Non-Playable Characters & Artificial Intelligence: A Case for Bespoke Characters & Automation Tools

Literature review for MSc Project Management & Research Methods

Contents

1 – Introduction

1.1 – Background

From the release of Pac-Man in 1980 to present-day examples of The Last of Us 2 in 2019 and Baldur's Gate 3 in 2023, video game worlds have been given life through the means of Artificial Intelligence (AI). Non-Playable Characters (NPCs) make use of AI systems to create a mixture of gameplay and narrative scenarios for players to experience. The rise of procedurally generated (PCG) NPCs – created with the intention of increasing the variety of characters across a game world while decreasing long-term workload required – could be argued to impede on the quality of games as a medium. PCG are being used where meaningful character interactions could take place, favouring sheer mass of content over refined and circumstantial player-NPC interactions. This is likely due to climbing production costs as game worlds increase in size, experimentations with newer game development technologies, and a need for worlds to feel palpable and full in the face of immersive gaming as a foundation for contemporary gaming.

1.2 – Objective

It is speculated that high quality friendly NPCs within modern video games do not need to be entirely focused on realism, nor entirely dynamic in how they operate to be deemed entertaining and captivating, or worth the audience's attention. A smaller dense environment, filled with bespoke NPCs and activities may be a solution to this, following a comment made by (Ion Storm Ltd., 1997): *"…Daggerfall with its hundreds of generic towns, its shallow conversations, and its randomly generated quests. The shallow simulation of huge environments is almost invariably perceived as a good thing."* Secondly, it has been identified that there is a noted lack of research regarding non-combative characters in video games in isolation.

A free-standing model will be established alongside the development of an easy-to-use Unreal Engine 5 editor tool, allowing for the simplified production of unique NPCs with their own unique traits. In use, the tool should allow designers and artists to easily implement new NPCs and be capable of producing a zero-player game experience. NPCs need to be able to interact amongst themselves without player input, and the player should be able to interact with the game world on the same terms as its NPCs.

2 – Contextual Review

In this review, I will discuss the use cases of NPCs in video games, and the benefits and burdens of bespoke NPC designs versus procedural NPCs in isolation and context of their game worlds, to conclude whether a world of unique NPCs holds significantly more value than a world of PCG NPCs. Combative NPCs will not be discussed, instead exclusively reviewing sources which discuss the history, design, and development of 'friendly' NPCs. The topic will be viewed in totality, considered arguments both for and against, looking at a range of video game related works (design documents, manuals, magazine excerpts, interviews) from the 1980s forwards, and psychological studies backdating to the 1940s.

2.1 – Defining Non-Playable Characters (and a short history)

Non-playable characters (NPCs) are defined in the NEXT Generation magazine (NEXT Generation Magazine, 1996), as originating in tabletop role-playing games and "not controlled by the user." While being defined in the source almost twenty years ago, NPCs have consistently been defined as characters that exist within a game world and provide level of substance to the player's gameplay experience; from narrative and aesthetic immersion, to aiding or impeding the player's progress (Warpefelt & Verhagen, 2015). Broadly, NPC typology is defined in Designing Virtual Worlds (Bartle, 2003) and further refined by (Warpefelt & Verhagen, 2015) as:

- **Functions:**
  - **Vendor** – buy, sell, or create game objects with,
  - **Services** – provide a service to the player,
  - **Quest giver** – be supplementary to world building and narrative, or dispense quests, can be a "special" or unique character,
- **Adversaries:**
  - **Enemy (sometimes Guard)** – protect and patrol locations,
  - **Opponent –** hinders the player's progression in some sense,
  - **Loot** – drop loot when killed, guards can also be this,
- **Friends:**
  - **Sidekick –** stays by the player's side,
  - **Ally –** may aid the player and leave when objective is complete,
  - **Companion –** functionally alike the Ally, though controllable by the player and usually more important to the narrative,
  - **Pet –** exists for player self-expression and customization,
  - **Minion –** units created by the player, to be mass-produced and disposable,
- **Providers:**
  - **Storyteller** – help the player achieve their objectives,
  - **Loot provider** – partially Loot,
- **Extras**: populate the game world, as set pieces.

It is important to note that the terms NPC and AI, while often used interchangeably, are separate concepts. Video game AI is a system that controls and determines the state an NPC or game world may be in, to create the illusion of being controlled by a human player (arm, n.d.; Dasha.AI, 2023).

Early text-based adventure games *Zork* and *Colossal Cave Adventure* would depict NPCs for one of the first times, though limiting player-NPC interactions to a set of predetermined commands. NPCs would

see an increase in complexity by the 1980s, with the releases of roleplaying games *Ultima* and *The Legend of Zelda* (Endicott, 2023). The NPCs of these video games would allow a wider range of interactions and integrate better with overall gameplay, compared to their predecessors (R., 2023). Video games continued to iterate on this more openly mechanical approach to NPCs until arriving at narrative storytelling with a more discreet cinematic approach. Scripted events within the cinematics of more recent video games, for instance the scripted sequences of 2005's *Half-Life 2*, creates the illusion of increased NPC intelligence and responsiveness dependent on the scenario. Valve's scripting system allows its designers to direct an NPC's interactions at a target, play through a selection of animations, and move to set positions in the game world (Valve, 2024).

Introduced in 2005, Bethesda Software's Radiant AI system *for The Elder Scrolls: Oblivion* and later *Skyrim* attempted to implement "full 24/7 schedules" in which their worlds' NPCs had independence to do as they willed. To keep characters within the worlds acting believably human, the AI system provided NPCs with general goals, such as where and what time they would eat. The studio's intention with this system was to move away from hand-crafting each NPC for efficiency in producing new characters and allowing for emergent narratives to unfold as NPCs cross paths while tending to their pre-planned schedules (Husemann & Cheng, 2005) (Howard & ywogrbpggxykt, 2010). Some instances found during playtesting that Radiant AI needed to be scaled back before the game's release due to unexpected behaviors as NPCs crossed paths, preventing quests and storylines from being completed by the player (bitmob, 2010).

