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## Analysis

### Problem Background

RISK is a classic board game of strategic warfare and global domination. Played on a world map divided into territories, players take turns to build armies, launch attacks, and forge alliances as they strive to conquer the world. The game blends strategy, diplomacy, and luck, challenging players to eliminate opponents and take over the world to come out victorious.

However, this game has a flaw: the board [1] is the same every time, and strategies have been created to exploit this board to win, has become dull to many players of the game.



[1] The original RISK board.

Tom is a RISK enthusiast who has been playing the game since he was a child. He enjoys the concept of the game and was interested in creating his own strategies for winning the game when he was first playing it. Now, a sporadic player on the multiplayer platform *RISK: Global Domination™* by Hasbro, he feels that tactics have been refined to meta strategies, reinforced by the influence of RISK youtubers.

After finding out about Tom's problem with *RISK*, I arranged a meeting to discuss a potential solution. He showed interest in creating a platform to play RISK on with the additional ability to build your own maps. (Transcript of the interview below)

S: How is your experience with the game RISK currently?

T: I occasionally play on an app on my phone. I love the strategy involved in *RISK* and that I can play a single player mode to challenge myself against online opponents and my friends. The trouble is that the game that I have has become quite monetised, and I don't want to spend my money to access the extra features like additional maps.

S: What can you access in the free version?

T: You can play on the Classic map, and I think there is a free map of the week as well. Those are your only options though. Also, you need to spend coins to play a game, which take ages to restock, or you

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could pay for extra. There's just a lot of annoying in app purchases, and too many advertisements as well.

S: So, what would your ideal *RISK* platform look like?

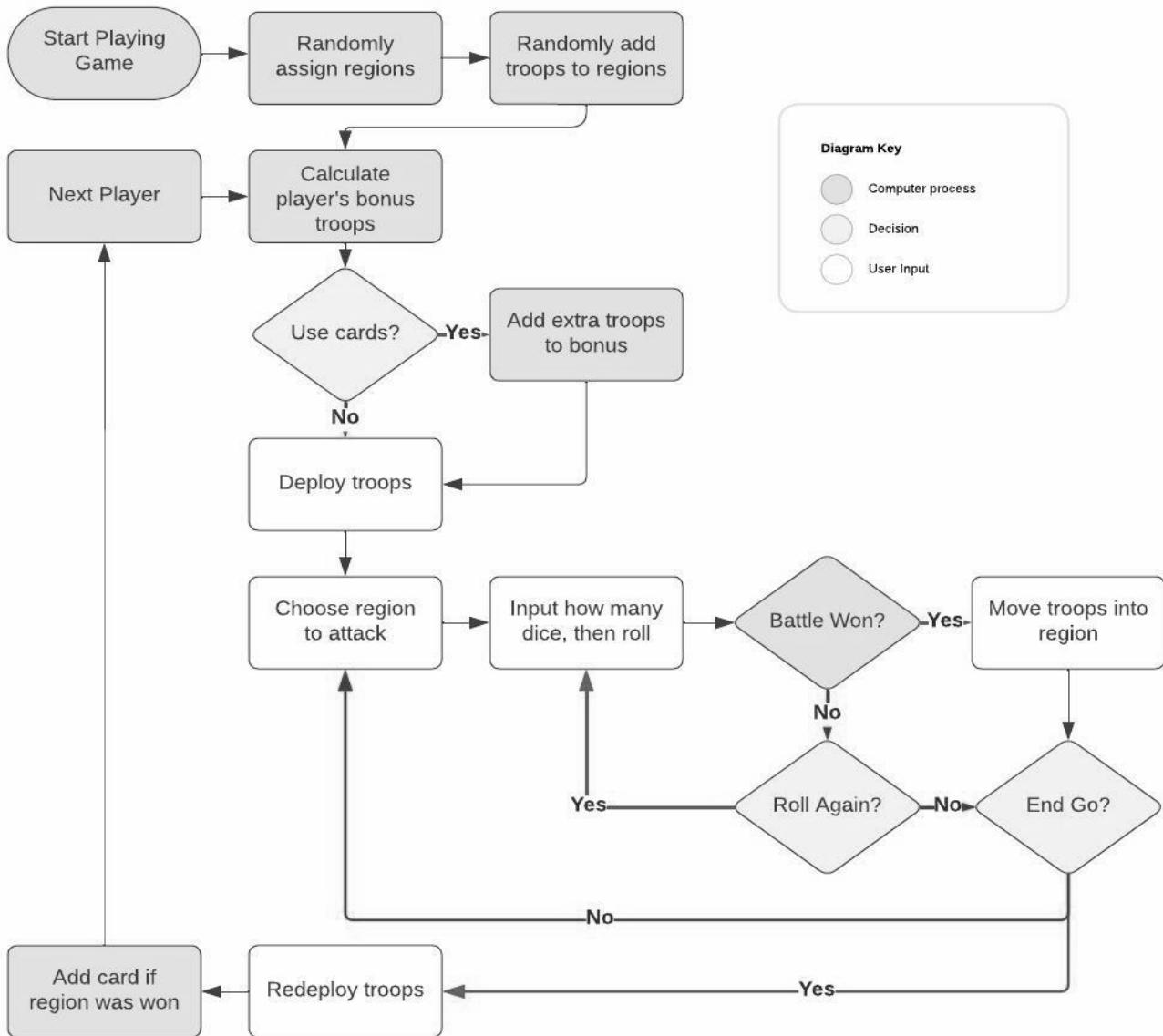
T: I think I would like to have a go at creating my own maps to play on. It would be nice to play on new maps every single game, which are more personalised to me. I want to have the satisfaction of developing new tactics for each new map I play, like it was when I was first learning *RISK*. My ideal system would have a single player mode so I can play on demand, but I would want to have the option to play with friends on other devices as well.

S: And is a mobile game a necessity to this ideal system?

T: Probably not. I usually play at home anyway, so a computer program would be fine.

## Problem Research

*RISK* is a multiplayer game where you compete against your opponents to conquer the map, by taking over all the regions. Your go consists of 3 phases: Deployment, Attack, and Fortification. During the Deployment phase you are given N troops which you can place onto your regions. N is calculated using the number of regions you own divided by 3, plus any 'continent' bonuses you have, if you are controlling whole sections of the map. Then in the Attack phase, you can choose to attack an adjacent region to one of your regions, by rolling dice. Your probability of success correlates to the number of troops each region has. After you have finished attacking, you can move any number of troops from one region that connects to another of your regions in the Fortification phase. Play then continues to the next player. I have drawn a *RISK* Gameplay process diagram below.



## Current Systems

I researched into Hasbro's *RISK: Global Domination™* on the App Store, which Tom currently uses. Although it does have some additional maps to play on, which Hasbro have developed themselves, these additional features require the premium paid subscription, which Tom cannot justify. Additionally, these extra maps are not tailored to what the user wants to play, they are more generic maps, like a singular continent instead of the world [2]. Tom also feels that the light blue theme of this game does not create the right atmosphere for a war game.



[2] USA and Europe maps on Hasbro's *RISK: Global Domination*



I also found other platforms on the App Store that offered multiplayer *RISK*, but all these games only have the Classic map to play on. This game has a simple layout, including a tally of which players own what countries (the multicoloured bar).

[3] Conquest on the App Store

## Proposed Solution

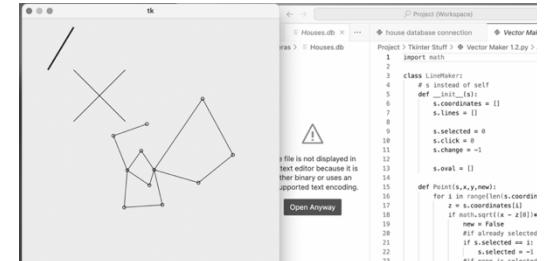
My proposed system will be a RISK playing platform, which has an extra map-builder function that allows the user to design and create their own personal maps. After the map is drawn on this function, it is saved to a database of maps, which you can then share with other users.

This program will contain a single-player RISK mode, where the user competes against an AI computer player, and a pass and play mode where multiple users can play against each other from the same device.

The program will also contain a multiplayer mode, where multiple users can compete on a Local Area Network.

I have decided to build this program in Python to make use of the Tkinter library. This GUI library includes line and vector tools [4] to provide the user with an easy experience when creating maps.

I will also include a login system so users can play with the maps that they have created, with the option of sharing them publicly.



[4] Basic of the map builder function on Visual Studio

## Prospective Users

I am creating this application for Tom, however there will be a multiplayer mode which means that Tom's friends are also potential users. I can assume that the average prospective user will be familiar with the game *RISK*, because they are using my version for a new challenge, with the addition of extra maps. However, I will still add a Help button just in case a user is not confident with the game mechanics. This will be more important to have for the Map Builder mode, as it is a new concept for all users.

## Identification of User Needs

In my second formal meeting with Tom, I proposed my application as a solution to his problem, and we finalised his needs as a prospective user.

1. The login page must function to direct users to their unique accounts.
2. The program should provide a fun, challenging RISK playing experience to the user.
3. The map building function should allow the user to design whatever map they want.
4. The map building function should then export and save the map in an organised way.
5. The multiplayer mode should run without too much lag to provide an adequate game play experience.
6. The interface should be user-friendly and easy to navigate, with an appropriate theme.

## Objectives

1. The login page must function to direct users to their unique accounts.

### Specific Objectives

1. Allow the user to enter a username.
2. Allow the user to enter a password.
3. Securely store the users' passwords
4. Have a button to submit their login information.
5. Have a section to create new accounts for new users.

2. The program should provide a fun, challenging RISK playing experience to the user.

### Specific Objectives

1. Allow the user to click on regions to select them for various in game tasks.
2. Allow the user to go through the 3 phases of their turn.
3. The game play must be versatile to cope with unseen maps created by users.
4. The game should function correctly as a game of *RISK*.

3. The map building function should allow the user to design whatever map they want.

### Specific Objectives

1. Allow the user to draw in lines into the canvas as borders.
2. Have a button to erase the last line drawn for the user to correct mistakes.
3. Allow the user to select territories, name them, and assign them to a 'continent'.
4. Allow the user to name the 'continents' and assign them bonuses.
5. Allow the user to give the map a name.

4. The map building function should then export and save the map in an organised way.

### Specific Objectives

1. Store the drawn lines as a list of points.
2. Create and store regions from enclosed polygons in the map builder.
3. Store the region connections as a matrix.

4. Export and save the new map to a database, with its name and an ID.
5. The multiplayer mode should run without too much lag to provide an adequate game play experience.

#### Specific Objectives

1. Work out a way to connect two devices online.
2. Add a turn timer so that players don't take too long.

6. The interface should be user-friendly and easy to navigate, with an appropriate theme.

#### Specific Objectives

1. Create a GUI containing named buttons to navigate easily between pages.
2. Provide guides on how to play *RISK* and how to operate the map builder.
3. Design the application with a dark colour theme.

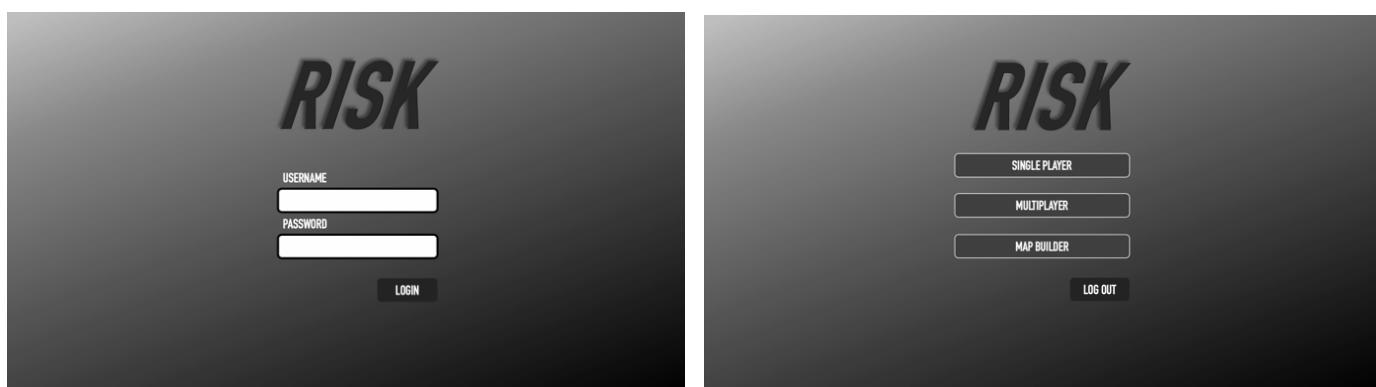
## Limitations

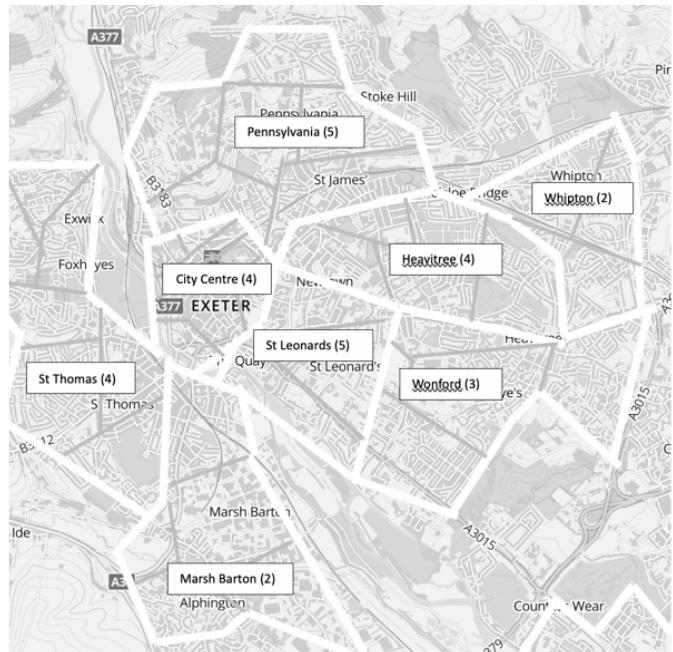
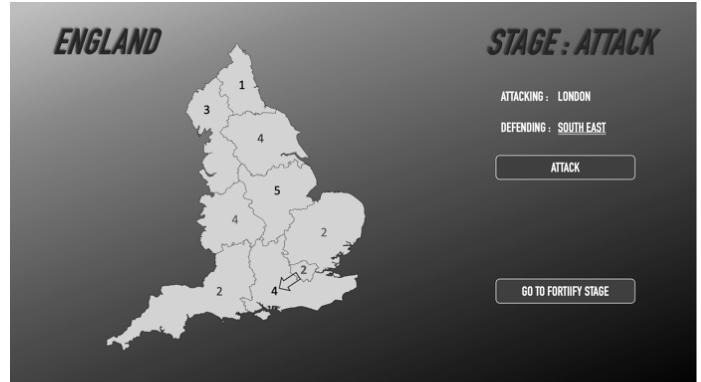
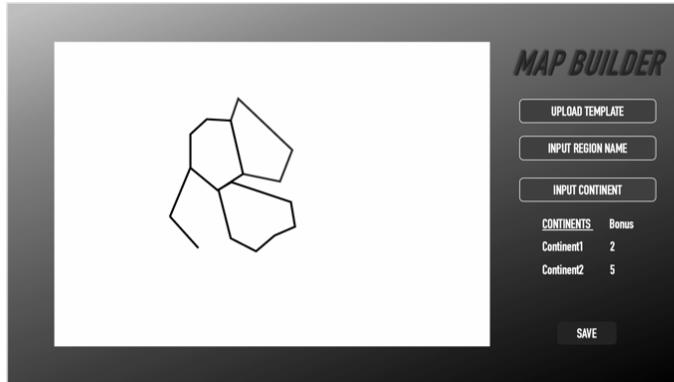
My limitations to this solution lie mostly in the multiplayer mode. Since my program will be in Python, I am limited in my web connection ability, as opposed to developing in JavaScript. I will attempt to solve this issue using sockets to allow Internet multiplayer, however I may be limited to a Local Area Network, where players join private lobbies using codes.

Another limitation is the strength of my AI for the single player mode. I must create an algorithm that can hold its own on an infinite number of maps, which users will have the upper hand as the creator of these maps. I will research into various game theory techniques to attempt to overcome this challenge. I believe that this AI will be very much based on probability, as it is with many dice-based games.

## High-Level Design

My initial design for the user interface was focused on the dark theme of war that is missing from previous systems. The first page is a login screen to access the game with a unique account, followed by the menu which you can choose to play single player, multiplayer, or map creating.

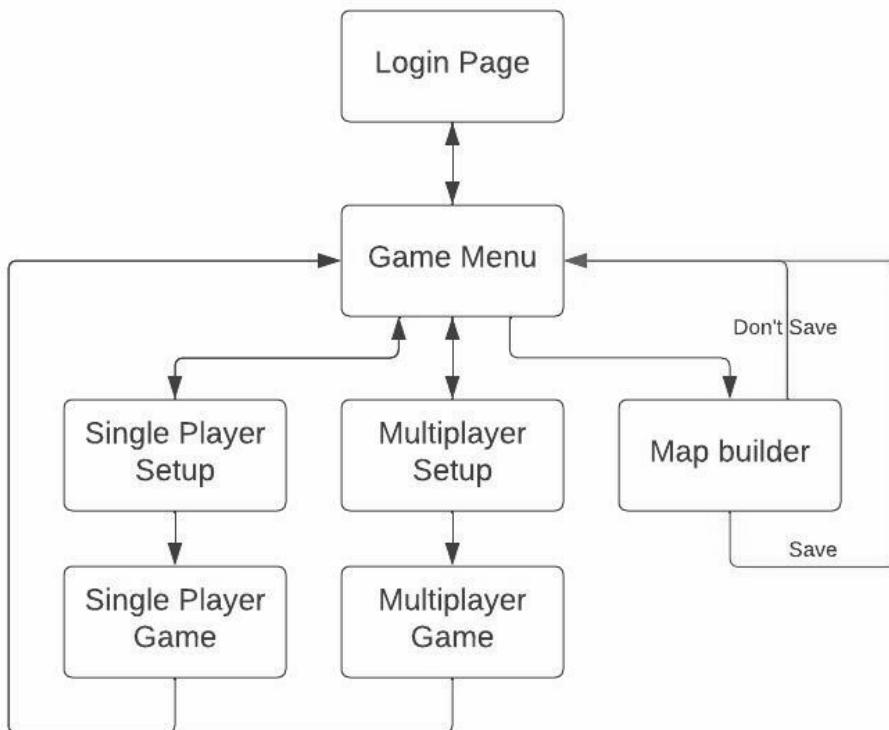




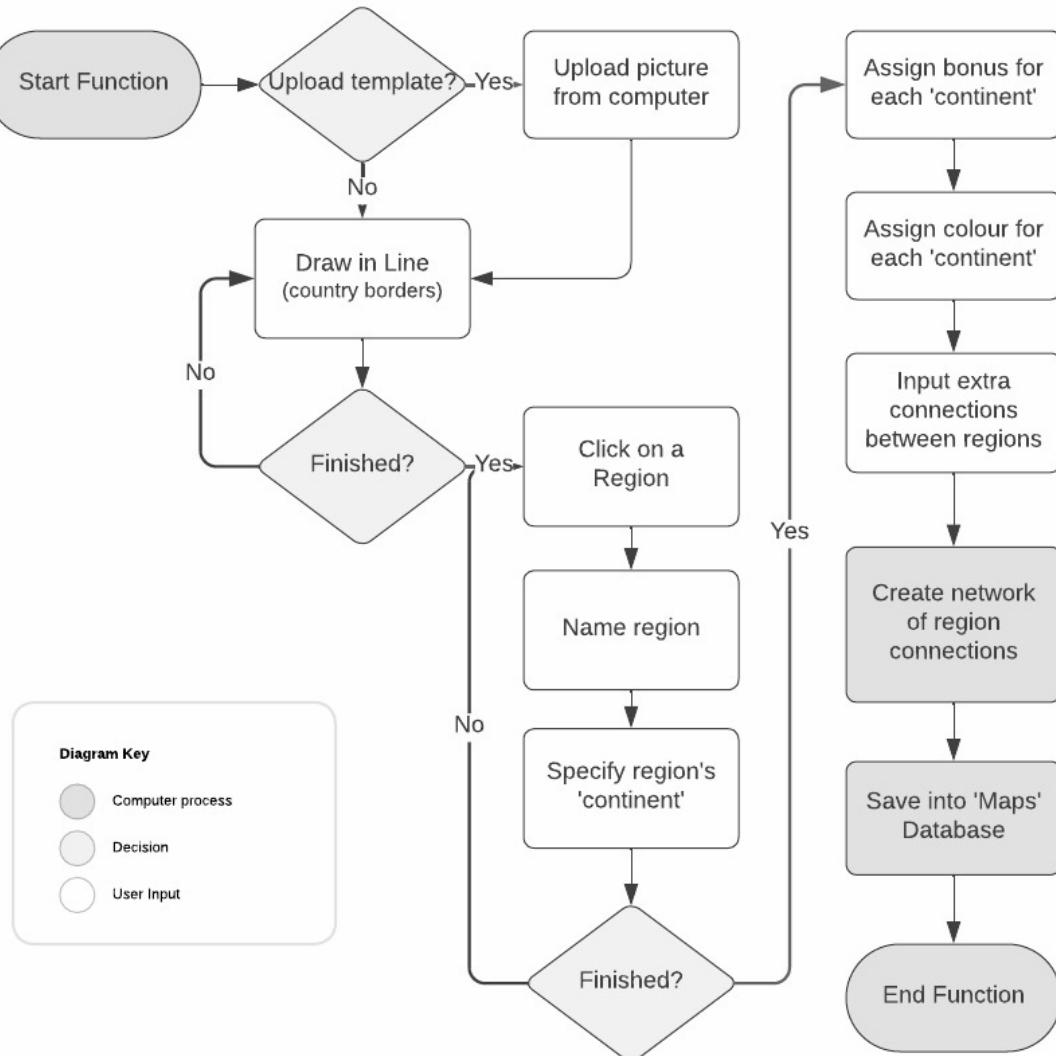
(4) A potential personalised map idea, Exeter.

