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Generating Character Narrative AI

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# Abstract

Many developers have attempted to procedurally generate narrative using AI but this is seen in very few games with common examples being Rimworld (2016) and Dwarf Fortress (2006) which have managed to develop a way for randomly generated characters to interact with the environment and each other to create a narrative which the player is invested in. in this study there will be a discussion of different methods to create a narrative AI for characters to interact with each other, develop relations and to call back on previous events for those interactions. Overall, in this project many methods were used including {add methods here} before it was found that the {best method} was ideal for this project.

# Introduction

# Literature Review

## Research methodology

### What are methodologies

Whilst there are many programming methodologies each are used for certain situations and deciding which to use can be very important for any project. Here the discussion will be limited to just waterfall and scrum methodologies, and which one is more suitable for a research project.

### Waterfall

Waterfall according to (M. Mahalakshmi, 2013) is a methodology where a project is developed on a set path with no deviation. The methodology is made up of 5 stages first being the requirements stage where all of the project features, software and hardware requirements are assessed this is done to aid the next step. the design stage is where the development of the features is planned out often with pseudocode and diagrams to help developers understand how the project will work. next is the implementation stage where the designs are implemented, in terms of programming this is taking the pseudocode and the diagrams from the design phase and physically programming it to develop the project, next is the verification stage where the project is tested to see if it meets the requirements from the first stage and is it fails the verification then the project would be repaired to meet the requirements. The final stage is the maintenance stage where the project is released and maintained to ensure it still works as the original requirements asked for.

This model is very useful for developing a project with that can or should be fully planned out as the advantages for a project created using the waterfall methodology as stated by (M. Mahalakshmi, 2013) are that because it is a sequential model with no deviations in its development means that development can be comparatively fast compared to other models like scrum as all of the features are planned out and just need to be applied stopping the scope of the project from getting larger than expected bringing development times down. However, there are also some disadvantages to using this model which are that because it is sequential once one stage of the methodology is complete you can not go back to a previous stage meaning any issues that are found from one stage of the project can not be changed resulting in poor quality project unless plenty of time and resources are given to ensure that the project has no or at least few mistakes. This is also an issue as if a client or project manager wants any additional features halfway through development there is no mechanism within the waterfall methodology that would allow for those features to be added.

### Agile

According to (Khalil & Kotaiah, 2017)the Agile methodology is an adaption of waterfall to help avoid the issues of the Waterfall methodology as mentioned above, while the stages on an Agile project are similar there is a major difference with the Agile methodology is that previous stages can be revisited to add additional features allowing any project to be expandable resulting in a better project overall this can also be backed up by (Khalil & Kotaiah, 2017)showing the total number of failed projects using the waterfall and agile methodology as well as challenged projects i.e. incomplete project and a successful project with all required features added and as seen in appendix 1.1 the average fail rate for agile(9%) is lower than waterfall (20%) with success rates being 54% for Agile and 35% for Waterfall showing how Agile can be have better odds of being either successful or at least partially successful project. However according to (Sheetal Sharma, 2012) the disadvantages of an agile project are that the time and cost requirements can go greatly over the target if managed poorly as the project is poorly planned as the scope is increasing causing unpredictable time and development costs which can cause the project to fail. Also due to the constantly changing project it may be harder to document the project as the documentation is also constantly being changed and expanded making maintenance of the project harder.

