A Comparison & Evaluation of Different Methods for Applying A.I. in Gaming

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BSc. Software Design 2016/17

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##### Declaration

I hereby certify that the material, which is submitted in this report towards the award of BSc. Software Design, is entirely my own work and has not been submitted for any academic assessment other than part fulfilment of the above named award.

Future students may use the material contained in this report provided that the source is acknowledged in full.

Signed…………………………………………….

Date………………………………………………

##### Abstract

##### Acknowledgements

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# Introduction

## Introduction

My name is Adrian McCormack and this will be a brief introduction into my research project. I am currently in my fourth year of college studying software design and I aim to be a game developer in the future. I have always been fascinated with games that incorporate complicated artificial intelligence that really makes you feel like the things moving around on screen have a genuine purpose or goal. Games such as real-time strategy games are examples of some of the best use of decision making AI currently in gaming. They manage resources, control armies, research, alliances, they react to the player’s strengths and weaknesses and really make their characters seem like a living and breathing society built into a game. Until now I have not done much work involving A.I. in my games and had always followed other people’s lead or works as examples in how I should implement A.I. in my games, rather than do the research myself and learn the possible benefits or drawbacks of the countless ways to do it. With this project, I aim to create a game styled simulation which uses multiple A.I. implementation strategies so that I can accurately evaluate and compare the different benefits or drawbacks of each strategy.

## Research Aims and Objectives

The aims and objectives for my research are as follows:

My aims are:

* To develop a game styled simulation that can act as a tool for running specific tasks with characters that use different AI strategies.
* To research AI in games and study the ways they have been implemented throughout the gaming industry.
* To apply my research of AI into my simulation allowing me to set up test cases, where an evaluation and comparison of the effectiveness of each strategy can be achieved.

My objectives are:

* To run test cases through my simulation. These tests will be specific to my simulation’s own type of game, this being a team collect and craft battle simulation, as well as different settings I apply during these tests. These differing settings will include different starting supplies, shorter or longer phase time limits and larger or smaller starting team sizes.
* To evaluate the results of each test case and compare their effectiveness with other similar test cases. E.g. compare the result of two AI strategies against each other where they both had large starting supplies but a short preparation time.
* To compare my result expectations with the actual results of the test cases
* To give my final evaluation of the tested AI strategies and discuss how they might best be applied in gaming.

In the next chapter I will be going through my background research into the field of Decision Making AI in Gaming. I will discuss where it began in the industry and how it has evolved into what it is today and its impact on the industry.

# Background Research

## Introduction

My main focus throughout the research process will be in the domain of Decision Making Artificial Intelligence. Decision making is just one of the several parts of gaming AI that can make a character seem to act or behave as though they are truly intelligent individuals. Decision making AI is the most deceptive feature a developer can use in a character as it is the primary tool used to fool a player into believing the character is real. Therefore, when a developer makes a truly great and engaging AI controlled character, it’s wonderful to see and often puzzling to know how the developer done it. In this chapter I am going to be researching the implementation strategies used by developers to bring that realism and believability to their characters. First however, I will discuss the history of AI, it’s significance in gaming and its impact on the industry.

## A Brief History of A.I. and its Importance in Gaming

Artificial Intelligence began as a problem-solving technique that has been used more and more throughout the years. Though the requirements and mediums involved change from one situation to the other, its purpose remains the same after all this time. Whether it’s a scientist running maths simulations, a software developer looking to make a more interactive user interface or a game developer deciding how to make the best use of a character’s skills, AI is incredibly adaptable and can suit so many situations.

Back in the 1940’s the first programmable computers were created with motivation stemming from the war effort in Europe. They were deployed to intelligence divisions in the war with the purpose of decrypting enemy transmissions. This was one of the first major uses of artificial intelligence using a computer. In the summer of 1956, the field of AI research was founded in Dartmouth College in the United States. From this point on research and development into AI continued with its highs and lows until what it has become today.

