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On Modeling of Interviewee Motivation Mental States for an Intelligent Coaching Agent

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***Abstract*—This paper is on agent based model of interview motivation to be integrated in a mental constructs model which serves as a basic mechanics for an intelligent virtual agent coaching for job interview. It has been hypothesized that interview motivation combines with self-efficacy and anxiety to define the mental state of a job interviewee. The concepts were modeled based on psychological theories defining human mental state in a time bounded tasking situation like job interview. The proposed model was formalized and simulated to according to its temporal behaviours. The results of the simulation conform to patterns of a number of relations and casual effects on motivation identified in literature. Additionally, the formal model has been automatically verified using Temporal Trace Language (TTL) to find out which stable situations exist. Consequently, this model can serve as a platform for designing an intelligent agent that can understand the metal state of the user during job interview coaching session.**

***Index Terms*—Cognitive Modelling; Intelligent Virtual Agent; Interview Mental State; Motivation in Job Interview.**

I. INTRODUCTION

Developing an intelligent coaching system to support applicants in seeking for jobs has gained some level of attention in recent times, e.g. [1], [2]. However, a solution from the angle of cognitive analysis that determines interviewee performance has yet to be explored. In line with this demand, with the development of an intelligent interview coaching agent may have a significant effect on intelligent virtual agent technology research and development.

Candidates seeking for jobs are faced with myriad of psychological and social related problems that can undermine their true performance during interviews. Apart from other external factors such as what the interview is actually designed to measure (ability or behaviour), medium of the interview, stereotypes (real or imaginary) and interviewer subjectivities; interviewee mental states is critical to his or her performance during the interviewing process [3]. This mental state has been described in terms of the interplay between motivation, self-efficacy and anxiety. Motivation is an inspirational source and a drive towards achievement related task and it is considered a critical component in interviewee's mental states. Several of the theories that relate to human performance and achievement related choices are routed in human motivation construct [4]. A formal analysis of interviewee motivation will contribute to the numerous literatures on human motivation as well as providing a base for integration of constructs on interviewee mental state. This integrated formal constructs can further serve as a foundation for building intelligent artefact for interview coaching [5].

The paper is organized as follows. Section II describes several related works. Later, Section III covers the underlying components of interviewee mental states. Section IV presents the simulation results, followed by a mathematical analysis in Section V. Finally, Section VI concludes the paper.

II. LITERATURE REVIEW

A number of researches so far done on interview coaching using intelligent virtual agents focus on general pedagogy and training on verbal and non-verbal interview skills. With respect to job interview coaching with virtual agent; [6] presents an agent that mimic two behaviour of supportive and challenging to the user during a simulated interview. Kwon *et al*. (2013) presented a virtual job interview simulation to coach students of a university in prepare for their first job interviews [7].While, [2] focused their research on a virtual agent to provide social skill training in interview situation, the system, known as My Automatic Conversation Coach (MACH), is a novel system using virtual agents to provide social skills and feedbacks through verbal and non-verbal communication to trainees. [8] presented a study on the design of a pedagogical empathic virtual agent in a narrative-centred learning environment. Their system adopts a cognitive model that is structured based on Bayesian network. The model includes personal attributes of users (i.e. personality and goals of students), and the environment variables (i.e. dynamic attribute capturing a snapshot of the student's situation and activity). The physiological data of the user behaviour (i.e. biofeedback parameters such as heart rate or galvanic skin response) was captured in the model as well. [9] developed an embodied agent in the setting of job interviews that is able to recognize physiological data of users in real-time.

In all the presented work so far, the technique adapted is similar by using a 2D virtual agent to conduct the interview. While a number of the studies focused on social cue, the few that duel on user's states based their model on empirical approach. However, our approach is to model user's mental state using analytical formal method. Though research on embodied conversation agent, intelligent virtual agent, and relational agent technology on training and pedagogy has gained prominence in recent times (e.g. [10]–[12]), nevertheless opening up the channel where the intelligence is defined from the psychological states of the user may advance the field.

