# Dialogue and social behaviour of agents in games

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## Abstract

As games keep evolving and improving in areas such as graphics, audio and physics, game players also expect the games to have believable agents. Many games have been criticised by players because of repeated dialogues; or because of the developers' lack of knowledge of the game world; or because the player is unable to avoid obstacles in the game; etc. Furthermore, games may also be unpopular when their agents do not make mistakes, or exhibit better behaviors than real humans.

This paper describes some state-of-the-art adaptive agents, and it focuses on dialogue and social interactions. It discusses game agents and their importance in games. It provides some history on what approaches have been used in games. This paper explains the basis and ideas used for adaptive agents (including emotion and personality models), and examines the approaches used by developers including Maxis (*Sims 3*), Valve (*Left 4 Dead*), The University of California (*Prom Week*) and StoryBricks.

**Keywords:** **video games, dynamic, dialogue, social behaviour, emotions, personality, model**

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## 1: Introduction

Agents have been used in games since the first days of gaming. Examples include the *Pacman*™ ghosts that chased the player (each one with a different algorithm); and, the *Mario Bros*™ goombas who only walk forward. Even some old text-based games had agents that would communicate or fight against the player. The agents in Role Playing Games (RPG) were usually the ones with the most complex behaviors (dialogues, interactions, movement, etc.). Nowadays, a wide range of games use complex agents.

An agent's behavior is fundamental to game immersion, and therefore there are several research topics involved in creating a realistic agent. Such topics include animation systems, path finding, expressing emotions and learning. However, the one we are going to focus on in this article is dialogue and social behavior.

Dynamic dialogue refers to a system where agents communicate with each other, the player, and the world. The dialogue is affected by the player's actions, the state of the world, other agents' actions,

and also by its personality and emotion. When discussing social behaviour, we refer to how agents are not limited to interact only with the players but also amongst themselves.

Dynamic dialogue and social behavior are two important aspects of an agent's behaviour. An agent that repeats the same dialogue over and over again, or that says something which feels inconsistent with the current game state, or that behaves in an unconventional way, breaks the immersion of the game and can make the game feel less fun.

The purpose of this article is to review some approaches and mechanisms used in games to create realistic dynamic dialogues and social interaction. The rest of the article is structured as follows.

- in Section 2, we discuss briefly how dialogues have been supported by games in the past;
- Sections 3 and 4 provide theoretical background and models that can be the basis for the realistic behavior of agents; and,
- Section 5 reviews a number of games that support realistic dynamic dialogues and/or social interaction.

## 2: History

In the 1980s, when text-based adventure games appeared, the rules for agents were simple: the whole game was a dialogue; and the programmers used conditionals and branches for the different options. As games started to improve, the previously mentioned approach became obsolete, and developers started to use dialogue trees. This enabled the player to hold a more complex conversation with agents, and to ask different questions or talk about several topics (see Figure 1).

The first agents did not consider the game state and they would always have the same dialogues. As more and more games were developed, special game events were considered, and flags were used to indicate that a particular event had happened. Using these flags, the agent would pick a dialog tree based on the flag that was set. The amount of dialog trees required was lineal. However, as story and situations became more complex, the system with flags and dialog trees also became obsolete.

The number of game events being considered was growing, and the stories were not as lineal as before, so several flags had to be set at the same time, and the characters had to have different dialogs for each one of these combinations.

The numbers of dialog trees were changed from lineal to exponential ($2^N$, where $N$ is the number of game events). The current state-of-the-art techniques involve creating a list of dialogues, and making the agent decide by itself what dialogues to speak and when to say them.

In order to do this, agents must understand what the player or other agent is trying to communicate, and must deliver a suitable dialogue.

Agents also must have different behaviors. A game which features an agent behaving unrealistically breaks the player's immersion. Having several agents all behaving the same way is also undesirable. Just as each person is different, players expect agents to be different too.

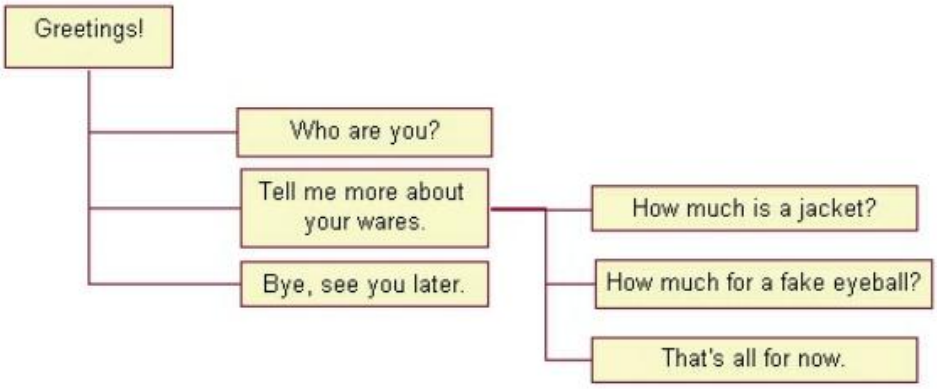


**Figure 1:** Dialog trees allowed developers to have more complex dialogues [1]

## 3: Theoretical basis

People share common behaviors, but they also have individual personalities that make them unique. A model that tries to create believable agents must allow creating this individuality amongst the characters, and to be able to behave as a person would. According to Evans (2011): [2]

