

# Emotional agents: how personalities change behaviour

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## ABSTRACT

This paper describes how personalities influence the behaviour of emotional agents. Two different emotional models are discussed, namely the OCC emotion model and the emotion-connectionist model. In both models personalities changes the behaviour on a different way.

This paper also presents an implementation of a prototype to evaluate the performance of the different personalities in the emotion-connectionist model, whose testing results are discussed. Medium susceptible to all emotions showed to perform best.

## 1. INTRODUCTION

Normally, behaviour of an emotional agent is influenced by the emotional state of the agent. Emotions usually are based upon the perceptions of the agents. There are several emotional models, of which the two described here are the OCC Emotion Model [RB92] and the Emotion-connectionist model [CJH02]. Different people have different reactions to the same situations, so personalities are used as a way how different situations affect the behaviour of an agent. The main question is *“How different personalities change the behaviour and performance of emotional agents”*. This is interesting, because if we could use personalities in the right way, it makes multi-agent systems for example more realistic, compared to human behaviour, and less predictable, what is useful in various simulations, for example a military training simulation, in which an enemy agent shouldn't always make the same in the same situation. To answer this question, first *“How do emotions change the behaviour of agents”* is tried to be answered. This is interesting, because we have to know how emotions change behaviour, before we can say something about how personalities could change the behaviour of emotional agents. So, secondly, we discuss *“How personalities change the behaviour of emotional agents”*. Finally, *“How different personalities change the performance of emotional agents”* is discussed. In this research, this question will only be tried to answer for a simple domain, namely the predator/prey-domain.

## 2. EMOTIONS

In this section is described how emotions influence the behaviour of emotional agents in the two emotional models mentioned earlier.

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## 2.1 OCC emotion model

The emotional model OCC divides the emotions in three types of subjective appraisals: the appraisal of the pleasingness of events with respect to the agent's goals, the appraisal of the approval of the actions of an agent with respect to a set of standards for behaviour, and the appraisal of the liking of objects with respect to the attitude of the agent. This model also proposes another set of emotions that are caused by combinations of other emotions. See also [RB92].

### 2.1.1 How emotions are determined

The emotions of the three types of subjective appraisals are determined as follows.

Events are judged by the emotional agent to be pleasing or displeasing to the agent's goals. Events are things that happen, including the actions of the agents. The judgment of these events increases the emotions joy and distress, based on how displeasing or pleasing the event was found to be. The prospect of future events determines the emotions fear and hope.

Actions of agents are judged by the agent to a set of standards, if they are approved or disapproved. These standards represent moral beliefs about what is right or wrong, as well as personal beliefs about the level of performance. By judging its own actions, the emotions pride and shame are influenced. Judging actions of other agents will influence the emotions admiration and reproach.

Objects, including agents, can be liked or disliked according to an agent's attitudes. Attitudes represent personal tastes and preferences. Objects that are liked by the agent, raises the emotion love towards the object, objects that are disliked, raises the emotion hate.

Emotions may also be combinations of the emotions described above. There are several combinations, like gratification is a combination of joy and pride, gratitude a combination of joy and admiration, remorse a combination of distress and shame, and anger a combination of distress and reproach.

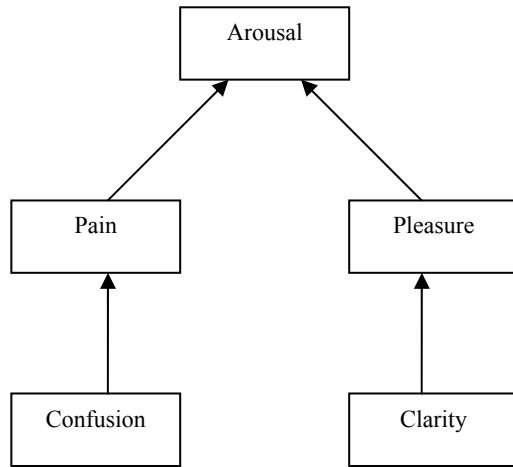
### 2.1.2 How emotions influence behaviour

The behaviour of an emotional agent based on the OCC emotional model is influenced by a set of agent-dependent rules for settings based on the current emotional state of the agent. This is for example used in the Iterated Prisoners Dilemma [BB01]. In the Iterated Prisoners Dilemma, an agent in the may choose to cooperate or defect, based on the emotion anger towards a neighbour agent, and also because of joy, distress and pity. The choice is based on the agent-dependent rules, so different agents in the same situation with the same emotions could make a different choice.