### Which is better for the research project

Choosing a methodology for this research project is crucial as a bad choice may cause this project to fail as according to (Kaushal Chari, 2017) many projects fail due to not choosing a methodology compatible with the type of project being made. As this is a research project waterfall could be useful as the research for the project could be for its design elements however there is a risk in utilizing this methodology as mentioned before there is no back-tracking allowed on a Waterfall project, if the project fails then there is no more planning whereas Agile allows for a failed project to be reiterated on although at the cost of extra time. Another reason to use an Agile framework for this project is that extra features and discussions can be had if time is available. However Agile is a whole group of methodologies and picking a specific methodology should be considered. According to (Igor Ribeiro Lima, 2012) Scrum is a methodology that could be useful in research setting as it allows a project to be developed in a series of sprints to get individual tasks done. This makes it useful as a research project is difficult to define the scope of early on and having this be the methodology for researching and developing the artifact means that the project can be expanded for as long as there is time. An important feature of the scrum methodology would have to be changed however as according to (Marchesi, Mannaro, Uras, & Locci, 2007)Scrum works with teams for example a Scrum master, product owner and individual team members however this is a research project with only one member of the team meaning that many of these roles are redundant and are not required is the planned implementation of the Scrum.

Overall Agile should be used in the research project as it allows flexibility in a field currently being studied and likely to need reiteration and redesigns to create the project successfully as well as further discuss potential features that could be added to the project or alternate ways for the project to be implemented. The specific Agile methodology chosen shall be Scrum as it provides the ability to sprint through features that can be expanded on as the research expands giving more liberty to research to add to the project.

## Introduction

### What is narrative AI

Narrative AI is the use of artificial intelligence techniques to generate stories this could be a whole story generator as seen with ??? which generates entire stories from a top-down approach or multiple agents and ai systems that create an emerging narratives i.e. each character have likes and dislikes which decides what they do or a personality that affects relations with other characters.

### History of Narrative AI

While it may be hard to define narrative AI so dating the first use of it may be difficult but, according to (procedural story telling book ref ) The history of narrative generation in games could be dated back as far as 1949 with the board game Cluedo and some of the earliest games to utilize narrative ai was the EA developed, Murder on the Zinderneuf which was a murder mystery game that generated a new mystery with each playthrough having a variety of characters any of which could be the murderer which the player had to deduce with in game clues that they could find by exploring and while being a very basic story generator with the only features changing in each playthrough being who murdered someone, the name of the victim and the clues for them, the game had to deal with the extreme computational limits of the time having only 48 kilobytes of memory which is minuscule compared to average gaming memory nowadays so since then narrative AI has been able to encompass more of the narrative in certain games like Dwarf Fortress (Bay12Games, 2021). which released in 2006 which heavily utilized narrative AI to generate an entire world with whole characters, nations and history being generated to create a unique and immersive world which has inspired many more games such as Rimworld in 2018 (Ludeon Studios, 2018). which focuses more on individual relationships between the generated characters.

### How narrative AI is used

As mentioned before narrative AI can be used to create whole stories as seen with Jamie Brew’s predictive text program (Hudson, 2016). which was used to generate a story feeding stories like Harry Potter to generate its own telling of the story. It worked by using a long-short term memory (LSTM) neural network which allowed the program to generate the story using the books as a reference and estimate what words would be used to create the story.

Other ways narrative AI can generate stories is through having individual AI agents and systems which can create emergent behaviours as seen in the previously mentioned games like Rimworld and Dwarf Fortress which generate a narrative using multiple methods with both games recording events that happened in the game and then reusing them for other things for example both games a an art creation system where a character makes a piece of art and its description is generated using those events to create art unique to the playthrough as seen in fig 1. Rimworld also has dialog between characters where they can talk about a number of things, flirt or insult each other which can raise or lower their reputation with each other fig 2. Another system in the storytelling AI in Rimworld that uses the value of the settlement you built as a heuristic to decide what events to throw at you with the more money you have the worse the events the AI can throw at i.e. large raids of hostile characters that could kill characters fig 3. All of these events together create the emerging story for the purpose of getting the player more invested.



Figure 1: art description from Rimworld generated using characters from the playthrough i.e. Boomrat and the Muffalo. this also show events being used with a date and the event of Boomrat catching fire

## Methods of generating narrative AI

There are many methods to creating narrative AI each being useful for different mechanics such as character behaviour as well as dialog and other text generation needs. Each method will be discussed to see how they work and how they can be utilized in this project.

