlds. Crimes such as fraud, gambling, hacking and robbery have been found to take place [10]. Thus in virtual worlds, where people hold valuable property, security of the virtual economies data must be a top priority. Privacy, security, and the integrity are factors that have been found to be of critical importance [11].

In regards to legal issues within Virtual Worlds, the main research conducted tries to understand how various real world laws apply within Virtual World Environments. There is quite a number of research studies that have discussed the legal implications of Virtual Property [10], [11], [12], [13], [14], [15], [16]. These papers have attempted to answer questions such as, *"What are the rights of a user in terms of virtual property?"* and how it relates to copyright laws [17],[18],[19], *What rights do users have? What jurisdiction is one under? Where the game servers and developers are located? Or where the player is located?* The general question of governance and how crime and gambling activities that are conducted within Virtual Worlds are handled in the real world [20], [21], [22], [23] are also important issues.

Other Issues that have been of particular interest to scholars are how taxes that are obtained from Virtual economic trades are handled [24], [25], [26]. Currently there is a large gray area that is undefined, and a few countries such as China and the USA have tried to pass legislation in regards to taxes. However, the governance of Virtual worlds and their implications to the society as a whole are still under study, as debates continue between governments and law officials.

A. CASE STUDY: SECOND LIFE

B. Background

To focus our research, we selected one of the dominate virtual worlds Second Life. Second Life (SL) was founded by Linden Research Inc. in San Francisco and was launched in June 2003. SL users or inhabitants are known as Residents. The residents of SL use the (L$) to trade for goods and services. As of March 2010 it was reported that there are about 826,214 users who are active and there were user transactions worth about $160 million [27].

To become a SL Resident one must register an account. In SL, there are two types of membership accounts. A basic membership, which is a free account, this type of account has certain limitations upon the user. The second type is the Premium membership which requires the user to pay a fee of US$72 per year. In return, users have additional access to technical support, the ability to own private regions, land and increased access to in world areas. Members also enjoy the benefit of receiving a weekly stipend of L$300. This type of membership is suitable for entrepreneurs, businesses and organizations wanting to develop their own islands.

C. Economy

In order to make purchases within SL for goods and services, residents need to own Linden Dollars (L$) which is the main currency within the world. A resident has several options for purchasing L$. This can be done at "Linden Web MarketPlace", the official L$ Exchange (LindeX) or other 3rd Party exchange services. Residents can buy L$ at L$ 260 for US$1 plus a service fee of US$0.30. The currency can be purchased using a PayPal account, Visa, MasterCard and other 3rd party affiliates. Apart from purchase of currency, one may choose to be employed in one of the many businesses running within SL in order to earn their L$. There is a wide range of jobs that an avatar can undertake. These include being a real estate agent, a sales person, an avatar billboard, customer service and support, being a DJ at the clubs, a dancer, answering surveys and camping to attract other avatars. Otherwise an avatar can become an entrepreneur and use their creativity to produce virtual goods such as clothes, furniture, houses and planes to sell to others in return for L$[28].

Once residents possess L$ they have the ability to purchase anything from items to personalize their avatar, their homes, transportation or virtual land. The most important purchase apart from the personalization of an avatar is land ownership. Land purchased can be used to lease to other avatars, to build homes, offices, shopping malls, points of attraction, nightclubs and anything the land owner wishes to do with their land, the only limitation being creativity and skill base. The minimum amount of land purchased is about 512m².

SL has taken a different approach to its business model than the earlier traditional Virtual Worlds. In SL, the End User License Agreements (EULA) and Terms of Service (TOS) state that the residents of SL possess ultimate control

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over their creations giving them full rights to their intellectual property.

SL encourages its residents to create and trade their creations, unlike other Virtual Worlds. SL's main vision for its Economy is to have *"a fully integrated economy, architectured to reward risk, innovation and craftsmanship."* [29]. SL does so by granting its residents copyright to their creations. These creations, can be sold to others for Linden Dollars (L$) which can either be exchanged back to real currency hence earning an income or can alternatively be saved in a Linden Bank to accrue interest. Through virtual trade and creativity residents are able to accumulate assets.

Earlier, SL had decided to tax users for L$ earned through trading within the SL Virtual Economy. However, the residents were not very pleased with this model and felt that it restricted them from earning a substantial amount off their creations. This eventually led to a "*Second Life* Tax Revolt". SL decided to modify this model to fit its residents' needs. In this modified model the residents are only charged a flat subscription fee and for purchase of land. The value of the land, just like in the real world is determined by location, "aesthetics" and traffic [30]. Therefore the balance between the currency and trading of Virtual Goods is very important in SL's business model..

D. Some Security Threats

SL's game architecture follows the traditional structure for most Virtual Worlds, which is a massive distributed grid of client server system architecture. Specifically in SL's case they use Debian servers for their technology, where each server instance located on a server simulates each SL region. This means that several clusters of servers, host different parts of the SL world. According to SL, each item created within the environment is known as an asset within the database and is given its own Universal Unique Identifier (UUID).These assets are located on MYSQL server farms separate from the regions. During high traffic, where multiple requests occur to the databases, the servers are vulnerable to slow response times. This can cause users to experience objects loading at a slower pace than the normal rate and difficulty in accessing asset inventory, regions or searching for other users. This type of architecture is vulnerable to race conditions, where hackers can take advantage of the fact that different transactions are taking place on multiple databases hosted in different servers. The outcome of this attack is the ability for a hacker to perform *duping*, a practice that enables them to duplicate assets within the system [6].

SL's game client is open source, meaning any one has access to the code. The advantage of this approach is that SL is sharing the creative power with their users. Users can contribute modules and code that will benefit SL's current environment and its security. Furthermore, this proves advantageous to those who wish to leverage the platform for business opportunities. However, the disadvantage in this is that hackers can study the code and easily manipulate it to introduce exploits into the system [32].

Furthermore, even though corporations operating in SL have the capability of owning their own Island, the servers are remotely controlled by SL. Therefore it may be hard for them to link the system to their internal systems. They also lack control over the security implementation and consequently security measures and levels are dependent on Linden Labs and their developers.

When creating a basic membership account, currently SL does not check the identity of the user. Therefore there is a possibility for users to create multiple accounts and abuse the system. In the case of accounts that have been banned for violating the TOS, users can easily create a second account under a different name and continue to be part of the SL environment. The lack of control over the authentication of membership registration makes the environment vulnerable to people who want to perform illegal activities such as griefing, gambling and hacking. To provide security to account information, SL encrypts credentials and makes use of a secure HTTP connection.

SL users have the ability to develop client side code using the LSL scripting language. This language gives the users capabilities to enhance certain attributes of objects including animation. This is a useful feature for users to enable them to add functionality to their items. For example a user who wants to create aircrafts can use the animation functions to simulate the flying motion. When abused, this ability may give griefers and hackers the ability to cause destruction and exploit the SL environment. Furthermore, developers have the ability to create scripts that are useful and sell them to others as third party tools. The problem with this is that, if there are any bugs or vulnerabilities within the tool it proves to be a risk to the environment. There have been instances where SL management has had to restrict the use of some programs created by users due to possible malicious code and denial of service attacks.

Currently Linden Labs and its affiliate websites use cookies to keep track of user sessions. It is up to the user to enable or disable them. However, disabling cookies on the clients browser may unable some functionality when operating their systems. Linden Labs uses information stored in cookies to access client account information including transactions that take place on "The Marketplace".

SL has provided some guidelines to its users on how to deal with "Password stealers". Some scams that they caution against include users being asked to provide credentials in-world during various transactions. The only legitimate login form is when logging into SL, beyond that it is not necessary to log in again.

SL also caution against phishing scams, emails that requires users to submit their Second Life credentials and links to third party websites asking for this information. Some phishing scams may include giving free assets to users for example Linden dollars after providing passwords.

In terms of copyright management, SL does not have a legal way of protecting user creations. The only measure taken by SL is to track copied materials and manually ban users. As SL and other virtual world's grow it will be much harder to only impose such measure when protecting user assets. Furthermore, this may result in fear of using the

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system, as valuable assets are at stake of simply being copied by others.

SL also has a hard time enforcing real world laws within the system. The only way SL has control is by banning users who violate the TOS. If users of SL conduct crimes within the Virtual World, they are under the jurisdiction of the country where they reside in. This means that every user is governed differently when it comes to taxed income and other violations.

E. Security service and Mechansims

Within SL's environment, users' posses information that needs to be kept hidden to protect their assets. This includes information such as those within their accounts. (Log-In credentials, L$Balance and contact lists). However, information concerning assets possessed by an avatar is contained within SL Viewer Cache in an unencrypted form. Information transmitted through audio and chat can be eavesdropped by others as it is not encrypted. It is possible to observe and follow other avatars and even eavesdrop on their conversations. Furthermore, video recordings can be used to monitor and perform surveillance on other avatars within the environment without their consent or knowledge [33]. To combat issues regarding confidentiality SL does offer full control on permission settings to private region owners. Private region owners are able to choose who has access to the region and the type of information they have access to.

Integrity of the assets exchanged within SL is important to ensure that the economy is not flooded with fake or duplicate Virtual objects as this creates a loss of value. Users who sell Virtual Goods may be concerned about the possibility of their creations being illegally copied or transferred to others without their permission. This may also lead to problems concerning Intellectual Property rights. Buyers also need to make sure that they have received an authentic copy of a Virtual Good that has been purchased. It is also of outermost important that the L$ is not falsely duplicated, hence causing inflation within SL's Economy.

The availability of the SL system overall and parts of its regions are critical to the ongoing activities that promote exchange of virtual currency, trading and creation. If parts of the servers are unavailable and a user's business is located on those servers, there is a risk of loss of traffic and revenue. Instances of DOS attacks have happened within SL causing a loss of service. Activities such as griefing may also cause users to avoid certain areas hence limiting the availability of these areas.

There are users who purchase virtual goods and later contact their credit cards companies to dispute the charges. Therefore these users keep both the virtual goods and their money. These charge backs are a type of fraud propagated within Virtual Worlds that posses a business model allowing free trade of virtual goods.

Apart from the fact that users can be monitored through their behavior, avatar body language and chats, some functions within the world can be used to collect data. For example the use of the LlGet LandOwnerAt function returns data regarding a user's virtual property. Such information can be used by hackers to target user accounts. Second Life states on their privacy policy that they keep aggregated information in their databases in regards to IP addresses, session data, how SL is used in terms of frequency and specific pages visits. Also the third party affiliates have limited access to user data.

F. Stackholders

There are two models that have already derived stakeholders of Virtual Worlds at large are the Yee Motivation Model [34] and the Manninen model [35]. These two models will be used to mapped the various SL roles with different types of risks and threats. This information will prove useful in categorizing the assets for each stakeholder. SL, identifies four types of user roles, these include "Business Owners", "Creators", "Educators", "Landowners" and "Solution Providers".

In the Motivation Model created by N. Yee, [34] it is suggested that sometimes users are motivated by the structure and design of some Virtual Worlds. This model defines users' motivation according to three main factors, "Achievement", "Social" and "Immersion".

The second Model [35], has assessed stakeholders of Virtual Worlds by applying the Social Construction of Technology SCOT framework to analyze the key participants who interact with assets within a Virtual Economy. This framework divides the stakeholders into three main categories; "The Players", "Game Controllers" and "Third Parties". The first type of users, "The Players" may be divided further, in order to obtain different type of users who overlap with [34] Motivation Model. These are the "Achievers", "Socializers", "Explorers", "Competitors", "Griefers", "Leaders" and "Performers".

First and foremost because SL is a social environment, most of its players engage in making friends, chatting with others and in creation of relationships. These types of users are most likely to value their social status and the contacts they make. Therefore if they accumulate assets, those assets that give them an identity and help them form relationship with others are the most valuable to them. These users are known as the "Socializers"[35].

"Achievers" want to gain something extra from their experiences. Therefore these types of users may want to earn more money and accumulate the most virtual property. In SL, this would be the users who are entrepreneurial in nature; they are motivated the most by the feeling of achievement. These users will value their creative assets in their inventory and those that they sell to others. Also, they will value their social contacts because through these contacts they are able to sell and showcase their creations and assets. The ownership of virtual property is a very important, valuable asset to these users. From the aforementioned SL roles, "Achievers" could be "Business owners", "creators" or "landowners".

Another category of SL stakeholders are the "Game controllers"; these are the users who directly have stake in the business model of the virtual world. In SL, we can

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describe this category as Linden Labs the owner of SL and other third party companies who provide SL with additional infrastructure or features for their experience. In the following section the assets for these identified stakeholders is assessed as well as the various threats and vulnerabilities.

G. Assets match with vulnerablities and Threatss

After having identified the various Stakeholders of SL, their assets are analyzed and identified here. Due to space limitation only some of the assets matching to the vulnerable will be presented here

The avatar is the player's identity and the central point of existence within a Virtual World. It is through the avatar that other assets are derived and possessed. It is emphasized that an avatar as an asset is detrimental to a users Virtual World existence [35], [36], [37]. It is through the Avatar that a user possesses assets such as virtual goods and land. Since the avatar is the point of access to the SL environment, its importance security-wise is equivalent to a user account.

The account consists of login credentials including the username and passwords as the means to controlling an avatar. This account also has other important information regarding the avatar's activities within the Virtual World, including how much virtual property they own, how much virtual currency they have on their balance, business transactions and their contacts which may be friends or business clients. A hacker may try to gain access to this using social engineering, spam or malicious code, if successful they can steal the user's virtual property and continue to deceive the user's contacts as well [10].

The SL Currency Linden$ is the most valuable asset to the Virtual Economy. If a hacker is able to duplicate the currency, then the whole Economy can collapse. This can cause serious damage to all operating within SL and especially to Linden Labs. Since the currency can be exchange to real money, its loss to an individual means loss of real money and is equivalent of credit or debit card theft.

For social residents who do not trade within SL and those that have the basic account may not be affected by this asset because they may not own a significant amount of it. Residents, who are entrepreneurs, regard currency as a very critical asset, because their main reason for using SL is to earn money.

Land on SL can be used to create virtual houses where an avatar “lives”, or can be rented to others as virtual real estate or it may be an island for an organization’s business. Anshe Chung who was the first self made SL millionaire, owns land estates on multiple servers which she rents and sells as part of her main business, for an entrepreneur such as herself she cannot afford to lose her valuable land or have one of these servers hacked into. For other organizations that conduct meetings or provide distance learning, it may be important that the land is protected for unauthorized access. Loss of an Island would be detrimental in such instances..

According to the aforementioned assets, there are several threats and vulnerabilities that can pose risks to the stakeholders.

Hackers can pretend to be SL employees and easily extract important information from users. This may include information such as their user name and password. Another way a hacker can phish for this information is through a user’s e-mail. A user may receive an e-mail asking for their credentials, once they provide this information. The hacker can take control of their avatar and account information. In this case assets such as social contacts, virtual property, virtual currency and land are at risk. They can also use the avatar to con others who trust the user [38]. Phishers may also find it easy to obtain credentials in this type of environment because young people tend to have the habit of sharing their credentials. Moreover, the credentials may be used in other systems which can make it easier for hackers who phish for these credentials to gain access elsewhere as well [8]. In some cases, threats in other web applications such as emails can endanger assets in the Virtual World. In this case if a user has opened an attachment with a trojan horse which is logging activities on their computer. The hacker may gain access to the user's passwords to SL and in turn steal their virtual currency or contacts. Also the hacker may have the ability to impersonate the user and conduct social engineering attacks to friends and colleagues [39].

Organizations that have employees in SL Islands run the risk of hackers engaging in Social Engineering tactics to obtain information. A hacker can contact any employee and engage in conversations with them which may result in confidential information being given out. Hackers can then use this information to break into other systems out of the virtual world of SL. Also because most of the content in SL can be viewed by others, hackers can use this information freely to collect data for social engineering purposes which may lead to identity theft.

Cheating is a violation of EULA agreement between the user of a Virtual World and its providers. This violation employs the use of tools to ensure that tasks are automated. Cheating is usually performed via 3rd party software tools; this type of software is usually known as Bots. Cheating has been classified as a threat to the Virtual Economy, because it may include activities such as exploitation of the system to take advantage of bugs or social engineering of others within the system [40]. In the instance of SL, the use of bots can be employed to make illegal copies of other users creations. This may cause copyright infringement and loss of value to goods hence destroying other's businesses. Also, bots can be used to cause DOS attacks to the system..

Griefing is the process where other users perform activities or actions that may tarnish the image or cause damage to ones avatar, business and reputation. Griefers rely on the fact that basic accounts do not require identity verification; anybody can create an account and use it to harm damage or cause disruption to others.

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Charlie Miller and Dino Dai Zovi set out to execute "a proof of concept exploit" in Second Life. In this case, the intention was to try to "steal" another user's Linden Dollars and convert it to real money.

At the time of the exploitation, Apple's QuickTime Player, which SL uses for rendering media such as audio, video and pictures contained a vulnerability. This vulnerability meant there was an opportunity to take advantage of the stack overflow. The researches created a malicious QuickTime file, hosted on their remote servers. In SL they created a cube which pointed to the URL of the malicious QuickTime file. At this point if an avatar happened to pass by the area containing the cube, a hacker could take control of the avatar. In this particular case the researchers were able to create a DLL to access functions within SecondLife including

III. RISK ANALYSIS

The use of Network analysis tools to understand the behavior of complex systems has been employed for more than eight decades. Throughout history this science has been adopted by sociologists, anthropologists, biologists, psychologists, mathematicians and economists to study various systems that exist within the society [41]. The data collected from the Case Study Analysis of SL was formatted and analyzed in a DNAT.

To conduct analysis and extract these measurements, the Organizational Risk Analyzer (ORA) was used. "ORA is a network analysis tool that detects risks or vulnerabilities of an organization's design structure." It has over 100 measures with 3 classifications based on risks and vulnerabilities. It is one of the DNAT developed by CASOS in order to measure Risk in Organizations [48]. However the data input in this tool are not only limited to Organizations, one can use this tool to analyze any type of scenario that can be depicted as a network. Previous research studies which have used this tool include impact analysis of weaponized biological attacks on cities, impact analysis of actions in asymmetric warfare simulation and estimating impact of organizational downsizing.

In order to analyze data in ORA, objects are identified and their relationships are defined according to the aforementioned five elements in rows and columns. These objects and relationships form a collection of networks known as the meta-matrix. This meta-matrix is the main input that is analyzed by ORA in order to detect potential risk.

The case study analysis of SL was used as a source to extract all the information possible in order to construct the required meta-network. To accomplish this, the first step was to create nodes and nodesets necessary to build the network. The first node set created was for all the key stakeholders as identified previously. The relationship between each is mapped by a binary number '0' or '1'. The task nodeset consisted of tasks that were needed in order to facilitate trading of virtual goods amongst the stakeholders. The knowledge nodeset was represented by those skills that were necessary to make money and socialize in the environment. The events depicted in the nodeset were those that could pose threat to the virtual economy of SL. Lastly the resource nodeset included the assets as categorized previosly. Each of the created nodes were combined to create subnetworks based on their relationships. The nodesets created for the experiment were: agent x agent, agent x knowledge, agent x resource, agent x task, agentNodeset, event x event, event x resource, eventNodeset, knowledgeNodeset, resourceNodeset, taskNodeset. All these nodesets were then imported into ORA. The outcome was a metamatrix identifying points of risk within the system. According to this input ORA performed statistical analysis to indicate probable risks within SL's Virtual Economy.