While not currently affecting game developers and artists, AI has seen a wider use as a development and art creation tool within the games industry as of 2023. Making use of Unity's Inworld AI service, detective video game Vaudeville contains characters that pose the ability to "think and speak for themselves". With Inworld enabling for additional nuance and volume in NPC interactions, it grants designers a production-friendly solution to the increasing sizes of game worlds (Unity Technologies, United States, 2024). Filtering Vaudeville's reviews on Steam by those posted in January 2024 to February 2024, where play time was more than ten hours, common observations were seen that its NPCs could not respond appropriately to some player remarks and is capable of mixing evidence to the detriment of its gameplay (Bumblebee Studios, 2023). To explain why this may occur, "generative AI techniques and methods differ from how human artists create art", or rather AI generates content by sampling existing works, while humans interpret and iterate their art with self-expression. With concerns that Inworld's generative AI model, GPT-3, "takes the fruits of Artists' labour (the art) and steals (samples) them to create a mesh of its novel art" (AbuMusab, 2023), the ethics of its usage are largely left to debate.

In the cell automation game Conway's *Game of Life* (Conway et al., n.d.), cells are configured in an 'alive' or 'dead' state, with each cell being configured before the game begins. Each cell follows a set of rules which are executed when the game is started. The configuration of the game world determines its outcomes over real-time. (Björk & Juul, 2012) defined this as a 'zero-player game'; a game which operates without input from a player. This concept can apply within friendly NPC areas in games, but as of current is typically only found in Radiant AI and 'AI vs AI' boardgame simulations (Steckles, n.d.).

The next two sections of this review will analyse NPCs and the specifics of their design and development. This will cover their cultural and psychological influences, as well as developer insights on the production of NPCs for games across the medium.

2.2 – Designing for a world of friendly NPCs

In 'A theory of human motivation' (Maslow, 1943), it is specified that there are at least five basic human needs; "physiological, safety, love, esteem, and self-actualization." These qualities are defined by Maslow as such:

1. **Physiological** – food, shelter, warmth,
2. **Safety** – security, avoidance of hazards,
3. **Love** – relationships, intimacy,
4. **Esteem** – feeling of accomplishment,
5. **Self-actualization** – achieving full potential.

The qualities are exhibited in the design of NPCs, discussed in a 2004 preview of *The Sims 2* (Fahey, 2005). The author recalls a presentation held in Edinburgh, where Maxis general manager Neil Young discussed the evolution of the titular Sims NPCs between the first and second games in the series, based upon Maslow's theory. In the former entry, Sims would be required to guide around and assist them in their basic physiological needs (SariaFan93 & Maxis Inc., 2017), while the latter entry focused on later human needs and long-term goals. The game's characters were more capable of self-preservation due to this design decision. Characters within the series are motivated by time-based physical and mental prerequisites, further mirroring the human needs concepts (Maxis Inc., 1997).

Other games in the Simulation genre, namely the *Animal Crossing series*, have foregone the physiological aspect of Maslow's theory entirely, thus preventing the appearance of any fail state related to food or shelter. Instead, the series opts to design its NPCs with a focus on the **Love**, **Esteem** and **Self-Actualization** categories. A focus on self-expression drives the series' format, with its animal villagers often mirroring the activities available to the player character – sending gifts and letters to the player, tending to relationships with the player and other villagers, and a concern over the aesthetic beauty of their homes and the game world (Benti & Stadtmann, 2021).

Considering the design of friendly NPCs from the players perspective, *Animal Crossing: New Horizons* character designer Asako Shibata specifies that its villagers were designed with a focus on appearance and behaviors to make them easy to empathize with. The ability to hold basic conversations with villagers to learn their likes, dislikes and to get to know them better was also a part of the series' design, with time spent with each villager playing a large factor into the range of engagements the player can make (Shibata, 2020).

"Personality Types" determine the fixed nature of NPC villagers; **Smug**, **Jock**, **Cranky**, **Lazy**, **Normal/Sweet**, **Uchi/Sisterly**, **Snooty** and **Peppy**, with the eight personalities being divided evenly between male and female villagers. The visuals of villagers often correspond to their set personality type. These personalities decide the activities and dialogue a given villager will choose, but ultimately all villagers are otherwise mechanically the same, excluding their unique aesthetics (chibisnorlax, n.d.). More general villager reactions are based upon the player's current state, such as comments about the player's clothing or home arrangement (Benti & Stadtmann, 2021). The villager dialogue does not extend any further out than these reactions, since being scripted based upon a narrow window of player actions. This limitation can lead to scenarios where players exhaust dialogue options with villagers; causing them to repeat, revealing their underlaying systems (Tong et al., 2021) and affecting player immersion as a result. (Lazzeretti & Gatti, 2023) further identifies the lack of nuance to a villager's

characterization, though defends this decision as enabling dialogic interaction between the player and NPC. The developer's choice for personality types to be static works in the favour of the characterization of its NPCs, though also leads to a lack of character depth such as expressing a wider range of emotions.

Scheduling can be present in game worlds as a system to allow NPCs to change their short-term goals, or for the state of the game world or narrative to shift upon an action taken by the player or an NPC. The Witcher 3's character-driven quests lead to different outcomes depending on actions the player takes per each of the game's narrative acts. In a specific example, the character Keira Metz is interacted with during the first act, leading to either her death by the protagonist's hand or her fate being determined in the second or third act where she will either be executed or enter a relationship with another NPC (Anon, n.d.). This leaves the fate of the character entirely in the hands of the player based upon their choices, in contrast to the chaos of Oblivion's Radiant AI during development.

Much like *Oblivion* and *Skyrim*, *The Witcher 3's* story plays out against a backdrop of war and civil conflict, providing many NPC interactions with a hostile or political context. The combination of decisions made by the player grows in complexity throughout the course of the game, creating a "unique narrative experience". The player being able to affect the lives of characters via their decisions may be considered a form of emergent narrative (Vickery et al., 2018). Once the player has completed the final quest in a narrative act, NPC locations and objectives are altered to match the world's changed state and convey the passage of time.