## 2.2 Emotion-connectionist model

The emotion-connectionist model consists of several interacting components: arousal, pleasure/pain and clarity/confusion. This is shown in Figure 1. The figure shows

which emotions the model has, and the arrows show how the emotions interact with each other. So, for example, clarity influences the level of pleasure.



**Figure 1: Emotion-connectionist model**

### 2.2.1 How emotions are determined

The Emotion-connectionist model follows [Gra99] that appraisal is based around goals. The most straightforward types of appraisal require monitoring whether goals have been achieved, have become likely or unlikely to be achieved, or have been deemed unachievable. If an agent doesn't know how to succeed its goal, it will find it unlikely to achieve it, and this will increase confusion. So the emotions clarity and confusion provide the agent an assessment of how effectively it can cope with the current situation.

The emotions pleasure and pain are influenced by stimuli which represent a threat or enhancement to survival. So stimuli what would help an emotional agent to survive are seen as pleasurable, stimuli what would impede the chance of survival of the agent will be seen as painful.

The arousal is mainly determined by how important the current situation is for the agent.

### 2.2.2 How emotions influence behaviour

In the emotion-connectionist-model, the primary way the emotional system influences the behaviour of the agent is through arousal. When an agent has a high level of arousal, it will narrow its focus of attention, and background noise is suppressed. Also, when an agent is highly aroused, it will make more emotional decisions, such as fleeing, and will respond purely reactive. An agent with lower arousal will act more cognitive, and will be less reactive. A way to accomplish this is to tag agent rules with arousal thresholds.

The second way how emotions influence behaviour is by the level of the emotions pleasure and pain. These inputs may influence the preferences and evaluations that the agent uses when comparing alternative courses of actions during re-planning or alternative interpretations during situation assessment.

## 3. PERSONALITIES

Because people have different personalities, and therefore different reactions to the same situations, personality models are needed. In both emotional models, different personalities

are possible, to affect the way how emotions will influence the behaviour of the emotional agent.

### 3.1 OCC emotion model

The personalities in the OCC emotion model can be based on agent-dependent rules. The emotional system develops an emotional state, what must influence the behaviour of the agent. These emotions influence the behaviour by a set of agent-dependent rules, which can have various parameters such as activation thresholds. By adjusting these parameters, different patterns of emotions are represented, which can be characterizes as different personalities [Lee01]. In the Iterated Prisoners Dilemma, for example, different agents with the same emotions don't have to cooperate or defect both, differences are possible because of the personalities.

The personalities in the OCC emotion model can also be based on the Five Factor Model (FFM). This model describes five factors influencing the emotional system, shown in Table 1.

**Table 1: Five Personality Dimensions**

Factor	Description
Extraversion	Preference for and behaviour in social situations
Agreeableness	Interaction with others
Conscientiousness	Organized, persistent in achieving goals
Neuroticism	Tendency to experience negative thoughts
Openness	Open minded-ness, interest in a culture

Considering the FFM, the personal dimensions Agreeableness, Neuroticism and Extraversion are the most important dimensions, as far as emotions are concerned. These personalities can influence behaviour for example by differences in changing moods, more about personalities and moods can be found in [Ksh02].

### 3.2 Emotion-connectionist model

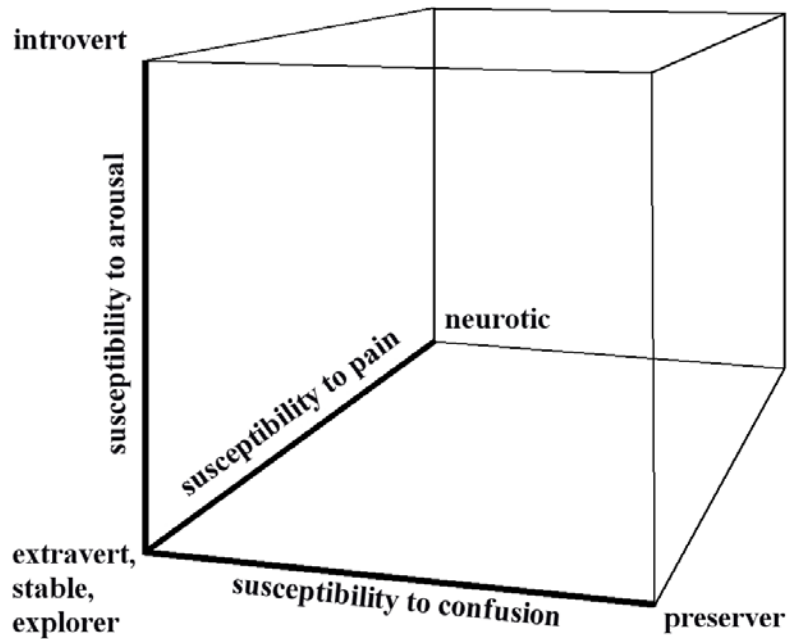
A three-dimensional personality space is used to influence the behaviour of an emotional agent, based on the Emotion-connectionist model [HJC03].