III. THEORETICAL FOUNDATION

Motivation represents drive, desire or will to act or to do something (goal). Once a goal is set, it's the motivation that direct and intensify efforts consciously or unconsciously towards achieving such intended goals [13]. However, motivation has a broad concept that can be viewed in many different perspectives but the interest of this paper is on *task-specific motivation* or the certain level of readiness to take action. The consistent issues by most motivation theories are centred on how human needs and desires are shaped by environmental and social factors and how the drives for these needs are influenced by subjective self- beliefs. This concept can be viewed in three different perspectives: *trait-centred*, *situation-centred* and *interactional views*[14]. Trait-centred viewed motivated behaviour primarily from inherent characteristics point while the situation-centred contends that the level of motivation is primarily determined by perceived/experienced situation. Thus, the interactional view suggests that motivation results from the interactions of the two previous factors namely; *intrinsic* and *extrinsic* categorization. These concepts explain the derivation of sources either from internal drive or from external expectations. The definition of interviewee motivation construct involves the theories and concepts that support the interactional view because employment interview is time bounded achievement oriented social task [3] and focuses more to the extrinsic drive.

Two main groups (affective and cognitive) are formed to unify the motivation constructs [15]. The categories of affective theories emphasize affective experiences of an activity such as interestingness and pleasurable (e.g. self-determination and flow theories), whereas *cognitive theories stress rational reflection* is concerning towards the consequences of an activity (e.g. expectancy-value theory) [15]. This model represents motivation as a causal factor for actions generated from the interplay of valence expectation (*incentives*) and feasibility expectation (*outcome expectation*). A valence expectation is the outcome of the interaction between affective and the cognitive valences of the intended action. Moreover, it also has been determined by specified goals as intended from the interviewee. For example, the envisage valence expectation is a result of an intricate interplay between affective, cognitive, positive and negative motivators. In this case, the affective valence is reciprocally affected by a perceived personal autonomy which is built from sense of freedom to take action. Feasibility expectation on the other hand stemmed from beliefs of competency and sense of external supports [16]. Another theory called, *the self-determination theory* postulates that "all human beings have fundamental psychological needs to be competent, autonomous, and related to others". Autonomy can be seen as the absence of external forces and the opportunity to be self-responsible, while competence reflects to the experience to undertake activities that are within the reach of a person's capacity. Relatedness is the feeling of connectedness to fellow human-beings within the activity context [4]. The flow theory contends with individual's competence evaluation in respect to activity challenge. Flow posits four consequents of interaction between competence and activity challenge; 1) *boredom* (competence is higher than the task challenge), 2) *apathy* (low competence in a low challenge task), 3) *flow* (high competence for a challenging task), and 4) *anxiety* (low competence faced with a challenging activity) [4].

According to the "Expectancy-Value theory", the motivation of a person to an event is determined by the success he/she *expects* and how much ***value*** he/she associates to the goal [17]. Expectancy theory explores how rewards affect motivation and its capability to perform a task. Likewise, value refers to how much a person intends to perform the task or values the outcome of completing the task. This model also provides crucial constructs for self-efficacy, ability, beliefs, and goal orientation. These beliefs to a large extent affect the orientation about goals and values associated to reward. For example, a number of achievements oriented motivation models have goal setting or orientation as its centre point. [18]. *Goal orientation* is the degree to which a person focuses on tasks and desirability of the task's end results. Those with strong goal orientation will adequately deploy their current resources and skills to accurately judge the effects of reaching the goal as well as the ability to fulfil that particular goal [13].

IV. FORMAL MODEL OF INTERVIEWEE MOTIVATION

This section discusses the details of the dynamic model. The characteristics of the proposed model are heavily inspired by the research discussed in the previous section on theories linked to the interviewee's performances. .

A. Conceptual Model of Interviewee Motivation

Once the structural relationships in the model have been determined (as in Figure 1), the model can be formalized. In the formalization, all nodes are designed in a way to have values ranging from 0 (low) to 1 (high). This model involves a number of instantaneous and temporal relations, which will be discussed in greater detailed below. Figure 1 represents the conceptual model of the interview motivation based on concepts and theories relating to task-specific motivation. The formalization would be conducted by categorizing the constructs into instantaneous (states with immediate actions) and temporal (states with accumulative effects of time) relations. A few parameters are used to regulate those instantaneous and temporal equations several parameters are used.

