Architecture

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1.1 Initial Architecture

All the diagrams mentioned in this document can be found in the 'Architecture' section of our website: https://publicmutiny.github.io/f1sh-webs1te/.

To ensure that our finished product met the requirements, we began the project by imagining, sketching and modelling a high-level architecture of the system's layout around the packages and utilities provided by LibGDX. We utilised LibGDX's features that enhance the game's interactive and visual elements like handling graphics, audio, and input processing. For instance, we integrated the 'InputProcessor' for sophisticated input management, 'SpriteBatch' for drawing sprites on the screen, 'Camera' to control what's visible on the screen and 'Vector2' for storing and manipulating points or directions in 2D space.

Using the 'Event Storming' approach, we initially identified key components for our architecture, including the 'Screen' interface from LibGDX for rendering game views, and the 'Entity' component for managing entities, starting with 'Player' and extendable to include non-player characters. The 'Screen' component retrieves necessary data and assets from other components to render the UI efficiently. Recognizing the utility of segregating game stages, we decided on implementing various screen classes. This approach not only enhances organisation by separating game phases but also optimises performance. By isolating resources and processing to the active screen, the game can efficiently manage memory and reduce loading times, ensuring smoother transitions and making the game more responsive.

From this simplified view of the system, we created the first architectural diagram as a set of Class-Responsibility-Collaborator (CRC) cards. We first identified all candidate objects and created a CRC card for each object. Each card contains the name of the class, the responsibility, or purpose of each candidate, and any other classes that are linked to it (collaborators). The collaboration between each object is organised using the delegated control style. We grouped similar candidates together and removed any duplicates. The CRC cards diagram can be found on our website (Architecture, Fig.1).

After reviewing the CRC cards, we identified some problems in our design, particularly with the MainGameScreen class handling game settings, character choices, energy levels, and audio. Modifying settings through the MainSettingsScreen class required an active MainGameScreen instance, which meant there was unnecessary resource usage and performance dips, as both UIs were rendered while in the settings screen.To solve this problem, GameData class was created to centrally manage game settings and data. This class is designed to be accessible by other classes. This ensured minimal performance impact and eliminated the need for MainGameScreen to be active during settings adjustments.

The sound and music classes (GameSound and GameMusic) were created to handle music and sound effects after only being called once - this reduces overhead and processing delays by efficiently handling sound resources. We introduced a ScreenHandler class to prevent performance issues by ensuring only one screen can be initiated at a time, reducing memory usage and improving game loading times. This class streamlines screen transitions, freeing up memory when switching screens, thereby enhancing user experience.

All the new classes were created one week after the CRC cards diagram was finished. We decided to reflect these changes in the initial class diagrams instead of further modifying the CRC cards diagram so we can focus on other parts of development. The initial class diagram was created using the CRC cards diagram as a reference. It can be found on our website (Architecture, Fig.2).

