

Downfall: A Computer game incorporating A* Pathfinding Algorithm

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ABSTRACT

Story-telling plays a big role in many forms of entertainment. This includes video games and how the story flows from humble beginnings, to an ending that will emotionally capture its players and audience. In this documentation, the developers illustrate the methodologies that other game developers have enforced in their games, and the method created to better suit the project based on the other methodologies. Downfall is a 2D top-down Role-Playing Game that places you in the center of a conspiracy to overthrow the king. The player is given the freedom to choose which one of the Great Families to support. Your choices throughout the game will have an impact on the game's ending as well as its various characters, allowing for multiple endings to occur within the game. Developed using RPG Maker VX Ace with Ruby as its scripting language, Downfall incorporated A* Pathfinding algorithm to create a memorable journey. The game uses a simple keyboard control scheme to control the player character, as well as to access the menu and dialogue controls.

Keywords: Downfall, Provia, RPG, Story-based games, and A Algorithm*

1.0 Introduction

Game Development is the process of creating a video game through the efforts of a game developer, which may range from a single person to a team of developers. Normally, video games are funded by a publisher, who turn in makes the game accessible to a wider scope of users.

In the history of game development, it is fair to say that when it was first started in the

1960s, it was only non-commercial games that were released. As we reached the 1970s, games were becoming more commercial thanks to the start of first generation consoles and Apple.

Most video games are developed in phases: pre-production, pitches, prototypes, and game design documents are written. If the idea is accepted and funding is acquired, the development process begins and ends with the release of the game.

1.1 Game Concept

Downfall is a top-down 2D RPG video game that utilizes the A* Algorithm as its pathfinding algorithm for the NPCs. It is developed using the RPG Maker VX Ace Engine with Ruby as its programming language.

Downfall is a role-playing game developed by Serpentine Interactive for PC. The story of Downfall takes place in the fictional nation of Provia, a highly autocratic nation on the verge of rebellion. The player character takes control of either Juliana or Oliver, each with their own backstory as they attempt to weave through the politics of the world and ultimately, launch a revolution against the current monarch.

Downfall is a story-based game, much of its gameplay is related to the progress of the story. It allows the player to take different story paths through their choices, resulting in different endings based on player's choices.

1.1.1 Game Flow

In the game, the player is forced out of his home and into the capital. The player's goal in the game is to launch a revolution against the current King. They will be given the chance to support one of the three great families of Provia. They will need to recruit allies, plan a scheme, or sabotage the regime.

It features a background and class selection, which can help determine the character's origins and current class (Noble or Commoner). Downfall relies on the standard RPG mechanics though with more emphasis on the story and the choices of the player. This mechanic in the game can aid or hinder the revolution. In addition to this, mechanics such as levelling, experience, abilities, and combat will be **disabled** to truly

bring the player towards the story. Items and quests remains and can be an advantage to the player's character revolution.

The scope of the game would encompass more than an hour of gameplay, different story endings, creating a world that would accurately describe Provia. The game is intended for users at least 15 years old and up. The game will not feature multiplayer or internet accessibility. It can also come up runtime errors in case the user is using an older system that does not at least have the minimum PC specifications required to run the game.

1.1.2 Game Genre

Role-playing games or known as RPGs is a game genre wherein the player controls the game characters who undertakes a quest in an imaginary world. Examples of this genre is Dungeons and Dragons, Warcraft, Fallout 3, The Witcher, Final Fantasy XII, and more.

According to the International Journal of Role-Playing, "Role-playing games, in their modern form, are generally held to have originated with Dungeons and Dragons in the 1970s (Mason 2004). Since then they have evolved into a wide variety of styles and media, including both digital and non-digital examples and with player numbers in an individual game ranging from a single person to the thousands."

1.1.3 Game Engine

Downfall is developed using the **RPG Maker VX Ace**, a game engine dedicated to the development of 2D RPGs. It not only has base tile sets but also allows importing of customs tile sets to be used as assets for the games in development. Its GUI has been simplified to work better with developers who are new to the engine but also allows

great control over the engine for those that are adept with the program.

