Reactive NPCs for Role-playing Games

GDEV60001 GAMES DEVELOPMENT PROJECT

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Contents

Abstract

The research investigates how making non-playable characters in role-playing games more reactive to the players' actions and abilities makes them feel more realistic and how this would improve player Immersion. Traditionally, static NPCs have served as background elements or quest-givers, but they often give repetitive dialogue and reactions, breaking the immersion of the player and a lack of consequences for their actions within the game. This study explores psychological theories such as Flow Theory (Csikszentmihalyi, 1990) and Social Presence Theory (Short, Williams, and Christie, 1976) to get a better understanding of player immersion. Different techniques and methods that are used to make NPCs more dynamic and believable in current video games are also investigated in order to determine what approach would be ideal for making more reactive and dynamic NPCs.

This study combines theoretical research with practical implementation of an artefact that compares two contrasting decision-making approaches: a Finite State Machine (FSM) and a Utility AI model. Both systems operate under identical environmental conditions and access the same player-character variables, including morality, recognition, charisma, strength, and dexterity. NPCs were designed to exhibit five distinct social reactions—excitable, friendly, indifferent, hostile, and terrified based on their evaluation of player attributes.

1. Introduction

Player immersion is a core principle in video games as it contributes heavily to player enjoyment (Jennett et al., 2008; Ermi & Mäyrä, 2005), shaping how players emotionally engage with a virtual world. Jenett, et al. (2008) mention that immersion is linked to a player's sense of presence within the task environment, where focused attention and reduced awareness of the real world enhance the gaming experience. This view is supported by Domingues, Filipe, Carita, and Carvalho (2024), who explore immersion within the RPG genre, arguing that it provides players with the opportunity to embody a character and actively engage with the narrative.

Non-Player Characters refer to characters in games that aren't controlled by the player and often are a detrimental factor in improving immersion for the player, especially when it comes to narrative and gameplay (Kounadi, Theodoropoulos, & Lepouras, 2025). Static NPCs help make a game feel livelier by making it less empty, creating the illusion of a community and social network (Magnus, 2013). However, static NPCs – NPCs that repeat dialogue, that don't react to important events within the game, nor 'remember' the player, take away from the immersion (Rennick & Roberts, 2021) as it breaks that illusion. In 'The Elder Scrolls V: Skyrim' (Bethesda Game Studios, 2011), the NPCs repeat dialogue and don't seem to react to changes in the player, breaking the immersion by making the player feel as if their actions have little to no consequences, which can then cause the player to become less interested in exploring NPC dialogue or even care less about the choices they make in the game (Scriven, 2022).

Traditionally, finite state machines have always been a go-to technique when it came to developing NPCs (Jagdale, 2021) and was used in games as old as Pacman (Namco, 1980), where the NPCs in the game (the ghosts) each had their own finite state machine that determined how they behaved (Manikanta, Shaik, Kancharla, Gurram, & Ramasamy, 2025). Over time, more techniques were introduced, such as behaviour trees (BT), Goal Oriented Action Planning (GOAP), Utility AI, and Hierarchical Finite State Machines (HFSM), which is an extension of FSM to allow more complex logic (Biggar, Zamani, & Shames, 2021). Each decision-making model has their own strengths and weaknesses, each of them best used for different purposes and can even be combined with other techniques to improve them.

Games in recent years have started to make NPCs more dynamic, meaning their behaviour can adapt to the players' actions, can "remember" past interactions, and they have contextual awareness. An example of this is shown in the game 'Baldur's Gate 3' (Larian Studios, 2023), where throughout the game, the NPCs remember and act differently based on the player's choices. Some NPCs follow a different path entirely based on the character's actions and choices, either becoming 'evil' or 'good'. In Act 1 of the game, the player has the option to save or slaughter a community, and depending on the player's choice, the people of the community give discounts and thank the player, whereas the other option causes NPCs to whisper about the 'slaughter'. This level of reactiveness makes the story significantly more engaging as it makes the player really feel the consequences and want to explore other outcomes.

The problem with games is the fact that most games lack reactive NPCs, making the world feel static. Making NPCs more reactive and believable builds a dynamic and believable environment, creating a more immersive experience for players. Without meaningful, persistent reactions, players can't build a connection or feel that their actions have real consequences, which ultimately diminishes immersion and the overall gaming experience. A more immersive experience increases the replayability and longevity, improving the value of a game, and investigating how this can be done and exploring the different methods would improve the game industry, as it could reduce workload in future games by reducing the number of interactions that are scripted.

2. Aims and Objectives

Many NPC systems fail to meaningfully react to player personality, traits, or behavioural identity, reducing the immersion and believability. The main aim of this study is to investigate and understand what makes an NPC believable, reactive, and how this is implemented in games. The study seeks to explore why believable NPCs improve immersion, strengthen narrative impact, and create more believable game worlds. Upon base research, it was discovered that the logic of non-playable characters (NPCs) or artificial intelligence (AI) in games is created using different decision-making models. This highlights the following research question of the paper:

- (RQ1) What does current research in the gaming industry say about what makes NPC s believable and the importance of reactivity when it comes to achieving this? Based on this research, how can decision-making models be used to enhance NPC reactivity to player personality in games?
- (RQ2) What decision-making models are currently used to create AI and what are the use cases for each model? What are the strengths and weaknesses of each model and what model would be best used to create reactive NPCs?
- (RQ3) How can existing decision-making models be adapted or combined to implement NPCs that meaningfully react to player personality and exhibit more believable behaviour?

The way these will be achieved is by researching and using the research to put together an in-depth literature review that covers existing knowledge on the subject area on player immersion, NPC believability, and decision-making models. An artefact will be created to further display how a reactive NPC system can be implemented, using the best suited decision-making model based on research. To further explain why this approach was used, it will be compared to another decision-making model which will be implemented in the same framework.

3. Literature Review

3.1 Why Reactive NPCs would improve Player Immersion

What is Player Immersion?

Immersion is a core principle of game experience (Haryanto, et al., 2023) and is what helps a player feel engaged and affects their enjoyment of the overall gaming experience. The ability to immerse oneself in a game world allows players to engage with the story on a personal level, feeling as if they are the character themselves and allowing them a distraction from reality (Jennett, et al., 2008). Jennett also suggests that there are three main features of immersion: a lack of awareness of time, loss of awareness of the real world, and an involvement and sense of being in the task environment. There are many psychological theories that back up this logic as well as imply their own takes on how a game can be more immersive. The three main theories that can be applied to player immersion are: Flow Theory, Social Presence Theory, and Self-Determination Theory.

Flow Theory

'Flow' refers to a state of mind where one is "in the zone" or "in flow" and is considered the optimal experience that leads to happiness and fulfilment (Csikszentmihalyi, 1990). This is when one is: fully focused, losing track of time, challenged the perfect amount, performing at one's best, and self-motivated (Perttula, Kiili, Lindstedt, & Tuomi, 2017). Csikszentmihalyi, the developer of flow theory, suggests that there are eight major components when it comes to enjoyment:

1. Clear goals
2. Immediate feedback
3. Balance of challenge and skill
4. Deep concentration
5. Sense of control
6. Merging of action and awareness (loss of consciousness)
7. Time distortion
8. Autotelic experience (rewarding experience done for its own sake)

There are many ways a game tries to implement these principles to allow the player to enter a state of flow, but there are two principles that can be applied to NPCs to help the player achieve a state of flow. The first principle is immediate feedback. This is when the player can know instantly whether they're making good progress toward their goal or not, allowing them to adjust their playstyle if needed (Schaffer & Fang, 2015). When the player has no idea how they are progressing, it can make them feel uncertain in their actions, make them go down the wrong route, and regret it once it is too late, consequently ruining immersion. Having immediate feedback allows the player to go back on their desired course before they waste too much time doing the 'wrong' thing, preventing their immersion from being ruined.

Reactive NPCs can also give that kind of immediate feedback to the player to showcase the consequences of the player's actions, rewarding good ones and punishing bad ones. In Baldur's Gate 3 (Larian Studios, 2023), the player can recruit NPCs as their companions, but depending on the player’s actions and choices, the companions can end up disliking the player, resulting in them choosing to leave, or may even fight the player for certain actions. Due to these consequences and feedback from the NPCs, the player may rethink their choices and think deeply about how they want to play the game. If they really liked an NPC that had a bad moral alignment and wanted to recruit them, the player may choose to do more morally bad actions to impress that NPC.

This then links to the next principle how NPCs can help players reach a state of flow, which is ‘merging of action and awareness’, which is when the player is completely absorbed in the game world or with playing the game to the point where the actions they take is done automatically without them having to think too much about it (Nah & Eschenbrenner, 2014). As the player continues playing the game, they would end up building their own character's morals, personality, and identity, one they can insert themselves into, making the choices they make in the game come as second nature since they already know what their character would do. If their character had been making morally good choices throughout the entire game, they wouldn’t randomly switch to doing something bad unless it benefited their character. Getting rid of the need to think about their actions makes their choices feel natural and fluid, making it feel like they are in the game world themself. With NPCs that can react to the player's actions and changes, the player’s actions become more meaningful and make it so that the NPCs feel real and further add to their immersion.

Social Presence Theory

Social presence theory (Short, Williams, & Christie, 1976) was originally a theory that explains how different communication in media vary in their ability to convey the presence of another person in an interaction. There are many interpretations of what ‘social presence’ means, but the most common appears to be feeling as if you are interacting with another social being (Krejins, Xu, & Weidlich, 2022, and Bickle, Hirudayaraj, & Doyle, 2019). Although the theory was initially used for telecommunications, it can be applied to games, as it provides another medium for how people can interact and connect with others (Kort, Ijsselsteijn, & Poels, 2007). However, it can also enhance the realism of environments and NPCs through key principles of the theory, such as awareness of others, intimacy, and immediacy (Cummings & Wertz, 2023).

Awareness of others refers to how real or present the other person feels in the interaction. This is usually measured by how attentive or responsive they come across, either by their replies, eye contact, or reaction. When NPCs react to the player’s actions, presence, or environment, it makes it feel like they are alive and real; the world feels as if it's lived in. The way this improves immersion is that the players feel less alone in the virtual world as a sense of community is created, and more like they are in a socially responsive environment.

Social presence theory defines intimacy as the perception of connectedness and emotional warmth in communication. In certain games, NPCs can react emotionally to the player's actions or choices, like reacting negatively if a player is caught stealing, or reacting positively when the player helps the NPC. Displaying emotions and remembering past interactions with the player makes them feel real and makes it easier for the player to emotionally connect to them. When the player accomplishes an objective, if the player has emotionally connected to an NPC, that NPC may congratulate them and celebrate the player's accomplishment, making them feel closer. This affects the immersion as the player starts to care about NPCs’ outcomes or personalities, making the world feel socially rich.

Immediacy is like immediate feedback in flow theory. It’s timely, direct feedback that shows that the other person is paying attention. This can be done by smiling, nodding, laughing at jokes, and showing how engaged they are. As for games, this is done when the NPC reacts to the player's presence immediately, either greeting you if they know the player or reacting with fear or hostility if they dislike the player. This makes interactions feel more personal and meaningful, creating a stronger sense of social presence, improving the aliveness of the NPCs, and overall keeping the player engaged.

In conclusion, higher social presence improves emotional connection, trust, engagement, satisfaction in communication, and sense of community. Reactive NPCs enhance immersion by simulating real social presence by responding to the player, showcasing emotions and personality, and engaging in reciprocal interactions, giving players the feeling that they're interacting with sentient agents rather than scripted bots.

