

Architecture

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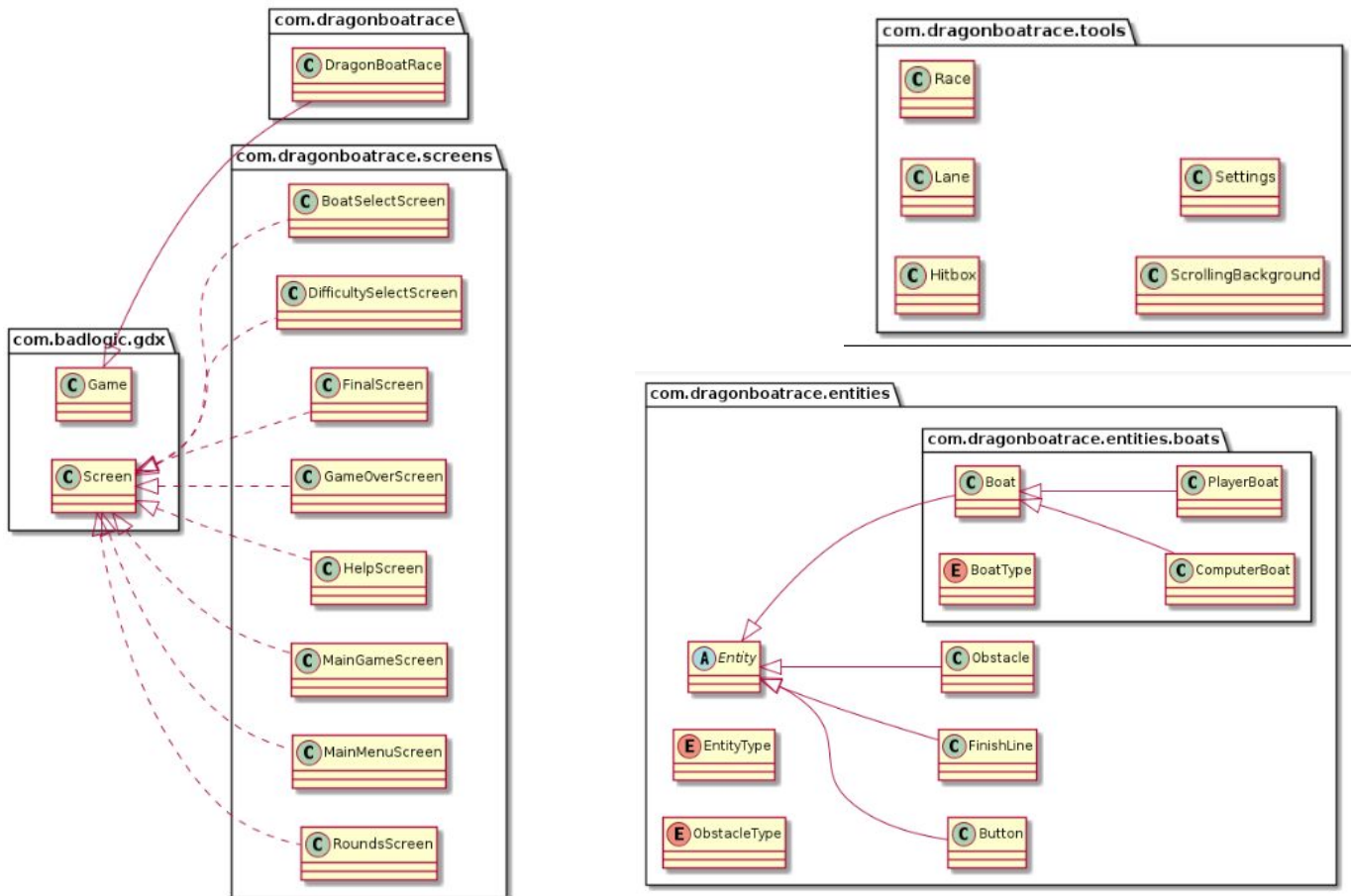
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Architecture

Abstract Representation of Software Architecture¹

Abstract diagram changed into the following diagrams by Team 12 for assessment 2. These show packages in our project also. **Please see footnote 1 for clearer diagrams.**



Concrete Representation of Software Architecture

In our team's Requirements Engineering, we used the PlantUML tool to create the UML class diagram above as a very high level, abstract representation of the game's Software Architecture. UML was our choice of modelling language, as using natural language to describe architecture can be imprecise and verbose since there are many different ways of doing the same thing, however UML graphical modelling allows people from all backgrounds, technical or nontechnical, to grasp the gist of complex concepts that code aims to carry out. As well as this, it is an industry standard and not language nor technology dependent.