> 'The first requirement on any computational model of personality is that a personality be composed of atomic units, which can be reused in a variety of different personalities.'

Having atomic units for personalities is necessary to be able to create new personalities cheaply. Adding a new personality would only require selecting a subset of atomic units. Without atomic units, the model would require each personality to be hardcoded manually, which could reduce the variety of personalities.

Behaviors and dialogues must not be linked to a particular agent – instead, each agent should decide what behavior or dialogue to use. It should be easy to incorporate new behaviors, dialogues or individual agents to the game. Since a game is usually a multidisciplinary task, it is fundamental for other specialists like writers or designers to modify the game as easily as possible. Thus they can focus on doing their job without requiring programmers or having to use programming code. Also, designers must be empowered; they should have artistic freedom, instead of just creating dialogs for situations predefined by programmers.

A 'stimulus' is defined as something that arouses or incites to activity. Each person reacts differently to the same stimulus, and the reaction of the individual is determined by his/her personality, emotion, history and mood. [3]

*Personality*

There are different personality models, and two of them are described: The OCEAN (Big Five) model; and, Reiss' Motivation Analysis model:

The 'Big Five' factors personality model

Raymond B. Cattell examined the English words to describe personality traits, and created 171 bipolar dimensions from a set of 18000 adjectives, before classifying them in 35 groups of related terms using clustering techniques. Cattell then reduced these groups down to 12 personality factors using Factor Analysis. [4]

Reanalyzes of Cattell correlation matrices have not confirmed the number of factors he proposed. Digman and Takemoto-Chock (1981) concluded that the original model was incorrect. Several researchers examined the 35 clusters. Tupes and Christal, after reanalyzing correlation matrices, found "five relatively strong and recurrent factors". These factors have been replicated in studies by other researchers. The 'Big Five' factors are shown in Table 1: [4,5]

**Table 1**: the Big Five groups all types of personalities into five groups [6]

| Factors | Low scorers | High scorers |
|---|---|---|
| **Extroversion** | Loner<br>Quiet<br>Passive<br>Reserved | Joiner<br>Talkative<br>Active<br>Affectionate |
| **Agreeableness** | Suspicious<br>Critical<br>Ruthless<br>Irritable | Trusting<br>Lenient<br>Soft-hearted<br>Good-natured |
| **Conscientiousness** | Negligent<br>Lazy<br>Disorganised<br>Late | Conscientious<br>Hard-working<br>Organised<br>Punctual |
| **Neuroticism** | Calm<br>Even-tempered<br>Comfortable<br>Unemotional | Worried<br>Temperamental<br>Self-conscious<br>Emotional |
| **Openness to experience** | Down-to-Earth<br>Uncreative<br>Conventional<br>Uncurious | Imaginative<br>Creative<br>Original<br>Curious |

Each of these factors consists of traits. For example, 'Openness' includes the traits 'creative' and 'curious', among others. A person's score in each factor is the average of how he/she matches the sub-traits. A personality test for each factor consists of a series of questions, which are used to measure if a person fits the sub-traits of that factor.

A high or low score doesn't indicate there is a score that is better than another; the score is just a measure of personality. People tend to have middle-ranking scores for most personality traits. The scores that are very low or high mark the traits that dominate our personality. The combination of all five factors defines the personality of each person. The stereotype 'geek' may possess a high score for Conscientiousness, and a low score for Extroversion.

Some critics have argued that the Big Five factors do not include some clusters of words. Paunonen and Jackson (2000) mentioned nine such clusters that – although they may not be orthogonal, and may contain words which in turn are related to some of the Big Five factors – can be important for

understanding human behavior. These nine clusters include some elements included in motivational analysis like 'manipulative' (Power), 'honesty' (Honor) and 'frugal' (Saving). [7]

Motivation Analysis

This personality approach was defined by Reiss (2001), who stated that most people are 'normal'. He agreed that there are some mental illnesses, but that a lot of eccentric behaviors such as being a 'workaholic' or a loner are not mild versions of mental illness, but instead are normal behaviors. [8]