## Process and Data Flow Diagrams

### Page Navigation Diagram



Map building process diagram



# Design

## Overview of System

The program will be developed in Python, to make use of its user interface library Tkinter. This GUI will allow the user to draw onto the program to create their own maps. The system will also connect to a database via SQLite and be able to store and import data from it, including created maps and user information. The system will be programmed using object orientated programming using classes to store data.

## User Interface Design (HCI)

The Graphical User Interface in this system will be using buttons and canvases for the user to navigate and input data, to satisfy objective 6.1. The interface will follow a consistent design across all windows and will be focused on a monochrome colour palette with dark red highlights to capture the right atmosphere and fulfil objective 6.3.

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Buttons which appear on many screens will be put in the same place on every screen to have consistency across modules. For example, the HELP and QUIT GAME buttons will remain in the same place during all 3 phases of attack in the gameplay module.

Each action that the user must take which requires some prior knowledge, such as the RISK gameplay, will have a HELP button. The user can access useful information to help guide them on how to use the system, satisfying objective 6.2. This will be especially useful in the Map Builder module, which may not be the most apparent how to use this function for a first-time user.

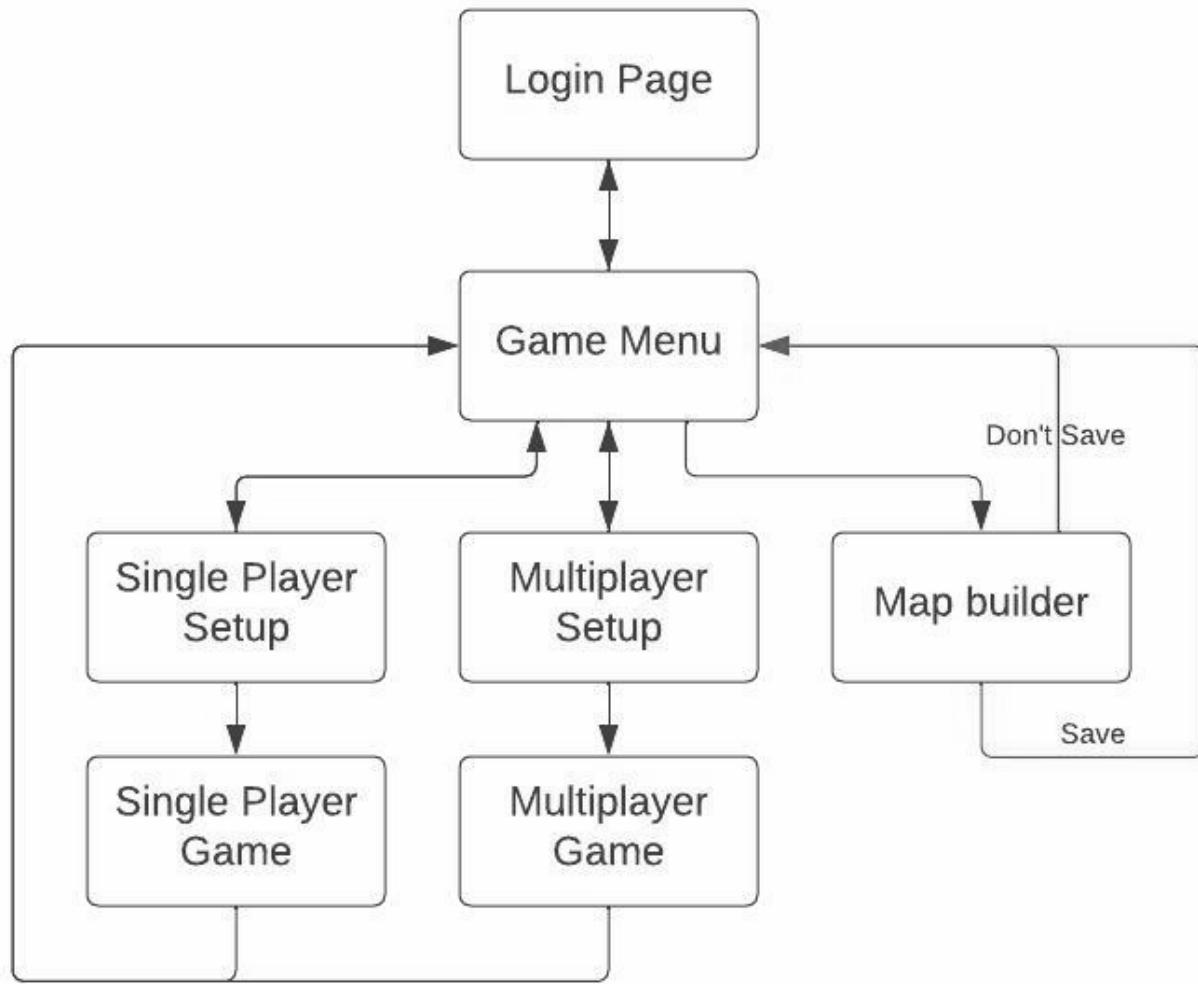
The initial designs for the windows are in each individual module section of the Design.

### Description and Navigation of Modular Structure

This program will be split up into modules, which will each have their own separate Tkinter window, that you navigate between. These are:

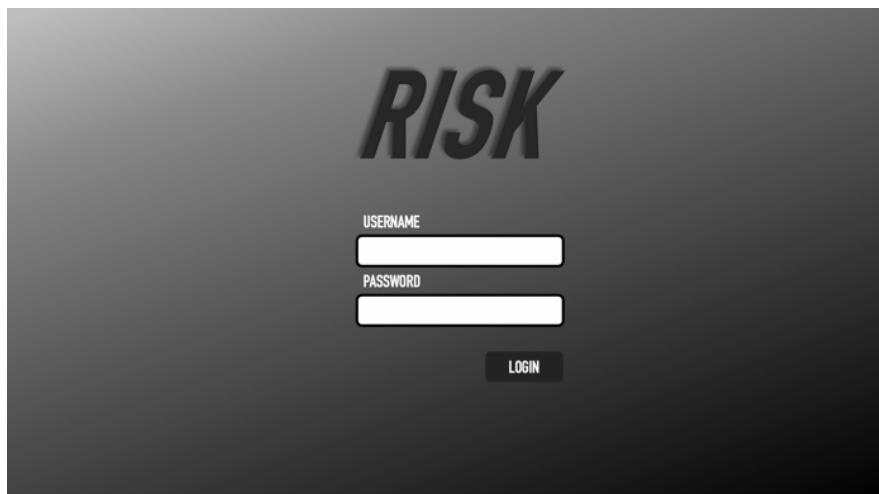
1. Login Page
2. Main Menu
3. Map Builder
4. Single player
5. Multiplayer
6. Setup Pages

The diagram below explains how the user will be able to navigate between modules.



### 1. Login Page

Below is the design for the initial screen when a user turns on the program. They will have to enter their details to access their RISK account. I will also include a New User button so that new accounts can be created.



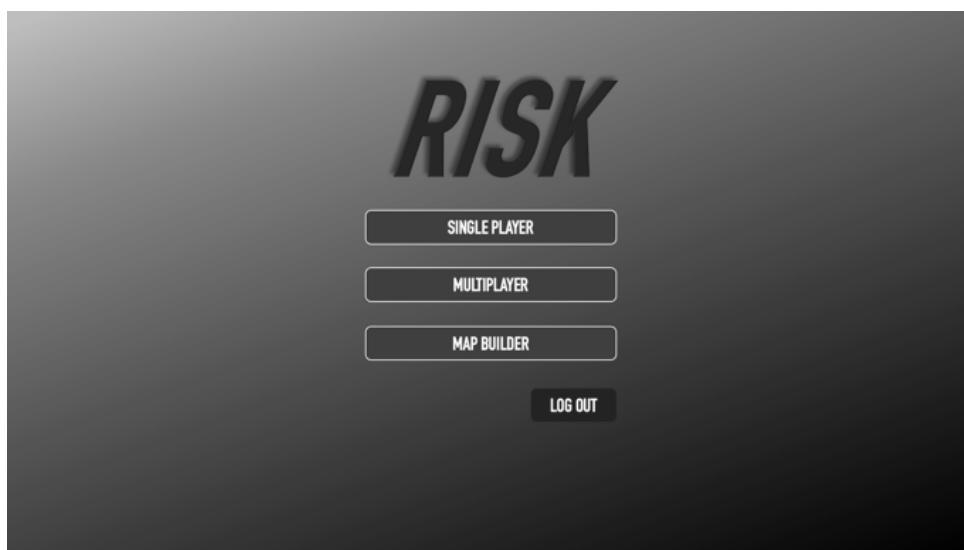
Inputs	Function
Username (entry)	User can input their username here
Password (entry)	User can input their password here
Login (button)	Process the username and password entries to verify the user. Find the correct account and open it on the menu page
New User (button)	Process the username and password entries and add a new user to the database. Log in with this new user

In the process described in the Login (button), the password will go through a hashing algorithm described below, and then compared to the hashed password stored in the database that is paired with the username entered. If the hashed results are the same, the password is verified, and the user is given access to their account.

#### Key Algorithms:

- A) Password hashing algorithm

## 2. Main Menu



Inputs	Function
Single Player (button)	Open the single player setup page

Multiplayer (button)	Open the multiplayer setup page
Map Builder (button)	Open the map builder page
Log Out (button)	Save all unsaved user information to the database and return to the login screen

The Main Menu page will also display user statistics on the right-hand side of the screen including number of wins and losses, and a leader board for win rate between users.

#### Key Algorithms:

- I) Retrieving Data from Database

### 3. Map Builder

The images below are the Map Builder pages, designed using the Tkinter GUI. The user loads on to the left image and draws their map. The ‘Finish Drawing’ button is then pressed which moves to the right image where the user can then name the territories and regions



Inputs	Function
Canvas	Plotting points and drawing lines for the map
Undo (button)	Deletes the last point/line that has been drawn
Finish Drawing (button)	Finish drawing stage and run polygon creator functions
Back (button)	Return to the Menu Page
Territory name (entry)	User can input the territory name here

Region name (listbox)	User can select the region for the territory here
Region name (entry)	User can input more region names for the region name listbox
Submit (button)	Enter the information for the territory
Finish (button)	Exports the map to the database

This module makes use of 2 main classes: LineMaker when drawing the map, and then AfterDrawing when naming territories. These classes are used to store the data about the map being created, and store methods involved in creating the map.

#### Key Algorithms:

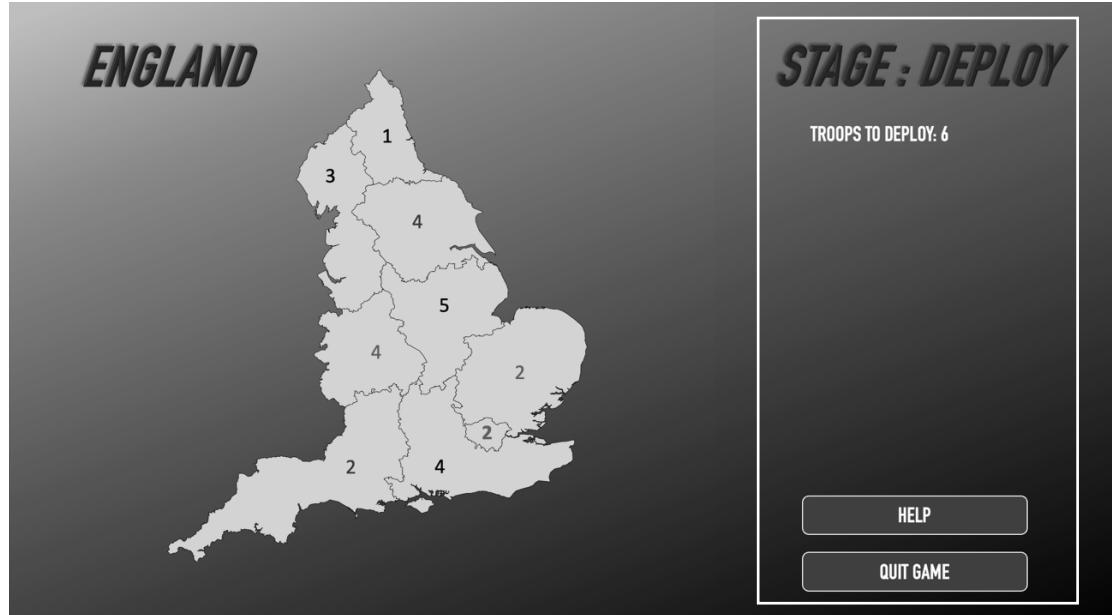
- B) Crossing Lines
- C) Finish Drawing
- D) Pathfinding algorithm for the perimeters of sectors
- E) Which sector is Click inside of

The lines that are created to draw the map are stored using coordinate geometry. There is an array of coordinates, with values such as [138,65] or [206,187]. The array that stores the lines stores the index of the coordinates that it corresponds to in the coordinates array. For example, the line [2,7] would be a line connecting the third and the eighth coordinate that had been plotted. Territory coordinates are stored in the same way, for example [3,5,1,4], with the fifth point connecting back with the fourth point.

#### 4. Single player

The single player mode will let the user play against friends on the same device, essentially a ‘Pass and Play’. There is capacity in this module to introduce a computer player so Tom can play by himself, however I have deemed this probably a stretch of my capabilities in the time I have. I will however code in the infrastructure of adding computer players in the Setup Page

The images below are the initial design of the single player game mode, according to the dark theme requested in objective 6.3.



### STAGE: ATTACK

ATTACKING: BRAZIL  
DEFENDING: NOT SELECTED

DICE 2 ROLL DICE

FINISH ATTACK

HELP QUIT GAME

### STAGE: FORTIFY

FROM: NORTH AFRICA  
TO: ARGENTINA

REDEPLOY

HELP QUIT GAME

The white box is dynamic, changing depending on the phase of the player's turn

The table below describes the function of all the buttons stated in the initial design.

Input	Function
Help (button)	Display a large label over the top of the game with help instruction. Changes depending on which stage you are in.
Quit (button)	Destroy game and return to Main Menu, counting game as a loss. Add a verifying step to check user wants to quit.
Dice (list box)	Allow user to roll with 1, 2 or 3 dice

Roll Dice (button)	Retrieve number of dice from entry and calculate result of attack. Take away troops.
Finish Attack (button)	Go to Fortify page
Redeploy (button)	Move desired troops to new location if the move is valid. Moves onto the next player

### Key Algorithms:

- E) Which sector is Click inside of (already described in Map Builder module)
- F) Rolling dice algorithm
- G) Verify that redeployment is valid
- H) Merge Sort

### Multiplayer

After some research into methods I could use to host a multi computer RISK game, I have realised that a Multiplayer mode will be a very time-consuming feature to have. Upon discussing this with Tom, he agreed that prioritising the Map Builder function as well as the ‘Pass and Play’ game mode so he can play with his friends on one device was the best plan. I will include the button for multiplayer on the Menu Page, so the project has capability to include a Multiplayer mode also.

### 5. Setup Pages

The image below is the design for the single player setup page. It allows the user to add players to their game and choose what map they want to play on. I will disable the ability to add computer players however, with the ability to add them later.

The screenshot shows the 'RISK: SETUP' screen. At the top right is a 'CHOOSE MAP' input field. Below it, there's a table for adding players:

Players	Colour	Computer	Name
Player 1	Blue	No	NAME: [input field]
Player 2	Pink	Yes	COLOUR: [input field]
Player 3	Green	Yes	COMPUTER: [input field]

Below the table are two buttons: 'ADD PLAYER' and 'REMOVE PLAYER'. At the bottom left is a 'BACK' button, and at the bottom right is a 'PLAY' button.

Input	Function
-------	----------

Choose Map (list)	Allow the user to pick a map from the database of created maps. These will all appear in a list and the user will be able to search for it.
Name (entry)	User can enter the name of a player
Colour (list)	User can select a colour that has not been chosen yet
Computer (list)	User can select whether a player is a computer or a human player
Add player (button)	Validate the entries in name, colour and computer. Add them onto the player list. Create a new instance of the player class
Remove player (button)	Remove the most recently added player from the player list (this will be a stack data structure)
Back (button)	Return to the menu page
Play (button)	Check that valid data has been entered and start the game if valid.

## Description of Classes

This program will make use of object orientated programming in the gameplay modules. There will be a map class to store the information about the map being used in the game, and there will also be a player class. Each player added will be an instance of this class and will make use of inheritance depending on whether the player is a computer or a human, as these two objects will need different properties.

Map	
- name	string
- territory_polygons	array
- territory_names	array
- player_in_territory	array
- region_names	array
- region_bonuses	array
- territory_regions	array
- connections	array (matrix)
- troops_in_territory	array
- coordinates	array
- label_coordinates	array

+ DisplayMap()  
+ Deal()

**Player**

- player_num	int
- name	string
- colour	string
- num_troops	int
- territories_owned	int
- cards	array

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The attributes of the class will be stored privately so that they can only be accessed from within the class, to prevent unintended access and modification of data.

Upon starting the build of the gameplay module, I added an additional class called Game to store any additional data needed for the game that doesn't fall under the Map or the Player classes. It is described below:

<b>Game</b>	
- next_action	string
- player_turn	int
- player_queue	queue
- phase	int
- stages	array
- troops_to_add	int
- attacking	int
- defending	int
- sending_troops	int
- receiving_troops	int
- card_recieved	bool
- deck	queue
- deck_front_pointer	int
- deck_back_pointer	int
+ ReceiveCard()	
+ ReturnCards()	
+ TurnResest	

I have also included a global class called Info, which is used to store information that is required across modules, so that it is accessible from everywhere in the program. It is defined at the beginning of the program and includes data such as the UserID and which module is currently being run.

<b>Info</b>	
+ UserID	int
+ MapID	int
+ next_page	str
+ players	str
+ colours	str
+ bot	str

RISK

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Candidate Name: Alexander Mulcahy

The Map Builder module also will use classes to store map data and methods for creating new maps.

They are Linemaker when drawing, and AfterDrawing when naming territories.

### Linemaker

drawing  
coordinates  
lines  
line\_equations  
selected  
click  
change  
undo  
oval

+ Point  
+ Line  
+ FindEquation  
+ CrossingLines  
+ Click  
+ Undo

### After Drawing

regions  
territories  
territory\_regions  
territory\_polygons  
polygons  
text\_coordinates  
map\_data

+ PlaceButtons  
+ MakePolygons  
+ Connections  
+ ClickOnTerritory  
+ NameAndRegion  
+ InputLabelPosition  
+ AddRegion  
+ Complete

### Key Algorithms

G- Turn Reset

## Design of Database

### Tables

This program will use 3 Tables to store data: Users, Maps and Current Game. I will be using the software SQLite to help manage and access my database from python.

#### Users

Primary Key: UserID

This table will store information about each user, including their username and password linked with a unique user ID. Note that the password will be hashed for security purposes, in case of an attempt to break into the database. It will also include game statistics to be used for the leaderboard.

This table will be accessed by the hashing algorithm to verify the password entered in the login page, and the users' statistics will be updated after a game is finished.

#### Maps

Primary Key: MapID

The Maps table will store the data required for each published map created by users. It will include the map's unique name, along with the map data. This will include regions, borders, and polygons.

This table will be added to at the end of the Map Builder process when a new map is finished. The table will be accessed during the Choose Map process in the setup page, where the data in the table will be transferred into a local class ready for the game.

#### Current Game

Primary Key: UserID

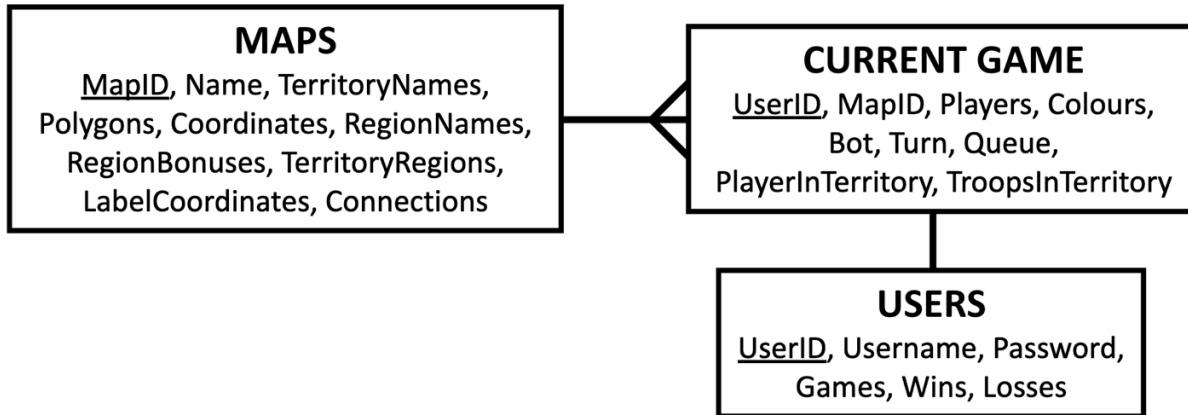
If a user wants to come back to their game of RISK at another time, the current game state will be saved to this table, which will be linked to the user's account by their UserID. When the user logs on again, they will be redirected immediately to their game in progress. A user will only be allowed to have 1 current game at one time to avoid data collision.