The SL Meta Network consists of six networks and five nodesets. The agent who in this case is the SL Stakeholder was the most important factor to the system. Without the stakeholders participating in SL's Virtual Economy, the system will cease to exist. The stakeholder was analyzed in terms of the resources, tasks, knowledge, events and to each other's interaction within the system. Finally the resources were also analyzed based on the various threats (events) that can affect them.

When visualizing the relationship between the stakeholders and the assets it is clearly demonstrated by ORA that the most critical assets are currency and avatar accounts. The currency and avatar account as critical assets relationship can be viewed by looking at the Agent X Resource Relationship within the SL Metanetwork as presented in figure 1. Also this can be seen in the relationship depicted by Agent Event X Resource. Here we can see that the currency is directly connected to the event currency inflation demonstrating its close link. Also currency appears the most central resource with the most connections, which means that removing this link from this equation will collapse the network and evidently it is a large risk. In the case of the avatar and accounts the relationship diagram shows that this is the most targeted asset. Four out five of the events are directly linked to the avatar and account asset, hence having direct impact and risk. These events are phishing, malware and bots, griefing, social engineering and currency inflation.

According to this visualization it can be concluded that the currency is the foundation of the economy and the accounts provide access to the trading of the economy. The removal of both of these from the system will affect the dynamics of the system and defeat the whole purpose of the system. All users of the system rely on these two resources to ensure that the system continues to operate at optimum efficiency. This is not to say the other resources are of no importance to the system whatsoever, it just shows that these are the most critical.

In addition to the visualization tool, various measures were used to analyze the risks of certain events within the economy. The capability measure depicted by Event X Resource shows which events are most capable of affecting

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each resource. This illustrated that the resources had a high risk from threats such as malware, bots and currency inflation. The malware and bots could affect the alteration of the resources and the trading of goods within the system.

Currency inflation would affect the economy by rendering the monetary value of goods useless. The Centrality measure of Agent X Resources depicted that avatar, accounts and currency as having the highest measure. This confirmed that the accounts and the currency were resources that ran the highest risk if a threat were to occur within the system. Also this measure illustrated that the creation of virtual goods and their sales were the most important tasks within the virtual economy shown by the Centrality Agent X Task.

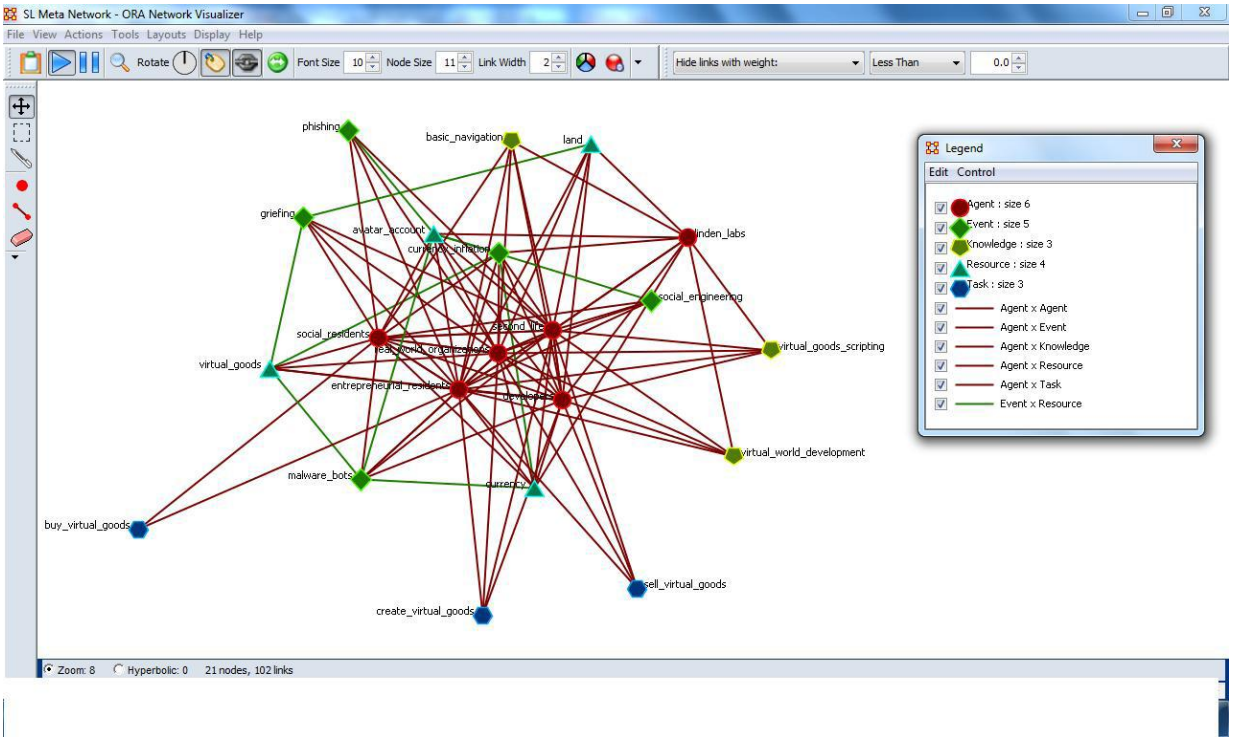

Figure 1. The Second Life MetaNetwork.

IV. DISCUSSIONS

The main goal of this paper has been to explore security risks that are inherent within Virtual Economies of Virtual World Systems. The paper outlines a high level case study analysis of the Virtual World Second Life. It is first viewed as a holistic system and the various implications to security are discussed including real world scenarios. This analysis is the basis for extraction of information regarding assets, vulnerabilities and threats within such an environment which in turn is used to construct data for risk analysis using DNA Tools.

The various stakeholders of SL's Virtual Economy were identified; also the assets that are related to these stakeholders and their threats and vulnerabilities were also identified and discussed. Finally all the data was formatted accordingly to Organizational Risk Analyzer (ORA) model which was identify Currency and Avatar/accounts being the most vulnerable assets, also that currency inflation was the biggest risk to the Virtual Economy of Second Life.

The findings have confirmed that there are real threats within Virtual Economies of Virtual Worlds, the most critical assets being user accounts and currency which are most vulnerable to malware, bots and inflation. Because of this discovery it is important for users especially those who are going to put their real resources within a Virtual Economy to be aware of the risks and how to protect themselves against these possible threats.

Future Work

According to the work performed in this paper it has become apparent that Virtual Economies are a new untapped research field. This field has a potential of becoming very important in the future as more and more

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social networking systems and virtual worlds embrace trading of virtual goods, especially if this new type of commerce emerges as a new platform for transaction processing on the Internet.

There are still a great numbers of questions that need to be researched in terms of security in Virtual Worlds and their economies. Specifically to complement the scenario based simulation conducted by the Dynamic Network Analysis Tool, other research methods and risk analysis techniques can be used to further explore the results and to understand their implications in a real world setting. Since the goal of this paper was to explore this new area, it hoped that other researcher can build on these findings to help individuals and organization better understand what real risks they are facing in these new virtual worlds.

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Study of Sociocultural Ontology

Papa Fary Diallo, Seydina Moussa Ndiaye and Moussa Lo
Laboratoire d'Analyse Numérique et d'Informatique (LANI),
UFR SAT – Université Gaston Berger,
Saint-Louis –BP 234, Sénégal.
fary85.diallo@gmail.com, seydina.ndiaye@ugb.edu.sn, moussa.lo@ugb.edu.sn

***Abstract*— In this paper, we propose a process of sociocultural ontology development to popularize and perpetuate the culture of a country through a sharing of customs and history of different localities. It can be compared with the construction of a platform that would be straddled between "corporate memory" and a "social network", but applied in the context of a country. This process is based on the theory of Russian psychologist Lev Vygotsky called "Vygotskian Framework". This process allowed us to model our ontology in three axes - Community, Artefact and Infrastructure -, which allowed us to have two levels of social network analysis. An intra-community level allows us to have knowledge within a community and inter-community level, through our index of "similarity of interest," allows us to form clusters of our network.**

Keywords-Social Network; Social Network Analysis; Semantic Web; Ontology; Activity Theory.

I. INTRODUCTION

For lack of knowledge of the Africans territories, it is very common to meet African youth knowing more about the geography of the West than their own countries. Thus, to refresh the memory of our fellow citizens and revive the many stories that accompany the creation and daily life of the different African territories, we initiated the establishment of an online sociocultural encyclopedia.

Our goal is to develop a distributed infrastructure that will allow the Senegalese communities to share their sociocultural knowledge, tourist, economic, educational, agricultural, etc. The infrastructure developed can be compared with a platform which would be straddled between a "corporate memory" (or "memory organization") and a "social network", but applied to the context of a country.

We propose to have a new point of view of the concept of community in the context of the social Web where the community typically represents a set of individuals sharing the same aspirations. Our approach is less focused on individuals (which are classically central points) than on the beliefs and knowledge they share. This shift of view allows us to approach a community as an atomic entity and focus this time on the sharing of knowledge between communities.

Semantic representation is based on a sociocultural ontology of which development is the objective of this paper.

The term "ontology" is borrowed from philosophy, where an ontology is the study of existence. According to [1], in the context of knowledge engineering, ontology "may take a variety of forms, but necessarily it will include a vocabulary of terms, and some specification of their meaning. This includes definitions and indications of how concepts are interrelated which collectively impose a structure on the domain and constrain the possible interpretations of terms". Such characterization accounts of various objects such as glossaries, terminologies, thesauri and ontologies (in the strict sense), implemented by various professionals (knowledge engineers, librarians, translators) and distinguished according to whether the focus is on the terms and their meanings.

The construction of our ontology is structured around the process "Vygotskian Framework" [2] proposed by the Russian psychologist Lev Vygotsky. This process examines relationship between knowledge and the development of a society in three areas: a) human (subject), b) objects (buildings, park, etc.) and c) artefacts (abstract things).

This paper continues by a state of the art in which we mention the work of the social web and the semantic web that have guided us in our approach. The third section will present our sociocultural ontology with the presentation of Vygotsky theory, concepts and relationships that make up our ontology and we propose an approach to the analysis of our network. We end with a conclusion and perspectives of this work.

II. SOCIAL WEB, SEMANTIC WEB

We place ourselves in the context of setting up a semantic web platform sociocultural ontology-based to enable communities to share their knowledge as in classical social network.

Semantic representation of resources manipulated in our "social network", we allow having rich information contained in the network. On the other hand, the Semantic Web opens up a semantic approach to social network analysis.

We are interested here in the development process of sociocultural ontology. There is not, to the best of our knowledge, this ontology. In this section, we present the work in the field of the social web and the semantic web that have guided our methodological choices.

A. Social Web

There are several definitions of the social web. However, in our study we consider the definition of [3], who defines the social web as an ecosystem of participation, where value is created by the aggregation of many individual user contributions. In our case, contributions that can introduce users will certainly be new structures that are newly set up in

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a locality (creating a new instance) and the relationships they have with those existing. Also, provide information on the events is unrolling or will unroll.

Once a social network is constituted, it can be analyzed by the study of social entities well as their interactions and their relationships. This is called social network analysis (SNA). Such analysis is related to the theory of social networks, which designs social relations in terms of nodes and links. The nodes are usually the social actors in the network but they may also represent institutions, and links are relationships between these nodes. This representation, called sociogram, has been proposed in [4]. Among the indicators of a social network, we can cite density and centrality.

Density allows defining the cohesion of a social network. It is defined as the number of existing links divided by the number of possible links. Its value is equal to one if all nodes are interconnected.

Centrality highlights the most important stakeholders of the network. Freeman [5] offers three definitions of centrality: (i) **degree centrality** treats the nodes which have the highest degrees of the graph, i.e., those which have more links in the network; (ii) **closeness centrality** indicates the degree whereby a node is close to all other nodes in a social network (directly or not). It is obtained by calculating the average distance of a node to all other nodes in the network; (iii) **Betweenness centrality** focuses on the ability of a node to serve as an intermediary in a graph. It is the shortest paths between any two nodes that pass through the given node.

However, [5] considers undirected relation. Yet in a social network, a relation-oriented alone contains much semantics. Relations-oriented leads to the concept of **prestige** that is more refined that centrality. We distinguish incoming (in-degree) and outgoing (out-degree) links. An actor is prestigious if it has the highest in-degree. The out-degree of an actor is often a measure of how influential the actor may have.

The emergence of the Semantic Web leads to apply the methods of analysis of networks on new traces generated by the use of the web.

B. Semantic Web

Berners-Lee [6] describes the web of tomorrow as a vast space for exchange of resources between humans and machines allowing exploitation large volumes of information and various services. The current Web is fundamentally syntactic, in the sense that document structure is well defined, but its content remains virtually inaccessible to machines treatment. Only humans can interpret their contents. Thus, the Semantic Web aims at overcoming this difficulty. Web resources are more easily accessible to both the man and machine, using the semantic representation of their contents. The Semantic Web is at first an infrastructure to allow the use of formalized knowledge in addition to the current informal web content, even if there is no consensus on the limits of this formalization. This infrastructure should allow first locating, identifying and transforming resources so robust and healthy while enhancing the openness of the Web with its diversity of users. It must be based on a certain level of consensus, for example, on representation languages or ontologies used. It should help ensure, as automatically as possible, interoperability and transformations between different formalisms and different ontologies. Thus, the Semantic Web provides the opportunity for machines to understand and exploit the resources of the web in an interoperable manner. For this, the W3C offers formalisms provided with XML syntax to model the concepts on the web, to instantiate it and query it [7].

C. The Semantic Web can be social

This question should be asked because papers such as [8][9][10] have defended the importance of social dimension in the construction of a Semantic Web life cycle and have proposed a new approach - the socio-semantic web - Authors radically oppose the traditional approach of the semantic web. In their approach, they subdivide the semantic web into two entities: the computational semantic web and the cognitive semantic web.

According to them computational semantic web "aims fundamentally at automating the search of information using software agents (...) and we will represent the ontologies and semantic networks using formal languages supporting inferences and powerful treatments, such as logical languages or object-oriented" [8] while cognitive semantic web "aims at supporting research activities of human users in complex and evolving corpus" [10]. Thus "while extending this perspective, socio-semantic web is positioned towards the Social Web (...) and it aims at supporting cooperation activities in which more structured interactions also rely on information or documents shared by a collective continuing, at least for a time, common goals" [9]. However, as shown in [11], there is a big difference between the Semantic Web and formal logic. According to [11], the semantic web is a family of languages of increasing expressiveness whose building blocks are not a logical but turn around the RDF model (model of triples to represent graphic descriptions of the resources) and semantic web does not object to the web dimensions semiotic, social or pragmatic. However, since [11], camp of socio-semantic web has changed its approach according to Manuel Zacklad "considering that there was indeed a form of complementary" between both even if he claims that "socio-semantic web initiative is a current particularly within semantic web". In this context, we see two forms of sociality.

The first form is the social network of communities. In this network, W3C formalisms allow us to model our social network, which is consistent with the position taken by Fabien Gandon who argues that "Semantic Web is not anti-social" [11] since the Semantic Web is not a revolution but a web evolution. Moreover, as we intend to use some indicators of social web we will need a powerful query language yet "cognitive Semantic Web does not usually make logically valid inferences automatically" [8].

The second form of sociality is located within the community. For its consideration, it will certainly be necessary to use socio-semantic web for the different views of members of a community that will bring "mutual understanding that encompasses all issues related to cultural

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and linguistic to establish an agreement between participants" according to Manuel Zacklad.

D. Semantic representation and social network analysis

FOAF (Friend Of A Friend) project is one of the largest projects on the Semantic Web. FOAF has become a widely accepted standard vocabulary for representing social networks [12][13][14]. However, it is an RDF vocabulary for describing people and the relationships they maintain between them while in our approach we want to model sociocultural knowledge of the different localities. The use FOAF ontology is therefore not appropriate in our context. It is why we propose the use of OWL ontology [15] in our modeling.

OWL (Web Ontology Language), a W3C Recommendation, is a language for defining and instantiating Web ontologies. An OWL ontology may include descriptions of classes, properties and their instances. Classifications expressed in OWL are based on a strict separation class/instance, inheritance of properties, the expression of cardinality constraints and logical constraints on the relationships between properties, etc. OWL provides three increasingly expressive sublanguages designed for use by specific communities of implements and users [15], among which we can mention OWL-DL language that we use. It supports those users who want the maximum expressiveness without losing computational completeness (all entailments are guaranteed to be computed) and decidability (all computations will finish in finite time) of reasoning systems.

Furthermore, social network analysis focuses on the nodes rather than types of node. Thus, we can use it in our case. However, as part of our work to apply the formalism of the Social Web in our ontology, it would be interesting to do so for a specific entity. Because in traditional social network where there is only one object type (people), in this network, it would be interesting to see the nodes that meet the different metrics across the network. In our "social network" where there are several types of concepts, find degree betweenness of the node for example has no real meaning as in conventional networks. However, it would be very interesting for the different components in each locality to see which one is more active by calculating the degree centrality. In the same sense considering the degree centrality, we can know the localities where there are many more sociocultural activities.

However, current approaches to analysis algorithms of social networks are based on definitions and characteristics of graphs representing social networks. The semantics of measured indicators are not taken into account. Social data described in RDF form a typed-graph that provides more powerful and richer representations compared to conventional models for graphical analysis of social networks. The majority of the research aims to calculate the metrics of social networks using the relations "knows" and "interest" of FOAF ontology [16] with the query language SPARQL (SPARQL Protocol And RDF Query Language), a W3C Recommendation, in particular, allows querying of RDF descriptions. However, SPARQL shows some limits on the semantic analysis of social networks. As shown in [17], RDF and SPARQL present all the characteristics for sharing, interoperability, query processing and social data on the web. However, they also show that the standard version of SPARQL is not expressive enough to query "global" on a social network, necessary to calculate the metric of the most SNA. Likewise, SPARQL lacks some key features for building powerful Semantic Web applications. Thus a new version, SPARQL 1.1 [18] in development since March 2009, seeks to rectify these omissions. It adds, among other things, an update language and supports aggregation, subqueries, creating values by complex expressions, extensible value testing, and constraining queries by source RDF graph. This new version is promising for the SNA mainly with the aggregation functionality.

We cannot conclude this section without mentioning works that have been done around Towntology project [19], even if they have not been developed within the Semantic Web. We mention them because their finality - design an urban ontology - seems to be a part of our work, since modeling sociocultural aspects of a community necessarily involves a consideration of the urban aspect. However, during the development of this ontology, designers have felt the need to develop their own language based on XML, so it is impossible to reuse it in our context. Nevertheless, in our modeling we will use some concepts (classes) of the project to build our ontology.

III. SOCIOCULTURAL ONTOLOGY

We propose a methodology to identify features that represent a community in its social aspects (in the broadest sense), modeling of these characteristics will represent our sociocultural ontology. The approach we use is based on a process called "Vygotskian Framework" proposed by Vygotsky. This process examines the relationship between knowledge and development of a society in three areas: a) human (subject), b) objects (buildings, park, etc.) c) artefacts (abstract things).

We mean by methodology, work procedures and steps that describe why and how of conceptualization then of artefact built. By lack of common guideline, there is no “correct” way or methodology for developing ontologies [20]. Thus, we will rely on the Vygotsky process for our methodology.

A. Vygotskian Framework

Vygotsky theory, sometimes called Activity Theory, is a metaphorical space representing the location of cognitive development, a site occupied by subjects, experts, and any other device capable of contributing in development. Activity theory sees human action as being mediated by objects such as tools that carry with them the cultural history of mankind. It describes two processes that are inseparably intertwined: internalization and externalization. Internalization is the process by which culture determines human action and ensures continuity. Externalization is the process by which human actions construct new instruments and forms of activity at collective and individual levels and thereby initiate social change.

