Analysing participants' performance in Idea Generation meeting considering emotional context-aware

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Abstract. In an idea generation meeting the emotional context-aware is correlated the with participants' performance. To achieve good results in idea generation sessions it is important that participants maintain a positive emotional state. In this paper we will present an agent-based idea generation meeting using an emotional context-aware model that includes several mechanisms, namely: the analysis and evaluation of events, emotion-based process and recommendation selection. In order to analyse and test the benefits of these mechanisms, we also created a simulated scenario where agents generate ideas and are affected by context-aware situations. The simulation reveals that these mechanisms can increase the participants' performance using some techniques. This study shows how the use of recommendation mechanisms can maximize meeting results in some situations.

Keywords: emotional context-aware, idea generation meeting, agent based simulation

Introduction

In last years the role of emotions is more correlated with several cognitive activities, namely: decision-making, learning, planning and creative problem solving [1][2]. Idea generation process, a part of creative problem solving cycle, is ever more used by organizations to create new products or services, new strategies and to change organization structures. Since organizations are made by multiple people from different areas, usually idea generation is done in groups, where interaction can be beneficial for the appearance of new ideas [3]. However, these interactions can affect negatively the participants' performance and consequently the group performance [4]. Based on the assumption that the emotions are

triggered by events, it is possible concluded that the individuals mood will be affected by social interactions. This fact is unfavorable to group idea generation how proved various studies [5][6][7].

According to Ortony [8], an emotion is the result of three types of subjective evaluations: evaluation of the triggered events considering the defined goals; evaluation of the actions taken by a certain agent, and also by the evaluation of the agent's own attitudes. This way, regarding the process of group idea generation, where events are triggered constantly, one can easily conclude that there is an emotional context associated to the process. According to the literature, it is possible to conclude that the emotional context of an idea generation meeting influences the performance of the participants. Several studies found in the literature prove that when the participants are in a positive mood, they generate more ideas and more creative ideas [5][6][9][10][11].

In this paper is used a model that aims are inferring every motional context of the meeting, allowing, this way, all the participants to spend as much time as possible over the process in a positive mood. This fact allows ideas to be generated in bigger quantities and with more creativity. This type of implementation is useful for generating ideas of big groups or groups that are not in the same space.

In order to validate the correct emotional context inference by the model, and also the increase of the participants' productivity in the group idea generation process a set of experiments were conducted. The experiments consisted in a set of simulations based on agents (agent-based simulation), in which the participating agents that represented the members of the idea generation group were modeled with profiles to have a certain type of action.

In the rest of the paper we first present the emotional context of group idea generation and how to model it. Next we present an agent based architecture to simulate an idea generation meeting scenario and the emotional context of this meeting. For that we present some experiments to evaluate the model and under-stand what is the influence of emotional context in group idea generation. In next section we analyses the results of experiments and in last section we present the conclusions and future work.

Emotional Context Modeling

In order to understand and simulate the emotional context of the group idea generation process it is necessary to model the emotional aspects of each participant in particular. Knowing that the emotional context of an idea generation meeting varies according to the events that happen and knowing which is the influence of those events on the participants' mood is an essential task. This way, in order to constantly adapt the meetings emotional context, facilitating actions are taken aiming at maintain the participants in a positive mood. These actions

contribute directly to the maximization of the participants' performance and, consequently, to the maximization of the idea generation meeting results.

The events considered in the emotional context modeling comprise every action that might be triggered in an idea generation meeting mediated by computer. The events may include the introduction of new ideas, the evaluation of the ideas, the visualization and analysis of the performance and the reception of facilitation recommendations. The participants are emotionally affected by these events, with the possibility of being positively or negatively affected, according to the desirability the participant has for that event.

