Virtual Coach: Towards Personalized Mental Support

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***Abstract*— Self-management is widely seen as a viable contribution to sustainable health-care as it allows to promote physical and mental well-being. A promising approach to promoting a healthy lifestyle is the deployment of personalized virtual coaches, especially in combination with the latest developments in the fields of Data Science and Artificial Intelligence. This paper presents a framework for a virtual coaching system, as well as a use case in which parts of this framework are applied. The virtual coach in the use case aims to encourage customer contact center employees to protect their mental health. This article outlines one part of the use-case in particular, viz. how to promote employee autonomy and supervisor support by, inter alia, monitoring employees' levels of emotional exhaustion. Current systems focus on providing users with insight in their health status or behavior, the authors developed the functional architecture for a system that can be implemented for different goals and generates personalized, real-time advice based on the combination of user preferences, motivational success and predicted user behavior.**

Keywords- virtual coach; emotional exhaustion; artificial intelligence; mental support; data science; behavioral change.

I. INTRODUCTION

Most people struggle with protecting their physical and mental well-being in daily life. A promising approach to promoting a healthy lifestyle stems from the development of eHealth and telemedicine services. Particularly, services that aim at increasing users' health prevention and self-management efforts, are gaining momentum [16]. This development, together with the increasing availability of data from mobile devices and techniques for real-time data analysis, provides new opportunities for health self-management via personalized virtual coaching.

As described by Blok and Dijkhuis [4], we define a virtual coach as an automated system that assists the user, either as a stand-in for or supplementary to a human coach, to exhibit desired user behavior. Additionally, we expand this definition by a generic lifestyle intervention framework which stresses the application of virtual coaches for health benefits. This framework emphasizes three domains of health: physical health, mental health, and social health [10]. A healthy lifestyle is a balancing act between the load, the recovery and the capacity of the individual [12]. Specifically, striking a balance between load (physical, mental and social) and recovery, enables individuals to sustain a healthy capacity to cope with daily life situations. For instance, mental load and the ability to recover are dependent on the individual's capacity to deal with stressful situations [27]. Examples of sources of mental stress are pressure at work or major life changes that are perceived negatively [12][27].

The remainder of this paper is organized as follows: the first section introduces the state of the art on virtual coaching systems. Subsequently, we describe the general, functional architecture for the virtual coach proposed by us. In the third section we present the use case in which the first modules of the virtual coach architecture are being implemented at the time of writing this article. The conclusion of the current state of this implementation and description of future steps completes the paper.

II. STATE OF THE ART

Effectiveness of (e)-Coaching depends on timeliness and personal contextual information in combination with actionable insights [8]. In other words the user needs to receive relevant information and advice at the appropriate time. In order to achieve this goal, various types of virtual coaches have been developed, for example self-monitoring of chronic diseases such as diabetes [15], motivating increased activity levels [25] or making healthier choices in daily life [17]. Currently available systems provide insight in health and behavior, but do not facilitate long-term behavioral change [13]. Spanakis et al. [23] predict eating behavior for the near future using rules learned from a predictive algorithm, however, they do not use personalized motivation techniques.

The architecture proposed in this article is a general, functional architecture that can be implemented in various situations, both for coaching on physical and mental health. The architecture provides not only insights, but also personalized real-time advice. During the generation of the advice, personal preferences regarding activities as well as the success rates of different motivational techniques are taken into account in order to strengthen motivation and support behavioral change. Furthermore, advice is not only based on current behavior, but also on predicted behavior in the near future.

To the best of our knowledge no systems exist that can be implemented for multiple goals (e.g., mental and physical health) and generate personalized real-time advice based on

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the combination of activity preferences, motivational success and predicted user behavior.

III. VIRTUAL COACH: FUNCTIONAL ARCHITECTURE

On the basis of our definition of a virtual coach, we have designed a functional, modular architecture that is applicable to multiple domains. The architecture proposed in this paper focuses on providing relevant real-time advice and supporting behavioral change.