Concrete diagram changed into the following diagrams by Team 12 for assessment 2

¹ Abstract Architecture: https://github.com/UmerFakher/ENG1Project/blob/website/Images/uml_relations.png

It is not feasible to fit these into this document so please follow the link. Please see footnote 2 for clearer diagrams.² Please see Appendix UML Diagrams for an overview.

Added Assessment 2 Requirements Justification (Moved to the top as important)

UR_DIFFICULTY_BEFORE_GAME: Make addition to the main game class, DragonBoatRace, with difficulty attribute along with relevant getter and setter implementation for DifficultySelectionScreen (see requirement below). [*] More obstacles will be spawned to increase difficulty and will be handled with lane class (see UR_POWERUP_RATE power ups are considered an ObstacleType as well for scalability). Lane class will also be edited to make sure the 3 initial 'negative' obstacle types added by the previous group will be more likely to spawn (see Impl2 for more details).

FR_DIFFICULTY_SELECTION: By adding DifficultySelectionScreen (to implement libgdx Screen interface) to let the user select the difficulty level of the game.

UR_POWERUPS: New ObstacleType options are added for new power-ups. Enums for health, stamina, agility, and speed and 'all' attribute powerup will be implemented as per UR_POWERUPS and more attributes for these obstacles to allow for these 'positive' effects will all be added in ObstacleType class ensuring we respect scalability.

FR_POWERUP_RATE: As the system must distribute an appropriate amount of power ups to spawn during a race. Please see UR_POWERUPS for types and additions. Please see [*] symbol in UR_DIFFICULTY_BEFORE_GAME above for treating these powerups as 'positive' obstacles.

NFR_ATTRIBUTES: Mentioned a lot above but will now fully print the values on the display for each attribute for each of the different BoatTypes on BoatSelectionScreen.

UR_SAVE_RESUME_GAME: Allow the player to pause the game save the game progress up to the start of the last leg started and resume this game later. User input (e.g. using a button like 'ESC') for pausing the game and save in game state (storing the player's total time, current round and difficulty selected as per UR_DIFFICULTY_BEFORE_GAME) in text file. This will be called in RoundScreen class and saving to file functionality will be implemented in this file. The MainGameScreen will have a new button to load from such a 'save game' text file in order to resume gameplay with correct round, time and difficulty for the game.

Justification for Abstract Representation of Software Architecture

This architecture was developed from the requirements we elicited, but reflects our decisions made prior to actual implementation, and serves as a basis for our lower level design, the concrete representation of our Software Architecture, which can be found further down this document. The architecture shows the classes (with self explanatory names) that the game will consist of, and we checked that every component in this abstract model relates back to the user requirements, to ensure that we were not diverging from the requirements set out.

² Concrete architecture

- <https://github.com/UmerFakher/ENG1Project/blob/website/Images/uml.png>
- https://github.com/UmerFakher/ENG1Project/blob/website/Images/uml_entities.png
- https://github.com/UmerFakher/ENG1Project/blob/website/Images/uml_screens.png
- https://github.com/UmerFakher/ENG1Project/blob/website/Images/uml_tools.png

This static perspective of our architectural model's structure enabled us to visualise and break down the most important requirements of the system (as defined in the System Requirements) that we needed to prioritise working on, allowing us to be more confident about satisfying the requirements and having a reliable system, but also make changes easily. Had it been a lower level design closer to the detail of the code, making necessary design adjustments would have been costly and difficult on top of already having invested considerable time, resources and effort. Not only is it useful for bridging the communication gap between system stakeholders and software engineers, but also it aids project planning by allowing us to make decisions such as on allocating work or design problems concerning trade offs amongst potentially conflicting quality attributes before actual implementation. Thus it was advantageous to spend some time using a higher level design as we did.

Justification for Concrete Representation of Software Architecture

Further on in our Software Development Lifecycle, we developed a concrete representation of what we have planned for the Software Architecture of the game. This concrete representation is composed of a structural diagram representing the static features of the system. We checked that every system requirement relates forward to at least one component in this architectural model, in order to make sure everyone's understanding was thorough and up to standard before implementation. The components of the concrete architectural diagrams' relation to system requirements (in turn derived from user requirements, so we are making sure that we are still following through with the requirements we elicited) are justified under "Justification".