The Legend of Zelda: Majora's Mask (hereby referred to as *Majora's Mask*) takes place in the land of Termina, with its central area 'Clock Town' acting as the game's hub. Given one year to create the follow-up to 1998's Ocarina of Time, the developers needed to consider ways to maximize game time by reusing assets and constructing the game's narrative around a three-day cycle. The cycle, referred to as the "Three-Day System", made this game's release possible (Iwata & Aonuma, n.d.). Rather than its passage of time being indicated by the conclusion of narrative arcs, its game time flows relative to real-world time; each minute in real-time being an hour in-game. Since time flows freely, characters move with their own volition and may only have their schedule interrupted if the player chooses to intervene. Each NPC has a unique visual design, dialogue, and objectives to complete – for instance, the mail carrier is delivering mail during the day, and the mayor is in office during the hours it is open.

To keep track of each major NPC in the game world, the player is given the Bomber's Notebook, a planner that automatically fills in each NPCs location at the times the player interacts with them. In the 2015 Nintendo 3DS re-release, Majora's Mask 3D, the Bomber's Notebook improves on this system. The game's developers opted to include an alarm system to alert the player to upcoming events after a restart of the Three-Day System, as it was deemed too easy to miss major events without it (Iwata & Aonuma, n.d.). While undocumented, it can be presumed that the developers planned NPC schedules for the game via spreadsheets. This method ensures that schedules properly overlap so that the player can optimize their playthrough on each three-day cycle.

In the next section, the technical and mechanical implementations for NPCs and NPC-adjacent systems will be explored to gain an understanding of how to recreate them. They will be discussed both in isolation and through their application within the context of a game world.

2.3 – Technical considerations for friendly NPCs

The AI systems of NPCs in games can be sorted into these non-exhaustive classifications (Bourg & Seemann, 2004; Pathak, 2021; DSouza, 2021; Sizer & Kylotan, 2018):

- **Rule-based** – constructed from a set of logic statements to decide behaviour,
- **Finite state machine (FSM) –** only one of many states can be true at a time and are decided by predefined criteria,
- **Fuzzy state machine (FuSM) –** an extension of FSM, allowing for the machine to decide its state based upon numerous values and choosing the most appropriate option,
- **Behaviour tree (BT) –** task-driven and expects success or failure to switch states/behaviors,
- **Utility-based (UBAI)** – unsorted actions are chosen from based upon the 'utility' of each action, making use of a planning phase with pathfinding to decide the best action(s),
- **Goal Orientated Action Planning (GOAP)** – like utility-based, uses a planning phase to inform actions, though by planning the best route *backwards* from the goal rather than forwards from the starting action,
- **Hierarchical Task Network (HTN)** – like GOAP, though uses an iterative approach to planning rather than a goal-orientated approach,
- **Machine learning (ML)** – AI model trained on existing 'learned' data,
- **Reinforcement learning (RL)** – learns based on what actions lead to successes during a simulation,
- **Generative AI –** generates content by sampling existing data within a defined context.

It should be noted that these systems are simply concepts and may be implemented and combined in many ways, based upon their required functionality. Each should be considered as components of a larger AI system. AI systems can be sorted into either deterministic (given inputs provide predictable outcomes) or nondeterministic (unpredictable or varying outcomes). Some AI systems intended to be deterministic may perform nondeterministic behaviors due to evolutionary design or unconsidered factors within the game world. This leads to **emergent gameplay experiences.**

For goal-orientated NPCs, a fuzzy state machine or behaviour tree affords the most control and best results due to their predictability during in-game use. This allows developers the ability to plan schedules and unique behaviors per NPC without introducing chaos or causing unintended outcomes. In terms of implementation, too many states in an FSM/FuSM will lead to a "state explosion" (Samek, 2016), or cluttered over-complexity. Making use of *super* and *sub states*, states may be nested inside one another, allowing for a primary and secondary evaluation of which state should be selected. Much like hierarchical FSM, BTs take a modular approach, though also reassesses its logic branches every tick (internal computer time) rather than when functionality is triggered (Ahmad, 2023).

GOAP adapts from (Fikes & Nilsson, 1971)'s STRIPS problem solving system for use with modern AI. An extension of FSM, GOAP makes use of goals and actions. The goals are then passed through the GOAP system, where it dynamically plans actions around those goals, using the current world state as a precondition to select actions. Rather than containing all functionality within each state, GOAP opts for a compact data-driven implementation.

The 2005 video game *F.E.A.R.* makes use of over 60 goals for its NPCs to follow, and 120 individual actions to achieve any set goal, and uses GOAP with three general FSM states in its AI (Orkin, 2006):

- **'Goto'** (for movement in the game world),
- **'Animate'** (to trigger animations),
- **'UseSmartObject'** (to interact with designated objects for NPCs to use).

The game's system is setup in such a way that designers can assign actions to the game's NPCs from a game engine tool, ensuring that performed actions abide by the characterization of its NPCs. (Dill & Dragert, 2017) explains that keeping AI behaviors separated prevents repetition and allows for the construction of robust agents which can exhibit complex operations with considerably less time required to implement versus non-modular AI. During circumstances where an NPC's goal is no longer achievable by the queued actions, F.E.A.R.'s GOAP system revalidates and is then capable of decided upon a new course of action to succeed in a goal. Without an additional step of validation, an NPC's logic would effectively break, leading to undesirable behaviors (Thompson, 2020). This system is suited for changing behaviors and deciding interactions to take within the game world. It is important to note that GOAP is a layer that sits atop a pre-existing AI system which extrapolates data from the game world and its present systems. Without that AI system, the GOAP system would not be able to perform its goals and actions. As such, an AI system is required.

(McManus, 2021) specifies that GOAP systems can be implemented with either a **monolithic** or **microlithic** method. The former refers to a system with one action fulfilling one goal, whereas the latter refers to a system with multiple actions chained together to fulfil a single goal. The monolithic approach is less scalable, while the microlithic approach has the advantages of scalability and greater variation of NPC behaviors by chaining actions together, though overall also being a more complex system.

AI systems commonly employ heuristic functions, which involves using rules of thumb or educated guesses to evaluate and discover potential solutions. Pathfinding functions utilize a type of heuristic function known as an **admissible heuristic** to efficiently navigate through search spaces (Autoblocks.ai, n.d.). One of the most common pathfinding methods in games is the **A* search algorithm**. This type of system has a history of use within the games industry, due to its ability to quickly find paths in the game world and its applicability across a wide variety of games (Newcastle University, n.d.). To decide on the optimal route to take to a destination, the AI will use the A* algorithm to determine a 'cost' for each potential movement and select the lowest costs every time, ensuring the most efficient route to the goal. This makes it ideal for use with most AI systems, such as GOAP and HTN. In other instances, A* may be used for decision making to path-find to specific destinations to fulfil one higher priority task before another. This allows for NPCs to act with perceived intelligence and may benefit gameplay and worldbuilding (Pihlgren et al., 2016).