The first dimension of personality is the susceptibility to arousal. In this dimension, an introvert agent is highly susceptible to arousal; an extrovert agent lowly susceptible to arousal.

The second dimension of personality is the susceptibility to pain. In this dimension, a neurotic agent is highly susceptible to pain; a stable agent is lowly susceptible to pain.

The third dimension of personality is the susceptibility to confusion. In this dimension, a preserver is an agent who is highly susceptible to confusion, an explorer is an agent who is lowly susceptible to confusion.

These dimensions are also shown in Figure 2. By using these dimensions of personality, it is possible to model an individual's personality such that it can lead to distinct decisions in a variety of emotionally charged scenarios.



**Figure 2: Personality space in the Emotion-connectionist model**

As said before, the behaviour of an agent is influenced by the level of arousal, pleasure and pain. An introvert agent is highly susceptible to arousal; its arousal will rise quickly. So an introvert agent will make an emotional decision, such as fleeing, faster compared to an extravert agent. Behaviour is also influenced by the level of pleasure and pain. For example, an agent will prefer specific actions, like fleeing, above other actions when the level of pain is high. So the behaviour of an agent is also influenced by how susceptible an agent is to pain. Because confusion and clarity also influences the level of pleasure and pain, these emotions also influence the behaviour of the emotional agent.

#### 4. PROTOTYPE

To test how different personalities change the performance of emotional agents, a prototype was built. In this research, only a prototype is build for testing the personalities of the emotion-connectionist model, and is chosen for a simple domain, namely predator/prey.

##### 4.1 The environment

For the environment, we took the implementation of [KAPN02]. The domain is a grid world containing grass, water pools, with or without water in it, apple trees, which can have apples growing on it, and rocks, which can have herbs growing on it.

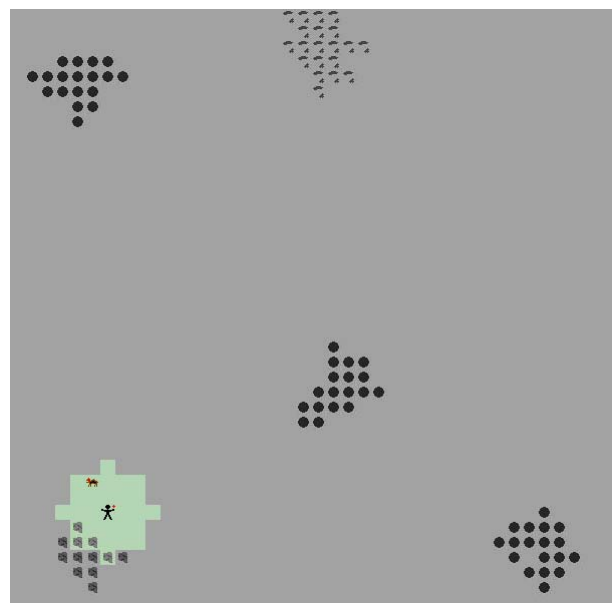
Multiple agents inhabit the grid world. An agent can only see a small part of the world, only the part near him. An agent only knows the location of the agents and predators he can see. The agent always knows the location of the trees, rocks and water pools without seeing them, but only knows if they contain an apple, water or herbs, if the agent can see the tree, rock or water pool.

Agents need food, which can be supplied by apples, and water, which can be supplies by the water pools. In the world, there are also predators, which can attack agents. When a predator attacks an agent, the agent will lose health. An agent

can regain health by eating an herb, which can grow on rocks. If an agent runs out of food, water or health, it dies.