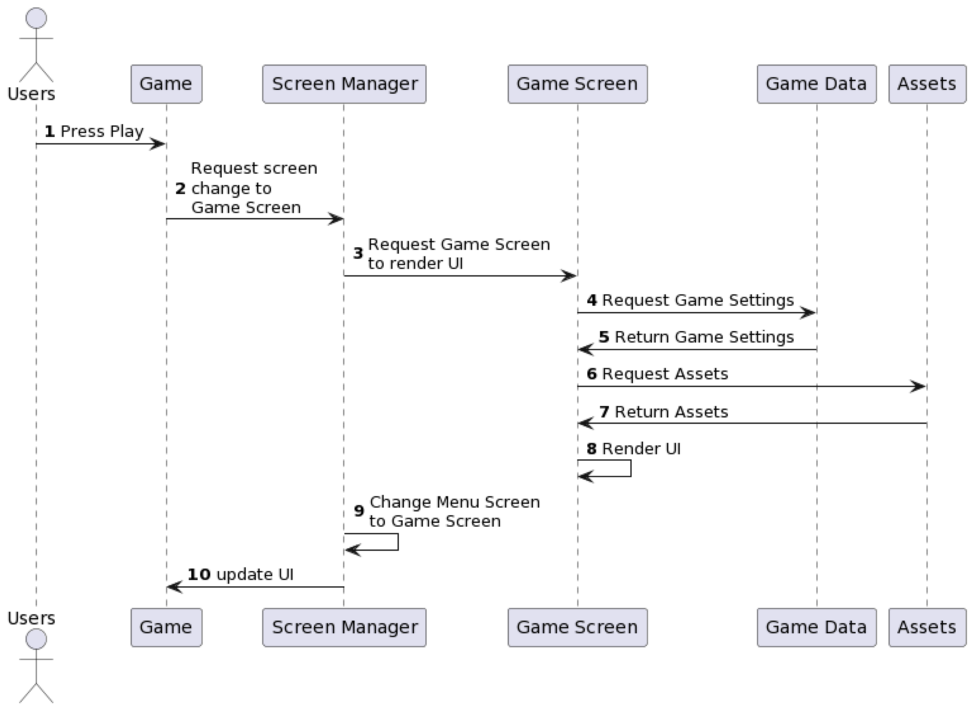
1.2 Justification of Tools

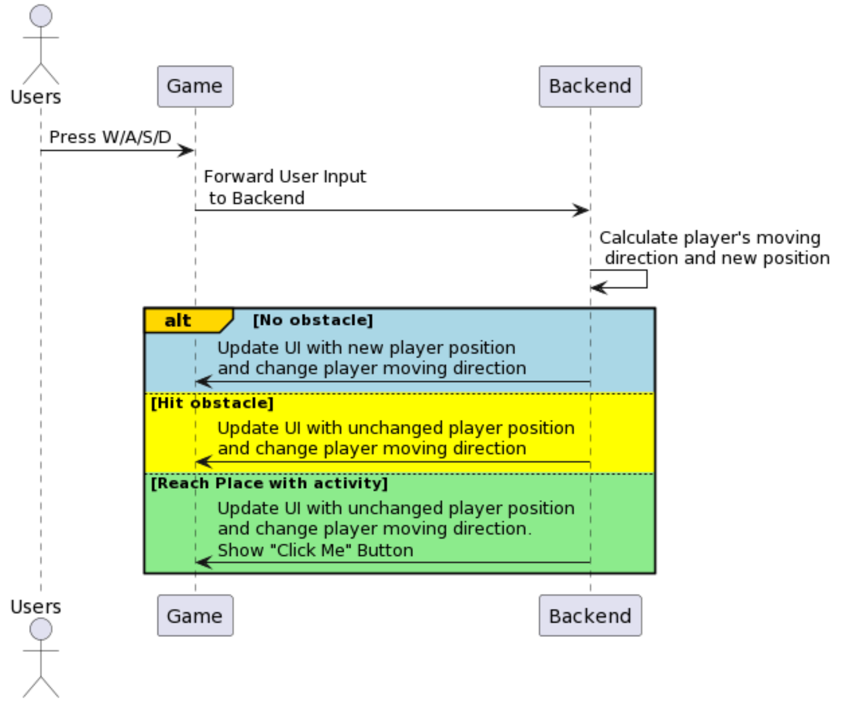
PlantUML is a simple and efficient way of creating diagrams that takes little time to learn, is easy to debug and integrates well into other software. We used it to create class and sequence diagrams, as well as plan our project with Gantt charts. This was easier than manually drawing diagrams because it is intuitive, and has autofill and suggestions that make the process quicker and easier than any other software. PlantUML was the right choice of tool for our team because it has good integration with Google Docs and IntelliJ IDEA, the IDE our team chose to use. The diagrams can be easily edited through both of these, making it the most practical platform to use. Also, *the created diagrams can be easily exported as .png files from IntelliJ, and can be placed on our website.*

We used the @startgantt/@endgantt to make Gantt charts, and @startuml/@enduml to create class diagrams with 'packages'. For the sequence diagram, we used @startuml with 'autonumber' and 'actor' to define how the user interacts with the front end of the system, which then interacts with the backend.