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Activity Theory is not a methodology; it is a philosophical framework for studying human practices as development processes. It offers, at least in principle, the possibility to conceptualize a scientific way of metacognitive processes, which allows to bind this cognitive development dimension in general and understand the origin of this capacity to control its own internal processes by the schema of Figure 1 and describes the transition from external and interpersonal control to individual intrapsychic control.

Thus, we could say that the Vygotsky theory is a "socio-historical-cultural development theory" [21]. With the three axes of Vygotsky theory, we can model the different concepts of our ontology:

- Subject: as in our "social network" we will replace human by communities. That axis represents communities.
- Object: can be different infrastructures of a community.
- Artefact: can be physical (tools), symbolic (text, taxes) or mental (architectural styles). For our modeling, it will represent cultural activities, historic events and localities of our country.

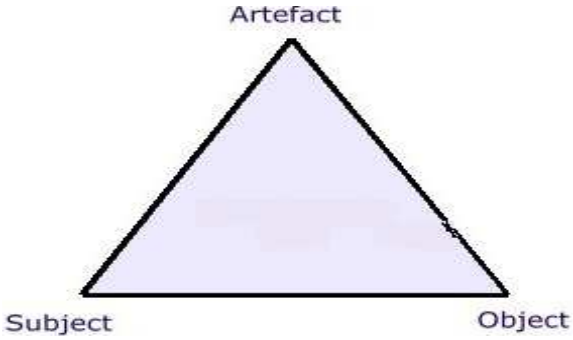

Figure 1. Vygotsky mediating triangle

B. Concepts and Relationships

The three axes of the Vygotsky process will be the fundamental classes in our ontology. As shown in Figure 2, an excerpt of the ontology includes main classes and their subclasses. Note *Historic_Site* class is the union of *Built_Area* and *Unbuilt_Area* classes. With these classes and their under classes we can capture all the sociocultural knowledge of a city.

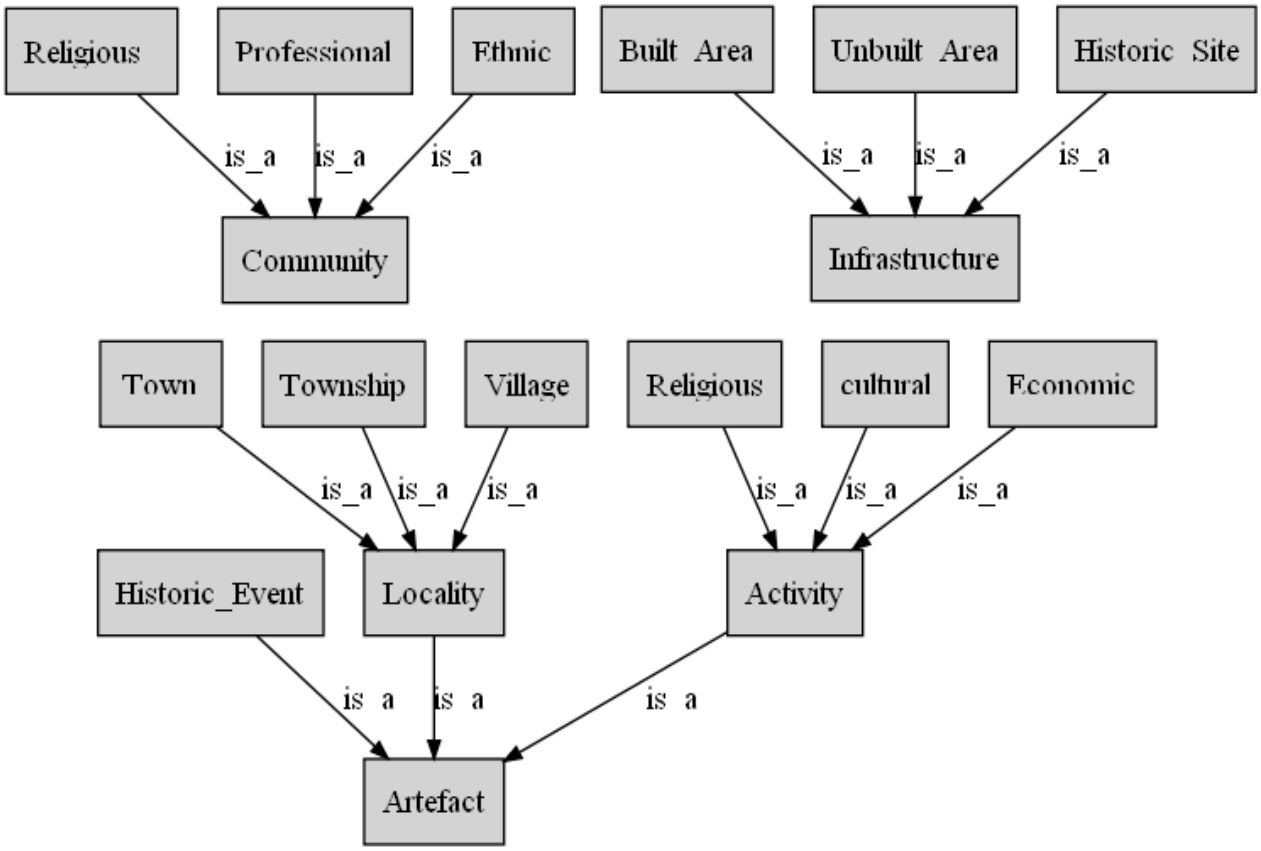

Figure 2. Extract of our sociocultural ontology (Basic Concepts).

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Classes alone will not provide enough information. They should be associating of attributes that play an essential role in ontology development. They describe properties of classes and instances. However, due to lack of space, we cannot detail the attributes of our various classes. Nevertheless, we will present two ontologies reused, which are W3C recommendations, OWL-Time ontology [22] proposed for modeling complex temporal phenomena for Semantic Web and GeoRSS-Simple ontology [23] a reference vocabulary for geospatial description of properties of Web resources.

We exploit OWL-Time ontology by defining two relations between, respectively, *Activity* and *Historic_Event* concepts of sociocultural ontology and *DateTimeDescription* and *Interval* concepts of OWL-Time ontology, due to *owl:equivalentClass* constructor of OWL-DL language. With first relationship, the *Activity* concept has properties (attributes) such as *hasBeginning* and *hasEnd* that mark respectively the beginning and the end of an activity. Since the *DateTimeDescription* concept is used to describe intervals implied, such as "May 8, 2007 at 12am 03mn 08s", which represent an interval of 24 hours, with the second relationship we enjoy this type of description for our *Historic_Event* concept.

With respect to GeoRSS-Simple ontology, we define a relationship between the *Infrastructure* concept of sociocultural ontology and the *gml:_Feature* concept of GeoRSS-Simple ontology. Due to *owl:equivalentClass* constructor of OWL-DL language, we get all properties of the *gml:_Feature* concept. Thus, many attributes- box, point, line and polygon- can be used to attach *Infrastructure* instances concrete geometries specified using strings following a certain format. Also we benefit of *WHERE* relationship that can bind *Infrastructure* instances to different geometries of *gml:_Geometry* concept.

Relations are, as classes, most important concepts in ontology development. A design choice that must be made during ontology development is to define when knowledge should be modeled in a property (attribute) or used as relation pointing to another concept. A criterion may be saying that is a property when values are of a type called primitive (integer, string), and it is a relationship when values are of a type said complex, i.e., another concept of ontology. However, this border can be questioned. Thus, Figure 3 illustrates the different relationships that may exist between our classes.

With these relations, we find Vygotsky mediating triangle at different levels. They allow representing different sociocultural knowledge:

- *Organize*, *Localize* and *Occur* relationships allow knowing the different interests of the *Community* based on their *Activity* it organizes. Likewise, we have an idea of the events that occur in a *Locality*.
- *Concern* and *Refer* relationships provide different historical narratives of a *Locality* or *Community*.
- *Is-in* relationship provides different communities of a *Locality*.

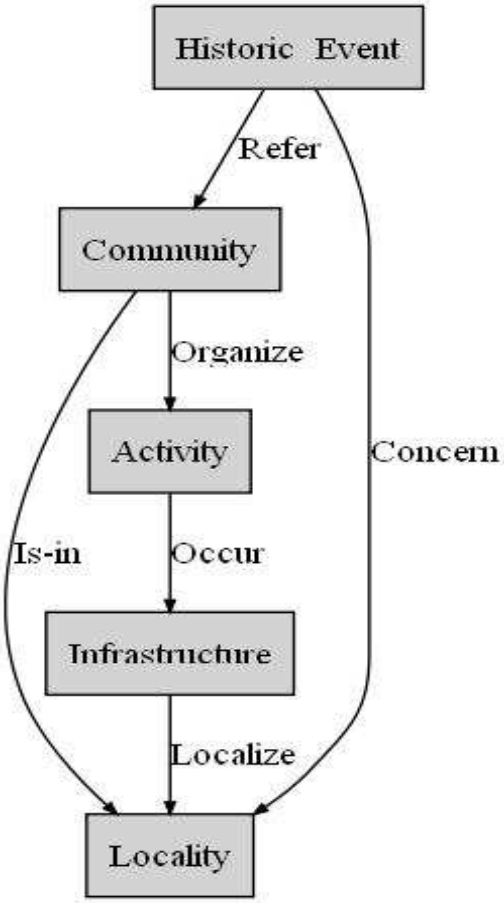

Figure 3. Relationships between classes.

C. "Social network" analysis

Analysis of our "social network" will be made by considering two levels in the definition of metrics.

A first level is to consider a social network within the Community. In this case, the basic elements considered are the different components of a community. Associations that are in place are the components. Considering associations we can calculate the degree centrality to see those that are more active in considering the relationship *Organize*, i.e., those which organize more activities. Similarly, for a locality, we know the various infrastructures and organizations that are there and their numbers thanks to the degree centrality. Therefore, with the degree centrality it is possible to find various information about a locality.

A second level is to consider an inter-community network. In this case, the basic elements considered are communities that make up our "social network". As in our first level we have important activities of the various components of a community, the idea here is to create a new indicator that can show the "similarity of interests" between communities. The similarity measure is built on the various activities within the Community. This indicator allows us to divide our communities clustered according to their center of interest. For example by calculating the

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degree centrality of different activities that are organized in a community, if we realize that religious associations are more active we can say that community has a religious interest. This "similarity of interest" can also be calculated using a descriptive vector. Thus from the vector, we can describe the different characteristics for which the similarity of interest will be calculated between communities. For example, we can take a vector whose first field contains the communities in which their cultural activity is between 20% and 25% of their activity, the second field in which economic activity is between 30% and 40% of their activity, etc. We can define several fields and so see the communities that share the same characteristics as this vector.

With different levels of our two metrics, we can have the interests of each community and with our index of "similarity of interests", it will be possible to divide our network according to their centers of interests.

IV. CONCLUSION

In this paper, we presented a method for developing sociocultural ontology in order to popularize and perpetuate the culture of a country through the sharing of customs and history of different localities of the country. This method is based on the process "Vygotskian Framework" which allowed us to model the main concepts of our ontology. Under the Social Web, we defined a new point of view of the concept of community. Thus, in our approach we have substituted a person to a community of people. Thus, focus on the information within a community but also between communities.

As a result, we have divided our system into two levels. The first level gives us rich information at a community level and the second allows us to divide our communities according to their focus through our index of "similarity of interests."

We have just completed a survey in the region of Louga in Senegal and we envision, at first, use the monograph obtained to populate and validate the sociocultural ontology. Likewise, we are going to try to see how to integrate socio-semantic aspects of our study.

Afterwards, we must imagine a semantic web platform around this ontology, a framework for sharing knowledge of Senegalese communities.

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Integrating Privacy During Requirements Capture for Ubiquitous Computing

Richard Gunstone
Computing and Informatics, School of Design, Engineering and Computing
Bournemouth University, Poole, Dorset, United Kingdom
rgunstone@bournemouth.ac.uk

***Abstract*—Use cases are used extensively in software requirements capture and representation in contemporary software system analysis and design. Ubiquitous computing systems are likely to require a high degree of user-centric requirements capture if they are to meet the often demanding requirements of the modern computer user. Such systems have a strong association with privacy issues, and their users are likely to have highly adaptive, complex privacy needs. This paper proposes a synthesis and extension of exant approaches to misuse cases for the special case of privacy issues in developing ubiquitous computing systems, catering for privacy enhancing technology. By incorporating privacy at the earliest and most critical phase of system development, we propose the enhancement provides greater emphasis on addressing privacy needs during systems development.**

***Index Terms*—use cases; privacy; ubiquitous computing**

I. INTRODUCTION

Use cases have found frequent use in software requirements capture and representation in contemporary software engineering and they are frequently integrated into business processes. The requirements engineering process is widely recognised as being crucial in the process of building a software system, by building a specification through iterative processes of elicitation, specification, and validation, ideally integrating multiple viewpoints to encourage objectivity [1].

The concept of *ubiquitous computing* is often attributed to Mark Weiser [2]. His vision of a pervasive, connected world through which computing would adapt to the environment, rather than the reverse, holds significant promise as a future paradigm for computing. Similarly, we view ubiquitous computing as a move toward an environment where technology diffuses into the background and where software systems are used that adapt to user needs autonomously. Ubiquitous computing examples are wide and varied, but they tend to require relatively advanced functionality in networks, context-awareness, and interaction design. Recent developments in consumer technology, particularly the convergence of technologies and information on mobile devices, have highlighted a growing interest in computers serving as communication tools in societal contexts. Use cases offer the potential to support the development of ubiquitous computing technology, where a high degree of user-centric requirements capture is likely to be necessary.

Use cases (or scenarios) serve as projections of future system usage and as projected visions of interactions with a designed system [3], providing a number of benefits to both requirements and software engineering. Use cases–as proposed originally and referred hereafter to as Ordinary Use Cases or (OUCs)–offer scalability and iterative improvement support [1], an intuitive graphical notation scheme; their use of natural language offers benefits such as partial specification and an opportunity to capture the user viewpoint [4]. They are also thought to suffer a number of disadvantages, including a lack of formal syntax and semantics that can lead to ambiguity, and not being amenable to formal analysis [1, 5].

While use cases offer benefits, their limitations have led to several proposals that aim to extend or replace the core modelling technique. In the following parts of the paper we focus particularly on privacy extensions to the requirements capture part of the development process. These extensions sit within a broader effort to address many of the problems identified with the original use case approach adopted by practitioners.

Modifications proposed in the literature sit within a spectrum of primarily augmentation approaches (i.e. incremental enhancements) on the one hand, and more extensive replacements formalisms on the other. Examples include incorporating goals and Non-Functional Requirements (NFRs), [6], e.g., the work of Lee and Xue [5], the use of more structured representations [4], using a more formal methodology for pre- and post-conditions [7], or considering the system within the environment [8]. Examples of more radical changes to the use case representation include the use of Petri nets via Constraints-Based Modular Petri Nets (CMPNs) [1] and Place Transition nets (PT or PrT nets) [9] and the generation of test requirements. We recognise some of these formalisms (e.g., PrT nets) are particularly interesting in their suitability for representing cross-cutting requirements such as security requirements.

We do make the implicit assumption however that augmentation of the methodology is appropriate for the purposes of privacy, rather than a complete replacement of the formalism. We note the observation made by Glinz, that while formal representations are useful for analysis and can achieve high levels of precision, this comes at the expense of readability and effort to write the scenarios [4].

The remainder of this paper is structured as follows. In section II, we explore the nature of privacy in the context of ubiquitous computing, contrasting to the similar, sometimes overlapping but distinct concept of information security. In

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section III, we attempt a synthesis of extant approaches to MUCs (that cater primarily for information security) and adapt these to the special case of privacy issues in developing UCSs. The paper is finished with conclusions and acknowledgements.

II. A NEED TO CATER FOR PRIVACY

We make the distinction in this paper between on the one hand *information security*, which is primarily concerned with the confidentiality, integrity, and availability of information, and *privacy* on the other. While Information Security is often an important element in ensuring effective privacy controls, it does not encompass all aspects of privacy provision. Similarly, privacy is not equivalent to information security.

Privacy is a difficult concept to formally specify, particularly for ubiquitous computing (and for computing more generally). At a theoretical level, theorists have evolved their articulation of privacy since the early legalistic definitions [10]. There has been a particular change in immediacy from the likes of *territorial privacy* toward more contemporary notions of *remote privacy* concerned with communications and information. As part of this change, privacy has evolved into a multidimensional concept (c.f. Marx's *personal border crossings* for *natural*, *social*, *spatial/temporal*, and *ephemeral/transitory* aspects of privacy [11]).

On a practical level moving from theories of privacy, which are useful in exploring the efficacy of the concept, toward building complex ubiquitous computing systems (UCS), inevitably requires specific technical developments to the system design to ensure privacy can be protected or enhanced. This necessitates the implementation of technical measures–*Privacy Enhancing Technology (PET)*. (Indeed, the introduction of PET serves to contrast ubiquitous computing privacy versus the classical models of privacy mentioned earlier.)

Individual users typically have dynamic privacy expectations. Such expectations vary according a multiplicity of factors (that are much more specialised than the broad themes proposed by Marx), for example: the other parties involved, timing, events, decisions recently made, the type of information to be shared, what the information will be used for. In tackling this highly variable user requirement, the provision of a suite of technical measures to fortify privacy and controlled by the user, therefore becomes crucial. (Indeed, this trend to push the locus of control for individual privacy to the user is increasingly commonplace in other areas of computing e.g., social networks).

Ubiquitous computing takes privacy considerations for contemporary computing much further, because a UCS is intrinsically based upon the collection and processing of information about their users, the environment, their property, actions, and so on. This information is collected all or most of the time, senses information types that are not readily accessible in contemporary computing paradigms (such as video camera feeds of rooms, contents of fridges via RFID, etc.), and is extensively processed to yield new useful information that can aid the activities of its users. Thus we argue a special treatment of privacy in ubiquitous computing is necessary and justified.

It is worthwhile at this point elaborating on what this paper regards as PET. We define PET to be 'technical means through which privacy can be preserved or enhanced according to the needs of the user'. PET can be implemented under a variety of categories, with some typical examples including: (1) *Information management policies* and provision of policy specifications and management infrastructure to govern the release of information, to whom and for what purpose, for how long, etc.; (2) *Statistical anonymisation*, encompassing techniques such as k-anonymity, and location cloaking such as adding noise, or discretization of location data; (3) *Communication privacy* including traditional approaches to ensuring privacy (encryption); (4) *Identity authentication and authorisation*, including federated identity technologies such as Shibboleth. (The broad range of PET categories serves to underline the need to derive PET from an analysis of risk during the design and development of a UCS.)

Privacy risks in ubiquitous computing are not often readily apparent, but surface in unanticipated ways often through the use of sources of information in unanticipated ways. A typical example is a ubiquitous computing infrastructure that collects information over a period of time and then due to an absence of privacy safeguards allows this information to be made available to an external party who takes actions that are unwanted by the user. For example, a smart space (environments equipped with extensive ubiquitous computing infrastructure) that monitors the amount of waste over a period of time, but then makes this information available to a local waste authority who made a supplementary charge for the property, clearly raises privacy and ethical questions. (For example, should UCS users be at a disadvantage to other members of society who do not use UCSs?)

Fundamentally, the use of ubiquitous computing technology implies the sharing of the association between identity and types of data that are often considered personal, for instance real-time location information. Poorly designed ubiquitous computing architectures open the opportunity for information to made available, and subsequently used, in a way that does not uphold such privacy requirements.

