

INTEGRATION OF AN EMOTION MODEL TO THE BOARD GAME “INTRIGE”

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Abstract: One important issue in gaming design is to let the player’s opponents appear as humanlike as possible. The underlying assumption of our work is that integrating artificial emotions to computer players will lead to a higher diversity of game situations and thus, to more interesting and joyful games. In this paper, we integrated an emotion model to agents playing the board game “Intrige”. The current emotional state influences the behavior of the agent. In experiments we have shown that success of agents depends on the used emotional states and the varying constellations of opponents lead to different distributions of emotional states.

1 INTRODUCTION

The gaming industry aims to design computer games providing a convincing projection of the reality. One important issue in gaming design is to let the player’s opponents appear as humanlike as possible. Emotions are one important aspect attributed to human beings. The underlying assumption of our work is that integrating artificial emotions to computer players will lead to a higher diversity of game situations and thus, to more interesting and joyful games. The underlying research question is if agents should be provided with emotions at all, and if so, for which kind of applications it could be useful.

The objectives of this research are to select an emotional model, integrate it into the behavior decision process of agents, and investigate how these emotions influence the results in a given environment.

In order to examine the differences of emotional agents the players will be playing an implementation of the existing board game “Intrige”. The investigation is about to find out whether emotional agents show any different behavior in the interaction with other players and if there are tendencies in the emotional development in certain combinations. In addition, the success rates of the different strategies will be compared.

Although the definition of emotions still varies

there are generally accepted approaches (Zimbardo, 1995). (Kleinginna and Kleinginna, 1981) define emotions as a complex pattern of changes including psychological arousal, affection, cognitive processes and behavior. They state that emotions occur when an individual perceives a certain situation to be of importance. A newer and more complex model defines emotions as a combination of certain tuples in an Cartesian coordinate system (Russell, 1980). Russell’s circumplex model of affect distinguishes between the activation and pleasure axis. He defines 28 different states of affect, while a modified version of the circumplex model (Schmidt-Atzert, 1996) uses only eight states which will be described later on. While criticism claimed that states like tiredness cannot be regarded as emotions (Schmidt-Atzert, 1996), the circumplex model allows a fair distinction between certain emotional states.

2 THE BOARD GAME “INTRIGE”

Intrige (engl.: intrigue) is a German board game where every player manages a court with four regions of different values. The player’s actions are twofold: Every court owner has a number of scholars (two priests, two writers, two physicians, and two

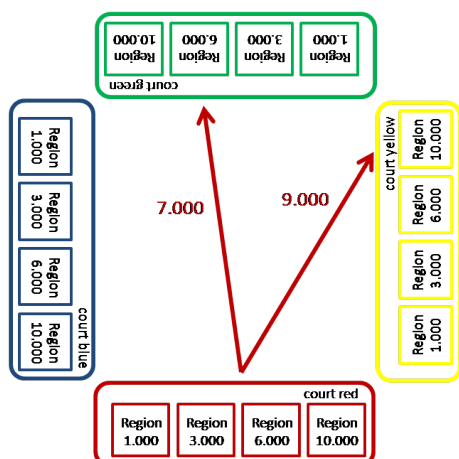


Figure 1: "Intrigue" board, sending out two scholars.

natural scientists) he wants to place in the other courts as well as he has to house scholars from other players in his four regions. The goal of the game is to earn as much money as possible. During the game, players negotiate about which scholar they are willing to accept or reject on their house positions aiming to earn the most money at the end by either collecting credits from their placed scholars or from the negotiations when accepting or rejecting the opponents' scholars. Since the game specifically allows every kind of contract between the players and often forces the player to break the contracts, it can be considered to possess the tendency to induce emotions.

Each game lasts five rounds in which each player has to do the three following actions if possible:

1. collecting credits from the bank
2. accepting or rejecting pending scholars
3. sending out two of his scholars

The simulation implements almost every rule of the game. However, the negotiations are currently based on the amount of the paid bribery only.