1.3 Assessment 1 Sequence Diagrams and UML.

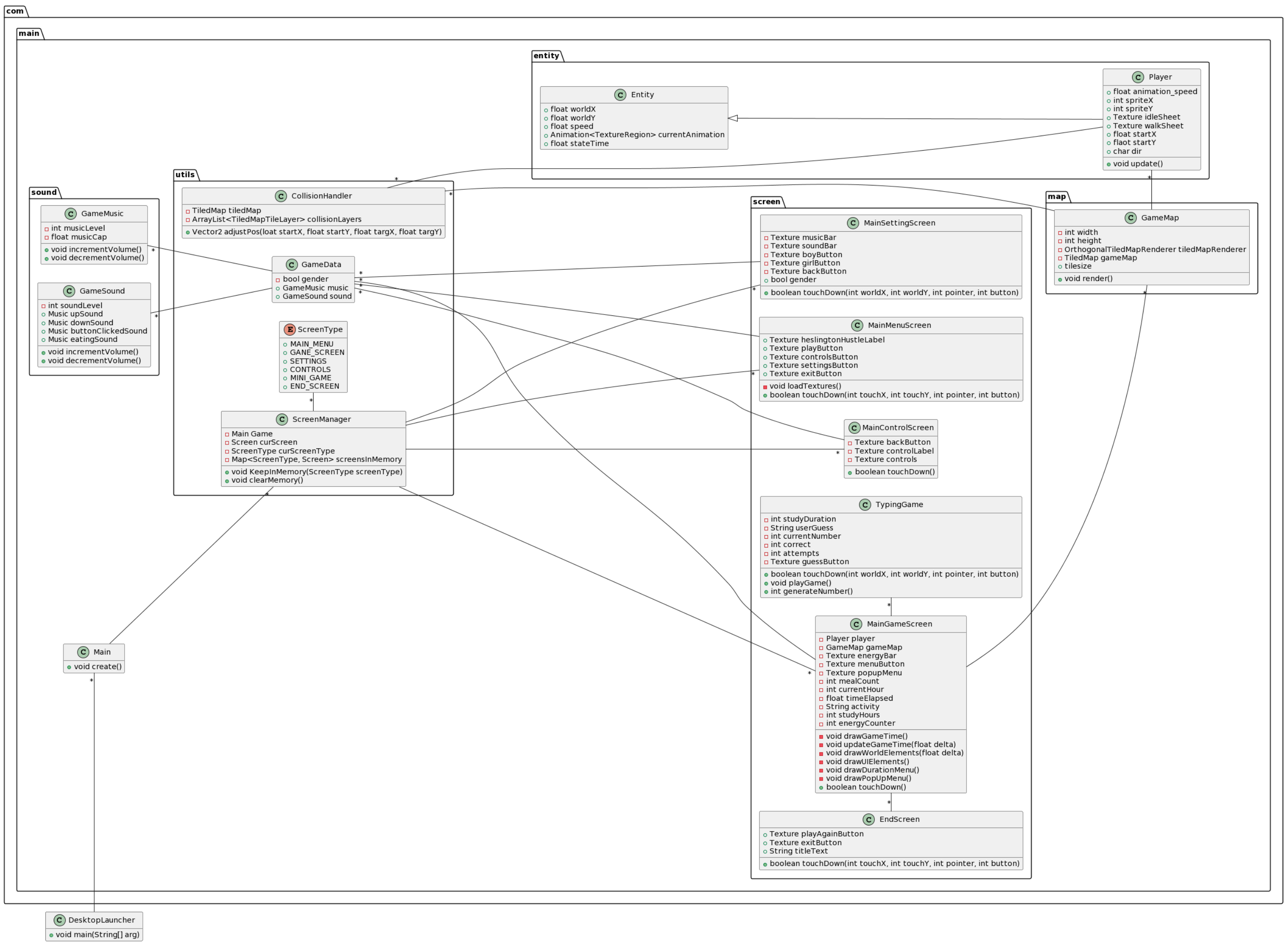
We created two sequence diagrams to show how the game reacts to users' input in different situations. The sequence diagrams are shown below, and can be found on our website (Architecture, Fig.4-5). The second of these diagrams focuses specifically on what happens when the user moves the sprite.




Users
Game
Backend
Press W/A/S/D
Forward User Input to Backend
Calculate player's moving direction and new position
alt
[No obstacle]
Update UI with new player position and change player moving direction
[Hit obstacle]
Update UI with unchanged player position and change player moving direction
[Reach Place with activity]
Update UI with unchanged player position and change player moving direction. Show "Click Me" Button

The final class diagram of assessment 1 is shown below, and can be found on our website (Architecture, Fig.3). We decided to use multiple packages to group classes:

- *The 'screen' package contains all screen related classes except the screen manager.*
- *All the classes related to sound effect and music are placed in the 'sound' package.*
- *Classes related to map rendering are placed in the 'map' package.*
- *Classes that will be used by other packages are placed in the 'utils' package*



1.4 Evolution of the Architecture

During implementation of the code, we adapted the architecture to suit the specific needs of our program's requirements. One problem we encountered was slow transitions to the Main Game Screen and inefficiencies in saving the 'gameScreenState'.