In order to increase the influence of a virtual coach, we propose to channel behavioral insights into concrete advice for the user. This advice needs to be personalized with regard to the user's context and (motivational) preferences. This is done in several steps, as shown in *Figure 1*. In Step 1, the virtual coach identifies the moments when the user is in need of intervention. When intervention is called for, an appropriate personalized intervention method is generated by performing steps two and three simultaneously, the function of Step 2) being to determine which action a user had best perform to support him/her in reaching his/her goal, and that of Step 3) to determine the motivation technique most likely to influence his/her behavior.

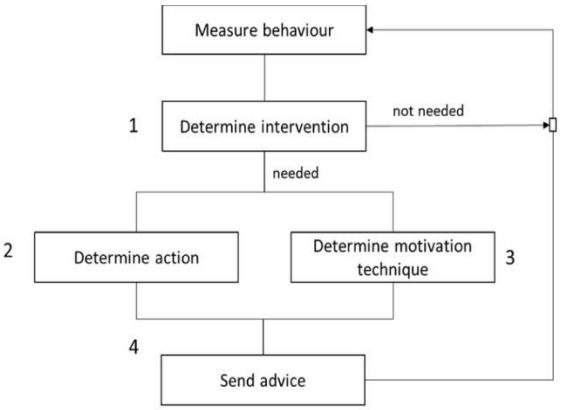

Figure 1. The steps in the functional architecture of the virtual coach.

All steps are geared to the user's specific context. In order to capture the user's context we combine behavioral data (generated by the user) with data from IoT-sensors and other sources (e.g., weather, location, time). This way, we take advantage of the variety of available data sources and enable a virtual coach to learn to interpret the user's context automatically. The final advice is then presented to the user, for example via a mobile application. In the following sections the above mentioned steps are described in more detail.

A. *Determine if intervention is needed*

The first step is the automatic identification of the moments when a user might need intervention. For this to be successful, a measurable and realistic goal must be set: the goals and needs of the user will have to be captured and objectively measured. Next, an appropriate amount of data must be collected in order to successfully establish whether or not a user reaches his goal. Patterns in the data can be learned using machine learning techniques, resulting in a predictive model [7]. The model has to be updated over time: the behavior of the user may change. Also, when the user frequently reaches his goal, the goal needs to be re-defined as well. The choice to intervene is context-aware and takes, for example, the hour of the day as well as the user's calendar into account.

B. *Determine action*

Once the virtual coach has determined that an intervention is necessary, the system provides the user with personalized suggestions for actions. These actions are tailored to the user's interests and preferences. Providing the user with a high variety of recommended actions is expected to increase user experience [14]. For the system to be able to recommend an appropriate and personalized action to the user, a list of possible actions must be created first. In order to overcome the cold start problems in the steps of the architecture, a new user completes an intake profile. This intake profile consists of, inter alia, the user's demographics and preferences for a random subset of items on the action list. Also, the intake profile is used to assess the user's ability. The virtual coach considers the feasibility of an action and links it to the user's ability level using a Rasch model in order to select appropriate action items [19]. Based on the user's ability, the probable willingness to engage in a particular action can be determined. When this probability is high, the action is seen as feasible. Note that a user's ability might change over time (for better or worse, depending on fluctuations in his/her health and fitness). These changes in ability need to be recomputed regularly in order to recommend appropriate actions. Furthermore, all action recommendations must be context-aware (e.g., don't send a user outside when it is raining).

C. *Determine motivation techniques*

There are many theories on how to motivate humans and they attempt to link individual motivation techniques to, inter alia, personality factors and locus of control. We are aiming for an approach that compares different motivational theories and systematically explores their effectiveness among users. Ultimately, we investigate whether tailoring actions by creating personality and preference profiles for motivation techniques stimulates behavioral change. First attempts to generate messages aimed at changing health-related behavior (e.g., handle potentially conflicting goals and motives) were introduced by Baskar et al. [3] and Op den Akker et al. [16]. Along with the above mentioned intake profile, a test battery, as well as a few examples of motivation messages may be given to the user right at the beginning, allowing him to rate the messages. Furthermore, clustering can be used to identify groups of users with a similar profile based on a questionnaire at the intake of the virtual coach. Individuals within the same group could initially be treated similarly [23]. The proposed model can be applied to several situations as long as the users' behavior can be measured frequently and the probability of users reaching their goal can be predicted accurately.