We used a class diagram form of structural modelling, as it is most applicable to the object oriented style used in our programming solution. It is clear that the class diagram builds from the abstract software architecture above and looks at the classes that are more specific to the code in more detail. The naming convention has also been kept the same from the abstract architecture as this allows us to clearly see the how we have built from it and causes less confusion. The tool used in order to make this diagram was the UML Class Diagram tool provided by the IntelliJ IDE.

The diagram provides a critical link between the requirements engineering and the actual design of the software we implemented. It identifies the main structural components in the system and the relationships between them. By generating the concrete architecture from the abstract architecture (the precursor of which in turn was the functional and nonfunctional requirements), it is ensured that we keep to the requirements set out by the stakeholders, and as a result the concrete architecture helps reinforce these requirements into our software implementation. A key difference in the two representations is that this representation has moved away from explicitly referring to the nonfunctional requirements, as they have been incorporated into the design, and since this one is more technical and closer to the code. Having this concrete representation of the design we have settled on will allow it to be easier for us to map the necessary components into the actual code in the organisational way we decided upon.

We also looked into common pre existing architectural patterns that we could reuse. We could have used an entity-component system, as it is notable in game development due to its not being subject to the rigid class hierarchies of object oriented programming (especially difficult when entities that incorporate different types of functionalities need to be added to the hierarchy), however we decided to use an object oriented approach via inheritance for the most part, due to the fact that the complexity of our game mechanic is not to such an extent that it would result in

inefficient code which would become increasingly difficult to maintain. Inheritance also allows for efficient code reuse, since changes in the parent class affect all children, avoids duplicity and data redundancy, and reduces time and space complexity. Additionally, we had to bear our time constraints in mind and stuck to what we had a solid understanding of. **Below is the justification for how the concrete architecture builds from system requirements:**

- MainGameScreen: This will be where NFR_MOVEMENT_EXPLANATION and NFR_RULES_EXPLANATION will be satisfied.
- MainMenuScreen: This class will be used to carry out the FR_CHOOSING_UNIQUE_BOAT and FR_DIFFICULTY_SELECTION system requirements, and play a part in NFR_POSITIVE_UX.
- GameOverScreen: After FR_GAME_DURATION, the player's outcome in the game is revealed, relating to NFR_END_SCREEN.
- Button: Linked to FR_INPUT_DETECTION, and this class shall process the input if it is a user click on a button.
- ScrollingBackground: This will allow the player to become invested in the simulation, and help build NFR_POSITIVE_UX.
- Boat: All objects that extend from this will be unique, relating to UR_BOAT_UNIQUENESS, and shall be described to the user as per NFR_ATTRIBUTES.
- PlayerBoat: Upon NFR_ATTRIBUTES being carried out, the player will choose their avatar, linking to the FR_CHOOSING_BOAT system requirement. It is controlled by standard WASD controls, relating to FR_INPUT_DETECTION and FR_MOVEMENT. If its health decreases according to numerous FR_HIT_DECREASED_BOAT_CONDITION on top of FR_TIMED_DECREASED_BOAT_CONDITION, such that FR_BOAT_BREAKAGE occurs, game ends and NFR_END_SCREEN happens.
- ComputerBoat: An object of this class will be the player's competition in every race. Will be an object of type Boat, which was not chosen by the player in NFR_ATTRIBUTES.
- Obstacle: This is dependent upon FR_OBSTACLE_RATE and FR_OBSTACLE_SPAWN.
- ObstacleType: This class allows for variation in obstacles to make the player more invested in the game, aiding the fulfillment of NFR_POSITIVE_UX.
- Hitbox: This implements FR_COLLISION_DETECTION between object of type Boat and object of type Obstacle. If true (i.e hit), FR_HIT_DECREASED_BOAT_CONDITION occurs.
- Lane: Using this class, FR_BOUNDARY_DETECTION checks if the player is in lane, else FR_AWARD_PENALTY is carried out.
- Race: This shall be used to implement FR_FINAL_RACE and FR_QUALIFIER_RACES, and during its duration FR_DECREASED_BOAT_CONDITION shall be affecting the Boat objects.
- FinishLine: Upon reaching this before their opponent, a player will win that race. Provides a sense of achievement before the grand finale of the competition for NFR_POSITIVE_UX. Timings in FR_QUALIFIER_RACES determine whether FR_FINAL_RACE shall involve the player or not.
- BoatType: This is an ENUM class that holds the different predefined attributes of various boats, such as their relative staminas, healths, speeds and velocities - relating to NFR_ATTRIBUTES and FR_CHOOSING_UNIQUE_BOAT. This class makes it easier to add new boats to the game as values don't need to be redefined for each new boat created in the project. As a result, it will result in boats being less error prone.