Self-Determination Theory

The core idea behind self-determination theory is that people are most motivated, productive, and psychologically healthy when three basic psychological needs are met (Deci & Ryan, 2000). The three fundamental needs are autonomy – a sense of control over one's actions, competence – the ability to develop and apply skills effectively, and relatedness – a meaningful connection with others (Cherry, 2025). Self-determination theory views motivation on a continuum from least to most self-determined and fundamentally consists of three main ranges: amotivation, extrinsic motivation, and intrinsic motivation (Ackerman, 2018). The reason this links to player immersion is that the more motivated a player is, the more immersed they will become with the game. When the player loses motivation to play the game, their immersion is impacted as the player begins to feel burnt out, making it difficult for them to focus on the game.

The diagram below (Ackerman, 2018) displays the three types of motivation described in self-determination theory and what causes/regulates that motivation, illustrating it on a continuum of how self-determined the motivation type is. Amotivation is the state where one lacks interest and has no desire to engage in activities. This is when the action lacks the three basic needs (value, skill, and relatedness), so one would not see the point of carrying out or engaging with that task. Extrinsic motivation is more versatile and can lean more towards nonself-determined motivation and self-determined motivation. This type of motivation is governed by external factors that may have a link to one's individual interest. An example of this are actions that are done out of compliance or to gain reward or avoid punishment from an external source, i.e. family. Near the other end for extrinsic motivation are actions that are completed because it benefits the person internally, often helping the person understand themselves better. The last type of motivation is intrinsic motivation, which is when one is motivated out of pure enjoyment and interest. They are not doing the task for any other reason aside from because they find it fun and satisfying.

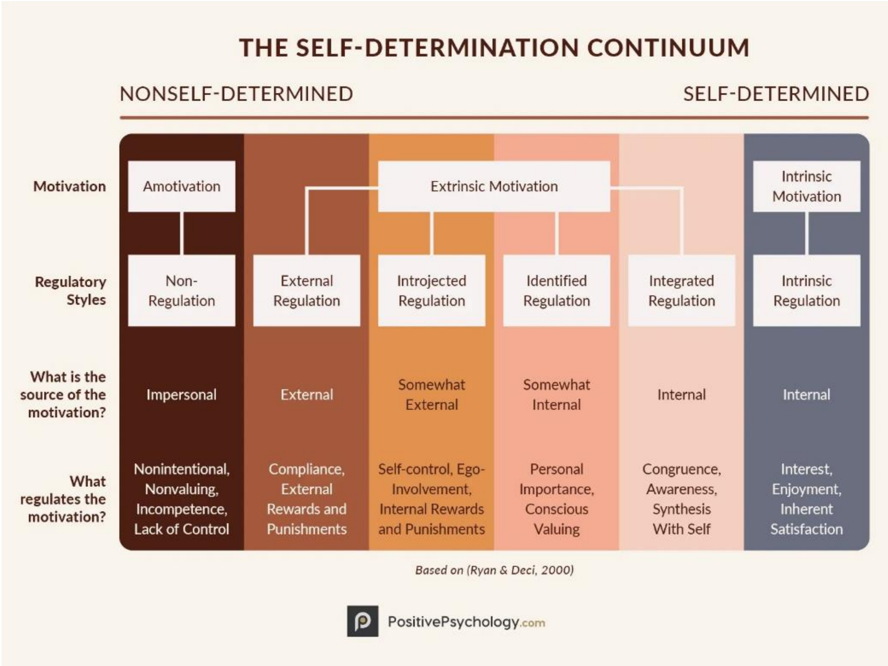

Figure 1 The Self-Determination Continuum diagram from Positive Psychology.

Autonomy is the feeling that the actions you take are self-chosen and aligned with your values (Ryan, Deci, Vanteenkiste, & Soenens, 2021). When your actions feel self-chosen, you act because you want to, not because you need to, hence improving motivation. In games, this is done when the player makes choices that feel meaningful to them, either in dialogue, choosing which route to take, and how they play the game (exploration, killing, improving NPC relationships, farming levels). Being able to make these choices is what makes a player feel in control of the character and allows a strong identification with the playable character. Dynamic NPCs can help reinforce autonomy by making the players feel consequential, e.g. an NPC refusing to help the player because the player betrayed them. The player would be exhibiting autonomic engagement, where the quests become compelling not because of the rewards but because they align with the player’s interests, and they gain satisfaction from it.

Competence refers to one of flow theory's major components – balance of challenge and skill. In self-determination theory, it describes how capable a person is at performing a specific task (Lopez-Garrido, 2023), and indicates that successfully completing a task or improving a skill encourages them to continue improving or engaging in more tasks. Some games have an adaptable difficulty that adjusts to how much the player is struggling or excelling, or NPCs themselves adapt to the player’s playstyle (allies focusing on healing if the player is reckless, or enemies keeping their distance more if the player uses close combat weapons). Doing this ensures that the player is motivated and kept in a state of flow as they feel the right amount of challenge and reduces the risk of them becoming bored or frustrated with the game.

Relatedness in self-determination theory refers to the feeling of being accepted and valued, as well as having meaningful relationships (Wang, Liu, Kee, & Chian, 2019). The theory suggests that when someone feels as if they belong or are cared for in a setting, the motivation becomes more inherent and self-driven (Capon-Sieber, Köhler, Christ, Helbing, & Praetorius, 2022) – doing it because they want to and not because they must. This is created in games like massively multiplayer online role-playing games by creating guilds or a community, or even completing quests together in a party, progressing the story because of the motivation provided by being in a group where you feel your role is valued. So, how would you recreate the feeling of relatedness within a single-player game? This is where reactive NPCs can simulate that feeling of relatedness. Making choices that affect your relationship with the NPCs would create that feeling of being valued and create a sense of belonging. For example, a hero and their efforts would be acknowledged by NPCs, resulting in them reacting positively, which causes the player to feel wanted in the game environment (Neufeld, 2025).

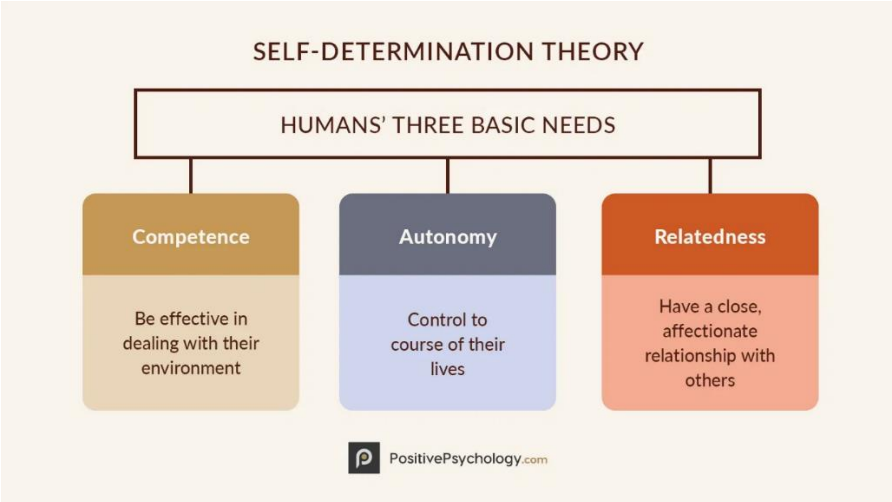

Figure 2 Self-Determination Theory diagram from positive psychology.

3.2 NPCs in games and believability

What are NPCs?

Non-player characters (NPCs) are characters that players cannot control in a game. They have been considered as the backbone of many video games (Kumbharkar, 2025) and provide to the game in various different ways, such as adding to the narrative and story, supporting the player, offering rewards, or simply just adding life to the world. Overtime, NPCs have become more advanced from simple characters that provide information such as *The Legend of Zelda: Ocarina of Time* (Nintendo, 1998) and *The Legend of Zelda: The Wind Waker* (Nintendo, 2002), to characters that can have multiple dialogue options and remember player actions like The Elders Scroll V: Skyrim (Bethesda Game Studios, 2011), The Witcher 3: Wild Hunt (CD Projekt Red, 2015) and *Read Dead Redemption 2* (Rockstar Games, 2018), to characters that can make their own decisions in games and impact the whole narrative like *Baldur's Gate 3* (Larian Studios, 2023). Newer role-playing games tend to have very advanced and dynamic NPCs, but there are still the exceptions that do not have reactive NPCs such as *Cyberpunk 2077* (CD Projekt Red , 2020). Although the game did well, upon release there were a lot of complaints regarding the game, one of them being that the NPCs felt unrealistic as they didn't react accordingly – e.g. not reacting to the player when the player takes out a gun, NPCs lacked the ability to interact dynamically with the player only offering one-line responses. These features were added in later patches in the game, but it highlights how important the believability of dynamic NPCs is to players.

Static vs Dynamic NPCs

Static NPCs refer to NPCs that are scripted (Mimic Minds, 2026). This means their actions are hard-coded and cannot react to the world or player. For example, if an NPCs script is to greet the player when interacted, they will without fail greet the player even if the player has stolen from them or offended them. On the other hand, when an NPC is dynamic, it means that they can change or progress. Examples of this are reacting to the player or actions in the game world, and make decisions based on those, like running away from the player if the player draws a weapon. This also creates the illusion of memory, e.g. an NPC might ‘remember’ a crime the player committed and may refuse to speak to the player or even avoid the player because of that. By creating this illusion, it makes the NPC come across as more realistic, or believable, as a human person would be hesitant or would flat out refuse to talk to someone who has upset them or they deem as suspicious. Figure 3 (Dill, 2013) illustrates a scale of different AI archetypes, left being least reactive but more control and right being more reactive but less control.

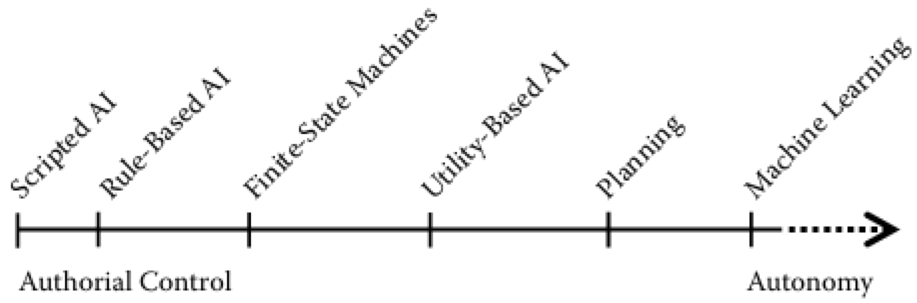

Figure 3 AI architectures and their level of autonomy from Game AI Pro 3, chapter 1 (Kevin Dill)

Both static and dynamic NPCs have their own advantages and disadvantages (Dill, 2013). Scripted AI and rule-based AI would be considered as static NPCs since they don’t adapt and strictly follow what they are programmed to do. An advantage of static NPCs is that the outcomes are consistent and reliable, making it less likely to break (Merseburg & Svenning, 2025). This means that NPCs would not do anything that is unpredictable, sticking to the rules and narrative, consequently guaranteeing the narrative of the game plays out how it should. With full control of the NPCs, the designers have full control over the pacing of the game narrative as well, making it easier to keep the player immersed by preventing them from getting distracted. However, this also means the players might find the NPC predictable, making it so that they get bored of the dialogue or feel as if the dialogue is meaningless. The player may skip the text or not bother exploring other NPCs as they all feel the same or are predictable. Additionally, static NPC actions can come across as unrealistic, breaking the immersion of the player as the interactions feel meaningless. In a case study, players were tested for their bonding with an NPC, half of players being tested against an AI-driven NPC that adapted their behaviour dynamically, while the other half were given a static NPC that could only give hard-coded and scripted responses (Singh, Banerjee, & Pandey, 2025). The outcome of the test results confirmed that players tended to skip over the static NPCs text since it began repeating but explored the AI-driven one. They also found that more players found the game ending was unique with the AI-drive NPC than the static.

