A Model for Experience-Based Agent Specific Trust

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Abstract — **Contemporary computerized tasks increasingly depend on inherently inaccurate information provided by autonomous agents. Reasons for the information inaccuracy are many, including the uncertainty in measurement (calibration errors), the process inherent inaccuracy (rounding), changing level of quality and, when humans are involved, differences in preferences (bias), (un)intentional violation of expectation to mention a few. Parameterization of this inaccuracy is demanded for prompt and justified adaption. Frequently, this parameterization is overlooked when models for reasoning on the inaccuracies are presented. In this paper, we address the parameterization of inaccuracy by an experience-based model. The model is based on Dempster-Shafer theory of evidence that relies on a history of experiences of subjective satisfaction on some provided data. From this history, the model derives the warranted belief and certainty that may justifiably be placed on the acquired data. The model facilitates decay and abstraction of a subset of history to a versatile score. This paper's contribution is in showing the experience-based model's generality and versatility by mapping it to EigenTrust, Subjective Logic and probabilistic trust management models.**

Keywords- Experience-based trust; multi-agent; evicence theory; adaptive systems.

I. INTRODUCTION

Collective intelligence, collaborative intelligence, participatory sensing and many related concepts share the idea of a set of decentralised autonomous agents interacting for a cause. This cause, whatever it may be, is realised as a resource that the provider(s) possess(es) and the consumer desires. Realistic examples of such resources include a measurement of a sensor, information an agent is willing to share. In such a setting, the level of trust the consuming agent may justifiably place on an acquired resource is inherently incomplete. This is due to the continuously changing context in which the resource was established, i.e., deviation in calibration, changes in temperature, mood, bias, time etc. Thus, though the provider would willingly and rightfully (untampered) share a resource, it may still be perceived by an agent as an unreliable provider in context. These inherent inaccuracies are acknowledged in participatory sensing [1] and as the parameters of quality of context by Buchholz et al. [2] as: precision (accuracy), probability of correctness (unintentional errors, e.g., bugs), *trustworthiness*, resolution (granularity, rounding) and up-to-dateness (age of measurement). They define trustworthiness as "how likely it is that the provided information is correct" [2] and as a parameter that the consumer evaluates on the provider. For the consumer (hereafter trustor) to evaluate the level of trust in a context on the provider (hereafter trustee), the history of experiences may be utilised.

An experience, as considered in this paper, is a first-hand posterior (subjective) evaluation by the trustor on a resource provided by the trustee in a proposition. The set of first-hand experiences is an agent's experience history. When combining several agents' experiences, the level of trust becomes reputation-based; a concept originally coined by Barber [3]. In reputation-based trust, referral experiences are used as witnesses to augment the first-hand experiences. Thus, reputation-based trust calls for trust transitivity and a means to discount the referrals' experiences. Further, combining the history of experiences on a system's global level provides a reputation of "what is generally said or believed" [4] about the trustee. This global view assumes a ground truth to exist that all trustees agree on. Thus, we model an experience as a posterior subjective evaluation by the *trustor* on the *trustee* at a *datum* in a *proposition* by a *score*. This four tuple view excluding the datum is shared by the FIdes REputation (FIRE) model [5]. Characterising for agent specific trust relying on experiences is that initially, in the absence of experiences, the level of trust should be vacuous. A vacuous level is the level of full uncertainty. The level of uncertainty is sometimes called the level of confidence [6]. We consider all experiences to increase certainty (decrease uncertainty); research not agreeing on this view exists [7].