There are numerous methods for NPC navigation, such as the **waypoint systems** used by (Kojima & KCEJ, 2001) for 2001's *Metal Gear Solid 2: Sons of Liberty*. The video game's guard NPCs follow along set routes, with key locations to move towards. If alerted by the player, a guard will be detached from their waypoint route and allowed to pursue the player character within the confines of the area they patrol (Birlew & Marcus, 2002). A similar system can be seen in *Majora's Mask*, where the game world's NPCs move along set paths according to their schedules, with game time being paused when engaging with an NPC to prevent each NPCs schedule from becoming uncoordinated. Waypoint systems may have been

technically performant during their most common use, they have now largely been superseded by the **navigation mesh** system. Navigation meshes are simplified representations of a game world's ground topography, generated by a game engine and used as bounds for where an NPC can or cannot navigate to. A* search and other pathfinding algorithms can be used with navigation meshes (jb-dev, 2018). NPCs leaving their assigned navigation meshes usually causes a failure in their movement functionality.

AI decision-making typically requires data input to search and inform actions, often in the form of the previously mentioned **world state**. This world state refers to the game's current state during gameplay. Namco's *Pacman* from 1980 uses a simple but intuitive targeting system alongside four states (**Scatter**, **Chase**, **Eaten** and **Frightened**) to ensure its opponents can pursue the titular character. Targets are placed on a tile in the 2D game world and updated on tick to track the player character's position. Based upon where the opponent is in relation to their target will determine with omniscience which route to the player they will take. Each opponent is intended to have unique behavioural traits, which is reflected in their variations on how they track the player's position. For the **Eaten** state, the opponent's target is set to an origin point, which they follow and return to the **Chase** state (Retro Game Mechanics Explained, 2019).

Despite the faultlessness of *Pacman's* AI, its rigidity and persistent knowledge of the player's position led to identifiable gameplay patterns, allowing players to exploit this and ultimately affect the experience that the game could provide. Later games introduced the concept of **senses**, to enable NPCs the ability to look, as well as sometimes hear and smell the world around them. Partial knowledge of the world state through the means of querying senses limits the performance requirements demanded by more complex game worlds and establishes a vast variety of potential outcomes. Physics raycasting, usually from the applicable NPC mesh, collects information about the perceived local world state for use as simulated eyes and ears. Unblocked raycasts often indicate visibility or audibility, while blocked raycasts prevent the NPC from sensing beyond the blocking object. The data obtained from a sensory system may be used as heuristic to reasonably inform AI actions. In *Thief: The Dark Project*, well-lit and dark areas within the game world also affect visibility, affecting whether an AI can detect the player character's presence (Leonard, 2003).

Unreal Engine 5 (UE5) contains its own set of bespoke systems for querying the current world state; that being pawn sensing and the Environment-based Query System (EQS). Pawn sensing is a pre-built sensory system for use with the game engine, like that discussed in *Thief*. The pawn sensing system can be used with UE5's **AI Blackboard** and **Behaviour Tree** systems to interface with any object per the data type of *Actor*, reserved for game objects with physical properties (position, rotation, scale). Much like the pawn sensing system, EQS can identify the Actor data type, or any classes which inherit from the Actor type. Objects of the Actor class can then query using a system of points with assigned values, referred to as "weighting" or "scoring". EQS must also be called from within an AI BT for use. Actor data alongside weighting determines the viability of points of interest in the world state (Epic Games, 2024).

The schedules of NPCs in the unofficial *Majora's Mask* decompilation project (zeldaret, 2024) is written out as a designer-friendly high-level scripting language to assist with the readability and modification of NPC locations across the game's three days. This scripting language allows for the output of a value depending on the current game state. In doing so, it provides a comprehensive understanding of the operation of the original game's scheduling system and associated game flags. It is understood that the implementation of the game's NPCs is hard-coded. *Cyberpunk 2077* similarly makes use of some hard-

coded NPCs with either basic pathfinding, or no movement and a repeating animation set. Rarely, some NPCs possessed unique names, with daily routines which are cycled as each in-game day passes. No other observable changes to their behaviors occurred.

It is speculated in that NPCs with daily schedules were largely removed from *Cyberpunk 2077* due to game performance issues and other miscellaneous problems. It can be assumed that the game's investor pressures, scale and mechanical complexity (Stanton, 2020) prior to launch left little time to add in every planned unique NPC. A designer-friendly interface for implementing unique NPCs may benefit similar open world game projects.

In (Garavaglia et al., 2022) dialogue systems function as a subsystem of an overall agent. An additional GOAP planner and **Drama Manager** is used to send story events to agents and affect displayed dialogue. Dialogue is also filtered by each agent's personality traits and mood, comparable to how Animal Crossing parses which dialogue a villager should use via its eight personality types. An editor tool allows for designers to set up new NPCs, and attach dialogue based on which prerequisites must be met for a player to receive them. Supergiant Games' project Hades contains a dialogue system which checks through an evolutionary tree of NPC dialogue responses, with special dialogue options only becoming available to the player once specific factors in the world state are fulfilled. Dialogue options also contain a priority value which ensures vital story elements are mentioned by NPCs before less important topics. Subplots throughout the story may be entered early or never experienced by the player due to its evolutionary dialogue system (Bratt & Sayers, 2020).

Emotions can be used to influence the specific actions taken by an NPC, selecting from a finite state machine as seen in (Gruenwoldt et al., 2005). Outcomes can be selected based upon the relationship between either an NPC and the player, or between two NPCs. This is referred to as the **Realistic Reaction System** (RSS). A relationship checking process occurs when two NPCs communicate. A single external **Relationship Manager** is queried to select from either **Positive**, **Neutral** or **Negative** states as a reaction to communication. The simplicity of three states may restrict NPCs from engaging in more meaningful ways. For further complexity in emotional responses, (Steunebrink et al., 2009) details an interpretation of the OCC model using 22 emotion categories. Applying specific context across a branching node graph, a precise result can be found matching many possible social scenarios. In this model, NPCs are shown to be emotionally influenced by one another, as well as objects and world state events. The extent to which emotions are felt is stored as an **intensity** variable.

