Final Report

General Overview:

A third-person puzzle solving game that was inspired from It Takes Two. The player will control a character and navigate through the levels. During their navigation, they will encounter puzzles and enemies. They must use their abilities to solve the problem and reach the end.

Clear Game Conditions:

Initially, the player will need to use their abilities to solve puzzles and reach the end of the map. At the end of all the puzzles, there will be a teleport that takes them to the next level. When they enter the teleport, the level will be marked as complete/clear. In the Sky Island map, the player has to defeat the boss and not get killed. When the boss is defeated, a transition will appear and entering it will take the player back to the main menu. Then the game will be marked as clear.

Player:

The player has basic movement controls and can move in any direction within the levels. In addition to the movement, the player can also jump and dash. Depending on the level, the player also has special interact controls.

Movement is controlled by WASD, jump by the space bar, and dash by left shift. The basic controls that are present everywhere (except the menu selections) are in a base controller. Since the abilities are different for each map, the player controller is changed whenever they enter another level. The controllers for each level are inherited from the base controller. In the Home and ClockLand level, the player can use E to use their special ability. In the Sky Island level, the player can hold space bar while they are in the air to glide and hold right click to use their jet ability. During the Sky Island map, the player will have the HP stat.

Animation was done using the animation blueprint and animation state machines in there.

Boss:

Given the name Wind Legend and the final obstacle the player has to go through to get back to their original world. Its movement and attack sequence is controlled using an AI controller, behavior tree, blackboard, and task nodes. Although it uses Unreal's AI system, the complexity of our boss's behavior and choices is quite simple and driven through randomness and timers/events. Animation was also done using animation blueprint.

More specific information on Sky Island section.

Levels:

Each level has a different theme with different puzzles to solve to proceed. There are three levels with a sequence of which one to complete first. The level will remain locked until

the prerequisite is met. The sequence starts with Home, then to ClockLand, and finally Sky Island.

- *Home Map:*
  - Represents the rooms inside a house. The player will initially spawn in the bedroom. Then move on to the living room etc. Each room may or may not have puzzles to solve.
  - The player's special ability on this map is the ability to use a hammer to break objects. And the puzzle of this map is designed around this ability.
  - The player will use the E button on the keyboard to use the hammer.
  - Puzzles:
    - The first puzzle is to break the planks on the door frame to get to the next room—a simple puzzle to let the player see that they can break things.
    - The second puzzle is also breaking things. But instead of direct access to the next room after breaking the object, breaking certain objects will trigger a response to one of two doors in the room, one on the left and one on the right (across from each other). For each object broken, the corresponding door will move down. Breaking enough of corresponding objects will fully open the door and the player can get through. Breaking the green furniture and the black table will open the door on the right (correct one) and breaking the purple ones and the clear statue will open the door on the left (a dead end).
      - There is a hint on the wall saying that there is too much stuff here which means the player needs to break things.
    - The third puzzle is a maze filled with breakable walls located in the room on the right when going down a hallway after the second room puzzle. The player will need to break the walls to proceed to the teleport which will bring them to the next level. They have to walk on the right path or else they will fall into the floor and respawn at their last checkpoint.
      - The hint for this puzzle is also on the wall "FRFLFLFFLFFF". Those are directions from the player's current perspective.
        - F = front
        - L= left
        - R = right

Starting from the white wall, the blue path is the correct way.

- - ■ There are also similar puzzles and traps around the other rooms of the map such as breaking planks and falling into the floor.
  - ○ Reaching the white, round teleport at the end will take the player to the ClockLand map. And ClockLand will be selectable from the map selection menu.

- *ClockLand:*
  - ○ The player stands on a huge clock in the sky and uses his unique ability to solve puzzles in the world. After finishing all the puzzles, the player can escape the clockland. The player spawn at a starting point which is completely safe.
  - ○ The player has one special ability —- backtrace (E). The player will leave a footprint on the ground, which lasts for 3 seconds. When using the backtrace ability, the player can go back to the position they stayed 3 seconds ago, which is the last footprint on the map.
  - ○ Puzzles:
    - ■ The first puzzle is to go across the clock to reach the elevating platform on the other side. There will be three clock hands, with different length and rotation speed. The player will die when they touch the clock hand. The player has to use their unique ability to finish this puzzle.
    - ■ The second puzzle is to press the buttons to spawn the road. Once the player reaches the elevating platform, they will press (stand on) a button to go up. This is for a demonstration so that the player knows there are buttons to trigger. There is a checkpoint when the elevating platform reaches the top. Once they elevated up, they needed to jump to another platform to trigger a button to spawn the road toward the center. However,

since the player cannot jump back from the lower platform, they have to use the ability to go back.