In this paper we parametrize inaccuracy in a computationally light experience-based general trust model. The model features learning to trust and means to build and maintain a level of trust within group of agents (agent societies) [8]. It was originally developed for deriving the level of momentary trust on continuously changing, subjective and inherently inaccurate data with varying quality [9]. The view is sketched in Figure 1, which is inspired by the sentient object model by Fitzpatrick et al. [10]. In Figure 1, an agent may consume resources of other agents or inquire agents as referrals. The acquired resources may be weighted by the momentary discounted level of trust the trustor has in the trustee and the level the trustee claims in the resource. If triggering an actuator, the posterior trust level forms the basis for an experience. If providing the level of trust in a trustee further to another agent, this agent acted as a referral. On this view, this paper outlines the model for

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storing, inquiring, delegating, decaying and abstracting the referrals provided experiences preserving a sense of privacy. The contribution of this paper is that we show the mapping of the general model to well-known trust management models from the autonomous agent systems point of view.

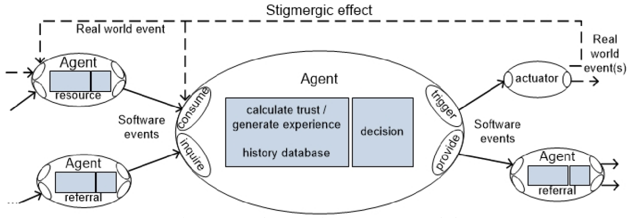

Figure 1. The sentient agent model.

The outline of this paper is as follows: in Section II we provide the motivating background and present related work. Following this, Section III introduces the foundation for the general experience-based trust model from a multi-agent perspective. Section III also defines the general model, of which a variant has successfully been implemented on in-house temperature data [9]. Section IV provides the contribution of this paper in the form of motivating the generality and versatility by mapping it to other computational models. Finally, Section V imposes a critical discussion on the findings and concludes the paper.

II. BACKGROUND AND RELATED WORK

Traditionally, trust in the context of computers related to authorisation of agents by security policies to access resources. This is an example of *policy-based trust*, a concept originally introduced by Blaze et al. [11] as a variant for specifying such security policies of a resource in terms of credentials and relationships for authorisation, also known as resource access trust [12] and credential based trust [13]. Fundamental for this is that these policies are effectively Boolean predicates and can be modelled mathematically within frameworks [13] [14] [15] providing an *absolute* level of trust in a proposition. For example, with respect to file-access rights, an agent may be trusted on a partially ordered discrete scale of *none* ≤ *read* ≤ *read/write* to the extent of *read* stating absolutely that this agent may not write the file under any circumstances. Implementations of policy-based trust include access control and firewall rules. However, as this paper considers agent specific trust for setting the level of reliance on a resource by experience, rather than access to it by policies, this paper will not consider policy-based trust as such. Interested readers are directed elsewhere [16].

Autonomous agents may in contemporary open systems be either software agents or human agents. Examples of such systems include Multi-Agent Systems and the "things" in the Internet of Things initiative. Regardless of the type of the agent, the benefits are in agent collaboration. This collaboration implies a sense of mutual trust between the interacting agents. However, in the set of agents providing a resource, the consuming agents need to “know which interaction partners to trust and how to select them” [17]. Moreover, as the preferences of the trustor may be subjective, or the behaviour of the trustee may change, the computational trust management system needs to be adaptive in providing the momentary level of trust. For this, experience-based trust models relying on authentication of the agent and its behavioural history recorded as experiences may be used. Related work on similar means only considering the first-hand experiences and the global reputation include TRAVOS (Trust and Reputation model for Agent-based Virtual OrganisationS) [6].

Implementations of experience-based trust models may be centralised or distributed. In a centralised environment dedicated agents gather all experiences making the level of experience-based trust representing the collective ‘belief’, ‘doubt’, ‘evidence’ or ‘support’ that the trustee will perform in accordance with the collective’s shared expectations. Examples include online auction sites such as Ebay, product review sites such as Epinions, and discussion forums (Slashdot’s karma), to mention a few. In centralised systems, the score type is typically uniform, e.g., in Ebay {-1, 0, 1}, and the proposition the "item to be as described". For such, research on forgiveness and regret in social online settings evaluating, among others, the EVENT with respect to the agent’s reputation have been researched elsewhere [18].