Initially, our ScreenHandler disposed of screens upon switching, leading to increased loading times and overhead due to frequent instantiation and data saving to the GameData class, especially for the resource-intensive MainGameScreen. To enhance performance, we refined ScreenManager to selectively keep certain screens, like MainGameScreen, in memory while disposing others as needed. This approach minimises loading delays, reduces data saving overhead, and maintains MainGameScreen's state for better performance and memory efficiency, ensuring it remains the only screen in memory when active and improving overall system responsiveness.

Introducing the CollisionHandler class segregates all collision related functionality into a single class, making the game engine more efficient. This reduces overhead and processor delays, thus ensuring smoother gameplay and optimising resource use whenever collision functionality is invoked.

Two classes that should have been implemented to segregate functionality are one for choosing gender and the popup menu, which is mentioned in the docs string in the code above the relevant method. This is to avoid unnecessary calls within the Player and MainGameScreen class, this separation could have optimised the code more,

We introduced a popup Menu activated by the CollisionHandler's 'isTouching' method, featuring buttons for different activities next to the player. Selecting 'study' connects MainGameScreen to TypingGameScreen. Enhancements like a fade effect and eating sounds improve user experience, signalling completed activities and smoothing transitions, such as starting a new day. Our minigame, TypingGame, challenges players to memorise and type increasingly long sequences of numbers, engaging them during study periods. Lastly, we added an EndScreen class that appears after 7 in-game days, offering options to replay or exit the game.

Throughout our development during assessment 2, our architecture went through very few significant changes, as we found that the base had been laid out by the previous group, allowing us to just implement the new functionality in their style.

There was still some change needed, mostly with the introduction of a few new classes and screens, so that our minigames would work as we intended them to, however this did not need much change of the existing architecture. As you will see below, the minigames and tutorial we wanted to add all used a new screen.

1.5 Assessment 2 Architecture

Behaviour diagrams:

Use case diagram:

This diagram shows a simplified version of what the second assessment requires in terms of the gameplay look and what the student can do in the game in terms of the essential requirements.

- Student clicks on 'Start' which is displayed on the menu screen
- Once the game starts the player can navigate the avatar around the map

- The sleep activity allows the player to gain energy and move on to the next day until day 7 which is when the game ends and the player's score is displayed on the screen with the leaderboard
- As well as sleep the player can study at the CS building and the library, complete activities (mini games) at the sports centre and where streaks will track study and activities.

Sequence diagram- memorisation game

This diagram shows the player's interaction with the memorisation game when the student wants to study. The student initiates the game which starts the gameplay loop where a number is generated for memorisation. The game generates a random number and displays it to the student. The student inputs their guess after trying to memorise the number and the game checks if its correct or not.

Sequence diagram-snake game

This diagram shows the player's interaction with the snake game when the student wants to go to Piazza. The instructions are displayed first and the player clicks the screen to continue. The aim is to move around and eat the apple and there is a timer which ends the game.