### Behaviour Trees

<https://arxiv.org/pdf/2107.06638.pdf>

https://www.gamedeveloper.com/programming/behavior-trees-for-ai-how-they-work

To create behaviours for characters in games there many methods and a popular one to look at are behaviour trees. Behaviour trees according to ??? as the name implies are a tree of nodes which run behaviours with several transition methods to control how the AI agent flows between the nodes. These transition methods are sequence which will sequentially run through each child node and run the behaviour for them however it only succeeds if all child nodes were successful is running their behaviours. Parallel which works by simultaneously running all child behaviours at once and only succeeds its tasks if a given number of child nodes were successful at running their behaviours. Selector is like sequence as it will sequentially run all child nodes however it will be successful when any child is successful ignoring the rest however the selector transition type will fail if all child nodes fail to run their behaviours. According to ??? all previously discussed transition types are known as composite nodes as they require one or more children however decorator nodes can only have one child these include inverter nodes which returns a success or failure opposite to what the child node returns, a succeeder that always returns success and a repeater which will repeat running its child node a given number of times before continuing but there is also a version that can repeat until the child returns a fail known as a repeat until fail node.

Behaviour trees are popular for modelling AI behaviours because according to ???1 they allow for relatively complex reactive AI as the tree structure con be made more complex to suit a number of emerging characteristics from few behaviours which could be useful for making an AI agent decide what to do for example throughout the day an AI agent has a number of items on their to-do list with the priority being eating breakfast before going to work then going out with friends later in the day. This allows for priority tasks to be completed first but could transition between behaviours when required as if the AI agent’s car breaks down they may stop to call a mechanic and wait before heading to work as the behaviour tree unsuccessfully attempt to get to work the behaviour would change. This can also have extra behaviours to be added on without adding much complexity as all the behaviours are modular and can just be added onto the tree in a clear order for what behaviours will trigger making ideal for relatively complex AI behaviours.

### HTN plans

https://arxiv.org/pdf/1403.7426.pdf

<https://www.researchgate.net/profile/Marc-Cavazza/publication/220851669_Interactive_storytelling_from_AI_experiment_to_new_media/links/580f3d0308aef2ef97afbf4b/Interactive-storytelling-from-AI-experiment-to-new-media.pdf>

According to (Humphreys, 2021). a HTN which stands for Hierarchical Task Networks are type of behaviour tree that are often used for planning in AI agents and is a behaviour tree made up of either primitive tasks which are simple tasks like opening a door or compound tasks which are a set of primitive tasks which have multiple solutions so for example a locked door may require a key so the AI agent would have to first find a key, then unlocking the door with the key before finally opening it or an alternative solution could be to bash the door down to open a door. This makes HTNs very similar to behaviour trees however HTNs differ by essentially generating its own tree from a pool of tasks known as the search space. The search space is a set of primitive or composite tasks which are then used by the HTN planner by taking all the primitive tasks and integrating them into the HTN’s behaviour tree and then deconstructing the composite tasks into primitive tasks and implementing those into the behaviour tree all these primitive tasks are then decomposed into a planned goal allowing a given AI agent to develop a plan. This could be for example an enemy AI soldier attacking the player, they will shoot, roll into cover and throw grenades however if a player gets to close new tasks will present a new way for the AI to achieve its goal of killing a player i.e. melee attack. According to ???2 this makes HTNs useful for creating interactive stories as each character in a given story could be given a goal which they can make a plan for using the search space to gather tasks to achieve that goal with for example a exiled king character in charge of a small county could have a number of actions available to them to either to do nothing however it may have a goal to retake their land so they may focus on tasks that build them an army to take back that land driving a narrative.