- Entity: This ENUM class makes it easier and less error prone to add new obstacles and boats to the program, as values don't need to be defined every time, instead they are just stored in the class - relating to NFR_ATTRIBUTES and FR_OBSTACLE_SPAWN and FR_CHOOSING_UNIQUE_BOAT.
- EntityType: This ENUM class makes it easier to add new boats to the game as values don't need to be redefined for each new boat created in the project. As a result, it will result in boats being less error prone. All attributes of the boats are predefined in that case - relating to NFR_ATTRIBUTES and FR_CHOOSING_UNIQUE_BOAT.
- DragonBoatRace: This class is used to initialise the game. This relates to UR_UX.

Bibliography

- "Software Engineering", Ian Sommerville, Chapter 6
- "UML Online Training", Tutorials Point
- "Use Case Models and State Models", Binary Terms
- Software Architecture: Foundations, Theory, and Practice, R.N. Taylor, N. Medvidovic, and E.M. Dashofy John Wiley & Sons, 2008.
- Clements, P., F. Bachmann, L. Bass, D. Garlan, J. Ivers, R. Little, R. Nord, J. Stafford. Documenting Software Architectures: Views and Beyond. Addison- Wesley, Boston, 2002.

Links

See concrete and abstract architecture here:

<https://github.com/UmerFakher/ENG1Project/tree/website/Images>

Abstract Representation:

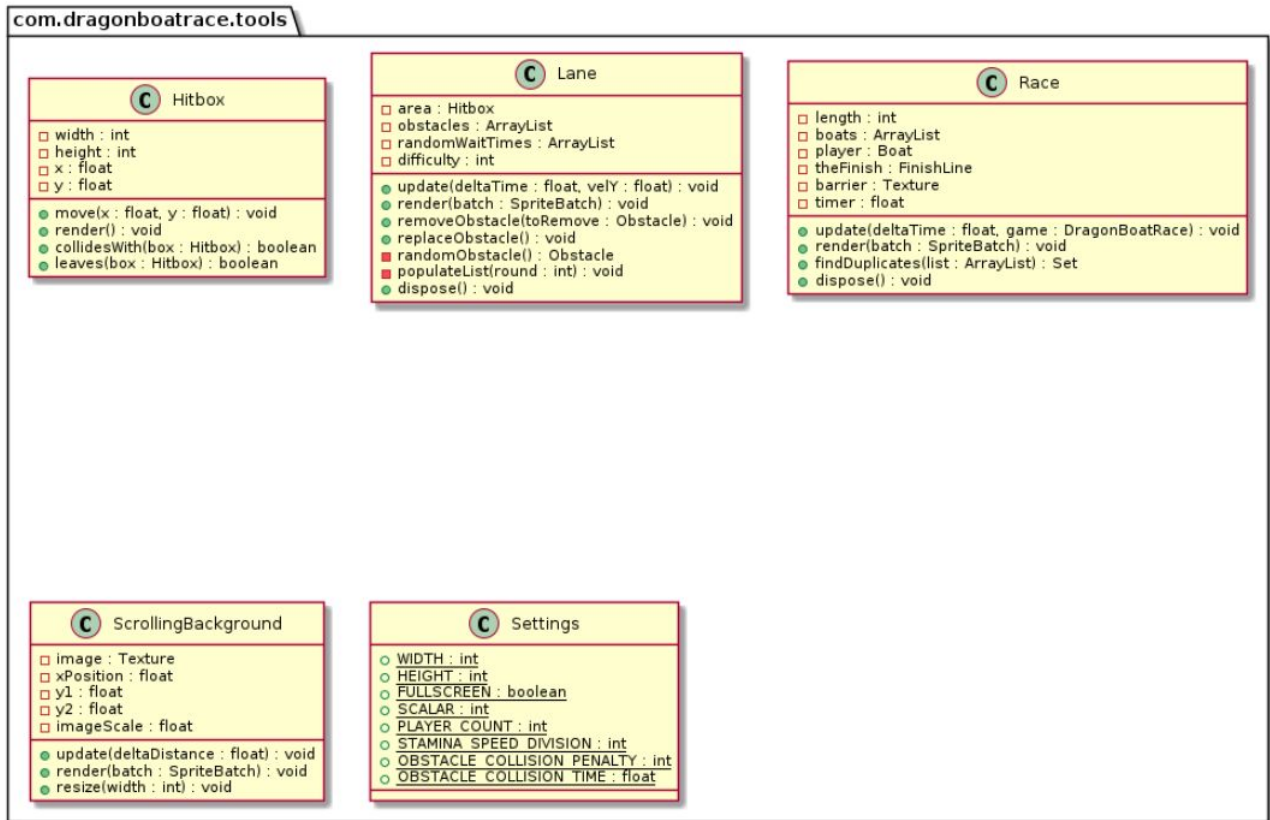
- uml_relations.png
- https://github.com/UmerFakher/ENG1Project/blob/website/Images/uml_relations.png