The emotional context model [12] presented in this section was developed on basis on 3 assumptions, resulting from the literature review:

1. The individuals have a tendency to have better performance (generate more ideas) when they are in a positive mood;
2. The ideas generated in a positive mood have the tendency to be more creative responses;
3. The inclusion of a facilitator in the group idea generation process has the goal of improving the group performance (generate more ideas);

This model is based on events, which are the input of the model, and applies the OCC model [8] to infer the participants' emotions. After calculating the desirability that each participant has for the event, one or more emotions are generated considering that same desirability. Since the mood represents the participants emotional state over the time, if the participant is in a negative mood, then recommendations are generated regarding the events that led the participant in that mood. This way, the output of the model are the recommendations which have the goal of keeping the participant in a positive mood, facilitating therefore the participant's performance, in a quantitative or qualitative level, i. e., the generation of more creative ideas.
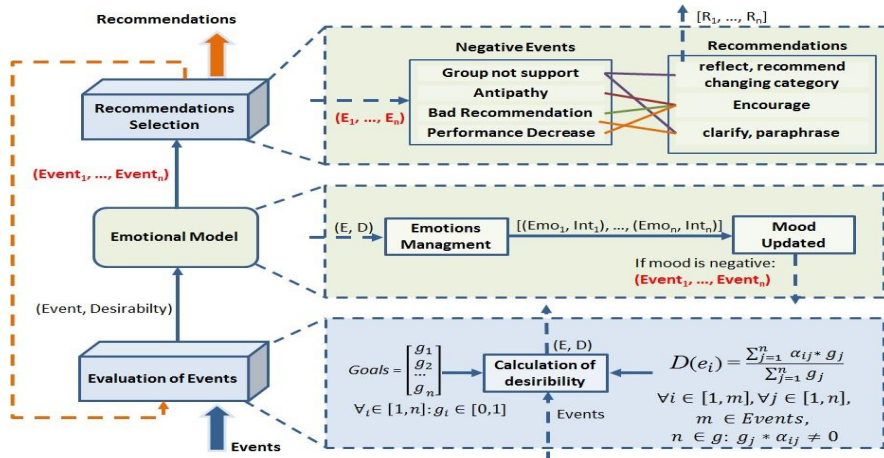

Figure 1. Emotional Context Model [12]

The **Evaluation of Events** component has the goal of evaluating the impact that a certain event has in the participant, i. e., the participant's desirability for a triggered event. The desirability is calculated considering the impact that the event has in the participant's objectives and also considering the importance of each in the participant's performance. These variables represent part of the participant's profile and allow representing the participant in the system. To better understand the calculation of the variable desirability, let us see the following scenario: a participant has the goal to receive the group support (g1), to have a good performance (g2), to receive good recommendations whenever they are necessary (g3) and to receive the group sympathy (g4). For that, the following values of the goals' importance were assigned: [0.8, 0.9, 1.0, 0.7]. Assuming that the idea rejection event was happening (¬group support the next step is to analyse the impact of this event in participant's goals. Considering that the participant has defined the following impacts: [-1.0, -0.8, 0.0, -0.7], where each column represents the impact in an objective (e.g.: this event has an impact of -1.0 in the objective g1), the desirability on the occurrence of "Group not support" event is:

$$D\left(\neg Group\ Support\right) = \frac{-1.0 * 0.8 + (-0.8) * 0.9 + (-0,7) * 0,7}{0.8 + 0.9 + 0.7} = -0.8375$$

The **Emotional Model** component infers that the emotions are generated in the participant. Considering the triggered events and the participant's desirability for its happening, certain emotions are generated that, in turn, will affect the participant's mood. Whenever the participant's mood reaches a negative level, the negative events that led to that state are sent to the **Recommendations Selection** component. The potential of the emotions generated has the desirability value of the desirability that participant has in the occurrence of this event. Each emotion follows a certain rule that is triggered whenever an event happens. If the triggered event is a desired event, then a positive emotion is generated, otherwise a negative emotion is generated. According to the example referred earlier, let us imagine that the event ¬Group Support is generated with a desirability of approximately -0.83. Then, a negative emotion will be generated, more specifically an emotion of sadness. The intensity of that emotion is represented by the difference between a defined threshold for that emotion and the potential of that emotion, which is the desirability value, i.e., -0.83. Assigning the value of 0.3 to the threshold of the emotion of sadness, that emotion is generated with an intensity of -0.53. The participant's mood is calculated by the sum of the positive emotions with the negative emotions, always considering that over the time the emotions' intensity will decline. In this example, assuming that this was the first emotion generated, the participant's mood would be negative, with a value of -0.53. In this case, the facilitator would be alerted to generate a recommendation in order to change the participant's mood.