To a large extent, the behaviour of a predator is random. The only exception is when a predator is near food, water or herbs. Then it will wait there, because it knows that agents will come there sooner or later. This means that the presence of a predator is an indication that food, water or herbs may be nearby. Also, the presence of food, water or herbs is an indication that a predator may be nearby.

In Figure 3, a picture of the environment can be seen, where the agent stands near rocks, and a predator is running after him.



**Figure 3: A picture of the environment**

## 4.2 The agents

The main goal of the agents is to stay alive as long as possible. The agents are implemented using the Emotion-connections model, with using the personalities from section 3.2.

The environment is turn-based, so every turn, the agent's emotions are recalculated, and the agent considers if it should change its current intention. After that, the agent decides in what direction it is going to move.

The emotions confusion and clarity are based on how effective the situation can be dealt with, according to the agent. If, for example, an agent wants to drink, but it spots a predator at the drinking place, confusion will rise. How much the confusion will rise, is based upon how susceptible the agent is to confusion, in other words, if the agent is more an explorer or a preserver. The emotions pleasure and pain are based on how dangerous or beneficial the current situation is for the agent. So, the current food-, water-, and health level will influence the pleasure and pain of the agent. If apples, water of herbs are nearby the agent, it will raise the emotion pleasure. If a predator is nearby the agent, the emotion pain will rise. The level of clarity and confusion also affects the emotions pleasure and pain. How much the emotions pain and pleasure will rise, is based on the susceptibility of the agent to pain and pleasure, if the agent is more stable or neurotic. The arousal of an agent is based on how important the current situation is to the agent. For example, eating an apple will be important for an agent, if the agent is hungry. The level of pleasure and pain also affect the arousal of an agent. How much the arousal will change is determined by how susceptible the agent is to arousal, in other words, how introvert or extrovert an agent is.

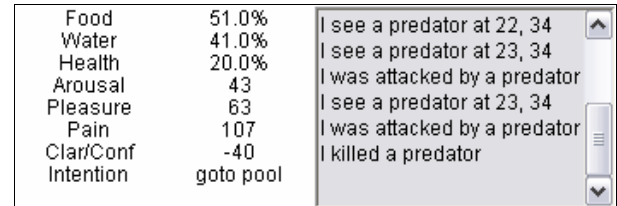
After the emotional state is updated, the agent can reconsider his current intention. Depending on the level of the arousal, the agent will change his intention. In Table 2, the possible intentions are shown.

**Table 2: Possible intentions**

Name	Description
Wait	Stay on the same location
Wander	Move randomly
Goto tree	Go to the nearest tree
Goto pool	Go to the nearest water pool
Goto rock	Go to the nearest rock
Eat apple	Eat the nearest apple
Drink water	Drink the nearest water
Eat herb	Eat the nearest herb
Attack predator	Attack the nearest predator
Flee	Flee away from the nearest predator

Every intention has his arousal thresholds, flee for example has more chance to be the next intention if the agent has high arousal, but 'goto tree' will only fire at low arousal. The choice of intention is also influenced by the level of pleasure and pain. It is less likely an agent will attack a predator, when the level of pain is high.

After the intention is generated, the agent will choose which way to move to. After the agents moved, the next turn begins. For every agent, its current state can be seen in a status display as seen in Figure 4.



Food	51.0%	I see a predator at 22, 34
Water	41.0%	I see a predator at 23, 34
Health	20.0%	I was attacked by a predator
Arousal	43	I see a predator at 23, 34
Pleasure	63	I was attacked by a predator
Pain	107	I killed a predator
Clar/Conf	-40	
Intention	goto pool	

**Figure 4: An agent status window**

## 5. RESULTS

Instead of testing with all possible personalities of the three dimensional personality space, we compare only the major three different personalities here. These three personalities are Extravert-Stable-Explorer (ESE), who is lowly susceptible to all emotions, Introvert-Neurotic-Preserver (INP), who is highly susceptible to all emotions, and the personality between it, who is medium susceptible to all emotions. The results are shown in Table 3.

**Table 3: Test results**

Agent	ESE-agent	Between ESE-INP-agent	INP-agent
Susceptibility to emotions	Low	Medium	High
Avg. time alive	155	202	185
Standard deviation time alive	77	135	96
% of times health causes death	60	35	25
% of times food/water causes death	40	65	75

The major difference in behaviour between the ESE- and the INP-agents occurred when a predator showed up. The ESE-agent, who is less susceptible to pain, mostly attacked the predator, which also often causes his own death, especially when there are more predators at the same spot, the agent can kill the first one, but the second one kills the agent. On the other side, when an INP-agent spotted a predator, it mostly flees, and while running away while the predator is chasing him, the agent doesn't think about food.