Concrete Representation of Software Architecture:

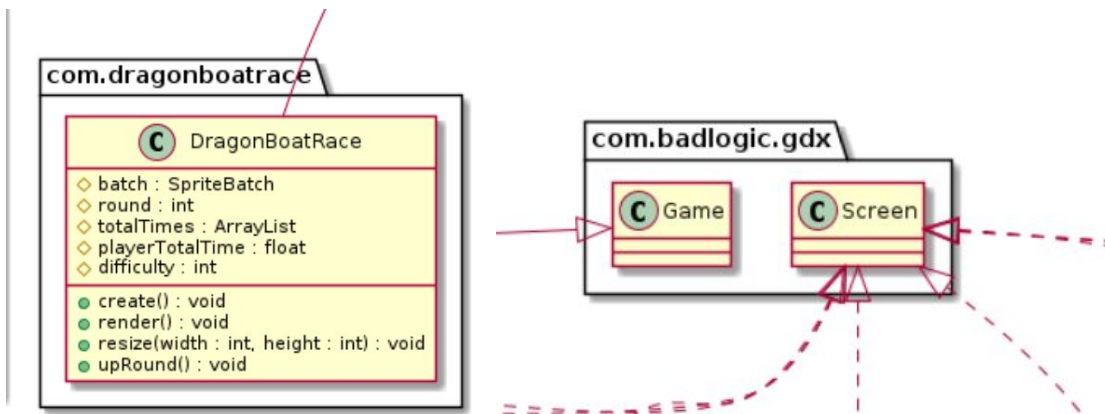
- uml.png
- uml_entites.png
- uml_screens.png
- uml_tools.png
- <https://github.com/UmerFakher/ENG1Project/blob/website/Images/uml.png>
- https://github.com/UmerFakher/ENG1Project/blob/website/Images/uml_entites.png
- https://github.com/UmerFakher/ENG1Project/blob/website/Images/uml_screens.png
- https://github.com/UmerFakher/ENG1Project/blob/website/Images/uml_tools.png

Appendix UML Diagrams:

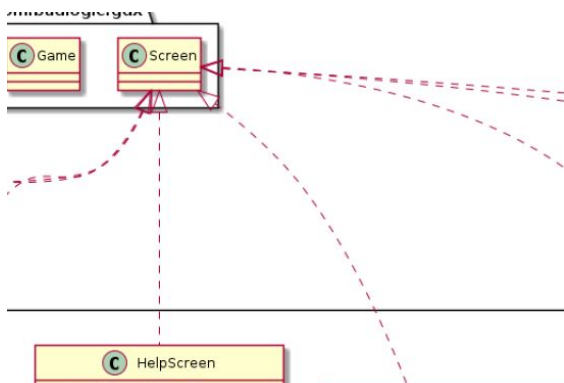
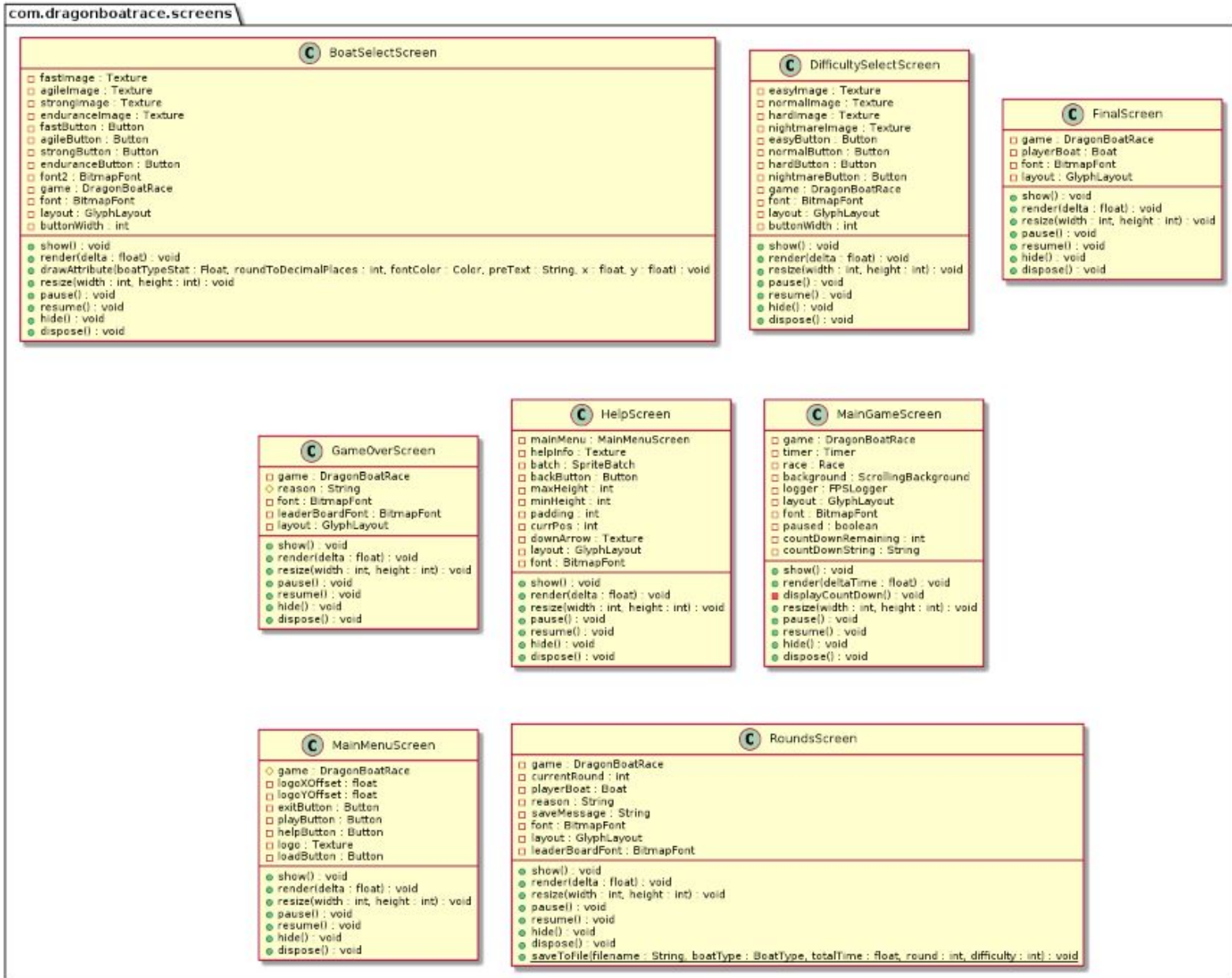
It is not feasible to fit these into this document so please follow the link. Please see footnote 2 for clearer diagrams in the page before. Appendix UML Diagrams is an overview. I have highlighted some of the main parts. Please see links to full diagrams which will make it easier to zoom in and out.



Dragonboatrace links to Game in libdgd as you can see the upward arrow in the full diagram (uml.png) links left screenshot to right screenshot.