The **Recommendations Selection** component aims at generating recommendations that will be sent to the participant with a negative mood. As regards to the negative events that led the participants in that state,

recommendations to "put" the participant in a positive mood are generated. However, the generated recommendations may not have a positive influence in the participant, because he/she can evaluate negatively the received recommendations. In this case, the event representing its own recommendation will be evaluated again by the **Evaluations of Events** component and thus it may generate the participant's negative emotions. Continuing, once again, the previous example, this component would generate 4 types of recommendations: reflect, recommend changing category, clarify and paraphrase, because these are the recommendations defined for the negative event "group not support".

Experiments

The ideas presented above, were developed into hypotheses in order to test the model presented in previous section. The hypotheses are the following:
- Hypothesis 1: The participants who are in a positive mood for a long period of time generate more ideas;
- Hypothesis 2: If the presented model analyses the events correctly, then the presence of a facilitator who sends good recommendations at the right time will result in a more productive and creative idea generation process. On the other hand, if the facilitator sends recommendations that affect the process, he will also be the responsible for affecting the productivity and creativity.

To demonstrate how it is possible to obtain a better participants' performance of an idea generation group, using the model presented and considering the number of ideas generated and the creativity related to each one of those ideas, several simulations were conducted.

Agent Based Architecture

In order to conduct the simulations that will make possible to test the presented hypothesis previously, a simulation architecture based on agents was used.
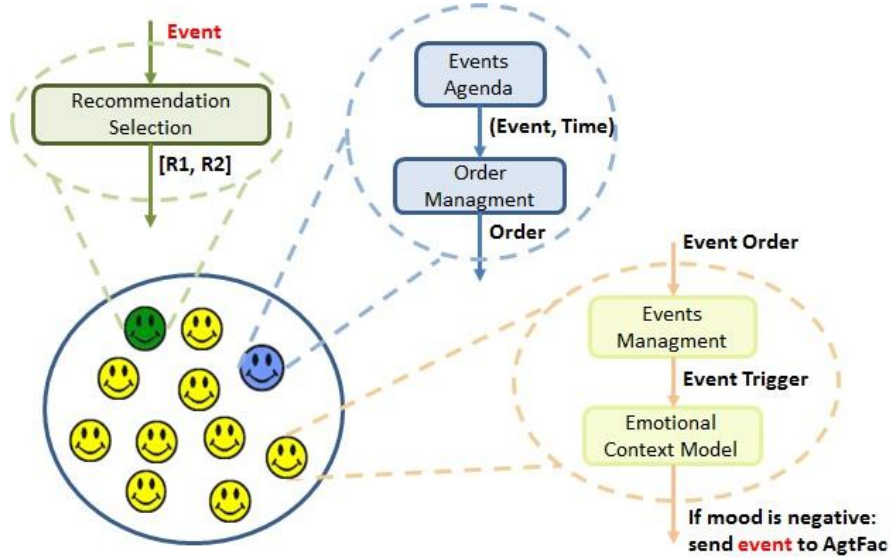
Figure 2. Agent Based Architecture to Group Idea Generation Simulation

The agents' community represented in the figure consists of three types of agents: the agent participant (AgtPart), the agent facilitator (AgtFac) and the agent simulation (AgtSim). The **Agent Participant** represents participant of idea generation meeting and has the capability to trigger the events scheduled by the AgtSim and also to infer the emotional context model. This agent receives information from the AgtSim related to the events that must be triggered and sends information to the AgtFac that is always in a negative mood. The **agent facilitator** represents the idea generation meeting facilitator and her function is to generate recommendations to send to one AgtPart, whenever he is in a negative mood. At last, the **agent simulator** is responsible for generate the entire simulation, i. e., schedule the events that will be triggered and send the execution order to the AgtPart that will trigger those events.

