GUI-based Coding Challenge

(Assessment Task 2) – Project Software Development Process

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# Problem Specification

To design and develop a GUI based traffic simulator that simulates a set of vehicles (car, bus, motorbike), that move in multiple directions on multiple roads and obey the stop and go commands of multiple traffic lights. The user will be able to enter two modes: City editing, that allows the user to build, save, edit and open a city that they created. And the simulation mode in which the simulation will run.

The program will be executed within a SimCity class and utilize a statistics class to keep track of the results of the simulation. Of course these are only the most basic classes and during the implementation of the project some auxiliary classes may appear.

This program will be used during JCU open day in 2020. It will behave like a simplified traffic simulator.

# Problem Decomposition

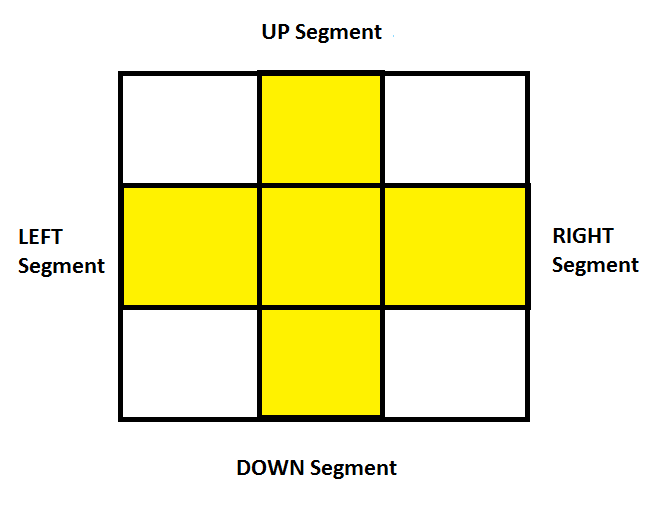
This program will be constructed using ~~fourteen~~ classes, in which comprises of many objects and methods.

## 2D City Road Planning

At the current stage of implementing the coordination for the city, I define a **CityCell** class. The **City** object will contain a fixed grid size of 20 by 20 cells (for simplicity sake). And after much deliberation with a hint of frustration, a new concept for the roads will be implemented to ensure a successful intersection.

Each city cell will contain 0 – 4 road segments, this layout is what will make a working intersection possible.

**Diagram:**



The central square will act as the intersection. When a vehicle reaches this square, the vehicle will choose a direction depending on the presence of the adjacent connected road segments.

A file format is needed in order to save the state of the city. The first line in the file will contain the grid dimensions (I haven’t used any of this yet) and the remaining lines will contain the sections of straight roads.

The coordinates set the beginning and end of the road:

**Example:**

X1, Y1, X2, Y2 …

Since each cell contains 0 – 2 segments of straight road, the layout of the coordinates are as follows:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cell 0 | | Cell 1 | | Cell 2 | | Cell 3 | | Cell … | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | … | … |

Let’s say we have a horizontal road, then the odd coordinates will indicate that the road begins (or ends) with the left segment, and even coordinates mean that the road begins (or ends) with the right segment. This is the same for vertical roads.

So inside the city.txt file (describing the city) the format is:

20, 20

1,1,1,40

1,1,40,1

21,2,21,39

10,10,30,10

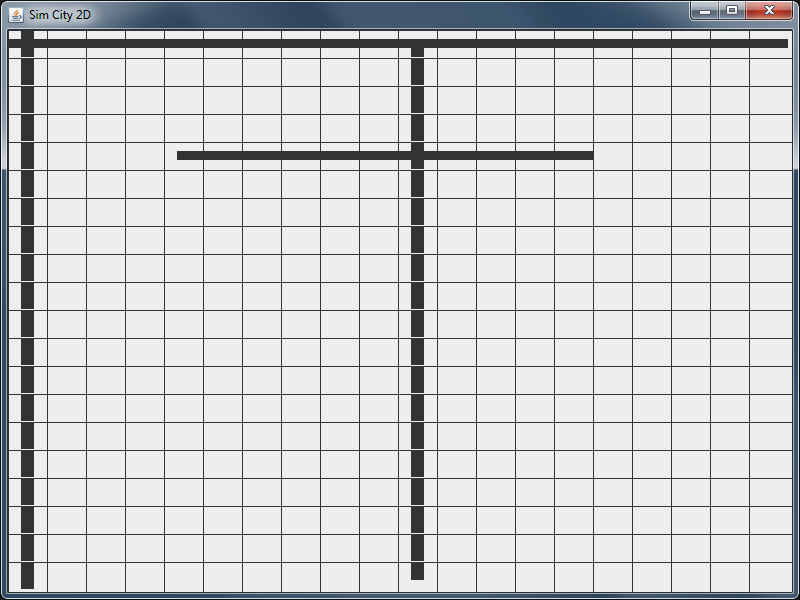
This defines a city that consists of **20 by 20** cells in which contain **4 roads.**

The functions for loading a file into the **City** class are also implemented

(loadCity(String) and addRoad(int, int, int, int)).