To explain such personality traits, Reiss developed a theory about 16 basic desires that drive the human psyche. Everybody embraces all sixteen basic desires, but prioritizes them differently; this prioritizing determines our personality and actions. The 16 basic desires are shown in Figure 2:

| Striving | Values in case of weak strivings | Values in case of strong strivings |
|---|---|---|
| Acceptance | Self-confidence | Acceptance |
| Beauty | Plainness | Beauty |
| Curiosity | Application/Practical knowledge | Theory/Intellectual knowledge |
| Eating | Nutritional basics | Variety of food |
| Expediency | Principles/Honour | Expediency/Purpose |
| Family | Freedom from family/Laissez-faire | Closeness to children & siblings |
| Idealism | Realism/Justice for self | Altruism/Humanitarianism |
| Interdependence | Self-reliance | One-ness/Team orientation |
| Order | Flexibility/Improvisation | Methodology/Structure |
| Physical Exercise | Relaxation/Lackadaisical lifestyle | Physical Activity/Active Lifestyle |
| Power | Non-directiveness/Service | Influence/Control |
| Saving | Extravagance/Generosity/Spending | Collection/Frugality |
| Social Contact | Loneness/Reservedness/Introversion | Extroversion/Fun with others |
| Status | Informality/Egalitarity | Formality/Social rank |
| Tranquility | Bravery/Risk-taking | Cautiousness/Risk-avoidance |
| Vengeance | Harmony/cooperation/peace-making | Winning/Competition/Revenge |

**Figure 2:** The value each person has in each basic desire determines his personality and actions. [9]

The claim behind Motivation Analysis is that every person needs to fulfil each basic need. We can think of it in terms of progress bars: each basic need bar decreases over time; and, the speed at which it decreases is proportional to the strength of the desire.

The strength of our desires for each one of the basic 16 needs is what determines our actions and personality. A person will always try to fill all bars, giving priority to the lowest one.

*History*

A person usually responds differently to the same stimulus. The response is based on how often the stimulus is repeated. For example, when someone moves to a new town, the experience is exciting when everything feels new, but after a while, being in a new town feels less exciting and becomes routine.

Emotions can be intense when they are generated. However, the emotion will lose its intensity over time, and it may or may not affect a person's mood. It is fundamental for a game agent to be able to 'remember'. Even if an agent has neither true emotions nor a mood model, it should remain true to its

basic needs and its values. This history can be reflected in the way of new desires, or new rules, or maybe a traumatic event that will affect the personality of an agent.

*Emotion and Mood*

As with personality, there are different models for emotions. In the OCC Model there are 22 defined emotions: joy, distress, hope, fear, satisfaction, disappointment, relief, fears (which are confirmed), happiness (for someone), resentment, gloating, pity, pride, shame, admiration, reproach, love, hate, gratification, remorse, gratitude and anger. [10]

Ekman (1992) defined six emotions that can be expressed by the facial muscles (and 17 by counting the ones that can't be expressed). [11]

The first six include: anger, disgust, fear, happiness, sadness and surprise. The other 11 include: amusement, contempt, contentment, embarrassment, excitement, guilt, pride in achievement, relief, satisfaction, sensory pleasure and shame.

Velasquez (1997) also used six families of emotions as atomic units, while considering other emotions as composition of these six basic emotions. These include: anger, fear, distress/sadness, enjoyment/happiness, disgust and surprise. [12]

Emotions are similar to personality traits as they motivate our attitudes and actions. The main difference is that emotions are more volatile. The personality of an adult tends to be the same or very similar during the whole life of a person, whereas emotions change several times during the day. [13]

'Mood' is considered to be less volatile and less intense than emotions. Mood is placed somewhere in the middle between Personality and Emotions. Emotions are usually triggered and directed to an event or situation, while moods usually are not directed to a specific event. An event can make you feel angry or happy about it, but as the emotion dissipates it can become a mood, that is no longer directed to that event and is less intense. Velasquez's model differentiates between emotions and mood in terms of levels of arousal, being emotions the one with a higher level of arousal. [12]

## 4: Social Games

Berne (1975, 2010), after observing social activities, noted that individuals show different behaviors, voice, vocabulary and other aspects among social interactions. He classified these behaviors into ego states and wrote, 'An ego state may be described phenomenologically as a coherent system of feelings.' [14, 15]

Each person has a limited repertoire of ego states, and these can be classified in three categories: Child, Adult and Parent.

The Child ego state includes all behaviors that can be associated with children (spontaneous, stubborn, spoiled, etc.). The Adult ego state is an objective discussion of reality. The Parent ego state includes all parental behaviors (giving advice, protecting, etc.).