This table will be updated if the user logs out during a game. It will include information about the players in the game, the map being used, and the number of troops in each region. The table will also be updated periodically in case the program quits unexpectedly, so the game can autosave.

### Entity Relationship Diagram and Normalisation Process

I have simplified my normalisation process diagram by combining all the MapData and GameData into one field each, however these are each multiple fields in my database that act together. I could have removed [players,colours,bot] from the game data and moved into a separate table, however this would have been problematic since players could be using the same names but different colours in multiple games. This would result in the data being incorrect.

Unnormalised	UserID	Username	Password	Games	Wins	Losses	MapID	MapName	MapData	GameData
(already in 1st normal form)	7	John Smith	67283917	8	6	2	4	America	[data]	[data]
	15	Mary Jane	25361178	4	1	3	2	Azureum	[data]	[data]
	2	Michael	76809321	42	30	12	4	America	[data]	[data]
<b>Users</b>										
2nd normal form	UserID	Username	Password	Games	Wins	Losses	MapID	MapName	MapData	GameData
	7	John Smith	67283917	8	6	2	7	4 America	[data]	[data]
	15	Mary Jane	25361178	4	1	3	15	2 Azureum	[data]	[data]
	2	Michael	76809321	42	30	12	2	4 America	[data]	[data]
3rd normal form	UserID	Username	Password	Games	Wins	Losses	MapID	MapName	MapData	GameData
	7	John Smith	67283917	8	6	2	7	4 [data]		
	15	Mary Jane	25361178	4	1	3	15	2 [data]		
	2	Michael	76809321	42	30	12	2	4 [data]		



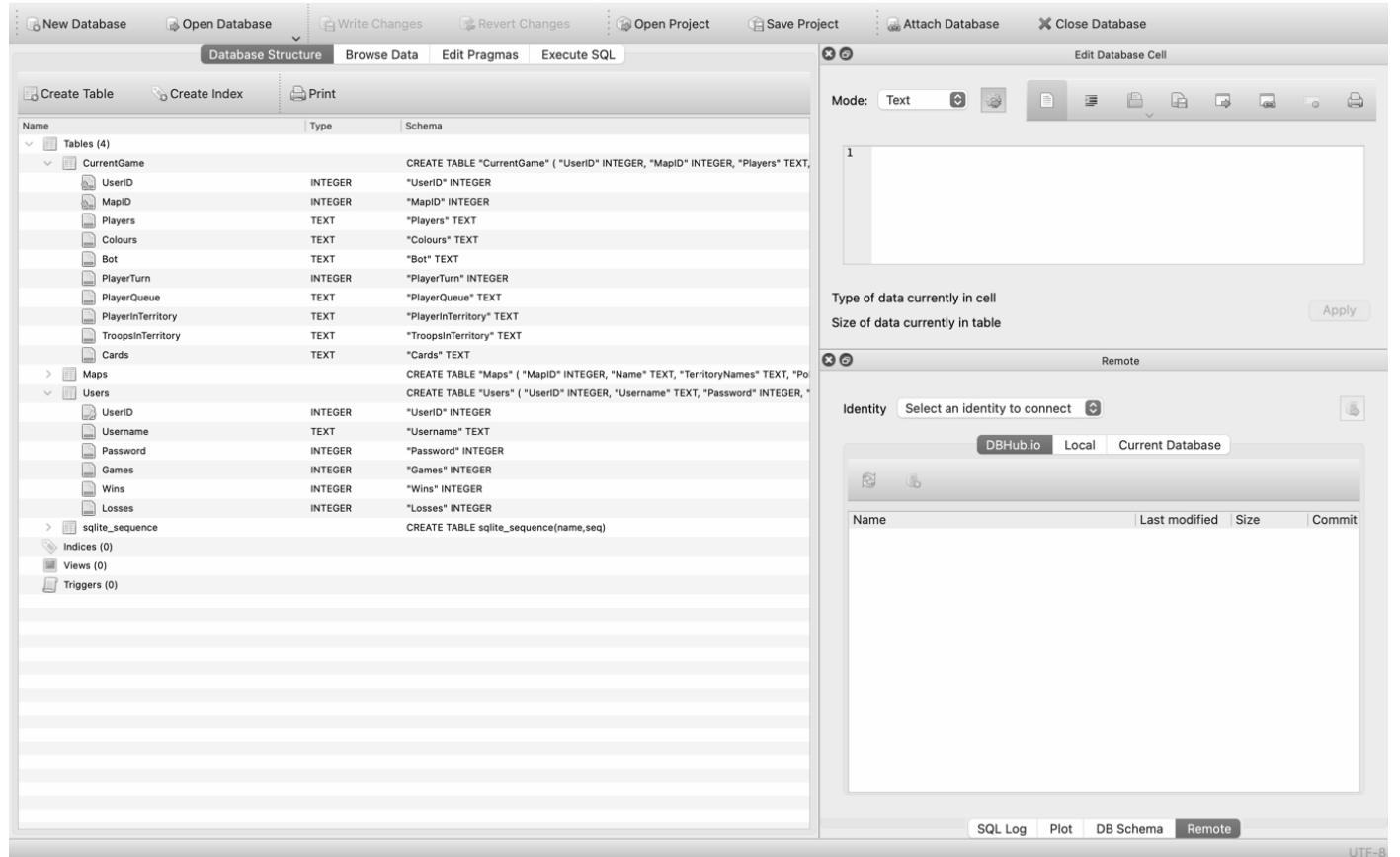
## Database Creation and SQL Commands

I am making use of the platform DB Browser for SQLite to help create the database. Here is an example of the code it made to create a table in SQLite:

```

CREATE TABLE "Maps" (
    "MapID"      INTEGER,
    "Name"       TEXT,
    "Regions"    TEXT,
    "Polygons"   TEXT,
    "Connections" TEXT,
    PRIMARY KEY("MapID" AUTOINCREMENT)
);

```



A screenshot of DB Browser for SQLite

Each time the program accesses the database, it will open the local database, run its query, and then close the database to ensure that data is not corrupted by opening the database multiple times at once.

Here is an example of an SQL statement in my code: Retrieving User information from username submitted, along with the code required to open and close the database.

```
#open
db_path = "./DataBase/ProjectDb.db"
connection = sqlite3.connect(db_path)
db_cursor = connection.cursor()

sql = 'SELECT UserID, Password FROM Users WHERE Username = ?'

db_cursor.execute(sql,(info.userID,))
data = db_cursor.fetchone()

#close
connection.commit()
connection.close()
```

## Tkinter components

This program makes use of the Tkinter GUI library on Python, which I am using to create the windows, receive inputs via buttons and entry boxes, and display outputs with labels and canvas items. The table below describes how I implemented these in the code.

Tkinter Component	Example
Button	B_Quit = Button(window, text='Login', background = 'white', command=Login)
Label	L_Attacking = Label(window, text = 'Attacking: ')
Entry	E_Username = Entry(window, width = 20)
Listbox	Li_Dice = Listbox(window, height = 1) Li_Dice.insert([1,2,3]) #the options are now 1,2,3
Canvas	canvas = Canvas(window, width=500, height=500, background="white")
Line	canvas.create_line(x1,y1,x2,y2,fill="blue",width=1)
Polygon	canvas.create_polygon([points],fill = '#444444', outline = 'white')

Each module is its own window which are opened and closed as the module functions are run. Below is the code required to create a Tkinter Window.

```
window = Tk()
#window.title('Login')

#Start up fullscreen
screen_width= window.winfo_screenwidth()
screen_height= window.winfo_screenheight()
window.geometry("%dx%d" % (screen_width, screen_height))
window.wm_attributes('-fullscreen', 'true')

#create canvas
canvas = Canvas(window, width=screen_width, height=screen_height)
canvas.place(x=-1,y=-1)

#Load background image
img = ImageTk.PhotoImage(Image.open('GreyBackground.jpeg'))
canvas.create_image(0,0,image=img,anchor='nw')
```

In order to close a window the program runs `window.destroy()`

## Imports

Below are the imports which I have used in this program.

```
from tkinter import *
from PIL import ImageTk, Image
import sqlite3
import math
```

```
from random import randrange
```

Import	Use
Tkinter	The library used for the GUI
PIL	importing images for background
sqlite3	tool for manipulating the database
math	Use functions such as sqrt() and trig functions to find gradients of lines
random	produce random numbers for dice rolls
regex	checking for disallowed characters in usernames

I am implementing regular expression (regex) to disallow special characters to be used in usernames. It will be used in the NewUser() function.

## Data Storage and Validation Routines

This table describes what data is stored in the database and some of the classes. The class Map has been left out as it is mostly a duplicate of the Database table Map.

Data	Type	What is stored
<b>DATABASE TABLE: Map</b>		
MapID	int	Unique identifier of the map (Autoincrement)
name	string	the name of the map, which will show up in the game Setup page
territory_polygons	array (list)	Each polygon is a list of point indexes, which each refer to a coordinate.
territory_names	array (str)	The name of the territories, for example 'England'. Used for territory labels in game
player_in_territory	array (int)	Stores the player number who owns each territory
region_names	array (str)	The name of each region, for example 'Europe'
region_bonuses	array (int)	The bonus associated with each region. The indexes match up with region_names
territory_regions	array (int)	The region which each territory is a part of. Many to one relationship so will have repeated values
connections	array (matrix)	If territory1 is connected to territory2, index[1][2] will be equal to 1 to show they are connected
troops_in_territory	array (int)	Stores the number of troops which are in each territory
coordinates	2D array	The coordinates of each point drawn for the map. These are called using the index of the array

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label_coordinates	2D array	The coordinates of where each territory label should be placed, to display the name
<b>DATABASE TABLE: Users</b>		
UserID	int	The unique identifier of the user (autoincrement) If logged in, this is stored globally in the class Info
Username	string	The unique name of each user, which is used to log in, and displayed on the leaderboard
Password	int	The hashed version of the user's password. These are all 8-digit numbers.
Games Played	int	Stores the number of games that a user has played. Is used in the games played leaderboard
Wins	int	Stores the number of games that a user has won
Losses	int	Stores the number of games that a user has lost
<b>DATABASE TABLE: Current Game</b>		
UserID	int/int	Each user will either have 1 current game or no current games. They cannot have multiple
MapID	int	Links the current game to a map and all of its data
Players	array	Stores the names of each player in the game
Colours	array	Stores the colour each player is.
Bot	array	Stores whether the player is a human or a computer
PlayerTurn	int	Stores the player index who is currently having their turn
PlayerQueue	array (queue)	Stores the queue of other player indexes
PlayerInTerritory	array	Each index in the array represents a territory. The value in the array represents the player index.
TroopsInTerritory	array	Stores the number of troops held in each territory. Same format as PlayerInTerritory
<b>CLASS: Player</b>		
player_num	int	stores the index of the player in the list of player objects. Also used in the player_queue.
name	string	Display name of the player
colour	string	The territories that the player owns will be displayed as this colour

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num_troops	int	Stores the total number of troops in all the player's territories. If it reached zero, the player is dead.
cards	array (int)	Stores the number of each card the player currently holds
CLASS: Game		
next_action	string	Stores the next action that the user must take and disables all other inputs that aren't that action. Also displayed on the screen to help the player.
player_turn	int	Stores the player number who is currently having their turn.
player_queue	queue	Stores the other player numbers in a queue structured list. This list then updates the player_turn variable at the end of each go
phase	int	Stores the index of which phase the player turn is in. The indexes correspond to the array 'stages'.
stages	array	Stores the phases of a player's turn. These are ['Deploy','Attack','Fortify']
troops_to_add	int	Stores the number of troops the player can add at the start of their turn. Calculated at the start of each turn.
attacking	int	Holds the territory number that is currently attacking. The number relates to the index of the territory_names in the Map class
defending	int	Holds the territory number that is currently defending
sending_troops	int	Holds the territory number that is currently sending troops. In the fortify phase
receiving_troops	int	Holds the territory number that is currently receiving sent troops. In the fortify phase
card_recieved	bool	Only one card can be received per go, so this value changes to True once a card has been given.
deck	queue (str)	Stores the cards, which are either 'Infantry', 'Calvalry' or 'Artillery' in a queue structured list
deck front/back pointer	int	Stores the index of where in the circular queue the front/back of the deck is.
Class: Info		
userID	int	Stores the user ID of the user that has signed in. Used to fetch statistics and save to Current Game
mapID	int	Stores the map ID of the map chosen in the Setup page so it can be loaded into the game
next_page	string	Stores the name of the module that the program should move to and run once the previous has finished
players	array (str)	Stores the player names chosen in the setup page to be used in the game

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colours	array (str)	Stores the colours to be used in the game by each player
bot	array (str)	Stores if each player is a human player or a computer player.

## Pseudocode for Algorithms

Below is the pseudocode for a few of the key algorithms identified in the technical solution.

### B) Map Builder: Crossing Lines

```
def CrossingLines(new line coordinates, existing line coordinates:

    if either line is completely vertical:
        return 0

    #Calculate Gradients
    Gradient1 = gradient of new line
    Gradient2 = gradient of existing line

    #Calculate Cs
    Constant1 = y coordinate of point - gradient1 * x coordinate of point
    Constant2 = y coordinate of point - gradient2 * x coordinate of point

    #Set lines equal to each other
    gradient3 = gradient1 - gradient2
    constant3 = (constant1 - constant2) * -1

    #Find point of intersection
    if line created is horizontal:
        return 0
    x = constant3 / gradient3

    #Check if intersection is within both lines
    if x is within new line and within existing line:
        return False #lines do cross

    return True #lines do not cross
```

### C) Map Builder: Finish Drawing

```
def FinishDrawing():

    #a function to check if all points are connected to at least 2 lines
    count = []
    for i in num_points
        count.append(0)
    for line in lines:
        #(lines are stored as lists of 2 points, like [0,1])
        count[line[0]] += 1
        count[line[1]] += 1

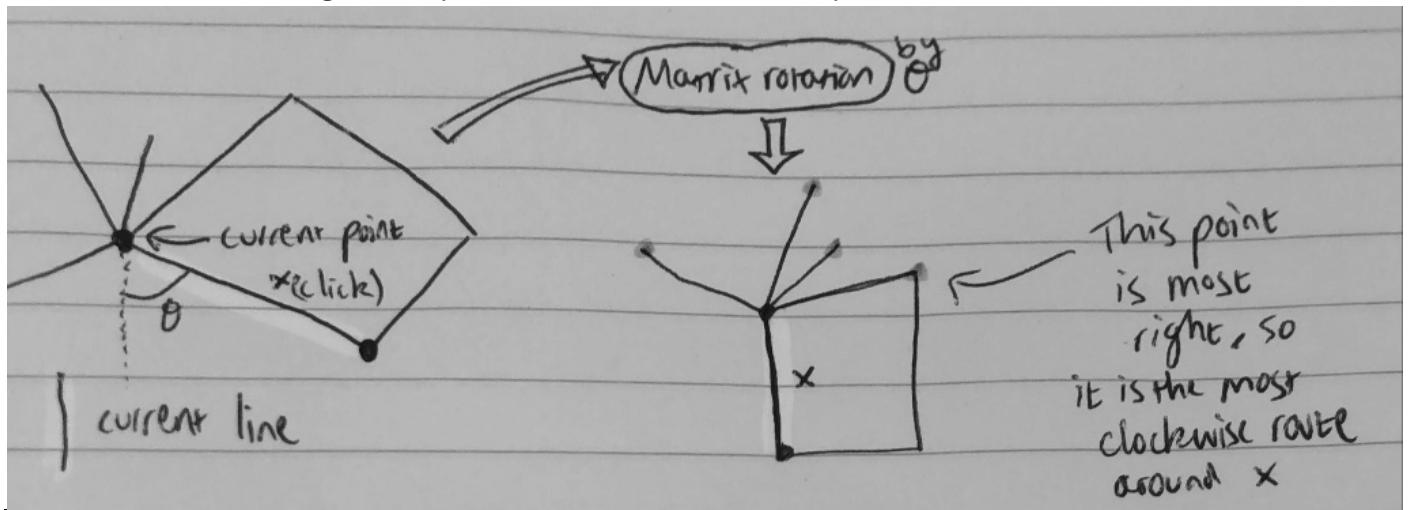
    valid = True
    for num in count:
        if num < 2:
```

```
#if any point has fewer than 2 connections, valid goes False
valid = False
```

```
if valid is True:
    start after_drawing
else:
    return False
```

## E) Map Builder/Gameplay: Which Sector is Click inside of

I have decided to use a matrix rotation in this algorithm to calculate which area a click is inside of. In the image below, the polygons are rotated clockwise by the angle theta to make the current line vertical, and then the rightmost point is found. This is then repeated with the new line.



While loop is True:

```
Angle = angle between current line and vertical
DoMatrixRotationOnPoints(Angle)
```

```
Higher_point = higher point in current line
For point in points_connected_to_higher_point:
    If point is furthest right:
        Select point as new_point
```

```
New line = [higher_point, new_point]
```

```
If new_point = first point
    #this means the polygon has connected up and the polygon has been found.
    Loop = False
```

## H) Gameplay: Merge Sort

```
def MergeSort(unsorted_list):

    Lists = unsorted_list(Items_split_individual)

    def Merge(a,b,c):
        if a and b are empty:
            return c
        elif only a is empty:
            c.append(b.pop(0))
            return Merge(a,b,c)
        elif only b is empty:
            c.append(a.pop(0))
```

```

        return Merge(a,b,c)
else:
    if a[0] > b[0]:
        c.append(a.pop(0))
        return Merge(a,b,c)
    else:
        c.append(b.pop(0))
        return Merge(a,b,c)

```

## Technical Solution

### Program.Main

The Modules are run from this Module Switcher loop, which I have implemented a match case. I have also included the global class Info and the imports for the project.

```

from tkinter import *
from PIL import ImageTk, Image
import sqlite3

import math
from random import randrange
import re

class Info():
    def __init__(s):
        s.userID = 0
        #this variable controls which module the program will go to next once the
        current one has finished
        s.next_page = 'LoginPage'

        s.mapID = None
        #for loading up previous games
        s.saved_game_data = None

        #setup (storing information from the setup page that must go between modules)
        s.player_text = ''
        s.players = []
        s.colours = []
        s.bot = []

info = Info()

#####
### MODULE SWITCHER #####
#####

running = True
while running == True:
    match info.next_page:
        case 'LoginPage':
            LoginPage()
        case 'MenuPage':
            MenuPage()
        case 'SetupSingleplayer':
            Setup()
        case 'Gameplay':
            Gameplay()
        case 'Map Builder':
            MapBuilder()

```

```
case _:
    running = False
```

## Key Algorithms in Code

- A) Login Page: Password Hashing Algorithm
- B) Map Builder: Crossing Lines (gradients)
- C) Map Builder: Finish Drawing
- D) Map Builder: Polygon Maker (perimeter pathfinding)
- E) Map Builder/Gameplay: Which Sector is Click inside of
- F) Gameplay: Rolling dice algorithm
- G) Gameplay: Verify that redeployment is valid
- H) Gameplay: Merge Sort
- I) Retrieving Data from Database

### A) Login Page: Password Hashing Algorithm

The purpose of this algorithm is to generate a hash key that is almost impossible to reverse engineer, for the user's passwords to be safe from attacks. I have implemented a series of mathematical operations to the password resulting in an 8-digit number which is then stored in the database.

```
def Hash(password):
    hash = 12345678 #starting hash number
    for x in range(len(password)): #each character in the password will do multiple
calculations on the hash. Each iteration ends on 8 digits.
        character = password[x]
        ascii_code = ord(character)

        hash = hash + (ascii_code * 7)
        hash = hash // 3
        hash = hash + 987
        hash = hash * 5
        hash = hash - (1000% ascii_code )
        new_hash = ''
        for y in range(len(str(hash))): #flips the number
            new_hash = new_hash + str(hash)[len(str(hash))-1-y]
        hash = int(new_hash)
        hash = hash - 98765
        hash = hash // 7

        if len(str(hash)) > 8:
            hash = int(str(hash)[0:8])#makes the has 8 digits
        elif len(str(hash)) < 8:
            add = 1
            while add != 0:
                hash = int(str(hash) + str(add))
                add += 1
                if len(str(hash)) == 8:
                    add = 0

    return hash
```

## B) Map Builder: Crossing Lines (gradients)

This subroutine is used on multiple occasions in the map builder module to verify if lines have crossed over each other. If so, the line cannot be drawn. The parameters entered are the coordinates of both lines to be compared. Line 1 has parameters  $x_1, y_1, x_2, y_2$ , and Line 2 has parameters  $x_3, y_3, x_4, y_4$ . This function returns True if the lines do not cross, which then validates the line being drawn.

```
def CrossingLines(x1,y1,x2,y2,x3,y3,x4,y4):
    #x1,y1,x2,y2 : new line
    #x3,y3,x4,y4 : existing lines

    if x1 == x2 or x3 == x4:
        return 0

    #Calculate Gradients
    g1 = (y2-y1)/(x2-x1)
    g2 = (y4-y3)/(x4-x3)

    #Calculate Cs
    k1 = y1 - g1 * x1
    k2 = y3 - g2 * x3

    #Set lines equal to each other
    g3 = g1 - g2
    k3 = (k1 - k2) * -1

    #Find point of intersection
    if g3 == 0:
        return 0
    x = k3 / g3

    #Check if intersection is within both lines
    within_line1 = (x+.0001 < x1 and x-.0001 > x2) or (x-.0001 > x1 and x+.0001 < x2)
    within_line2 = (x+.0001 < x3 and x-.0001 > x4) or (x-.0001 > x3 and x+.0001 < x4)

    if within_line1 and within_line2:
        return False

    return True
```