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IV. USE CASE: SERVICE WITH A SMILE

Research suggests that people who report high levels of work stress run a greater risk of developing a range of mental and physical health conditions such as depression, anxiety, hypertension and heart disease [11]. Work-related issues, like the combination of high demand and low control, have been shown to require sustained physical and psychological effort. These sustained efforts typically come at significant physiological and psychological costs [6][22] and have been linked to increased employee burnout, turnover, absenteeism and decreased performance [2]. Unfortunately, after recovering from these experiences, individual employees are often assigned less responsibility, they work fewer hours and are paid less than before [18], turning work-related mental health issues into the cause of serious long-term problems for both employees and employers.

Especially in highly demanding service environments, where employees are expected to deliver 'service with a smile', many of the above mentioned negative health consequences are very common. In addition, the subsequent high rates of employee turnover entail enormous direct and indirect costs because of the expenditure of hiring and training new employees and the financial impact of diminished service quality [1]. It is crucial that employers create environments where employees can be themselves, because exhausted employees can neither enjoy their job nor deliver good service.

Customer service centers are typically such highly demanding service environments. Hence, most customer service centers struggle to sustain their employees' wellbeing; exhaustion, high stress levels and burnouts are common among call center employees [5].

While employees need to take into account that a customer's perception of a company is determined by the quality of their interactions [21] and hence have to maintain a friendly disposition, they are also expected to quickly solve the issues of their customers. Matching these job demands has been shown to negatively influence job satisfaction and job performance because of, inter alia, emotional dissonance [28] and emotional exhaustion [24]. The above mentioned research outlines how high levels of psychological stress in call center employees lead to health impairment (particularly emotional exhaustion) and demotivation [26].

Both, job autonomy and supervisor support are the most commonly found work-related factors to negate the above mentioned health risks for customer service center employees (particularly emotional exhaustion)[28]. Providing customer service center employees with autonomy means providing them with a degree of freedom to make at least some decisions on their own. Autonomy has been shown to improve coping with emotionality of customers, to relate significantly to job satisfaction and performance [20] and to alleviate negative emotions felt by customer service employees doing stressful work. When autonomy in the workplace is absent, however, customer service center employees have been found to be more stressed, less satisfied and to report poorer mental and physical health [9].

V. DIGITAL CUSTOMER CONTACT CENTER ASSISTANT

In collaboration with the customer contact center of Van Lanschot, a private Dutch bank, we set out to develop a virtual coach or 'digital customer contact center assistant' (hereafter: DC3A) with the aim of diminishing negative mental health influences and increasing the motivation of employees. As outlined in the virtual coach framework, the DC3A assesses the mental state of the employees (e.g., emotional exhaustion) on the basis of both direct and indirect factors. After each call, employees indicate, inter alia, the perceived tone of the call (positive, neutral or negative). This feedback serves as a direct indicator of their emotional exhaustion (i.e. the higher the number of negative customer interactions, the higher the level of emotional exhaustion). When employees are emotionally exhausted, both key performance indicators and service quality indicators are expected to decrease. Hence, the DC3A extracts relevant key performance indicators and service quality indicators from customer interaction records and links the employees' feedback to these two sets of indicators. Machine learning techniques (such as classification and clustering), but also automated text analysis of call scripts are used to find patterns and assess the level of emotional exhaustion. On the basis of this assessment, the DC3A determines whether an intervention is needed and, if so, which type of action needs to be recommended (e.g., taking a break or seeking supervisor support). As described in the general framework for the virtual coach, the type of motivation that is paired with the recommended action is determined by using hybrid recommender systems. This allows us to optimize the action with a personalized motivational approach, based either on facts extracted from calls or on an informed selection of the type of action. We postulate that this added motivational component enhances a) the action's level of persuasion and therefore b) the employee's level of compliance. Both action and motivation are then combined to formulate the intervention message for the employee, aiming at initiating behavior that decreases levels of emotional exhaustion. The effect of this intervention, and whether or not the message is understood, is measured through key performance indicators and service quality. On the basis of the results of our first prototype we will adjust algorithms for both content and timing of the messages for the employees, and incorporate the necessary changes.