Since the **CityView** class is the direct descendant of the JPanel, redefining the paintComponent() function to draw the city grid is necessary.

As a result, I have this view of the city:



## SimCity

This class simply creates a window and is responsible for starting the execution of the program. It is composed of a new instance of the SimCity2D class and will execute that instance to start the simulation.

## SimCity2D

A JFrame that will contain a city view, a status bar (for displaying statistics and a menu bar. This class will load the coordinates for the layout of the city and initialize the conditions of the JFrame. run() is a method of this class in which will perform the steps of the simulation and catch any errors that may occur. *I originally was going to implement the JFrame conditions inside main() but I feel it would be best to have these parameters as a separate class (initControls()) inside SimCity2D so that I have better control and workflow.*

City

This class contains all the objects of simulation. It contains three separate lists for the vehicles, traffic lights and roads. This class allows the user to add new objects and implements the method step() in which performs one cycle of the simulation, calling the appropriate methods for all of the objects.

## CityView

This class is a representation of the city and will be implemented as a JPanel in which all the objects of the simulation will be displayed.

## EditCityView

This class extends Jpanel and creates another panel that is displayed when the user clicks on ‘City -> Edit’. This class also contains methods to handle a mouse listener in which implements a MouseListener interface. When a user right clicks on the grid and selects ‘Done’ the current city will be made according to the cells selected by the user.

## CityCell

This class is used to represent the roads within the city. This class is composed of the City class and issues a new array instance for the roads passing the number of segments. It is responsible for driving the coordinates that the vehicles will follow in order to move from one road to the next. It contains four instance variables; ‘x’ & ‘y' coordinate for the city within the grid, a city object to be defined, and an array of ‘Road’ objects. This class also contains methods to define whether there is at least one road, to return adjacent roads, and to set a new road with a specified direction.

SimItem

This is an abstract class that will be the base class for all the objects (vehicles, traffic lights and roads) in the simulation and implements the *Position* and *Drawable* interfaces.

## Road

This class is responsible for constructing the conditions such as the length and the x & y coordinates in which the vehicle object will travel on. Much the same as in the first part of the assignment but is redesigned to be able to intersect with other roads.

## Direction

Direction is an enumerated class that serves the purpose of representing a direction within a 2D plane. This class defines four possible directions and each direction stores a relative direction for the road (UP, RIGHT, LEFT, DOWN).

## Mode

An enumerated class that defines two possible modes for the simulation: Edit & Simulation.

## TrafficLight

Defines the condition that changes the behavior of the vehicle to move or stop.

## Vehicle

This abstract class define various vehicles. The move() method will determine the logic of the car’s movement. It follows the vehicle if there is one in front, chooses a random direction at intersections and obeys the commands of a traffic light.

## Car, Motorbike, Bus

Inheritors of the Vehicle class, these are the objects in which will represent vehicles in the simulation. They each contain their own x & y coordinates (double), a road to travel on, a position on that road (int), a direction to travel and a speed (int).

## Drawable

This class is responsible for determining the method for drawing an object.

## Controller

This Class includes one instance variable of ‘SimCity2D’ in which handles the user’s actions. Within the ‘init()’ method, a Timer class is initialized to make the car move when the user clicks on ‘Sim -> Run’. This method also contains lambda expressions to implement action listeners to all the items on the menu.

## Position

This Class determines the current coordinates of an object.

### Final Notes

I was not able to get these functions working properly:

1. City -> Edit
2. Sim -> Update Rate
3. Sim -> Spawn Rate

City -> Edit function should allow the user to select a cell for road to be edited, but when the user right clicks on cell and selects “Done” nothing happens.

City -> Update Rate doesn’t have a listener, so it won’t work as expected.

City -> Spawn Rate also does not have a listener, so it won’t work as expected.

I also was not able to slow down the rate at which the traffic lights change color. It's possible to slow down the rate by inserting Thread.sleep(...) in the simulation, but this causes the whole simulation to slow down. To slow down the rate separately, the program would need to create a separate thread or take advantage of the SwingWorker, or possibly something else. But I found this task really difficult and was not able to implement it successfully. I am also aware that I have committed part of the assignment late, and I take full responsibility for that. But I just couldn’t leave this project with the way I had it on the due date (even though it wasn’t too bad) and was determined to finish as much as I could, as best I could, and this is the result. I will most likely try to finish this simulator in the future.