VX Ace runs using the **Ruby programming language** for simplicity. The developers are also allowed to use the language to write scripts of their own to have the program run more complicated steps involved in the development of the game.

1.2 Objectives of the Study

This study sought to attain the following objectives:

- To develop a game that would employ A* Algorithm in its final output.
- To develop a game utilizing Ruby as the programming language.
- To develop a game that would rely on the player's decision making.

2.0 Literature Review

2.1 Computer Game

A “computer game” is a term used for video games that are mostly played using a computer, not consoles. Sometimes, they are used only for learning but also for entertainment. They come in a variety of genres include but are not limited to: shooting games, fighting games and role-playing games.

2.2 A* Algorithm in Video Games

The A* Pathfinding Algorithm is an extension of the original Dijkstra's Pathfinding Algorithm in which both get the same outcome but with different sets of instructions the ultimately lead to the goal or chosen node.

The difference between the two is that A* maps out routes individually and in comparison to the shortest route found then deletes the routes that take too long in comparison to the shortest route saved. Dijkstra's Pathfinding Algorithm on the other hand, maps out all the possible routes before deciding on the best route

The developers have discovered that certain games bear some semblances of A* pathfinding algorithm within it. Notable ones include the Civilization series, Xcom series, Total War series, and The Banner Saga series. These games are all principally strategy games by design as we concluded that pathfinding algorithms have a greater impact on strategy and simulation games than on any other genre.

3.0 Methods

Video Games are more profitable and popular than ever and are widely recognized as a source of entertainment, a medium to release stress, some even recognize it as a sport with its own domestic and international tournaments. Though it might seem simple minded and only a form of entertainment to some, Video Games can also be a medium of creativity, acting, and story-telling.

The story and story-telling of a game alone is enough for people to play the game, as a good story can capture the hearts of many. The game need not even have immersive gameplay or amazing graphics to tell the story it needs to. In the example of one of the oldest and most well-known games, Super Mario Bros. for the NES system in 1985, the players play through the levels to save the Princess Toadstool (Better known as Princess Peach) from the Main Antagonist. In this example, the simple and primitive platforming experience was not a downfall or a distraction from the main story, as the players

know they are progressing towards their main goal and major plot point, which is rescuing the princess.

A good story can essentially make or break a game, it is even enough to pull a game up from its reviews of its gameplay or graphics thus, the developers have considered the different methods of storytelling in-game.

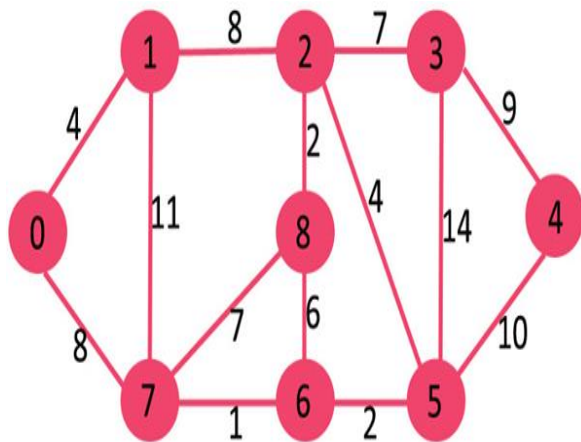


Figure 1: A* Algorithm Showcase

3.1 Project Methodology

For this project, the developers use a “Dialogue and Text” (“The Four Types of Video Game Storytelling”, 2013) heavy gameplay methodology, with a mix of show-not-tell (“Opinion: Play, Don’t Show”, Richard Fine, 2011) and Cutscenes (using text) as it works best in a 2D Top-Down Role-Playing Game.

A pathfinding algorithm (A* Algorithm, Hart, Nilsson and Raphael, 1968) was implemented into Downfall to ensure the NPCs move around the map to designated destinations with ease and speed. Without speed, the NPCs would look like robots, carefully processing each step before taking it, and as such not make for a living world.