On the scale, utility-based AI is considered more reactive than finite state machines and behaviour tree’s but are still somewhat dynamic since they calculate a score and can make their own choices to react to something based on a score, meaning they are still making a decision, but the decision is based on information provided. The advantages and disadvantages of dynamic NPCs are the opposite of static NPCs. Dynamic NPCs can create realistic, lifelike behaviours since they tend to be capable of having more reactivity (Mimic Minds, 2026). This could be a good, and bad thing. Having more reactivity means that there is more replayability since the NPCs are unpredictable therefore creating more unique interactions since a player’s playstyle can differentiate and cause different reactions from the same NPC. The problem with this is that because they are unpredictable, debugging is significantly harder and there can be inconsistencies in the NPCs personality or ‘memory’. An NPC that suddenly starts acting out of character would break the immersion and take away from the believability instead of adding to it. Furthermore, this unpredictability could also cause major bugs where the player gets ‘soft-locked’ out of the game. This means that the player is unable to progress in the story of the game, since something unpredictable can happen to an important story NPC, such as being killed or upsetting the NPC so that they refuse to talk to you. Furthermore, making every NPC in a game dynamic can be quite expensive since they require more advanced logic than a static NPC, which could ruin the overall performance of the game.

Nowadays, most games use both dynamic and static NPCs or make even make a dynamic NPC that is still restricted by certain rules in order to keep consistency. Both have their own strong points and their own areas where they thrive in. For example, in first-person shooter games, you would want more dynamic NPCs, so they are not losing the game for you nor making the game unfun for the opposing team by being too good at the game. Whereas static NPCs would be better for characters where stability is important, such as main story NPCs where their purpose is to deliver lore and history to the player, or shopkeepers so the play can sell or buy loot. In an RPG, both can be useful as dynamic NPCs in the environment would help make the game more believable, while static NPCs would guarantee stability and maintain the main story.

Believability in NPCs

When talking about believability in game theory, it often refers to how ‘realistic’ the action the AI takes comes across. This could be from making a chess piece move, to how they react to the world environment. When humans make choices, they either act on rationality or on emotion (Vlaev, 2018), but since computers do not have emotion, they can only act on ‘rationality’ or what they are programmed to do. If an AI were to always choose the optimal decision, it could make the game unfun by making the AI impossible to beat consequently taking away from the players immersion by frustrating them instead thus resulting in lowered motivation based on flow theory (Csikszentmihalyi, 1990). An example of this can be AI in first-person shooter (FPS) games. If the AI had perfect reaction time, perfect aim, and perfect pathfinding, the player would struggle significantly when playing against the AI, dying instantly, hence causing frustration. This also applies if the AI is on the same team as the player, as the AI would always outperform the player, take kills, and essentially not let the player play the game (Liu, 2024). Furthermore, most humans would not have perfect aim, perfect reaction, or perfect pathfinding, so allowing the AI to fail and make imperfect decisions is what makes them more human-like and believable. Examples of imperfect decisions is randomising reaction times to make it appear as they reacted slower in certain scenario’s (Barriales, 2021).

To make a background character believable, there are several factors that must be considered. In Warpefelt’s view on NPC believability, NPCs do not need to be incredibly realistic but just need to meet the players expectations consistently and contextually (Warpefelt, 2016). As mentioned earlier, a dynamic NPC is one that can react realistically and even adapt, meaning reacting to the player and environment. For an NPC to adapt their behaviour, there are information they need to remember and recall so that they can base their behaviour off that information. If an NPC caught you stealing, they would react negatively to you in that moment. However, if they are unable to remember that incident, they would greet you normally moments after. This would make their behaviour unbelievable since someone would usually form a negative opinion of you after the incident, so ‘memory’ is needed in order to make an NPC react accordingly and hold opinions. Not only does memory allow the NPC to react, but the ability to recall that information makes them feel alive. It also makes the NPC feel more aware.

Another factor that can be considered is emotions (Lankoski & Björk, 2007). One paper suggests that emotion and personality strongly enhance believability as it is the reason for why NPC behaviour differentiates from one another (Silva & Ribeiro, 2021). When an NPC displays emotion, it makes them feel alive and relatable. By exhibiting emotions, NPCs not only appear more lifelike but also influence how players perceive and interact with them, creating a deeper sense of immersion and engagement within the game environment. It creates a sense of self. In one study (Ou, 2025), a test was conducted where players would interact with an AI-powered NPC which would give human-like reaction based on personality archetypes (warrior, healer, merchant) or traditional NPCs. The results of the experiment showed higher engagement and immersion with the AI-powered NPCs because they were able to connect with the player on an emotional level. It made the gaming experience feel more unique and rewarding as the NPCs felt alive, making the players choice feel impactful. There are many personality models based on psychology that can be used to design NPCs and characters in general from, such as *the Five Factor Model* (Costa & McCrea, 1992) and the Myers-Briggs Type Indicator (Myers, McCaulley, Quenk, & Hammer, 1998 and Simkus, 2025). Both models have traits that are measured, and both share two of those traits (extraversion and neuroticism), suggesting that these two traits stand out the most when it comes to personality.

The Five-Factor Model of Personality		
Factor	**Low Score Description**	**High Score Description**
Neuroticism	Calm, Even-tempered, Self-satisfied, Comfortable, Unemotional, Hardy	Worrying, Temperamental, Self-pitying, Self-conscious, Emotional, Vulnerable
Extraversion	Reserved, Loner, Quiet, Passive, Sober, Unfeeling	Affectionate, Joiner, Talkative, Active, Fun-loving, Passionate
Openness to Experience	Down-to-earth, Uncreative, Conventional, Prefer routine, Uncurious, Conservative	Imaginative, Creative, Original, Prefer variety, Curious, Liberal
Agreeableness	Ruthless, Suspicious, Stingy, Antagonistic, Critical, Irritable	Softhearted, Trusting, Generous, Acquiescent, Lenient, Good-natured
Conscientiousness	Negligent, Lazy, Disorganized, Late, Aimless, Quitting	Conscientious, Hardworking, Well-organized, Punctual, Ambitious, Persevering
Taken from McCrae and Costa (2003)		

Figure 4: FFM by Costa and McCrae found here

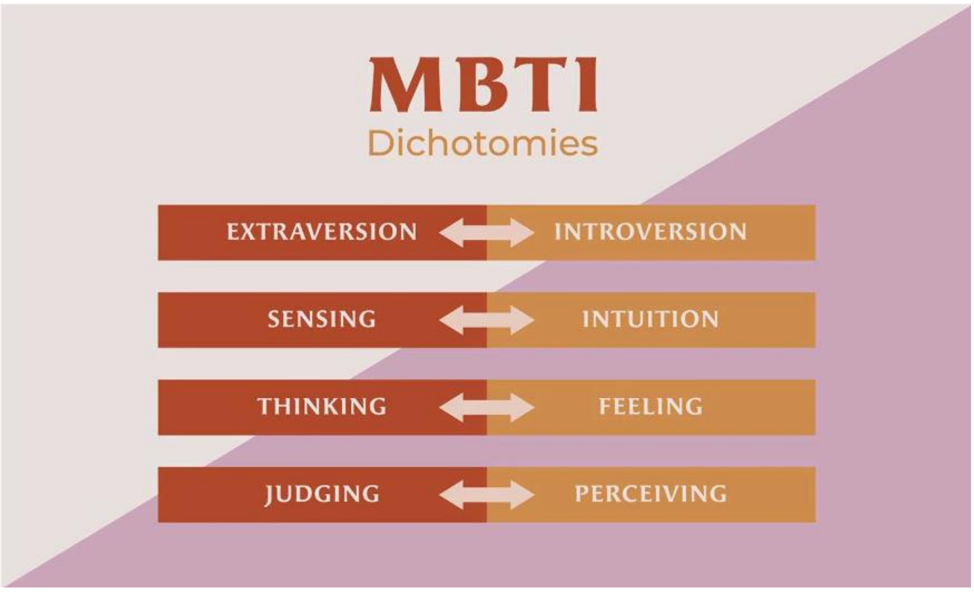

Figure 5: MBTI traits from Simply Psychology

Believability can also be achieved by giving a NPC a routine and schedule, making them to appear as if they have a life in the game environment. Graham (2013) covers different techniques used to breathe life into background characters and make them appear less static. Even NPCs that are stationary can be made to look as if they have a life in the game world by giving them a task, e.g. an idle animation where they are interacting with the world making the world feel less stale. Another technique used for simplistic behaviours is randomly selecting points for the NPC to walk to, though in terms of believability, it is not realistic. Even so, it creates the illusion that the NPC is at least doing something. These simple techniques are often used in games for background characters instead of creating an in-depth routine since it is less expensive on the memory. If a game has a large number of NPCs, each with an individual routine, it can be quite intensive on the overall performance, and that memory could be used on more important features of the game. Despite this, if the games main mechanic and features revolve around the NPCs, it would be detrimental to make them believable and richer. In the game *Dwarf Fortress* (Bay 12 Games, 2006), there is a gossip system that revolves around interactions and rumours between NPCs, making it appear as if knowledge is being spread and shared from NPC to NPC.

In Game AI Pro 3, Ryan and Mateas present an architecture they created influenced by the gossip system and were creating a game that revolves around the gossip system itself. The main concept of the game is that one player would act as detective trying to discover who the lover of a deceased NPC, suspecting that they murdered the NPC for the inheritance (Ryan & Mateas, 2017). Another player would act as the lover character, and their goal is to remain undetected, blending in with the other NPCs and spreading misinformation. To do this, the NPCs need to be believable to allow player to hide amongst them, as well as have some form of ‘memory’ to remember and spread information to other NPCs. What information they need to retain and how needs to be considered. In this scenario, appearance is important as the detective player is trying to identify what the lover character looks like. As for how they perceive another NPC, that is done by giving a radius to the NPC. This radius also determines if an NPC can ‘eavesdrop’ on a conversation. The detective player can also try and extract information from NPCs but would need to decipher on whether that information is true or not. The NPCs being able to influence and interact with each other creates a sense of social network that the player themselves are involved in, creating a sense of presence which as previously mention, heightens immersion (Short, Williams, & Christie, 1976).

Games with Believable and Reactive NPCs

In recent times, there has been an influx of games with more reactive and believable NPCs. This section covers examples of believable and reactive NPCs in a variety of games and what makes them believable.

Red Dead Redemption 2:

Red Dead Redemption 2 (RDR2) (Rockstar Games, 2018) is a western-themed action-adventure game in an open-world setting where the player plays as the character ‘Arthur Morgan’ and explores his story while also exploring the world environment. The players actions within the world influence the way the story ends.