In a distributed system, where each agent stores its own possibly subjective experiences, there is no global objective level of trustworthiness. For the agents to acquire second-hand trust levels (using referrals), the trust score level needs to be uniform. They are frequently partially ordered and often totally ordered [19]. Existing representations include {0, 1}, {-1, 0, 1} with $-1 \leq 0 \leq 1$, any real in [0, 1], {*low*, *med*, *high*} with *low* ≤ *med* ≤ *high*. Related work often overlooks the merger of a set of such scored experiences or provides a level with semantics such as "the greater the better" or a probability [20]. Such models work well when assuming that each agent has an objective level of trust and the model's task is to figure this out [21], e.g., determining if a dice is biased by repeated testing that is a stochastic processes for which statistical and probabilistic model checkers have been developed.

In an open system assuming biased agents with non-uniform preferences, varied aspiration levels and possible performance changes in the producers, stochastic processes do not suffice. In such settings, a momentary and agent specific level of trust is reasonably sought. On this, related literature has applied logical reasoning on (i) binary and discrete values, (ii) fuzzy on continuous values, (iii) transitivity and (iv) probabilistic reasoning on a value range. Existing implementations of these include (i) summation [22] [23], (ii) Regret system [24], (iii) PageRank [25], and (iv) Bpdf [26] [27] [28], EigenTrust [29] respectively. Thus, open systems demand an agent specific versatile model considering the subjectivity, means to store and share levels of trust while preserving the referral’s privacy. Moreover, as of the limited evidence, the trustor’s level of (un)certainty need to be parameterized; with the initial level of ‘no certainty’. This level of trust is dynamic, emergent, incomplete, relative, subjective and decentralised making the experience based trust systems very hard (if not impossible) to define formally [13].

Computational models for such a level “aims at supporting a decision making by computational agents in the presence of unknown, uncontrollable and possibly harmful entities and in contexts where the lack of reliable information makes classical techniques useless" [11]. Common to such models are the demand of good quality inputs. To the best of our knowledge, general models capturing the fundamentals of trust calculations have been considered by Krukow et al. [13] [30]. TRAVOS [6] model considered a very similar view, however, omitting decay or discounting of second-hand trust levels that they correctly note to be truth tellning.

III. EXPERIENCE-BASED TRUST

Experience-based trust is frequently defined in line with Gambetta [31] as a subjective probability between two individuals, also called 'reliability trust' [4] describing the probability an agent *A* expects agent *B* to deliver. However, we consider experience-based trust as a parameter supporting a decision with a sense of relative security. For example, having an infinite resource of single coloured balls *ball* ∈ {*red*, *green*, *blue*}, the posterior reliability trust indicate the reliance that the next picked ball is of a specific colour. From this, assuming even distribution, a utility function defining the rationality of the decision can be defined.

To capture this, we use the broader definition of trust, called 'decision trust' [4] similar to that of McKnight and Chervaney [32] with the extension that the trustee is any identifiable matter [33], def. 1: Trust: "*The extent to which a trustor is willing to depend on a trustee in a given situation with a feeling of relative security, even though negative consequences are possible*". This definition implies that trust is relevant only when something can go wrong, that trust is proposition specific and that it is a metric describing the relation of warranted reliance a trustor places on the trustee. Let this relation be denoted by $_{\mathrm{T}}$. Moreover, consider the definition's situation as the proposition ζ that defines the exclusive and exhaustive outcomes of a frame of discernment, i.e., a trust relation with a level ω in a proposition ζ between *A* and *B* is denoted $A_{\zeta\mathrm{T}\omega}B$. The definition also underlines the need of *uncertainty* as opposed to certainty, where uncertainty for "*do not know*" must not be confused with distrust of "*do not trust*" [14]. Thus, the definition calls for a metric where increased uncertainty in an experience indicate a decrease in the weight of the evidence. This view enables a *decay* of experiences without subverting the foundational meaning of the experience, e.g., by time as a function of forgiveness or regret [34].