Simulations

It were conducted 30 simulations for each one of the three experiments described below where, to better understand the difference in the number of ideas generated, the time for each simulation is equivalent to 120 minutes. Our idea generation scenario was inspired by a real situation, where the participants (members of an idea generation group) had the goal of generating ideas. Experiment 1 was conducted without the facilitation process; Experiment 2 was conducted with a good facilitation process; and Experiment 3 was conducted with a bad facilitation process.

Data resulting from a case study conducted in [13] were used. All agents of type agent participant were modelled with profiles of real potential participants. The focus of each experience will be an agent participant that had the following profile:

Table 1. Participant Desirability

	Desirability
Group Support	0.68
Group not Support	-0.55
Performance Increase	0.75
Performance Decrease	-0.58
Receive Good Recommendations	0.80
Receive Bad Recommendations	-0.80
Sympathy of other participants	0.80
Antipathy of others participants	-0.80

Table 1 represents the participant's desirability for all triggered events. These data are important to emotional model of the participant.

Table 2. Average time to events triggered

		$\bar{x}$ (minutes)	σ
Generated Ideas	**Positive Mood**	4	2
	Neutral	7	4
	Negative	12	5
	Analyse Performance	8	5
	Analyse Empathy	8	5

Table 2 represents the average time ($\bar{x}$) of an event to be triggered and the standard deviation (σ) of this average time. These data allow generating random values based on a normal distribution.

Table 3. Probability of events triggered

		$\bar{x}$ (Probability)	σ
Facilitation Quality	**Good**	0.7	0.2
	Bad	0.2	0.2
	Group Support	0.71	0.47
	Sympathy	0.56	0.4

Table 3 represents the occurrence probability of a given event. Considering a probability average ($\bar{x}$) and standard deviation (σ), a random value is generated

based on a normal distribution. For example, the average probability of group support occurrence is 0.71 and the standard deviation is 0.47.

Analysis of Results

The first experiment consisted in simulating the entire idea generation process without a facilitator. In the second and third experiment a facilitating agent was included that had the goal to control the entire process and send recommendations to the participating agents, as explain before. The facilitating agent included in the second experiment presented a good recommendation average of 0.70 with a standard deviation of 0.20 (being therefore considered a good facilitator). In the third experiment was used a facilitating agent with a good recommendation average of 0.20 with a standard deviation of 0.20.

Table 4. Idea Generated in three experiments

	Generated Ideas	Average of ideas (30 Simulations)	Standard Deviation
1st Experiment	565	18.83	4.14
2nd Experiment	664	22.13	4.56
3rd Experiment	511	17.03	4.09

Table 4 shows the number of ideas generated by the participating agents in each of the experiments. One can see that with the inclusion of a good facilitator in the presented model, the participating agent generated a higher number of ideas when comparing to the experiment that had no facilitator and to the experiment that included a bad facilitator. One can also see in Figure 3 that the largest amount of ideas generated was verified in almost every simulation.
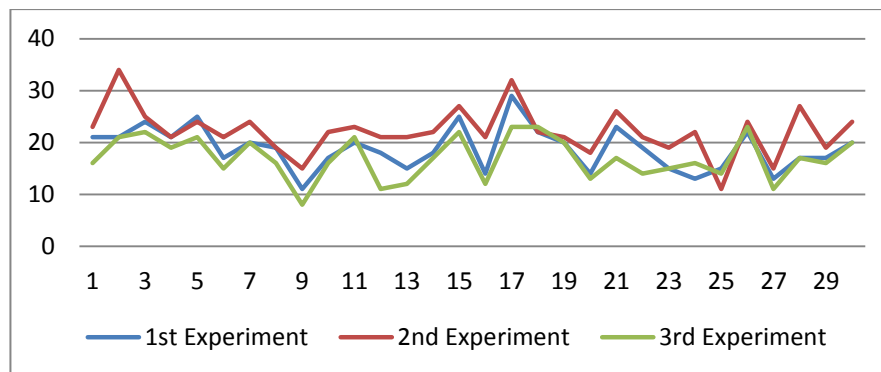

