System design document for Adlez

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This version overrides all previous versions.

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1 Introduction

1.1 Design goals

The application must follow the MVC design pattern. The design should therefore be modular so that different parts of the application can be exchanged without affecting other parts. In particular, the visual representation must be completely separated from the game logic and data. Also, subsystems such as file handling should be communicated by using interfaces so that they can be substituted without ramifications on the rest of the application.

The model package should also strive to have as loose coupling as possible within itself. It should be the basis for all tests of the application.

1.2 Definitions, acronyms and abbreviations

- MVC: An architectural pattern that divides the application into three parts, the Model containing the logic, the View containing the graphical user interface based on the Model and the Controller that handles the user's input and updates the Model.
- Screen: It is where the game will be rendered on, drawing the game.
- World object: An object in the game such as a wall, obstacle, character etc.
- Area: An area in the game which contains world objects.
- Player: The character that is controlled by the user of the application.
- LibGDX: Game-development application framework.
- JSON: Short for JavaScript Object Notation. Data format used for storing information in an organized and easy understandable manner.
- Game loop: Common design pattern for games. Involves a method that continuously loops and updates game logic and data, graphics, acknowledges user input etc. One (1) game loop is one loop of this method.
- DeltaT: Short for delta time, the time since the last update of the game.
- NPC: Non-player character

2 System design

2.1 Overview

The application is based on a MVC structure. The application is split into different screens that are managed by a screen manager. The screen manager loads the data for the individual screens when they are to be displayed.

The game screen is the screen that handles the core gameplay of the game and can be seen as a sort of top level controller. It contains the game loop which is responsible for updating the game model and rendering the view. The update is done through controllers for either individual objects such as an enemy or families of objects such as obstacles. User input is handled by the PlayerController class which registers what key was pressed and proceeds with performing appropriate actions such as telling the player model to move.

2.1.1 Model structure

The game is split into areas which hold the state for all the game objects except for the player. The area handler holds the state for each area. The state for the player is held by the class *Adlez* that also manages the state of the player together with the current area being played. All changes of the model therefore goes through the class Adlez. The game screen retrieves the game data from Adlez. Adlez is the top level class for the model and since only one instance is needed it appropriately uses the singleton pattern.

2.1.2 Areas

The game's world is divided up in different smaller areas where each area contains the game's different objects such as enemies and obstacles. The areas are handled through an area handler which handles every object that an area needs. With the help of the area handler Adlez can save the game effectively since it handles every object.
The different components to fulfill an area, such as obstacles, are implemented separately as model and view. While the area handler handles all the models (obstacles, enemies…), the game screen will render the objects graphics.
The areas maps are drawn using the program Tiled, which is a tile map maker. We are using it as a background, so it will not have any logical affections.
When all components are ready, Adlez has a setup for each area that sets all objects on their place.

2.1.3 Collision handling

Collisions are handled at the end of each game loop by a collision handler, more specifically the *CollisionHandler* class. Only one instance is needed of this class so it also employs the singleton pattern. How it works is that each object in the world inherits from the *WorldObject* class, which contains position and size information about the object. The collision handler handles collisions by seeing all objects as world objects and then checking for each object if it overlaps with another. If there is an overlap, a collision has happened. The collision handler then proceeds with invoking the object in question's *onCollide(Collidable other)* method, which then performs the appropriate actions depending on what kind of object *other* is. The method like this for the *Player* class for example:

```
public void onCollide(Collidable other) {
    super.onCollide(other);
    if (other instanceof IAttack && !((IAttack) other).byPlayer()) {
        IAttack attack = (IAttack) other;
        setHealth(getHealth() - attack.getDamage());
    }
}
```

Objects only get checked if they have been collided on by relevant objects though. For example, it wouldn't make sense (and would consume unnecessary cpu power) to check if a wall has collided with another wall. The relevant objects that are checked against are therefore only attacks and interactions for now, but more possibilities could easily be added later if the application was to be further developed. Additionally, while all world objects do have an onCollide method, some, like *Wall*, have empty bodies for them. This is done so that all objects at least have the possibility to have their functionality extended by allowing them to react to collisions in some way. If we're to take the wall example, a possibility for extension could be to introduce destructible walls in the game.