Using Ruby as the scripting language, the A* Pathfinding Algorithm has been incorporated into the game engine with speed in mind. Compared to the original Dijkstra’s Pathfinding Algorithm (Dijkstra’s Algorithm, 1959), A* is faster as it does not take its time calculating all possible paths and comparing them to each other but rather saving the shortest path found so far and comparing them with the other available paths, all the while changing the saved path if a shorter path is found.

The script itself works by first stating the number of maximum iterations to be made, in the case of Downfall, 100. Following this is the declaration and initialization of the destination nodes. The paths are then defined by slowly processing whether or not the nodes adjacent to the beginning point or node is passable, and the nodes that follow suit. The cost of a path is taken into account before comparing it to a second path and the lesser of the two will be kept, until it is compared with all other paths available, all the while keeping the path with the least cost. Once the shortest path is found, the game proceeds with moving the character itself from the beginning node, following the defined path until it reaches the destination node.

As Downfall is a story-heavy game, the researchers built the game around the story, first ensuring that the story had a solid flow and that each branch of the story had a proper ending. Each family’s story was assigned to either a pair of researchers or an individual in the group, ensuring progress and so that one researcher did not have to do all the story boarding.

The kingdom of Provia was next to be developed, shaping an older styled kingdom to fit the feel and atmosphere. The maps were made, designed and filled with NPCs as well

as the key characters that would bring about the story.

Once all the kept map accents are developed, the story is then implemented into the maps and characters through the dialogue and conversations using text. The characters are shown to talk to each other while the players see their conversations as text. The characters in Downfall were also given step animations when walking, ensuring a livelier setting. The A* Pathfinding Algorithm was also implemented while designing the walking to display that the characters are alive and can find their own way around the kingdom.

Testing was done throughout each phase of the development process, from how the map looks when walked through or how each dialogue is shown as text and whether or not the decisions inputs actually affect the story.

3.1.1 Game Development Life Cycle

3.1.1.1 Idea

The idea of Downfall was heavily inspired by other Role-Playing Games that places the players in huge dilemmas, as well as the Game of Thrones series. The idea of political power that shifts through the decisions of certain individuals is what drives the premise of Downfall, as it is the player's decisions that will affect and ultimately decide the story line.

3.1.1.2 Game Design

Downfall is a 2D top-down Role-Playing game with heavy emphasis on its story and the player's part in the story. The player is given choices from time to time that will heavily affect the course of the story, from which family they support to whether or not the coup is successful. The assets used in the

game itself are given defaults by the engine, RPG Maker VX Ace as well as other royalty-free assets found online.

3.1.1.3 Technical Requirement Analysis

As Downfall is a 2D game that does not rely on its graphics, the technical requirements to smoothly run and play the game are not very demanding.

CPU: At least i3 Generation Processors

Space Requirement: Enough to hold at 100MB worth of data

GPU: Integrated Intel HD Graphics 4th Generation or higher

RAM: At least 2Gb RAM

3.1.1.4 Programming

The A* Algorithm used in Downfall to control the Non-Player Characters were scripted into the game using RPG Maker VX Ace's language of choice: Ruby. The A* pathfinding algorithm calculates the shortest path to take by tracing out, saving, then comparing two given routes at a time then saving the shorter route, repeating this process until the shortest route is found or 100 cycles of the process has taken place. Compared to Djikstra's pathfinding algorithm, which traces and saves every possible path then comparing all of them to each other, A* is much faster, and takes up less resources.

The script itself works by first stating the number of maximum iterations to be made, in the case of Downfall, 100. Following this is the declaration and initialization of the destination nodes. The paths are then defined by slowly processing whether or not the nodes adjacent to the beginning point or node is passable, and the nodes that follow suit. The cost of a path is taken into account before

comparing it to a second path and the lesser of the two will be kept, until it is compared with all other paths available, all the while keeping the path with the least cost. Once the shortest path is found, the game proceeds with moving the character itself from the beginning node, following the defined path until it reaches the destination node.