According to transactional analysis, the unit of social intercourse is a transaction: when a person talks to another person, this is called a transaction stimulus; and, the reply from the other person is called a transactional response. A transactional response is also a transaction stimulus for a new transaction, so these can be chained. Transactions can continue smoothly as long as the transactions are

complementary; this implies that the response is expected or socially healthy. Figure 3 shows two types of complementary transactions: Adult-Adult; and, Child-Parent transactions. Other complementary transactions include Child-Child, Adult-Child, Parent- Parent and Adult-Parent transactions.

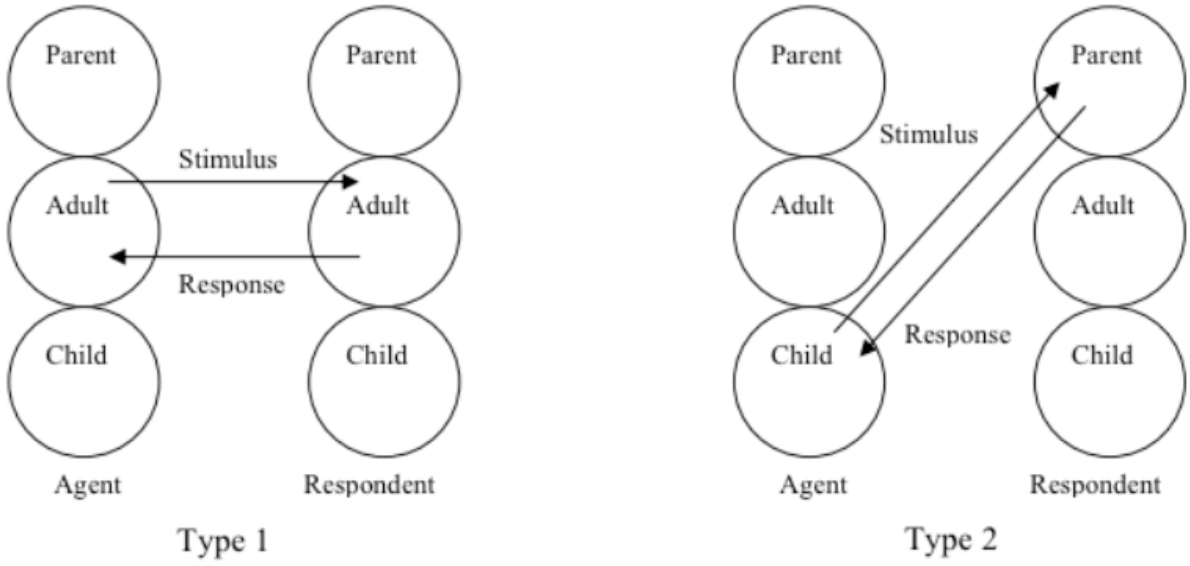


**Figure 3**: A complementary transaction is where the lines don't cross, so the conversation can flow.

A crossed transaction is one where the stimulus and response lines cross. The most commonly crossed transaction is the one with an Adult-Adult stimulus but a Child-Parent response. An example would be, "I think you have gained weight" (Adult-Adult), and a response such as, "You're always telling me I'm fat" (Child-Parent).

When a crossed transaction occurs, the current conversation cannot continue until the vectors are complementary, in the example mentioned before, the conversation can continue if the first person takes a parental role, so the transaction is switched to Parent-Child, or if the second person takes an Adult role and the transaction becomes Adult-Adult.

A more complex form of transactions are the ulterior transactions. In these transactions there are more than two ego states occurring simultaneously. Angular transactions involve three ego states. Duplex transactions involve four ego states.

The simplest transactions are procedures and rituals: procedures are a series of simple complementary transactions; and, a ritual is a stereotyped socially accepted set of simple complementary transactions. A surgical operation or driving a car is a procedure. Exchanging greetings are an example of rituals. Both of these transactions are predictable - once they start, the outcome can be predicted (unless something uncommon happens).

Pastimes are a series of simple complementary transactions around a single field of material, e.g. 'lady talk' (conversations about grocery, kitchen, wardrobe, etc.), the primary goal of which is to structure time.

Games are a series of complementary ulterior transactions progressing to a well-defined outcome. The main difference from pastimes is that in a game, there is an ulterior nature in the transactions, and there is a payoff. Pastimes and rituals have no conflicts, whereas games are more dishonest, since some of their transactions are just a play in the game directed toward a goal.

Berne (2010) described several social games, including the amount of participants, the role they play (Parent, Adult or Child), the goal of the game, the ulterior motive and the advantages. [14]

## 5: Case Study

There are different projects involving dynamic agents, we'll review the case of *Sims 3, Left 4 Dead* and *Prom Week*.