The only objects that don't get checked for collisions at the end of each game loop are characters. This is due to complications that occurred when characters collided with other objects while moving in intercardinal directions (e.g. northeast). Collision checking for characters is therefore done by using the observer design pattern. The collision handler first registers itself as an observer to every character. Directly after a character has moved it notifies its observers, which includes the collision handler. A solution could have been to limit the game to only cardinal directions (e.g. north), but we didn't want to limit the game like that.

2.1.4 Attacks

When a character attacks, an attack object is created and added to the world as any other world object. Say for example that the player performs a melee attack. This is handled by the creation of an attack object that gets situated right in front of where the player is facing. If the collision handler then finds that, say, an enemy has collided with the attack, the enemy's onCollide(Collidable other) method will be invoked with the attack object as the parameter. The enemy's method will register that other is an attack from the player and will do what needs to be done, in this case decrease the enemy's health depending on the attack's damage.

A strength of this way of handling attacks is that an attack can go on and live its own life in the world, so to speak. An attack representing a bullet for example could travel in the world independent of what else is happening. If it then eventually collides with something, the onCollide method will perform the appropriate actions.

A small comment about attacks is that the graphics were not prioritized, so the attacks lack any real visual representation. To at least show were the player's latest attack landed, a hollow rectangle is rendered to represent the attack.

2.1.5 Interactions

Interactions are handled in a similar way to attacks. If the player presses the interaction button, an interaction object is created and placed in front of where the player is facing. If the interaction doesn't collide with anything that can be interacted with, nothing happens. If it does though, say with a chest, the onCollide method of the chest will handle the transaction of the chest's contents to the player.

2.1.6 Movement

Movement incorporates delta time so that even if the game's update frequency drops, a character will still move the same distance.

2.1.7 Enemy AI

Enemy AI wasn't prioritized so it's handled very simply in that an enemy will start moving towards the player if the player gets within a certain proximity. The enemy will then attack if it gets close enough to the player. The frequency at which an enemy can attack is handled by the time variable *cooldown*. This variable gets incremented with the value of deltaT every game loop. Only if the variable has reached a certain limit is the enemy allowed to attack. When the enemy has attacked, the variable gets reset and the enemy has to again wait for a while until it's allowed to attack.

2.1.8 Enemy factory

The enemy factory's purpose is to have easy access to different enemies where each enemy has stats assigned to it. This design saves much time and space for implementation of enemy related components.

2.1.9 Saving/loading game

The game can be saved at any time using the key "0". Only one game can be saved at a time so when the game is saved a previous saved game will be overwritten. A user can load a saved game either from the main menu or from the game over menu. When a user loads a saved game, the player will be placed at the start of the area that the user previously saved the game from. More on how the saving and loading of the game works can be read about in section 2.4 Persistent data management.

2.1.10 Area switching

By interaction with an *AreaConnection* object the player will switch to the next area and since it uses the save-load mechanism, the areas will be saved as they were when the player left them. So if the player switches to the next area after killing all enemies and then goes back, the enemies will not be there. The area switching is handled by the *ScreenManager* class which is notified by an area connection object using the observer pattern. When the player interacts with the area connection, it notifies all listeners to the area connection, which would be the screen manager.