1) Instantaneous Relationships

Perceived relatedness (*Pr*) can be conceptually defined as the interviewee's sense of connection to the interviewer or other social element in the interview environment. It can be causally formulated from interviewer's disposition (*Id*) and interviewee's personality (*Pn*).

$$Pr(t) = \omega_{pr}.Id(t) + \left(1 - \omega_{pr}\right).Pn(t) \tag{1}$$

$$Pa(t) = \alpha_{pa}.\Big(\omega_{pa1}.Fa(t) + \omega_{pa2}.Fa(t) + \omega_{pa3}.Fa(t)\Big) + \Big(\left(1 - \alpha_{pa}\right).Av(t)\Big) \tag{2}$$

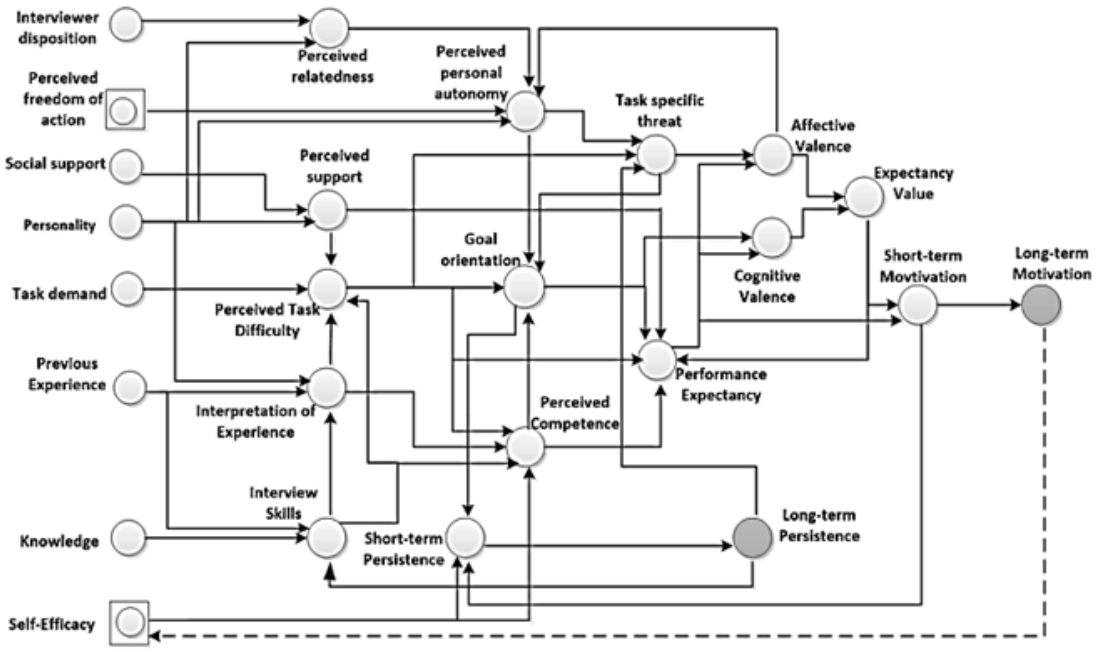

Figure 1: A conceptual model of interview motivation

Perceived personal autonomy (*Pa*) during the interview process is derived from the sense of perceived freedom (*Fa*), personality (*Pn*), and perceived relatedness to the social milieu (*Pr*). This concept can be further elaborated through the interaction of an intrinsic motivation on the task defines by affective valence (*Av*).

$$Ps(t) = \beta_{ps}\,.Ss(t) + \left(1 - \beta_{ps}\right).Pn(t) \tag{3}$$

Perceived support (*Ps*) is generated from the belief built from socio-cultural environment of the interviewee (*Ss*) and personality (*Pn*). Social element motivates an individual during demanding situation and it can be parents, teachers and even the interviewers. While, culture provides structure, guidelines, expectations and rules to help people understand and interpret behaviours. The interpretation of these variables is subject to one's personality profile. For example, the conscientiousness and extraversion traits can predict changes in perceived social support [19].