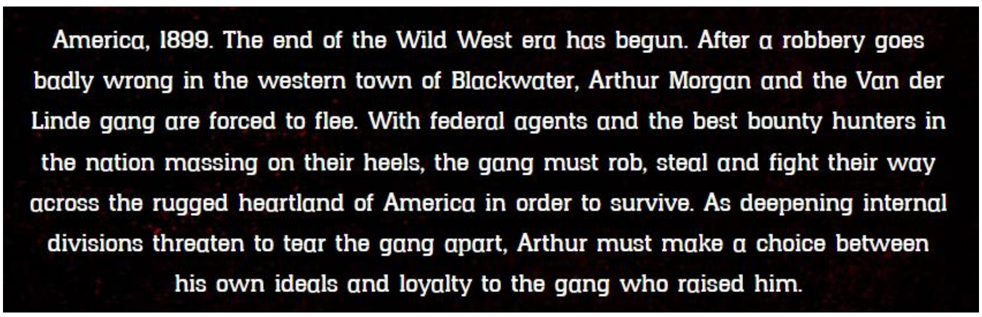
America, 1899. The end of the Wild West era has begun. After a robbery goes badly wrong in the western town of Blackwater, Arthur Morgan and the Van der Linde gang are forced to flee. With federal agents and the best bounty hunters in the nation massing on their heels, the gang must rob, steal and fight their way across the rugged heartland of America in order to survive. As deepening internal divisions threaten to tear the gang apart, Arthur must make a choice between his own ideals and loyalty to the gang who raised him.

Figure 6 Description of Red Dead Redemption 2 from the Official Website

The NPCs in RDR2 are considered as one of the most realistic in various review websites such as *'The Gamer'* (Mubeen, 2024), '*PC Gamer*' (Macgregor, 2020), and *'Early Game'* (Verbitskiy, 2024), and is even considered to have more believable NPCs than newer games, and for good reason. The NPCs have many layers and are incredibly rich and detailed, capable of reacting in various ways to the player, remembering the player (Kumbharkar, 2025), and having their own routines (Shaikh & Tadavi, 2025). Most NPCs have full daily routines such as waking up, eating working, socialising, and sleeping, making it as if they are truly living in the RDR2 world. In addition, if the player follows the NPCs, they grow agitated and impatient, giving warnings and threats and acting on them if the player continues to follow them or stand too close, each having their own emotion and perception and react different based on personality archetypes which makes their behaviour unpredictable and unique (Zhang, 2023). They are also capable of reacting to player actions, laughing at the player and making a comment if the player falls off a horse, or report crimes the player is committing in front of them. If a player does upset a group of NPCs via attacking, stealing, etc, those NPCs remember those actions and can even come to hunt the player down later (Moser, 2022). Their dialogue varies based on the players appearance, honour level, and recent actions (fighting, helping, or even falling off a horse), making their dialogue feel meaningful and realistic.

Rain World

Rain World (Videocult, 2017) is a 2D survival-platformer where the player plays as a creature in an apocalyptic world searching for food to hibernate before torrential rain arrives while also being hunted by predators (Jakabsson, 2017).

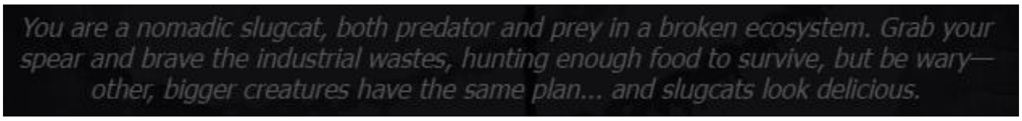

Figure 7 Description of the game Rain World from Official Website

In this game, the NPCs are any other creatures within the game. Believability is created with the actions that the creatures take, including movement, pathfinding, and fight or flight, and having to consider believable animalistic behaviours. As the player explores the world, the player can come across with variety of different creatures each with their individual behaviour. These creatures could be hostile, neutral, or edible. These creatures can also engage in combat with one another regardless of if the player is there, making the world feel alive even without the presence of the player (Andriano & Caracciolo, 2025). Some creatures in the game can also be influenced by the player and adapt their behaviour. One example of this are lizards, which usually try to eat the player, but if the player feeds them food, they could then follow the player around and even protect the player, which is realistic behaviours similar to that of a stray dog. Another example of this are scavengers, which react to the player based on the players reputation. If the player acts in a way that could be considered threatening, e.g. raising a weapon, the scavengers will be wary and alert. High reputation will prevent the scavengers from being hostile to the player and even choose to shelter with the player randomly, whereas low results in them attacking the player on sight. This adaptive behaviour creates believability by making it appear as if these NPCs are capable of having feelings, family, as well as personality as well as making the players actions feel consequential.

The way the AI in the game makes their decisions is using utility theory for a variety of tracker systems (Jakobsson & Therrien, 2024). Figure 8 displays various AI modules within the game, but what determines what the AI does when around a player is the utility tracker, which takes values from the prey tracker, threat tracker, rain tracker, and injury tracker. Each tracker returns a value that has a weight which influences the choice a creature may make. For example, they prey tracker returns a value when a prey is detected so they would chase the prey. That value is then influenced if there is a threat like a bigger predator nearby either causing them to fight or flight depending on the weighting. This logic creates unpredictable behaviours, as the weighting can vary for different creatures resulting in different scoring and results.

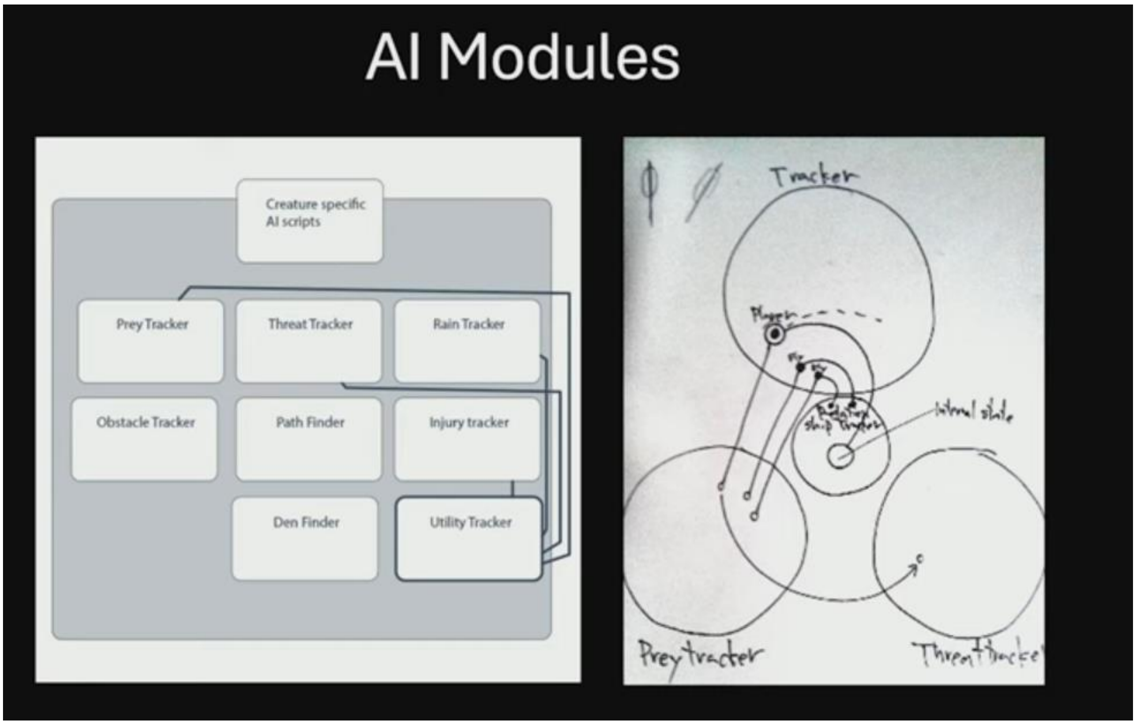

Figure 8 Slide from AI and Games Conference: Rain World: An AI Post-Mortem

3.3 Decision-Making Models

As explored, a believable AI is one that can react and make decisions. Decision-making models are methods that can be used to decide what actions the NPC takes (Karlsson, 2024), or how it reacts. These models determine what behaviour is the most appropriate at the time using rules set by the designer (Millington, 2019). This can be as simple as attacking when the player is detected, or running when the health is low, or as complex as betraying the player based on personal traits, goals, or alliances. Different models have different use cases and have their individual strengths and weaknesses. In this section, existing decision-making models will be explored.

Finite State Machines

Finite state machines (FSM) have been used in gaming since the beginning of computer games, going back as far as *Pacman* (Namco, 1980). An FSM consists of various states that are connected to each other via conditions (Jagdale, 2021). When a specific condition is met, the state will transition to the next state. Referring to Pacman, the logic of the ghosts in the game use finite state machines to determine the action they take. For example, if they see the player, a condition is met to transition their default state of wandering randomly to chase the player instead. This transition can either return to moving randomly if the condition for “player is dead” or “player lost/not detected” is set to true. Alternatively, it can be set to run from the player if another condition is met such as “player is powered up”. The simplicity of the logic makes FSMs easy to implement, but since they can only be in one state at a time (Roberts, 2023), it is bad for more complex logic. Let’s say there are two states, shooting and moving. A finite state machine would not be able to do both shoot and move, and if that behaviour was necessary to implement, a new state would need to be added for that action to be carried out. Another disadvantage of FSMs is that simplistic behaviours can be predictable and results in gameplay becoming monotonous (Immanuel, Veeraragavan, & Sudharsan, 2025). The more actions that are added, the more difficult it is to keep track of all the states and modify it (Karlsson, 2024), increasing its complexity as the number of states grow.

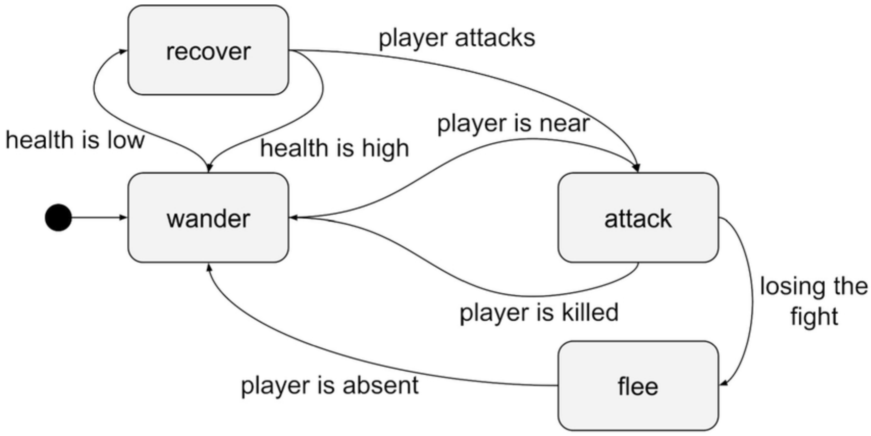

Figure 9 FSM flowchart example (Uludagli & Oguz, 2023)

However, there are many ways FSMs can be improved upon. One method is implementing a hierarchical structure, where each state can be an FSM. This method is known as a hierarchical finite state machine (HFSM). For example, a background NPC may have three states such as its default, when it is agitated, and when it is scared. Each of those states could then have more states contained inside of it. Figure 10 illustrates this example, the circles each representing an FSM that also acts as a state. The states inside of these circles could also be an FSM and contain more states within it, creating a hierarchical structure. A normal FSM would have each individual state with transitions between each of them and various conditions between each state, which could become difficult to manage and debug (Roberts, 2023). Furthermore, this also allows AI to appear as more reactive while also being manageable (Schiel, 2026). An AI can start off in its default state, that being idling or patrolling, but can react in a scared or agitated state depending on certain conditions, such as player level and AI health. Though an HFSM improves the manageability and scalability of an FSM, it still has no concept of memory and cannot the previous state it was in (Roberts, 2023).