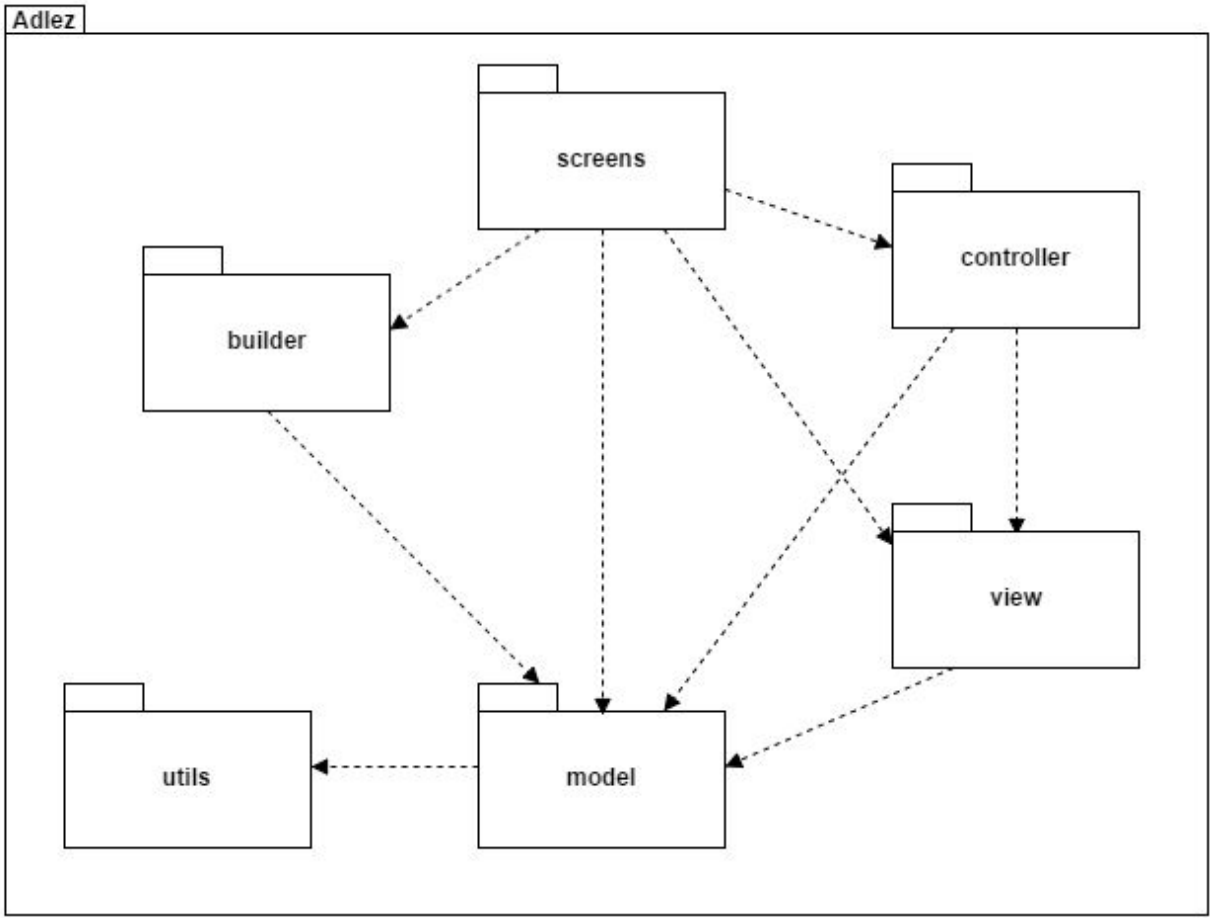
2.1.11 Items and shop

There is a friendly NPC in every area where the player can buy and sell items. The NPC has different items for sale and can buy up everything the player wishes to sell. The currency in Adlez is gold and gold is acquired by killing enemies. The items that the player equips will buff up the player's stats, such as health points and attack damage.

2.2 Software decomposition

2.2.1 General

The application is decomposed into the following top level packages.



- Screens includes the ScreenManager and all the screens for the different views of the game such as the main menu, the game screen, the inventory.
- Builder includes the AreaHandler and the AreaBuilder which handles the saving and loading of the game.
- Model, controller and view includes what there names say.
- Utils include general things that possibly can be reused.