*Sims 3* (Electronic Arts, 2009)

*Sims 3* has a model of individual personality based on traits. Each Sim character can have up to 5 traits, which are drawn from a list of 80 traits. These traits are atomic; the combination of them can create particular behaviors, but since these traits are not orthogonal, there are traits that have incompatibilities, and these were authored by hand. In the game, the personality traits affect autonomous behavior in three main ways:

1. Each trait has a unique motive associated with it. For example, a Sims character who dislikes children becomes irritated in the presence of children.

2. When a Sims character interacts with objects, its traits affect the emotional state.

3. When a Sims character interacts with other Sims characters, traits affect its emotional state via 'if-then' rules. For example:

    a. "If my interlocutor makes a joke, then I find it amusing."
    b. "If my interlocutor makes a joke, but I have no sense of humor, find it boring."
    c. "If my interlocutor makes a joke, and I have no sense of humor, but we are good friends, then I pretend to be amused."

The trait-specific clauses override the more general ones, so each Sims character responds in a manner based on its personal traits. This system was used in *Sims 3*, and although the game A.I. received good reviews, it had some flaws:

- Adding a new personality was not easy. Each new Sims personality required creating a unique motive to it, and 'hard-coding' its interactions with objects and the effects of the objects on its emotional state. Also, incompatibilities with other traits had to be checked.

- A *Sims* character's actions were associated with the trait-motives that they sought to satisfy. Many so-called bugs were events where that premise was broken. If a Sims character started an action, but for some reason it could not satisfy the motive, then the Sim character would repeat the same actions, falsely believing that it could succeed.

Evans (2011) proposed an improved approach, using traits as conditionals that try to correct all the flaws on the design of *The Sims* AI. In this approach, a personality trait is represented by a

declarative conditional, specifying the condition under which the character has an emotional state. For example, disliking children can be represented as: [2]

> "If there are kids around me, I feel upset."
>
> "If I say something false, I feel ashamed."

The left side is always a state of the world, and the right side is always an emotional state.

Another change is to have a looser relation between actions and traits. In *Sims 3*, each action was directly tied to a trait; on this system, actions are tied to post conditions, and those are tied to the emotions. The traits are used to plan what action to perform, based on what would be the emotional state after performing the action. When an action is performed, the post condition it fulfils is added to the agent's database, and the traits update the emotional state based on them.

This conditional model allows game developers to easily create personality characteristics including the Big Five factors. For each one of the Big Five factors, the *Sims 3* game included a pair of conditionals: positive values, and negative values. With this approach, most of the issues of *Sims 3* were resolved. Adding personalities or actions is easier since they are not strongly tied. Adding an action or personality trait has no direct effect on emotions. This model is more flexible, and it is possible to add new personality traits at the time of execution; this can help with the creation of new traits following traumatic events. For example, after one Sim character fights another Sim character, it becomes frightened when it sees the same character.

The *Sims 3* program can detect incompatibilities on traits. If a post condition triggers two opposite emotions, then there is an incompatibility, and the programmers no longer need to manually check them. The advantages of this system are that it is easily expandable, and it is relatively easy to debug, since the characters only have five traits. However, the system is not very dynamic. For example, children's dislikes and preferences are a binary reaction, in that they are either happy or stressed, and do not express a wide range of responses.

*Left 4 Dead* (Valve, 2009)

*Left 4 Dead* is a frantic four-player game about surviving hordes of zombies. It is designed to be replayed, so the player will be in the same scenario many times. Therefore it is necessary to have a variety of dialogues so that the game does not become repetitive. Secondly, not all four players may be alive at certain times, so the dialogue system must handle the case where there is just a subset of players.

Contrary to *Sims 3*, this game doesn't focus on creating autonomous characters. Each player directly controls an avatar (and the 'bots' are controlled by a different AI system). The focus of the dialogue system is to allow the characters to have dialogues based on the current surroundings and game state without input from the player.

Having automatic dialogues makes it easier for international players: there is no need for moderated conversations; the gameplay feels smoother since players need not spend a long time writing messages; and this helps the feeling of immersion, as every character speaks a with its characteristic voice, and the 'bots' can communicate as if they were real human players.

One of the main requirements is that writers can have complete freedom on creating dialogues for all kind of situations. Instead of programmers creating specific triggers and making writers fill a form with

the texts for those triggers, the system allows writers to generate dialogues for all kind of situations; therefore making it simpler and easy to add new dialogues and situations.

The system uses a database of rules. Each rule consists of a list of criteria about the game state, and there is a response for each rule. A criterion is a function that returns `True` if a game state is true. For example, `True` could equal `total lives greater than three`. Figure 4 shows the general idea of the system. When it is time to say a line, the rule that betters matches is the one which is executed. A rule matches if all the criteria are true. If several rules match, the one that is chosen is the one with most criteria (the most specific one).