3.1.1.5 Testing

Throughout the development process, many testing phases have taken place, mostly at the end of each chapter as they are developed. The main point of testing are the story phases and story lines that should happen depending on the choices the player makes.

3.1.1.6 Deployment

After the development of Downfall, it has been finalized and saved as a playable file (.exe) along with its required assets in a folder. At the request of players, they can be sent copies of the game as it does not require to much space and can be downloaded online through a google drive link.

3.2 Gameplay

The gameplay of Downfall is played like a story. The plot of the game develops as the player makes his decision. Combat, travelling, and party members in the game are disabled. The gameplay plays homage to games such as Pokémon and Final Fantasy.

3.2.1 Objective of the Game

The player's objective is to join a family and to overthrow the current monarch. The ending they achieve will depend on the achieved conditions and on the chosen family.

3.2.2 Play Flow

The game flow is fairly straightforward with the story progressing constantly and without any side quest, the player is allowed to focus on the bigger picture.

3.3 Mechanics

The game mechanics of Downfall leans heavily towards dialogues and choices and they all exist within real time. There are certain conditions that need to be met in order to achieve a certain ending.

3.3.1 Screen Flow

Downfall transitions from one scene to another by teleporting the player while playing a transition animation until the player has arrived at the destined location.

3.4 Game Options

There are only two options that exists for the game menu: **save** and **exit** game. Since the game features choices and no combat, other options were disabled.

3.5 Story Board

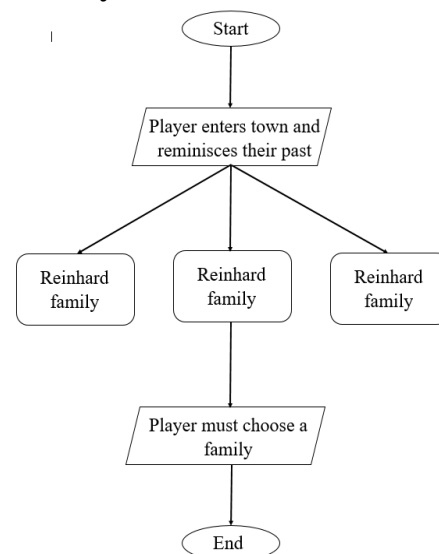


Figure 2: Story Diagram

Figure 2: Story Diagram - The main story begins with the player being introduced to the kingdom of Provia. While the player roams through the different parts of Provia, they will encounter key characters from the three Great Houses of Provia. They will be introduced to the characters and may or may not have to do a little quest. At the end of the day, once the player retreats back to their room, they will choose a family of the key characters to side with, which will dictate their storyline for the game.

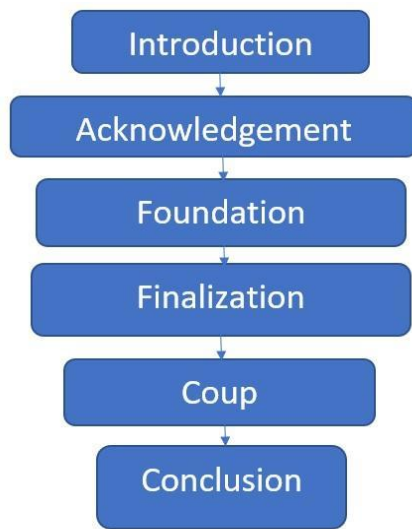


Figure 3: Conceptual Framework

Figure 3: Conceptual Framework - The Conceptual Framework above illustrates the different points in the plot of Downfall. Beginning with the Introduction of the player to the world of Provia. The next phase is being Acknowledged by the key characters to the story and building their foundation of trust with the player. The Finalization is when the key character and their family has accepted the player into their ranks, which leads to the Coup d'état, or the overthrowing of the current monarch. The Conclusion is affected by the player's decisions throughout the game and will tell whether or not it is the king's downfall, or their own.