2.4 – Conclusion: The research and development of friendly NPCs

In this section, I will summarise the content covered thus far in the literature review, provide observations, and lastly identify any gaps in the topic's research and outline potential solutions to address these gaps.

The purpose and function of each NPC in a game world must be considered while designing, along with the game genre and world setting. Models exist, such as Maslow's *A theory of human motivation* and Warpefelt's *Towards an updated typology of non-player character roles*, which can aid designers in this process. NPCs designed with their physical and emotional needs in mind are likely to resonate with players and enable deeper immersion as they explore game worlds and interact with their inhabitants.

Observing Barlow's and Warpefelt & Verhagen's NPC typologies as their in-game systems and considering the schedules of NPCs present in *The Witcher 3* and *The Legend of Zelda: Majora's Mask*, it is understood that distinct types of NPCs will call for different mechanical implementations. A vendor, for instance, may not require the need to move between locations on a schedule, while a storytelling might be expected to move through the game world either due to a change in time or progressing of the game's narrative.

Friendly non-playable characters may be identified as one of three technical types, each weighing their own benefits and disadvantages:

	Benefits	**Disadvantages**
Single-function friendly NPC	• Faster to produce, • Helps to illustrate clear gameplay objectives, • Low performance cost.	• Repetition of dialog affects player's relationship to agents, • Players may view the NPC as a gameplay device, not character.
Schedule-based friendly NPC	• Players may perceive NPC as intelligent, • Creates a dynamic game world with the potential for emergent properties.	• NPC schedules may conflict if not implemented correctly, • Complexity of systems means longer development time required.
PCG/Generative AI-based friendly NPC	• External data can be used to quickly generate content, • Can fill in absent content around existing game content, • Potential for dialogue inputs and outputs to act as context for future dialogue outputs.	• Nondeterministic behaviour can cause confusing and unclear gameplay experiences, • Ethically unclear practice, • May break player immersion if generated content does not follow the game's internal logic.

It was found that it is common practice for game managers of varying types to be initialised to control the given dialogic and emotional responses of agents during gameplay. Despite this, complex dialogue and emotion is often not exhibited in agents. Few existing game projects make use of wide ranges of dialogue options and emotional responses, to audience acclaim and success, and thus confirming the viability of their inclusion.

The depth of which character relations and emotions are implemented into games such as *Animal Crossing: New Horizons* is typically hard-set as a value, promoting a limited characterization. A **Realistic Reaction System (RSS),** as seen in Moody5, may benefit the character-based systems of the previously mentioned game and others in the same genre. The **revisited OCC model** makes use of 22 emotion categories which could take the place of the positive, neutral, and negative states seen in RSS to provide a wide gradient of emotions for designers to select from. This will allow uniquely crafted NPCs to express emotions on intensity values set by designers. NPCs can then express themselves freely, while having some emotion intensities set to a low value to prevent unwanted emotions from occurring.

Primarily, NPCs receive input from the player's actions on the world state and their direct actions, influencing NPC emotional states and relationships. NPC variance over time is likewise dependent largely on the player's input. It could be argued that the player has more agency over the narrative and game world than any of its agents do, in stark contrast to **zero-player games** such as *Conway's Game of Life*, which only requires an initial setup by the player. This approach to simulated worlds is typically not considered in present open-world games. It is likely due to optimization issues, as having many agents interacting and fulfilling tasks on a large scale is computationally expensive.

Scheduling systems are not currently commonplace in video games, although have seen some notable use as early as 2005. It is understood that the effectiveness of AI scheduling systems on narrative immersion in comparison to other types of AI systems has not been thoroughly studied yet. In contemporary video games, scheduling systems are frequently cut due to development difficulties and a focus on higher priority game features. External to friendly NPCs, AI planning systems such as GOAP and HTN are used for enemy NPCs in games for the purpose of perceived intelligent decision making, indicating the likelihood that friendly NPCs can operate on the same level of complexity if prioritized during development. Agent actions, goals and other subsystems are best kept as modular elements so that they may be easily interchanged by designers and modified with ease by developers.

Pathfinding in AI planning systems is vital to ensuring an NPC can reach scheduled locations or goals via the shortest possible route. Pathfinding and general decision-making methods are included as easy-to-use features in many modern game engines (Unity Engine, Unreal Engine, etc.). The most used pathfinding method makes use of generated navigation meshes to determine the bounds an agent can manoeuvre within. This helps with controlling the activity of larger game worlds and prevents performance issues and an excess of nondeterministic events by reducing the number of elements interacting in a single area. Sensory systems are used as inputs through local game space, while major world changes are often passed to agents through external systems for the sake of game performance optimization and reduced implementation complexity.

These components (scheduling system, planning system, reaction system, relationship system, dialogue system, etc.) should be connected as separate modules for the purpose of quick design adjustments and effective bug fixes during development. In complex systems, it is essential that system and state diagrams overviewing how components interface with one another are created to allow for a stronger workflow and better optimised programming.

3 – Materials and Methods

3.1 – Materials

Through exploring the topic, it has been understood that friendly NPCs are often underdeveloped due to development time constraints, or a prioritisation of other game features, leading to the usual exclusion of complex AI systems for friendly characters. It is observed that there is currently no specific research or model for the creation of unique friendly NPCs in modern open-world games, which could benefit the quality and production of commercial game projects. To address this space in the subject area, a model will be developed together with a tool for Unreal Engine 5 which will allow for the creation and customisation of friendly NPCs. An initial setup menu will be included with the tool to allow designers to easily define each NPC's unique traits (aesthetics, emotions, habits, relationships, etc.).