VI. CONCLUSION

We have designed a functional architecture for a virtual coach that addresses the mental health and operational support of customer contact center employees. Our design and approach are based on research that addresses mental health problems of people working in highly demanding service environments. A first prototype, aiming at supporting the mental health and well-being of customer contact employees, is currently being tested in an organization whose customer contact center is a key instrument in achieving customer satisfaction.

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During the development of the presented architecture, as well as during the building process of the first prototype, the authors encountered a few challenges. One of these challenges was bridging the various, necessary fields of expertise (e.g., find a common understanding of the problem and agree on vocabulary and methods). Another challenge was the business driven use-case; the authors were asked to work with mostly predetermined information and minimize the collection of new data points. Both challenges could be addressed successfully by forming a dedicated, multidisciplinary research team with a common goal. This dedicated team, consisting of experts in the areas of Computer Science, Software Engineering, Psychology, Applied Mathematics and Artificial Intelligence, formed the basis for a new ecosystem. This ecosystem is sponsored by the involved private businesses as well as academic institutions and enables the team to take the next steps in the development of the virtual coach. These steps are: 1) development and implementation of the first prototype in the use case, and 2) combine this work with exploratory research at academic institutions to fill gaps and further interdisciplinary research in other related areas.

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REFERENCES

[1] A. Alexandrov, E. Babakus, and U. Yavas, "The effects of perceived management concern for frontline employees and customers on turnover intentions: moderating role of employment status," Journal of service research, vol. 9, no. 4, pp. 356-371, 2007.

[2] A. B. Bakker, and E. Demerouti, "The job demandsresources model: State of the art," Journal of managerial psychology, vol. 22, no. 3, pp. 309-328, 2007.

[3] J. Baskar, R. Janols, E. Guerrero, J.C. Nieves and H. Lindgren, "A Multipurpose Goal Model for Personalised Digital Coaching," In: Agents and Multi-Agent Systems for Health Care A2HC 2017, AHEALTH 2017. Lecture Notes in Computer Science, vol. 10685, S. Montagna, P. Abreu, S. Giroux and M. Schumacher, Eds. Springer, Cham, 2017.

[4] J. Blok, T. Dijkhuis and A. Dol, "Toward a generic personalized virtual coach for self-management: A proposal for an architecture," The Ninth International Conference on eHealth, Telemedicine, and Social Medicine (eTelemed 2017), Nice, France.

[5] F. Castanheira and M. J. Chambel, "Reducing burnout in call centers through HR practices," Human Resource Management, vol. 49, no. 6, pp. 1047-1065, 2010.

[6] E. R. Crawford, J. A. LePine and B. L. Rich, "Linking job demands and resources to employee engagement and burnout: A theoretical extension and meta-analytic test," Journal of applied psychology, vol. 95, no. 5, pp. 834, 2010.

[7] T. Dijkhuis, F. Blaauw, M. van Ittersum, H. Velthuijsen and M. Aiello, "Personalized Physical Activity Coaching: A Machine Learning Approach" Sensors, vol. 18, no. 2, pp. 623, 2018.

[8] M. Gerdes, S. Martinez, and D. Tjondronegoro, "Conceptualization of a Personalized eCoach for Wellness Promotion," in Proceedings of ACM 11th EAI International Conference on Pervasive Computing. Barcelona: Association for Computing Machinery, 2017.

[9] L. Holdsworth and S. Cartwright, "Empowerment, stress and satisfaction: An exploratory study of a call centre," Leadership & Organization Development Journal, vol. 24, no. 3, pp. 131-140, 2013.

[10] M. Huber et al., "How should we define health?," BMJ, vol. 343, no. 9666, p. 41-63, 2011.

[11] International Labour Office (ILO) (2016). Workplace Stress: A collective challenge. International Labour Office – Geneva: ILO, 2016.