3.5.1 Story and Narrative

Provia is a nation formed through hardship and sacrifices. Originally a divided nation, it was forged into a single nation through the efforts of the Faulk Family and their allies. Fiercely nationalistic and talented, the young nation of Provia endured the aggressions of its neighbors in the north and west until the efforts of a young King Justinian finally proved to be the straw. Under the subjection of the Kingdom of Artogen, Provia proved to be a nuisance to the Artogenians. Finally rebelling under the leadership of Julis Reinhard, the nation of Provia was once again independent. Now, with the changing tides, Provia looks to prove itself as the world's greatest power.

3.5.2 Characters

3.5.2.1 Playable Characters

3.5.2.1.1 Juliana

Juliana is a member of the noble family of Anburg. Her childhood was marred with family intrigue until finally, she had enough and ran away from her family. She is described as an enthusiastic person who has some traces of an idealist in her.



Figure 4: Juliana

3.5.2.1.2 Oliver

Oliver is a commoner, he was raised in an orphanage until he was enamored with the local gangs and joined them. With his talents, he rose up in the ranks until he managed to

buy himself off his leader. His experiences in his youth have made him a sarcastic individual who despises any propaganda but would have no issues placing his faith in a person instead.



Figure 5: Oliver

3.5.2.2 Reinhard Family

The Reinhard family are a military-centric family that have served the Royal Family for centuries. Originally the dominant family in the Region, they ceded their power peacefully to the rising Faulks. Nominally in the role of Defense Minister, they have a proud history of their family serving in the military as well as their head being a Patriarch. This changed with the surprise ascension of Julis Reinhard, who after brutally securing her place as leader, led the nation in revolt and won a series of victories that guaranteed her country's independence. In a moment of controversy, she restored power to the Faulks instead of taking it for herself. Many have wondered why up to this day but it cannot be denied that starting with Julis, the Reinhard's have begun to move to a more liberal side with the latest successor, Lily Reinhard, possibly the most liberal among all Reinhard's.

3.5.2.2.1 Lily Reinhard

Lily is the heir to the Reinhard Family and a notable scion. Her intelligence and reputation make her an influential figure in the Kingdom. Her ultimate end goal is to replace the monarch with her in a benevolent

dictatorship. She is one of the possible principal allies in the game.



Figure 6: Lily Reinhard

3.5.2.2.2 Heinrich Reinhard

Heinrich Reinhard is the second in the line of succession of the family, a Reinhard through and through. His rise through the ranks have been swift and merited and he currently occupies the position of the Defense Minister's Adjutant.



Figure 7: Heinrich Reinhard

3.5.2.3 Holmes Family

The Holmes are the loyal steward of Jahl Kingdom, they soon transferred their services to the rising kingdom of Essaria, first under the rule of the Reinhard's then followed by the Faulks. Often called the Champions of Liberty. Serving faithfully and diligently as the Minister of Interior, the Holmes family have continued to demonstrate their love for their nation. Working closely with the Reinhard's during the Liberation Campaign and nurtured a close relationship with each other.

3.5.2.3.1 Eurydike Holmes

Eurydike Holmes has a strong sense of justice but would also like to implement freedom in her view of justice.



Figure 8: Eurydike Holmes

3.5.2.3.2 Greisy Holmes

Greisy is a charming and energetic, an outgoing and kind person. Everyone who is in need of help, she helps them with all her might.



Figure 9: Greisy Holmes

3.5.2.3.3 Lyndzei Holmes

Lyndzei is the quick-witted one but soft spoken. She is the youngest amongst the three. She does not like to be told what to do, and uses her wits to escape sticky situation.



Figure 10: Lyndzei Holmes

3.5.2.4 Leviathan Family

A mercenary family, the Leviathans were southerners that controlled the distinguished mercenary company, "The Black Roses". While they commanded the company, it eventually collapsed due to political

infighting and financial missteps. One man eventually escaped from the south and found his way in Provia. With nothing to lose and everything to accomplish, they joined a new company and with their experiences, rose up the ranks and eventually became the Chairman and renamed the company, "Black Roses Company", in honor of his origins. As Chairman of the enterprise, they became involved in the politics of the region and against expectations, ran for the position of Minister of the Economy and won it. Their seat is unsteady but the Leviathans have endured and will endure.