### Recursive narrative scaffolding

<http://dspace.mit.edu/handle/1721.1/54502#files-area> really bloody long but might be good read

Recursive narrative scaffolding is a term given by (Garbe, 2018). to describe the use of events in a narrative AI being used to generate a history which can be referred to. This takes into consideration the use of narrative scaffolding for use in world building where for a character could be born into a noble family and that family could have a rival noble family which may have wrong the character’s family in the past i.e. sided against the king in a civil war. This lays the groundwork for this character as when the story for the character starts there is a predefined history for the character that makes other characters in their family or the rival family have history with them and drives a narrative. Now this can be used is a procedural generation model as mentioned by (Jason Grinblat, 2017). where events are generated before the character exists which defines how they will subsequently interact with the world.

How recursive narrative scaffolding could be implemented is apply this model to all generated characters to generate their history and be used in newer history to generate art or dialog.

<https://link.springer.com/article/10.1007/s13164-021-00595-w>

### POCL plans

<https://www.cc.gatech.edu/~riedl/pubs/riedl-ai4games.pdf>

use of partial order casual link (POCL) plans to allow ai to guide a story

POCL or Partial Order Casual Link is a planning system

### Natural language processing

<https://www.ibm.com/cloud/learn/natural-language-processing>

<https://openai.com/blog/better-language-models/>

https://www.theverge.com/21346343/gpt-3-explainer-openai-examples-errors-agi-potential

<https://play.aidungeon.io/>

https://arxiv.org/pdf/1909.01326.pdf

According to ???ibm Natural language processing or NLP is the process of using a computer to process and understand language using statistical and machine learning principals. NLPs like are able to recognize speech and the intent behind its content for example the word catch could mean the verb ‘to catch’ but an AI may not be able to understand the saying “what’s the catch” as catch here means a downside of something rather than the typical meaning of the word with speech tagging through machine learning and/ or statistical analysis an NLP can be taught the difference between these to saying to add context and understanding of the content given. Models like GPT-2 ???2 an AI agent could be able to talk and understand dialog between different characters using GPT-2’s NLP to use the sentences given by other characters and process a response to them and this response could even implement the characters background and relation with other characters as a way to guide how a given character would respond to a sentence for example a character (Bob) talks about cats to another character (Dave) however Dave hates so the response could be tagged as an angry response about how the character hates cats and the NLP will attempt to generate the response and if Bob likes cats the NLP could use that fact as a tag to attempt to argue back to Dave. This could massively improve any narrative AI however NLPs face many flaws that may make it unusable in this project as according to ???3 many NLPs like GTP-2 and its successor GTP-3 still have many issues with speech recognition and intent with one example of an AI with GTP-3 being asked “which is heavier a pencil or a toaster” with the NLP simply responding “a pencil is heavier than a toaster” so while NLPs like GTP-2/3 are very capable of understanding language and context they often can have issues and require fine tuning with its complexity being very difficult to work with. This complexity can also cause issues with speed as implemented a NLP into a real-time game into even a single character could greatly affect performance let alone multiple characters talking with each other. These performance issues can be seen in games like the text-based dungeon crawler, AI dungeon ???4 which can take up to a few seconds to generate a line of dialog making it very difficult to implement into a real-time game without any major slowdown issues or major optimisation which may be too large in scope for this project to handle. Another issue with the text generation in NLP is how they can be unpredictable in what they will say and game designers and writers may want to make sure that the content they are producing is suitable for what they want in the game and NLPs are naturally unpredictable as previously seen. As stated by ???5 in the case of GTP-2 natural bias in the AI could contribute to undesired stereotypes in what characters would say an example stated in the paper shows the AI being asked a number of statements and were judged on what someone from a demographic is and the results showed a net negative for certain groups such as black and gay people which could create unwanted bias in dialog created by NLPs which may require further tweaking to solve.

Overall while it is an effective strategy to utilize an NLP as a text generator its unwieldy, unpredictable and performance intensive problems make it unusable in this project.