- ■ The third puzzle is to trigger two buttons within one second. There are two buttons in the center with a fixed distance. The player has to use their ability to trigger these two buttons at a very close time. Once the two buttons are pressed, a hint will show: "Backtrace to the original", and the level transition actor will spawn at the center of the clock. The player can jump from the platform to reach the level transition actor, or can use the elevating platform to go back to the clock.

- *Sky Island:*
  - A pure boss fight level that takes place on a floating island. The player needs to defeat the boss in order to clear the game whilst trying not to die from the boss's attacks. The fight is constrained to a fixed part of the map with invisible barriers to keep the player within.
  - Boss overview

    The boss has HP, two attacks, a core crystal, and phases. The two attacks are named Rock Throw and Ring Wave.

    Rock throw
    Throws blue gems towards the player, and damages them if hit. The blue gems also get destroyed upon impact when hitting the player or environment, but do not get destroyed when colliding with the boss's other attack. When it collides with the boss's core crystal, it will damage the boss.

    Ring wave
    Throws multiple walls of horizontally-long green gems towards the player, and damages them if hit by a gem. These gems do not disappear upon impact and can deal damage to the player multiple times if colliding multiple times. The gems disappear after 10 seconds.

    The boss also has a core crystal, which is a single white gem that randomly teleports around the map during the fight. If the boss's rock throw comes into contact with the crystal, it will inflict damage onto the boss and teleport to a random location on the map. This is the only way to damage the boss. If the crystal has not been hit for 15 seconds, it will randomly teleport to a different location on the map.

The boss has two phases, which determine the chance of attacks the boss will perform. Phase one takes place when the boss is at or above 50% HP. Here the ring wave attack has a 25% chance of occurring and rock throw has a 75% chance of occurring. Phase two occurs when the boss is below 50% HP. Here, ring wave and rock throw have a 40% and 60% chance of occurring, respectively.

The boss waits 3 seconds between attack sequences to allow the player to adjust.

- ○ Player special abilities
  The player has three special abilities.

  Glide (hold space bar) allows the player to fall slower by lessening the effect of gravity on the player when falling. This can help the player dodge the boss's ring wave attack by making it easier to move through the gaps in its attack.

  Jet (hold right click) launches the player upwards. The player can use this to dodge any of the boss's attacks.

  The player also has a passive heal that heals the player when they haven't been damaged for 7 seconds.

Data Management:
Data is saved throughout our game and includes the saving of player progress, certain actors, and graphics settings. We utilize Unreal's SaveGame class and uproperty specifier to make this happen.

Saving of player progress and actors takes place in the Home, Clock, and Sky levels. Saving only occurs when the player overlaps with a checkpoint or the level transition actor. When overlapping with either of these, any actor currently in the world that inherits our interface, ISavableActorInterface, will be saved. Aside from the data that the actor decides to save using the SaveGame uproperty specifier, we save the actor's name, class, and transform. This allows us to handle loading data for actors that were destroyed or spawned in at runtime. Loading takes place upon entering a level, so this code is in APlayableGameModeBase.

Graphics settings were saved using SaveGame as well, and due to the little amount of data we needed to save, this was done in blueprint. Saving takes place when backing out of the graphics menu. Loading takes place when first opening the graphics menu.

GUIs:
- *Main Menu*
  - What the player sees when they first start the game.
  - It shows the character the player will be controlling standing somewhere on Sky Island. The title of the game is on the right side with two option buttons below it.
  - The player will be using their mouse cursor to select and click on the options.
  - Start button: Bring the player to the map selection menu
  - Quit button: Exit the game
- *Map Selection*
  - The player sees an image of part of the map when selecting which level they want to play and the name of the level.
  - The player can use their mouse cursor to select and click on the level they want to play. However, if they didn't complete the prerequisite level when selecting a certain level, "Level Not Yet Unlocked!" will show up to let the player know they need to complete the previous level to unlock it.
  - Back button: Goes back to Main Menu
  - Left button: Bring one of the levels on right to the center for preview and move the current one off screen to the left. If there are no more maps on the right, it won't do anything.
  - Right button: Bring one of the levels on the left to the center for preview and move the current one off screen to the right. If there are no more maps on the left, it does nothing.
  - Home button: Selecting it will bring the player to Home Map level and the player can start their gameplay.
  - ClockLand button: Selecting it will bring the player to ClockLand Map level and the player can start their gameplay.
  - Sky Island button: Selecting it will bring the player to Sky Island Map level and the player can start their gameplay.
- *Pause Menu*
  - Activated when P from the keyboard is pressed.
  - A menu will pop up and the game will be paused and two options will be available for the player to select with their mouse cursor.
  - Resume button: Unpause the game and pause menu disappears. The player can continue their gameplay on where they left off.
  - Main Menu button: Go to the Main Menu and they can select options from there.
- *Player Death Menu*
  - Shows up when the player ran out of HP during the boss fight.
  - Restart button: Restart this boss fight from the beginning and the menu disappears.
  - Main Menu button: Go to the Main Menu and they can select options from there.