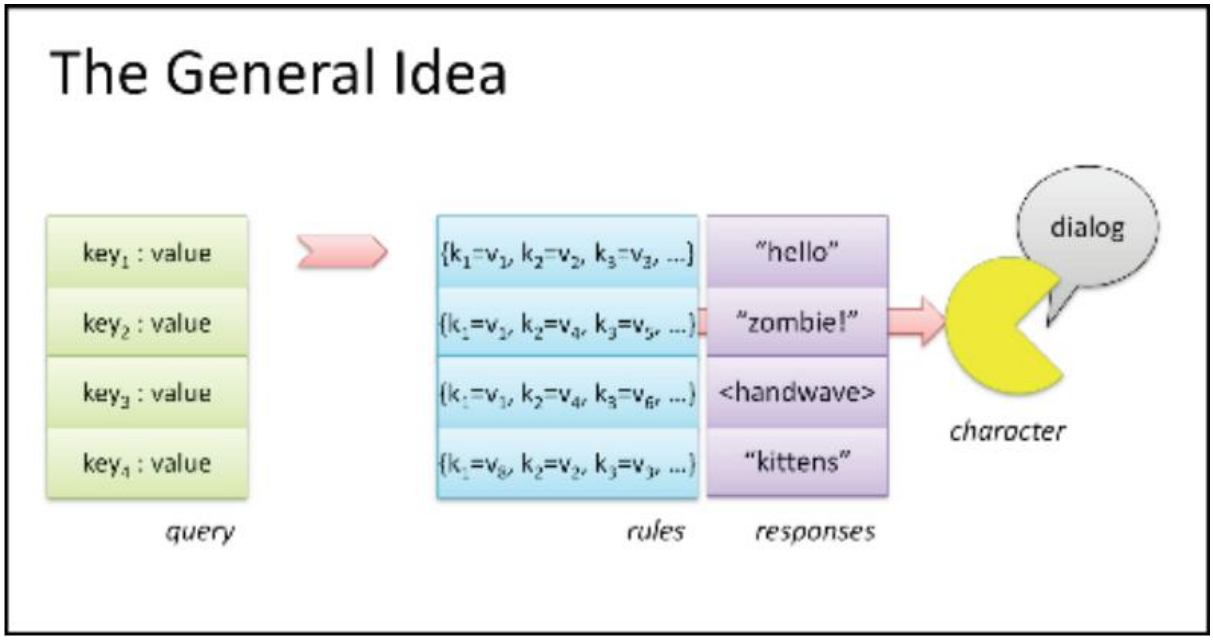


**Figure 4**: The queries are filled with the values of the roles, and a dialog is chosen based on the result of it. [16]

Programmers may not be the people who are going to create the rules, so it is important to have a simple way to add new ones. A criterion requires access to all game states, and a way to compare them (i.e. 'greater than', 'equal', 'lower than').

A 'fact' is a piece of world state, a `key:value` pair, such as `enemiesInLevel: 39`. The keys are stored on strings, and values can be numbers, strings or pointers. The game state is represented as a pile of facts stored in a dictionary. This system makes it easier for writers to know what variables are accessible, without having to search inside different classes. The dictionary encapsulates all the game states and makes them accessible all in the same place. Using sub-name spaces also helps to make it more readable. An example is shown in Figure 5:


**Figure 5**: The state of the game is stored in a dictionary which helps designers to access the information wanted. [16]

A query is a list of facts used to select a rule. A typical list may be hundreds of items long. Creating a query requires taking information from the function that calls it, such as: (i) the information specific to the character involved; (ii) the memory of that character (e.g. how many times it has been shot, number of zombies it has killed, etc.); and, (iii) the world state.

Dialogue can be expressed using rules. For example, if a player sees a zombie, the response is 'zombie'. If the player sees a zombie and has a powerful weapon, then the response is 'a zombie, but don't worry I can handle this'. As was used in the *Sims 3* system, a general rule may be overwritten by specific rules. In the *Sims* games, we can have a general rule, e.g.:

**If a Sim makes a joke → Laugh**

...and have a trait that precedes it, for example:

**If a Sim makes a joke but I don't like that Sim → Act bored**

In this system, that trait can be translated as two rules:

```
"Sim.Action = joke", response = "laugh"

"Sim.Action = joke" and "Player.dislikesSim = true",
response = "act bored"
```

If both conditions are true, the rule that has two criteria will be preferred over the rule with one criterion.

In the *Left 4 Dead* game, rules can also write facts to the character's memory. For example, it can write a timer to avoid repeating the same rule many times, or it can increase a variable's value to keep track of the number of times the rule has been applied. The response is the execution of an action once a rule has been selected. This could include playing a sound, or playing a random sound from a list; it can include code or calling a script. At this point, the system allows characters to speak when a rule matches. However, in order to have dialogs, it is necessary for two or more players to call out and reply to one other. This is accomplished by the response that can trigger other rules.