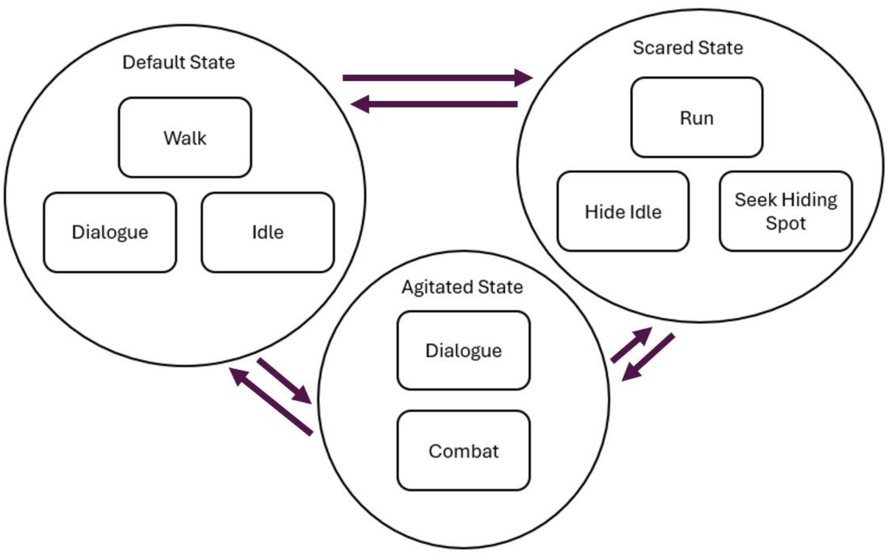

Figure 10 Example of Hierarchical Finite State Machine

Behaviour Trees

Similar to HFSMs, behaviour tree's (BT) also use a hierarchical structure when it comes to making decisions (Francis, 2017) and is considered as more scalable than an HFSM (Sekhavet, 2017). The way a BT works is using nodes. Behaviour trees, typically consist of three nodes known as sequence nodes, selector/fallback nodes, and parallel nodes (Rallabandi & Roberts, 2024). A sequence node is a node that goes through each of its child one by one in order, and returns true one all of its children have completed executing. A selector node acts like an 'OR' statement and executes its child nodes in any order until any of them returns true. Both of these nodes are considered as a 'non-leaf' node as they must contain children in order for it to return true. The parallel node executes all children at the same time, returning true when the required amount of children succeed and fails if the requirment is not met. Starting with a root node, each node is traversed depending on the logic behind the node (Gugliermo *et al*., 2024).

The way this differentiates from finite state machines is that in FSMs, states need to be exited and entered one at a time and cannot be in two states at once, whereas behaviour trees have a specific node (parallel nodes) that allows this type of behaviour (Gugliermo *et al*., 2024). Behaviour tree's not having transitions allows them to enter any state at any time if the condition is met, but a finite state machine require transitions to switch states between states. They are also of capable of passing values between nodes and remember previous states they were in, unlike FSMs (Sekhavet, 2017) consequently allowing to return to previous states or even restart from the root at each new input (Scukins *et al*,. 2022). Furthermore, since transitions are not required between each state, it is easy to remove and add new nodes since no new transitions would need to be considered between existing states. Overall, this makes BTs able to be more reactive than FSMs as they can always react to the environment no matter what state its in, whereas an FSM would need to be in specific conditions first. Even so, it is still subjected to becoming very complicated and difficult to manage despite being more manageable than an HFSM trying to do the same behaviours as a BT. Like HSFMs and FSMs, the more logic required, the messier it gets and can even slow down the decision making since traversing a large tree with a large number of nodes would be taxing on the system (Rallabandi & Roberts, 2024).

Goal Oriented Action Planning

Goal-Oriented Action Planning (GOAP) is the most used out of the planners in decision-making models when it comes to the gaming industry (Karlsson, 2024). A planner creates a sequence of actions that NPCs will execute during run time (Barros, 2024). In GOAP, the planner can access information about the world state such as variables that describe the current environment, as well as modify the world state through their actions, which results in the planner to search for the next action based on the updated world state. With this decision-making model, behaviours are not defined and more created by trying to achieve goals. The decision-making comes into play with how the goal is achieved, and what actions are taken to achieve it. Different planners have different functionality, but GOAP is well-suited for problems of moderate complexity since it chooses between simple goals and actions (Schiel, 2024). These actions typically consist of preconditions, effects, and costs to determine what the AI decides on doing. To determine the optimal sequence of actions, GOAP uses search algorithms such as A* to evaluate the cost of an action and select the most efficient path toward the goal. This system is used in games such as *F.E.A.R* (Monolith Productions, 2005) and Middle-earth: Shadow of Mordor (Monolith Productions, 2014).

The strength in GOAP lies in its ability for agents to dynamically generate their own plan for the course of action that is taken (Karlsson, 2024). Unlike FSMs, adding new actions does not require redesigning and considering the whole system again, making it more scalable (Barros, 2024).

Although it allows the agents to solve solutions on their own, it makes their behaviour difficult to debug as it is not clear what could be causing their actions to not be what is expected. One of the main weaknesses of GOAP is its intensive on the CPU as it puts the workload on the computer to search and calculate the best action to take. When comparing GOAP to FSMs and BTs, it has the lowest in terms of CPU performance, setup, and debugging, with FSMs being better than the other two when it comes to those statistics. On the otherhand, it is better in terms of scalability with FSMs being the weakest when it comes to scalability. Another advantage GOAP has over FSMs and BTs is that it is capable of emergent behaviours, whereas FSMs are not capable of that and BTs are very limited when it comes to creating emergent behaviors due to their behaviours being scripted rather than as a result of goals.

Utility AI

In Utility AI, the approach agents take when it comes to making decisions is determined on an evaluation of their needs in the game world (Saldvidar, 2026). Each action that can be taken is given a score based on different thresholds, and the action that scores the highest is the decision that is made. These scores are often normalised so that they can be consistent throughout the entire system, as values ranging from 0 – 1 are easier to handle (Graham, 2015). There are different thresholds that can be applied to different actions to improve the calculation, such as binary, linear, and exponential (Mark & Dill, 2010).

The most simplistic threshold is the binary threshold. Finite state machines logic is typically the same as this threshold, as it is a sudden change in state going from 0 to 100 instantly, but can be adjusted to be less binary by implementing fuzzy state logic (Mohmed, Lotfi, & Pourabdollah, 2020). The binary threshold logic is not always the most realistic as a person's emotional state rarely changes this drastically. Applying this to a realistic scenario, when approaching a deadline, one's anxiety would now drastically change from 0 to 100 instantly. Another threshold is the linear threshold, where a value increases in proportion to another value. Using the same scenario, this would mean anxiety would grow the same amount each day you get closer to the deadline. Although this is more realistic than the binary threshold, again it is not the most realistic as anxiety would increase faster the closer a threat is. If that threat is a deadline or how close a knife is to you, one's anxiety would rapidly grow the closer that threat approaches as the threat begins to feel more detrimental and demanding. This is known as the exponential threshold. The logistic curve tends to rapidly increase within a soft threshold, but outside the threshold the threat does not appear to be as threatening. Figure 11 showcases the different values different curves would output at the same distance.

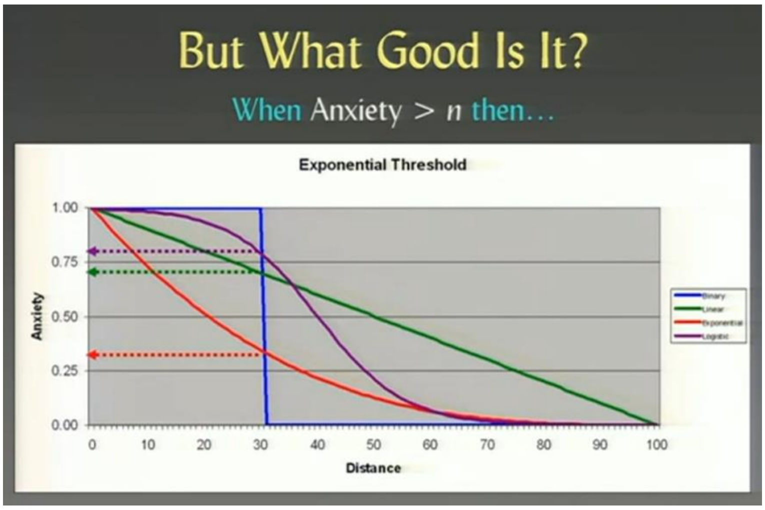

Figure 11 Threshold curve graph from Game Developer Conference Talk (Mark & Dill, 2010)

In *Sims 4* (Maxis, 2014), characters have different needs that are affected by their individual traits. For example, the needs in Sims 4 consist of: hunger, hygiene, bladder, energy, hygiene, social, and fun. The social need could use the exponential threshold whereas the hunger need could use a concave curve which means the curve tends to grow quickly earlier and reaches the max 'anxiety' to perform the eat action earlier (Saldvidar, 2026) than the social need would, even if the social stat was of a lower value than the hunger. By being able to do this, it makes the behaviours come across as more realistic, as they are not drastically changing. Utility AI's strongest feature is how reactive it is as it is capable of taking in various world variables and react accordingly to it. However, the disadvantage of this is that people without technical knowledge on math or curves would find it difficult to implement.

Comparisons

In figure 12, a table has been created that depicts where each decision-making model's strengths and weaknesses are based on the research conducted. A value represents how capable a model is in that area, higher meaning more capable. Despite some models having and overall higher total score than other models, that does not necessarily mean they are better. For example, every other model is significantly worse or not capable of long-term planning than GOAP, making GOAP the only viable option if long-term planning was a necessity for your AI, or FSMs are the best at creating quick and easy AI logic that is not expensive on the CPU, but won't be able to create complex AI. Utility and Behaviour Trees are the most capable when it comes to creating reactive behaviours. Furthermore, these can vary depending on the context of the situation.

Area of Capability	FSM	HFSM	BT	GOAP	Utility AI
Implementation	5	4	3	2	3
Debugging	5	4	4	2	3
Scalability	1	2	4	3	4
Reactive Behaviour	2	3	5	3	5
Emergent Behaviour	1	1	3	4	4
Long-Term Planning	1	1	2	5	2
Performance (CPU)	5	4	4	2	4

Figure 12 Decision-Making Models comparison

4. Research Methodologies

4.1 Design and Approach

This study uses a comparative research methodology, where the design, implementation, and evaluation reactive NPC systems using different AI decision-making models will be compared against. The artefact aims to explore different techniques and showcase how these models can be used to create a scalable AI system where NPCs can react to the player, creating the illusion that they are 'adapting' as their behaviour would change.

Rather than measuring subjective player immersion through player testing, this research evaluates architectural and behavioural properties associated with reactive and believable NPC behaviour. A prototype artefact was developed in Unity, implementing two contrasting decision-making approaches:

- A Finite State Machine (FSM)
- A Utility AI

These systems were designed to operate under identical gameplay conditions, allowing direct structural and behavioural comparison. These two were chosen as FSMs have been the industry standard and around since early days of game development (Jagdale, 2021), and based on research, Utility is considered to be the best when it came to reactivity and comparing values. Using Unity allows me to focus solely on creating the NPC reaction system without having to use time on creating a framework from scratch.