- *Battle HUD*
  - Only on the Sky Island map
  - Show the HP status of the boss and player throughout the battle
- *Graphics Setting*
  - Gives control over Ray Tracing and Upscaling
  - When instantiated, it checks what upscaling technologies are available and lists them for selection
  - Once one is selected, it finds all the quality options for that technology
  - When a quality is picked, it is applied through the library functions
  - Each upscaling technology requires separate blueprint functions as they all have their own types and function calls

Graphics:

Our game uses many high-definition assets, so we needed to add some graphics controls and features to allow the game to perform well on various hardware configurations. In the pause menu, users can enable and disable ray tracing, as well as hardware acceleration with it. This allows players to experience highly realistic lighting and shadows on modern hardware, without impacting the experience on lower-end systems. Another major feature is the availability of upscaling techniques. DLSS, FSR, and XeSS* are supported, providing the best upscaling experience possible, regardless of GPU manufacturer. These technologies will upscale a lower-resolution render of your game. This increases performance as the game is rendered at a lower resolution, but an AI model (DLSS and XeSS) or handwritten algorithm (FSR) increases the resolution of the image so that it isn't very noticeable. Ray tracing and upscaling have massive impacts on performance, as seen by the below benchmarks:
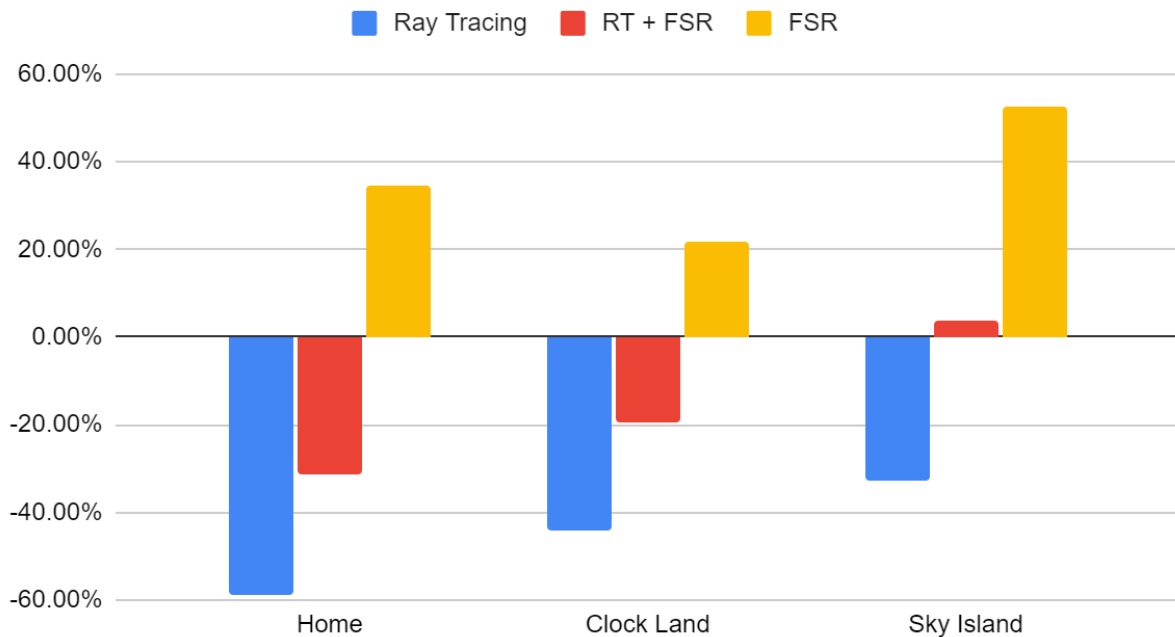
Performance Comparison (FPS)
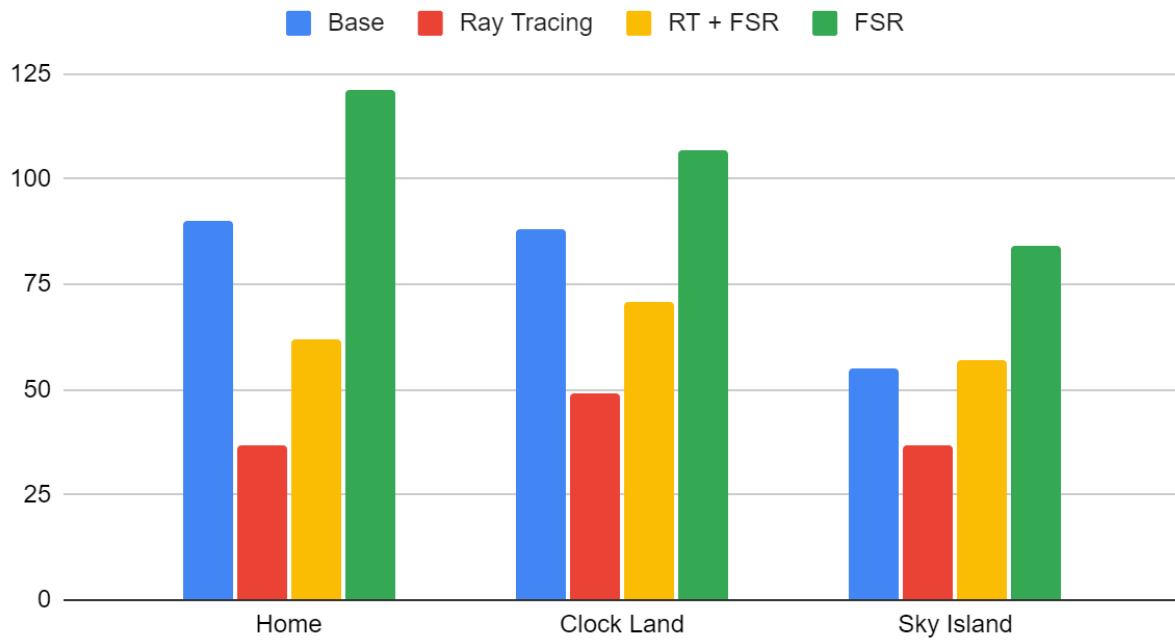
This chart shows the FPS under various configurations across the different levels. As you can see, enabling ray tracing reduces the fps to a stuttery sub-60. However, enabling FSR brings it back up to over 60fps, maxing out the refresh rate of average monitors. And for those playing on high-refresh rate displays, FSR without ray tracing produces a smooth experience across the board.