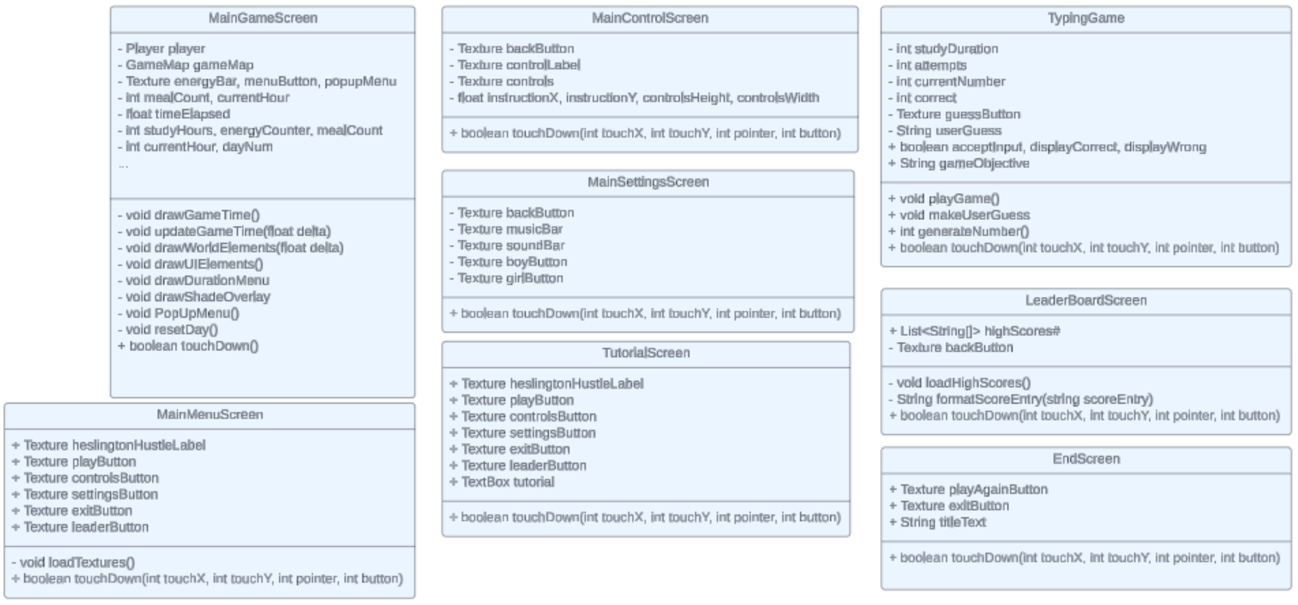
Sequence diagram - pong game

This diagram shows the player's interaction with the pong game where the ball is the main object and the player has a paddle and has to hit the ball with a battle. This game also has instructions and a timer where the game ends after 20 seconds.

Structural diagrams:

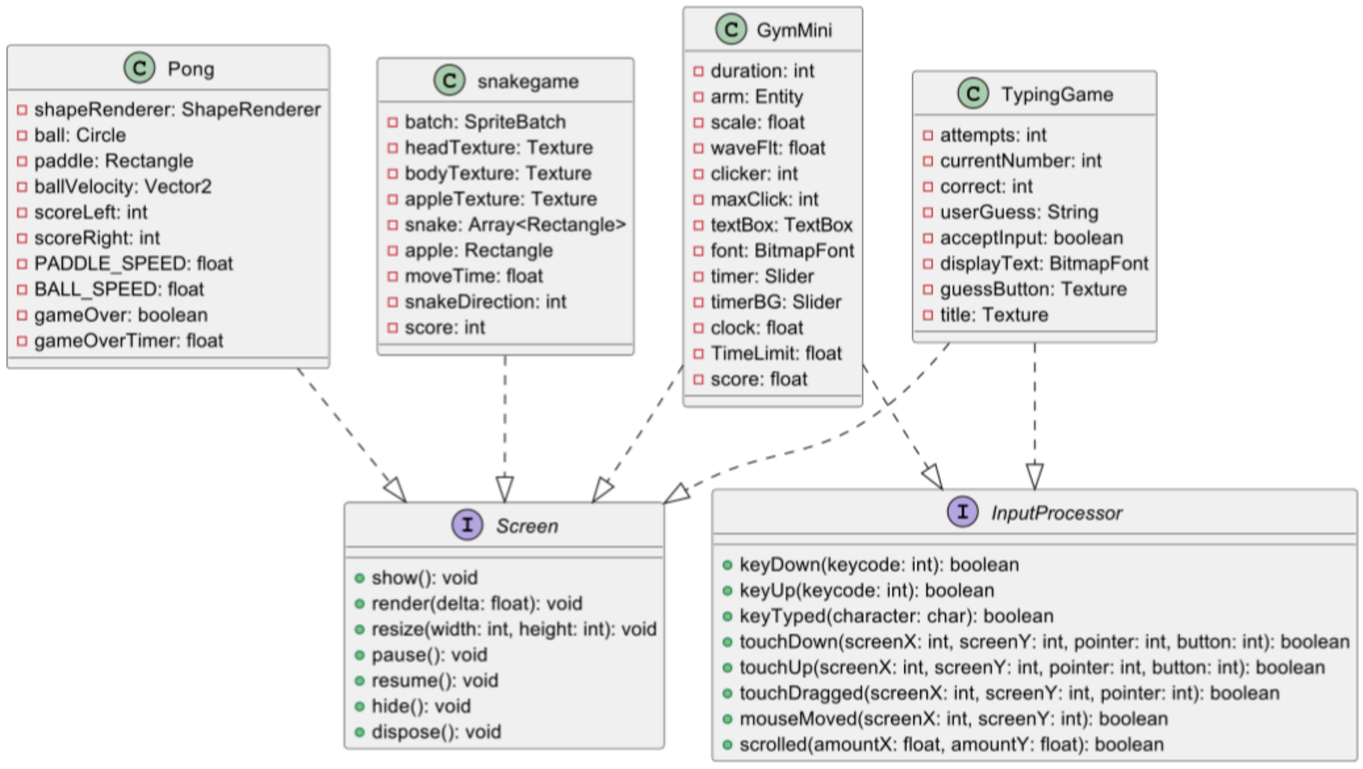
Screens:

Finishing the tutorial and the addition of a leaderboard meant that two new screen classes were needed. The diagram below shows these new classes along with the updated older screen classes. The implementation of the leaderboard required that a 'leaderButton' needed to be displayed, and is present in the MainMenuScreen.

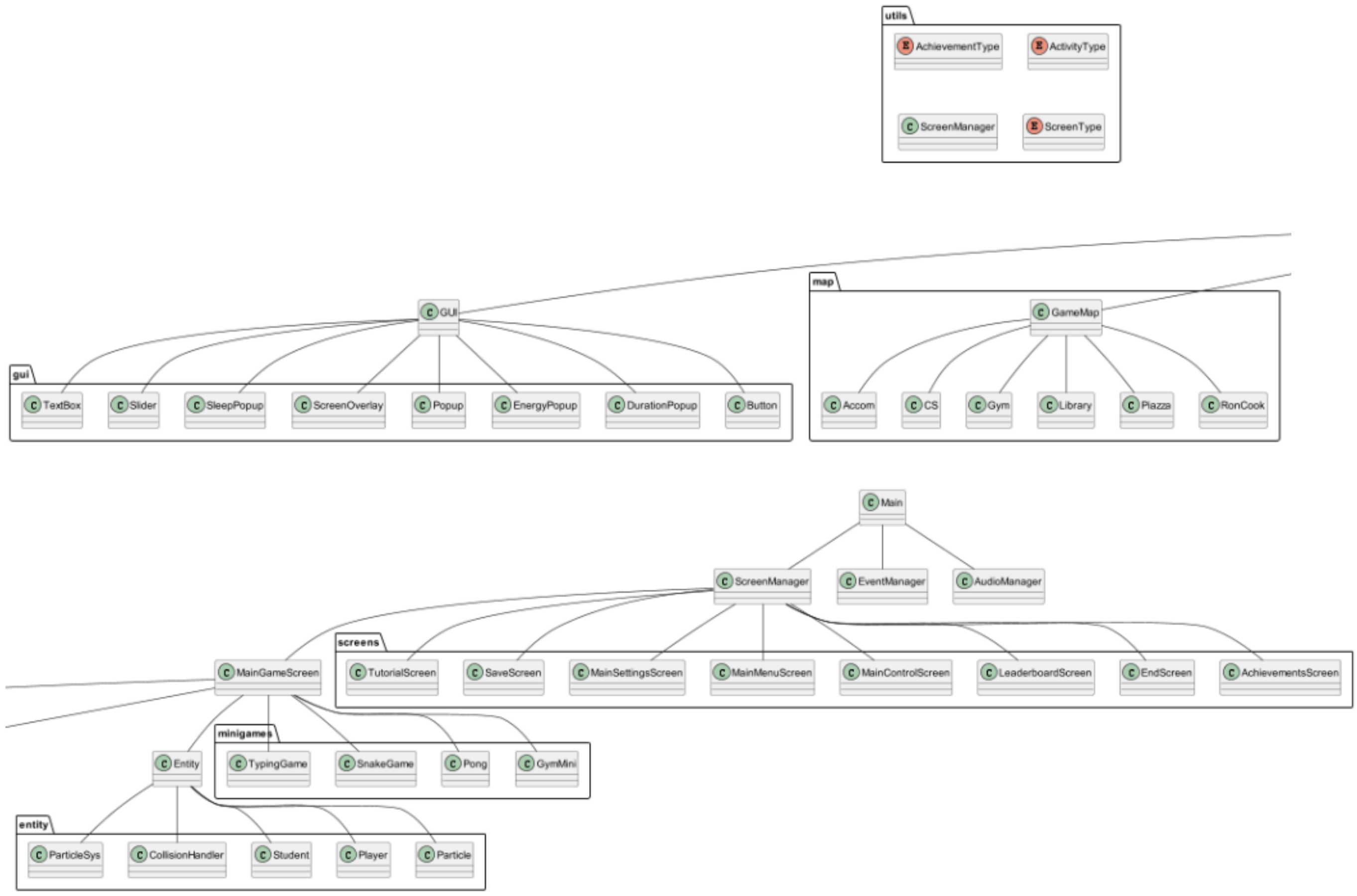


Minigames:

The diagram below shows how the 4 minigames use ‘Screen’ and ‘InputProcessor’ interfaces from LibGDX which are commonly used for game screen management. We have separate classes for each minigame within the minigames package. This modularity helps maintain the game and decreases the chance of error-making changes within one mini-game to affect others.



Main final architecture diagram:



1.6 Relating the Architecture to the Requirements
Assessment 1:

FR_INTERACTION_TRIGGER:
Class: CollisionHandler
Role: The CollisionHandler class plays a crucial role in detecting player Interactions with tiles.
isTouching Method: This method is designed to detect when an object is touching tiles of a certain layer for instance a door, building or tree
Justification: The isTouching Method in CollisionHandler directly contributes to the FR_INTERACTION_TRIGGER by providing the necessary logic to identify when an interaction-triggering condition occurs in the game
Class: MainGameScreen
Role: Acts as the main interface for player interaction within the game.
drawPopUpMenu Method: Once the CollisionHandler detects a trigger con-dition, the MainGameScreen class responds by generating a popup menu
Justification: The drawPopupMenu Method fulfils the FR_INTERACTION_TRIGGER by providing an interactive response to the detected player action.

FR_COMPLETE_ACTION:
Class: MainGameScreen:
Role: Main interface for player interaction within the game.

Method: touchDown
Justification: This method directly fulfils FR_COMPLETE_ACTION by providing the functionality for the player to select and complete various activities from the interaction menu. Depending on the player's touch input, it triggers different actions such as studying, exercising, sleeping, or eating. Additionally, it handles interaction triggers by displaying a popup menu, allowing the player to choose actions like studying, eating, or exercising upon touching specific doors.

FR_START_GAME
Class: MainMenuScreen
Role: Representing the main menu screen and handling interactions within it.