2.2.2 Decomposition into subsystems

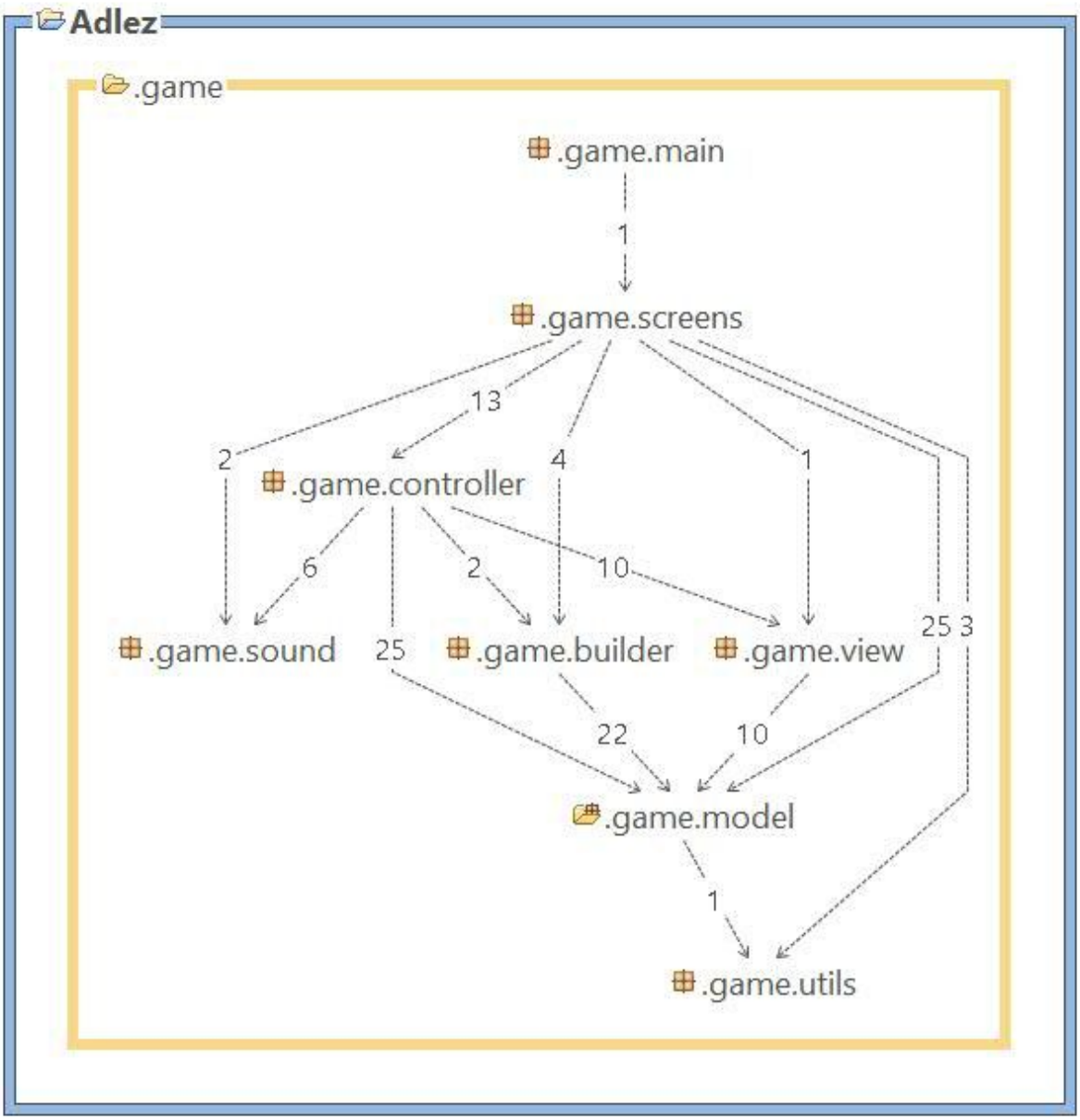
The system that handles the saving and loading of the game is a subsystem with the following interface.