$$Sk(t) = \gamma_{sk}.\left(\sigma_{sk}.Sk_{norm} + (1 - \sigma_{sk}).Kn(t)\right) + (1 - \gamma_{sk})\,.\left(\omega_{sk}.Pe(t) + (1 - \omega_{sk}).Lp(t)\right) \tag{4}$$

$$Ie(t) = \pi_{Ie}\,.Pe(t) + (1 - \pi_{ie})\,.\left(\omega_{ie}.Pn(t) + (1 - \omega_{ie}).Sk(t)\right) \tag{5}$$

Skill (*Sk*) organizes and processes information from basic skills and supported by the combination of knowledge (*Kn*) and personal experience (*Pe*). Also, persistence over time (*Lp*) has equally been found to improve one's skill [13]. The Interpretation of experience (*Ie*) describing the perceived mastery experience in interview domain can casually be built from previous experience (*Pe*) either through previously attended interview or interview coaching experience [17].

$$Pd(t) = Td(t).\left(1 - \left(\omega_{pd1}.Ie(t) + \omega_{pd2}\,.Sk(t)\right)\right) \tag{6}$$

$$Pc(t) = \left(\rho_{pc}.\left(\omega_{pc1}.Se(t) + \omega_{pc2} * Sk(t)\right) + \left(1 - \rho_{pc}\right).Ie(t)\right).\left(1 - Pd(t)\right) \tag{7}$$

Perceived task difficulty (*Pd*) is a construct that greatly influence personality beliefs which defines desires and motivation during an interview session. It affects goals, expectancy, and values [13]. Thus, this concept can be perceived as proportional impact from task demand (*Td*) and negative proportion from an aggregated impact level of interpreted experience and interview skills.

Perceived competence (*Pc*) has been identified in literature correlates to the expectancy or probability of success [20]. It refers to the extent of one can estimate their capability to complete a task. Normally, it also related to the self-efficacy belief (*Se*) and personal interview skills.

$$Ge(t) = \left(\omega_{g1}.Pc(t) + \omega_{g2}.Pa(t) + \omega_{g3}.Pd(t)\right).\left(1 - Tt(t)\right) \tag{8}$$

$$Th(t) = Pd(t).\left(1 - \left(\varphi_{tt}.Pa(t) + (1 - \varphi_{tt}).Lp(t)\right)\right) \tag{9}$$

Goal orientation (*Ge*) is the degree to which interviewee is focused on his/her desire. The impact on personal goal (*Gp*) is contributed by interplays between personal competence, perceived autonomy, and perceived difficulty. However, task related threat (*Th*) is capable to distract the interviewees from their target goal. Aggregated contribution of long term persistence (*Lp*) and personal autonomy (*Pa*) have negative impacts on task specific threat, and it is positively influenced by perceived task difficulty (*Pd*).

$$Ep(t) = \Big(\alpha_{ep}.\Big(\omega_{ep}.Pc(t) + \big(1-\omega_{ep}\big).Ps(t)\Big) + \big(1-\alpha_{ep}\big).\Big(\omega_{ep1}.Go(t) + \big(1-\omega_{ep1}\big).Ve(t)\Big)\Big) .\big(1-Pd(t)\big) \quad (10)$$

Expectancy belief (*Ep*) defines the probability of success in performing task. This process is directed to the self-efficacy and ability belief constructs. Moreover, it is related from personal competence belief and perceived external social factors (*Ps*) [16]. Goal orientation and subjective value of the task (*Ve*) also provide positive contribution to the construct [17]. Perceived task difficulty impacts negatively on expectancy construct.

$$Av(t) = Ep(t).\big(1-Tt(t)\big) \quad (11)$$

$$Cv(t) = \alpha_{cv}.Pd(t) + \big(1-\alpha_{cv}\big).\big(\beta_{cv}.Go(t) + \big(1-\beta_{cv}\big).Ep(t)\big) \quad (12)$$

$$Ve(t) = \lambda_{ve}.Av(t) + \big(1-\lambda_{ve}\big).Cv(t) \quad (13)$$

Affective valence (*Av*) defines the internal feelings of interviewee during task. It emphasises the affective experience of activity like having interest and pleasure while performing given tasks (intrinsic motivation). The expectancy value is regulated negatively by task specific threat to casually define affective valence.