3.5.2.4.1 Alucard Leviathan

Alucard Leviathan is the patriarch of the family and the Chairman of the Black Roses.

3.5.2.4.2 Nero Leviathan

Nero Leviathan is the first born son of Alucard Leviathan. He is a man of principle, pride and intelligence.



Figure 11: Nero Leviathan

3.5.2.4.3 Athena Leviathan

Athena Leviathan is the first born daughter of Alucard Leviathan and a sister to Nero Leviathan. She is a charming, mysterious, and independent young woman.



Figure 12: Athena Leviathan

3.5.2.5 Character Allies

3.5.2.5.1 Margaret

Margaret is a quick and witty person who perfectly complements Lily's cause with her unorthodox strategies and plans. She is Lily's maid and sooner became her confidant.



Figure 13: Margaret

3.5.2.5.2 Axel

Axel is orphaned at a young age. He was taken in by the Reinhardt thanks in large part to his imaginative and innovative mind. He currently serves as Lily's unofficial retainer.



Figure 14: Axel

3.5.2.5.3 Arthur

Arthur is a close friend of Nero; he is a member of the City Guard. Loyal and

hardworking, he quietly supports his friends in all matters.

3.5.2.5.4 Andrea Thorn

Andrea Thorn is the commander of the King's Personal Guard. She is a brave yet paranoid individual due to her initiation into the guard.

3.5.2.5.5 Arnold Schor

Arnold Schor is the commander of the 1st Division, often described by observers as the King's man in the military and by his men and he strictest General they have ever had.

3.5.2.5.6 Julian Sander

Julian Sander is the King's Royal Messenger. He was appointed into the role by Theodore. An orphan, he made a reputation using violent means.

3.5.2.5.7 Eric Lanstein

Eric Lanstein is the Magistrate of the Capital. He has held onto his power for many years, developing the city as a place of prosperity. Despite this, there have been criticisms of his racism.

3.5.2.5.8 Jesse Evans

Jesse Evans is a former criminal and the current Chief Justice. He has dedicated the rest of his life redeeming himself in the name of justice.

3.5.2.5.9 Princess Katrina

Princess Katrina is the only daughter of the royal family. She is a princess to most

observers yet turns to her real self in moments when she feels like it.

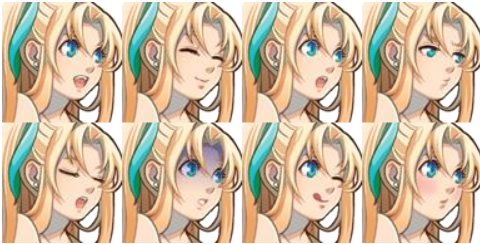


Figure 15: Princess Katrina

3.5.2.5.10 Shinji Niyama

Shinji Niyama is a prominent businessman and is from the far north. Despite the animosity, he developed an arms monopoly and is more or less content with his role in society.

3.5.2.5.11 Altina

Altina is a disgraced but genius inventor, the fact that she is a female is hidden to a select few. Her times in exile taught her many lessons which she still uses to this day.

3.5.2.5.12 Juliet Shields

Juliet Shields is an immigrant from Artogen. She was an idealistic person when she arrived. While she is the vice guild leader of the number one guild, her experiences have made her into a cynic.

3.5.2.5.13 Holy Council Member

Holy Council Member is one of the members of the Ionian Church's council, they are mysterious in various ways.



Figure 16: Holy Council Member

3.5.2.5.14 Lucille Snow

Lucille Snow is the niece of the Prime Minister, Theodore Day. Her sharp mind and various skills make her valuable to any side she chooses to ally with.