Video gaming was born in the mid-20th century with games like “Pong” being one of the first in an industry that what would one day be worth tens of billions all across the world. Games such as “Pong” and “Space Invaders” spawned several clones which done very little to expand on the industry and its technology. At the late 1970’s and early 1980’s, people began to be introduced to new concepts in gaming. In May 1980, a company by the name of Namco released one of the most historic games ever that became an instant classic in its time. That game was Pac-Man and it changed the way people looked at games. In no video game until Pac-Man had there been a type of enemy that reacted specifically to the player’s actions or location quite like they did in this innovative game. By today’s standards the idea seems simple enough, you move around, the ghosts chase you, you get a special pickup and now you chase the ghosts. But before this time no one had made a game that used these sorts of features and it’s all thanks to new advancements in AI concepts and implementations. Pac-Man used what’s called a State Machine to control and change how the enemies behaved by checking the situation the player is in and changing the enemies state according to how they are supposed to act in that situation. New AI concepts and ideas had expanded the potential of games to all new heights.

Jumping ahead to the year 2000, AI in games had advanced in many ways. In February of 2000, a company called Maxis had released a game called The Sims. A hugely popular game, The Sims set the standard for individual based decision making AI in gaming for years to come. The Sims sold to players the idea that the characters in The Sims were real people with families, traits, opinions, goals and relationships. Many games at this time use the simple AI I described with Pac-Man whereas game like The Sims were creating new possibilities and even goals for the gaming industry as a whole.

Games today have expanded on the possibilities their predecessors have set. The internet is a huge part of this rapid development. With faster and wider reaching communication of ideas throughout the world, more and more people are learning, optimising and expanding on the ideas they discover. To see evidence of this you need only look at the industry today. Though admittedly having some commercial problems over the years, Microsoft’s Kinect allows games to react to the players actual body movements using an infrared camera and motion tracking. The idea of the player physically altering things in the game expanded to include virtual reality headsets putting the players right in their character’s shoes interacting with the world. Concepts for characters’ personalities in games have also expanded greatly. In a game called Middle Earth: Shadow of Mordor, the development team brought a whole new feature to the Role-Playing Game genre. This feature, they named The Nemesis System, lets the characters that the player interacts with in game dynamically learn, react, build an history with and behave appropriately to the relationship they’ve built up with the player’s character. The idea of this feature is nothing new, however it has until this time been implemented with scripted events or characters pre-built with a certain disposition towards the player’s character. The Nemesis System is a dynamically learning system that adapts to all kinds of behaviours, whether the player defeats the enemy in combat, flees, loses or even lets their enemy escape. That enemy will remember the events that transpired and behave according to them in their next meeting. This gives the player the feeling of building up some sort of odd rivalry type of relationship with even the lowest of common ‘grunt’ typed enemies. And that is a true art in gaming, giving the player a real feeling of interacting and building a history with a games character that leaves an attachment there that pulls the player back and drives them to build their own story with this character. It lets them see where they and their rivals story goes till its inevitable bitter end.

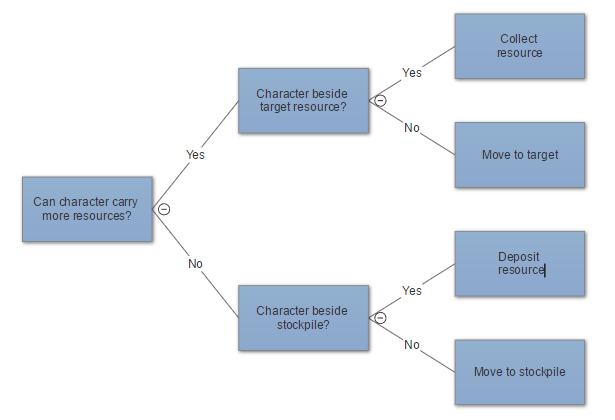
## Common AI Strategies Used Today

Until now I haven’t explained what an AI Strategy is. An AI Strategy is not a chunk of code you can copy from an online source and then paste into your game, it’s more along the lines of a development mindset when dealing with a problem. Take for instance a character that your games player character runs into, who is it? What is their personality and behaviour traits? Are they here to help or harm the player? Do they have a set of skills or vital information that can help the player? Is this character even relevant? All these questions and more must be asked before a developer can proceed with deciding on a Decision-Making Strategy for this character. I will begin this section discussing one of the most popular, basic Decision Making AI implementations used today, Decision Trees.