Method: touchDown()
Justification: This method processes touch events on the main menu screen. In the context of FR_START_GAME, it detects when the player touches the "START GAME" button and initiates the game accordingly.

FR_FULLSCREEN
Class: MainGameScreen
Role: Represents the main gameplay interface where all game elements are rendered, including the player character, map, UI elements, and pop-up menus.
Method: resize(int width, int height)
Justification: The resize method ensures that all elements on the screen, including the player character, map, UI elements, and pop-up menus, are properly adjusted and scaled to fit the new window size, thereby fulfilling the requirement for a full-screen display on any window size.
Class: ScreenManager
Role: Manages the game screens, including creation, switching, and memory management of screens.
Justification: ScreenManager class plays a vital role in ensuring that all screens, including MainGameScreen, are resized appropriately to maintain full-screen display. Its resize() method iterates through all screens, including the current screen (MainGameScreen), and adjusts their dimensions to fit the new window size, thereby fulfilling the requirement for a full-screen display on any window size.

NFR_SCALABILITY
The Architecture of the ScreenManager and GameData class supports further development by another team:
The ScreenManager class streamlines game screen management, offering an intuitive interface for screen creation, switching, and memory handling. Its use of a Map for storing screens enhances efficiency and scalability. The clearMemory() method aids in optimal memory use by removing unneeded screens, while setScreen() and createScreen() methods simplify adding and creating new screens.
The GameData class centralises game settings, such as gender selection and audio levels, facilitating easy access and modification. Its methods for setting preferences ensure a straightforward interaction with game data, promoting modular development and future extensibility.

NFR_EFFICIENCY
The MainGameScreen class architecture reduces CPU and resource usage. Its Efficient Rendering method updates game elements as needed, clears the screen, and draws world and UI elements separately to cut down on needless rendering and enhance performance. The dispose() method disposes of unused resources, preventing memory leaks and optimising resource management.