For the project artefact, a software tool will be created for use in Unreal Engine 5.2 onwards. A game project will then be developed using this tool to prove its use in current game development. An anonymous sample group familiar with the subject will play the project, which will be compared with **other narrative-orientated open-world video games***. A second sample group of game designers will use the tool in in-engine directly. Sample data will then be collected to confirm two points:

i. The developed project's friendly NPCs out-perform those of the ***other tested video games** in the following factors:
    a. NPC individuality/expression,
    b. NPC agency in the game world,
    c. Player engagement/immersion,
    d. NPC-player relationships.
ii. The NPC development tool is user-friendly for designers and new NPCs can be implemented into a game project and adjusted quickly.

The model will be iterated on throughout testing until a final version is established. The model will detail the main system and each subsystem involved in the NPC main system, including but not limited to:

i. Animation system,
ii. Pathfinding system,
iii. Planner system (GOAP or HTN),
iv. Scheduling system (persistent in world),
v. Dialogue system,
vi. Emotion system,
vii. Relationship system (persistent in world).

Pre-artefact data is to be collected to form a baseline to compare against with later participant data. This will assist in finding any existing connections between AI agent behaviors and qualities, and how audiences may have valuable or positive experiences with them. This pre-artefact data will also serve to inform the development of the artefact itself, both in its features and aesthetics.

3.2 – Participants

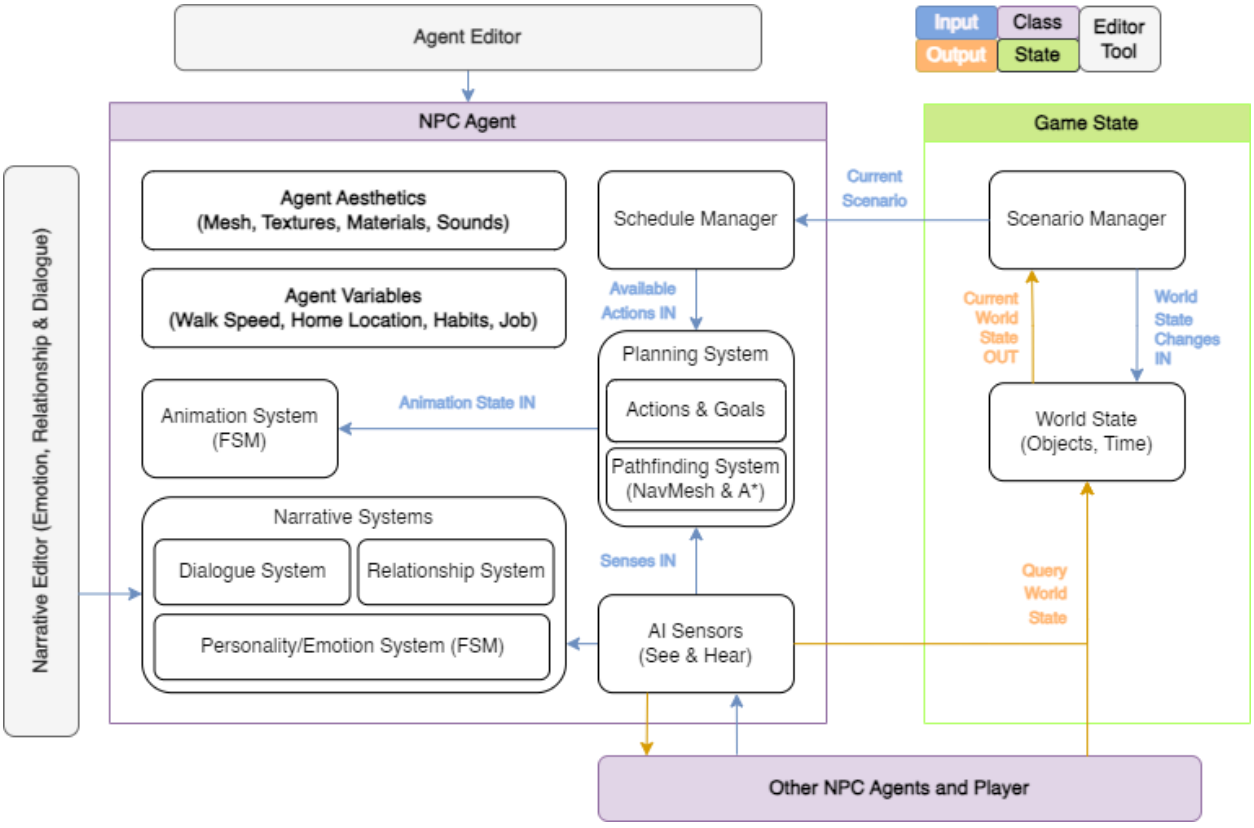
This pre-artefact survey (Appendix A) collects participant data on their individual experiences with a selection of commercial video game titles:

- The Witcher 3,
- The Legend of Zelda: Majora's Mask,
- Cyberpunk 2077
- The Sims 2 & 3,
- Animal Crossing: New Horizons.

The broad spectrum of game options within the initial survey should provide enough information to assist in the development of the artefact. A later survey is necessary to gauge the effectiveness of the artefact and suggest whether complex systems within 'friendly' AI agents are valuable to the audience's experience or not.

3.3 – Procedure

The artefact was developed in Unreal Engine 5.2, making use of the newly released StateTrees plugin. A simple utility editor widget was created to generate each AI agent from a base class, which included all vital variables for the utility tool to produce. Further details are exposed for potential designers to make use of after the creation of a child AI agent.



The testing area for AI agents includes two camping tents, a campfire and numerous fruits, with one special 'SmartObject' - a game object with unique properties to produce varying outcomes on

interaction based on settings included within. This object was positioned away from the rest of the game objects for testing purposes.

Unreal Engine 5 includes no features to store the world state automatically, and so a world query system (WQS) was created. The WQS receives unique tag identifiers from important objects and locations in the world, which can then be re-received by the game manager and AI agents when requested. The data was stored exclusively as boolean and Vector3 variables to keep processing times for game data to an absolute minimum. This may help when using the WQS with the development of significantly larger game worlds.

Individual states were created within the new StateTree system, taking inspiration from Jeff Orkin's F.E.A.R. GOAP implementation. Three overall states are included; Animate, MoveTo, and UseSmartObject. This helps to maintain simplicity in the inclusion of new AI agent behaviors.