Cognitive valence (*Cv*) is a thought process leading to subjective value associated to a task, while cognitive theories stress rational reflection concerning to the consequence of activity (extrinsic motivation). Perceived task difficulty (*Pd*) refers to the value associated to a task. Regulated summation of goal and expectancy can be aggregated to task difficulty component, as define to the subjective task value. Value expectation (*Ve*) is the value associated with successful task behavioural or task performance. This subjective task value is impacted by high or low combinations of affective (positive) and cognitive (positive) valence [16].

$$Ms(t) = \psi_{ms}.Ve(t) + \big(1-\psi_{ms}\big).Ep(t) \quad (14)$$

$$Sp(t) = \Big(\varphi_{sp}.\big(Se(t) + Ms(t)\big)\Big).Ge(t) \quad (15)$$

Short term motivation (*Ms*) provides a task-specific motivation which is the readiness to take specific action relatively available to a person [16]. As in most motivation theories, it functions as an expectation for success (expectancy) and utility or resourcefulness of the outcome of such success (value). This concept can be translated through the development of persistence (together with self-efficacy).

2) Temporal Relationship

Long-term motivation (*Ml*) is the accumulation exposure of short-term motivation (*Ms*) over time. λ_{ml} relates the decay function to represent possible degradation in motivation. The formation of long-term persistence (*Lp*) is modelled from the accumulated presence of short-term persistence level (*Sp*).

$$Lm(t+\delta t) = Lm(t) + \beta_{lm}.\big[Pos\big(Sm(t) - Lm(t)\big).\big(1-Lm(t)\big) - Pos\big(-(Sm(t) - Lm(t) - \lambda_{ml})\big).Lm(t)\big].\delta t \quad (16)$$

$$Lp(t+\Delta t) = Lp(t) + \alpha_{lp}.\big[\big(Sp(t) - Lp(t)\big).Lp(t).\big(1-Lp(t)\big)\big].\Delta t \quad (17)$$

B. Simulation Results

This section presents results for different cases in motivational levels for fictional interviewees during interview tasks. All parameters were regulated to represent six different motivational cases. These cases are: 1) highly motivated interviewee, 2) low motivated interviewee, 3) moderately motivated interviewee, 4) interviewer effect on interviewee motivation, 5) self-efficacy effect on interviewee motivation, and 5) personality disposition on interview motivation. The duration for the simulation is fixed at 500 time steps to simulate an interview session. The session can be divided into three time-frames with changes in task demands and interviewer dispositions. The parameters were initialized at Δt=0.2$\omega_{pa1} = \omega_{pa2} = \omega_{pa3} = 0.33$, $\omega_{g1} = \omega_{g2} = 4$, $\omega_{g3} = 2$, αcv = 0.2, $\lambda_{ml} = 0.001$. All other parameters were initialized using value = 0.5. The inputs to define the six cases are presented in Table 1.

Table 1
Input values of the six simulated cases based on input factors.

Factors/Cases	#1	#2	#3	#4	#5	#6
Id	1	0.9	1	0.1	0.9	0.9
Fa	1	0.9	1	0.1	0.9	0.9
Ss	0.8	0.1	0.5	0.9	0.9	0.9
Pn	0.9	0.2	0.5	1	0.9	0.1
Td	0.1	0.8	0.5	0.9	0.2	0.2
Pe	0.8	0.2	0.5	0.9	0.9	0.9
Kn	0.9	0.2	0.5	1	1	0.8
Se	1	0.1	0.9	1	0.1	0.9
SK_{norm}	0.9	0.2	0.5	0.9	0.9	0.9

1) Scenario #1:A competent and positive personality individual will be motivated towards a task where interviewer is viewed as being positive.