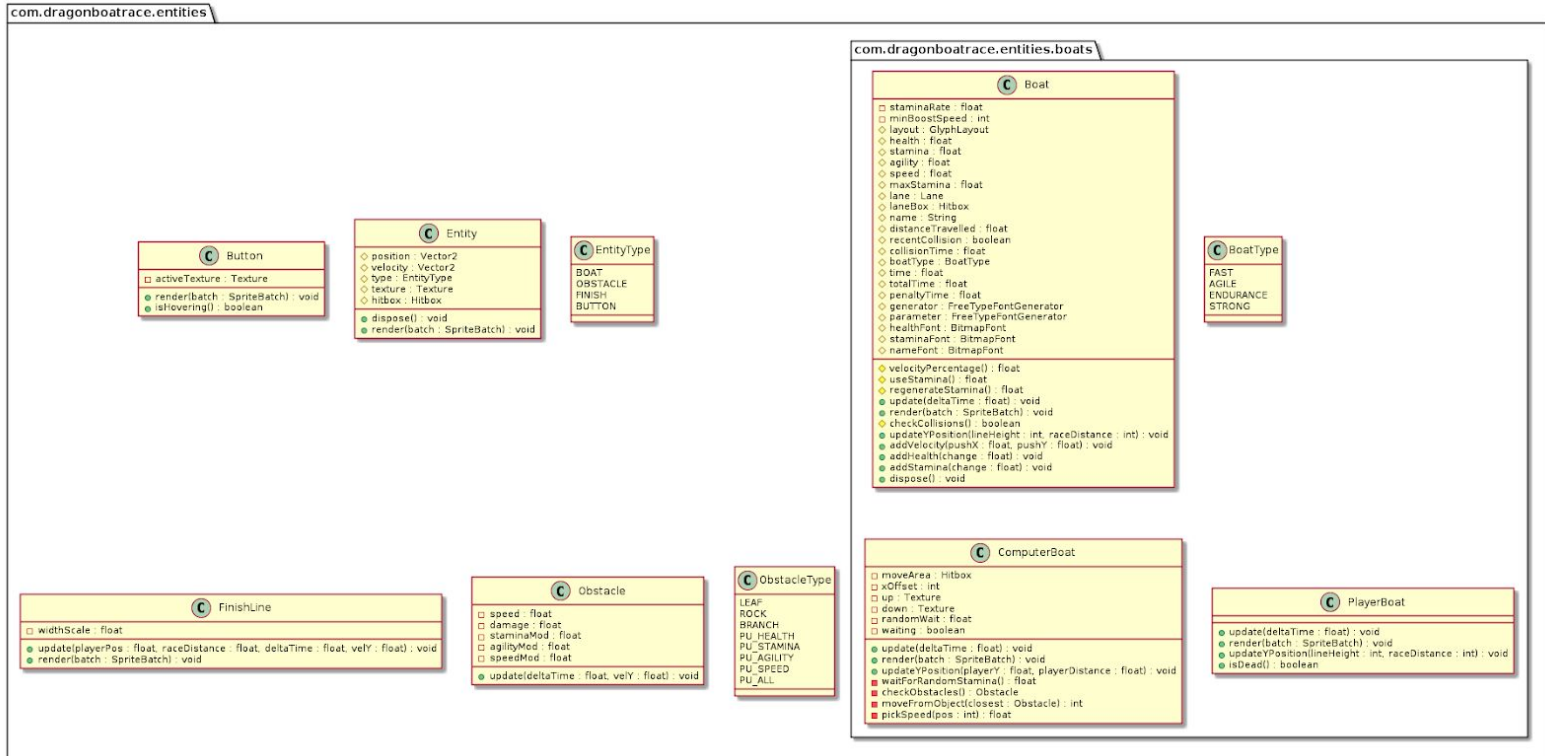
The dashed arrows from screen in libgdx are linked to the all of the screens with dashed arrows (these aren't shown on this particular screenshot (uml_screens.png) below but is on uml.png)



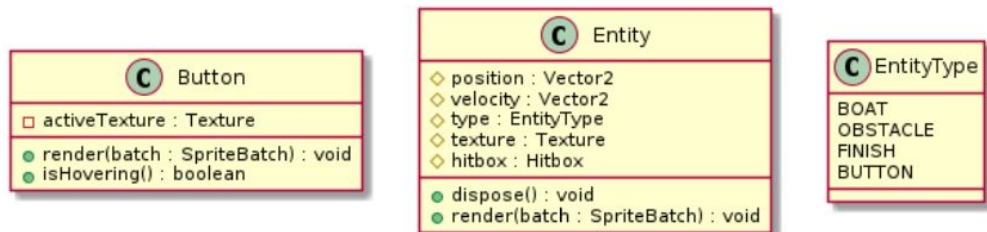
For example in uml.png they will look like this.

com.dragonboatrace.entities

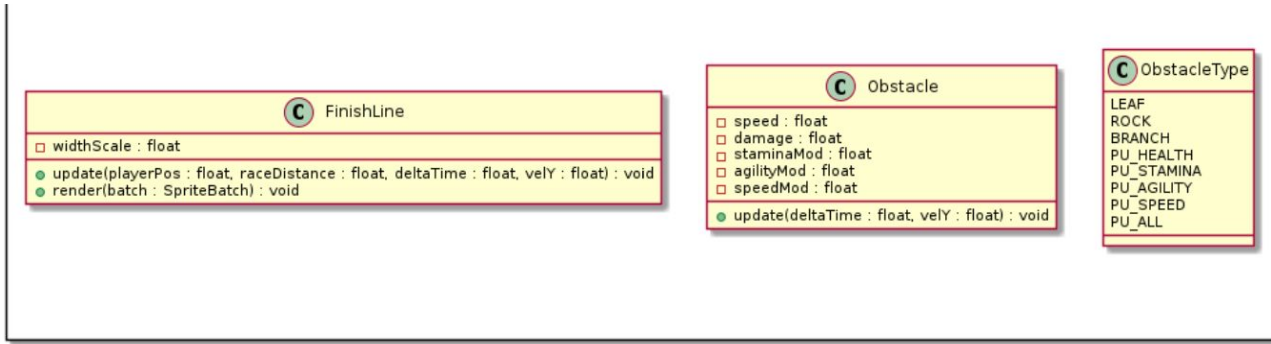
These are in uml_entities.png.