Addressing privacy considerations is, then, a mixture of *countermeasures to enhance privacy* (sometimes referred to as *privacy enhancing technology* or *PET*) and a *consideration of potential privacy-breaching activities*. We established in Section 1 that the requirements engineering process is widely recognised as being crucial in the process of building a software system, and thus we argue the process of identifying suitable countermeasures should begin when requirements are being established. Similarly, use cases are a logical methodology to adopt given the benefits discussed earlier. However, in their extant form use cases are not ideal in that they tend to model the intent of cooperative users of the system.

We draw attention to this, and underline the need to be able to explicitly represent (1) PET; (2) the uncooperative users of the system (or information) and (3) the relationships between OUCs, privacy risks and PET. While it may be possible to use OUCs to represent privacy requirements, without explicit elements within the formalism to represent these aspects the requirements engineering process is potentially at risk of losing information. Crucially, such information would be useful for subsequent phases of UCS development.

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As has been established, the existing meta-model for OUCs does not provide formalism for representing these extensions. Thus, it is desirable to extend the use case methodology to accommodate privacy concerns, and to potentially have a means to develop the requirements and consequential system design in such a way as to address any concerns identified during use case analysis. Any PET identified can then be developed sourcing appropriate requirements in the use case model.

III. Representing Privacy using Use Cases

In developing a use case augmentation that can cater for privacy, there are several considerations. Firstly a representation must be able to represent the risks to privacy; that is, the representation should explicitly model the risk formally without recourse to supplementary models. The representation should also be able to represent the PET to counter such risks; it should contain sufficient information to lead to the development of PET as requirements are carried through from the requirements capture phase through all subsequent phases of the ubiquitous computing project. Finally, the augmentation should provide a straightforward way of translating all relevant use cases into implementation, particularly with respect to privacy features.

One approach to representing privacy concerns is to extend the use case diagram to accommodate features that are complementary to the 'cooperative' elements discussed earlier. A class of use case formalism, referred variously as *misuse cases* and *abuse cases*, has emerged in recent years, primarily focused on Information Security risk analysis but we argue applicable more broadly to privacy.

Alexander presents a well-known extension using the "misuse case" (MUC) [12], that has been acknowledged in various studies. This concept simply represents a negative scenario, a use case from the point of view of an actor hostile to the system. An example of a malevolent actor might be a car thief, a hacker, a rogue employee, or non-human entity (or process such as the weather). Such actors are represented diagrammatically as an additional actor. Using Jacobson's original use case formalism, the MUC is represented as a series of parallel use cases that threatens the ability of the friendly actor to perform an ordinary use case. A MUC describes potential system behaviours that are deemed unacceptable to the stakeholders of a system [13]. MUCs are structured and use the same representational principles as ordinary use cases. Their connection to ordinary use cases are represented via *«threatens»* and *«mitigates»* relationships between the two types of case respectively, leading to a zigzag pattern of play and counter-play. In so doing, they potentially represent a means through which risk can be explicitly modelled.

In Alexander's approach, an iterative style of development leads to an enumeration of MUCs and additional use cases that can mitigate the threat posed by MUCs. During the requirements elicitation process the requirements analyst should enumerate each stake holder's 'doomsday scenario', in order to identify potential misuse cases [13]. Through an iterative process it should be feasible to enumerate all potential use cases and MUCs (as far as practicable). MUCs also provide a basis for developing new subsystems and components that lead to countermeasures. These developments may themselves lead to new types of threat, that require the evaluation of further countermeasures, thus spurring on the iterative process to conclusion.

In practice countermeasures derived from use case analysis are likely to vary depending on context of use. For instance, a financial trading system may use the same software product family as a small business, however the consequences should confidentiality be compromised are potentially more significant. Authentication in such a case, may require a more complicated form of authentication rather than simple password authentication. (It follows, therefore, that some variance in implementation may emerge depending on the software product line.)

This particular aspect of uses cases is explored in [14] where the authors propose the introduction of separate use cases to the use case diagram (i.e. the development of a parallel model to support the main use case model). Their rationale for separation is to reflect the variability in application and security requirements and consequently they propose a separation of security concerns is appropriate for use cases. In this approach, Security Use Cases (SUCs) are specified separately to the application use cases and can incorporate parametrisation. SUCs are subsequently integrated into the use case diagram using *extension points*, which focus as the "bridge" between the UC and SUC models. For instance, a parametrised SUC may be defined for an authentication service, which determines whether the accessor is a valid user. This could be subsequently fulfilled by two alternate use cases for example, one authenticating using an ID and password, and the other authenticating using a biometric (such as a fingerprint). This leaves the application use cases to specify business functionality, and the parameters for the SUCs are set, as mentioned, on the basis of the product line.

Similarly, Rosado et al. [15] (looking at Grid computing) also identify a need for SUCs, and propose extensions including specialisations of the generic use case for misuse, mobility, and security (Røstad proposes an extended notation for misuse cases [16] particularly focused on Information Security and a review of previous work in the area of misuse cases).

A number of observations are appropriate on the basis of such studies, particularly with a view to the development of PET in ubiquitous computing: (1) it is not feasible at the requirements capture stage to overlook events that may impact the privacy expectations of the anticipated users of a system. As the introduction noted, the requirements engineering process is widely recognised as being crucial in the process of building a software system [1]. Indeed retro-fitting PET to a system that has not been developed from first-principles to cater for privacy is unlikely to be economic or straightforward; (2) use case models need to represent additional actors in addition to the anticipated actors or users of the system. At a minimum an additional class to cater for "misusers" or similar of a system is necessary; (3) a commonality across several extensions to the use case formalism is that a further type of use case is necessary to cater for categories of risk that

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misusers of a system present (the "misuse case"); (4) a further use case type is necessary to encapsulate countermeasures; and, (5) extension points offer a means through which a use case model can 'drill down' to a level of detail suitable for the development of countermeasures.

We thus envisage two actors as follows: (1) The uncooperative user or actor (akin to "misuser" in MUCs) is an individual who wishes to invade the privacy of a legitimate user of the system; (2) The legitimate user or actor ("ordinary actor") is one who the UCS is designed for and both performs legitimate actions using the UCS, and performs actions that protect or enhance his or her own privacy. Considered together, three tiers of activity emerge, leading to the following types of use case ('prototypes' in the terminology of Rosado et al.):

OrdinaryUseCase (UC)–this is a use case of the form currently used in mainstream use case modelling, representing the legitimate actions of the "ordinary actor". This continues to represent a flow of events [1], includes a description comprising structured or unstructured text [17], contains a sequence of actions (or transactions) performed by the system leading to an observable result that is of value to an actor [17, 18, 19]. The standard relationships *«extend»* and *«include»* are compatible with this type. UCs are evolved using standard, widely-accepted practices.

PrivacyMisuseUseCase (PMUC)–this represents a privacy risk to the privacy expectations of ordinary users of the system. Within this context, the PMUC represents the characteristics associated with the standard use case. The relationships *«threaten»* and *«mitigate»* are compatible with this type, after Alexander [12]. (To aid reproduction, we represent the PMUC as a double-circled variant of the standard use case.)

PrivacyEnhancingUseCase (PEUC)–this represents a *privacy-enhancing use case*, and acts as the anchor point for PET. We propose this type will normally be associated with an extension point that permits a range of PET options. The relationship *«threaten»* (from a PMUC) is compatible with this type. (This diverges from Røstad's proposal, which uses the standard use case type for countermeasures and is more straightforward.)

PETUseCase (PET)–anchors to the extension point of the PEUC and can use the *«mitigate»* relationship. This is used to represent PET within the model. At the extension point we propose they may or may not be included as part of the main use case model, decided as necessary by the analyst. (Diverging from the practice advocated in [14].) The relationship *«mitigate»* is compatible with this type, after Alexander [12].

Further, we define the following additional type of actor:

UncooperativeActor (UA)–an actor associated with PMUCs, for whom the successful completion of their nefarious activity achieves value. While the use case model is not intended to cater for this type of actor in terms of services offered by the system, their inclusion is (as the paper implies) to develop countermeasures to safeguard the privacy of the intended users. Within this context, the UA shares the properties and characteristics of a standard actor in the use case meta model. (This actor is complemented by the conventional UML actor, which we abbreviate as Cooperative Actor or *CA*.)

A complexity with this proposal when representing privacy

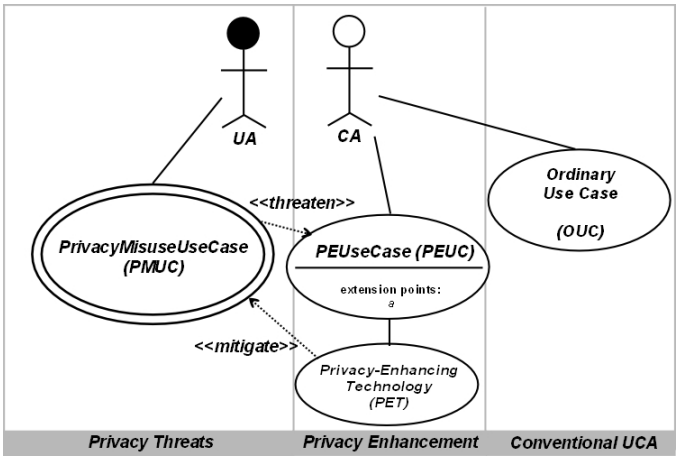

Figure 1. The main diagrammatic elements for modelling privacy in the proposed model. The introduction of a third tier concerned with *Privacy Enhancement* serves to contrast the proposed approach with traditional MisuseCases (MUCs).

at the use case analysis stage is how best to represent the interplay between privacy threats and the actions of the cooperative user of the system. Encapsulating this by linking PMUCs directly to OUCs (via e.g., <<*threaten*>>) might appear sufficient, however this implies a threat to the actions of the CA more akin to traditional Misuse Cases (MUCs), whereas in the case of privacy, the CA will usually be able to perform their actions regardless of any privacy threats, with privacy risks surfacing subsequently and not directly jeopardising the original activity. The unwanted tracking of a UCS user, for instance, does not necessarily jeopardise the sharing of location information. We propose this logical impasse can be overcome by assuming the areas where the CA wishes to enhance privacy are known to the CA and these are correspondingly represented separately in a second middle tier; the interplay then occurs between the PMUCs of the UA and the PEUCs (and PETs) of the CA. (This leaves the conventional use case analysis separate.) Figure 1 shows these new constructs diagrammatically.

This additional group of PEUCs can be enumerated according to the following outline repetitive process for developing and elaborating the use case model: (1) Identify, enumerate and represent the Ordinary Use Cases (OUCs) of the CA; (2) Identify, enumerate and represent the Privacy Misuse Use Cases (PMUCs) of the UA. (These represent the privacy threats to the normal performance of OUCs.); (3) Identify, enumerate and represent Privacy Enhancing Use Cases (PEUCs) to counter the privacy threats posed by PMUCs. Generic PEUCs are appropriate in this type of use case, for instance "Cloak location data"; (4) Identify, enumerate and represent Privacy Enhancing Technology (PET) use cases attached to relevant extension points on the PEUCs identified above. An example of PET for an extension point for the previous example may be "Discretize location" or "Implement k-anonymity or return no information"; *(5) Repeat steps until use case analysis is complete.*

In terms of their textual representation, PMUCs, OUCs, and PEUCs should share the conventional textual representation of

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contemporary use cases, adapted as appropriate to privacy.

IV. Conclusion

Use cases have achieved widespread use in software engineering problems, and more widely as a generic term for user needs from products and services.

In this work-in-progress paper, we have proposed a synthesis of extant approaches to MUCs and evolved these to the special case of privacy issues in developing UCSs. The proposed approach is particularly attuned to the PET requirements of ubiquitous computing.

In modelling privacy at the use case development stage a number of advantages are evident:

- Privacy is explicitly modelled early-on during the system development process (the most critical phase of system development). This provides an opportunity to carry through the privacy requirements identified during use case analysis through into system development.
- Privacy-enhancing technology is accommodated in the use case model, and the analyst has a choice as to whether to include PET use cases directly via extension points into the use case model, or to represent these separately.
- The use case development process for misuse cases provides an outline of the iterative process required to develop use cases, PET and associated privacy-related use cases. Through iterative development, PET should emerge from the use case model to enhance the system development process.
- The modifications represent an augmentation to the standard use case methodology, providing familiarity and a straightforward development process for software engineering and development.

Further developments to this approach include validating the methodology against a real-world system example, and introducing a more formalised description of the elements introduced (akin to the modelling approached used in [14]).

V. Acknowledgements

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Automatic tracking and control for web recommendation

New approaches for web recommendation

Samuel Nowakowski , Anne Boyer, Cédric Bernier
LORIA-KIWI
Campus scientifique – BP239 - F-54506 Vandœuvre-lès-Nancy Cedex
Samuel.nowakowski@loria.fr
Anne.boyer@loria.fr
Cedric.bernier@loria.fr

***Abstract*— In this paper, we assume that users and their consumptions of television programs are vectors in the multidimensional space of the categories of the resources. Knowing this space, we propose an algorithm based on a Kalman filter to track the user's profile and to foresee the best prediction of their future position in the recommendation space. The approach is tested on data coming from TV consumptions. Using these results, we derive a new strategy for web recommendation based on a control loop. To conclude, we propose a new users' monitoring approach.**

Keywords-recommender system; user profile; target tracking; Kalman filter; control loop

I. INTRODUCTION

In Web-based services of dynamic content, recommender systems face the difficulty of identifying new pertinent items and providing pertinent and personalized recommendations for users.

Personalized recommendation has become a mandatory feature of Web sites to improve customer satisfaction and customer retention. Recommendation involves a process of gathering information about site visitors, managing the content assets, analyzing current and past user interactive behavior, and, based on the analysis, delivering the right content to each visitor.

Recommendation methods can be distinguished into two main approaches: content based filtering [9] and collaborative filtering [10]. Collaborative filtering (CF) is one of the most successful and widely used technology to design recommender systems. CF analyzes users' ratings to recognize similarities between users on the basis of their past ratings, and then generates new recommendations based on like-minded users' preferences. This approach suffers from several drawbacks, such as cold start, latency, sparsity [11], even if it gives interesting results. Furthermore, this approach does not consider the dynamical aspect of web browsing, i.e., going from page to page (or web resources) as we can move from place to place.

This is the reason why the main idea of this paper is to propose an alternative way for recommender systems based on the following assumption: we consider Users as target moving along a trajectory in the recommender space. This dynamic system can be modeled by techniques coming from control system methods and we use Kalman filtering to predict future positions of the users in the recommender space, i.e., the expectable movies categories to be seen. We will detail the backgrounds of this approach. Then, we expose the recommendation strategies. In our conclusion, we will give some guidelines for future works.

II. PRINCIPLES

Kalman filter is an optimal state estimator of a linear system. It can estimate the state of the system using a priori knowledge of the evolution of the state and the measurements. Kalman filter has main applications in control systems and in target tracking.

A. *Target tracking in the cyberspace*

Our hypothesis: the user is a target which is moving along an a priori unknown trajectory in the multidimensional space of the categories. Figure 1 shows the principle of our approach.

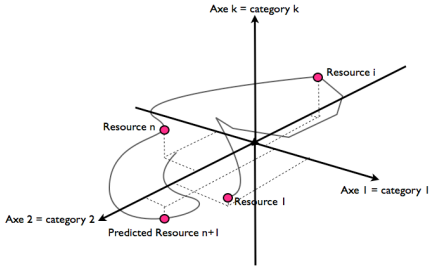

Figure 1. Trajectory in the recommender space

By measuring the successive positions of the users in the space (the seen movements), we can model a trajectory and by using a state space cinematic model, we can predict future positions in the space.

B. *Kalman filter: equations*

How can we know about a target moving in the recommender space?

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We choose to represent a state vector containing three components: one for the position, one for the speed and one for the acceleration. The state vector has the following form:

$$X_k = \begin{bmatrix} x \\ \dot{x} \\ \ddot{x} \end{bmatrix}_k \quad (1)$$

where:

x is the vector containing the position vector (the position is given by the Quantity of Interest given related to the different categories see Part IV)

$\dot{x}$ is the vector containing the speed vector

$\ddot{x}$ is the vector containing the acceleration vector.

$\dot{x}$ and $\ddot{x}$ are introduced in the state vector to take into account the dynamic variations in the positions of the target.

The dynamic of this state vector will be modeled by a state space model which has the following form:

$$\begin{cases} X_{k+1} = AX_k + w_k & (2.a) \\ Z_k = HX_k + v_k & (2.b) \end{cases}$$

where matrix A includes the relationship between the position, speed and acceleration where T represents the time period. In our case, we consider T = 1. w_k and v_k are random noises which take into account unexpected variations in the trajectories.

$$A = \begin{bmatrix} \alpha & T & \frac{1}{2}T^2 \\ 0 & \alpha & T \\ 0 & 0 & \alpha \end{bmatrix} \quad (3)$$

Matrix H, called the measurement matrix, is structured to obtain in equation (2.b) the values of the positions in the recommender space. Thus, H will have the following structure as shown in the figure 2.

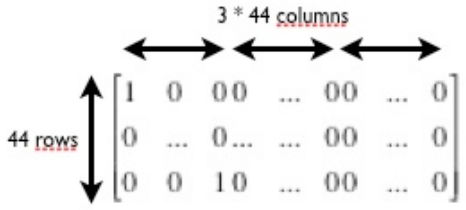

Figure 2. Structure of Matrix H

The Kalman filter equations are then given by the following equations [6]:

Prediction: it is the predicted state knowing past values

$$\begin{cases} \hat{X}_{k+1/k} = \hat{X}_{k/k-1} + K_k\left(Z_k - H\hat{X}_{k/k-1}\right) \\ \qquad = \left(A - K_kC\right)\hat{X}_{k/k-1} + K_kZ_k \end{cases} \quad (4)$$

Kalman gain: it described the dynamic of the filter. The dynamic takes into account the variations of the moving target.

$$K_k = AP_{k/k-1}H^T\left(HP_{k/k-1}H^T + R\right)^{-1} \quad (5)$$

The evolution of the uncertainty on the estimation is then given by:

$$P_{k+1/k} = AP_{k/k-\&}A^T - AP_{k/k-1}H^T\left(HP_{k/k-1}H^T + R\right)^{-1}HP_{k/k-1}A^T \quad (6)$$

where the initial conditions (which initialize the filter) are given by:

$$\hat{X}_{0/-1} = X_0\ ,\ P_{0/-1} = P_0$$

and the state prediction by:

$$\hat{X}_{k+1/k}$$

The principle of the filter is described by the following figure:

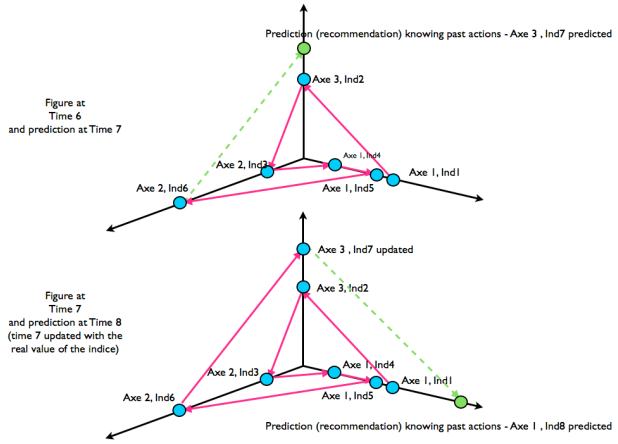

Figure 3. Principle of the position prediction

We apply these equations on an experiment based on TV consumptions.