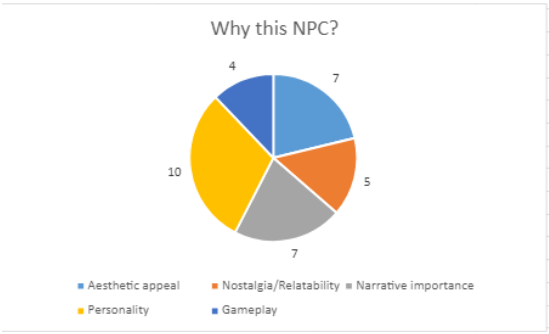
Lastly, a scheduling system was developed via a dictionary, or map, which stores keys and values together. For this system, the keys were an integer, keeping track of a game clock which rotates a sped-up 24-hour day cycle, while the values were locations and triggers for AI agents to respond to when the inputted time occurred.

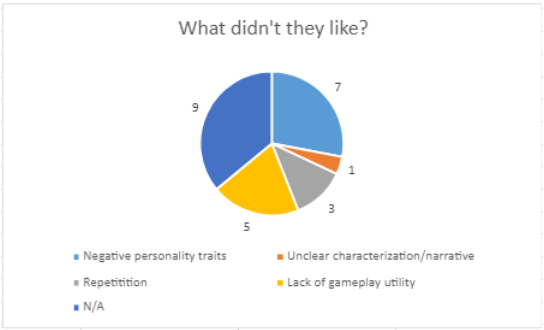
3.4 – Statistics

Many NPCs were chosen from the main cast of each game in the survey due to a variety of reasons. Categories have been created based on the responses given to refine the research data. Where multiple reasons are given, points will be put into multiple categories to represent the data as accurately as possible.

Regarding why participants chose the NPC they did, data showed most chose based on personality. Across all gathered data, there were only four mentions of gameplay as a reason for choosing an NPC. Most mentioned NPCs were also main characters or fundamental to the plot of their respective games.

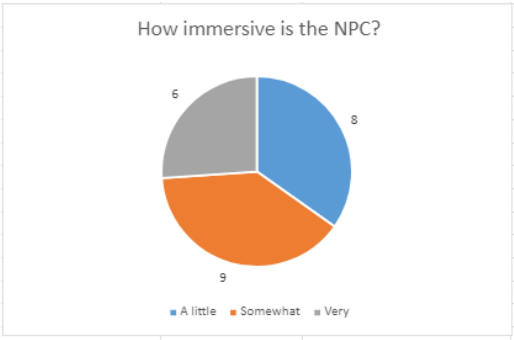
Most participants did not have any negative comments about their favourite NPC, though several comments were made about negative personality traits and a lack of gameplay utility, whether that be because the NPC was not available to interact with often enough or if the NPC's functionality was too limited when they were available.





Almost all participants noted their NPC to have a degree of individuality even despite a lack of any agency within the game world, restricted by the limits that their respective game's gameplay imposes. For instance, Isabelle from Animal Crossing: New Horizons was shown to have actions that reflected her personality yet had little actual control over the game state and was unable to freely wander the game world. In contrast, other friendly NPCs were described to be able to alter at least a portion of the game world. "Quests" and "missions" were mentioned frequently when discussing in-world agency, showing that participants were aware of the gameplay-narrative overlap in some cases.

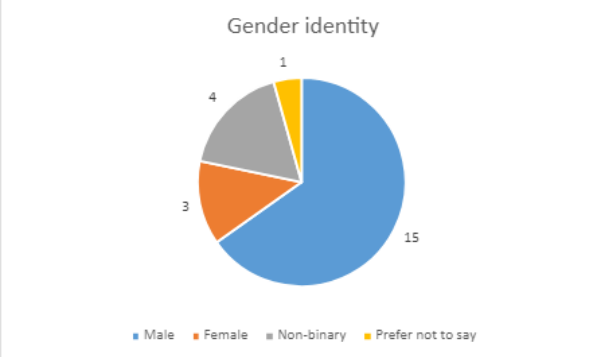
Regarding immersion, it was common for participants to describe the NPC as a guide around the world or aiding with worldbuilding by some other means. NPCs approaching the player first and engaging with other NPCs in the vicinity of participants had a positive effect on how they saw both their chosen NPC and other NPCs in the game world. Dialogic NPCs and other NPCs with backstories incentivized participants to want to learn more about and engage with NPCs again. It is implied through the research data that the repeated interactions with each participant's respective NPC are why most had selected them.

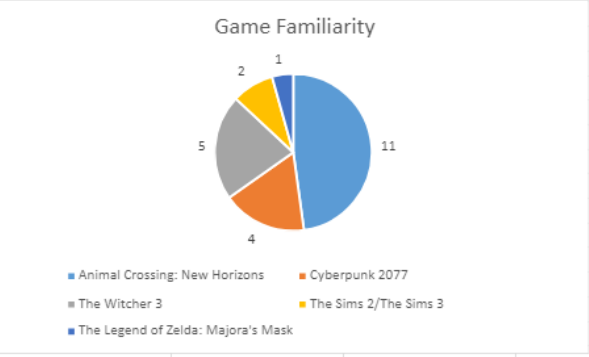


When asked about how the player-NPC relationship, interactions and dialogue could be improved, some suggested that the work required to improve their relationships be increased as they are too friendly for their initial interaction. Many others noted a lack of variety in dialogue and day-to-day schedules causing NPCs to feel more like a collection of systems rather than believable characters with their own thoughts and feelings. The lack of dialogue variety also restricted how much participants could get to know their chosen NPC. NPC expression was not considered to be obstructed by factors such as NPC animations.

Memorable interactions with chosen NPCs often related to the climax of the game's narrative, or the NPC's character arc. In other answers, participants mentioned other key moments in a character's narrative (moment of exposition), and pleasing interactions with the game world, such as one character listening to and dancing to a radio after turning it on.

Testing was undertaken via word-of-mouth and flyer posting around a single location with a large majority of male persons. As a result, the data has a strong bias towards male opinions. If this survey were taken again, it would be advisable to run it in other locations, and specifically screen for female and LGBT individuals to eliminate gender-based biases. Likewise, game familiarity had a strong bias towards Animal Crossing: New Horizons. This is likely due to the selection of games chosen, where New Horizons received a large amount of attention during a recent pandemic as its commercial release coincided with and better satisfied people's psychological needs throughout the incident (Yee & Sng, 2022). Researching recent popular games with NPCs would have helped in the game selection process (Gilbert, 2020), and may have led to better distributed results, though it could also be argued that many recent games contain less novel and varied examples of specifically friendly AI in games.