## C) Map Builder: Finish Drawing

This function runs a check to see if all coordinates are connected to at least 2 lines. If not, then there is a section of the map that is not enclosed in a polygon, so the program will not move on to the next stage of map creating. If the check is ok, then the function begins the after drawing phase.

```
def FinishDrawing():

    #if there fewer than 3 lines then no polygons could have been created
    if len(linemaker.lines) < 3:
        return False

    #Check if any points have only 1 connection
    count = []
    for i in range(len(linemaker.coordinates)):
        count.append(0)
    for line in linemaker.lines:
        count[line[0]] += 1
        count[line[1]] += 1

    valid = True
```

```

if any points have less than a count of 2, then they are connected to less than 2
lines. Return false.
for num in count:
    if num < 2:
        valid = False

if valid == False:
    return False

linemaker.drawing = False

#Start after_drawing phase
after_drawing.PlaceButtons()
after_drawing.MakePolygons()
after_drawing.Connections()

```

## D) Map Builder: Polygon Maker (perimeter pathfinding)

This algorithm is run when the user has finished drawing their map, and the computer must work out what sectors have been created by the lines drawn. This algorithm took a lot of reworking.

```

def MakePolygons(s):
    #import global variables as local ones
    lines = linemaker.lines
    coordinates = linemaker.coordinates
    lines_used = []
    for x in range(len(lines)):
        lines_used.append(0)

    polygons = []

    for i in range(len(coordinates)):
        coordinate = coordinates[i]
        finding_polygons = True
        #find every polygon attached to a point
        while finding_polygons:
            #find smallest polygon first
            queue = [[i, [i]]]
            searched = []
            path = [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]
            finding_smallest_polygon = True
            while queue != []:
                searching = queue.pop(0)

                searched.append(searching)
                #find all paths to search that are connected to
                #point and havent been used twice
                for l in range(len(lines)):
                    if searching[0] in lines[l] and lines_used[l] != 2:

                        #find next node
                        next = lines[l][0]
                        if next == searching[0]:
                            next = lines[l][1]

                        #add new node to potential path, add path to queue
                        if (next not in searching[1]):
                            #so it doesnt mess up lists
                            temp = []
                            for item in searching[1]:
                                temp.append(item)
                            temp.append(next)
                            searching[1] = temp
                            lines_used[l] = 2

```

```

        #if it has made a loop, check if loop is smallest
        elif next == i and len(searching[1]) > 2:
            #check if polygon has already been found
            found_already = False
            for polygon in polygons:
                if SamePolygon(searching[1],polygon):
                    found_already = True
            if found_already == False and len(searching[1]) <
len(path):
                path = searching[1]

        #if path has not been updated since it was initiated, finish
        if path != [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]:
            polygons.append(path)
        else:
            finding_polygons = False

        #adding to lines used
        for x in range(len(lines)):
            for y in range(len(path)-1):
                if (lines[x][0] == path[y] and lines[x][1] == path[y+1]) or
(lines[x][0] == path[y+1] and lines[x][1] == path[y]):
                    lines_used[x] += 1
                if (lines[x][0] == path[len(path)-1] and lines[x][1] == path[0]) or
(lines[x][0] == path[0] and lines[x][1] == path[len(path)-1]):
                    lines_used[x] += 1

        #remove biggest polygon (this is the perimeter of the whole land mass)
        if 1 not in lines_used:
            biggest = [0,0]
            for x in range(len(polygons)):
                if len(polygons[x]) > biggest[1]:
                    biggest = [x,len(polygons[x])]
            polygons.pop(biggest[0])

        #print them
        s.polygons = polygons

        colours = ['#333333','#444444','#555555','#666666','#777777','#888888']
        for i in range(len(polygons)):
            temp = []
            for point in polygons[i]:
                temp.append(linemaker.coordinates[point])
            canvas.create_polygon(temp,fill=colours[i%6],outline='white')
    
```

## E) Map Builder/Gameplay: Which Sector is Click inside of

This function makes use of the rotation matrix with trigonometric functions to calculate which territory a click is inside of to then select as the active territory. It first finds the closest line via perpendicular distance to the click, and then takes the most clockwise route around the click to find the nodes of the correct polygon that the click is inside of, which corresponds to a territory.

The function returns the index of the territory that the click is inside of, or False if outside all regions.

```

def WhichArea(click,coordinates,polygons):

    # find the closest line to the click
    smallest_distance = 1000
    for i in range(len(polygons)):
        for j in range(len(polygons[i])):

```

```

coord1 = coordinates[polygons[i][j]]
try:
    coord2 = coordinates[polygons[i][j+1]]
except:
    coord2 = coordinates[polygons[i][0]]
gradient = (coord1[1]-coord2[1])/(coord1[0]-coord2[0])
k = coord1[1] - gradient * coord1[0]

#find equation of line perpendicular to line that goes through click
opposite_gradient = -1 / gradient
opposite_k = click[1] - opposite_gradient * click[0]

closest_x = (k-opposite_k)/(opposite_gradient-gradient)
if (closest_x > coord1[0] and closest_x < coord2[0]) or (closest_x <
coord1[0] and closest_x > coord2[0]):
    closest_y = gradient * closest_x + k
    distance = math.sqrt((closest_x - click[0])**2 + (closest_y - click[1])**2)

if distance < smallest_distance:
    try:
        points = [polygons[i][j],polygons[i][j+1]]
    except:
        points = [polygons[i][j],polygons[i][0]]
    best_line_gradient = gradient
    best_line_k = k
    smallest_distance = distance
    best_closest_x = closest_x
    best_closest_y = closest_y

#Finding next points along
if coordinates[points[0]][1] < coordinates[points[1]][1]:
    higher_point = points[0]
    lower_point = points[1]
else:
    higher_point = points[1]
    lower_point = points[0]

#Find potential polygons that it could be, along with their next points
potential_polygons = []
for polygon in polygons:
    for x in range(len(polygon)):
        #one direction
        try:
            if polygon[x] == lower_point and polygon[x+1] == higher_point:
                potential_polygons.append([polygon,polygon[x+2]])
        except:
            try:
                if polygon[x] == lower_point and polygon[x+1] == higher_point:
                    potential_polygons.append([polygon,polygon[0]])
            except:
                if polygon[x] == lower_point and polygon[0] == higher_point:
                    potential_polygons.append([polygon,polygon[1]])
        #other direction
        try:
            if polygon[x] == lower_point and polygon[x-1] == higher_point:
                potential_polygons.append([polygon,polygon[x-2]])
        except:
            try:
                if polygon[x] == lower_point and polygon[x-1] == higher_point:
                    potential_polygons.append([polygon,polygon[len(polygon)-1]])
            except:
                if polygon[x] == lower_point and polygon[len(polygon)-1] ==
higher_point:

```

```

#Matrix rotation algorithm to check if it's left or right
rotating_point = [click[0] - best_closest_x,click[1] - best_closest_y]
angle = math.pi/2 - math.atan(best_line_gradient)
if angle > math.pi/2:
    angle = angle - math.pi
new_point = [math.cos(angle) * rotating_point[0] - math.sin(angle) *
rotating_point[1], math.sin(angle) * rotating_point[0] + math.cos(angle) *
rotating_point[0]]
if new_point[0] > 0:
    right = True
else:
    right = False

# matrix thing again to see which side is the correct one. Finds the next point
attached to highest point on line and sees which is
for potential_polygon in potential_polygons:
    next_point = potential_polygon[1]
    gradient = (coordinates[next_point][1] -
coordinates[higher_point][1])/(coordinates[next_point][0] -
coordinates[higher_point][0])
    matrix_thing = math.cos(angle) * (coordinates[next_point][0]-
coordinates[higher_point][0]) - math.sin(angle) * (coordinates[next_point][1] -
coordinates[higher_point][1])
    if right == (matrix_thing > 0):
        for x in range(len(polygons)):
            if polygons[x] == potential_polygon[0]:
                return x

return 'false'

```

## F) Gameplay: Rolling dice algorithm

This function generates random numbers for the number of dice being rolled, calculates who wins the battle and removes troops accordingly. I decided to automate the defending player's dice roll for the sake of easier gameplay. This means that the defending player does not have to input any decision on the attacking players turn.

This function does not return any value, but it updates the troops count of the players and the territories, and displays the dice rolls in the label L\_DiceRolled

```

def RollDice(num_attacking_dice):

    #this calculates the number of defending dice, based off the amount of      troops
    in the defending territory
    num_defending_dice = min(map.troops_in_territory[game.defending],2)

    #ROLL
    attacking_dice = []
    attacking_dice_text = ''
    for x in range(num_attacking_dice):
        num = randrange(1,7)
        attacking_dice.append(num)
        attacking_dice_text += str(num) + ' '
    attacking_dice.sort(reverse=True)

    defending_dice = []
    defending_dice_text = ''
    for x in range(num_defending_dice):
        num = randrange(1,7)
        defending_dice.append(num)
        defending_dice_text += str(num) + ' '

```

```

defending_dice.sort(reverse=True)

L_DiceRolled.configure(text=attacking_dice_text + 'VS ' + defending_dice_text)

#Work out which dice won.
troops_lost = [0,0] #each index of this array is a player in the battle
for x in range(min(num_attacking_dice,num_defending_dice)):
    if attacking_dice[x] > defending_dice[x]:
        troops_lost[1] += 1
    else:
        troops_lost[0] += 1

```

After this procedure runs, the troops are removed from the players that `troops_lost` has calculated.

### G) Gameplay: Verify that redeployment is valid

In the redeploy stage of RISK, a player can move troops from one of their territories to another, provided they are connected via a path of territories owned by the player. This algorithm implements a breadth first search using the graph *connections*. The parameters are the start and the goal node, and the program can only search nodes that are owned by the current player.

This function returns True if the countries are connected, and False if they are not

```

def ConnectedTerritories(start,goal):

    visited = [start]
    queue = [start]
    #repeat until queue is empty and there is no other node to search
    while len(queue) != 0:
        parent = queue[0]
        for x in range(len(map.connections[parent])):
            if (map.connections[parent][x] == 1) and (x not in visited) and
            (map.player_in_territory[parent] == map.player_in_territory[x]):
                visited.append(x)
                queue.append(x)
            if x == goal:
                return True
        queue.pop(0)
    return False

```

### H) Gameplay: Merge Sort

In order to sort the random dice rolled, I have implemented a merge sort to do so efficiently. The merge sort uses recursion to build the individual lists back together again.

```

def MergeSort(unsorted):
    lists = []
    for item in unsorted:
        lists.append([item])
def Merge(a,b,c):
    if a == [] and b == []:
        return c
    elif a == []:
        c.append(b.pop(0))
        return Merge(a,b,c)
    elif b == []:
        c.append(a.pop(0))
        return Merge(a,b,c)
    else:
        if a[0] > b[0]:

```

```

c.append(a.pop(0))
return Merge(a,b,c)
else:
    c.append(b.pop(0))
    return Merge(a,b,c)

```

## I) Retrieving data from database

This is an example of the code I used to connect to the database to retrieve information, taken from the Menu Page, when the statistics are being retrieved.

```

db_path = "./DataBase/ProjectDb.db"
connection = sqlite3.connect(db_path)
db_cursor = connection.cursor()

sql = 'SELECT Games, Wins, Losses FROM Users WHERE UserID = ?'

db_cursor.execute(sql,(info.userID,))
user_stats = db_cursor.fetchone()

sql = 'SELECT Username, Games, Wins FROM Users'
db_cursor.execute(sql)
leaderboard_stats = []
loop = True
while loop:
    temp = db_cursor.fetchone()
    if temp == None:
        loop = False
    else:
        leaderboard_stats.append(list(temp))

connection.commit()
connection.close()

```

# Testing

## Test Details

TestID	Details	Input Data	Expected Outcome	Pass/Fail
<b>1) Login Page</b>				
1	Attempting to login with a valid username and password	sandy password 123	The program will move to the Menu Page, showing Sandy's game statistics	pass
2	Attempting to login with an invalid username and password	sandyy iloverisk	The program will clear the password input and remain on the login page	fail
3	Attempting to login without a password	sandy	The program will do nothing	pass
4	Attempting to create a new valid user	newriskplayer, Password !	The program will add the new player to the database and move onto the menu page.	pass

## RISK

Candidate Number: 1318

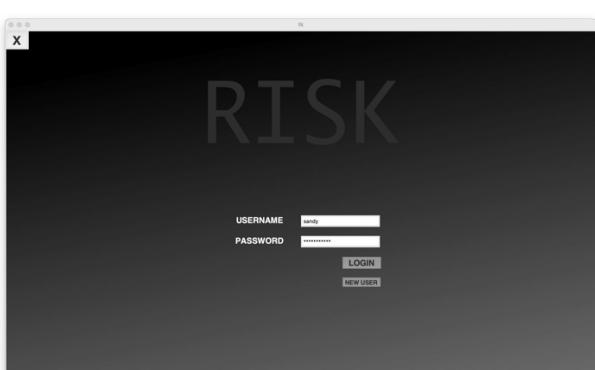
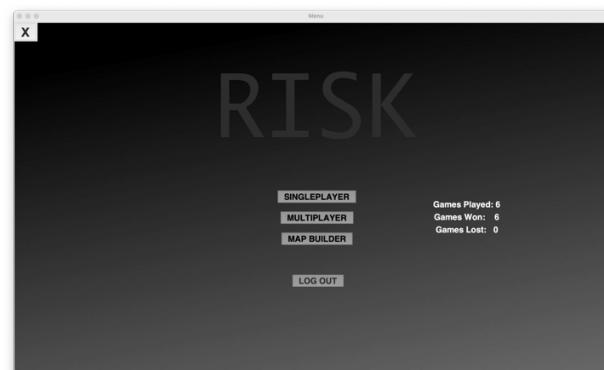
Candidate Name: Alexander Mulcahy

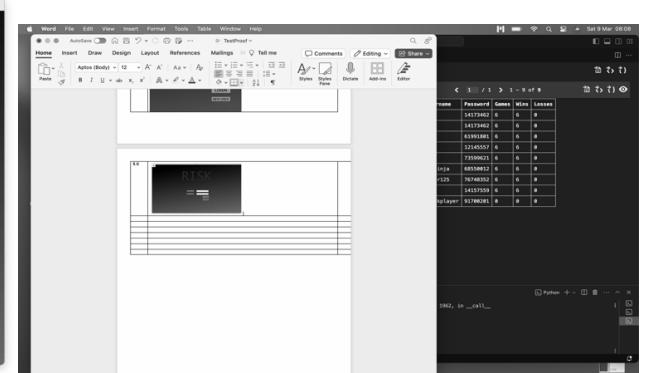
5	Attempting to create a new user with a username already taken	sandy iloverisk	The program will remain on the login page	pass
6	Close Program when X is clicked	X button	The program will close	pass
7	Store new password using encryption in database	Password !	The program will store the password as an encrypted 8 digit number	pass
<b>2) Menu Page</b>				
1	Move to Single player Setup when button is pressed	singleplayer button	The program will move to the setup page	pass
2	Don't do anything when multiplayer button is clicked	multiplayer button	The program will remain on the Menu Page	pass
3	Log out when Log Out is clicked	Log Out button	The program will return to the Login Page	pass
<b>3) Map Builder</b>				
1	Draw a node onto the map		A small circle will appear on the canvas	pass
2	Draw a node outside map		Nothing will be drawn on the canvas	pass
3	Create line connecting 2 nodes		A blue line will be drawn connecting the 2 nodes	pass
4	Draw perfectly vertical line		The program will not draw the line	
5	Undo a line drawn	Undo button	The program will remove the most recently drawn line,	pass
6	Double click node to deselect		When drawing another node the previous node will not connect	pass
7	Attempt to draw a line crossing another line		The node/line trying to be drawn will not be drawn	pass
8	Attempt to Finish Drawing with unconnected lines	Finish Drawing	The program should not allow the drawing to be finished	fail
9	Create territories from a map with convex polygons	Finish Drawing	The program will turn the lines drawn into polygons, each a random shade of grey	pass
10	Create territories from map with concave polygons	Finish Drawing	The program will turn the lines drawn into polygons, each a random shade of grey	fail
11	Add a region to the region list	'asia' AddRegion	'asia' will appear in the regions listbox	pass
12	Click on territory to select it		The territory will turn white, with a red border	pass
13	Add a name and region to the selected territory	top right shape	The territory will change to a colour dependent on its region, and label with the name will appear	pass
14	Attempt to add a name without selecting a region	top left shape	The program will do nothing and wait for a territory to be selected first	pass
15	Export map correctly into the database	map name: shape	The Map Builder module will return to the start again, and the map data will be put into the database	pass

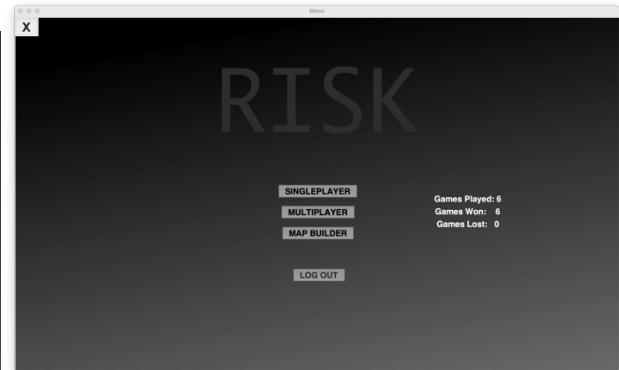
4) Single Player				
1	Attempt to add troops onto owned territory	click territory	The troop count of that territory will increase	pass
2	Attempt add troops onto territory that is not owned	click territory	The troop count of the territory will stay the same	pass
3	Move to Attack phase after deploying all troops	StartAttack button	The right side of the screen will change to show new controls	pass
4	Move to Attack phase before deploying all troops	Start Attack button	The Start Attack button will not do anything and the program will remain on the deploy phase	pass
5	Select territory to attack from, and territory to defend	click territories	The names of the territories involved in the battle will be displayed on the right side of the screen	pass
6	Attempt to select not owned territory to attack from	click territory	The name of the territory will not be displayed in the attacking: section	pass
7	Attempt to select territory to attack which is already owned	bottom right – top right	Attacking from switches to this territory	pass
8	Roll Dice when attacking, defending, and num. dice are selected	Emberlyn Capital 3 dice	The display will show the dice rolled underneath the Roll button, and take away troops from territories.	pass
9	Roll Dice before attacking, defending and num. dice are selected	Celestial P Azurea [no dice]	The program will not carry out a dice roll	pass
10	Reach only 3 troops when rolling with 3 dice	Marshes Aurumvale 3 dice	num. dice will deselect and remove 3 dice as option in list box	pass
11	Win a battle and take over the territory	Desert East Coast 3 dice	the defeated territory will turn the colour of the winning player. Roll button will change to Move troops.	pass
12	Receive a card at the end of go if successful attack	attack = true	a random card will be added to player's cards for next turn	pass
13	Attempt a valid fortify at end of turn		Troops should move from one territory to the other.	pass
14	Cash in cards when player has a set	one of each card	the number of troops to deploy will have an extra 10 troops	pass
15	Take opponents cards when they are killed completely		red has 2 cards, green kills red, green adds 2 cards to their 2 cards, now has 4 cards	pass
16	Win message shown when a player wins the game	player wins game	display message “[player_name] wins!” at the top of the screen	pass
17	Display a help message when help button is pressed (Deploy phase)	Help button	Message will be displayed on the bottom of the screen	pass
5) Setup Page				

1	Input player name, colour, and status into the player list	player1 orange human	The player information will be displayed in the player list	pass
2	Attempt to use same player name twice	player1 blue human	nothing will happen	pass
3	Attempt to use same colour twice	orange	orange does not appear on the list of colours any more	pass
4	Remove most recent player from player list	remove button	The data on the bottom of the list will be removed	fail
5	Choose map from listbox	Hexagonia	The desired map will be accessible	pass
6	Attempt to add computer player to game	computer green	The data will not be added to the player list	fail
7	Attempt to start game with fewer than 2 players	North America [Invalid players]	The program will do nothing	pass
8	Attempt to start game with valid number of players	North America [Valid players]	The setup page will move to the gameplay page, and load up the North America map	pass
9	Attempt to start game without selecting a map	no map selected	The program will do nothing	pass