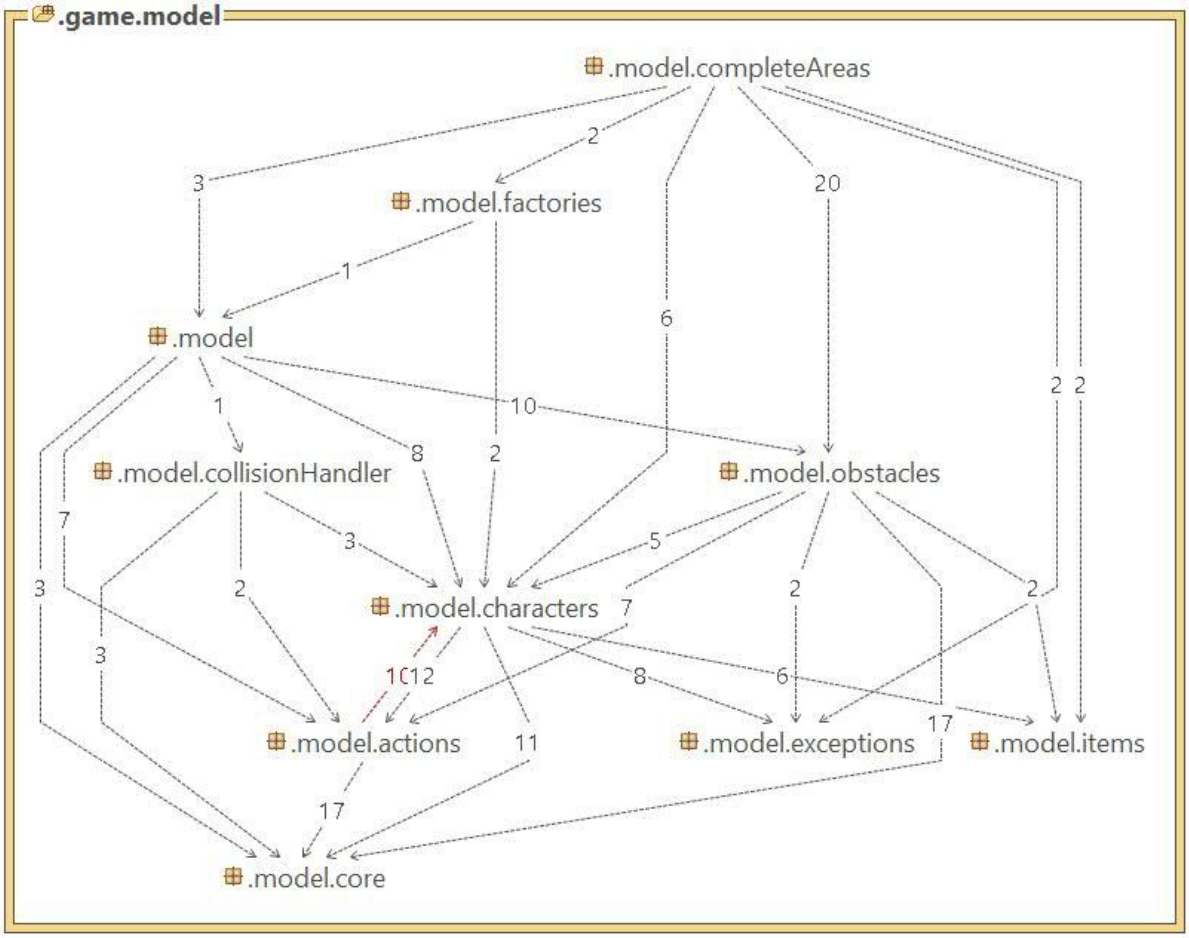
```
public interface GameIO {
   void savePlayer() throws IOException;
   void saveAreaHandler() throws IOException;
   IPlayer loadPlayer() throws IOException;
   AreaHandler loadAreaHandler() throws IOException;
}
```

2.2.3 Layering

NA.

2.2.4 Dependency analysis





The game has a circular dependency between the packages character and actions. The circular dependency comes from the fact that an attack or interaction takes the character that performed the the attack or interaction as a parameter in its constructor. The character on the other hand has to handle attacks inside it's onCollide(Collidable other). This is something that needs to be fixed and can be done by changing the constructor of attacks and interactions to take only the information they need. They would need to know where and by who they are performed, the direction of the player etc. Due to not wanting to confront a possible domino effect of bugs in the last days, this dependency wasn't rectified.

2.3 Concurrency issues

The game runs on a single thread.

2.4 Persistent data management

The game's state is located in two classes, the Area Handler which has the state of every Area in the game which in turn has the state of every object in the game, the other class is Player

which holds the state of the character that the user controls and is the only object that can travel between areas.

The game is saved through a subsystem that implements the interface GameIO containing the methods savePlayer(), saveAreaHandler(), loadPlayer() and loadAreaHandler(). This is implemented by saving the necessary data in two files using JSON format,

- One file containing the data of each area such as the enemies' locations, the obstacles and the chests.
- One file containing the data for the player, such as health and items.

Only the data is saved so that the logic of the model can change while the saved files are still usable.
Part of an example of a file containing saved player data can be seen below.

```
{
        name:null,
        xPos:522.6215,
        yPos:213.6999,
        height:17,
        width:17,
        speed:2.0,
        maxHealth:100,
        health:29,
        maxMana:100,
        mana:40,
        attackDamage:20,
        direction:2,
        gold:121,
        level:0,
        inventory:[
                {
                        itemType:Weapon,
                        type:type_weapon_sword,
                        name:iron_sword,
                        goldValue:200,
                        stats:60
                },
                {
                        itemType:Armor,
                        type:type_armor_body,
```

2.5 Access control and security

Only one user and one kind of access and no need for security for the application.

2.6 Boundary conditions

No need, the application launched and exited as normal desktop application.

3 References

- LibGDX: https://libgdx.badlogicgames.com/
- MVC: https://en.wikipedia.org/wiki/Model%E2%80%93view%E2%80%93controller
- JSON: http://www.json.org/

APPENDIX

A. Class diagram of the model