Pre-artefact survey participants pivoted towards characters with:

- More influence over the game world,
- Extroversive and expressive personalities,
- Deeper backstories,
- Appealing character designs,
- Subtle/hidden gameplay systems versus obvious gameplay systems,
- Non-exhaustive or varied dialogue options.

These factors should be considered during the NPC design process and will be included in some form during the development of the project artefact.

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5 – Appendix

Appendix A

Questionnaire on NPC Behaviors in Games

Thank you for considering this survey! It helps in collecting data on friendly NPCs in games. The data will be used to create an NPC creator tool for Unreal Engine 5.2, which will be made freely available on the conclusion of the project alongside the collated research data, via nestrd.github.io/NPC.

1. **Select your age range.**
   - 17-21,
   - 22-26,
   - 27-30,
   - 31-40,
   - 40+
2. **Select your gender identity.**
   - Woman,
   - Man,
   - Non-binary,
   - Prefer not to say.
3. **Which game are you choosing for this survey?**
   - The Witcher 3,
   - The Legend of Zelda: Majora's Mask,
   - Cyberpunk 2077,
   - The Sims 2/The Sims 3,
   - Animal Crossing: New Horizons.
4. **Which is your favourite Non-Playable Character (NPC) from your chosen game?**
5. **Why did your choose this NPC?**
6. **Is there anything you don't like about this NPC?**
7. **How does this NPC express its individuality (sense of self) within the game world?**
8. **How much agency does the NPC display within the game world?**
   - None – The NPC serves a single purpose or does not move from a fixed location, repeats the same dialogue.
   - A little - The NPC serves either several purposes or has an important single purpose, dialogue changes.
   - Some - The NPC moves around the game world and can communicate with other NPCs or the player to some degree.
   - A lot - The NPC moves around the game world, influences the state of the game world or the game's story, and has their own priorities (job, home, food, etc.).
9. **If possible, describe a time the NPC acted with agency within the game world.**
10. **How much does the NPC engage or immerse you in the game world?**
    - None - The NPC is clearly designed as a game system and is not directly interesting.
    - A little - The NPC is obviously a game system but is interesting to interact with.
    - Some - The NPC's systems are subtle, and/or they are remarkably interesting to interact with.
    - A lot - The NPC is compelling; I care about them and/or they enhance my immersion in the game world.
11. **If possible, describe a time the NPC made you feel immersed and/or caught your attention.**
12. **How would you describe the relationship or interactions between yourself and the NPC?**
13. **Could anything be done to improve the relationship, interactions, dialogue between yourself and the NPC?**
14. **Are the NPC's animations convincing?**
    - No - The animations do not play as expected (intentional or not), or the animations obviously repeat.
    - Somewhat - Animations are unrealistic, but still fit the NPC's or game's aesthetics well.
    - Yes - The NPC's animations are convincing.
15. **Is the NPC's movement convincing?**
    - No - The NPC struggles to find a location to move to or often glitches.
    - Somewhat - The NPC knows where to move to and does so effectively, though movement is rigid or unnatural.
    - Yes - The NPC's movement is convincing.
16. **Is the NPC's capability to make plans or a schedule convincing?**
    - No - The NPC does not make plans or the plans are extremely limited.
    - Somewhat - The NPC makes or has a regular plan/schedule.
    - Yes - The NPC has a full routine which is convincing in the context of their game world.
17. **Is the NPC's dialogue convincing?**
    - No - The NPC often repeats dialogue or is uninteresting.
    - Somewhat - The NPC feels responsive and/or clearly reacts to changes in the game world when spoken to.
    - Yes - The NPC is capable of a wide range of conversations and/or the player can learn a lot from their conversations together.
18. **Is the NPC capable of expressing emotion?**
    - No - The NPC does not express a clear emotion or any at all.
    - Somewhat - The NPC expresses a limited range of emotions based on changes in the game's narrative or other changes in the game world.
    - Yes - The NPC is capable of a wide range of emotions which are affected by the world around them.
19. **Is the NPC capable of establishing relationships with other NPCs or the player?**
    - No - The NPC does not maintain relationships at all.
    - Somewhat - The NPC maintains limited relationships with the player and/or other NPCs.
    - Yes - The NPC maintains a complex relationship with the player and/or other NPCs.
20. **Describe a time when the NPC had interesting dialogue, expressed emotion in a noticeable way, or had an interesting relationship with the player or another NPC.**

6 – Further Reading

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7 – Glossary

Artificial Intelligence (AI) – A system developed with the intention of acting with perceived intelligence, controlling outcomes in interactive technologies.

Non-Playable Character (NPC) – Unit in a game world which engages with the player(s) or game world in some capacity.

Agent – Term for the main system in a game which contains NPC assets, AI scripts and sometimes planners, dialogue, and other miscellaneous components for additional functionality.

Steam – Valve's online video game marketplace.

Dialogic Interaction – An interaction where a learner asks questions, discusses their perspective, and makes comments on the ideas of others.

Procedural Content Generation (PCG) – The process of generating contents for use in video games, using tools or systems to quickly iterate and produce variations on mass. Often used to increase productivity in open-world style video games.

Unreal Engine 5 (UE5) – A game development engine with a full graphical user interface and many features, suited for the creation of modern games.

Blackboard System – An AI method built upon a set of information. The information is iteratively processed until the AI can come to a decision based upon the given information in its 'blackboard'.

Tick – A repetition of computer processing logic, used as internal system time in computing.

Mesh – A 3D structure comprised of vertices (mathematical points), connected by edges (point-to-point lines). An isolated set of vertices and edges is referred to as a polygon or face. Together they serve as representations of objects in 3D space.

Physics Raycasting – A line is generated from an origin point to an end point for a duration in a game world. Collisions with the raycasting line are returned as a type of data.

AI Director – A global AI system designed to modify elements of a game in real-time to provide an improved gameplay experience.