The study follows a design science research approach, which consists of:

1. Identifying the problem (limitations in reactive NPC behaviour)
2. Artefact design and implementation
3. Comparative evaluation
4. Analysis

Although player immersion was studied, this was purely to done to gain an understanding of what behaviours and characteristics are considered believable and how it can be used when making an NPC reactive.

4.2 Artefact Design and Implementation

Since the area of focus is on background NPCs in role-playing games, the artefact was based on reaction system that would fit how an NPC could react to the player based on emotion, induvial personality, and player statistics.

Player Trait Model

A player-character stat system was designed to simulate personality and identity variables. The variables consisted of:

- Recognition – whether the player is well known in the game world
- Morality – where the players moral alignment lies (evil or good)
- Charisma – how easy it is for an NPC to like or dislike the player
- Strength – how easy it is for an NPC to be intimidated/underestimated by the player
- Dexterity – how easy it is for an NPC to be intimated/underestimated by the player (different NPCs desire different stats)

These variables were also used with the NPCs, each of them randomly generating which stats they find desire or despise, which would then result in their reaction. During runtime, the user can use UI to modify the players stats to see how the NPCs react.

NPC Reactions

NPCs were designed to exhibit multiple social reactions such as:

- Excitable
- Friendly
- Indifferent
- Hostile
- Terrified

In the current artefact, for the sake of simplicity, each reaction sparks a different dialogue outcome, and a colour change to symbolise the change in state/action. This could be further expanded to help illustrate the change in behaviour by adding in steering behaviours such as follow, avoid, attack.

Both AI models were required to access the same player data, produce behaviour from the same reaction, and operate under identical environmental constraints, ensuring a fair comparison.

FSM Implementation

The FSM model used states and predefined transitions to trigger each reaction. Each transition would consist of a threshold condition based on the players stats. Figure 13 illustrates how each reaction would interact with each other. It would be unlikely for an NPC to drastically change from terrified to indifferent, so I didn't include that transition. The model emphasises explicit transition logic and rule-based branching.

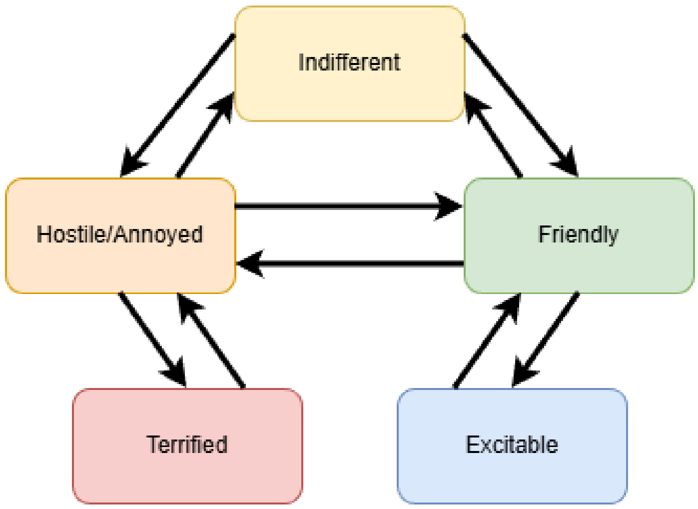

Figure 13 NPC reaction FSM model diagram

Utility Implementation

The Utility model calculated weighted scores for each possible reaction using an evaluation function that was called whenever the player was in range of the NPCs detection radius. The reaction that occurs is the reaction that has the highest utility value when the player is in the detection. This model allows different variables to be always considered simultaneously if the player is in range, allowing the NPC to react if the player stats change.

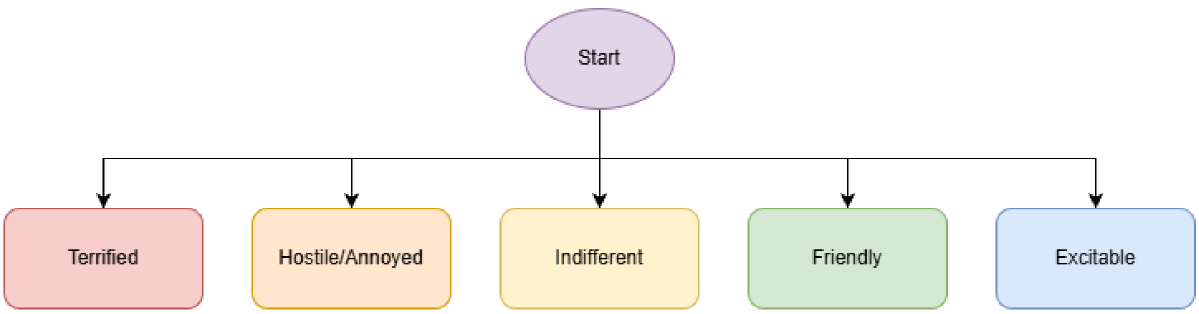

Figure 14 NPC reaction Utility AI model diagram

4.3 Data Collection

Since the focus of this study is on how decision-models are implemented, no human participants are required so the data collected is mainly primary quantitative data. Different criteria were evaluated in each decision-making reaction systems.

Data collection Criteria:

Criteria 1: Behavioural Flexibility

This is measured by:

- Number of variables influencing the decisions
- Ability to respond to multi-variable combinations
- Continuity of behavioural variation

Criteria 2: Reactivity Depth

This is the degree which multiple player attributes influence the NPC behaviour simultaneously. This will be analysed by comparing the threshold-based conditional transitions in FSMs with the weighted multi-factor scoring in Utility AI.

Criteria 3: Scalability

This is measured by:

- Complexity growth when adding new behaviours
- Number of additional transitions required
- Structural maintainability

Criteria 4: Decision Variability

The player stat adjustments, repetition frequency, behavioural diversity, and sensitivity to stat changes can all be observed. How does this differentiate between the two models.

Data Collection Procedure:

Testing involved a controlled environment within the prototype, where three of each NPC models would spawn randomly in the setting. The player can approach each NPC and see how they react to the player stats, which can be modified in real-time. The responses were logged and compared across both models.

No player perception data was collected due to time scope and prioritising implementation and research.

4.4 Ethical Considerations and Limitations

As this study does not involve human participants, personal data collection, or psychological testing, ethical risk is minimal. The research focuses solely on system architecture and computational behaviour.

As for limitations, the absence of user testing means perceived immersion or realism cannot be validated, which could've further supported the findings and results as to why the behaviour is more reactive from a player immersion viewpoint. Results are also limited to the specific context the model is implemented in, meaning it may not generalise between all game genres. However, the study provides architectural insight into how the models influence reactive NPC logic.

5. Results and Discussion

The two models were tested in the same environment in different scenarios. Some context information is that the colours represent different states. The FSM NPCs have a white arrow, and the Utility NPCs have a black arrow. All NPCs start off as indifferent as the players stats start at zero. The player stats can be adjusted using the UI and the NPCs should react in real-time to these adjustments. As an addition feature to make testing easier, a hover feature was implemented to view different NPC states or traits, allowing the user to see the utility NPC stat values and the FSM NPCs state value.

Colour	Emotion
Red	Terrified
Orange	Hostile
Blue	Indifferent
Green	Friendly
Yellow	Excited

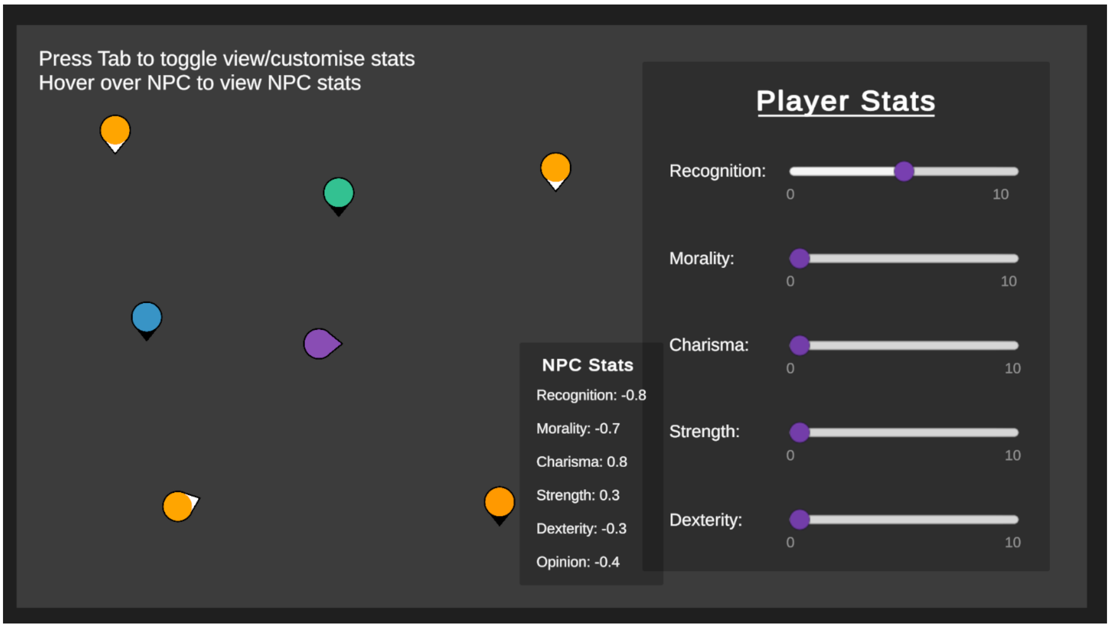

Figure 15 Scenario A of testing results

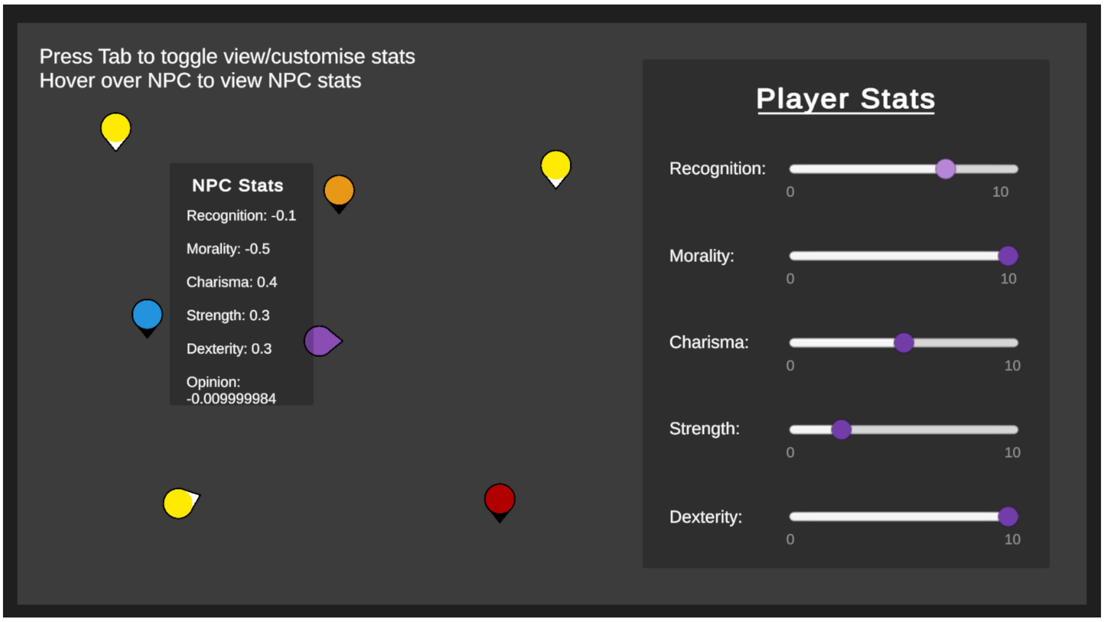

Figure 16 Scenario A with different stats

In Figure 15 I only modified the recognition variable for the player and already a difference can be seen between the two models. All the FSM NPCs turn orange from blue, which is because they feel hostile towards the player as the player has a low morality value and they are able to recognise the player. This suggest that all the FSM NPCs have a morally good alignment. However, there is also one utility-based NPC that is also orange, but its stats display that it hates morality. By that logic alone, the NPC should have a positive reaction towards the player as the player has a low morality score. The reason it is showing hostile is because it takes into account of all the other variables, so since the NPC has a high negative weighting for recognition, it lowers the score for the NPC liking the player a lot. This can be interpreted as an NPC with low moral goals but a contempt for those who are famous, possible a pessimistic low-class NPC.