The agent with the personality between the ESE and INP-agent, seems to take advantage of both personalities, and survived in average longer then the ESE and INP-agent, but the differences in performance of this agent were bigger in comparing to the ESE- and the INP-agent, as shown in the row 'Standard deviation time alive'.

## 6. CONCLUSIONS

In this paper is discussed how personalities can change the behaviour of emotional agents. In both emotional models, the OCC emotional model and the emotion-connectionist model,

different personalities can change the behaviour of the agents, but in both models in a different way.

In the OCC emotional model, the personalities can be based on agent-dependent rules. In this case, the emotional system develops an emotional state, what influences the behaviour of an agent by a set of agent-dependent rules. The personalities in the OCC emotion model can also be based on the Five Factor Model (FFM), consisting of the five factors extraversion, agreeableness, conscientiousness, neuroticism and openness.

In the emotion-connectionist model, a three-dimensional personality space is used to influence the behaviour of an agent. These dimensions are the susceptibility to arousal, pain and confusion. When highly aroused, an agent will make more emotional decision compared to when lowly aroused. Also, the level of pain and pleasure influences the behaviour of the agents, because the level of pleasure and pain influences the preferences and evaluations of the agent.

Personalities in the emotion-connectionist model also affect the performance of the agents. The prototype showed that being too highly or too lowly susceptible to emotions, decreases the performance of the agents. Medium susceptible showed to perform the best.

## 7. DISCUSSION

The times alive of the different agents shown in table 3 are averages after 20 fully completed tests. Some tests were stopped manually before finished, because an agent was in infinite loop walking between water and apples, without meeting a predator at all.

The results showed that agents in the predator/prey domain as described above who are medium susceptible to emotions performed best. To see if this is correct in general, experiments on different domains should be carried out as well.

The tests only include agents based on the emotion-connectionist model with low, medium and high susceptibility to all emotions. To see how the individual dimensions of the personality space influence the performance of the agents, future research is required.

## REFERENCES

- [RB92] W. Scott Reilly and Joseph Bates, Building emotional agents, Technical Report CMU-CS-92-143, School of Computer Science, Carnegie Mellon University, Pittsburgh, PA, May 1992.  
<http://citeseer.nj.nec.com/reilly92building.html>
- [CJH02] Chown, E., Jones, R.M., & Henninger, A.E., An architecture for emotional decision-making agents, *Proceedings of Autonomous Agents and Multi-Agent Systems*, 2002
- [BB01] Ana L. C. Bazzan and Rafael H. Bordini, A framework for the simulation of agents with emotions, *Proceedings of the fifth international conference on Autonomous agents*, 2001, 292–299
- [Gra99] Gratch, J., Why You Should Buy an Emotional Planner. *Proceedings of the Agents '99 Workshop on Emotion-based Agent Architectures (EBAA'99) and ISI Research Report ISI/RR-99-465*
- [Lee01] Kwangyong Lee, Integration of various emotion eliciting factors for life-like agents, *Proceedings of the seventh ACM international conference on Multimedia (Part 2)*, 2001, 150-165,  
<http://doi.acm.org/10.1145/319878.319920>
- [Ksh02] Sumedha Kshirsagar, A multilayer personality model, *Proceedings of the 2nd international symposium on Smart graphics*, 2002, 107-115,  
<http://doi.acm.org/10.1145/569005.569021>
- [HJC03] Henninger, A.E., Jones, R.M., & Chown, E., Behaviors that emerge from emotion and cognition: implementation and evaluation of a symbolic-connectionist architecture, *Proceedings of the second international joint conference on Autonomous agents and multiagent systems*, Melbourne, Australia, SESSION: Emotion, 2003, 321 – 328, ISBN:1-58113-683-8,  
<http://doi.acm.org/10.1145/860575.860627>
- [KAPN02] Kesteren, A.J. van, Akker, R. op den, Poel, M, Nijholt, A, Simulation of emotions of agents in virtual environment using neural networks, 2001,  
<http://doi.acm.org/10.1145/375735.376313>