Fig. 1 illustrates a situation where player red sends out two of his scholars. He bribes player green with 7000 credits to get position 6000 and bribes player yellow with 9000 to get position 10000. Paying bribes does not guarantee that agreements are kept, i.e., players green and yellow are free to put the scholars in any of the regions independent of the negotiation.

The game's rules additionally have some restrictions, e.g., every court can only host one scholar of each type and each region has only place for one person. For more details we refer to the Intrigue game's rules (Dorra, 2003).

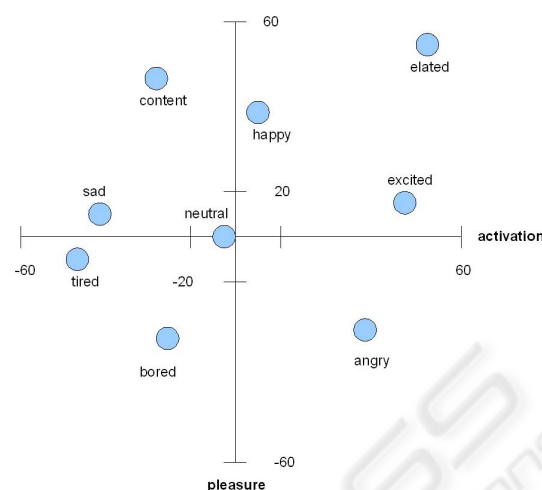


Figure 2: Emotional states.

3 "EMOTIONAL" AGENTS

The emotional agents designed for this simulation implement Russell's simplified circumplex model with a certain playing strategy in accordance to their game experience. After experiencing emotionally relevant incidents their emotional state can vary and therefore their playing strategy can change. This section illustrates the origins of the emotional model and the different strategies, defined for each state.

3.1 Emotion Model

The emotion model is based on the circumplex model (Schmidt-Atzert, 1996) where eight different emotional states are listed: elated, excited, happy, content, tired, bored, sad, and angry. In addition a ninth state called neutral was added knowing as a starting point to investigate the changes in emotional states. By differing the two values activation and pleasure into three categories named low, neutral and high, it is always possible to determine the emotional state of the agent. Fig. 2 shows how these different emotional states result from the different intensity values of activation and pleasure. Threshold values (± 20) indicate the regions' borders of the different emotional states.

3.2 Agent Behavior

For the scenario outlined in the previous section we developed an agent architecture which contains an explicit model of emotions. The underlying idea is to enable an agent to select specific strategies in its behavior, i.e., bribing strategy, w.r.t. its emotional state.

Table 1: Action types and substrategies.

Action Type	Potential Sub-Strategies
conflict handling	avoid, invoke, random
sendout position selection	high, low, random
bribe value selection	high, low, normal
accepting scholar preference	old, new, random

The reaction of the other players as well as the success of the agent's actions are used for transforming the emotional state:

- **sendout of scholar**
 - accepted: increase activation
 - banished: decrease activation
- **balance**, i.e., earnings minus expenses
 - increased: increase pleasure
 - decreased: decrease pleasure

The emotion model as well as the transformation rules introduced above are used for determining and changing an emotional state of an agent. The agent selects its behavior in accordance to its emotional state. The mapping of state to behavior is implemented by a strategy concept, i.e., one strategy is assigned to each emotional state. Without consideration of emotions, an agent has to perform different types of actions. It has to be decided where to send a scholar, amount of bribery, where to place foreign scholars, and how to handle conflict situations. Therefore the strategy concept consists of an allocation of one sub-strategy to each of the four major action types (cf. Table 1).

The first three action types deal with sending out a scholar. In the first step, the agent has to select the destination court. In this process, conflicts can be avoided or provoked; the agent can also select the court by random. After court selection, it is decided if the scholar is sent to a region with high, low, or random value. The third step is to calculate the bribe value, namely high, low, or normal. Normal bribe equals the value of the region. Finally, the accepting scholar preference addresses the handling of foreign scholars in the own court. The substrategy *old* means that in conflicting situations the scholar who entered first is accepted while *new* accepts the latest.