Another notable difference is that all the utility-based NPCs react differently from each other unlike the FSM NPCs. In figure 16, the variables were adjusted and the NPCs react accordingly. With high morality and high recognition, the player is seen as a hero by the FSM NPCs. On the other hand, utility-based AI have a vary of reactions. The orange utility-based NPC in figure 15 turns red, meaning they are terrified of the player. Looking at its stats in figure 15, this can be interpreted as the NPC fearing the players dexterity skills and morality, perhaps afraid the player might attack the NPC since its morality is low suggesting they may have committed crimes.

The FSMs also change colours instantly, whereas the utility-based NPC colours change based on the opinion, showing that it can be In between states or about to switch to another state. With FSMs, the way they are structured prevents them from switching between certain colours. Excited state cannot drastically change to indifferent state or hostile state (yellow to blue, or yellow to orange) and requires going to the friendly state (green) before it can access the other states. This

Another result that was encountered but difficult to show in a figure is that the FSM conditions to change the states were difficult to implement because of the number of transitions and variables that had to be considered for each variable. At some points, the colours (states) would switch repetitive despite not changing variables, suggesting there was a flaw in the logic of one of the transitions. Since utility scores a value of opinion, even if more variables were added such as extraversion, it would be easy to implement it into the scoring. Whereas the finite state machine currently has ten transitions that may or may not now need to consider a new variable. This also applies to adding another reaction or state. A utility-based system would just need to give it a score condition that it needs to meet, whereas in an FSM, transitions from the five other states now need to be considered to this new state.

From these tests, it showcases that utility decision making models are significantly better at creating different behaviours and have a significantly higher reactive depth as they are able to consider variables from the player and the NPC itself, whereas with FSMs, the way I had implemented it only considered the players stats. Initially, the FSM was going to compare the NPCs traits to the players' traits, simply checking if the players trait was higher than the NPCs, but it was difficult to design how this would work with the reaction states. Referring to figure 12, which is a table of observations made from the research conducted, the results found from the testing mostly agree with the table when it comes to FSM and utility AI, but when it comes to implementation and debugging, it would differentiate. This is mainly because FSMs are only easy to implement when the logic behind it is simple (Karlsson, 2024), and utility AI's complexity increases when threshold curves are introduced, which is not implemented in this framework. As for scalability, reactive, and emergent behaviours, it can be confidently concluded that utility AI performs better than FSMs as the reactions the NPCs chose were not hard coded, thinking of cases that the designer may not consider. Furthermore, these results further illustrate the reasoning behind why older games struggles to create believable and realistic behaviours for their NPCs when it came to reactivity and how far games are able to come now due to the advancement of decision-making models.

6. Conclusion

In this dissertation, different decision-making models were investigated on how they can influence non-player character (NPC) reactivity within an interactive game environment. Through an extensive literature review and the design and implementation of a comparative prototype, and understanding was reached on why and how utility-based models are frequently used in the gaming industry to create reactive and believable NPC behaviours and reactions.

6.1 Key Takeaways

One of the most significant insights gained from the research gathered in the literature review is that the believability in NPCs is not solely on the complexity of the behaviour, but the consistence as well. Drawing on theories such as Flow Theory (Csikszentmihalyi, 1990), Social Presence Theory (Short, Williams, & Christie, 1976), and Self-Determination Theory (Deci & Ryan, 2000), it became clear that reactive NPCs contribute to immersion by reinforcing autonomy, relatedness, and meaningful feedback. Rather than perfectly simulating humans, responding in ways that align with player expectations and maintain consistency is what makes NPCs believable.

From analysing games such as *Red Dead Redemption 2* (Rockstar Games, 2018), *Rain World* (Jakabsson, 2017), *Baldurs Gate 3* (Larian Studios, 2023), and *The Elder Scrolls V: Skyrim* (Bethesda Game Studios, 2011), it was discovered that memory, emotional expression, personality differentiation, and routine-based behaviour are central to perceived believability. Reactive systems create a sense of presence and consequence, making the players actions feel meaningful to NPCs as well as the player and consequently making the player feel acknowledged.

A deeper understanding of the structural differences between various decision-making models such as Finite State Machines, Behaviour Trees, Goal-Oriented Action Planning, and Utility AI was developed, with Finite State Machines and Utility AI being further explored within an artefact. FSMs offer clarity, predictability, and control, but struggle with scalability. In contrast, Utility AI excels at handling simultaneous variables, allowing it to produce emergent reactions through weighted scoring systems. This research reinforced that architectural design decisions directly influence the expressive range of NPC behaviour.

6.2 Achievement of Aims and Research Questions

The primary aim of the study was to investigate how decision-making models can enhance NPC reactivity to player personality and improve believability. This aim has been achieved.

- **RQ1** was addressed throughout the literature review, which established that reactivity, memory, emotional consistency, and contextual awareness are key components of believable NPCs. The research conducted demonstrated how reactive NPCs support immersion through psychological mechanisms such as feedback, relatedness, and autonomy.
- **RQ2** was addressed in the third section of the literature review where different decision-making models were explored, identifying their strengths and weaknesses and then further exploring these strengths and weaknesses within an artefact and specific scenario.
- **RQ3** This was partially achieved within the artefact, as the artefact implements and compares two of the models into a framework where NPCs can react to player traits. he comparative analysis and implementation confirmed that while FSMs are efficient and manageable for simple behaviours, Utility AI provides greater reactivity depth and scalability for systems involving multiple personality variables.

The artefact successfully demonstrated that Utility AI produced more varied, personality-driven, and context-sensitive reactions than the FSM implementation under identical conditions. It also highlighted how structural design influences behavioural flexibility and scalability.

6.3 Key Accomplishments

1. Strong research that allowed an integration of immersion theory with AI architecture which resulted in a clear conceptual framework linking psychological principles to technical implementation.
2. A controlled comparative design within Unity for the artefact allowed for a fair and structured comparison.
3. A clear behavioural differentiation was found in the results, being depicted visibly in screen shots and showcasing the reactivity depth.

The implementation successfully showcased that Utility AI could evaluate multiple personality traits simultaneously, producing behaviour that was not explicitly hard-coded, supporting claims about emergent and reactive design.

6.4 Challenges

1. FSM complexity escalated, making it so that it possibly was not reacting correctly to stat changes and not switching states when intended or vice versa. Conditional statement became prone errors and required frequent debugging when adding it a new personality trait to consider.
2. The lack of player testing means that improvements in reactivity cannot be linked to perceived immersion. Although the research supports the findings, user testing would have strengthened the conclusion.
3. Simplified Utility implementation prevented exploration and development of further enhanced behavioural realism and could have demonstrated a deeper emotional modelling.

6.5 Final Reflection

Overall, this dissertation demonstrates that the believability and reactivity of NPCs are heavily influenced by the decision-making models' capabilities and how it is implemented. While FSMs remain useful for simple and controlled behaviours, Utility AI provides significantly greater behavioural flexibility, scalability, and reactivity depth when modelling personality-driven reactions.

The research supports the argument that reactive NPC systems contribute to immersion by reinforcing psychological principles of feedback, autonomy, and relatedness. More importantly, it highlights that immersion is not solely a narrative achievement but an architectural one: the structure of AI systems fundamentally shapes the player's perception of aliveness and consequence.

Future research can expand this work by integrating hybrid AI architectures, incorporating emotional decay using threshold curves, or perhaps adding a persistent memory system. Further user testing can be carried out to measure perceived immersion which can then be linked back to the architecture. In conclusion, the study provides both theoretical insight and practical demonstration that decision-making models play a critical role in shaping believable, reactive, and immersive game worlds.

References

Ackerman, C. E. (2018, June 21). Self Determination Theory and How It Explains Motivation. Available at: https://positivepsychology.com/self-determination-theory/#self-determination-theory-and-goals (Accessed: 9 January 2026).

Andriano, A. M., & Caracciolo, M. (2025). Metroidvania ecologies: Exploration and the environmental imagination in Hollow Knight and Rain World. *Eludamos Journal for Computer Game Culture 16(2)*, 9-28.

Barriales, S. O. (2021). You had me at 'AAAAHHH' – On the importance of reactions in game. *Game AI Pro – Online Edition 2021*.

Barros, R. (2024). The Game AI's Guide to Decision Making. *Sumo Developer Conference (SDC)*. Sumo Digital.

Bay 12 Games. (2006). *Dwarf Fortress.* [Video Game]: Kitfox Games.

Bethesda Game Studios. (2011). *The Elder Scrolls V: Skyrim.* [Video game]: Bethesda Softworks.

Bickle, J. T., Hirudayaraj, M., & Doyle, A. (2019). Social Presence Theory: Relevance for HRD/VHRD Research and Practice. *Advances in Developing Human Resources, 21(3)*, 383-399.

Biggar, O., Zamani, B., & Shames, I. (2021). Modular Decomposition of Hierarchical Finite State Machines. *Dissertation*.

Capon-Sieber, V., Köhler, C., Christ, A. A., Helbing, J., & Praetorius, A.-K. (2022). The Role of Relatedness in the Motivation and Vitality of University Students in Online Classes During Social Distancing. *Front Psychology 12*.

CD Projekt Red . (2020). *Cyberpunk 2077.* [Video game]: CD Projekt Red.

CD Projekt Red. (2015). *The Witcher 3: Wild Hunt.* [Video game]: CD Projekt Red.

Cherry, K. (2025, October 29). *How Self-Determination Theory Explains Motivation*. Retrieved from Very Well Mind: https://www.verywellmind.com/what-is-self-determination-theory-2795387

Costa, P., & McCrea, R. (1992). The Five-Factor Model of Personality and Its Relevance to Personality Disorder. *Journal of Personality Disorders 6(4)*.

Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience.* Harper & Row.

Cummings, J. J., & Wertz, E. E. (2023). Capturing social presence: concept explication through an empirical analysis of social presence measures. *Journal of Computer-Mediated Communication, 28(1)*.

Deci, E. L., & Ryan, R. M. (2000). The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological Inquiry 11(4)*, 227-268.

Dill, K. (2013). What Is Game AI? In S. Rabin, *Game AI Pro* (pp. 4-9). CRC Press.