### Decision Trees

There can be simple systems or complicated thought processes when applying AI to a character. Most developers like to keep unimportant characters or game features as simple and uncomplicated as possible to either get it out of the way or prevent it from causing problems down the line. One of the simplest and most widely used Decision-Making AI Strategies is the Decision Tree.

The idea behind a decision tree is that it poses one question to the character after another. This process continues until each of the answers guides the decision-making process through the ‘tree’ to an eventual outcome. Below is an example of a decision tree I used in my simulation, it runs through a few simple yes or no questions to find an appropriate outcome based on the answers.

A decision tree

The more complex the questions are, the more branches the tree may have leading to a very convoluted tree with many repeating patterns which may only have subtle differences. Trees like these may lead a developer to choose a different AI Strategy which better suits the complexity of the specific situation. A character with a specific goal would not be well developed under this strategy as it involves complex proactive planning on the part of the developer. I will be discussing Goal Based Decision Making next.

### Goal Based Decision Making

This strategy is very literal in that you as a developer must define your character’s goals before anything. Many strategies would be considered reactive in nature, goal based decision making is more proactive as it focuses decision making around that which furthers a character towards its end, mid, or starting goals.

Take a character in The Sims for example, when a character is created, certain aspirations are selected for them. These aspirations set a long line of objectives that a character must meet in order achieve their aspirations. Imagine the character wants to become a head chef at a restaurant. To do this the character must join the culinary career path. Our character is not in the mood to look for a job. This is where the decision making begins, the character will now decide on what physical or social aspects of their life that needs improvement before eventually working on them and obtaining a good mood. When the character is in a good mood it can look for a job. That is where our character’s course begins, with small goals that lead to the larger goal in its sights.

This type of Decision Making AI is great for all types of games in but games like The Sims, team based games or games in the Real-Time Strategy genre it is almost perfectly suited. The next strategy I will be discussing will be based on stats and skills.

### Skill Based AI

This strategy is best suited to situations where the game’s character has some form of stat or skill tracker. The developer should use these trackers to compare each one of a character’s skills and set a priority for the character to behave in a way that utilises its most proficient skills before all others. This strategy can also be used quite effectively in team styled games.

In EA’s FIFA football series, teams are set out by the AI in a way that fills the pitch with the best people for each position. Characters with the best reflexes are assigned as goalies, the best tacklers are assigned as defenders, the best playmakers are in midfield and the best strikers are up front ready to score goals. If there is a missing player in midfield, the balance of the team would be shifted around to ensure that the positions on the field are filled with the best available players.

This strategy plays on the efficiency side of gaming. Many gamers would refer to this strategy as a type of “Min/Maxing” strategy where there is minimum priority in using or training the worst parts of a character and maximising the focus on a characters strongest features.

I will be going into further detail on the implementation side of these strategies in the next chapter where I will cover the planning and development of my own simulation for testing and comparing Decision Making AI Strategies.

# System Design

## Introduction

In this chapter I am going to be covering the many different stages of development involved in the making of the simulation I built for my research.

## Requirements

## Architecture

## Design

## Implementation

# Testing and Evaluation

## Introduction

## Testing

## Evaluation

# Conclusions

## Introduction

## Reflection

## Recommendations

##### References

[1] I. Sommerville, *Software Engineering*. Boston: Addison-Wesley, 2011.

##### Glossary

##### List of Abbreviations

###### Appendix Title uses ‘Heading 6’

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