Table 2 shows the combination of activation and pleasure values in accordance to the resulting emotional state and corresponding strategy. The strategies of the agents are divided into three categories:

- upper strategies: agents willing to pay large amounts of bribe (excited, elated, happy)
- lower strategies: agent paying small amounts of bribe (content, sad, angry)
- normal strategies: agent paying the position value (tired, bored, neutral)

3.3 Agent Types

Each emotional state is combined with a certain strategy which is basically connected to the way how a player is sending out its scholars, how much credits he is willing to pay, and how he deals with requests of other players. Altogether the simulation consists of eleven different types of agents, nine of them play one certain emotional state, one is playing randomly (random agent) and one plays all of the emotional states in accordance to his activation and pleasure values (emotional agent). Additionally, a human player has been implemented for testing purposes.

4 EVALUATION

In order to investigate the simulation, different groups of configurations have been defined which determine what agent types participate in one set of thousand games. The number of players is set to four and for each position one out of the eleven agent types can be chosen. Additionally, for the emotional agents, it is possible to select if the emotional state should be reset at the end of every game.

In the experiments, we focused on the observation of one agent in the game setting. Every configuration is described by a notational string of the type 031-1[ti](2)3r-nr-01 where "031" represents the ID of the configuration "1[ti]" indicates that one emotional player (in this case the tired player) on Position "(2)" plays against three random player ("3r") and the emotion values will not be reset after the game ("nr") and the run number "01" has been investigated.

For evaluation purposes, different values are captured: The number of won games (i.e., highest credits), the credits at the end of the game, and the emotional state (for the emotional agent).

4.1 Calibration

The evaluation of the simulation is based on a calibration. The calibration should guarantee that each emotional agent can reach as many emotional states as possible and at the same time being neutral for a fairly amount of times after many games. In order to evaluate the simulation the sensible bribe value had to be re-adjusted by adding the suitable multiplying values. Fig. 3 shows the distributions of emotional states before and after an experimental reconfiguration was accomplished (without reset of emotional states). The calibration values have been identified empirically. The charts show how often a player is

Table 2: Activation and pleasure of emotional states.

Emotional state	Activation	Pleasure	Conflict handling	Sendout position	Bribe value	Accepting scholar
neutral	neutral	neutral	random	random	normal	random
excited	high	neutral	invoke	high	high	random
elated	high	high	invoke	high	high	new
happy	neutral	high	random	random	high	new
content	low	high	avoid	low	low	new
tired	neutral	low	avoid	low	normal	random
bored	low	low	avoid	low	normal	old
sad	low	neutral	random	random	low	old
angry	high	low	invoke	high	low	new

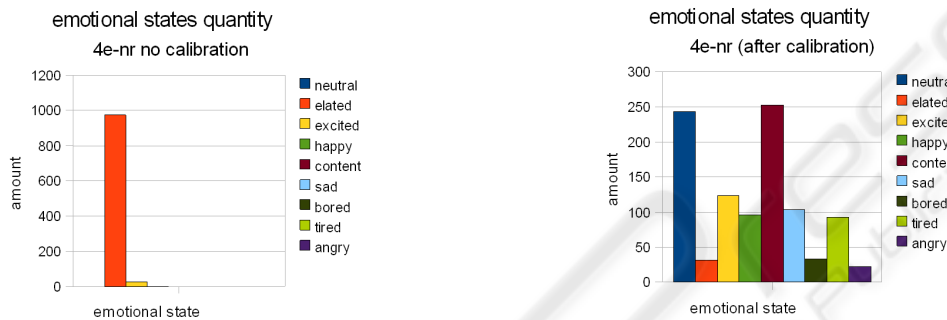


Figure 3: Emotional states before and after calibration.

in a certain emotional state after one game (repeated 1000 times).