Requirement ID	**Related Architecture**
UR_MOVEMENT	*The player is able to move the avatar around the 2D map with the use of the Arrow keys. The movement of the Avatar is implemented in the Player class.The Player class represents the character in the game, handling movement, collision, and animations. The player class uses the setPos method in order to set the player's position to the specified coordinates adjusting the worldX and worldY variables*
UR_CONTROLS	*The game's controls are intuitive and are clearly presented to the player on the controls screen which is accessed via the main menu. Visually explaining the controls of the game is implemented through the MainControlScreen which is associated with the ScreenManager in order for it to be displayed. The ScreenManager class manages the game screens, including creation, switching, and memory management of screens.*
UR_ACCESSIBILITY	*The game is for new players, so it is easy to understand and play with no prior experience. This is reflected in the games easy to understand User Interface and the ability to access the main menu whenever.The MainMenuScreen class represents the main menu screen for the game. It handles the display and interaction with the main menu, including navigating to different parts of the game such as starting the gameplay, viewing controls, adjusting settings, or exiting the game.*
UR_TIME_SCALE	*In the game, one real-time minute equals one in-game day. The MainGameScreen manages time, updating the timeElapsed and currentHour variables to track in-game time, ensuring days align with real-time minutes. Three methods handle time display: updateGameTime() cycles active hours (8 AM to 12 AM), resetDay, and drawGameTime(). At 12 AM, the game resets to 8 AM for a new day.*
UR_RECREATION	*There is a building that the avatar can interact with to recreate. The recreation activity that has been used in the game is exercise in the gym. When exercise is selected the user is offered a choice of hours they would like to spend exercising from 1 to 4. When a time is selected a time skip occurs and the recreation count is incremented. For the MainGameScreen the code for recreation is within the touchdown() method.*
UR_STUDYING	*There is a building that the avatar can interact with to study. There are two buildings where the studying action can be started from. When selected the user will be prompted to select the amount of hours and then afterwards the studying minigame will start. Within the MainGameScreen class the method touchdown() is in charge of commanding the study activity. The method uses ScreenManager in order to switch to the minigame.*
UR_SLEEPING	*There is a building that the avatar can interact with to sleep. Sleeping can only be started after 8pm and is automatically completed when every day is over. After sleeping has finished, your character's position is placed outside the sleeping building. In the class MainGameScreen the method touchDown() is where the sleeping function is selected. A fade out is activated and the energy bar is reset.*
UR_EATING	*There is a building that the avatar can interact with to eat. In the class MainGameScreen the method touchDown(), along with the use of a switch statement is used to determine when to proceed with the sleeping function. When eating is selected the game data class is needed to be called in order to activate the associated sound. When eating is commenced the energyCounter is increased by 3 and the mealCount is incremented.*

Assessment 2:

Requirement ID	**Related Architecture**
UR_STREAKS	The game tracks player streaks for consecutive days of activity completion. The PlayerProgress class manages streaks, updating the streakCount variable each day the player completes all required activities. The method in the PlayerProgress class is called at the end of each in-game day by the MainGameScreen class to verify if the player's streak continues. If a streak is maintained, the player receives bonuses, which are managed by the rewardStreak() method. The StreakDisplay class handles the visual representation of the player's current streak on the main game screen.
UR_SCORE_LEADERBOARD	The game features a leaderboard to showcase the highest scores achieved by players. The LeaderboardManager class is responsible for storing and retrieving top scores. The updateLeaderboard() method updates the leaderboard whenever a player's session ends with a new high score. This method is invoked by the MainGameScreen class at the end of each game session. The MainMenuScreen class interacts with LeaderboardManager to display the leaderboard to players, ensuring it is visible and up-to-date in the main menu. The LeaderboardManager maintains a persistent record of high scores across sessions.
UR_ACHIEVEMENTS	The game includes an achievement system that tracks and awards players for reaching specific milestones. The AchievementSystem class manages the list of possible achievements and their criteria. The checkAchievements() method evaluates the player's actions and progress, unlocking achievements when conditions are met. This method is called at relevant points during gameplay by the MainGameScreen class. The AchievementNotification class handles the in-game notification when a new achievement is unlocked, providing immediate feedback to the player. Achievements are displayed in the MainMenuScreen, where players can view their progress and earned awards.