Domingues, J., Filipe, V., Carita, A., & Carvalho, V. (2024). Understanding the impact of perceived challenge on narrative immersion in video games: The role-playing game genre as a case study. *Information*, 294.

Ermi, L., & Mäyrä, F. (2005). Fundamental components of the gameplay experience: Analysing immersion. *DiGRA Digital Library*.

Francis, A. (2017). Overcoming Pitfalls in Behaviour Tree Design. In S. Rabin, *Game AI Pro 3* (pp. 115-125). CRC Press.

Graham, D. (2013). Breathing Life into Your. In S. Rabin, *Game AI Pro* (pp. 451-458). CRC Press.

Graham, D. (2015). An Introduction to Utility Theory. In S. Rabin, *Game AI Pro* (pp. 113-126). CRC Press.

Gugliermo, S., Domínguez, D. C., Iannotta, M., Stoyanov, T., & Schaffernicht, E. (2024). Evaluating behavior trees. *Robotics and Autonomous Systems178*.

Haryanto, H., Gamayanto, I., Kadianawati, A., Rosyidah, U., Mulyanto, E., & Sutojo, T. (2023). Improvement of Imaginative Immersion in Role Playing Serious Game using Appreciative Game Activity. *In: 2023 International Conference on Electrical and Information Technology (IEIT).* Malang, Indonesia: IEEE.

Immanuel, V. T., Veeraragavan, R., & Sudharsan, D. (2025). A Comparative Study Of Ai Techniques In Gaming:. *International Journal of Creative Research Thoughts 13(2)*, 304-313.

Jagdale, D. (2021). Finite State Machine in Game Development. *International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)*.

Jakabsson, J. (2017). *Rain World*. Retrieved from Rain World Game: https://rainworldgame.com/

Jakobsson, J., & Therrien, J. (2024, November 8). AI and Emergent Systems - A Rain World Retrospective. *Rain World: An AI Post-Mortem*. AI and Games Conference.

Jennett, C., Cox, A., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., & Walton, A. (2008). Measuring and defining the experience of immersion in games. *International Journal of Human-Computer Studies*, 641-661.

Karlsson, T. (2024). Making Up Your AI's Mind Decision-Making Architectures. In P. Roberts, *Game AI Uncovered 2* (pp. 47-56). CRC Press.

Kort, Y. D., Ijsselsteijn, W. A., & Poels, K. (2007). Digital Games as Social Presence Technology: Development of the Social Presence in Gaming Questionnaire (SPGQ). *Journal of Applied Mechanics*.

Kounadi, V., Theodoropoulos, A., & Lepouras, G. (2025). AI-driven npcs enhancing player challenges and skill development in games. *Proceedings of the 3rd International Conference of the ACM Greek SIGCHI Chapter*, 78-83.

Krejins, K., Xu, K. M., & Weidlich, J. (2022). Social Presence: Conceptualization and Measurement. *Educational Psychology Review 34*, 139–170.

Kumbharkar, H. (2025). Emergent Minds: The Evolution and Future of AI in Video Game NPCs. *International Journal for Multidisciplinary Research 7(3)*.

Lankoski, P., & Björk, S. (2007). Gameplay design patterns for believable non-player characters. *DiGRA 2007 Conference* (pp. 416-423). Authors & Digital Games Research Association (DiGRA).

Larian Studios. (2023). *Baldurs Gate 3.* [Video game]: Larian Studios.

Liu, X. (2024). The application of artificial intelligence in FPS Games. *Applied and Computational Engineering*, 201-206.

Lopez-Garrido, G. (2023, July 10). *Self-Determination Theory: How It Explains Motivation*. Retrieved from Simply Psychology: https://www.simplypsychology.org/self-determination-theory.html

Macgregor, J. (2020, April 16). *Which game has the best NPCs?* Retrieved from PC Gamer: https://www.pcgamer.com/which-game-has-the-best-npcs/

Magnus, J. (2013). *Do non player characters dream of electric sheep? A thesis about players, npcs, immersion and believability.* (Dissertation, Stockholm University) Department of Computer and Systems Sciences.

Manikanta, R. A., Shaik, B. A., Kancharla, Y., Gurram, R., & Ramasamy, G. (2025). Ai-driven game mechanics: Implementing Finite State Machines in pac-man. *2025 IEEE International Conference on Interdisciplinary Approaches in Technology and Management for Social Innovation (IATMSI)*, 1-6.

Mark, D., & Dill, K. (2010). Improving AI Decision Modelling through Utility Theory. Game Developer Conference.

Maxis. (2014). *The Sims 4.* [Video Game]: Electronic Arts.

Merseburg, S., & Svenning, A. (2025). uilding and Testing a Game to Compare Scripted and LLM-Driven NPCs: Impact on Player Immersion. *Dissertation*.

Millington, I. (2019). *AI for Games.* United States: CRC Press.

Mimic Minds. (2026, January 17). *AI NPCs vs Scripted NPCs: When AI Improves Gameplay and When It Breaks It*. Retrieved from mimicminds: https://www.mimicminds.com/post/ai-npcs-vs-scripted-npcs

Mohmed, G., Lotfi, A., & Pourabdollah, A. (2020). Enhanced fuzzy finite state machine for human activity modelling and recognition. *Journal of Ambient Intelligence and Humanized Computing*, 6077-6091.

Monolith Productions. (2005). *F.E.A.R.* [Video Game]: Warner Bros. Games.

Monolith Productions. (2014). *Middle-earth: Shadow of Mordor.* [Video Game]: Waner Bros. Games.

Moser, H. R. (2022). "A Crash of Worlds": How Red Dead Redemption II Creates a World Where Players Experience Empathy Through Character Performance. *Theses and Dissertations*.

Mubeen, A. (2024, August 25). *Games With Most Realistic NPCs*. Retrieved from TheGamer: https://www.thegamer.com/games-with-most-realistic-npcs/

Myers, I. B., McCaulley, M. H., Quenk, N. L., & Hammer, A. L. (1998). *The MBTI Manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator.* Palo Alto, California: Consulting Psychologists Press.

Nah, F. F.-H., & Eschenbrenner, B. (2014). Flow in gaming: Literature synthesis and framework development. *International Journal of Information Systems and Management*.

Namco. (1980). *Pacman.* [Video game]: Namco.

Neufeld, A. (2025). Putting Self-Determination Theory Into Practice: A Practical Tool for Supporting Medical Learners' Motivation. *Clin Teach 22(4)*.

Nintendo. (1998). *The Legend of Zelda: Ocarina of Time.* [Video game]: Nintendo.

Nintendo. (2002). *The Legend of Zelda: The Wind Waker.* [Video Game]: Nintendo.

Ou, H. (2025). AI-Powered NPCs in Virtual Environments: Creating Believable Characters Through Machine Learning. *Applied and Computational Engineering*, 96-102.

Perttula, A., Kiili, K., Lindstedt, A., & Tuomi, P. (2017). Flow experience in game based learning – a systematic literature review. *In: International Journal of Serious Games*, 57-72.

Rallabandi, S., & Roberts, P. (2024). Reactive Behaviour Trees. In P. Roberts, *Gane AI uncovered : Volume 1* (pp. 78-85). Taylor & Francis Group.

Rennick, S., & Roberts, S. (2021). Improving video game conversations with trope-informed design. *Game Studies. Volume 21 (3)*.

Roberts, P. (2023). Decision-Making. In P. Roberts, *Artificial Intelligence in Games* (pp. 125-150). CRC Press.

Rockstar Games. (2018). *Red Dead Redemption 2.* [Video game]: Rockstar Games.

Ryan, J., & Mateas, M. (2017). Simulating Character Knowledge Phenomena in Talk of the Town. In S. Rabin, *Game AI Pro 3: Collected Wisdom of Game AI Professionals* (pp. 433-446). CRC Press (Taylor & Francis Group).

Ryan, R. M., Deci, E. L., Vanteenkiste, M., & Soenens, B. (2021). Building a Science of Motivated Persons: Self-Determination Theory's Empirical Approach to Human Experience and the Regulation of Behavior. *Motivation Science 8(2)*, 91-110.

Saldvidar, M. (2026). Simplifying Utility AI through Predefined Utility. In P. Roberts, *Game AI Uncovered : Volume Four* (pp. 94-109). Taylor & Francis Group.

Schaffer, O., & Fang, X. (2015). Finding Flow with Games: Does Immediate Progress Feedback Cause Flow? . *Emergent Research Forum Papers*.

Schiel, A. (2024). Generalised AI Planners. In P. Roberts, *Game AI Uncovered : Volume 2* (pp. 200-210). Taylor & Francis Group.

Schiel, A. (2026). Stable Reaction Systems. In P. Roberts, *Game AI Uncovered 4* (pp. 269-271). Taylor & Francis Group.

Scriven, P. (2022). "You're the lucky one, Dani": NPC Empathy and Meaningful Play in Farcry 6. *Proceedings of the Digital Games Research Association of Australasia (DiGRAA 2022).*

Scukins, E., Iovino, M., Styrud, J., Ögren, P., & Smith, C. (2022). A survey of Behavior Trees in robotics and AI. *Robotics and Autonomous Systems 154*.

Sekhavet, Y. (2017). Behavior Trees for Computer Games. *Internation Journal on Artificial Intelligence Tools*.

Shaikh, A. A., & Tadavi, J. S. (2025). Artificial Intelligence and Machine Learning. *International Journal of Advanced Research in Computer and Communication Engineering 14(10)*, 70-74.

Short, J., Williams, E., & Christie, B. (1976). *The Social Psychology of Telecommunications.* London : Wiley.

Silva, G. A., & Ribeiro, M. W. (2021). Development of Non-Player Character with Believable Behavior: a systematic literature review. *Anais Estendidos do Simpósio Brasileiro de Games e Entretenimento Digital (SBGames).* Sociedade Brasileira de Computação (SBC).

Simkus, J. (2025, October 20). *Myers-Briggs Type Indicator (MBTI)*. Retrieved from Simply Psychology: https://www.simplypsychology.org/the-myers-briggs-type-indicator.html

Singh, D., Banerjee, J., & Pandey, J. (2025). AI-Driven NPC Dialogues for Immersive Gameplay: Integrating OpenAI's NLP Technology in Unity-Based Games. *International Conference on Intelligent Computing and Virtual & Augmented Reality Simulations (ICVARS)* (pp. 50-55). Birmingham, United Kingdom: IEEE.

Uludagli, C., & Oguz, K. (2023). Non-player character decision-making in computer games. *Artificial Intelligence Review 56(12)*, 1-33.

Verbitskiy, N. (2024, October 20). *Top 13 games with the most engaging NPCs*. Retrieved from Early Game: https://earlygame.com/guides/gaming/games-with-the-most-engaging-npcs

Videocult. (2017). *Rain World.* [Video Game]: Akupara Games.

Vlaev, I. (2018). Local Choices: Rationality and the Contextuality of Decision-Making. *Brain Sci*.

Wang, J. C., Liu, W. C., Kee, Y. H., & Chian, L. K. (2019). Competence, autonomy, and relatedness in the classroom: understanding students' motivational processes using the self-determination theory. *Heliyon 5(7)*.

Warpefelt, H. (2016). The Non-Player Character – Exploring the believability of NPC presentation and behavior. *Dissertation*. Department of Computer and Systems Sciences, Stockholm University.

Zhang, H. (2023). The application of artificial intelligence technology in game. *Applied and Computational Engineering 19(1)*, 197-204.