Figure 3. Chart of idea generated in three experiments

It was also verified that the standard deviation resulting from each one the experiments didn't present values with relevant differences. As mentioned before in the literature review, another important factor to be analysed is the study of the participating agent mood at the moment an idea was generated. In Table 2 are presented the results for the number of ideas generated in each experiment only when the participating agent was in a positive mood.

Table 5. Idea Generated by participant in positive mood

Positive Mood	Generated Ideas	Average of ideas (30 Simulations)	Standard Deviation
1st Experiment	388	12.93	5.03
2nd Experiment	529	17.63	4.53
3rd Experiment	319	10.63	4.50

These data show that besides obtaining a higher number of ideas with the inclusion of a good facilitator in the idea generation process, by using the proposed model, the number of ideas generated in a positive mood is also high if the facilitator is considered to be good. Regarding only the ideas generated in a positive mood, we obtained a good average of ideas generated by simulation of 10.63 when there was no facilitator included, and of 12.93 with a bad facilitator and an average of 17.63 with a good facilitator. This demonstrates the difference between the average of ideas generated in a positive is higher than the difference between the average of ideas generated in total.
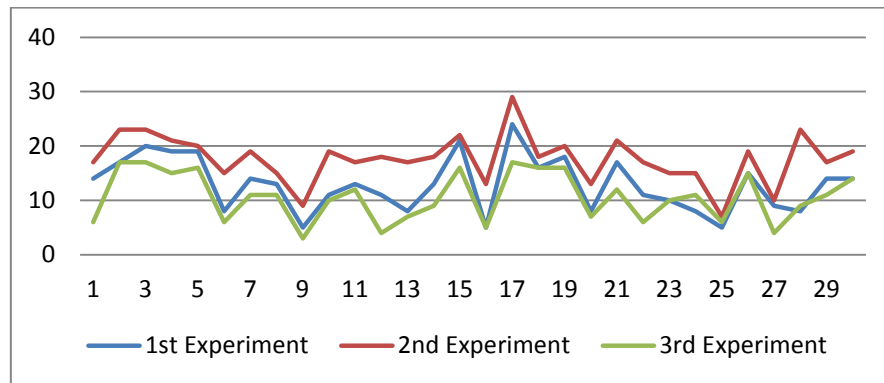
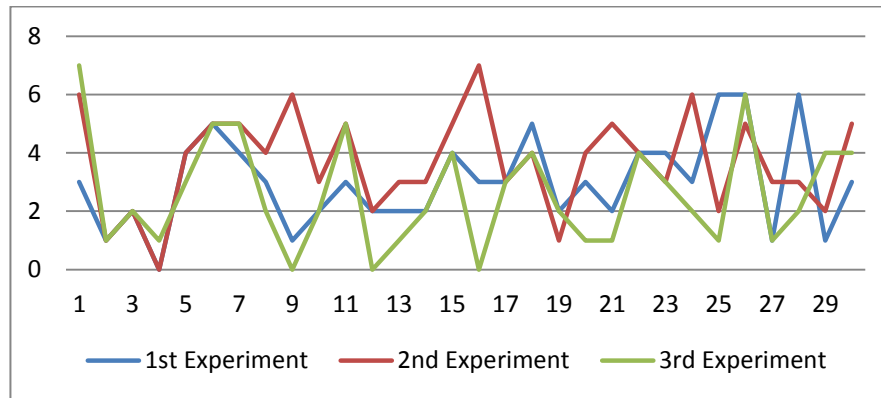**Figure 4.** Chart of Idea generated by participant in positive mood

Figure 4 shows the number of ideas generated by simulation in a positive mood. Hirt et al. [6] concluded that the process that contributes to a specific mood is not relevant; what matters is whether individuals are in a positive mood to generate more creative responses to an experimental task. This way, the ideal in an idea generation context is to obtain the maximum number of ideas generated in a

positive mood. Table 6 shows the number of ideas generated by the participating agent in a neutral mood.