### Heuristic ai planning – (needs ref)

## Artifact – Design

### Project requirements

#### Unity

The project will utilize the unity game engine to develop the project. This was chosen instead of an inhouse crafted game engine or an engine such as Unreal Engine as the engine will not affect any parts of this project as the performance of the project is not expected to make the choice of engine crucial. As for not using the inhouse engine and instead using Unity may even benefit them with ease of use features and the time saved from the engine being already developed.

Other ideas?

### How this project will use narrative AI

The plan behind this project is to mimic much of the emerging narrative systems in Rimworld and dwarf fortress with a small settlement filled with auto generated people each with different personalities, like and dislikes which change how they interact with each other some could have an abrasive personality that might make them more likely to insult someone if they talk about something they do not like. Each character is given a set of relation scores which determine how friendly or intimate they are with each character which can change with the dialog they have with each other. With other features such as the art feature like Rimworld where actions are recorded and can be referred again by the characters.

## Artifact - Implementation

## Further improvements

# Reference list – DELETE THIS

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needs reviewing – discussion of how dwarf fortress uses narrative through events although this more through a narrative perspective rather than a programming method

<https://stars.library.ucf.edu/elo2020/asynchronous/proceedingspapers/10/>

discusses systems relating to character believes in a style similar to dwarf fortress and how other characters interacting with each other can cause them to come into conflict

<https://ieeexplore.ieee.org/abstract/document/7439785>

story generator

<https://www.researchgate.net/profile/Marc-Cavazza/publication/220851669_Interactive_storytelling_from_AI_experiment_to_new_media/links/580f3d0308aef2ef97afbf4b/Interactive-storytelling-from-AI-experiment-to-new-media.pdf>

use of htp systems to create actions the user takes and for other character to interrupt task of the player to help generate narrative

<http://project.jacobgarbe.com/simulation-of-history-and-recursive-narrative-scaffolding/>

this one is important talking about using game event data as a scaffold for a later event

<https://ojs.aaai.org/index.php/AIIDE/article/view/13046/12894>

story generator using natural language processing could be too complex to implement

<https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1024747>

HTN with emergent ai creating stories

<http://ceur-ws.org/Vol-2862/paper25.pdf>

talks about the human influence in narrative ai as well as how this helps social believable

<http://www.journalssystem.com/shagh/Reactive-games-as-an-example-of-extensive-use-of-evocative-narrative-elements-in,132785,0,2.html>

talks about how these games can be used to help create narrative using youtuber as an example of games like dwarf fortress can be used as a narrative tool.

[Subverting Historical Cause & Effect: Generation of Mythic Biographies in Caves of Qud (acm.org)](https://dl.acm.org/doi/pdf/10.1145/3102071.3110574)

Talks about the text generation system from caves of qud a dwarf fortress inspired game and how events can change the relationships between characters and the game world through generative methods

[ResearchGate](https://www.researchgate.net/publication/337325308_Evaluating_AI-Based_Games_through_Retellings/link/5dd283bd299bf1b74b4b86ac/download)

Shows how the project could be tested with player retelling to deal with complex and difficult to imperially answer questions about the project

[(PDF) A Personalized, narrative and interactive simulation based on a rules-engine system designed to confront informal caregivers with personalized virtual Alzheimer's patients and to train their communicative coping strategy skills (researchgate.net)](https://www.researchgate.net/publication/345241095_A_Personalized_narrative_and_interactive_simulation_based_on_a_rules-engine_system_designed_to_confront_informal_caregivers_with_personalized_virtual_Alzheimer's_patients_and_to_train_their_communicat)

Use of narrative AI beyond games but to help Alzheimer’s

[(PDF) Characters in Search of an Author: AI-Based Virtual Storytelling (researchgate.net)](https://www.researchgate.net/publication/221594595_Characters_in_Search_of_an_Author_AI-Based_Virtual_Storytelling)

Follow up on htn paper

# Conclusion

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