Responses can also dispatch a rule to all characters around the player. The character with the rule that better matches the player's petition is the one that will respond. This allows specific interactions to occur between characters. When a character finishes saying a line, it can dispatch a rule to another character or himself so it can continue speaking. A long speech is cut in little pieces, and can have one line triggering the next one. This can be used so a player can interrupt or argue with another character.

The reason for this mechanism is so that the rules are matched when they are dispatched. This allows for a change in dialogue if the situation changes. For example, if the players are speaking in a safe area and a zombie suddenly appears, then the safe dialogue rule will not match and the dialogue will be stopped automatically. This system has the advantage of making life easier for writers and designers to add new dialogues without requiring help from programmers. The rule and response system allows for a wider kind of logic, so writers can even implement dialogue trees.

*Prom Week* (UC Santa Cruz, 2012) [17]

The *Sims 3* game uses a personality model that allows agents to start a conversation or other activities autonomously based on traits. This system works well for that game, but the creators of *Prom Week* aimed to create more interesting social interactions. *Prom Week* uses Reiss' Basic Desires for its personality model; the whole process is shown in Figure 6:

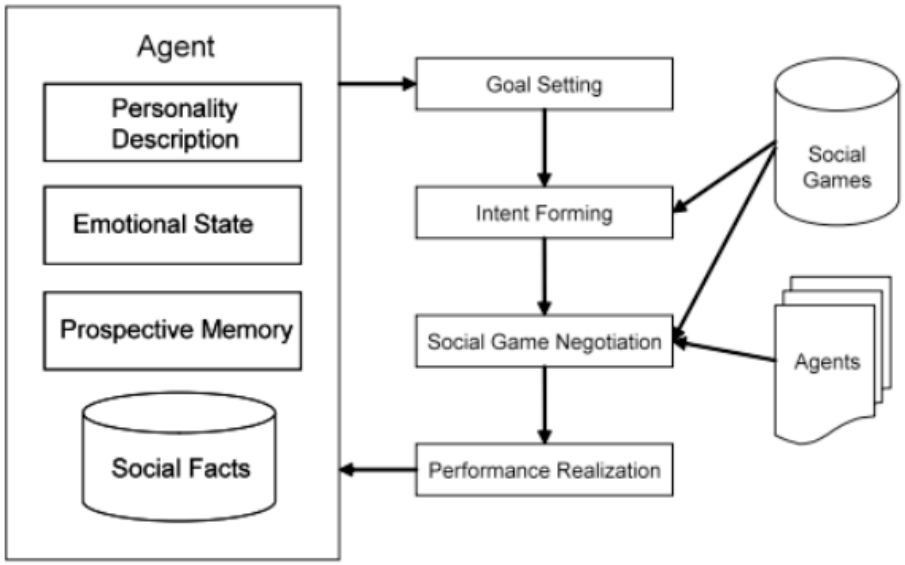


**Figure 6**: The architecture of the AI of Prom Week [17]

The personality description uses the 16 basic desires; three traits (which are based on the basic desires); a social game that they usually engage in; and, a goal for the scenario, which is used to give more support to designers.

The social state consists of the current social state, and a list of previous social states. **Social facts** (shown in Figure 6) are the basic units of social states, which can be a basic need fact, as in "George curiosity = 0.2" or social status facts like "George = friend of Harry". The current social state includes

an array of the basic needs of each agent, and a list of changes in social status over time. The list of past social states stores what games were played, who played them and the outcome of them (all of which are in chronological order). This is represented on the **Agent** block in Figure 6. The **Personality Description** has an array of the basic needs of each agent. The Emotional State has the current social status. The past social states are stored in the Social Facts database.

The basic needs and the goals are pondered and a goal is chosen (it can be to satisfy a basic need or the predefined goal). After this, the **Intent Forming** module chooses a social game that fits the previously chosen goal; it calculates all roles in all social games, weights them, and chooses one that is sent to the **Social Game Negotiation** module.

At the time of the **Social Game Negotiation**, the agent already has decided a social game and his role on it, so this module fills the open positions for the game; all agents participate in every role negotiation process. Each agent forms an intention for each open position. Then the system assigns a role to agents based on their intentions.

*Story Bricks* (Namaste Entertainment, 2012) [18]

Story Bricks is not a game, but an engine, designed to provide believable characters with memory, emotions, and emerging behaviors.

Contrary to other approaches (e.g. *Prom Week*, where each character has a list of personality traits, a list of behaviors, and a list of rules that connect the personality traits or needs to the behaviours), *Story Bricks* tries to eliminate the rules, so it has traits connected to behaviors, and it goes even further - it tries to use the same structure for both behaviors and traits, simplifying the process.