[12] G. Kentta and P. Hassmen, "Overtraining and recovery: A conceptual model," Sport Medicine, vol. 26, no. 1, pp. 1–16, 1998.

[13] R. Klaassen, K. Bul, R. op den Akker, G. J. van der Burg, P. M. Kato and P. Di Bitonto, "Design and Evaluation of a Pervasive Coaching and Gamification Platform for Young Diabetes Patients," Sensors, vol. 18, no. 2, pp. 402-429, 2018.

[14] B. P. Knijnenburg et al., "Explaining the user experience of recommender systems," User Modeling and User-Adapted Interaction, vol. 22, no. 4-5, pp. 441-504, 2012.

[15] L. Piwek, D. A. Ellis, S. Andrews and A. Joinson, "The rise of consumer health wearables: Promises and barriers," PLoS Med., vol. 13, no. 2, 2016.

[16] H. op den Akker, M. Cabrita, R. op den Akker, V. M. Jones and H. J. Hermens, "Tailored motivational message generation: A model and practical framework for real-time physical activity coaching," Journal of Biomedical Information, vol. 55, pp. 104–115, 2015.

[17] H. J. A. op den Akker, R Klaassen and A Nijholt, "Virtual Coaches for Healthy Lifestyle" In: Toward Robotic Socially Believable Behaving Systems, Volume II., Intelligent Systems Reference Library, vol. 106, A. Esposito and L. Jain, Eds. Springer, Cham, 2016.

[18] Organisation for Economic Co-operation and Development (OECD 2012) "Sick on the job? Myths and realities about mental health and work", ISSN: 22257985.

[19] M. Radha, M. C. Willemsen, M. Boerhof and W. A. IJsselsteijn, "Lifestyle Recommendations for Hypertension through Rasch-based Feasibility Modeling", Conference on User Modeling Adaptation and Personalization (ACM, 2016), New York, NY, USA, pp. 239-247.

[20] S. Saragih, "The effects of job autonomy on work outcomes: Self-efficacy as an intervening variable," International Research Journal of Business Studies, vol. 4, no. 3, pp. 203-215, 2015.

[21] O. Sawyerr, S. Srinivas and S. Wang, "Call center employee personalityfactors and service performance," Journal of Services Marketing, vol. 23, no. 5, pp301-317, 2009.

[22] W. B. Schaufeli, A. B. Bakker and W. van Rhenen, "How changes in job demands and resources predict burnout, work engagement, and sickness absenteeism," Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior, vol. 30, no. 7, pp. 893-917, 2009.

[23] G. Spanakis, G. Weiss, B. Boh, L. Lemmens, and A. Roefs, "Machine learning techniques in eating behavior e-coaching", Pers Ubiquit Comput, vol. 21, no. 4, pp. 645-659, 2017.

 ISBN: 978-1-61208-688-0

[24] D. D. van Jaarsveld, D. D. Walker and D. P. Skarlicki, "The role of job demands and emotional exhaustion in the relationship between customer and employee incivility," Journal of Management, vol. 36, no. 6, pp. 1486-1504, 2010.

[25] A. Watson, T. Bickmore, A. Cange, A. Kulshreshtha, A. and J. Kvedar, "An internet-based virtual coach to promote physical activity adherence in overweight adults: randomized controlled trial," Journal of medical Internet research, vol. 14, no. 1, p. e1, 2012.

[26] D. Wheatley, "Autonomy in paid work and employee subjective well-being," Work and Occupations, vol. 44, no. 3, pp. 296-328, 2017.

[27] J. M. Williams and M. B. Andersen, "Psychosocial antecedents of sport injury: Review and critique of the stress and injury model'," Journal of Applied Sport Psychology, vol. 10, no. 1, pp. 5–25, 1998.

[28] M. Zito, F. Emanuel, M. Molino, C. G. Cortese, C. Ghislieri and L. Colombo, "Turnover intentions in a call center: The role of emotional dissonance, job resources, and job satisfaction," PloS one, vol. 13, no. 2, 2018.

 ISBN: 978-1-61208-688-0