A. General properties of a trust relation

The most important property of a trust relation is the *unique identification* of the counterpart. The arity have been defined as a one-to-one, one-to-many, many-to-many or many-to-one [12] where many is an identifiable set of trustees. Other properties outline that a trust relation is 1) subjective, 2) asymmetric, 3) incomplete, 4) evolves over time, 5) proposition specific and 6) transitive (with restrictions). Below we briefly discuss 6), directing interested readers elsewhere [35].

The trust relation's transitivity is frequently disputed, i.e., if $A_{\zeta\mathrm{T}\omega}B$ and $B_{\zeta\mathrm{T}\omega}C$ does this imply that $A_{\zeta\mathrm{T}\omega}C$? Related literature examines this problem in greater detail [12] [36] [37]. For this paper we consider trust relations transitive over a chain of 'positive' decision trust propositions, i.e., if ω indicates a level for an affirmative decision, then $A_{\zeta\mathrm{T}\omega1}B \wedge B_{\zeta\mathrm{T}\omega2}C \Rightarrow A_{\zeta\mathrm{T}\omega3}C$. For ω indicating distrust, this is considered not to hold as it would require deciding whether or not your enemy's enemy is your friend [38]. Hence, trust is in this paper considered transitive, but distrust is not [39].

B. The Experience(s)

For representing an experience and the history of such, we follow Krukow's [13] and Teacy et al. [6] general models. We consider an experience a four tuple and utilise Dempster-Shafer theory view of subjective probabilities. An element of this tuple is the score that should be accurate enough to have semantics, and at the same time general enough to map to computational methods. As the score type is subject to the used computational method and this paper is about a general model, we present a score type only as proof of concept when the model is mapped to other methods. Moreover, to meet with the property of incompleteness and that trust evolves; a means for decay per experience is introduced. We stress that this decay must not subvert the experience, merely degrade its weigh.

An experience *Exp* is the manifestation of an agent's (trustor) posterior subjective evaluation score $\eta \in \{<score>\}$ of an observation on a trustee $\delta \in \{< agents >\}$ at datum ϵ in a proposition $\zeta \subseteq \{< proposition >\}$. We represent this as a four tuple $(\delta, \epsilon, \zeta, \eta)$, e.g., an experience by trustor $P \in \{<agents>\}$ at datum $\epsilon \le \epsilon_0$ where ϵ_0 is the momentary datum in proposition ζ with score η is denoted $Exp^P(\epsilon) = (\delta, \epsilon, \zeta, \eta)$. The history of an agent *P*'s experiences $Exp^P(\epsilon_i)$ for $i = 1, \ldots, n$ is a set of such four tuples, i.e., $\{(\delta, \epsilon_i, \zeta, \eta)\}$. Thus, adding a new experience $(\delta, \epsilon_0, \zeta, \eta)$ to the history $\{(\delta, \epsilon_i, \zeta, \eta)\}$ is straight forward $Exp^P(\epsilon_j) = (\delta, \epsilon_0, \zeta, \eta) \cup \{(\delta, \epsilon_i, \zeta, \eta)\}$ where $j = 1, ..., n, \epsilon_0$. The datum may be virtually any continuous matter or composition of such, but often considered time. Projections on this four tuple is possible. That is, $Exp^A(B, \epsilon)$ defines the projection on agent *A*'s experiences on (B, ϵ) and similarly for other projections, i.e., $Exp^A(B, \epsilon) = \{(B, \epsilon, \zeta, \eta)\}$ and $Exp^A(B, \epsilon_p, x) = \{(\epsilon_i, \eta)\}$ for $x \subseteq \zeta$ and $\epsilon_i \le \epsilon_p$ for $i = 0, 1, \ldots p$. Thus, for a specific datum ϵ_i the projection returns a singleton assuming that an agent cannot interact in several matters simultaneously. In addition, we note the deliberate loose definition of δ, that with this notation may be a group of agents, supporting the trust relation's arity.