4.2 Hypotheses

In this work three different hypotheses have been claimed:

1. The different strategies vary in their success, i.e., there are strategies which are more successful than others in certain configurations.
2. Emotional agents are influenced differently w.r.t. their emotional state depending on the set of opponents.
3. Given a sufficient number of games, the results using emotional agents vary from the results using only random players.

In order to proof the first hypothesis a configuration has to be found where one player has more success in the sense that he wins the game more often than another player does in another configuration.

The second hypothesis states that the artificial emotional environment leads to different distributions of emotional states. Given three different strategy groups (upper, lower, and normal), hypothesis two will be proven, if there exists a configuration in each strategy group where the emotional agent is in more than 50% of the games in a certain emotional state.

The third hypothesis states that the introduction of emotional agents changes the outcome of the game compared to configurations where only random players participate. While the first hypothesis aims to show that the simulation is a “real” game in the sense that different strategies lead to different outcome, the second hypothesis claims that real tendencies of emotional states can be found among the artificially created emotions. The third hypothesis justifies the use of emotional players by showing the variety arising from their game results and is proven if

1. The root square deviation of the credits of the investigated configurations is bigger than when random players compete ($sc \geq 50000$)
2. There are configurations where the amount of victories is almost equally balanced among the players ($sv \leq 20$)
3. Every emotional state can win in a certain configuration
4. Every position can be victorious

4.3 Results

Among the so-called lower strategies, meaning a strategy in which the emotional agent is not willing to pay much bribe, there are two strategies which were very successful even when running the configuration several times (in this case ten times). Com-

Table 3: Distribution of two successful configurations.

059-1e(1)3[ha]-nr	052-1e(2)3[ex]-nr
871, 841, 841, 843, 852, 875, 857, 853, 846, 844	794, 808, 821, 822, 818, 819, 828, 822, 821, 821

Table 4: Maximal number of emotional states with corresponding configuration.

configuration	state	value
132-1e(4)3[n]-r	neutral	538
072-1e(2)3[bo]-nr	elated	115
070-1e(4)3[ti]-nr	excited	660
150-1e(2)3[ti]-r	happy	347
051-1e(1)3[el]-nr	content	995
137-1e(1)3[an]-r	sad	443
161-1e(1)3[an]-r	bored	234
164-1e(4)3[an]-r	tired	242
078-1e(4)3[sad]-nr	angry	375

Table 5: Emotional state distributions for three selected configurations.

051-1e(1)3[el]-nr	070-1e(4)3[ti]-nr	132-1e(4)3[n]-r
993, 987, 989, 990, 987, 988, 988, 991, 986, 990	606, 625, 598, 588, 599, 580, 619, 600, 580, 629	530, 516, 484, 506, 514, 520, 512, 522, 507, 525

paring these two successful strategies where the emotional agent on player position 1 archives generally more than 800 victories in 1000 games, the results of the students t-test states that the two value sets are statistically significant differently and hence *hypothesis 1* is proven. Table 3 shows the distribution of the two successful configurations 059 and 052.

Regarding the different emotional states in which the emotional agent can end up in accordance to the configuration, Table 4 shows nine configurations where (in comparison to all other configurations) the player ended up in a certain state more often than any other configuration.

By choosing configuration 051 of the upper strategies (willing to pay much credits), configuration 070 of the lower configuration group and configuration 132 of the normal strategies (paying normal bribes), one configuration of each group could be found where more than half of the games the agent ends up in a certain state. The execution of the Student's t-test statistically proved that these values are significantly differently proving *hypothesis 2*. Table 5 shows the ten different emotional state distributions for all three selected configurations.

In order to prove that the results of the simulation

Table 6: Distribution of won games.