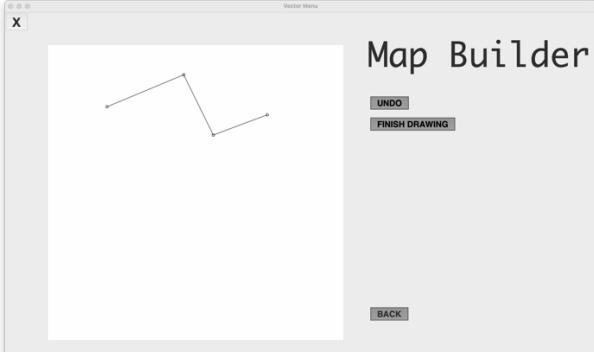
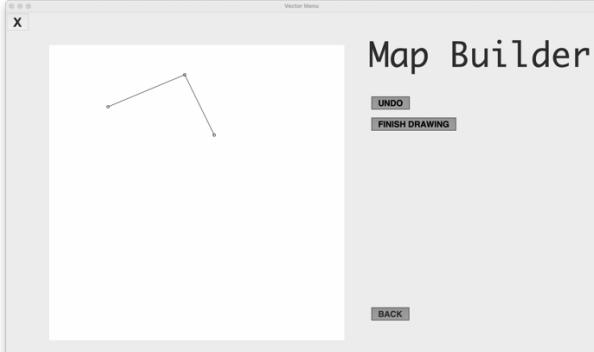
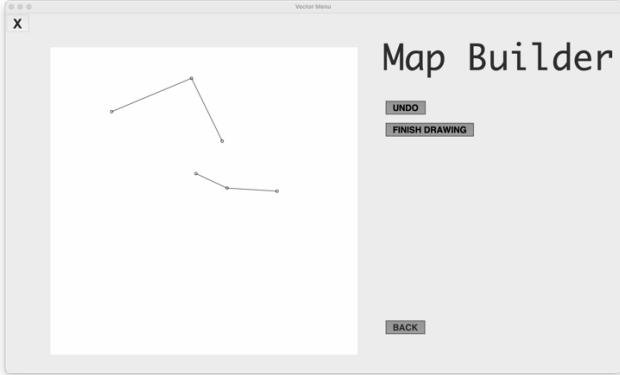
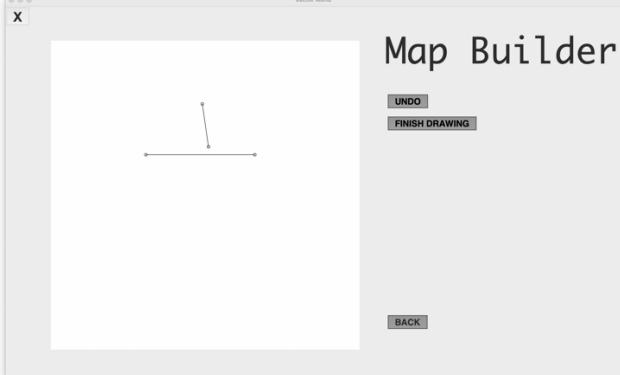
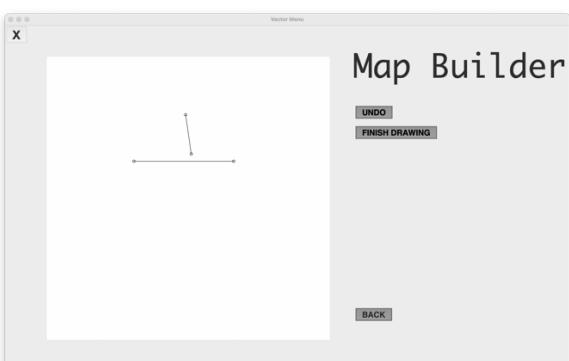
## Test Proof

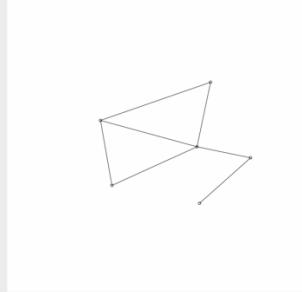
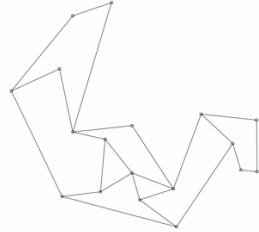
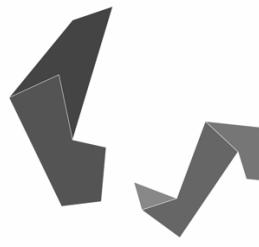
TestID	Proof
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1.2	<p><b>USERNAME</b> <input type="text" value="sandy"/></p> <p><b>PASSWORD</b> <input type="password" value="*****"/></p> <p><b>LOGIN</b></p> <p><b>NEW USER</b></p>	<p><b>USERNAME</b> <input type="text" value="sandy"/></p> <p><b>PASSWORD</b> <input type="password" value="*****"/></p> <p><b>LOGIN</b></p> <p><b>NEW USER</b></p>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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<tr><td>14157609</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157610</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157611</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157612</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157613</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157614</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157615</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157616</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157617</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157618</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157619</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157620</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157621</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157622</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157623</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157624</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157625</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157626</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157627</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157628</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157629</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157630</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157631</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157632</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157633</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157634</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157635</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157636</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157637</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157638</td><td></td><td>6</td><td>6</td><td>0</td></tr> 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<tr><td>14157669</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157670</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157671</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157672</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157673</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157674</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157675</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157676</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157677</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157678</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157679</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157680</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157681</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157682</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157683</td><td></td><td>6</td><td>6</td><td>0</td></tr> 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<tr><td>14157729</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157730</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157731</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157732</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157733</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157734</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157735</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157736</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157737</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157738</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157739</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157740</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157741</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157742</td><td></td><td>6</td><td>6</td><td>0</td></tr> <tr><td>14157743</td><td></td><td>6</td><td>6</td><td>0</td></tr> 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Username	Password									
tedstar125	76748352									
james	14157559									
newriskplayer	91700201									
2.1	<p style="text-align: center;"> <a href="#">SINGLEPLAYER</a>  <a href="#">MULTIPLAYER</a>  <a href="#">MAP BUILDER</a>   <a href="#">LOG OUT</a> </p>	 <p>The Setup screen allows users to choose a map (West) and add players. It includes buttons for 'NAME', 'COLOUR', 'BOT?', 'ADD PLAYER', and 'REMOVE PLAYER'. Navigation buttons 'BACK' and 'START' are at the bottom.</p>								
2.2	<p style="text-align: center;"> <a href="#">SINGLEPLAYER</a>  <a href="#">MULTIPLAYER</a>  <a href="#">MAP BUILDER</a>   <a href="#">LOG OUT</a> </p>	 <p>The main menu displays the RISK logo and game statistics: Games Played: 6, Games Won: 5, Games Lost: 0. It also features a 'LOG OUT' button.</p>								
2.3	<p style="text-align: center;"> <a href="#">SINGLEPLAYER</a>  <a href="#">MULTIPLAYER</a>  <a href="#">MAP BUILDER</a>   <a href="#">LOG OUT</a> </p>	 <p>The login screen prompts for 'USERNAME' and 'PASSWORD'. It includes 'LOGIN' and 'NEW USER' buttons.</p>								

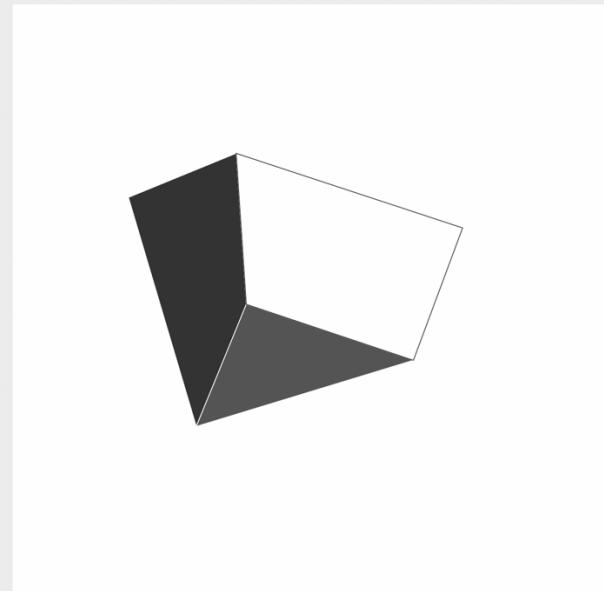


3.4	
3.5	 
3.6	
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3.8	 <b>Map Builder</b> UNDO FINISH DRAWING BACK	 <b>Map Builder</b> Territory _____ Region _____ Add Region SUBMIT ClickOnTerritory BACK FINISH
3.9	 <b>Map Builder</b> UNDO FINISH DRAWING BACK	 <b>Map Builder</b> Territory _____ Region _____ Add Region SUBMIT ClickOnTerritory BACK FINISH
3.10	 <b>Map Builder</b> UNDO FINISH DRAWING BACK	 <b>Map Builder</b> Territory _____ Region _____ Add Region SUBMIT ClickOnTerritory BACK FINISH
3.11	<b>Territory</b> _____ <b>Region</b> _____ asia Add Region	<b>Region</b> asia asia Add Region <b>SUBMIT</b>

3.12

# Map Builder

Territory Region 

NameAndRegion

3.13

**Map Builder**

Territory  top-right  
 Region  shape  
  
  
 NameAndRegion

**Map Builder**

Territory   
 Region  shape  
  
  
 ClickOnTerritory

3.14

**Map Builder**

Territory  top-left  
 Region  shape  
  
  
 ClickOnTerritory

**Map Builder**

Territory  top-left  
 Region  shape  
  
  
 ClickOnTerritory

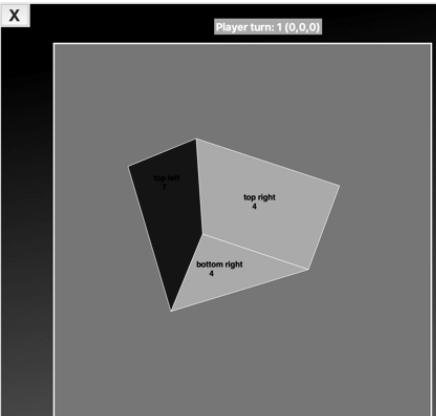
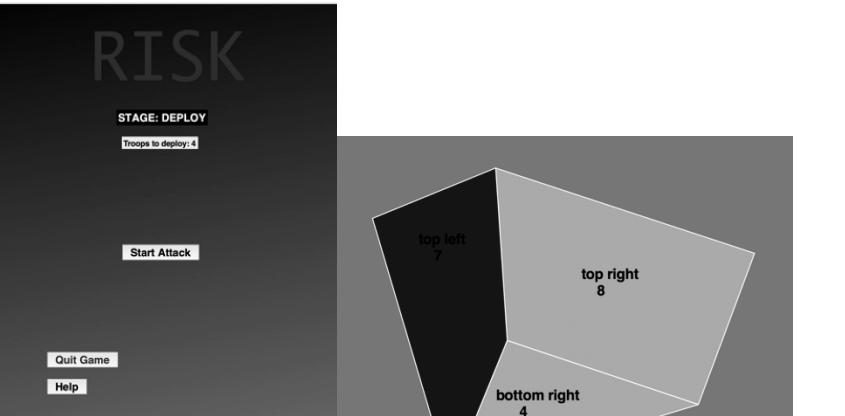
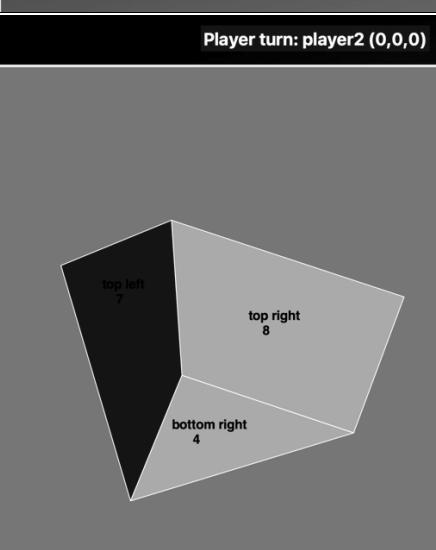
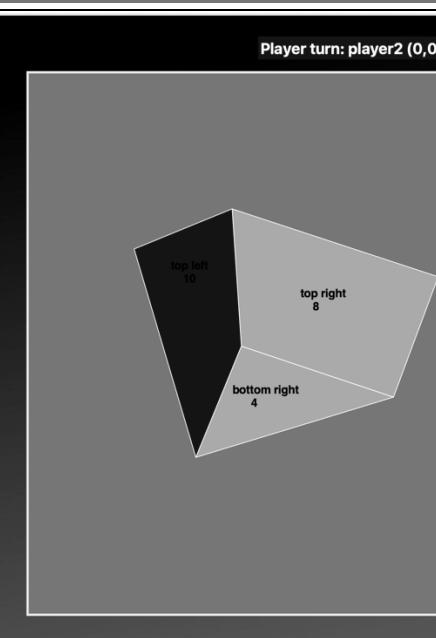
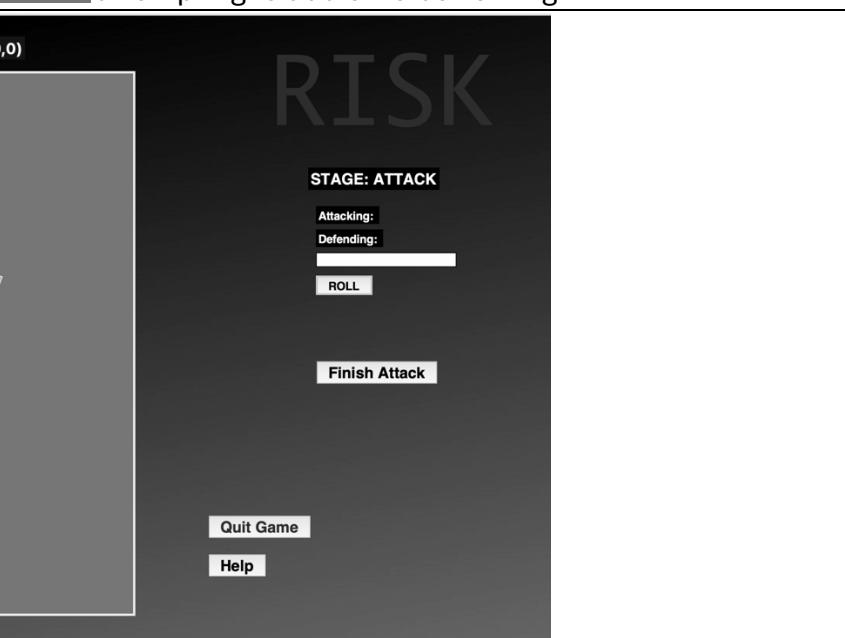
3.15

**Map Builder**

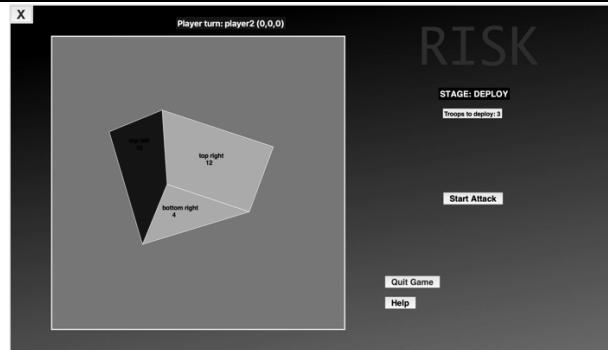
Territory   
 Region  triangle  
  
  
 Map Name:  shaped  
 map name and finish

**Map Builder**

MapID	Name	TerritoryNames	Polygons	Coordinates
9	shape	top right/top left/bottom right	[1, 2, 3, 4]/[0, 1, 4, 5]/[3, 4, 5]	[139, 230]/[266, 178]/[533, 266]/[

4.1	 
4.2	 attempting to add onto bottom right
4.3	 

4.4



the program remains on this page

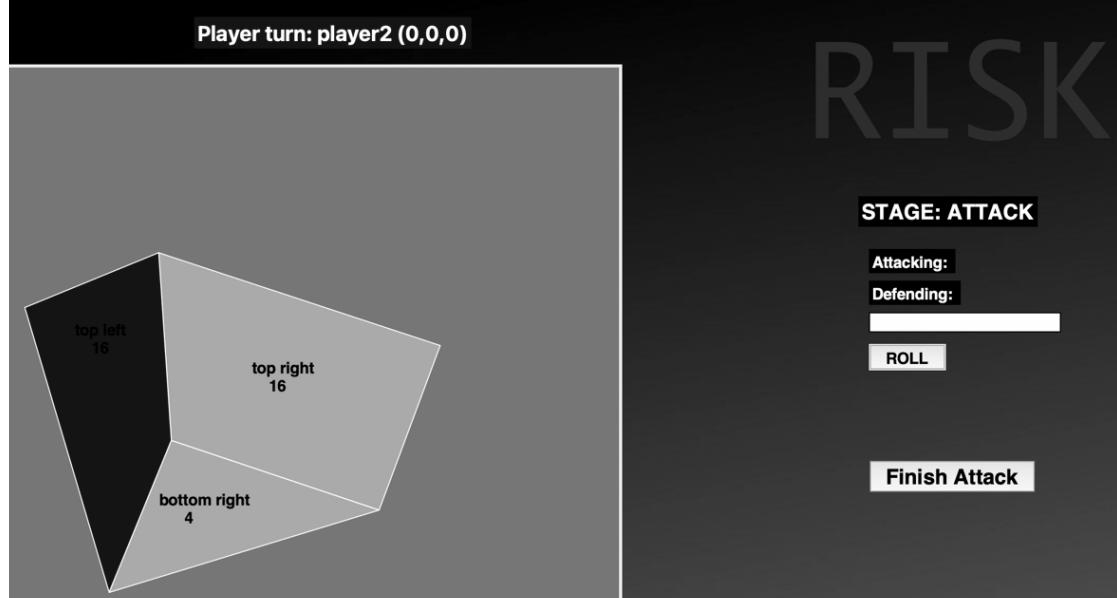
4.5

**STAGE: ATTACK****Attacking:** top left**Defending:** bottom right

1

**ROLL**

4.6



attempting to select top right as attacking territory

4.7

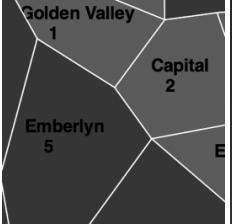
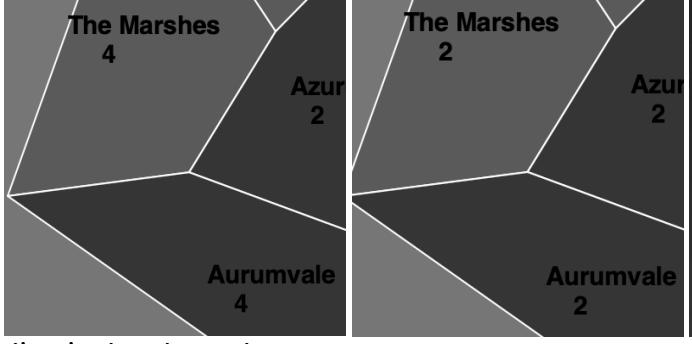
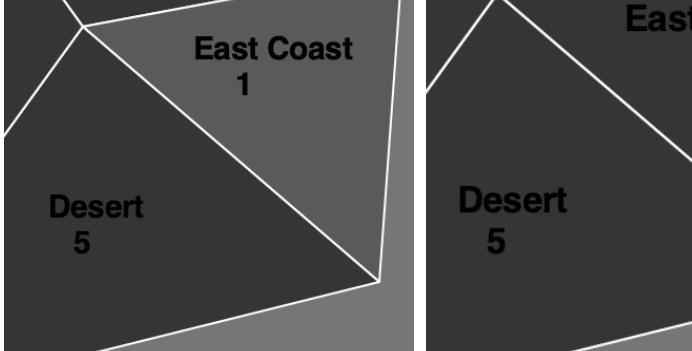
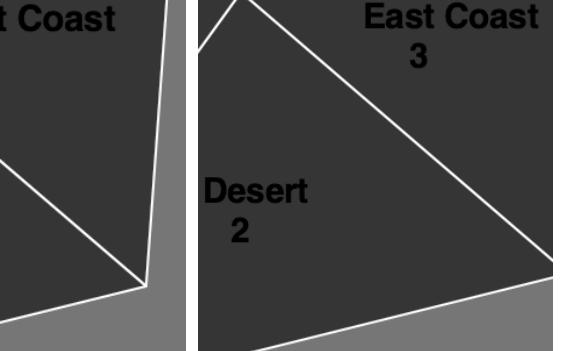
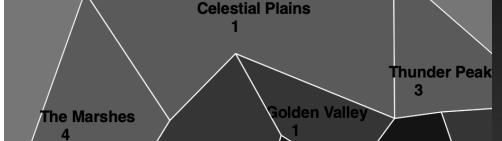
**STAGE: ATTACK****Attacking:** bottom right**Defending:**

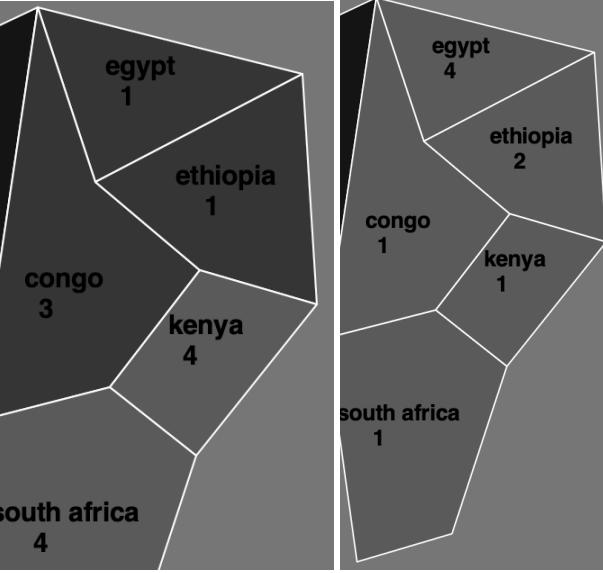
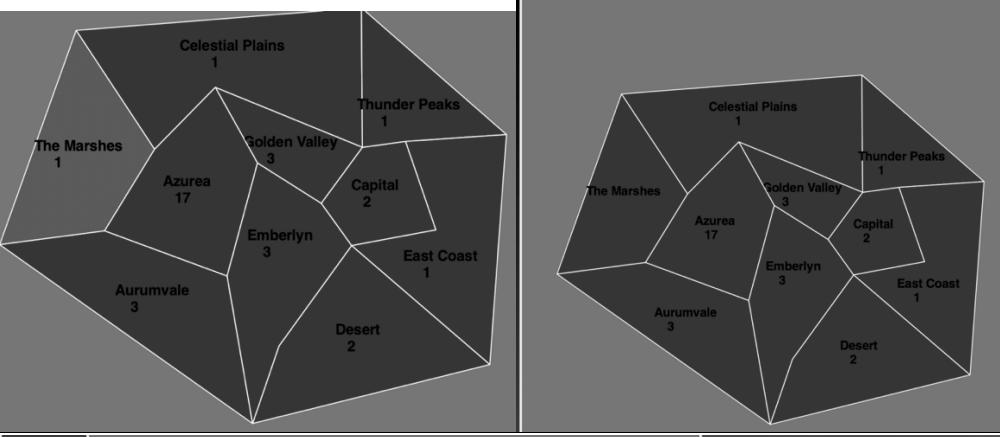
1