III. FIRST EXPERIMENT

A. *Description of the experiment*

The dataset is the TV consumption of 6423 English households over a period of 6 months (from 1st September 2008 to 1st March 2009) (Broadcaster Audience Research Board, [7]), [8]. This dataset contains information about the user, the household and about television program. Each TV program is labeled by one or several genres. In the experiment, a user profile build for each person. The user profile is the set of genres associated to the value of interest of the user for each genre. This user profile is elaborated in

function of the quality of a user's TV consumption: if a TV program is watched entirely, the genre associated to this TV program increases in the user profile. Several logical rules are applied to estimate the interest of a user for a TV program.

The methodology of the experimentation is the following:

- The Kalman filter is applied iteratively to estimate the future positions of the user in the space.

The entire consumption is described by 44 categories, which will define the 44 dimensions of the recommender space where users are "moving".

B. Numerical results

The obtained results can be exposed as follows:

Kalman filter predicts the interest of a specific user for a subset of genders knowing his past. Using this prediction, we can propose a new recommendation strategy:

- If the Quantity of Interest (QoI) of the user is predicted to be in one specific region of the space, we can recommend something inside this specific region:
  - For example, if the specific region is defined by dimensions Documentary and Drama, we can recommend contents related to these two dimensions
- If the predicted quantity of interest (QoI) changes to another dimension of the space, we can automatically recommend content from this new region of the space.

C. Results

The results can be analyzed as follows: Kalman filter predicts the specific interest for a category of contents of one user.

Figures 4 and 5 show Estimation / Prediction computed by Kalman filtering. Doted-lines show the evolution of the real values. Continuous lines show the obtained predictions.

In Figures 4 and 5, we can see the estimation/prediction given by the Kalman filter: green lines show the prediction obtained at each time using the knowledge we have of the degree of interest of each user. We can see that the prediction fits the real values even if they present abrupt variations.

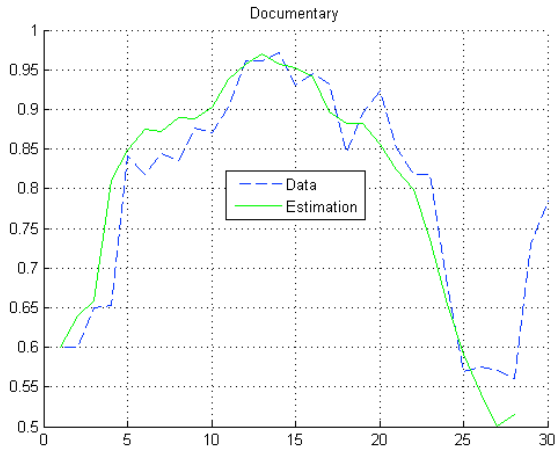

Figure 4. Prediction for Drama

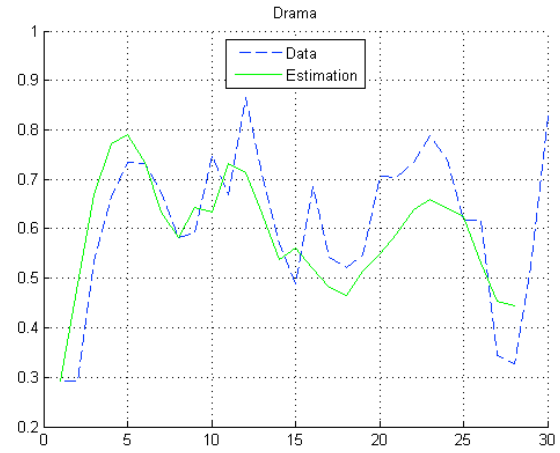

Figure 5. Prediction for Documentary

IV. RECOMMENDATION STRATEGY

In this approach, we can build a recommendation by analyzing the estimation provided by Kalman filter.

The profile is built from the consumption of TV programs. Each TV program is defined by concepts such as entertainment, science fiction, talk show, etc. The analysis of the way different TV programs are watched allows deducing the interest of a user for each concept.

Our new recommending strategy is based on control loop which can be described by Figure 6.

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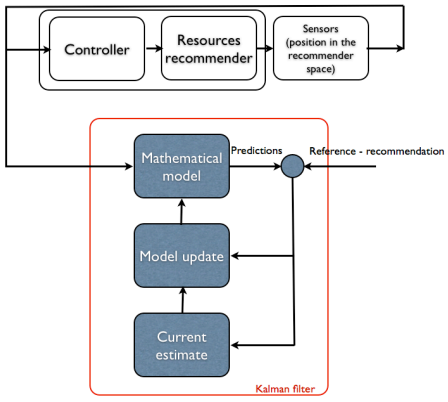

Figure 6. Control loop for recommendation

This control loop will observe the difference between the estimated concept and the calculated concept and it will integrate the controller/recommender the following strategy:

- If the computed concept is superior to the estimated concept (noted negative difference), then the user's interest for this concept is decreasing.
- If the estimated concept is superior to the computed concept (noted positive difference), then the user's interest for this concept is increasing.

The process will focus on the concepts showing up a big difference: the concepts with an important positive difference influence the recommendation towards these concepts, whereas the concepts with an important negative difference discourage the recommendation towards these concepts.

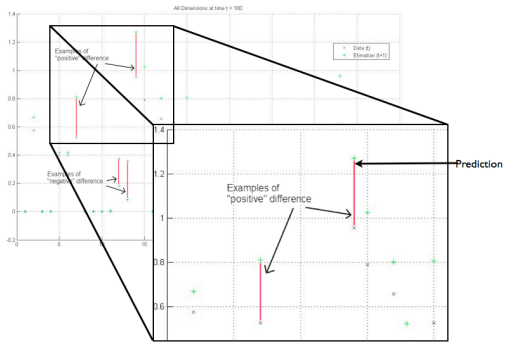

Figure 7. Analysis of the evolution of the prediction for recommendation

Conversely to existing methods which recommend precise contents for a given user, this method will performs on the macroscopic level, i.e., subspaces of specific categories. The strategy will isolate the appropriate subspace and the recommendation will be done in the related categories. Then, we can imagine to have a more precise recommendation by computing a second iteration (target tracking in the trajectory in the subspace and positions prediction) on the subspace (zoom effect).

To summarize, the recommendation is based on the two preceding arguments.

- the user's actual state of mind
- the subset of retained dimensions.

From these “positive” or “negative” dimensions and from the TV program, we have to define the recommendation for a set of TV programs for that day. Furthermore, according to what the user watched during the day, we can refine our recommendation. Indeed, in our example, if the user is interested in contents of types x, y and z and if he has already watched content of type x and y that day, the recommendation would essentially concentrate on content of type z.

Hence, we will need to make a last step which will be devoted to the identification of the appropriate content which corresponds to the estimation of the dimensions' evolution.

V. CONCLUSION

Our original approach considering users as target moving along trajectories in subspaces of the recommendation space will solve web recommendation as a control system problem. Web recommendation becomes a system described by a state space model to be controlled or tracked. By comparing inputs to predicted and/estimated values, we obtain a new kind of recommender systems which will consider as moving targets to be identified or dynamic systems to be controlled.

Then, in our case, knowing the past positions of the user in this space along the different axis of the 44 dimensions space, our Kalman filter based recommender system will suggest:

- if the user is interested in contents of types x, y and z and if he has already watched content of type x and y, the recommendation would essentially concentrate on content of type z.

At last, the strength of our approach is in its capability to make recommendations at a “higher level”, which fit users habits, i.e., given main directions to follow knowing the trajectory in the space and not to suggest specific resources. Furthermore, the trajectories in the recommender space give the opportunity to compute a monitoring system where we can visualize in real time the users’ trajectories (see Figure 8).

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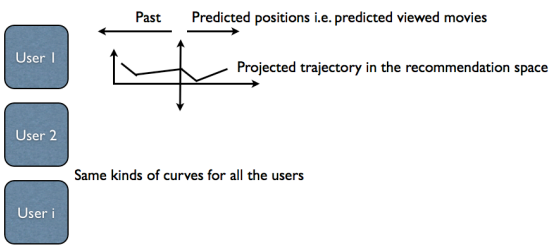

Figure 8. Users monitoring

Future works will be focused on tracking groups of users and on the definition of the topology of the recommendation space as a space including specific mathematical operators.

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Modeling Democratic Elections via Congestion Networks

Guillermo De Ita Luna, Yolanda Moyao and Meliza Contreras
Computer Sciences Faculty, Autonomus University of Puebla, México
Email: {deita, ymoyao, mcontreras}@cs.buap.mx

***Abstract*—We address the problem for selecting a representative via a democratic election simulated by a multi-agent system. Due to lack of analytic tools for simulating electoral tendencies, we propose here, a model based on a set of non-cooperative agents which are competing for obtaining a maximum number of votes from a population. A key element in this model is to recognize the 'profiles' that characterize in a specific election how the voters make their political decisions. In order to influence the voters, the agents apply different strategies. In our model, an agent's strategy is represented via a vector of weights which indicate the amount on each profile the agent utilize to persuade the voters. We have programmed a simulation system of the voting tendencies by sectors, in agreement with the changes of strategies that the candidates perform throughout their political campaign. As the profiles used for characterizing the voters, and forming the strategies of the agents have a limited nature, then a congestion network is built. The use of a congestion network allows us to search the singular points of the competition system, enabling us to predict the possible winner of that competition according to the strategies used by the agents.**

Keywords-Multi-Agent System; Congestion Games; Electoral Simulation; Voting Tendencies

I. INTRODUCTION

The Artificial Intelligence (AI) has motivated the exploration of new reasoning issues and methods, as well as combined disparate reasoning modalities, into an unified framework which allows to deal with incomplete, imprecise, contradictory, and changing information.

In the AI, the application of intelligent agents has brought a great commercial interest, and it has been useful for decision making. One of the possible applications of the intelligent agents is to simulate specific human tasks. For example, an important human task has been the selection of a representative from a population.

The selection of a representative is both an important and common problem. For instance; selecting the candidate of a political party, the head of a department, a supervisor, etc. This means, when it is necessary to select the best representative within a group of people. Different methods have been intended to carry out this task.

We consider each one of the candidates as an independent player with his own strategies. Each agent competes against each other in order to win a political election. In [2], [3], [7], [8], [15], several models of voting are established assuming democratic systems. Particularly, the absolute majority system, where the player who obtains a relative majority becomes the winner, is studied.

In such systems, a candidate must obtain over 50% of the popular ballots to become the winner of the election. If none of the players overcome this threshold in the first round, then there is a runoff between the two top candidates to decide who is the winner.

Different mathematical formalisms have been developed to describe electoral systems and outcomes by modeling both voting rules and human behavior [3], [7], [15], [16]. We remit the reader to [3], [7], for a survey on the fundamental characteristics in voting and election theories. And in [6], [11], [15], [16], we can find practical examples of particular vote schemes occurring around the world.

In [9], [16], an analysis on the winning coalition structure of an election system is done as a simple legislative game, considering the importance of relative ideological positions in a legislative decision game, that is, as a non-cooperative game.

While in [3], [6], [13], the dynamics of their model is based on applying the search for equilibrium points, which must resolve the expectations of voters and the optimum policy choices of representatives assuming stationary environments.

Nowadays, demoscopic studies (opinion polls) are accomplished in order to determine some electoral preferences. Those surveys, as describers of a moment, allow us to make predictions for a very short term. An opinion poll, in its traditional elaboration form, usually reflects outlying questions about the candidates, and about the political competition such as; popularity indexes, perceptions on the nature of the candidates or their images, the impact of their campaigns, mottos, etc. Many times the factors that are measured through those surveys answer more to the interest of the political parties than to the perception of the voters.

Due to this panorama that lacks the necessary analytic tools for studying electoral tendencies, we propose a simulation system of the political behavior for certain voters segments in accordance to the changes of strategies that the candidates perform in the course of their campaign.

A key element for determining the winner of the contest, is to recognize the profiles characterizing the voters, given that all agents form their set of strategies based on promises and actions which try to influence the voters. Those promise and actions are reflected via a set of weights assigned to the profiles characterizing the voters.

Our logical model is an application of a congestion game [5], [10], [12]. Building a congestion game, allows us to realize a search for the singular points in the competition system,

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enabling us to predict the possible winner of an specific electoral contest. Once the singular points have been achieved, we can determine the winning strategy and the agent that will obtain the largest number of votes, that is, we can determine who will be the winner as well as its winning strategy.

In Section 1, we describe the problem to consider. In Section 2, we present the definition of the concepts and the mathematical objects to be used in our model. In Section 3, we describe how to model the political preferences of the voters. As well as the method used for determining a relative hierarchy among those preferences. In Section 4, we show the method used for computing the number of votes according to the hierarchy previously established. In Section 5, we describe a case study made during the principal' election in the Faculty of Computer Sciences- BUAP, México. In that election, we apply our model in order to predict the expected voting results by the student's sectors. In Section 6, we present the conclusion and future works.

II. Building the Multi-Agent Scenario

Let $\mathcal{A} = \{A_1, A_2, \ldots, A_n\}$ be a set of n intelligent agents. $A_i \in \mathcal{A}$ represents one of the competitors contending for a position or, in political terms, a candidate competing in a political election.

In the selection of a representative among a group of intelligent agents, it is common that beyond the beliefs, such selection also depends on the actions and the set of resources that each agent holds in order to persuade the population to vote for him.

We represent the resources used by the agents via a discrete set $\mathcal{P}\int = \{P_1, \ldots, P_m\}$. The elements of $\mathcal{P}\int$ are called "profiles". Such profiles are the key objects to characterize as the voters as the strategies of the candidates.

Each agent has to make sure to possess (or to offer to the voters) a certain quantity of each profile. The quantity of a profile that an agent believes to have is represented by a weight. An agent (and sometimes, his campaign's team) organizes the profiles and their corresponding weights in different ways, creating so different political programs to be used in accordance with the answer of the population.

We call to each one of the agent's programs a *strategy*. An agent apply one of its strategies to compete with other agents in order to obtain a maximum number of votes. A strategy s_i of A_i is a set of pairs: $s_i = \{(P_1, w_{i1}), (P_2, w_{i2}), \ldots, (P_m, w_{im})\}$, where each weight $w_{ij}, j = 1, \ldots, m$ is the amount of the profile P_j that the agent A_i applies in one of his political programs (s_i).

In fact, each agent (or his advisers) has to determine which profiles (and their corresponding weights) an agent should promote, and he also has to plan how to arrange those profiles in his political program. According to the different scenarios or to the results obtained through the opinion polls, as well as to the agent's knowledge about the preferences of the voters, the agent selects one of his strategies. However, the agents are autonomous and consequently, their strategies are private.

Let $S(A_i) = \{s_{i1}, s_{i2}, \ldots, s_{in_i}\}$ be the set of different strategies that the agent $A_i \in \mathcal{A}$ can apply for attracting voters.

TABLE I
Example of a strategies-matrix for a set of n agents

	P_1	P_2	P_3	...	P_m
s_{11}	20	25	0	...	10
s_{12}	0	20	10	...	15
...				...	
s_{1n_1}	5	0	10	...	10
s_{21}	5	15	0	...	10
s_{22}	0	10	10	...	15
...				...	
s_{2n_2}	20	0	10	...	10
...				...	
s_{n1}	5	5	30	...	0
s_{n2}	10	10	15	...	5
...				...	
s_{nn_n}	10	10	0	...	17

We can order the set of strategies of the agents via a matrix called the strategies-matrix (see Table I). Once all agents have chosen one of their strategies $s_i \in S(A_i)$, $i = 1, \ldots, n$, a state (an action in the multi-agent system) is formed $e = (s_1, \ldots, s_n) \in S(A_1)X \ldots XS(A_n)$. Let $\mathcal{S} = \{e_1, \ldots, e_o\}$ be the set of different states formed by the multi-agent system.

Then, a state $e_j, j = 1, \ldots, o$ is one of the possible configurations of the multi-agent system, and according to the strategies applied by the agents, they obtain a certain number of votes in each state. As the agents change their strategies in order to obtain more votes, they interactively form new states into this multi-agent system.

While more and more agents utilize the same limited profile, such profile tends to saturate, and its influence on the voters will also become smaller and smaller. Thus, a congestion network is an ideal gadget for modeling this kind of share resources.

A congestion network game is a triple $(\mathcal{A}, \mathcal{P}\int, k)$, where $\mathcal{A}$ is a set of n players, $\mathcal{P}\int$ is a set of m limited resources, and k is an increasing cost function, which depends on the number of agents using the same resource [6], [13]. Every player has to choose a strategy which allows him to decrease his cost function value. A state $e = (s_1, \ldots, s_n)$ occurs when each player selects a strategy s_i. For each resource $P_i \in \mathcal{P}\int$, let P_i's congestion n_i be the number of players whose chosen strategy contains the profile P_i. The gain for player $A_t \in \mathcal{A}$ is $\sum_{P_j \in s_i} k_{P_j}(n_t)$ and the goal of each player is to maximize his earnings.

The cost of a resource (one edge on this network) is given by the function of the congestion, i.e., the number of agents allocating the same resource. This class of congestion networks has been extensively used in game theory [2], [5], [10]. In many applications, players incur some costs when they change their strategy. Hence, it is reasonable to assume that a player is only interested in changing his strategy if it significantly increase his earnings.

Seeking for the optimal interactive strategy of an agent is a hard problem, because its effectiveness depends mostly on the strategies of the agents involved [4]. Thus, we are modeling the selection of a representative as a non-cooperative

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game, where there is a limited quantity of each profile which represents a limited resource in a congestion network.

Another relevant element of our model consists in the way to characterize the voters' population. We use the same profiles applied in the codification of the strategies of the agents for characterizing the sector's of voters.

III. Characterizing the Sectors of Voters

Let $Pot = \{Z_1, Z_2, \ldots, Z_k\}$ be a population of voters distributed in k sectors. Let $WZ_i = |Z_i|$ be the number of voters of the sector Z_i. We assume that the cardinalities $WZ_i, i = 1, \ldots, k$ are known values. The members of each sector are characterized and identified by a set of 'profiles' which represents the main political characteristics of the members in that sector.

An important problem is to determine the main profiles used for characterizing each sector, as well as to determine its relative political importance among them. Usually, political experts can approximate those values after analyzing previous elections and carry out a profound study on the political behavior of the voters' population.

In our model, a significant sample of each sector of voters is selected to apply opinion polls. The responses obtained allow us to configure the set of profiles $\mathcal{P}\int$ as well as to determine the relative order of importance of each profile in each sector.

For designing the opinion polls, we considered the historical political behavior of the voters, the identification of their political and economical necessities, and the current electoral interests. In fact, the questions included in the opinion pulls are directed to recognize the real neccesities of the voters and not just to quantify the popularity of the candidates.

Given a sector $Z_i \in Pot$, a weight wz_{ij} for each profile $P_j \in \mathcal{P}\int$ is computed based on the responses obtained in the opinion polls. If a profile P_j is not relevant, then $wz_{ij} = 0$, and if a profile P_j is too important for characterizing Z_i, then wz_{ij} has to be a greater value than the other profiles' weights.

In some cases, the values wz_{ij} are obtained as the average of the values assigned to that profile by the selected sample of each sector. Therefore, if the weight of each profile is computed through opinion polls, it is adequate to calculate the average of responses, and to apply minimum squares to fit each poll with the average values of the sector in order to eliminate 'false positives'.

The false positives cases are represented as responses of voters who do not want to cooperate with the opinion polls, either when they try to be tricky or when a voter had sluggish responses. A formula which could be applied to eliminate false positives consists in, for example, eliminate the response of the voters whose total sum over the difference with the averages of the sector is greater than the 50% of the sum of the averages in that sector.