C. Type of Score

The general model's score type must be versatile. For this, we propose the score type of a tuple (*sat*, *unsat*) as for satisfactory and unsatisfactory where *sat*, *unsat* ∈ [0, 1] and *sat* + *unsat* ≤ 1. Subadditivity is fundamental for expressing uncertainty and decay without subverting the semantics of the experience, i.e., the level of certainty is *sat* + *unsat* where theoretical full certainty is *sat* + *unsat* = 1. Moreover, coarsening a multinomial proposition $|\zeta| \ge 3$ to a binomial $|\zeta| = 2$, this binomial score type is applicable on any $|\zeta| \ge 2$, e.g., let *ball* ∈ $\{r, g, b\}$, deriving $\{r, b\}$ is $\{r\}$ + $\{b\}$ + $\{r, b\}$ where '+' denote sum of *sat* and *unsat* respectively.

With score η, an experience is $(\delta', \epsilon_i, \zeta, (sat, unsat))$. Related work considering a similar score type include Noorian et al. [40] and methods using Beta probability density functions. The type's semantics incorporate that of Dempster-Shafer theory, i.e., experience certainty is captured by the combined weight and distribution by relative weigh. A vacuous experience may thus be expressed as (0, 0), a dogmatic experience (the probabilistic view) is when *sat* + *unsat* = 1, and absolute experiences (binary or Boolean view) when (*sat*, *unsat*) = (0, 1) or (*sat*, *unsat*) = (1, 0). Thus, a score *sat* = 0.3 and *unsat* = 0.5 is valid indicating a certainty of 0.8. From this, uncertainty *u* is easily derived, $u = 1 - sat - unsat$ as is the dogmatic expectation value of satisfyability as *sat* / (*sat* + *unsat*).

D. Decay of Experience

Decay of an experience relates to forgetting or forgiveness. When the datum is time, it is natural to weigh recent experiences over older. Let the decay factor be λ where 0 ≤ λ ≤ 1. This factor relies on a continuous datum ϵ by which it decays. We write d_{ϵ_m} for the general decay function d at datum ϵ_m on an experience $Exp^{\delta}(\epsilon_i)$ where $\epsilon_i \leq \epsilon_m$ as:

$$d_{\epsilon_m}\left(Exp^{\delta}(\epsilon_i)\right) = (\delta', \epsilon_i, \zeta, \lambda^{\epsilon_m - \epsilon_i} * \eta) \tag{1}$$

Dually, this decay may be applied on the history of experiences where ϵ_n = 1, …, *m* and $\epsilon_n \leq \epsilon_m$:

$$d_{\epsilon_m}\left(Exp^{\delta}(\epsilon_n)\right) = \{(\delta', \epsilon_n, \zeta, \lambda^{\epsilon_m - \epsilon_n} * \eta)\} \tag{2}$$

Here each experience is decayed by λ, defining the speed of 'forgiveness'. The closer λ is to 1, the slower the speed with λ = 1 indicating no decay motivated when consistency is assumed. Dually, λ = 0 indicate complete decay, motivated when the experiences are random. Hence, the effect of decay is that an experience score η is reduced by factor λ with respect to the datum, i.e., η at ϵ_m is less or equal to η at ϵ_n when *n* ≤ *m* and λ ≤ 1. Realistically, ϵ may be time.