3.5.2.6 Non-Player Character

NPCs exist in the game to guide the player in making the right decisions. On certain maps, NPCs may wander around or walk to the player to trigger an event.

3.6 Levels

There is no indication on which the level the player are though the terms “chapter” were used heavily by the team during development.

3.7 Interface

The Downfall's interface is heavily pixelated and is classified as a 2D style. It features a game menu, save/load menu, dialogue text box that all appear in the game's 640x480 pixel screen.

3.7.1 Control System

The Downfall's controls consist of the arrow keys for movement, escape for exiting, and the action button for performing an action.

3.7.2 Audio, Music and Sound Effects

The music of Downfall is tailored to fit each scene and its impact. Progressing through the story, there will be scenes of a castle or a bustling market, or even a busy meeting room. The music for each scene sets the tone for each atmosphere.

The sound effects of the game were taken from the game engine and a copyright free source.

3.8 Technical

3.8.1 Target Hardware

Downfall would only be released on PC with the minimum being **Intel Pentium** or **AMD Athlon XP** (CPU) and **1 GB RAM**. An Integrated or Dedicated Graphics card is optional but recommended and the PC must at least run a version of **DirectX**.

3.8.2 Network Requirements

The game does not require constant internet connection to be played. As a single player game, it would be shameful to require constant internet access.

3.9 Game Art

The game art that were used as assets for the game are multiple images taken from various of copyright free sources as well as creating custom artwork for the game itself.

4.0 Results and Discussion

The following screenshots are from the working version of Downfall. The assets used are ran in the RPG Maker Engine.



Figure 17: Downfall Title Screen - The title screen as well as the basic user interface will be shown once the player starts the game.



Figure 18: Dialogue Interaction - It shows an example of the interface the player will see when interacting with NPCs and the NPC reply with a dialogue. The character's profile image will be seen on the left and their dialogue will be illustrated next to it.



Figure 19: Player Choice Screen - The Player can be allowed to choose their gender for their playable character at the beginning of the game. The interface screen can also be

illustrated like the one shown in the screenshot above.



Figure 20: Environment - A playable character is illustrated in a market environment, one of the many possible environments that can be found in Downfall.

5.0 Summary, Conclusion and Recommendation

Summary

This thesis project is entitled **Downfall: A Computer Game incorporating A* Pathfinding Algorithm** is a video game for the PC platform that has the player taking the role of helping a powerful family of their choice to overthrow the current monarch of the kingdom of Provia.

Using textual Dialogue and on-screen text, the player gains clues to solve problems and make decisions that will ultimately affect the outcome of their story in the world of Downfall.

The game engine **RPG Maker VX Ace** was used to develop Downfall while using the programming language Ruby for in-game scripting. The assets used in the game consist of royalty-free assets, default assets supplied by the game engine and assets created using RPG Maker's character creation tool.

Conclusion

Based on the findings of the study, the following conclusions were drawn:

1. The developers created a game that would employ A* Algorithm in its final output. The characters and NPCs of Downfall would be stale and stagnant without the movements programmed using the A* Pathfinding Algorithm. It has helped bring life through movement of characters through the land of Provia.
2. The developers created a game utilizing Ruby as the programming language. The A* Pathfinding Algorithm as well as other game settings have been scripted using Ruby, the programming language of choice of the game engine used in the development of Downfall, RPG Maker VX Ace.
3. The developers created a game that would enhance the player's decision making ability. The final output of Downfall showcases how the story flows with the player's decisions, from the family they support to ultimately how the family will fare in their coup against the current king of Provia. With these decisions in tow, it makes for multiple story branches, as well as endings.

Recommendation

The developers recommend that the game be further improved by adding additional characters, refining the existing quest lines, and giving more dialogue to the NPCs with the goal to retain the player's interest in the future. As **Downfall** has multiple endings, the developers also recommend that the player take time to experience the different endings and how different decisions affect the story.

As per feedbacks, the users recommended that further dialogue be added to flesh out the characters and delve deeper into the world lore.