Figure 2 visualizes the scenario of a positive personality who believes in his/her competence engaging in solving the task (interview session) and perceived it as "not demanding". The discrepancy is connected to the low value of task difficulty. In this case, the long-term motivation maintained a high value with short -term motivation but later decline due to decay.

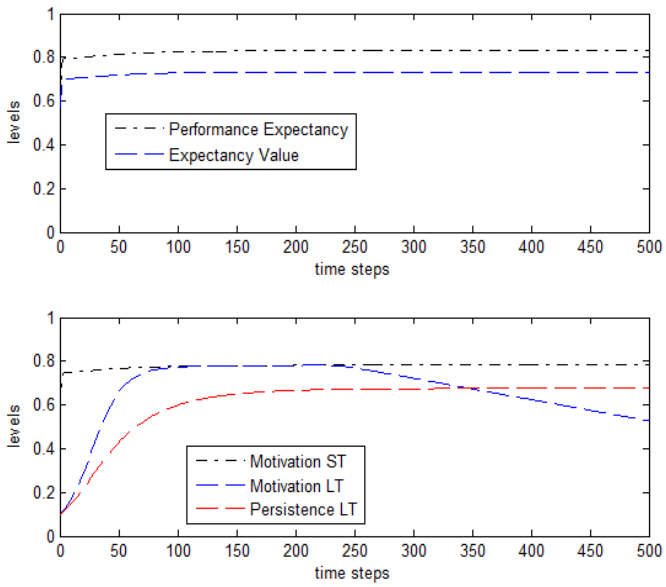

Figure 2: High motivated agent

2) Scenario #2: Low competency with a perceived demanding interview task and with a favourably disposed interviewer.

The simulation result shown in Figure 3 represents the condition for low motivated individual due to the unfavourable social and environment inputs and demands. In addition, the individual will experience the low motivation and persistence regardless the favourable behaviours of the interviewer. Another condition can be viewed is the expectancy value is higher than then performance expectancy due to the high task demand.

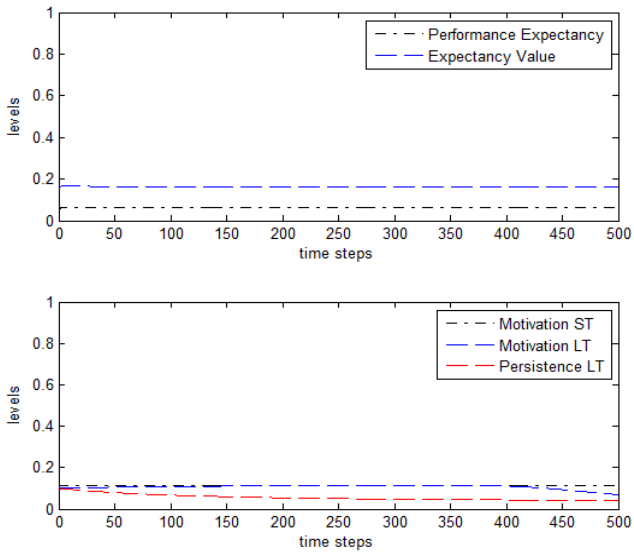

Figure 3: Low motivated agent

3) Scenario #3: An interviewer with average competency and task demand.

Figure 4 presents the expectancy and value threading simultaneously. This explains a typical task motivation level with an average task demand, competence and social support of an average performer.