E. Abstracting Experiences

To calculate with a set of experiences, a composition to an abstract experience, denoted *Abs* is necessary. This abstraction is done by some datum, say ϵ_m, hence Abs_{ϵ_m}. The composition of decayed experiences outlines a momentary decayed score, the abstracted score *absscore*. We define this for ϵ_n = 1, …, *m* and $\epsilon_n \leq \epsilon_m$:

$$Abs_{\epsilon_m}\left(Exp^{\delta}(\epsilon_m)\right) = (\delta', \epsilon_m, \zeta, \textstyle\sum_{d_{\epsilon_m} Exp^{\delta}(\delta', \epsilon_n, \zeta)} \eta) \tag{3}$$

Thus, $Abs_{\epsilon_m}\left(Exp^{\delta}(\delta', \epsilon_m, \zeta)\right) = (absscore)$. We define *absscore* as a tuple (*abssat*, *absunsat*) where *abssat*, *absunsat* ∈ $\mathbb{R}^+$. The semantics of this is linear: "the greater the more certain". Updating the *absscore* is recursive [41] whenever λ is universal, continuous and applied on all experiences locally.

$$Abs_{\epsilon_{m'}}\left(Exp^{\delta}(\epsilon_i)\right) = \delta', \epsilon_{m'}, \zeta, \left(Exp^{\delta}(\delta', \epsilon_{m'}, \zeta, \eta) + Abs_{\epsilon_m}\left(Exp^{\delta}(\delta', \epsilon_m, \zeta)\right) * \lambda\right) \tag{4}$$

Here $Exp^{\delta}(\delta', \epsilon_{m'}, \zeta, \eta)$ is the new experience. In case no new experience was recorded at $\epsilon_{m'}$, $Exp^{\delta}(\delta', \epsilon_{m'}, \zeta, \eta)$ = (<vacuous>), i.e., (0, 0). Thus, abstraction is irreversible and provides a sense of privacy that decay enhances on.

IV. THE GENERAL MODEL MAPPED TO EXISTING COMPUTATIONAL METHODS

In the subsequent sections, we will show how the general model may be mapped to a probabilistic view.

A. Probabilistic views

Semantically a purely probabilistic view is very rich. From the *absscore* expectation value this is directly derived by *abssat* / (*abssat* + *absunsat*). However, the probabilistic view abstracts (assumes) certainty, i.e., the expectation value outcome is equivalent for Beta (4, 2) and Beta (12, 6) where obviously, the latter should indicate higher certainty. Hence, for the probabilistic view to be reasonable, certainty is complete, i.e., it is a dogmatic view. We can see this as a valid approach only for statistical modelling. In addition, the presented general model also captures consistent behaviour, e.g., assume there to be an event of 0.7 probability of success, then by setting λ = 1, *absscore* will approach the 0.7 relation between *abssat* and *absunsat*. On such an event, the model holds as decay does not subvert the expectation value. Thus, we conclude that the probabilistic view can be expressed by the general model.

B. Discrete views

A discrete view is one where the level of trust is expressed in a countable space. This space is a set that is typically totally ordered, e.g., none ≤ small ≤ large. Thus, as probabilistic views are possible, this less expressive discrete view on a totally ordered set is possible to express by the general model as well.

C. EigenTrust

EigenTrust [29] is an algorithm originally targeted for Peer-to-Peer systems that computes a global trust value for an agent. The algorithm requires each experience to be rated either satisfactory or unsatisfactory, making the score binary $\eta \in \{0, 1\}$. Such experiences may be modelled by the general model, and merged to the *absscore*. Thus, EigenTrust function on the abstracted score $scr_{\delta\delta'}$ of agent δ on δ' as $scr_{\delta\delta'}$ = $abssat_{\delta\delta'}$ - $absunsat_{\delta\delta'}$. A score $scr_{\delta\delta'}$ is normalized with respect to $scr_{\delta\delta''}$ where $\delta'' \in$ {<agents>} \ δ , i.e., with respect to agents δ have recorded direct interaction with whenever $scr_{\delta\delta''} \geq 0$, otherwise $scr_{\delta\delta''} = 0$. These normalized values is the $scr_{\delta\delta''}$ vector that when organized as a global *I*-by-*J* matrix M denoting on one row the level of trust an agent perceives in the other agents. When M is transposed M^{T}, a row denotes the level of trust others' have in an agent. Hence, multiplying M^{T} by itself is as if asking friends, i.e., $(M^{\mathrm{T}})^2$. Obviously, this assumes transitivity, and as the score is positive, only positive transitivity. For $(M^{T})^{n}$ where n is sufficiently large, the matrix rows will converge within some tolerance providing an unweighted the global objective trustworthiness vector. Thus, the general model maps to EigenTrust.