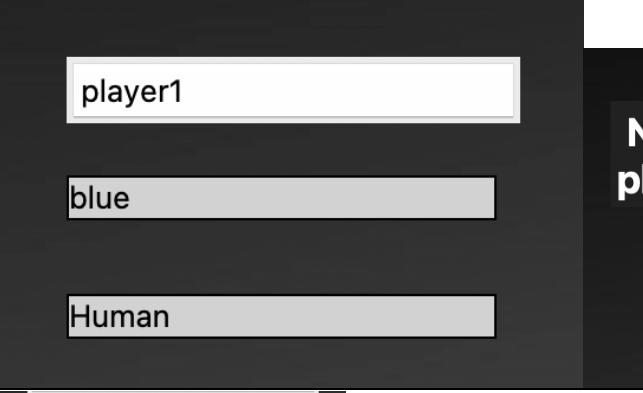
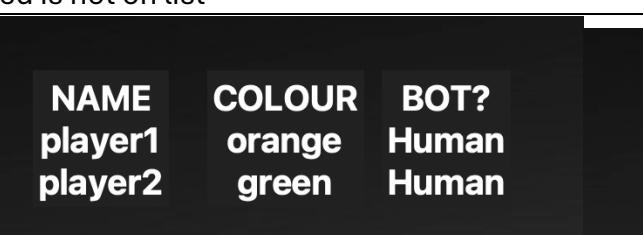
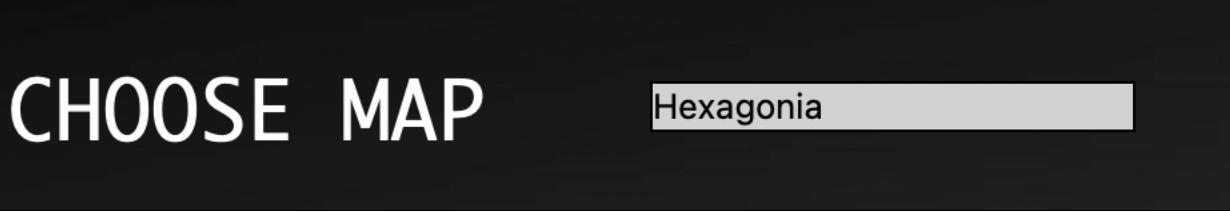
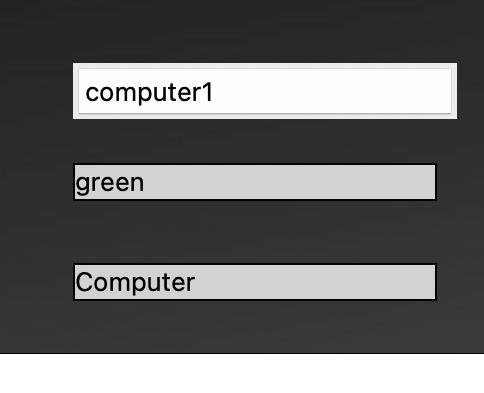
**ROLL****STAGE: ATTACK****Attacking:** top right**Defending:**

1

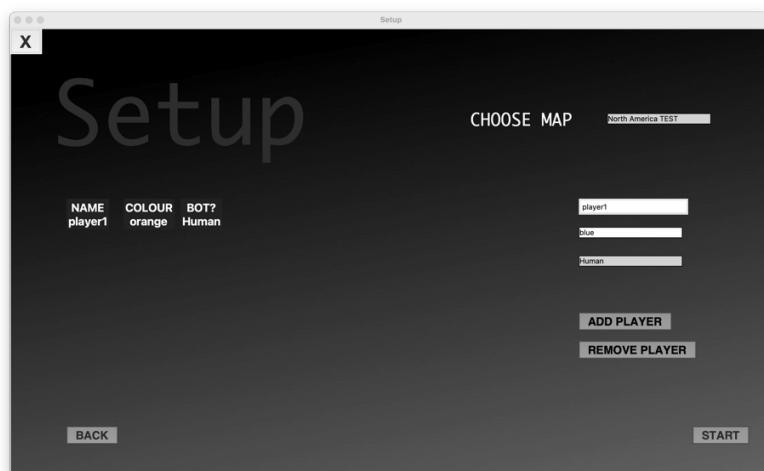
**ROLL**

4.8	<p><b>STAGE: ATTACK</b></p> <p>Attacking: Emberlyn Defending: Capital 3</p> <p><b>ROLL</b></p>	 <p><b>Attacking: Emberlyn</b> <b>Defending: Capital</b> 3</p> <p><b>Move troops</b></p> <p><b>5 3 5 VS 1 1</b></p>
(the roll button changed to a Move Troops button because the capital was defeated)		
4.9	<p><b>Attacking: Celestial Plains</b> <b>Defending: Azurea</b> 1</p> <p><b>ROLL</b></p>	<p><b>STAGE: ATTACK</b></p> <p>Attacking: Celestial Plains Defending: Azurea 1</p> <p><b>ROLL</b></p>
(does nothing)		
4.10		<p><b>Attacking: The Marshes</b> <b>Defending: Aurumvale</b> 1</p> <p><b>ROLL</b></p> <p><b>5 1 3 VS 5 6</b></p>
dice is deselected		
4.11		
4.12	<p><b>Player turn: 1 (0,0,1)</b></p>	<p><b>Player turn: 1 (0,1,1)</b></p>
the displays of cards on consecutive turns for the red player		
4.13		<p><b>STAGE: FORTIFY</b></p> <p>Sending troops: The Marshes Receiving troops: Thunder Peaks 1</p> <p><b>Move troops</b></p>

4.14	<p><b>STAGE: DEPLOY</b></p> <p><b>Player turn: 1 (1,1,1)</b></p> <p><b>Troops to deploy: 17</b></p>
4.15	<p>player received an additional 10 troops for one of each card</p>  <p><b>Player turn: Player2 (1,1,2)</b></p>
4.16	 <p><b>1 wins!</b></p>
4.17	<p>click your territories that you want to give more troops to</p> <p><b>Help</b></p>

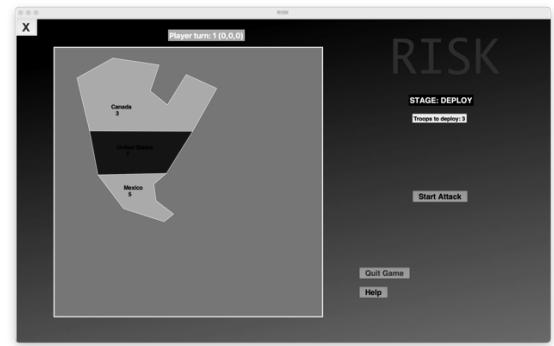
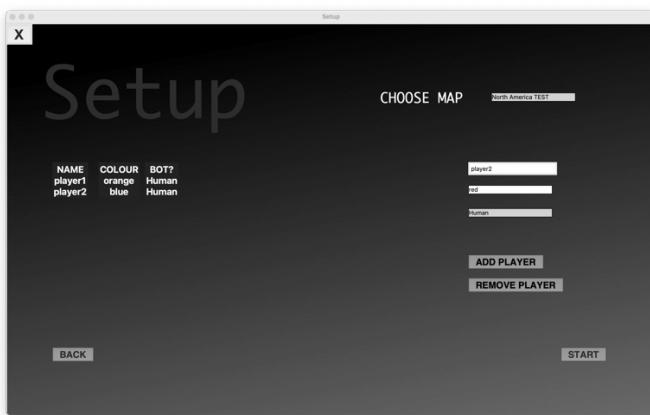
5.1		<b>NAME</b> player1  <b>COLOUR</b> orange  <b>BOT?</b> Human
5.2		<b>NAME</b> player1  <b>COLOUR</b> orange  <b>BOT?</b> Human
5.3		red is not on list
5.4		<b>NAME</b> player1 player2  <b>COLOUR</b> orange green  <b>BOT?</b> Human Human
5.5		Hexagonia
5.6		<b>NAME</b> computer1  <b>COLOUR</b> green  <b>BOT?</b> Computer

5.7

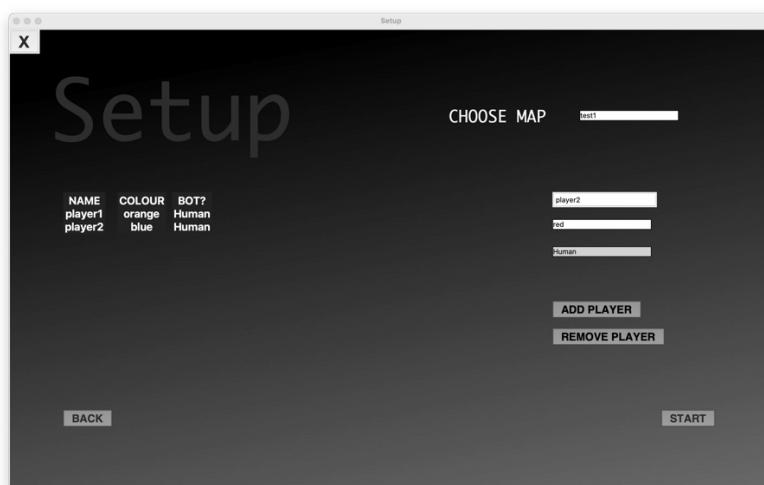


does nothing

5.8



5.9



does nothing

## Amendments

### 1.2

If the username/ password is invalid, it returns false, and I added the middle line to clear the password Entry box also.

```
if username == '' or password == '':
    E_Password.delete(0, END)
    return False
```

3.8

## RISK

Candidate Number: 1318

Candidate Name: Alexander Mulcahy

I had forgotten to use a return False statement if the program found a point that was only connected to one line.

```
if valid == False:  
    return False
```

## 3.10

This bug is not a quick fix as I would have to rewrite the function to have it working 100% accurately. It seems like the program struggles with convex shapes because it is trying to navigate circular paths, like going around a clock. The more random the points are in the shape, the more likelihood that the program will take the wrong path.

## 5.6

I added an extra clause in the Add Player function, so the program does not allow computer players. This can easily be changed again if computer players are added to the game.

```
if name == '' or name in info.players or colour in info.colours or bot == 'Computer':  
    return False
```

# Evaluation

## Comparison of Project Performance against Objectives

1. The login page must function to direct users to their unique accounts.

### Specific Objectives

1. Allow the user to enter a username.

This objective has been met. The username can be entered in the Entry box.

2. Allow the user to enter a password.

This objective has been met. The password can likewise be entered in an Entry box.

3. Securely store the users' passwords

This objective has been met. See test 1.7 for hashed passwords.

4. Have a button to submit their login information.

This objective has been met. Login Button on the login page

Have a section to create new accounts for new users.

This objective has been met. There is a separate button for adding a new user.

2. The program should provide a fun, challenging RISK playing experience to the user.

### Specific Objectives

1. Allow the user to click on regions to select them for various in game tasks.

This objective has been met. The Which Area function allows this.

2. Allow the user to go through the 3 phases of their turn.

This objective has been met. See tests 4.1, 4.5, 4.13 for Deploy, Attack, Fortify stages.

3. The game play must be versatile to cope with unseen maps created by users.

This objective has been met. The game worked with all maps that were tested on

4. The game should function correctly as a game of *RISK*.

This objective has been met.

3. The map building function should allow the user to design whatever map they want.

### Specific Objectives

1. Allow the user to draw in lines into the canvas as borders.

This objective has been met.

2. Have a button to erase the last line drawn for the user to correct mistakes.  
This objective has been met. See test 3.5 for Undo button.
3. Allow the user to select territories, name them, and assign them to a 'continent'.  
This objective has been met. Users can select territories after drawing to name them.
4. Allow the user to name the 'continents' and assign them bonuses.  
This objective has been partially met. The bonus assignment is computed, not chosen.
5. Allow the user to give the map a name.  
This objective has been met. See test 3.15 for naming a map.

4. The map building function should then export and save the map in an organised way.

#### Specific Objectives

1. Store the drawn lines as lists of points.  
This objective has been met.
2. Create and store regions from enclosed polygons in the map builder.  
This objective has been partially met. Create Polygons generally works, however occasionally errors with convex shapes.
3. Store the region connections as a matrix.  
This objective has been met. See AfterDrawing.Connections.
4. Export and save the new map to a database, with its name and an ID.  
This objective has been met.

5. The multiplayer mode should run without too much lag to provide an adequate game play experience.

#### Specific Objectives

1. Work out a way to connect two devices online.  
This objective has not been met. Multiplayer remains a possible extension to the project.
2. Add a turn timer so that players don't take too long.  
This objective has also not been met.

6. The interface should be user-friendly and easy to navigate, with an appropriate theme.

#### Specific Objectives

1. Create a GUI containing named buttons to navigate easily between pages.  
This objective has been met. Buttons remain in the same place across pages.
2. Provide guides on how to play RISK and how to operate the map builder.  
This objective has been met. See test 4.17 for example help message.
3. Design the application with a dark colour theme.  
This objective has been met.

## User Feedback

Upon meeting with Tom to present the final project, he was pleased to see a working game of risk. He enjoyed playing on some maps that I had created during testing and was impressed at the Map Building page. The Map building function worked correctly when Tom built his own map with 6 concave territories all in one roughly circular shape, however it struggled to detect all the territories he tried to make in a crescent shaped map.

## RISK

Candidate Number: 1318

Candidate Name: Alexander Mulcahy

He commented that the design of the program was appropriate and easy to navigate, and he liked the colour scheme chosen for the game. Although, he pointed out that there was a limited number of colours to choose from as player colours, which is something that I could add.

Tom suggested that a computer player to play against would be the best next step for this program, which would be my first addition to the project. He also thought it would be a good extension to add an ability to play across devices.

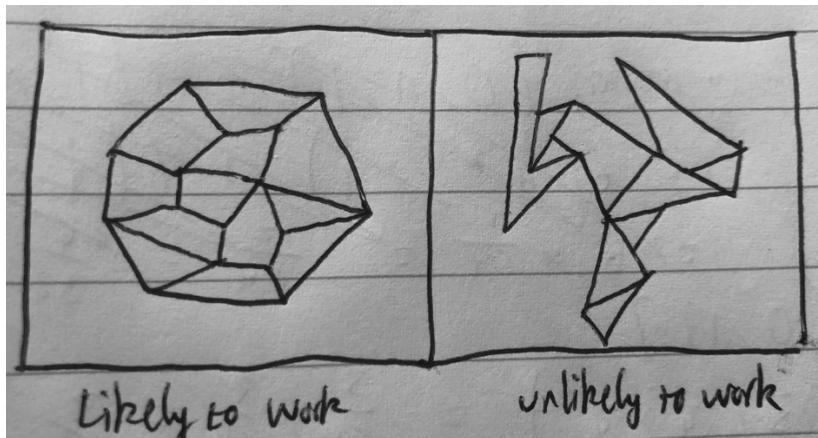
Overall, my client seemed to be satisfied with the product that I presented him with, saying to me that he will use this in his spare time to create his own personal maps to play on with his friends.



Feedback Authenticated by Tom:

## Possible Extensions

Although most faults found in testing were easily fixed, I would develop this project by rewriting the Create Polygons function so that it works 100% of the time, including with more complex shapes that are in a more complex configuration. Below is a diagram showing potential maps and the respective likelihood of the function working.



There is scope in this project to introduce a multiplayer mode which I was planning on in the early stages of development. This mode could involve a lobby format to allow for players on different devices to play with each other, whether that be on the same WIFI network, or with a code. I would also add features such as a turn timer for the multiplayer mode.

My first extension to this project would be to add a computer 'AI' that can play against the user. This model would be based on the probability of winning certain attacks, considering the number of troops potentially lost against the potential troop gain of holding bonuses and having cards. I would consider creating a neural network to play the game, and train it against itself and users to develop a working computer player, but a probability base model would be simpler. This computer player could easily be added to the functionality of the game, as I have accommodated for it in the Setup page already.

A simple addition to this project would be to add a step in the map building process to allow the users to choose how much they want the bonus to be for a region when naming them. I would add an extra

entry box below the region name entry box, and only allow a region name to be entered if a number was also provided in this box. I would then disable the function that automatically computes them.

I followed up on Tom's feedback to increase the range of colours that a player can choose to play as on the setup page. This will be useful when playing a game with more than 4 players. Below is the line of code that I adjusted to add more colours.

```
308     def Setup():
309         colours = ['orange', 'blue', 'red', 'green']
```

```
308     def Setup():
309         colours = ['orange', 'blue', 'red', 'green', 'pink', 'purple', 'yellow', 'brown']
```

## Conclusion

It is clear from the feedback from Tom that this system will be useful and entertaining for him as a game.

There are some simple changes to the program that could easily be added to the functionality of the system. There are also some further extensions to the project that, if I or anyone else felt inclined to add them, then there would be scope to do so.

## **APPENDIX**

### MODULE 1: LOGIN PAGE

Functions:

- Close
- LoginUser
- NewUser
- AccessDatabase
- \*Hash\*

```
def Close():
    info.next_page='Close'
    window.destroy()

def LoginUser():

    username = E_Username.get()
    password = E_Password.get()
    if username == '' or password == '':
        return False

    hashed_password = Hash(password)

    DB_data = AccessDatabase(username)

    #Verify
    if DB_data[1] == hashed_password:
        info.userID = int(DB_data[0])

    #@ MODULE Menu
    info.next_page = 'MenuPage'
    window.destroy()
```

```
def NewUser():
    username = E_Username.get()
    password = E_Password.get()
    if username == '' or password == '':
        return False

    hashed_password = Hash(password)

    #Check if username already exists
    if AccessDatabase(username) != False:
        return False

    #Regex checking
    disallowed_character = re.findall("[@#?!$%&*]", username)
    print(disallowed_character)
    if disallowed_character != []:
        return False

    db_path = "./DataBase/ProjectDb.db"
    connection = sqlite3.connect(db_path)
    db_cursor = connection.cursor()
    #insert new user
    sql = "INSERT INTO Users(username,password,games,wins,losses) VALUES (?,?,?,?,?,?)"
    db_cursor.execute(sql,[username,hashed_password,0,0,0])
    #find UserID
    sql = "SELECT UserID FROM Users WHERE Username = ?"
    db_cursor.execute(sql,[username])
    info.userID = int(db_cursor.fetchone()[0])

    #@ MODULE Menu
    window.destroy()
    info.next_page = 'MenuPage'

    connection.commit()
    connection.close()

def AccessDatabase(username):
    #Fetch user data from database
    db_path = "./DataBase/ProjectDb.db"
    connection = sqlite3.connect(db_path)
    db_cursor = connection.cursor()

    sql = 'SELECT UserID, Password FROM Users WHERE Username = ?'
    db_cursor.execute(sql,[username])

    #If there is a user, verify password. If not, show NewUser button and halt.
    try:
        data = list(db_cursor.fetchone())
        connection.commit()
        connection.close()
        return data
    except:
        connection.commit()
        connection.close()
        return False

def Hash(password):
    hash = 12345678
    for x in range(len(password)):
        character = password[x]
        ascii_code = ord(character)

        hash = hash + (ascii_code * 7)
```

```
hash = hash // 3
hash = hash + 987
hash = hash * 5
hash = hash - (1000% ascii_code )
new_hash = ''
for y in range(len(str(hash))):
    new_hash = new_hash + str(hash)[len(str(hash))-1-y]
hash = int(new_hash)
hash = hash - 98765
hash = hash // 7

#this section makes sure the result of the hash has 8 digits, either by cutting
off digits, or adding on extra
if len(str(hash)) > 8:
    hash = int(str(hash)[0:8])
elif len(str(hash)) < 8:
    add = 1
    while add != 0:
        hash = int(str(hash) + str(add))
        add += 1
        if len(str(hash)) == 8:
            add = 0

return hash

#####
#Creating the window and the Tkinter components

window = Tk()
#window.title('Login')

#Start up fullscreen
screen_width= window.winfo_screenwidth()
screen_height= window.winfo_screenheight()
window.geometry("%dx%d" % (screen_width, screen_height))
window.wm_attributes('-fullscreen', 'true')

img = ImageTk.PhotoImage(Image.open('GreyBackground.jpeg'))
canvas = Canvas(window, width=screen_width, height=screen_height)
canvas.place(x=-1,y=-1)

canvas.create_image(0,0,image=img,anchor='nw')
canvas.create_text(screen_width/2,200, text='RISK', font = 'Ayuthaya 200 bold',fill ='#9A1111')
'Zapfino, DIN'

#Username
canvas.create_text((screen_width)/2 - 100,463, text='USERNAME',font = 'Helvetica 20 bold',fill='white')
E_Username = Entry(window,width=20)
E_Username.place(x=(screen_width)/2,y=450)
#Password
canvas.create_text((screen_width)/2 - 100,513, text='PASSWORD',font = 'Helvetica 20 bold',fill='white')
E_Password = Entry(window,show = '*',width=20)
E_Password.place(x=(screen_width)/2,y=500)

#Login
B_Login = Button(window,text='LOGIN',font = 'Helvetica 20 bold', foreground =
'#9A1111',highlightbackground='#444444',borderwidth=0,command=LoginUser)
B_Login.place(x=(screen_width/2 + 100),y=550)
#NewUser
```