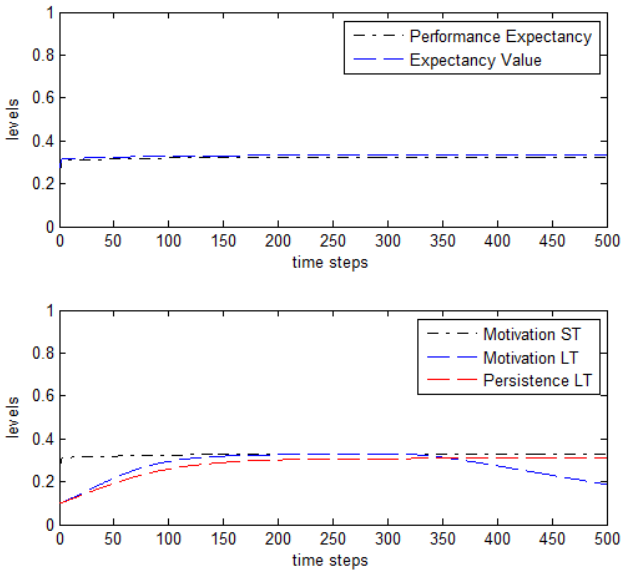

Figure 4: Average motivated agent

4) Scenario #4: Interviewer disposition on motivation.

Figure 5 shows the effect of an interviewer disposition towards interview motivation and persistence. For example, a negatively disposed interviewer can induce a task specific threat that has negative casual effects on goal orientation and affective values. Thus, this reduces the motivation level to all interviewees.

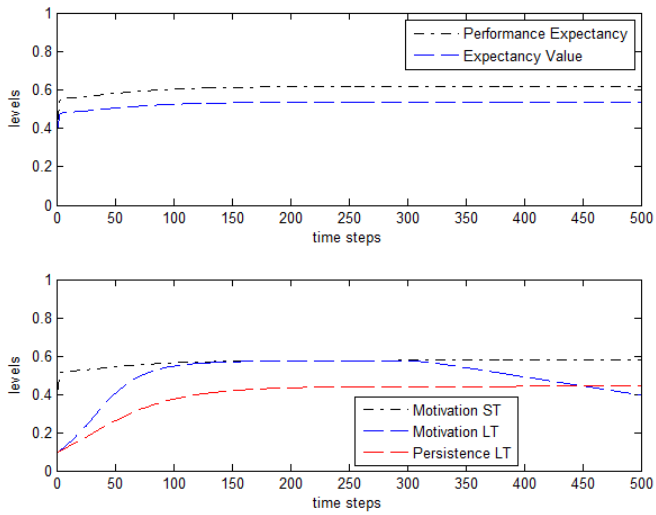

Figure 5: Effect of interviewer on motivated agent

5) Scenario #5: The effect of Self-efficacy on interviewee motivation and persistence

This scenario aims to prove the effect of self-efficacy on both motivation and persistence. The persistence trajectory shows the significant impact of self-efficacy on persistence (as in Figure 6). This is consistent with both motivation and self-efficacy theories [21].

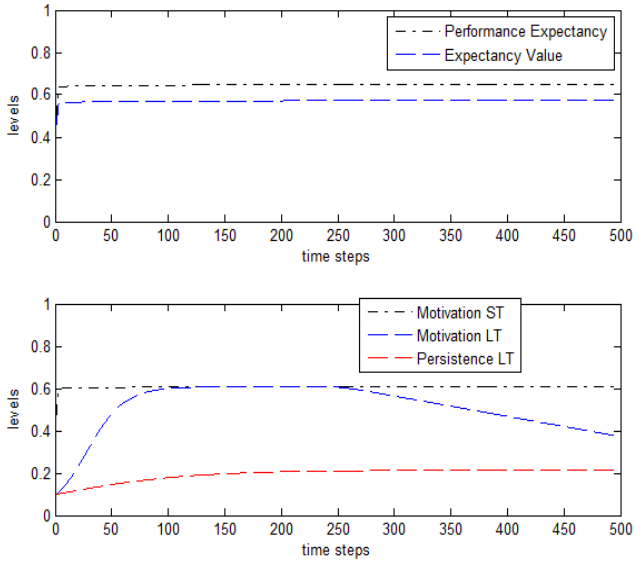

Figure 6: Effect of self-efficacy on motivated agent

6) Scenario #6: Personality profile on motivation

In this scenario (as in Figure 7), the simulation result shows that personality profile has a great impact on expectancy and value. Despite all the positive inputs, negative personality was able to reduce the motivation trajectory and with a negative proportion on persistence also.