Percentage Performance Change From Base

This graph highlights the performance change compared to base from the various settings. With this, we can get a better idea of how each setting affects the different maps. The Home map has a lot of indoor lighting with lots of bounces and reflections. This causes the biggest performance loss from ray tracing, as we would expect. The Clock Land level is quite simple, with only a few assets. Due to the simple geometry and low poly count, not much is gained from enabling FSR. Sky Island has the most complex geometry of all the levels due to the foliage across the island. Since it is only lit by the environment, ray tracing doesn't cause as significant a hit. On the other hand, FSR causes an extreme improvement. The dense, realistic foliage of the scene is expensive to rasterize, so lowering the resolution helps vastly. The performance improvement of fsr is even enough to outweigh the slowdown due to ray tracing, unlike other levels.

Benchmarking done on an Arc A750 with an i9-13900, 32gb of ddr5 ram.

*XeSS broke close to the submission deadline and would corrupt any blueprints in which it was used. I spent hours trying to resolve this but couldn't, so the final submission won't have XeSS.

Credits:
- Character Model and Animations: from Mixamo - Kachujin G Rosales
  - https://www.mixamo.com/
- Home Map Assets: Unreal Marketplace: LPGenericPropsSet10 and Grocery store props collection
  - https://www.unrealengine.com/marketplace/en-US/store

- Gem assets - Ancient Treasures (Unreal Marketplace)
- Boss model and animations - Quadruped Fantasy Creatures (Unreal Marketplace)
- Sky Island
  - Sky - Good Sky (Unreal Marketplace)
  - Auto landscape material - Landscape Pro 2.0 Auto-Generated Material (Unreal Marketplace)
  - Music - Mechanical Rage (It Takes Two OST)
- Home and Clock ambient sounds
  - https://freesound.org/