*StoryBricks* uses a multi-attribute utility system based on the Big Five personality model, and both behaviors and traits use the same attributes and scale, so they can be compared with each other (Figure 7). This multi-attribute utility system can also be used for objects or locations in the game, simplifying the process of deciding what behavior to use and in what location and object, since they all use the same system. Even though the process of choosing behaviors is simplified, it still requires a planner and negotiation to decide which behavior to choose and what characters will be involved.

## 6: Conclusions

The behavior of an agent in a game has progressed, from simple conditionals and scripted dialogues, to agents with personality and emotions. We mentioned the theory behind an agent's behavior, including two personality models and the social game theory of Berne, but there are many more psychological approaches and theories that can be used. [14,15]

Every one of the games presented has different goals and requirements for its agents, so they use different approaches. And believability needs differ from one game to another. In *Left 4 Dead*, there is neither the need nor the time to try to have deep interactions among characters.

The aim of the creators of *Left 4 Dead* was to easily convey the world state among the game players. Their system can be expanded to include all kind of behaviours, and helps to immerse players (e.g. by conveying information about gun supplies or the world state). There are other modules which may be used to be able to make characters move and act as if they were other human players. However, this paper mainly focused on the speech and behavior models.

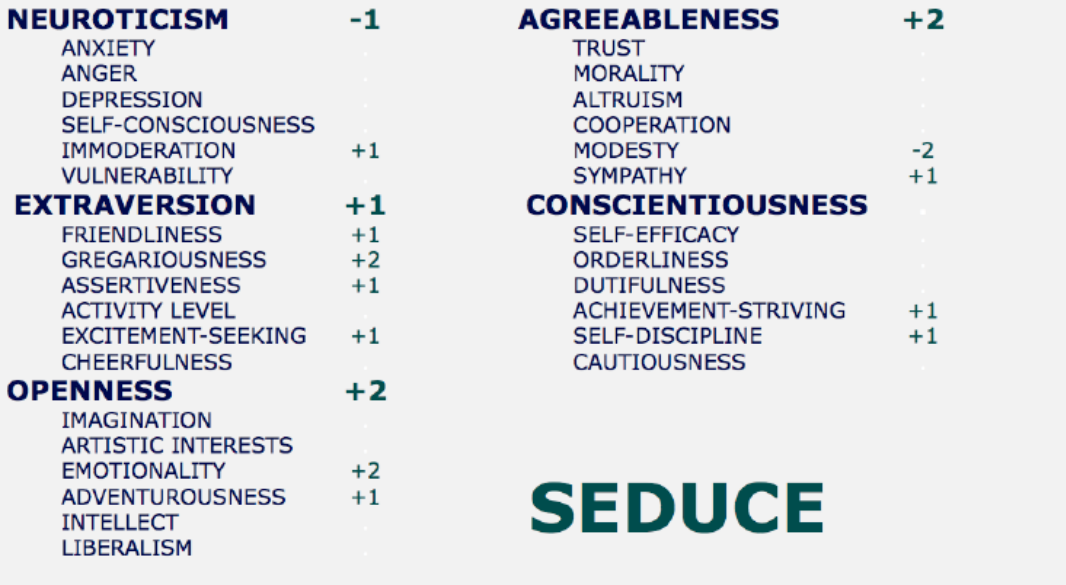


**Figure 7**: The structure used by *StoryBricks* to store the attributes of behaviors, locations, items and personalities. [18]

The goal behind *Sims 3* was to have autonomous characters in the Sims World which can engage in social activities, whilst the players can see their outcomes. Its designers included many routine activities such as going to bed, shopping, cooking, etc. without focusing on any particular kind of activities. Although the *Sims 3* system does not follow a specific personality model, the OCEAN 5 model is visible.

The goal behind *Prom Week* was to have rich social interactions where each and every action has repercussions. Although the agents have personalities and desires, they can only engage in social interactions. In that sense they are not as autonomous as the *Sims 3* characters, but their social interactions (social games) are richer and focused on teenage behaviors.

The computational cost of some A.I. engines can be prohibitive, especially for games that already use a lot of resources for other areas. Another cost associated is time; *Prom Week* employed more than 5000 rules, and the time needed to test and tweak such a system can be prohibitive.

Even though believability is a desired feature in games, there are degrees of believability, and each game may, or may not, need to have believable behaviors in order to make the game more fluid or fun. Future game developers may wish to reduce the numbers of dialogs and rules required for agents (e.g. in *StoryBricks*). Developers may also be more flexible, and may create code which allows the behaviors to be overwritten for certain moments (e.g. for cut scenes or for forcing certain interactions); or may disable certain features to make the game more fluid.

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