## RISK

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```
B_NewUser = Button(window, text='NEW USER', font = 'Helvetica 15 bold', foreground = '#9A1111', highlightbackground='#444444', borderwidth=0, width=7, command = NewUser)
B_NewUser.place(x=(screen_width/2 + 100), y=600)

#Close program
B_Close = Button(window, text = 'X', font = 'Arial 30 bold', foreground='#9A1111', background = 'black', command=Close)
B_Close.place(x=0, y=0)

window.mainloop()
```

## MODULE 2: MENU PAGE

### Functions:

- GoToSingleplayer
- GoToMultiplayer
- GoToMapBuilder
- LogOut
- Close

\*Retrieving statistics from database \*

```
def GoToSingleplayer():
    #Check if user has a current game first
    db_path = "./DataBase/ProjectDb.db"
    connection = sqlite3.connect(db_path)
    db_cursor = connection.cursor()

    sql = 'SELECT * FROM CurrentGame WHERE UserID = ?'
    db_cursor.execute(sql, (info.userID,))
    data = db_cursor.fetchone()

    if data == None:
        info.next_page = 'SetupSingleplayer'
    else:
        info.saved_game_data = data
        info.mapID = data[1]
        info.next_page = 'Gameplay'

    connection.commit()
    connection.close()
    window.destroy()

def GoToMultiplayer():
    return False
    info.next_page = 'SetupMultiplayer'
    window.destroy()

def GoToMapBuilder():
    info.next_page = 'MapBuilder'
    window.destroy()

def LogOut():
    info.next_page = 'LoginPage'
    info.userID = 0
    window.destroy()

def Close():
    info.next_page= 'Close'
    window.destroy()

#####
#####
```

```
#Get Stats from Database
db_path = "./DataBase/ProjectDb.db"
connection = sqlite3.connect(db_path)
db_cursor = connection.cursor()

sql = 'SELECT Games, Wins, Losses FROM Users WHERE UserID = ?'

db_cursor.execute(sql,(info.userID,))
user_stats = db_cursor.fetchone()

sql = 'SELECT Username, Games, Wins FROM Users'
db_cursor.execute(sql)
leaderboard_stats = []
loop = True
while loop:
    temp = db_cursor.fetchone()
    if temp == None:
        loop = False
    else:
        leaderboard_stats.append(list(temp))

connection.commit()
connection.close()

#####
window = Tk()
window.title('Menu')

#Start up fullscreen
screen_width= window.winfo_screenwidth()
screen_height= window.winfo_screenheight()
window.geometry("%dx%d" % (screen_width, screen_height))
window.wm_attributes('-fullscreen', 'true')

img = ImageTk.PhotoImage(Image.open('GreyBackground.jpeg'))

canvas = Canvas(window, width=screen_width, height=screen_height)
canvas.place(x=-1,y=-1)

canvas.create_image(0,0,image=img,anchor='nw')

canvas.create_text(screen_width/2,200, text='RISK', font = 'Ayuthaya 200 bold',fill ='#9A1111')
'Zapfino, DIN'

#BUTTONS to go to modules
B_SingleLayer = Button(window, text = 'SINGLEPLAYER', font = 'Helvetica 20 bold',
foreground = 'black', highlightbackground='#444444',borderwidth=0,
command=GoToSingleplayer)
B_SingleLayer.place(x=(screen_width/2 - 92),y=400)

B_MultiLayer = Button(window, text = 'MULTIPLAYER', font = 'Helvetica 20 bold',
foreground = 'black', highlightbackground='#444444',borderwidth=0,
command=GoToMultiplayer)
B_MultiLayer.place(x=(screen_width/2 - 85),y=450)

B_MapBuilder = Button(window, text = 'MAP BUILDER', font = 'Helvetica 20 bold',
foreground = 'black', highlightbackground='#444444',borderwidth=0,
command=GoToMapBuilder)
B_MapBuilder.place(x=(screen_width/2 - 83),y=500)

#Logout
```

## RISK

Candidate Number: 1318 Candidate Name: Alexander Mulcahy

```
B_Logout = Button(window, text = 'LOG OUT', font = 'Helvetica 20 bold', foreground = '#9A1111', highlightbackground='#444444',borderwidth=0, command=LogOut)
B_Logout.place(x=(screen_width/2 - 57),y=600)

#Close program
B_Close = Button(window, text = 'X', font = 'Arial 30 bold', foreground='#9A1111', background = 'black',command=Close)
B_Close.place(x=0,y=0)

#stats
canvas.create_text(screen_width*3/4,435, text='Games Played: ' + str(user_stats[0]), font = 'Helvetica 20 bold',fill ='white')
canvas.create_text(screen_width*3/4,465, text='Games Won: ' + str(user_stats[1]), font = 'Helvetica 20 bold',fill ='white')
canvas.create_text(screen_width*3/4,495, text='Games Lost: ' + str(user_stats[2]), font = 'Helvetica 20 bold',fill ='white')

window.mainloop()
```

## MODULE 3: MAP BUILDER

Classes:

- Linemaker
- AfterDrawing

Functions:

- Linemaker.Point
- Linemaker.Line
- Linemaker.FindEquation
- Linemaker.CrossingLines
- Linemaker.Click
- \* Linemaker.Undo \*
- AfterDrawing.PlaceButtons
- AfterDrawing.MakePolygons
- AfterDrawing.Connections
- AfterDrawing.ClickOnTerritory
- AfterDrawing.NameAndRegion
- AfterDrawing.InputLabelPosition
- AfterDrawing.AddRegion
- AfterDrawing.Complete
- FinishDrawing
- SamePolygon
- ListToString (this function converts an array into a string to be stored in one cell of the database)
- \* WhichArea \*
- ExportMap
- Back
- Close

```
class LineMaker:
    # s instead of self
    def __init__(s):
        s.drawing = True

        s.coordinates = []
        s.lines = []
        s.line_equations = []

        s.selected = 0
        s.click = 0
```

```

s.change = -1
s.undo = False

s.oval = []

def Point(s,x,y,new):
    s.undo = [s.selected]
    #This loop iterates through the existing points, checking if the new point is
close enough to be one.
    for i in range(len(s.coordinates)):
        z = s.coordinates[i]
        #This calculation checks if the click is in a certain radius of points
already drawn
        if math.sqrt((x - z[0])**2 + (y - z[1])**2) <= 6:
            new = False
            #if already selected is selected again, deselect
            if s.selected == i:
                s.selected = -1
            #if none is selected already, select new click
            elif s.selected == -1:
                s.selected = i
            #if already selected and other is selected, wait until line drawn
            else:
                s.change = i

            s.oval = [z[0],z[1],False]

            s.click = i
    #If none of the existing points are close enough, create a new point
    if new == True:
        s.coordinates.append([x,y])
        s.click = len(s.coordinates) - 1
        s.oval = [x,y,True]
        s.change = s.click

def Line(s):
    if s.selected != s.click:
        x1,y1 = s.coordinates[s.selected][0], s.coordinates[s.selected][1]
        x2,y2 = s.coordinates[s.click][0], s.coordinates[s.click][1]
        Valid = True
        for i in range(len(s.lines)):
            if s.selected not in s.lines and s.click not in s.lines:
                valid = CrossingLines(x1,y1,x2,y2,s.coordinates[s.lines[i][0]][0],
s.coordinates[s.lines[i][0]][1],
s.coordinates[s.lines[i][1]][0],s.coordinates[s.lines[i][1]][1])
                if valid != True:
                    Valid = False
                    s.change = s.selected
        if Valid == True:
            s.lines.append([s.selected,s.click])

s.line_equations.append(FindEquation(s.coordinates[s.selected][0],s.coordinates[s.selected][1],s.coordinates[s.click][0],s.coordinates[s.click][1]))
    canvas.create_line(x1,y1,x2,y2,fill="blue",width = 1)
    s.undo.append('line')
    s.selected = len(s.coordinates)-1
else:
    s.oval[2] = False
    s.coordinates.pop(len(s.coordinates)-1)

def FindEquation(x1,y1,x2,y2):
    #Gradient
    if x1 == x2:
        return False

```

```

m = (y2-y1) / (x2-x1)
#Constant
c = y1 - m * x1
return [m,c]

def CrossingLines(x1,y1,x2,y2,x3,y3,x4,y4):
    #x1,y1,x2,y2 : new line
    #x3,y3,x4,y4 : existing lines
    # y = mx + k

    if x1 == x2 or x3 == x4:
        return 0
    #Calculate Gradients
    g1 = (y2-y1)/(x2-x1)
    g2 = (y4-y3)/(x4-x3)
    #Calculate constants
    k1 = y1 - g1 * x1
    k2 = y3 - g2 * x3
    #Set lines equal to each other
    g3 = g1 - g2
    k3 = (k1 - k2) * -1
    #Find point of intersection
    if g3 == 0:
        return 0
    x = k3 / g3
    #Check if intersection is within both lines
    within_line1 = (x+.0001 < x1 and x-.0001 > x2) or (x-.0001 > x1 and x+.0001 < x2)
    within_line2 = (x+.0001 < x3 and x-.0001 > x4) or (x-.0001 > x3 and x+.0001 < x4)
    if within_line1 and within_line2:
        return False

    return True

linemaker = LineMaker()

#####
def Click(event):
    #After drawing is finished, this function is used to create the regions instead
    if linemaker.drawing == False:
        if after_drawing.next_action == "ClickOnTerritory":
            after_drawing.ClickOnTerritory(event.x,event.y)
        elif after_drawing.next_action == "InputLabelPosition":
            after_drawing.InputLabelPosition(event.x,event.y)

        L_NextAction.configure(text=after_drawing.next_action)
        return False

    linemaker.Point(event.x,event.y,True)
    #print('['+str(event.x)+','+str(event.y)+']')
    print(linemaker.selected)

    if linemaker.selected != -1:
        linemaker.Line()

    if linemaker.change != -1:
        linemaker.selected = linemaker.change
        linemaker.change = -1

    if linemaker.oval[2] == True:
        canvas.create_oval(linemaker.oval[0] - 3, linemaker.oval[1] - 3,
linemaker.oval[0] + 3, linemaker.oval[1] + 3)
        linemaker.undo.append('point')

```

```

def Undo():
    #Don't run if undo has happened just now OR if drawing stage is over
    if linemaker.undo == False or linemaker.drawing == False:
        return False

    if 'line' in linemaker.undo:
        line = linemaker.lines[len(linemaker.lines)-1]
        linemaker.lines.pop(len(linemaker.lines)-1)
        linemaker.line_equations.pop(len(linemaker.line_equations)-1)
        #drawing over the line in white

        canvas.create_line(linemaker.coordinates[line[0]][0],linemaker.coordinates[line[0]][1],
                           linemaker.coordinates[line[1]][0],linemaker.coordinates[line[1]][1],fill="white",width
                           = 3)
        #redrawing circles attached
        canvas.create_oval(linemaker.coordinates[line[0]][0] - 3,
                           linemaker.coordinates[line[0]][1] - 3, linemaker.coordinates[line[0]][0] + 3,
                           linemaker.coordinates[line[0]][1] + 3)
        canvas.create_oval(linemaker.coordinates[line[1]][0] - 3,
                           linemaker.coordinates[line[1]][1] - 3, linemaker.coordinates[line[1]][0] + 3,
                           linemaker.coordinates[line[1]][1] + 3)

        if 'point' in linemaker.undo:
            coordinates = linemaker.coordinates[len(linemaker.coordinates)-1]
            linemaker.coordinates.pop(len(linemaker.coordinates)-1)
            #drawing over the circle
            canvas.create_oval(coordinates[0] - 4, coordinates[1] - 4, coordinates[0] + 4,
                               coordinates[1] + 4,outline='white',fill="white")

linemaker.selected = linemaker.undo[0]
#So you can only do 1 undo
linemaker.undo = False

#####
class AfterDrawing:

    regions = []
    territories = []
    territory_regions = []
    #this is for when each is selected, to put them in order
    territory_polygons = []
    #this is when all of them are created at the start
    polygons = []

    text_coordinates = []

    map_data = []

    def __init__(s):
        s.next_action = 'ClickOnTerritory'
        s.clicked_polygon = -1

    def PlaceButtons(s):
        L_NextAction.place(x=867,y=550)

        background.create_text(905,260, text='Territory', font = 'Helvetica 20 bold',
                           fill ='black')
        background.create_text(900,310, text='Region', font = 'Helvetica 20 bold', fill
                           ='black')

        E_Name.place(x=970,y=250)

```

```
Li_Region.place(x=970,y=300)

E_AddRegion.place(x=970,y=350)
B_AddRegion.place(x=1200,y=351)
B_Finish.configure(text='FINISH',command=ExportMap)
B_Finish.place(x=1200,y=700)

B_SubmitNameRegion.place(x=867,y=450)

canvas.delete('all')
B_Undo.destroy()

def MakePolygons(s):
    lines = linemaker.lines
    coordinates = linemaker.coordinates
    lines_used = []
    for x in range(len(lines)):
        lines_used.append(0)

    polygons = []

    for i in range(len(coordinates)):
        coordinate = coordinates[i]
        finding_polygons = True
        #find every polygon attached to a point
        while finding_polygons:
            #find smallest polygon first
            queue = [[i,[i]]]
            searched = []
            path = [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]
            finding_smallest_polygon = True
            while queue != []:
                searching = queue.pop(0)

                searched.append(searching)
                #find all paths to search that are connected to point and havent
been used twice
                for l in range(len(lines)):
                    if searching[0] in lines[l] and lines_used[l] != 2:

                        #find next node
                        next = lines[l][0]
                        if next == searching[0]:
                            next = lines[l][1]

                        #add new node to potential path, add path to queue
                        if (next not in searching[1]):
                            #so it doesnt mess up lists
                            temp = []
                            for item in searching[1]:
                                temp.append(item)
                            temp.append(next)
                            queue.append([next,temp])

                        #if it has made a loop, check if loop is smallest
                        elif next == i and len(searching[1]) > 2:
                            #check if polygon has already been found
                            found_already = False
                            for polygon in polygons:
                                if SamePolygon(searching[1],polygon):
                                    found_already = True
                            if found_already == False and len(searching[1]) <
len(path):
                                path = searching[1]
```

```

if path != [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]:
    polygons.append(path)
else:
    finding_polygons = False

#adding to lines used
for x in range(len(lines)):
    for y in range(len(path)-1):
        if (lines[x][0] == path[y] and lines[x][1] == path[y+1]) or
(lines[x][0] == path[y+1] and lines[x][1] == path[y]):
            lines_used[x] += 1
        if (lines[x][0] == path[len(path)-1] and lines[x][1] == path[0]) or
(lines[x][0] == path[0] and lines[x][1] == path[len(path)-1]):
            lines_used[x] += 1

#remove biggest polygon (this is the perimeter of the country) $won't work with
multiple land masses
if 1 not in lines_used:
    biggest = [0,0]
    for x in range(len(polygons)):
        if len(polygons[x]) > biggest[1]:
            biggest = [x,len(polygons[x])]
    polygons.pop(biggest[0])

#print em
s.polygons = polygons
colours = ['#333333','#444444','#555555','#666666','#777777','#888888']
for i in range(len(polygons)):
    temp = []
    for point in polygons[i]:
        temp.append(linemaker.coordinates[point])
    canvas.create_polygon(temp,fill=colours[i%6],outline='white')

def Connections(s):
    #creating the 2D matrix
    connections = []
    temp = []
    for x in range(len(after_drawing.polygons)):
        temp.append(0)
    for x in range(len(after_drawing.polygons)):
        connections.append(temp)

    #Find which polygons the lines are connected to. If connected to 2 polygons,
make a connection between them
    for x in range(len(linemaker.lines)):
        connection = []
        for y in range(len(after_drawing.polygons)):
            for z in range(len(after_drawing.polygons[y])-1):
                if after_drawing.polygons[y][z] in linemaker.lines[x] and
after_drawing.polygons[y][z+1] in linemaker.lines[x]:
                    connection.append(y)
                if after_drawing.polygons[y][len(after_drawing.polygons[y])-1] in
linemaker.lines[x] and after_drawing.polygons[y][0] in linemaker.lines[x]:
                    connection.append(y)

        if len(connection) == 2:
            connections[connection[0]][connection[1]] = 1
            connections[connection[1]][connection[0]] = 1

def ClickOnTerritory(s,x,y):
    #highlight the polygon that you are naming
    s.clicked_polygon = WhichArea([x,y],linemaker.coordinates,s.polygons)

```

```
if s.clicked_polygon == 'false' or s.clicked_polygon in s.territory_polygons:
    return False
s.territory_polygons.append(s.clicked_polygon)

temp = []
for point in s.polygons[s.clicked_polygon]:
    temp.append(linemaker.coordinates[point])
canvas.create_polygon(temp, fill='white', outline='red')

s.next_action = 'NameAndRegion'
L_NextAction.configure(text=s.next_action)

def NameAndRegion(s):
    if s.next_action != "NameAndRegion":
        return False

    try:
        name = E_Name.get()
        E_Name.delete(0,END)
        region = Li_Region.get(Li_Region.curselection())
    except:
        return False

    if name == '' or region == '':
        return False

    s.next_action = "InputLabelPosition"
    L_NextAction.config(text=s.next_action)

    s.territories.append(name)
    for i in range(len(s.regions)):
        if s.regions[i] == region:
            s.territory_regions.append(i)

def InputLabelPosition(s,x,y):
    s.text_coordinates.append([x,y])
    temp = []
    for point in s.polygons[s.clicked_polygon]:
        temp.append(linemaker.coordinates[point])

    colours = ['#142C85','#A5322E','#238026','#FFEA00']

    canvas.create_polygon(temp, fill=colours[s.territory_regions[len(s.territory_regions)-1]],outline='white')
    canvas.create_text(x,y, text=s.territories[len(s.territories)-1],font = 'Helvetica 15 bold')

    #finished?
    if len(s.territory_polygons) == len(s.polygons):
        s.Complete()
    else:
        s.next_action = "ClickOnTerritory"
        L_NextAction.config(text=s.next_action)

def AddRegion(s):
    if len(s.regions) == 4:
        return False
    value = E_AddRegion.get()
    if value == '':
        return False
    s.regions.append(value)
```

```
Li_Region.insert('end',value)
#E_AddRegion.text = '' $

def Complete(s):
    s.next_action = 'map name and finish'
    L_MapName.place(x=1200,y=520)
    E_MapName.place(x=1200,y=560)

    s.map_data.append(ListToString(s.territories))

    ordered_polygons = []
    for polygon_index in s.territory_polygons:
        ordered_polygons.append(s.polygons[polygon_index])
    s.map_data.append(ListToString(ordered_polygons))
    s.map_data.append(ListToString(linemaker.coordinates))
    s.map_data.append(ListToString(s.regions))
    #S
    region_bonuses = []
    for x in range(len(s.regions)):
        #This calculates how much a bonus should be for each region (num
territories in it / 2)
        count = 1
        for y in s.territory_regions:
            if x == y:
                count += 1
        region_bonuses.append(count // 2)
    s.map_data.append(ListToString(region_bonuses))

    s.map_data.append(ListToString(s.territory_regions))
    s.map_data.append(ListToString(s.text_coordinates))

    s.map_data.append('N/A')

after_drawing = AfterDrawing()

#####
def FinishDrawing():

    if len(linemaker.lines) < 3:
        return False

    #Check if any points have only 1 connection
    count = []
    for i in range(len(linemaker.coordinates)):
        count.append(0)
    for line in linemaker.lines:
        count[line[0]] += 1
        count[line[1]] += 1

    valid = True
    for num in count:
        if num < 2:
            valid = False

    if valid == False:
        linemaker.drawing = True

    linemaker.drawing = False

    after_drawing.PlaceButtons()
    after_drawing.MakePolygons()
    after_drawing.Connections()
```

```
#OTHER METHODS
```

```
def SamePolygon(polygon1,polygon2):
    count = 0
    for point in polygon1:
        if point in polygon2:
            #coudn't just remove it because it was messing up list on outside
            count += 1
    if len(polygon2) == count:
        return True
    return False

def ListToString(list):
    temp_string = ''
    for x in list:
        temp_string += str(x) + '/'
    temp_string
    return temp_string[:-1]

def WhichArea(click,coordinates,polygons):
    smallest_distance = 1000
    for i in range(len(polygons)):
        for j in range(len(polygons[i])):
            coord1 = coordinates[polygons[i][j]]
            try:
                coord2 = coordinates[polygons[i][j+1]]
            except:
                coord2 = coordinates[polygons[i][0]]
            gradient = (coord1[1]-coord2[1])/(coord1[0]-coord2[0])
            k = coord1[1] - gradient * coord1[0]

            opposite_gradient = -1 / gradient
            opposite_k = click[1] - opposite_gradient * click[0]

            closest_x = (k-opposite_k)/(opposite_gradient-gradient)
            if (closest_x > coord1[0] and closest_x < coord2[0]) or (closest_x < coord1[0] and closest_x > coord2[0]):
                closest_y = gradient * closest_x + k
                distance = math.sqrt((closest_x - click[0])**2 + (closest_y - click[1])**2)

                if distance < smallest_distance:
                    try:
                        points = [polygons[i][j],polygons[i][j+1]]
                    except:
                        points = [polygons[i][j],polygons[i][0]]
                    best_line_gradient = gradient
                    best_line_k = k
                    smallest_distance = distance
                    best_closest_x = closest_x
                    best_closest_y = closest_y

    #canvas.create_line(click[0],click[1],best_closest_x,best_closest_y)

    #Finding next points along
    if coordinates[points[0]][1] < coordinates[points[1]][1]:
        higher_point = points[0]
        lower_point = points[1]
    else:
        higher_point = points[1]
        lower_point = points[0]