Table 6. Idea Generated by participant in neutral mood

Neutral Mood	Generated Ideas	Average of ideas (30 Simulations)	Standard Deviation
1st Experiment	90	3	1.58
2nd Experiment	111	3.7	1.68
3rd Experiment	78	2.6	1.85

One can see that in any of the experiments the difference in the number of ideas generated in a neutral mood is not very relevant. One can also see that in Figure 5 there is no tendency in none of the moods.
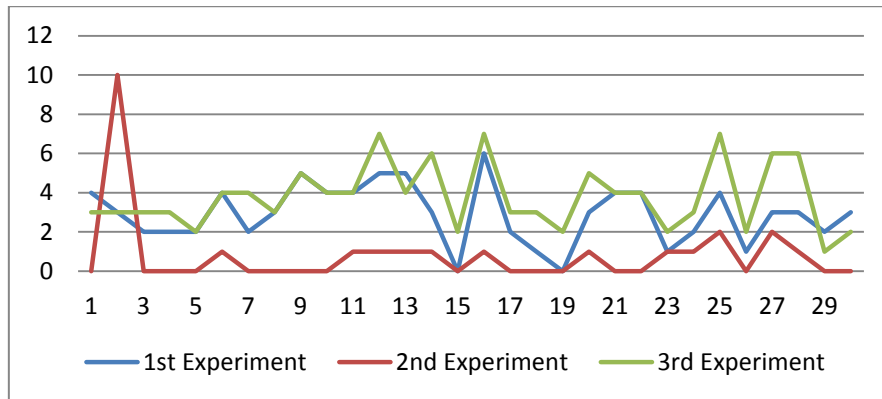

Figure 5. Chart of Idea generated by participant in neutral mood

Finally, the number of ideas generated in a negative mood, in each experiment, was analysed. Table 7 presents the results obtained.

Table 7. Idea generated by participant in negative mood

Negative Mood	Generated Ideas	Average of ideas (30 Simulations)	Standard Deviation
1st Experiment	87	2.9	1.49
2nd Experiment	24	0.8	1.85
3rd Experiment	114	3.8	1.67

One can see that with the inclusion of a good facilitator there are practically no ideas generated by the participating in a negative mood. Figure 6 shoes how the number of ideas generated in a negative mood is much higher when there is not a facilitator or when there is a bad facilitator.

Figure 6. Chart of Idea generated by participant in negative mood

This is due to fact that there is no monitoring in the participant's mood, or any kind of action to revert the situation when the participant is in a negative mood. On the other hand, the recommendations sent by the bad facilitator sometimes worst the participating agent's.

One can see the model is able to understand the multiple events that happen throughout the group idea generation process. The model presented can be aware of the various actions that take place throughout the process that can affect the participant's mood. The inclusion of a good facilitator can increase significantly the number of ideas generated by the participating agent, as well as to increase the number of ideas generated in a positive mood and decrease the ideas generated in a negative mood.

Conclusions and Future Work

With the results obtained it is possible to see the importance of the inclusion of a good facilitator. It was possible to understand that the model represents correctly the events of an idea generation process and the facilitator has the correct acting timing. Obviously the improvements presented in the participants' performance are not just due to the presence of the facilitator, but to the way the facilitator takes part of the process. With the conducted experiments, one can verify that when recommendations sent by the facilitator are good, they improve the performance of the group members. Even though the verified benefit in the use of proposed recommendations and in their timing of use, we intend to develop in the future a learning module to be integrated in the facilitator. It is intended that the facilitator may become increasingly assertive in his recommendations over several meetings, as he/she knows more about each participant.

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