We consider as a relevant profile $Pc \in \mathcal{P}\int$ the impact that the political campaign has on the voters, in such a way that we are able to evaluate some changes of preferences of the voters before and during the political campaign. Furthermore, we have found that as a reflection of the heterogeneous character of the sectors, the profiles can have a positive or a negative influence on the voters when they make their political decision.

TABLE II
Relative weights for profiles characterizing each sector

$Sectors$	P_1	P_2	...	P_m
Z_1	AvP_1Z_1	AvP_2Z_1	...	AvP_mZ_1
Z_2	AvP_1Z_2	AvP_2Z_2	...	AvP_mZ_2
...				
Z_k	AvP_1Z_k	AvP_2Z_k	...	AvP_mZ_k

An order of relevance is given over the profiles of each sector $Z_i \in Pot$. Let AvP_jZ_i be the relative value given to the profile P_j with related to the other profile's values of the sector Z_i. For example, AvP_jZ_i could be the percentage of members from Z_i in which the profile P_j is their main profile.

The values $AvP_jZ_i, j = 1, \ldots, m$ could be percentages that determine a relative order over the set of profiles characterizing Z_i and then, usually $\sum_{j=1}^{m} AvP_jZ_i = 100\%$. Then, the values AvP_jZ_i build a hierarchy among the profiles of a same sector.

A simple way to determine the percentages values AvP_jZ_i of a sector Z_i, is to assign the same importance to all profiles and then, each percentage AvP_jZ_i is equal to 100% divided by the number of relevant profiles in Z_i.

Other way to compute $AvP_jZ_i, j = 1, \ldots, m$ is by adding up the average weights wz_{ij} obtained for all profiles and then, divide the corresponding weight of each profile by such sum, that is, for each fixed sector $Z_i, i = 1, \ldots, k$ $AvP_jZ_i = w_{ij} / \sum_{Pj \in \mathcal{P}\int} w_{ij}$.

Many times the sum of averages for the positive profiles is greater than the sum of averages of the negative ones, because the positive profiles have a greater influence than the negative ones to decide the vote in a proportion according to the political scenario which is being modeled.

We order the relative percentages AvP_jZ_i in a vector VZ_i, that is, $VZ_i[j] = AvP_jZ_i, j = 1, \ldots, m, i = 1, ..., k$. Each vector $VZ_i, i = 1, \ldots, k$ operates like a 'sieve' that selects the adequate proportion of the profiles to characterize a sector Z_i. The vectors VZ_i are stored as rows of a matrix $MPot$ (see Table II).

In the following section, we present a way to distribute the total number of votes among the agents. Such distribution depends on their strategies and the relevance of the profiles characterizing each sector.

IV. Computing the number of votes

Given a state $e = (s_1, \ldots, s_n)$, let w_{ij} be the weight for the profile $P_j \in \mathcal{P}\int$ that the agent $A_i \in \mathcal{A}$ applies in his strategy s_i. For each relevant profile P_j of a given sector Z_i, a sum of the weights of that profile is done among the agents determining the value $Top_j = \sum_{A_l \in \mathcal{A}} w_{lj}$. Top_j represents the total quantity of P_j to be shared among all agents.

Then, the value $PA_lP_j = (w_{ij} * AvP_jZ_i)/Top_j$ represents the proportional part that each $A_l \in \mathcal{A}$ has contributed to Top_j. Notice that $AvP_jZ_i = \sum_{A_l \in \mathcal{A}} PA_lP_j$.

Given a state $e \in \mathcal{S}$ and a sector Z_i, for each agent $A_l \in \mathcal{A}$, let $S(e, A_l, Z_i) = \sum_{j=1}^{m} PA_lP_j$ be the proportion of voters from the sector Z_i which are potential voters for the

agent $A_l, l = 1, \ldots, m$. The cardinality of the sector WZ_i is divided among all agents in a proportional way due to the sum $S(e, A_l, Z_i)$.

We denote the number of voters of a sector Z_i for an agent $A_l \in \mathcal{A}$ as #Vote(A_l, Z_i) and that values is computed as:

$$\#Vote(A_l, Z_i) = WZ_i * (\frac{S(e, A_l, Z_i}{100}) \quad (1)$$

The value #Vote(A_l, Z_i) represents the proportional part of the members in the sector Z_i which are potential voters for $A_l, l = 1, \ldots, n$. Then, #Vote(A_l, Z_i) is computed for all sector $Z_i \in Pot$ in order to count the total voters from the population corresponding to an agent. Let $\#Votes(A_l, e)$ be the total voters for A_l and considering all the population, then

$$\#Votes(A_l, e) = \sum_{i=1}^{k} \#Vote(A_l, Z_i) \quad (2)$$

Given a state $e = (s_1, \ldots, s_n) \in S$, an *improvement step* for an agent A_i is a change of his strategy from s_i to s_i' changing to a new state e' and where his number of votes $\#Votes(A_i, e')$ increases with respect to the previous value $\#Votes(A_i, e)$.

Thus, we can see the neighborhood of a state e consisting of those states that derive from e only in one agent's strategy. The improvement over the number of votes of an agent A_i is precisely $\#Votes(A_i, e') - \#Votes(A_i, e)$. Consequently, the potential function for our system is $Total\_\#Votes(e) = \sum_{A_l \in \mathcal{A}} \#Votes(A_l, e)$.

Given a state e, a move of improvement through local optimal values is made by the search of a neighbor e' where $\sum_{A_i \in \mathcal{A}} \#Votes(A_i, e') > \sum_{A_i \in \mathcal{A}} \#Votes(A_i, e)$.

Notice that given a state e, there is an agent who obtains the maximum number of votes, we call such an agent *the candidate in the state e*, and it is denoted as $Candidate(A, e)$, which is computed as:

$$Candidate(A_l, e) = max\{\#Votes(A_l, e), l = 1, \ldots, n\} \quad (3)$$

Although to change an agent's strategy (even if the $Candidate$ does not change his strategy) represents a change in the state from e to e', and the agent who obtains the candidacy could change too.

In our system, we can analyze the fluctuations of the votes' tendencies in order to organize the strategies of a specific agent, either as 'bad' or 'good' strategies, according to the number of votes that the agent obtains. Furthermore, we can find which are the better strategies for a particular agent, according to a specific electoral scenario.

Assuming that all the people really vote, we have a fixed total number of votes and, if we look for an optimal point the search could be cyclic. Meaning that if an agent reduces his number of votes, then any other agent will increase his own number of votes. So, some agents could always improve their number of votes from one neighbor to another.

An adequate variable to avoid cyclic searches, is to consider the percentage of abstention in each sector. Although the abstention is a real fact in democratic systems, to determine the percentage of that abstention require a profound analysis of the traits and behavior of the population in previous elections.

In our system, the political campaign is developed on a certain time in such a way that when a candidate recognizes a new way to improve his strategy, that new strategy is applied and then, the number of votes have to be re-computed for all the involved candidates. This continues until no further impact can be produced on the number of votes or when the political campaign is finished.

Of course, there are factors and events in an election that could not be directly modeled via a congestion game, since there are some hiding and misleading events that can occur throughout democratic elections. For example, in the presidential elections in México in 1988, during the counting of votes, the computational system 'fell down' for a certain number of hours, and when the system was finally restored, the voting tendencies had changed. Such tendencies did not change again during the remaining time of the computing process, giving so the victory to the candidate belonging to the government's political party [1], [14].

Thus, modeling electoral competitions, even though they call themselves democratic, holds a high grade of extra-legal manipulations that cause that the results of any computational system differ from what really happens. Specially, in corrupted processes, when the rules are manipulated, or when the rules are not clear established during the competition.

V. A Case Study

We have modeled the elections of the principal in the Faculty of Computer Sciences (FCC) in Puebla, México, where the vote casts are organized in 11 sectors; 5 belonging to professors, 5 to students and 1 to administrative workers.

In the FCC, there are two bachelor programs: Computer Sciences and Engineering in Computing. For each bachelor program, there are two sectors; Basic and Formal sectors. Then, there are four sectors at bachelor level; Basic_Eng, Advance_Eng, Basic_Cs, Advance_Cs and one sector at post-graduate level: Postgrade.

There are about 1900 students at the bachelor level and 46 students at post grade level. There are 117 Professors and 15 administrative workers. In this election, 1448 of bachelor students and 40 posgrate students voted. While 100% of administrative workers voted and 111 professors voted.

The political preference for professors and administratives can be captured via classical opinion polls due to the size of those sectors. In fact the biggest size of any of those sectors was 32 professors. Then, we can collect, for all professors and administratives, their political preference. On the other hand, the size of population of students and their vague answers for determining just one preferable candidate, generate the adequate scenario to prove our model. Thus, we simulate the tendencies of the vote just for the five students' sectors.

Then, we applied an opinion poll in order to recognize the profiles that distinguish the main features that students deem important to decide their vote. We found that the following

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TABLE III
MAIN PROFILES FOR CHARACTERIZING THE STUDENTS

Profile	*Description*
P1	Opinion of the classmates
P2	Opinion of the academic advisers
P3	Opinion of the professors
P4	Opinion of the political student groups
P5	Opinion of the official administration
P6	Commitment shown by the candidate
P7	Academic background of the candidate
P8	Political group that supports to the candidate
P9	Political work during the campaign
P10	Possible contact with the candidate
P11	Image and confidence shown by the candidate
P12	Whether they support reelection or desire a new administration

12-profiles were the most important for deciding their vote, (see Table III).

Afterward, another opinion poll was applied to the students in order to assign a relative order of the profiles according to what they consider from more to less important for making their political decision. We processed such opinion polls and computed the average of the responses. Adjustment by minimum squares was applied to the sample in order to eliminate the 'false positives'.

The formula applied to eliminate false positives consists of eliminating the students' cases where the sum of the difference with the averages of the sector is greater than the 50% of the sum of the same averages of that sector.

We found that some profiles have positive influences (called positive profiles) and others have negative influence (called negative profiles) on the students when they are deciding their vote. We also assign a relative percentage to each profile, according to the relative importance assigned by the students to those profiles. It is important to note that the FCC is an institution belonging to the area of engineerings and by tradition, the students give a great importance to the academic and professional aspects of the professors, sometimes they give much more relevance to those aspects than the image and the way that the professors interact with them.

The sum of the percentages over the positive profiles was 100%, while the sum of the percentages over the negative profiles generally gave values from 40% to 50%. According to the atmosphere that exists in the FCC, we detected that positive profiles had more impact than negative ones.

TABLE IV
RELATIVE WEIGHTS FOR PROFILES CHARACTERIZING SECTORS

Profile	Basic_Eng	Adv_Eng	Basic_Cs	Adv_Cs	Posgrade
P1	-1.1062	-2.789	-2.957	-0.9381	-3.06
P2	-0.9878	-0.194	9.58	-0.187	9.51
P3	10.896	10.361	10.46	9.41	8
P4	-1.3414	-1476	-1.7	-2.44	-1.66
P5	-1.15	-2.0354	-1.73	-4.41	-1.22
P6	19.565	19.458	16.64	17.47	17.956
P7	16.197	17.651	15.96	15.46	17.07
P8	11.677	12.168	10.91	12.5	11.11
P9	39.13	38.916	33.278	34.95	53.867
P10	14.92	14.94	13.563	15.6	12.889
P11	13.958	13.615	11.364	13.844	12.62
P12	-38.646	-39.124	-35.463	-39.5	-35.31

In Table IV, we present the results obtained after processing the opinion instruments showing the relative percentage of importance for each profile in each one of the 5 students' sector. Negative values are indicative of profiles with a negative impact on the students.

Of course, the agents do not know precisely neither what the most important profiles nor their importance is. Although, they intuitively recognize the importance of some profiles and they try to impact the voters through their political programs (strategies).

The strategies of each agent can be considered as a vector of 12-values, each value represents the intention of the candidate to influence the voters trough that corresponding profile. The weights constituting the strategies of the candidates were computed based on; the curriculum vitae, the proposals, the political group supporting the candidates, and in this particular case, in the knowledge and perception that the authors have about the candidates.

For any other electoral contest, opinion polls could be designed to calculate the corresponding weights in order to form the agents' strategies. Each agent applies one of his strategies creating a state e of the multi-agent system. The agents change their strategies at the moment and in accordance to the opinion polls that they know.

In Table V and VI we present some of the strategies used by the agents. At the beginning, we considered three agents competing for the position (see Table V). Later on, only two agents were considered, and we also recognize that the strategies applied to the bachelor sectors were different to those used for the postgraduate sector.

We analyze the percentages of the votes assigned to each candidate in accordance to the main changes in their strategies. The formulas (1) and (2) allow us to compute the number of votes for each agent, and in fact, is a way to simulate the outcomes obtained by the agents.

In Figure 1, we show three moments of the change of strategies just for one of the competing agents; at the beginning, in the middle and the final period of the political campaign. We also show the real percentages obtained for the selected agent in order to compare it with the estimations previously made.

TABLE V
INITIAL STRATEGIES' AGENTS

Profile	Director	Opponent_1	Opponent_2
P1	8	6	4
P2	6	5	4
P3	8	6	3
P4	5	5	2
P5	7	5	2
P6	10	5	5
P7	8	4	8
P8	8	8	3
P9	0	0	0
P10	8	5	5
P11	8	5	5
P12	10	-3	-5

The curve labeled as 'Initial_Vote_Estimate' represents the estimation of the percentage of votes obtained for A_1 con-

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sidering three competing agents. While the other two curves represent the estimation of the percentages of votes obtained for A_1 considering just two competing agents, which was the real number of competing candidates in this election.

TABLE VI
FINAL STRATEGIES' AGENTS

Profile	Dir_Bachelor	Dir_Post	Opp_Bachelor	Opp_Post
P1	9.5	5	5	8
P2	8	9.5	5	4
P3	7	9	8	5
P4	8.5	8.5	5	5
P5	6	6	3	3
P6	7	7	4	4
P7	8	8	5	5
P8	8	8	6.8	6.8
P9	6	9	8.5	5.5
P10	7	7	7	7
P11	8	8	6	6
P12	10	10	1	1

Comparing the estimated results at the end of the campaign versus the real percentages of votes, the absolute errors on the percentages of the votes obtained for the candidate labeled as *Opposite*, were: 2.5, 11.5, 2.5, 3.6, 7.2, which correspond to the sectors: Basic_Eng, Advance_Eng, Basic_Cs, Advance_Cs and Postgrade sectors, respectively.

If we want to model elections at the scale of, for example, governor of a city, the key point in our proposal is the partition of the voters into sectors with common and recognized necessities (profiles). That implies that we do not only have to know the sizes of the sectors, but we also have to analyze the political and economical historical behavior of those sectors. The demoscopic studies can be helpful for recognizing the profiles and their relative importance among them. Of course, this imply a bigger effort than just to apply the common opinion polls for analyzing political preferences. However, predictions more precise request deeper studies. And our model is a guide for how can be done those studies.

VI. CONCLUSION AND FUTURE WORK

We have designed a multi-agent system that simulates the process of selecting a representative in a democratic system organized by sectors. In our proposal, we assume that each prospectus determines a finite set of strategies (political programs). Each one of these strategies is constituted by a set of weights on the profiles characterizing the voters.

Our system can be used to study the tendencies of the vote and for this, it's necessary to determine the relevant profiles that characterize the political behavior of the voters. Those profiles model how the voters, in a specific election organized by sectors, make their political decision.

The profiles used for characterizing the voters, and for forming the strategies of the agents, have a limited nature. Consequently, a congestion network is built. Working with congestion networks allows us to apply a search for the singular points in the competition system, enabling us to predict which agent is expected to win the electoral contest and also, what was his winning strategy.

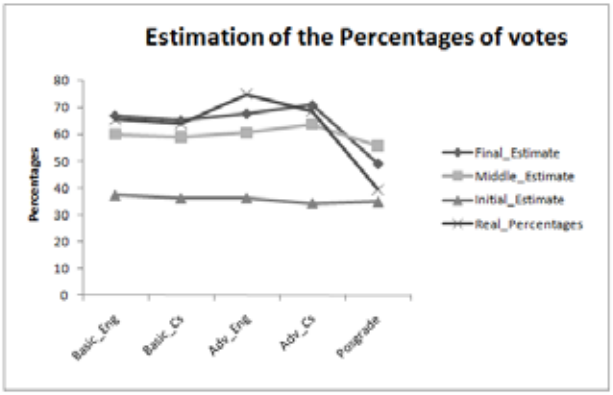

Fig. 1. Percentages of votes estimated and obtained for one of the candidates

We have applied our model to simulate the elections of the principal in the FCC - BUAP University, obtaining estimations very close to the real outcomes. Future works could come from the application of our model in other electoral contests, and specially, to scale our method at the level of cities' and countries' elections.

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E_Universities Services in the New Social Eco-systems:

Using Conversational Agents to Help Teach Information Security Risk Analysis

Stewart Kowalski, Robert Hoffmann, Rohan Jain, Majid Mumtaz
Department of Computer and Systems Sciences, Stockholm University,
Stockholm, Sweden
stewart@dsv.su.se, robe-hof@dsv.su.se, roha-jai@dsv.su.se, mmumtaz@dsv.su.se

Abstract— **New social eco-systems and globalization are creating new challenges to educational institutions. Teachers need now not only to consider personal differences among their students, but also to take care of different cultural behaviors. Teachers are now expected to provide both a standardized and individual knowledge transfer to their students. This conflict may be resolved by utilizing results from artificial intelligence research, in particular chat bots. By giving the teacher a virtual assistant who can take care of the basic knowledge provisioning, the teacher has more freedom to handle the complex situations. In this paper we provide a short overview of relevant research that we used to build our own knowledge bot. The results from using the bot in teaching a undergrad class in Sweden is presented, together with an analysis and some suggestions for future work.**

Keywords -AI; knowledge bot; learning; teaching

I. INTRODUCTION

New and developing global social eco-systems are creating new challenges for educations institutions. The globalization of knowledge creation and transfer now means that educational institutions now must compete for students from around the world. These global students expect definitive answer and to be educate anywhere and at any-time. University educators now must not only adapt their teaching to different learning styles they must also take care of different cultural behaviours and in real time. In this paper, we describe an attempt to deal with the problem faced by these new e-learners as they learn to us an artificial intelligent conversational agent to assist in teaching a course in information security organization and management. Students were given the opportunity during the course to work with the courses content either via a wiki page moderated by a teaching assistant or through discussion with the AI conversational agent. Findings from the analysis of the student activity logs suggest that most of the students seem to preferred the AI conversational agent to the wiki work process.

In the first part, we will describe the theoretical aspects of using bots in teaching and existing research. The second part discusses our own bot and our experiences from using it. The paper ends with a conclusion and suggestions for further work.

II. THEORETHICAL ASPECTS

A. *Cultural issues in teaching*

As a result of increasing globalization, we live in a world where we are surrounded by people of different origins with their own different cultures. Universities are a good example of such a place where we encounter people from different parts of the globe working and interacting in the same environment. To work with such an international audience as a teacher and express ones own thoughts and ideas is a challenge in itself. An even bigger problem however arises when the audience needs to interact with the teacher by bring forward their own opinions and questions.

We have observe during lectures that, whenever a teacher poses an open question in front of the class, that a large majority of the students remain silent. Research that was done in the USA [1] indicated that culture plays a vital role in influencing how a individuals is either too open or too shy towards the world. For example, in Asian countries, people tend to be much shyer as compared to those in western occidental countries. One of the possible rationalizations behind this fact is that most of the times, a person's success is credited externally to his family, parents, teacher or others, while his failure is entirely blamed on him.