com.dragonboatrace.entities

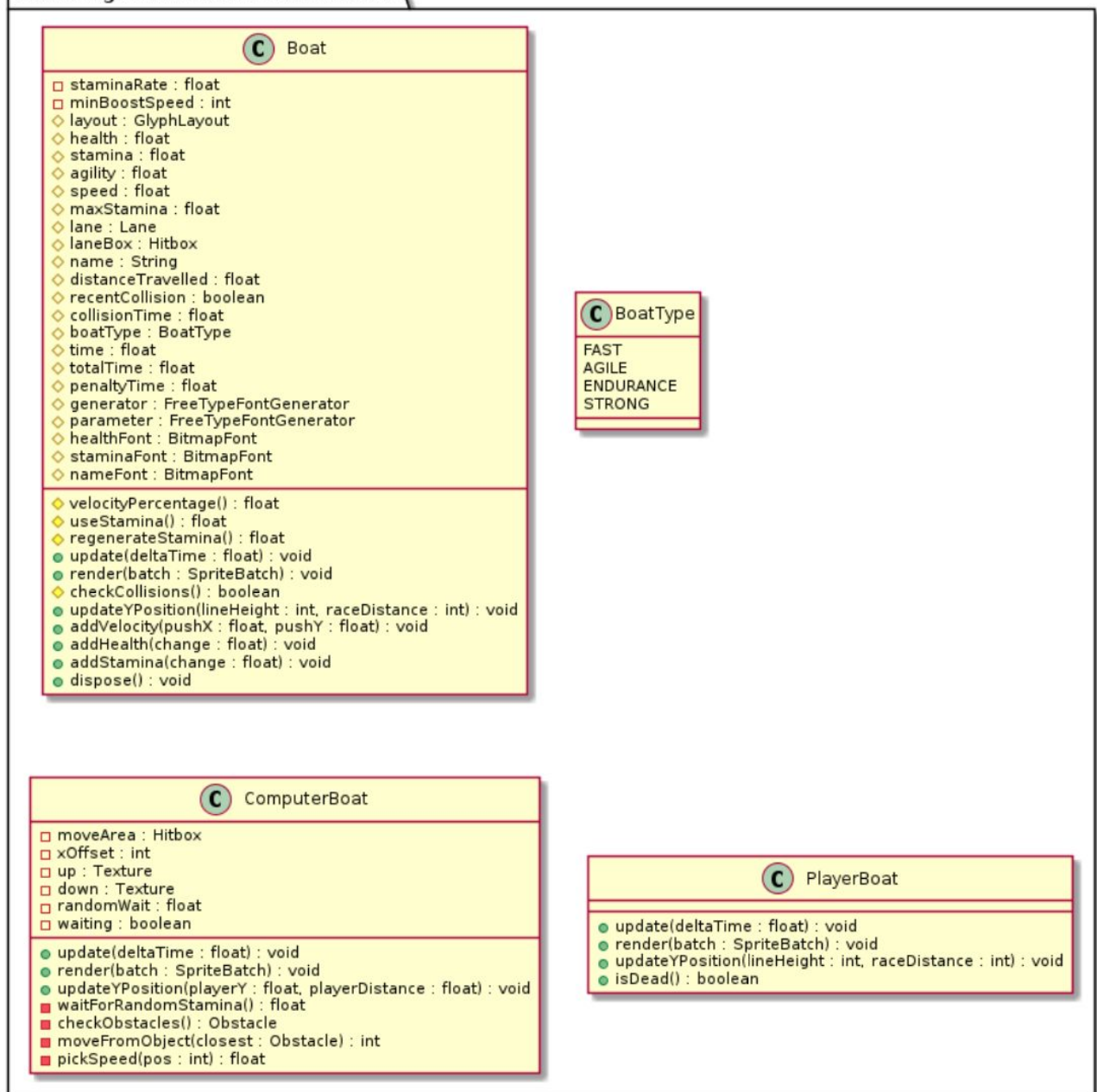


Top left



Bottom left

com.dragonboatrace.entities.boats



Right hand side of screenshot this is contained without entities also.