D. Subjective Logic

Subjective Logic (SL) is a probabilistic logic providing a means for transitivity and derives a level of subjective belief in an entity in a proposition developed primarily by Jøsang [27] [38]. It is related to Dempster-Shafer theory and consists of a set of well-defined logical operators on its basic type *opinion* ω being a four tuple (b, d, u, a) as for belief, disbelief, uncertainty and base rate. This opinion represents a binomial view, i.e., one where the exclusive and exhaustive frame of discernment polarity is 2, for and against. SL on dogmatic opinions (no uncertainty) falls back on traditional probabilistic logic and functions as Boolean logic when the opinions are absolute.

For the opinion to capture the general model's *absscore* overlooking the level of (un)certainty, a non-informative prior weigh parameter W is introduced. The assignment of W is delicate depending on the frequency of new experiences with respect to the datum and level of decay making it application specific. With this, the expectation value is defined *abssat* / (*abssat* + *absunsat* + W) implying that W guarantees incompleteness in form of non-additivity. A mapping function from *absscore* including W to the opinion type basing on the abstracted history of experiences have been presented by Jøsang [27] [41]:

$$\omega \begin{cases} b = \frac{abssat}{abssat+absunsat+W} \\ d = \frac{absunsat}{abssat+absunsat+W} \\ u = \frac{W}{abssat+absunsat+W} \\ \quad a = base\ rate \end{cases} \Leftrightarrow \left. \begin{matrix} abssat = \frac{Wb}{u} \\ absunsat = \frac{Wd}{u} \\ \\ \\ a = base\ rate \end{matrix} \right\} exp. \quad (5)$$

The SL is also related to a Beta probability density function (Bpdf) [28] as *absscore* maps to the Bpdf input tuple (α, β). Hence, visualising the SL as a Bpdf is possible. For a vacuous initial view $i = 0$ of $Abs_{\epsilon_m}\left(Exp^{\delta}(\epsilon_i)\right) = (0, 0)$ to be a horizontal Bpdf, the non-informative prior weigh W need to be 2 and the base rate 0.5. Thus, we conclude that the general model maps to opinions of SL.

V. DISCUSSION AND CONCLUSION

To capture the uncertainty of 'do not know' for something unanticipated, we have presented a general model for experience based trustworthiness relying on Dempster-Shafer theory of evidence. More pragmatic studies on the application of this are found elsewhere [9] [42]. As $|\{(\delta, \epsilon, \zeta, \eta)\}|$ is finite, $|absscore| < \infty$ holds whereas the evidence on any binomial view is incomplete voiding the traditional probabilistic views of Markov chains or Monte Carlo simulations. In addition, the well-known shortcoming of Dempster's rule of combination producing counter-intuitive results in case of strong conflict has been resolved [43]. This is also in line with Pearl [44] stating that "belief theory is a theory on the probability of provability as opposed to probabilities of truth". In addition, fuzzy logic operating on crisp measures about linguistically vague and fuzzy propositions is different from the presented model operating on uncertain but on crisp propositions [38] [45].

This general model of trust presented in this paper parameterises the level of reliability placed on a trustee in a proposition by disjoint experiences. The model has been implemented on real data in related work [9]. This paper shows how to abstract these experiences to a composite score and how this score may be mapped to well-known methods. Thus, the contribution of this paper is in motivating the generality and versatility of the experience-based trust model and the specific score type. Further facilitating the use of an experience-based model alike is its computational lightness featuring decay by some datum.

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