Adam	Betty	Carry	Dylan	RSD
249,45	263,86	248,89	238,39	173,97

vary from the games where only random agents participate, certain pre-defined requirements have been tested. The hypothesis could be verified, because configuration 4e-r and 4e-nr (4 emotional players compete with and without reset) had a root square deviation (RSD) of the credits $sc \geq 50000$ and there were more than one configuration with $sv \leq 20$ (168-4[ha]-nr with a value of 14.02). In order to illustrate the variety of the simulation, Table 6 sums up the winning distribution among all players (ordered by their position) and showing the root square deviation (RSD) of the investigated set. The third requirement can be deduced by referring to the results from this table. The fourth requirement has also been proven so that *hypothesis 3* is proved as well.

5 RELATED WORK

Simulation affection in a computer environment was, for instance, the approach Dörner chose when designing PSI, a learning software agent designed to survive on an "island" by investigating his surroundings. Although PSI was designed to experience many different "needs", it has yet not been able to interact with other PSI agents (Dörner, 2002).

The software agent Max, developed at the University of Bielefeld (Boukricha et al., 2007), is even able to perceive emotions of the other players and therefore can be considered to be empathic. In an investigation, Max is playing a card game against a human player and is differently reacting on the test persons emotions, giving the test person the opportunity to evaluate Max reactions. Max is yet not able to change his game play according to his emotions.

(Reilly and Bates, 1992) introduce the emotion model *Em* which has been developed within the *Oz* project. The project aimed at the development of technologies for interactive fiction and virtual realities. The emotion model for the agents in the *Oz* world is based on an cognition-based model by Ortony, Clore, and Collins (OCC). The adapted model used by Reilly and Bates consists of 14 emotions like joy and distress. The activation of emotions can have different causes, e.g., depending on goal success or failure. The behavior decision process is influenced by a set of features which are controlled by functions based on the emotional state (Bates et al., 1992).

(Camurri and Coglio, 1998) present an architec-

ture for emotional agents. The authors propose an architecture including an emotional state that evolves over time. The emotional changes depend on the input and create an output possibly influencing rational or reactive behavior of the agent. Two two-dimensional “emotional spaces” are presented where emotional stimuli move the current position of the emotional state. While the motivation of this approach is similar to the one in our approach (trying to create more realistic or entertaining behavior), Camurri and Coglio aim at an emotional architecture for robots with real-time interaction.

An approach to modeling emotional BDI agents is presented by (Pereira et al., 2006). They introduce the multi-modal logic *EBDI* where an emotional component influences the interactions of beliefs, desires, and intentions. In their paper, besides the basic emotional model they provide a specification of a fearful emotional BDI agent. Pereira et al. consider threats and unpleasant facts triggering fear.

(Steunebrink et al., 2007) introduce a formalization of the OCC model of emotions mentioned above. They introduce a logical language (and its semantics) which they have used to formalize qualitatively all 22 emotional states of the OCC model.

6 CONCLUSIONS

The work proved that there are configurations which are significantly less successful in their environment than others and that the artificially created emotions are indeed significantly influencing each other in the context of the gaming environment. Although not yet completely determinable the idea of game variety has been investigated by guaranteeing that the new emotional agents affect the game play severely.

Altogether the work achieved to construct a simulation of artificial emotions in a gaming environment. In order to investigate the plausibility of certain emotional reactions a survey on the human player (like Max) could be interesting. A competition with human players could lead to interesting results, because it is yet not sure that lower strategies might loose of their strength when competing with human players (who would accept an extremely small bribe?). Another possible step is to adjust the complexity of the bribing system by offering the players to bargain much more as they like to.

Further interesting extensions could address the integration of promises (in the sense of commitments) as additional means for negotiations– and, of course, the satisfaction or violation of such promises. In the current emotional agents, each agent has only one

general emotional state. It would also be interesting to introduce “directed” emotions, i.e., emotions w.r.t. an individual player who has acted in a pleasant or unkind way.

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