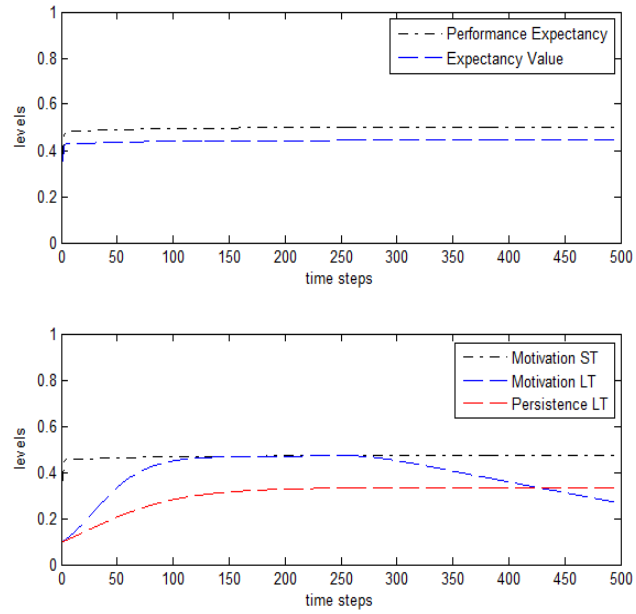

Figure 7: Effect of personality on motivated agent

V. Formal Analysis

In order to verify whether the model indeed generates results that adherence to psychological literatures, a set of properties should be identified from related literatures. After that, these properties should be specified by a language called Temporal Trace Language (TTL). TTL is built on atoms to states of the world, time points, and traces. This relationship can be presented as *holds(state (γ, t), p) or state(γ, t) |= p,* which means that state property *p* is true in the state of trace *γ* at time point *t* [22]. Based on that concept, dynamic properties can be formulated using a hybrid sorted predicate logic approach, by using quantifiers over time and traces and first-order logical connectives such as ¬, ∧, ∨, ⇒, ∀,and ∃.

VP1: Positive Personality Improves Persistent

Individuals with positive personality develop lesser chance of having low persistent.

VP1≡ ∀γ:TRACE, t1, t2:TIME, v1,w1,w2:REAL
[state(γ, t1)|= personality(v1) &
state(γ, t1)|=persistent(w1) &
state(γ, t2)|=persistent(w2) &
v1 > 0.7] ⇒ ∃t2:TIME > t1:TIME &
[w2 > w1]

VP2: Difficulties to Maintain a Long-Term Motivation

Regardless personality attributes, most of the interviewees motivation level will reduce at later time.

VP1≡ ∀γ:TRACE, t1, t2, t3 :TIME, v1,w1,w1,w3:REAL
[state(γ, t1)|= personal_ability(v1) &
state(γ, t1)|=long_term_motivation(w1) &
state(γ, t2)|=long_term_motivation(w2) &
v2 > 0.8] ⇒ ∃t3:TIME > t2:TIME &
t2:TIME > t1:TIME [state(γ, t3)|= long_term_motivation (w3) & w1 > w3]

VP3: Monotonic Decrease of Variable, v

For all time points t1 and t2 between tb and te in trace γ if at t1 the value of v is y1 and at t2 the value of v is y2 and t1 < t2, then y1 ≥ y2

VP3 ≡ ∀γ: TRACE, ∀t1, t2:TIME, ∀Y1,Y2:REAL
[state(γ,t1)|= has_value(v, Y1) &
state(γ,t2)|= has_value(v, Y2) &
tb ≤ t1 ≤ te &
tb ≤ t2 ≤ te &
⇒ Y1 ≥ Y2

VI. Conclusion

This paper presents a formal model of interview motivation which was simulated to relate its dynamic properties with identified situations in literatures. Practically, the result forms an underlying principle in designing an intelligent virtual agent that understands interviewee mental state. In order to fully achieve this practical application, therefore, the other two construct (self-efficacy and anxiety) that represent the mental state are needed to be formalized and integrated. The integrated model can be incorporated into software agent to serve as its reasoning mechanism during job interview coaching sessions.

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