B. *Chat bots*

A chatterbot, chatbot or conversation agent is a software program developed to imitate human like conversation, either in text form or via audio. This fast growing technology already plays an important role in various fields such as help desk tools or customer support. Some chat bots provide online help, personalized services and information acquisition services, which requires them to be rather sophisticated in processing natural language. But the common technology is based on pattern matching such as those of the ALICE systems, which use the AIML computer language [2].

Chat bots can play a useful role for educational purposes, because they are an interactive mechanism as compared to traditional e-learning systems. Students can continually interact with the bot by asking questions related to a specific field. Although chat bots have been around since the middle of 1960's, only few of them have been used for educational purposes and all were related to specific subjects. The Virtual Patient bot (VPbot) is an example of an educational bot used at the Harvard Medical School. Medical students

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could interact with the bot and asked him for medical knowledge, whereupon the VPbot would answer them via audio or text [3].

Another Chat bot used for educational purposes was Sofia [4]. It was developed for the mathematics department of Harvard. The main purpose of this bot was to teach algebra. Students interacted with Sofia by asking specific questions related to mathematics and teachers could at the same time improve the bot's knowledge. This was done through analysing the chat logs to see which types of questions the students asked frequently and which questions needed better answers. This analysis was not only very helpful in improving the bot, but also the teachers improved their teaching patterns in classes as well [3][4].

C. Use of bots in learning and information

1) Advantages of using bots

Chat bots are not only an interesting way of providing knowledge to the audience, but they can also be the enabler to allow the audience to participate. By talking to a neutral entity the students might be less inhibited and will show more participation. An experiment where a chat bot was used to teach English as a foreign language resulted in 85\% of the students preferring the bot over a human teacher [6].

The bot can also help the teacher to become more efficient. By answering recurring questions and providing basic knowledge it can take a certain amount of the workload away and thereby enable the teacher to focus on more specialized or complicated questions. Furthermore can the bot collect anonymous questions and forward them to the teacher. This lowers the barrier for the students to ask questions and bring in opinions.

2) Creating believable bots

For a bot to seem real and thereby accepted as a conversation partner he has to behave in a social way. Previous research in this area [7] tries to show how one can make the bot more realistic and believable during a conversation by adding some parameters related to general awareness. The authors demonstrate different kinds of parameters that define environmental, self and interaction awareness in the conversational agents. To test their theory, they performed an experiment where the test users were made to interact with some conversational agents as well as humans in a virtual world simulation and hence had to deduce if they were talking to a human or a robot. Their experiment was quite successful and demonstrated that it was much more difficult for the participants to differentiate between an aware conversational agent and a human. Hence, it was concluded that by adding such parameters to an agent, we can create a strong and much more believable bot tool for effective conversations.

3) Two corporate case studies

One of the authors has previously evaluated the use of chat bots for security training in an enterprise environment [8].

In the first case study the design and usage of a chat bot was investigated from an end user perspective. The author conducted a survey by dividing the end users into two groups. One group was given the chat bot while the other group was exclusively using an e-learning product. The main goal of the education was to teach knowledge, attitude and behavior in regard to security issues. As the result of this case study it was shown that the group which had used the chat bot showed better results than the e-learning users. It can therefore be concluded that the chat bot was the more effective technology for creating security awareness among users.

The second case study was performed on security specialists. They were divided into two groups and one was asked to use the bot for a period and then post their views about information they got from it. Although both groups showed the same level of knowledge afterwards, the group that used the bot reported a better learning experience and was eager to use it again.

4) Using bots in the classroom

The paper by Knill investigates the benefits and risks in pedagogic environment [4]. The main aim of using media and technology in classroom is to provide interaction choices for students and teachers, and also to have access to knowledge 24x7. But there are also risks. If used inappropriately in the classroom, the technology can be used to perpetuate the old model of teaching and learning. And there are also new risks such as equipment failures, bugs in software and hardware, security vulnerabilities, compatibility issues, and human issues.

The Freudbot is another example of a successful bot usage [9]. The aim of this text based chat bot was to let psychology students interact with a virtual Sigmund Freud. They could discuss Freudian concepts, theories and biographical events. It was an attempt to use technology for improving distance education. In the survey that was taken after the experiment the students gave a very positive feedback and especially valued the feeling of talking to the real Freud.

5) Pedagogical challenges

New technology cannot simply be introduced into a learning environment, but rather has to be adapted to the needs of the student and the teacher, as Laurillard shows in her paper [10]. She explains that in order to exploit the technology in teaching, we need to define the different pedagogical challenges. She also considers how the needs of both teachers as well as learners can be represented with respect to collaborative learning and hence provides a "Conversational Framework" explaining how one can use a pedagogical framework and integrate it with technology to deliver an interactive and genuinely enhanced learning environment for people. The full framework embraces all the elements prioritized by each of the main pedagogic approaches such as instructionism, constructionism, social learning and collaborative learning and demonstrates the complexity of what it takes to learn: a continual iteration between teachers and learners, and between the levels of theory and practice.

6) Automated social engineering

Unfortunately can bots also be misused as Huber shows in his master thesis [11]. Social engineering attacks are prevailing these days in the internet world via various social networking services such as Facebook, MySpace etc. In his

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thesis, the author describes different principles that are involved along with various techniques adapted by the attackers. But his main task was to perform an automated social engineering attack on an organization using a chat bot. To conduct the experiment, the author created two fake profiles called "Julian", managed by a human and "Anna", a chat bot. A group of test persons were instructed about the experiment and then had to communicate with a randomly chosen profile. Their task was to deduce if they were communicating with the human or the bot.

The results showed that the users were able to differentiate successfully between a human and machine. However, this thesis also showed that social engineering attacks are possible today and can pose a serious threat to an organization. This kind of threat is relatively new and no strong security measures are adopted by companies to handle them.

III. USING A BOT TO TEACH RISK ANALYSIS

Similar to the Sofia bot and Freudbot, our team developed a bot for information security students, called Octavius. He was used as an aid in teaching the OCTAVE risk analysis method [12], hence his name.

The whole system is web based and consists of the chat bot and also a Wiki site. The bot itself is based on the ALICE system and therefore AIML. But it was extended to be able to open Wiki pages as part of the answer, if appropriate. This allowed the bot to give short and precise answers, but at the same time also provide in depth information through a Wiki page.

The students were introduced to the bot at the beginning of the 10 weeks course, and its knowledge was improved over time through a continuous log file analysis. All participants were aware that their conversations and IP addresses were logged, but also that there was no interest in identifying the actual users. This created an anonymous environment in which the students could openly chat with the bot.

Also had the students the choice of using the bot, only the Wiki or neither.

A. Technical environment

The client side was written in HTML and JavaScript and served through a regular Apache web server using HTTPS.

The server side bot engine was written in Python, based on the PyAIML interpreter [12] by Cort Stratton. It was extended with multi-processor capabilities, load balancing and statistics generation.

OpenBSD 4.8 (http://www.openbsd.org) was used as the operating system, running on an Intel quad-core CPU. This gave a sustained performance of more than 20 answered questions per second and less than 0.2 seconds answer time per question, which resulted in an immediate feedback for the user.

The default AIML set as provided by the ALICE project [2] was slightly modified and extended with specific OCTAVE knowledge.

B. Student reactions

63 sessions were done with the bot, in which he was asked 510 questions. The median session time was 35 seconds. Based on the evaluated log files we can see that this resulted often from insufficient flexibility of the bot. The users often could see that they were talking to an artificial being. It is planned to mitigate this effect in the future through refined AIML sets. One of the main problems in this regard is from our experience the balance between small talk and specific know how. Too much of the former results in a bot without value, whereas too little of it makes the bot seem unnatural.

But still the bot provided a positive learning experience for the students. While they had the choice between the bot or the Wiki alone, nearly all of them preferred to talk to the bot. This shows that the provisioning of such a system alone already encourage interest in it.

During an informal discussion with the students after the course, the general feedback was positive. They encouraged the usage of the bot, given that the knowledge base is improved so that he becomes more valuable in terms of a time spent versus knowledge gained decision.

C. Conclusion

There will be an increasing demand for IT based teaching, especially on university in the new developing social eco-systems. The different cultural backgrounds, and therefore learning styles and behaviors, require the teacher to focus more on the needs of his students. Given his limited time and resources, this can be supported by moving the task of basic knowledge transfer to an automated system or knowledge bot. This allows him to spend his efforts on high value interactions and newly upcoming questions, while still providing all necessary knowledge to his class.

We have shown by various examples that students can benefit from such a system and usually are very open minded in using it. But still a considerable effort has to spend on creating such a system in a way that makes it look real to the audience.

1) Future work

We will continue to improve Octavius, and at the same time branch off the system into other bots for different subjects. On the theoretical side have we identified the need for research into utilizing AIML. Only by fully exploiting the possibilities of the language will it be possible to create realistically behaving ALICE bots.

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User Semantic Model for Hybrid Recommender Systems

Sonia Ben Ticha
URPAH & KIWI-LORIA Teams
Tunis, Tunisia & Nancy, France
e-mail: sonia.benticha@loria.fr

Azim Roussanaly
KIWI Team
LORIA laboratory
Nancy, France
e-mail: azim.roussanaly@loria.fr

Anne Boyer
KIWI Team
LORIA laboratory
Nancy, France
e-mail: anne.boyer@loria.fr

***Abstract*— Recommender systems provide relevant items to users from a large number of choices. In this work, we are interested in personalized recommender systems where user model is based on an analysis of usage. Collaborative filtering and content-based filtering are the most widely used techniques in personalized recommender systems. Each technique has its drawbacks, so hybrid solutions, combining the two techniques, have emerged to overcome their disadvantages and benefit from their strengths. In this paper, we propose a hybrid solution combining collaborative filtering and content-based filtering. With this aim, we have defined a new user model, called user semantic model, to model user semantic preferences based on items' features and user ratings. The user semantic model is built from the user-item model by using a fuzzy clustering algorithm: the Fuzzy C Mean (FCM) algorithm. Then, we used the user semantic model in a user-based collaborative filtering algorithm to calculate the similarity between users. Applying our approach to the MoviesLens dataset, significant improvements can be noticed comparatively to standards user-based and item-based collaborative filtering algorithms.**

Keywords-Collaborative filtering; semantic attribute; fuzzy clustering; hybrid recommender system.

I. INTRODUCTION

Recommender Systems (RS) provide relevant items to users from a large number of choices. Several recommendations techniques exist in the literature. Among these techniques, there are those that provide personalized recommendations by defining a profile for each user. In this work, we are interested in personalized recommender systems where the user model is based on an analysis of usage. This model is usually represented by a user-item ratings matrix, which is extremely sparse (> 90% of missing data).

Collaborative filtering (CF) [11] has been the first personalized recommender system. In CF, user will be recommended items that people with similar tastes and preferences liked in the past. Content-based filtering (CB) [5] is another important technique of recommendation; it assumes that each user operates independently. In content-based recommender systems, user will be recommended items similar to the ones he preferred in the past. CB uses techniques developed in information retrieval and information filtering research. The major difference between CF and CB recommender systems is that CF uses only the user-item ratings data to make predictions and recommendations, while content-based recommender systems rely on the features of items (semantic information) for predictions.

However, those techniques must face many challenges [13], like the *data sparsity* problem due to missing data in user-item matrix; the *scalability* problem for big database with great number of users and items; the *cold start* problem when new user logs in, the system ignores he or her preferences. Furthermore, each technique introduced its own shortcomings. In CF technique, if new item appears in the database, there is no way to be recommended before it is rated, this problem is known also as Cold-start problem. *Neighbor transitivity* refers to a problem with sparse databases, in which users with similar tastes may not be identified as such if they have any items rated in common. CB filtering suffers a problem of over-specialization where a user is restricted to seeing items similar to those already rated.

To overcome the disadvantages of both techniques and benefit from their strengths, hybrid solutions [4] have emerged. Most of these hybrid systems are process-oriented: they run CF on the results of CB or vice versa. CF exploits information from users' ratings. CB exploits information from items and their features. However, they miss the relation between users' ratings and items' features. This link may explain the user interests for an item.

In this paper, we propose a hybrid solution, adopting CF principle, by introducing in its recommendation process, data from usage analysis and semantic information of items. Our solution builds a new user model, *user-semantic model*, to model user preferences based on items content (semantic information). Therefore, our user model is the link between users' ratings and items' content by modeling users' features preferences.

The *user-semantic model* is built from users' ratings and items features by using machine learning: the Fuzzy C Mean (FCM) algorithm [2]. This model is used in a user-based CF algorithm to calculate the similarity between users. We have compared our results to the standards user-based CF [9] and item-based CF [10] algorithms. Our approach results in an overall improvement in prediction accuracy.

Our contribution is summarized as follows: (i) we construct a novel *user-semantic model*, representing the link between user's preferences and item's features, (ii) we use a machine learning algorithm, the Fuzzy C Mean clustering algorithm, FCM, for the construction of this model, (iii) we provide predictions and recommendations by using the user-semantic model, in a user-based CF algorithm [9], for

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computing similarity between users, (iv) we perform several experiments with MoviesLens data sets, which showed improvement in the quality of predictions compared to user-based CF, item-based CF and a hybrid algorithm.

The rest of the paper is organized as follows: Section 2 summarizes the related work. FCM algorithm is described in Section 3. Standard user-based CF is described in Section 4. Section 5 describes our approach and experimental results are given in Section 6. Finally, we conclude with a summary of our findings and some directions for future work.

II. RELATED WORK

Recommender systems have become an independent research area in the middle 1990s after the apparition of the first paper on personalized recommender systems based on collaborative filtering [20]. Collaborative filtering is the most widespread used technique in recommender systems. It was the subject of several researches [3][9][10][19].

Purely content-based recommender systems are less widespread. Techniques used are from information retrieval and information filtering research. Notable works can be found in [21][22][23].

Several recommender systems use a hybrid approach by combining collaborative and content-based methods, which helps to avoid certain shortcomings of CB and CF systems. The Fab System of Balabanovic [1] counts among the first hybrid RS. Many others systems have been developed since [14][15][16][17][18]. A comprehensive survey of hybrid recommender systems can be found in Burke [4]. Most of these hybrid systems are process-oriented: they run CF on the results of CB or vice versa. In [7], authors integrate semantic similarities of items with user-rating similarities. The combined similarity measure was used in an item-based CF to generate recommendations. These works ignore the dependency between users' ratings and items' features. Taking account of the link between them can improve the quality of recommendation. In [12], this dependency was computed using the *term frequency/inverse document frequency* (TF-IDF) measure that is the most widespread measures for specifying keyword weights in Information Retrieval. The authors use this measure to calculate the weight of feature for each user. For computing this weight, they use only the items liked by the user; which forces to define a rating value threshold to select the items preferred by user. This solution has two shortcomings; first, the threshold value is very subjective, rating value 3 for an item on a scale from 1 to 5, can be a good value for a user and average value for another. Second, two users share the same tastes when, not only, they like the same things, but also, when they hate the same things; but in this approach, items not liked by users are not selected.

III. FUZZY C MEAN ALGORITHM (FCM)

The FCM algorithm is one of the most widely used fuzzy clustering algorithms. This technique was originally introduced by Jim Bezdek in 1981 [2]. The FCM algorithm is similar to the k-mean algorithm, but it provides non-disjointed clusters. It attempts to partition a finite collection of M elements, defined in N dimensional space, $E=\{X_1, X_j, X_M\}$ into a collection of L fuzzy clusters with respect to some given criterion. Given a finite set of data, the algorithm returns:

- a list of L cluster centers C_k such that $C_k=c_{k,i}, i=1,...,N$
- a partition matrix P such that: $P=P_{kj}$, $k=1,...,L$ and $j=1,....,M$, P_{kj} is a coefficient $\in[0,1]$ giving the degree to which the element X_j belongs to the k-th cluster. Usually, the sum of those coefficients for any given element X_j is defined to be 1 as shown in (1).

The center of cluster Ck is the mean of all elements X in E, weighted by their degree of belonging to the cluster k (2).

$$\forall X_j \in E, \left(\sum_{k=1}^{L} p_{k,X_j} = 1 \right). \quad (1)$$

$$C_k = \frac{\sum_{X_j \in E} p_{k,j}^m X_j}{\sum_{X_j \in E} p_{k,j}^m}. \quad (2)$$

The coefficient of belonging is related to the inverse of the distance to the cluster center. In (3) the coefficient is normalized and "fuzzyfied" with a real parameter $m>1$ so their sum is equal to 1.

$$p_{k,j} = \frac{1}{\sum_{i=1}^{L} \left(\frac{distance(C_k, X_j)}{distance(C_i, X_j)} \right)^{2/(m-1)}} \quad (3)$$

The FCM algorithm consists of the followings steps:

-Choose a number of clusters, L

-Assign to each element $X_{j,\ j=1..M}$ coefficients $P_{k,j}$ of belonging to cluster $k_{,\ k=1..L}$.

- Repeat until the algorithm has converged:
  * Compute the center for each cluster, using the formula given by (2).
  * For each element, compute its coefficients for being in clusters, using the formula given by (3).

IV. USER BASED CF ALGORITHM

In collaborative filtering, active user (indicated with a subscript *a*) will be recommended items that people with similar tastes and preferences liked in the past. Breese et al. [3] have identified two classes of CF algorithms: *memory-based* and *model-based* algorithms. Memory-based algorithms use the entire of the user-item matrix to generate predictions. This allows them to be very reactive, by integrating immediately modifications of users' profiles into the system. However, even if these methods work well with small-sized database, Breese et al. [3] think that their scalability is problematic for big databases with great number of items and/or users. The *model-based* algorithms constitute an alternative to this problem. These algorithms build descriptive models via a learning process. Then, predictions are inferred from these models.

User-based [9] and Item-based, introduced by Sarwar et al. in [10], algorithms are the most prevalent memory-based

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methods. They are both based on the *k*-Nearest-Neighbors algorithm. The first computes similarities between users and in the second, similarities are computed between items. In our approach we have applied the user-based CF algorithm for recommendation. Therefore, in this section, we describe its principle that consists of the following steps:

- *Calculate the similarities sim(u_a,v):* which reflect the correlation between the active user u_a and all others users *v*. The similarity is computed by the Pearson correlation (4), introduced by Resnick et al. [9].
- *Compute the predictions pr(u_a,i):* predict the rating value of active user u_a on non rated item *i*. In the user-based *CF* algorithm, a subset of nearest neighbors of the active user u_a are chosen based on their similarity with him or her, and a weighted aggregate of their ratings is used to generate predictions for the active user. Formula for computing predictions is given in (5).
- *Recommendation*: the system recommends to the active user, items with predicted ratings greater than a given threshold.

$$sim(u_a,v) = \frac{\sum_i (r_{u_a,i} - r_{u_a})(r_{v,i} - r_v)}{\sqrt{\sum_i (r_{u_a,i} - r_{u_a})^2}\sqrt{\sum_i (r_{v,i} - r_v)^2}} \quad (4)$$

where the *i* summations are over the items that both users u_a and *v* have rated and, r_v is the average rating of the rated items of the user *v*.

$$pr(u_a, i) = r_{u_a} + k \sum_{v \in V} sim(u_a, v)(r_{v,i} - r_v) \quad (5)$$

$$where \quad k = \frac{1}{\sum_{v \in V} |sim(u_a, v)|}$$

V denotes the set of the most similar users to the active user u_a (called the nearest neighbors) that have rated item *i*. *V* can range anywhere from 1 to the number of all users.

V. PROPOSED APPROACH

Several personalized recommendations techniques have been developed throughout recent years. CF is one of the most prevalent and older technique. Although CF has been very successful, it must face several challenges, like the data sparsity, the scalability and the cold start problems. One of the prospected solutions is to develop hybrid recommendation strategies that combine CF with CB filtering techniques.

We propose a personalized hybrid RS, adopting the principle of collaborative filtering, which includes in its recommendation process data from usage analysis, the users' ratings, and semantics information from items.

Fig. 1 shows the architecture of our system. It consists of two components:

- *Building the user semantic model*: provides the user semantic preferences by taking into account the dependency between users' ratings and items' features. This model is represented by a users-features matrix that predicts for each user a rating for each feature. This matrix, has no missing value, and is used to calculate the similarities between users in the recommendation process. This processing will be computed offline.
- *Computing predictions and Recommendations:* we predict for each user a list of relevant items based on the user-based CF algorithm. Similarities between users are computed, by using the user-feature matrix instead of the user-item rating matrix.

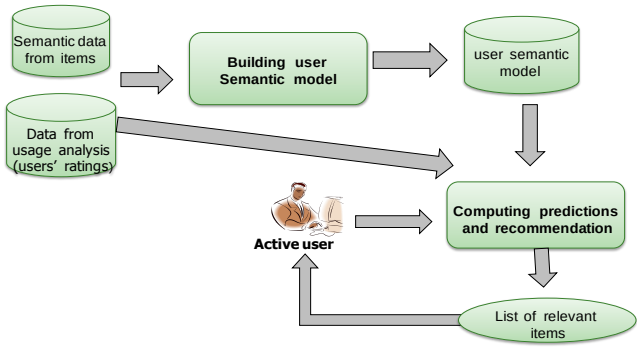

Figure 1. Architecture of our system

Although we apply a user-based CF for recommendation, our approach is also a model-based method. Indeed, user-semantic model is built from usage and semantic data, and used to predict ratings of active user on non rated items. This model allows a dimension reduction since the number of columns of the user-feature matrix is much lower than those of user-item rating matrix. Furthermore, the computing of similarities between users can be done offline. Thus, only the computing of predictions will be done online. For these reasons, our approach resolves the scalability problem.

Beside the scalability problem, our algorithm alleviates the data sparsity problem. Indeed, the user-features matrix, modeling the user semantic preferences, is a full matrix containing no missing value, thus, all similarities can be computed. This is not the case with user-item ratings matrix, because similarities between users who have no co rated items cannot be computed.

In the following sections, we describe each component in detail. All used symbols are described in Table I.

A. Building the users semantic model

Before defining the semantic profile of a user, we need to give some definitions. In this work, we suppose that items are described by a structured data in which there is a small number of attributes, each item is described by the same set of attributes, and there is a known set of values that each attribute may have. For example, the attributes of a movie can be: *title, genres, actors, director*. An attribute may have many values; each value is called *feature* or *semantic attribute* (used by Mobasher et al. in [7]). For a same item, if an attribute has many values (features), it is called *multi-valued attribute (genres* and *actors* in a *movie*), while if it must has only one value, it is called *mono-valued attribute* (*director* in a *movie*). The semantic profile of user *u* is then a vector A_u that each column, $a_{u,f}$ provides preference of *u* to a corresponding feature *f*. (value or semantic attribute) This preference is a real number like the rating value. In the

TABLE I
DESCRIPTION OF THE USED SYMBOLS

Symbol	Meaning	Description
N	Number of users	
M	Number of items	
L	Number of features	
U	The use-items ratings matrix	Missing values
$I=U^t$	The items-users ratings matrix	U transposed
U_u	The ratings vector of user u	The user's profile
I_i	The ratings vector of item i by all users	Item usage profile
F	The Items-features matrix	No missing value
F_i	The features vector of item i	Item semantic profile
$b_{i,f}$	The value of item-feature matrix	0 or 1
A	The users-features matrix	result of our approach
A_u	The user-features profile of user u	
?	Missing value	
$r_{u,i}$	Rating of user u on item i	
f	Feature	
i	Item	
u	User	
P_{ki}	The degree of item i of being in the cluster k	Fuzzy C Mean
nbMinR	Minimum Number of rating for items selected in computing the initial center of clusters	Fuzzy C Mean

following, we build *user-semantic model* for only one attribute and we suppose that it is multi-valued.

The usage analysis profile of user *u* is defined by a ratings vector: $U_u=(r_{u,1},r_{u,2},\ldots,r_{u,i},\ldots,r_{u,m})$.

The profile of item *i* is defined by 2 vectors, the first is based on usage analysis (ratings) and the second on features (values) of an attribute:

- Item usage based profile: a ratings vector: $I_i=(r_{1,I},r_{2,i},\ldots r_{u,i},\ldots,r_{N,i})$
- Item semantic based profile : a features vector for a multi-valued attribute: $F_i=(b_{i,1}, b_{i,2},\ldots,b_{i,L})$ where:

$$b_{i,f} = \begin{cases} 0 \; if \; item \; i \; hasn't \; feature \; (value) \; f \\ 1 \; if \; item \; i \; has \; feature \; (value) \; f \end{cases}$$

User-semantic model is defined by a *user-feature matrix* *A* (*N* lines and *L* columns) as shown in Fig. 2. Each line describes the semantic preferences of a corresponding user *u* and is defined by the vector $A_u=(a_{u,1},\ldots,a_{u,f},\ a_{u,L})$, *L* is the numbers of features and $a_{u,f}$ indicates the preference of user *u* on feature f.

The semantic profile of users is computed from items semantic profiles and users' ratings. For example, assume that we have a movies Data set with users ratings, and we want to predict the preference of user *u* for the *action movies* This means calculating an aggregation overall ratings of user *u* on all *action movies*:

$$a_{u,genre=action} = AGGR_{i.genre=action} r_{u,i} \quad (6)$$

The aggregation function can be a simple function like the average (*AVG*), or more complicated mathematical, or special user-defined function. In our approach, we choose to define a special user function, so we use a machine learning algorithm to learn the user semantic profile.

The idea is to partition items, defined by their usage profiles, in *L* clusters. Each cluster represents a feature (semantic attribute) of the selected attribute. Thus, the center of each cluster provides the profile of the corresponding feature in *N* dimensional space. In *movies* dataset, if we choose the attribute *genre*, then each cluster regroups movies with same *genre* (*action, children's, comedy*…) and its center provides the profile of the corresponding genre in *N* dimensional space.

However, as we have already said, the attribute is multi-valued, thus, the partition cannot be disjointed (for the *movie* data set, a same *movie* can have many *genres*; then it can belong to several clusters). For this case we need to use a fuzzy clustering algorithm to provide non-disjointed clusters. After a study of several fuzzy clustering algorithms we choose de Fuzzy C Mean (FCM) for its simplicity especially the number of clusters in our case is known and it's equal to the number of features.

Items semantic profiles are used for initializing the centers of clusters and the partition matrix.

The construction of user semantic model consists of 2 steps as shown in Fig. 2:

1. Clustering items, represented by their usage based profile, by using the FCM algorithm. This step provides L non-disjoints clusters represented by their center $C_k=(c_{k,1},c_{k,2},\ldots,c_{k,N})$ $k \in [1,L]$. The profile of feature k is then the vector C_k and *C* is a centers-clusters matrix, as

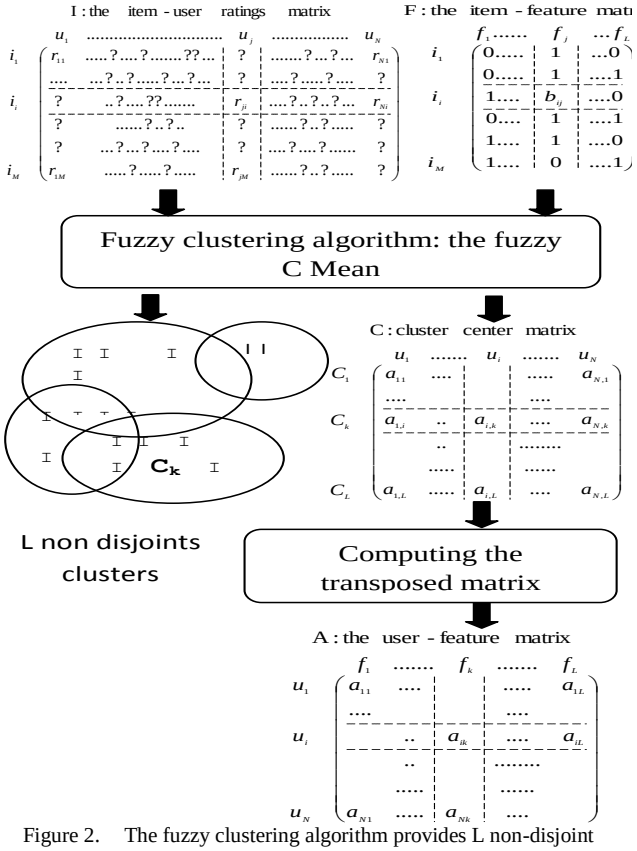

Figure 2. The fuzzy clustering algorithm provides L non-disjoint clusters. C_k is the centroid of the cluster k, C_k is profile of the feature f_k, defined in user dimensional space N. $C_k=A^t_k$

shown in Fig. 2, defined in *L (features)*x*N (users)* dimensional space.

2. Computing the transposed matrix of *C*: each line in *C* defined the corresponding feature profile. The transposed of *C* gives the matrix *A*, the user-feature matrix. *A* provides for each user *u* his or her features' preferences for the selected attribute. The matrix *A* has no missing value, what allows computing the similarity between all users. This is not the case when matrix has missing values.

In our approach, user semantic model is built by applying the collaborative principle. Indeed, in clustering process, items are defined by their usage based profiles. So, semantic profile of a user is computed from the ratings of all users, and not from his or her ratings only. This is not the case of the simple aggregation like the *AVG* function.

1)Initialization of the partition matrix of FCM algorithm

Semantic profiles of items are used to initialize the partition matrix *P*. In our algorithm, we initialize this matrix with respect to the formula given in (1). We use, for that, the items-features matrix *F*, then the degree to which the item i belongs to cluster k is given by (7)

$$p_{k,i}\begin{cases} = \dfrac{1}{\sum_{j=1}^{L} b_{i,f_j}}, if \quad b_{i,f_k} = 1 \\ = 0, \quad if\ b_{i,f_k} = 0 \end{cases} \qquad (7)$$

Example:

	f_1	f_2	f_3
i_1	0	1	1
i_2	1	0	1
i_3	1	1	1
i_4	1	1	0

In this example, we have three features, so 3 clusters. Item i_4 belongs to two clusters 1 and 2. Thus, $p_{3,4}=0$ because $b_{4,3}=0$, that means i_4 hasn't f_3; $p_{2,4}=0.5$ and $p_{1,4}=0.5$ because item i_4 has two features for the selected attribute. Thus, $p_{1,4}+p_{2,4}+p_{3,4}=1$. We assume that all features of a same item have the same weight. This assumption can be changed if we have information about the weight of each feature in item.

2)Initialization of the cluster centers

The initialization of the clusters centers is deducted from the partition matrix *P* by the formula given in (2). To compute the initial centers of clusters, we select only items having a number of ratings higher than the threshold *nbMinR* that its value will be defined empirically.

B. Computing predictions and Recommendation

To compute predictions for the active user, we use the user-based CF algorithm described in Section IV. In the standard user-based CF algorithm, the users-items matrix is used to compute users' similarities (see formula given in (4)). In our algorithm, we use the users-features matrix instead; thus, formula given in (8) is used to compute similarities. This allows inferring similarity between two users even when they have any co-rated items because the users-features matrix has no missing value. Thus, our approach provides solution to the neighbor transitivity problem emanates from

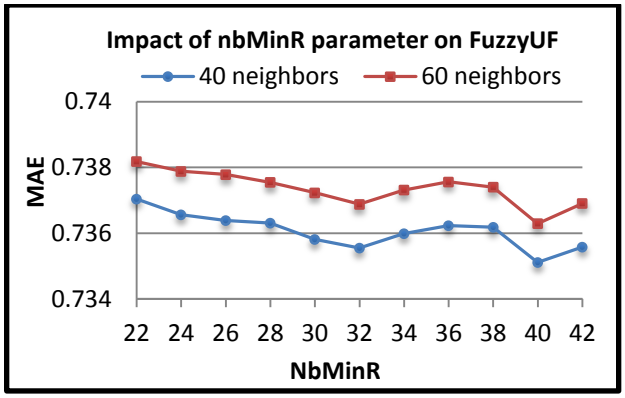

Figure 3. Impact, of the minimum number of ratings in initilization of clusters' centers on recommendation accuracy.

the sparse nature of the underlying data sets. In this problem, users with similar preferences may not be identifies as such if they haven't any items rated in common.

$$sim(u_a,v) = \frac{\sum_f (a_{u_a,f} - a_{u_a})(a_{v,f} - a_v)}{\sqrt{\sum_f (a_{u_a,f} - a_{u_a})^2}\sqrt{\sum_f (a_{v,f} - a_v)^2}} \qquad (8)$$

where the f summations are over features, and a_{Ua} is the average of $a_{ua,f}$, $f=1,\ldots,L$.

VI. PERFORMANCE STUDY

In this section, we study the performance of our algorithm, called *FuzzyUF* on the figures, against the standard User-Based CF (*UB*), the standard Item-Based CF (*IB*) [10] and Average User Feature algorithm (*AvgUF*). For *IB* algorithm, we compute predictions using the *Adjusted Cosine* correlation measure which provides, according to [10], best prediction accuracy. The *AvgUF* is building user semantic profile by using the average (*AVG*) as an aggregation function (see formula in (6)). We evaluate these algorithms in terms of predictions relevancy.

A. The used corpus and experiments

In order to compute the prediction relevancy in our system, we used the data set of the MovieLens recommendation system [8], collected by the GroupLens Research Project [24]. This Data set contains 100,000 real ratings on 1682 movies from 943 users. Items are movies, and the used attribute is movie's genre that has 18 features (Action, Romance, Horror, etc.). Each user has rated at least 20 items. The data set has been divided into a training set (including 80% of all ratings) and a test set (20% of all

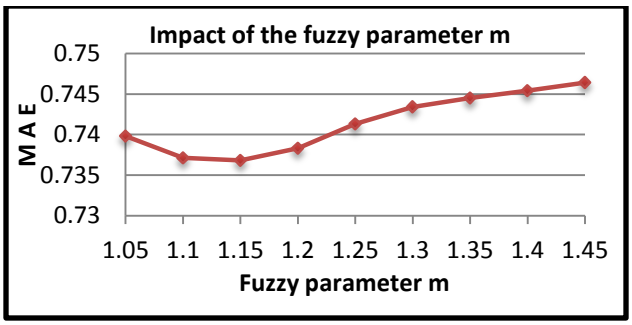

Figure 4. Impact of the parameter m on recommandation accuracy

ratings). We use the five training and test set (*u1 to u5*) provided by GroupLens for cross validation. Thus, we repeat the experiment with each training and test set and we average the results.

For the FCM algorithm, after having tried several distance measures, the Manhattan distance provides the best result. We have executed the FCM for many values of the fuzzy parameter *m*, and *nbMinR*. In all experiments, the FCM has converged to a global minimum.

B. Results

We evaluate our algorithm by using the *Mean Absolute Error* (MAE) [6]. MAE is the most widely used metric in CF research literature, which computes the average of the absolute difference between the predictions and true ratings, as shown in (9).

$$MAE = \frac{\sum_{u,i} \left| pr_{u,i} - r_{u,i} \right|}{d} \qquad (9)$$

where *d* is the total number of ratings over all users, $pr_{u,i}$ is the predicted rating for user u on item *i*, and r_u, *i* is the actual rating. Lower the MAE is, better is the prediction.

In Fig. 3, the MAE has been plotted with respect to the minimum number of ratings for selecting items in initialization of the centers of the clusters (*nbMinR*). In both cases (40 and 60 neighbors), the MAE converges for 40 ratings. This plot shows the impact of *nbMinR* on the accuracy of the recommendations, which is expected since the number of item ratings influences the accuracy of the user semantic profile. Fig. 4 shows that small values of *m* improve the accuracy of our algorithm. The reason is when *m* is close to 1, then the cluster center closest to the items is given much more weight than the others and the FCM is similar to K-means algorithm. The minimum is obtained for *m*=1.15.

Fig. 5 depicts the prediction accuracy of our algorithm in contrast to those produced by *IB*, *UB* and *AvgUF*. In Fig. 5, the MAE has been plotted with respect to the number of neighbors in the *k*-Nearest-Neighbors algorithm. In all cases, the MAE converges between 30 and 40 neighbors, however, our algorithm results in an overall improvement in accuracy.

The improvement of accuracy can be explained by many reasons. First, taking into account the semantic profile of items in the recommendation process. Second, user semantic model is built according to a collaborative principle; ratings of all users are used to compute the semantic profile of each user. It is not the case of the *AvgFU* algorithm; this may explain its results despite taking into account the semantic aspect. Third, the choice of the attribute can have significant influence on improving the accuracy. Indeed, movie genre represents a very important evaluation criterion for users. Lastly, users-features matrix has no missing value, so, it allows inferring similarity between two given users even when they have any items rated in common.

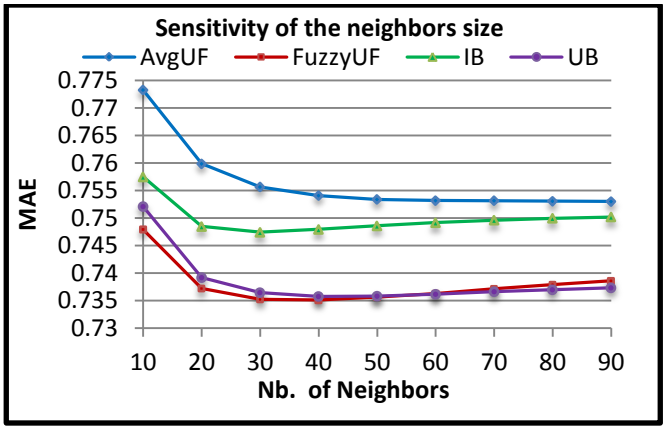

Figure 5. Prediction accuracy for Fuzzy User Features v. Item-Based, User-Based and Average User Features

VII. CONCLUSION AND FUTURE WORK

In this paper, we have proposed a hybrid solution combining collaborative filtering and content-based techniques. The contribution of our solution over the solutions proposed in literature is the identification of the link between users' ratings and items' features. This link was defined by the user semantic model that modeled user-features preferences. This model was built by a machine learning algorithm, the Fuzzy C Mean, and used to compute the users' similarities in a user-based CF algorithm. The built of the semantic model and the computing of similarities can be done offline, so, only predictions must be done online. Thus, our approach provides solutions to the *scalability problem*. Therefore, it alleviates the *data sparsity problem* by reducing the dimensionality of data. Users-features matrix has no missing value, thus, similarities between all users can be computed. This has solved the *neighbor transitivity problem*, in which users with similar tastes may not be identified, if they have not both rated any of the same items.

The results obtained, on movies dataset, are encouraging; they improve prediction accuracy compared to standards item-based CF [10] and user-based CF [9], despite the use of one attribute. As futures works, first, we will extend the user semantic model to many attributes. Only the significant attributes must be used, that is to say, those are important to users. Second, we will use the user semantic model to solve the cold start problem in which new items cannot be recommended to users because they haven't any rating. Lastly, we will apply others Data mining algorithms to construct the user semantic model and compare their results.

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