    #Find potential polygons that it could be, along with their next points
```

```

potential_polygons = []
for polygon in polygons:
    for x in range(len(polygon)):
        #one direction
        try:
            if polygon[x] == lower_point and polygon[x+1] == higher_point:
                potential_polygons.append([polygon, polygon[x+2]])
        except:
            try:
                if polygon[x] == lower_point and polygon[x+1] == higher_point:
                    potential_polygons.append([polygon, polygon[0]])
            except:
                if polygon[x] == lower_point and polygon[0] == higher_point:
                    potential_polygons.append([polygon, polygon[1]])
        #other direction
        try:
            if polygon[x] == lower_point and polygon[x-1] == higher_point:
                potential_polygons.append([polygon, polygon[x-2]])
        except:
            try:
                if polygon[x] == lower_point and polygon[x-1] == higher_point:
                    potential_polygons.append([polygon, polygon[len(polygon)-1]])
            except:
                if polygon[x] == lower_point and polygon[len(polygon)-1] == higher_point:
                    potential_polygons.append([polygon, polygon[len(polygon)-2]])

#Matrix rotation algorithm to check if it's left or right
rotating_point = [click[0] - best_closest_x, click[1] - best_closest_y]
angle = math.pi/2 - math.atan(best_line_gradient)
if angle > math.pi/2:
    angle = angle - math.pi
new_point = [math.cos(angle) * rotating_point[0] - math.sin(angle) *
rotating_point[1], math.sin(angle) * rotating_point[0] + math.cos(angle) *
rotating_point[0]]
if new_point[0] > 0:
    right = True
else:
    right = False

# matrix thing again to see which side is the correct one. Finds the next point
attached to highest point on line and sees which is
for potential_polygon in potential_polygons:
    next_point = potential_polygon[1]
    gradient = (coordinates[next_point][1] -
coordinates[higher_point][1])/(coordinates[next_point][0] -
coordinates[higher_point][0])
    matrix_thing = math.cos(angle) * (coordinates[next_point][0]-
coordinates[higher_point][0]) - math.sin(angle) * (coordinates[next_point][1] -
coordinates[higher_point][1])
    if right == (matrix_thing > 0):
        for x in range(len(polygons)):
            if polygons[x] == potential_polygon[0]:
                return x
#? this wont work if they share 2 lines. it will need to loop round this last
section until different lines

return 'false'

def ExportMap():
    if after_drawing.next_action != 'map name and finish':
        return False

map_name = E_MapName.get()

```

```
if map_name == '':
    return False

map_data = after_drawing.map_data
map_data.insert(0, map_name)

#Connect to Database
db_path = "./DataBase/ProjectDb.db"
connection = sqlite3.connect(db_path)
db_cursor = connection.cursor()

sql = "INSERT INTO
Maps (Name, TerritoryNames, Polygons, Coordinates, RegionNames, RegionBonuses, TerritoryRegion
s, LabelCoordinates, Connections) VALUES (?,?,?,?,?, ?, ?, ?, ?, ?)"
db_cursor.execute(sql, map_data)

connection.commit()
connection.close()

window.destroy()

def Back():
    info.next_page = 'MenuPage'
    window.destroy()

def Close():
    info.next_page = 'Close'
    window.destroy()

window = Tk()
window.title('Vector Menu')

screen_width= window.winfo_screenwidth()
screen_height= window.winfo_screenheight()
window.geometry("%dx%d" % (screen_width, screen_height))
window.wm_attributes('-fullscreen', 'true')

background = Canvas(window, width=screen_width, height=screen_height)
background.place(x=0, y=0)

canvas = Canvas(window, width=700, height=700, background="white")
canvas.place(x=100, y=75)

background.create_text(1125,100, text='Map Builder', font = 'Ayuthaya 80 bold', fill ='#9A1111')

img = ImageTk.PhotoImage(Image.open('IMG_3772.jpg'))
#canvas.create_image(0,0,image=img,anchor='nw')

#BUTTONS
B_Undo = Button(window, text='UNDO', background='white', font = 'Helvetica 20 bold',
foreground = 'black', highlightbackground='#444444', borderwidth=0, command=Undo)
B_Undo.place(x=867, y=200)

B_Finish = Button(window, text = 'FINISH DRAWING', font = 'Helvetica 20 bold',
foreground = 'black', highlightbackground='#444444', borderwidth=0,
command=FinishDrawing)
B_Finish.place(x=867, y=250)

B_Back = Button(window, text = 'BACK', font = 'Helvetica 20 bold', foreground =
'#9A1111', highlightbackground='#444444', borderwidth=0, command=Back)
B_Back.place(x=867, y=700)
```

## RISK

Candidate Number: 1318

Candidate Name: Alexander Mulcahy

```
L_NextAction = Label(window, text=after_drawing.next_action, font = 'Helvetica 20 bold')
E_Name = Entry(window)
B_SubmitNameRegion = Button(window, text = 'SUBMIT', font = 'Helvetica 20 bold',
foreground = 'black',
highlightbackground='#444444', borderwidth=0, command=after_drawing.NameAndRegion)

Li_Region = Listbox(window, height=1)
E_AddRegion = Entry(window)
B_AddRegion = Button(window, text='Add Region', background = 'white', font = 'Helvetica
15 bold', foreground = 'black', highlightbackground='#444444', borderwidth=0,
command=after_drawing.AddRegion)

L_MapName = Label(window, text='Map Name:', font = 'Helvetica 20 bold ')
E_MapName = Entry(window)

canvas.bind("<Button 1>", Click)

#Close program
B_Close = Button(window, text = 'X', font = 'Arial 30 bold', foreground='#9A1111',
background = 'black', command=Close)
B_Close.place(x=0,y=0)

window.mainloop()
```

## MODULE 4: SINGLEPLAYER

Classes:

- Map
- Player
- Game

Functions:

- Map.DisplayMap
- Map.Deal (randomly giving territories at start of game)
- Game.RecieveCard
- Game.ReturnCard
- Game.TurnReset (this resets all the variables and list boxes for the next turn)
- \* WhichArea \* (same as in Map Builder)
- Click (this is where most of the RISK game logic is, and runs depending on which phase the turn is in)
- \* MergeSort \*
- \* RollDice \*
- MoveTroops
- CalculateExtraTroops
- \* ConnectedTerritories \*

```
class Map:

    coordinates = 0

    def __init__(s, map_data):

        #putting all of the map_data from the database into the map class
        s.name = map_data[0]

        s.territory_polygons = map_data[2]
        s.coordinates = map_data[3]
        s.label_coordinates = map_data[7]

        s.territory_names = map_data[1]
        s.player_in_territory = map_data[9]
        temp = []
```

```

for x in s.territory_names:
    temp.append(1)
s.troops_in_territory = temp

s.region_names = map_data[4]
s.region_bonuses = map_data[5]
s.territory_regions = map_data[6]
s.connections = map_data[10]

def DisplayMap(s):
    canvas.delete("all")
    for x in range(len(s.territory_polygons)):
        polygon_coords = []
        for point in s.territory_polygons[x]:
            polygon_coords.append(s.coordinates[point][0])
            polygon_coords.append(s.coordinates[point][1])
        canvas.create_polygon(polygon_coords,
fill=players[s.player_in_territory[x]].colour, outline='white')
        message = s.territory_names[x] + '\n' + ' ' * (len(s.territory_names[x]) // 2) + str(s.troops_in_territory[x])
        canvas.create_text(s.label_coordinates[x][0], s.label_coordinates[x][1],
text=message, font = 'Helvetica 15 bold')

def Deal(s):
    #put all territory indexes into a list
    unpicked_territories = []
    for x in range(len(s.territory_names)):
        unpicked_territories.append(x)

    while len(unpicked_territories) != 0:
        #each player gets a random territory index from the list, it is then
removed. Repeat until none left
        for player_num in range(num_players):
            if len(unpicked_territories) != 0:
                num = randrange(0, len(unpicked_territories))
                s.player_in_territory[unpicked_territories[num]] = player_num
                unpicked_territories.pop(num)

    return s.player_in_territory

#STARTING UP THIS INSTANCE OF GAME

#IMPORT MAP DATA
db_path = "./DataBase/ProjectDb.db"
connection = sqlite3.connect(db_path)
db_cursor = connection.cursor()
sql = 'SELECT * FROM Maps WHERE MapID = ?'
db_cursor.execute(sql, (info.mapID,))
map_data = list(db_cursor.fetchone())
map_data.pop(0)

#get rid of the /
for x in range(len(map_data)):
    if '/' in map_data[x]:
        if '[' in map_data[x]:
            map_data[x] = map_data[x].replace('/', '')
            #split up brackets
            for y in range(len(map_data[x])):
                map_data[x][y] = map_data[x][y][1:-1].split(', ')
                #make them integers
                for z in range(len(map_data[x][y])):
                    map_data[x][y][z] = int(map_data[x][y][z])
    else:
        map_data[x] = map_data[x].split('/')


```

## RISK

Candidate Number: 1318

Candidate Name: Alexander Mulcahy

```
#changing region bonuses and territory regions into integers
if x == 5 or x == 6:
    map_data[x] = list(map_data[x])
    for y in range(len(map_data[x])):
        map_data[x][y] = int(map_data[x][y])

#create player in territory
temp = []
for x in range(len(map_data[1])):
    temp.append(-1)
map_data.append(temp)

connection.commit()
connection.close()

#####
class Player:

    def __init__(s, player_num, name, colour, num_troops):
        s.player_num = player_num
        s.player_name = name
        s.colour = colour

        s.num_troops = num_troops
        s.cards = [0,0,0]

#####
class Game:
    def __init__(s):
        s.next_action = 'move troops'

        s.player_turn = 0
        s.player_queue = []
        s.phase = 0
        s.stages = ['STAGE: DEPLOY', 'STAGE: ATTACK', 'STAGE: FORTIFY']

        s.troops_to_add = 0

        s.attacking = -1 #these are territories, not players
        s.defending = -1

        s.sending_troops = -1 #these are for fortify phase
        s.receiving_troops = -1

        s.card_recieved = False
        #QUEUE STRUCTURE FOR DECK
        s.deck = []
        temp = []
        for x in range(14):
            temp.append(0) #Infantry
            temp.append(1) #Cavalry
            temp.append(2) #Artillery
        #shuffle
        for x in range(len(temp)):
            num = randrange(0,len(temp))
            s.deck.append(temp[num])
            temp.pop(num)
        s.deck_front_pointer = 0
        s.deck_end_pointer = 41

    def ReceiveCard(s):
        card = s.deck[s.deck_front_pointer]
```

```

players[s.player_turn].cards[card] += 1
s.deck[s.deck_front_pointer] = -1
s.deck_front_pointer = (s.deck_front_pointer + 1) % 42
def ReturnCards(s, bonus):
    if bonus == 4:
        players[s.player_turn].cards[0] -= 3
        cards = [0,0,0]
    elif bonus == 6:
        players[s.player_turn].cards[1] -= 3
        cards = [1,1,1]
    elif bonus == 8:
        players[s.player_turn].cards[2] -= 3
        cards = [2,2,2]
    else:
        players[s.player_turn].cards[0] -= 1
        players[s.player_turn].cards[1] -= 1
        players[s.player_turn].cards[2] -= 1
        cards = [0,1,2]
    for card in cards:
        s.deck_end_pointer = (s.deck_end_pointer + 1) % 42
        s.deck[s.deck_end_pointer] = card

def TurnReset(s):
    s.attacking = -1
    s.defending = -1
    L_Attacking.configure(text='Attacking: ')
    L_Defending.configure(text='Defending: ')

    s.sending_troops = -1
    s.receiving_troops = -1
    L_SendingTroops.configure(text='Sending: ')
    L_ReceivingTroops.configure(text='Receiving: ')

    Li_Dice.delete(0,END)
    Li_MoveTroops.delete(0,END)
    L_DiceRolled.configure(text='')

game = Game()

#####
def WhichArea(click,coordinates,polygons):
    smallest_distance = 1000
    ij = [0,0]
    for i in range(len(polygons)):
        for j in range(len(polygons[i])):
            coord1 = coordinates[polygons[i][j]]
            try:
                coord2 = coordinates[polygons[i][j+1]]
            except:
                coord2 = coordinates[polygons[i][0]]
            gradient = (coord1[1]-coord2[1])/(coord1[0]-coord2[0])
            k = coord1[1] - gradient * coord1[0]

            opposite_gradient = -1 / gradient
            opposite_k = click[1] - opposite_gradient * click[0]

            closest_x = (k-opposite_k)/(opposite_gradient-gradient)
            if (closest_x > coord1[0] and closest_x < coord2[0]) or (closest_x < coord1[0] and closest_x > coord2[0]):
                closest_y = gradient * closest_x + k
                distance = math.sqrt((closest_x - click[0])**2 + (closest_y - click[1])**2)
                if distance < smallest_distance:
                    smallest_distance = distance
                    ij = [i,j]

```

```

if distance < smallest_distance:
    try:
        points = [polygons[i][j], polygons[i][j+1]]
    except:
        points = [polygons[i][j], polygons[i][0]]
    best_line_gradient = gradient
    best_line_k = k
    smallest_distance = distance
    best_closest_x = closest_x
    best_closest_y = closest_y

#Finding next points along
if coordinates[points[0]][1] < coordinates[points[1]][1]:
    higher_point = points[0]
    lower_point = points[1]
else:
    higher_point = points[1]
    lower_point = points[0]

#Find potential polygons that it could be, along with their next points
potential_polygons = []
for polygon in polygons:
    for x in range(len(polygon)):
        #one direction
        try:
            if polygon[x] == lower_point and polygon[x+1] == higher_point:
                potential_polygons.append([polygon, polygon[x+2]])
        except:
            try:
                if polygon[x] == lower_point and polygon[x+1] == higher_point:
                    potential_polygons.append([polygon, polygon[0]])
            except:
                if polygon[x] == lower_point and polygon[0] == higher_point:
                    potential_polygons.append([polygon, polygon[1]])
        #other direction
        try:
            if polygon[x] == lower_point and polygon[x-1] == higher_point:
                potential_polygons.append([polygon, polygon[x-2]])
        except:
            try:
                if polygon[x] == lower_point and polygon[x-1] == higher_point:
                    potential_polygons.append([polygon, polygon[len(polygon)-1]])
            except:
                if polygon[x] == lower_point and polygon[len(polygon)-1] ==
higher_point:
                    potential_polygons.append([polygon, polygon[len(polygon)-2]])

#Matrix rotation algorithm to check if it's left or right
rotating_point = [click[0] - best_closest_x, click[1] - best_closest_y]
angle = math.pi/2 - math.atan(best_line_gradient)
if angle > math.pi/2:
    angle = angle - math.pi
new_point = [math.cos(angle) * rotating_point[0] - math.sin(angle) *
rotating_point[1], math.sin(angle) * rotating_point[0] + math.cos(angle) *
rotating_point[0]]
if new_point[0] > 0:
    right = True
else:
    right = False

# matrix thing again to see which side is the correct one. Finds the next point
attached to highest point on line and sees which is
for potential_polygon in potential_polygons:
    next_point = potential_polygon[1]

```

```

gradient = (coordinates[next_point][1] -
coordinates[higher_point][1]) / (coordinates[next_point][0] -
coordinates[higher_point][0])
matrix_thing = math.cos(angle) * (coordinates[next_point][0]-
coordinates[higher_point][0]) - math.sin(angle) * (coordinates[next_point][1] -
coordinates[higher_point][1])
if right == (matrix_thing > 0):
    for x in range(len(polygons)):
        if polygons[x] == potential_polygon[0]:
            return x

return 'false'

def Click(event):
    x = WhichArea([event.x,event.y],map.coordinates,map.territory_polygons)
    if x != 'false':

        # DEPLOY: add troops to player's territories
        if game.phase == 0 and map.player_in_territory[x] == game.player_turn and
game.troops_to_add != 0:
            map.troops_in_territory[x] += 1
            game.troops_to_add -= 1
            L_TroopsToDeploy.configure(text='Troops to deploy: ' +
str(game.troops_to_add))

        if game.troops_to_add == 0:
            L_TroopsToDeploy.place_forget()
            game.next_action = 'pick fight'

        # ATTACK: choose territory to attack
        if game.phase == 1 and game.next_action == 'pick fight':
            if map.player_in_territory[x] == game.player_turn:
                game.attacking = x
                L_Attacking.config(text = 'Attacking: ' + map.territory_names[x])
                #delete defending incase its invalid
                game.defending = -1
                L_Defending.config(text = 'Defending: ')

            else:
                if game.attacking != -1:
                    #checks if other territory is someone elses and connected to
attacking. May fail if attacking hasnt been chosen
                    if (map.player_in_territory[x] != game.player_turn) and
(map.connections[x][game.attacking] == 1):
                        game.defending = x
                        L_Defending.config(text = 'Defending: ' +
map.territory_names[x])

                if game.attacking != -1:
                    Li_Dice.delete(0,END)
                    for i in range(min(map.troops_in_territory[game.attacking]-1,3)):
                        Li_Dice.insert(i, i+1)

        # FORTIFY: choose territory to give troops
        elif game.phase == 2:
            #same idea as attacking and defending actually.

            #need a way to deselect since all of them are one player's
            if game.sending_troops == x:
                game.sending_troops = -1
                L_SendingTroops.configure(text = 'Sending troops: ')
                #Delete receiving incase invalid

```

```

game.receiving_troops = -1
L_ReceivingTroops.config(text = 'Receiving troops: ')

#This must go before the sending troops one so it doesn't just always jump
off sending one
elif game.sending_troops != -1:
    #checks if other territory is theres, and connected to sending
territory
    connected = ConnectedTerritories(game.sending_troops,x)
    if (map.player_in_territory[x] == game.player_turn) and connected ==
True:
        game.receiving_troops = x
        L_ReceivingTroops.config(text = 'Receiving troops: ' +
map.territory_names[x])
        for i in range(map.troops_in_territory[game.sending_troops]-1):
            Li_MoveTroops.insert(i,i+1)

elif map.player_in_territory[x] == game.player_turn:
    game.sending_troops = x
    L_SendingTroops.config(text = 'Sending troops: ' +
map.territory_names[x])
    #delete recieving incase its invalid
    game.receiving_troops = -1
    L_ReceivingTroops.config(text = 'Receiving troops: ')

map.DisplayMap()

#####
#####

def MergeSort(unsorted):
    lists = []
    for item in unsorted:
        lists.append([item])
def Merge(a,b,c):
    if a == [] and b == []:
        return c
    elif a == []:
        c.append(b.pop(0))
        return Merge(a,b,c)
    elif b == []:
        c.append(a.pop(0))
        return Merge(a,b,c)
    else:
        if a[0] > b[0]:
            c.append(a.pop(0))
            return Merge(a,b,c)
        else:
            c.append(b.pop(0))
            return Merge(a,b,c)

length = len(lists)
while length > 1:
    new_lists = []
    for x in range(length//2):
        new_lists.append(Merge(lists[2*x],lists[2*x+1],[]))
    #add extra list thats not a pair
    if length%2 == 1:
        new_lists.append(lists[length-1])

    lists = new_lists
    length = len(lists)

```

```
return lists[0]

def RollDice():
    if game.attacking == -1 or game.defending == -1:
        return False
    try:
        num_attacking_dice = Li_Dice.get(Li_Dice.curselection())
    except:
        return False
    num_defending_dice = min(map.troops_in_territory[game.defending], 2)

    #ROLL
    attacking_dice = []
    attacking_dice_text = ''
    for x in range(num_attacking_dice):
        num = randrange(1,7)
        attacking_dice.append(num)
        attacking_dice_text += str(num) + ' '
    attacking_dice = MergeSort(attacking_dice)

    defending_dice = []
    defending_dice_text = ''
    for x in range(num_defending_dice):
        num = randrange(1,7)
        defending_dice.append(num)
        defending_dice_text += str(num) + ' '
    defending_dice = MergeSort(defending_dice)

    L_DiceRolled.configure(text=attacking_dice_text + 'VS ' + defending_dice_text)
    L_DiceRolled.place(x=1040, y=380)

    #Calculates number of troops each player lost based on the dice rolled
    troops_lost = [0,0]
    for x in range(min(num_attacking_dice, num_defending_dice)):
        if attacking_dice[x] > defending_dice[x]:
            troops_lost[1] += 1
        else:
            troops_lost[0] += 1

    #take away troops lost in battle from the player totals and the territory amounts
    players[map.player_in_territory[game.attacking]].num_troops -= troops_lost[0]
    players[map.player_in_territory[game.defending]].num_troops -= troops_lost[1]
    map.troops_in_territory[game.attacking] -= troops_lost[0]
    map.troops_in_territory[game.defending] -= troops_lost[1]

    map.DisplayMap()

    #changes listbox IF attacking troops were lost and the troops in territory are 3
    #and below. This is when it is needing to change
    #i got rid of troops_lost[0] != 0 and map.troops_in_territory[game.attacking] < 4
    if num_attacking_dice > map.troops_in_territory[game.attacking]-1:
        Li_Dice.delete(0,END)
        for i in range(min(map.troops_in_territory[game.attacking]-1,3)):
            Li_Dice.insert(i, i+1)

    #if the battle is won
    if map.troops_in_territory[game.defending] == 0:
        #change colours and numbers
        dead_player = map.player_in_territory[game.defending]
        map.player_in_territory[game.defending] =
        map.player_in_territory[game.attacking]
        map.troops_in_territory[game.defending] = ''
```

```

#recieve card
game.card_recieved = True

win = CheckDead(dead_player)
if win == True:
    Win()

#Moving troops widgets
map.DisplayMap()
Li_MoveTroops.place(x=1040,y=310)
B_MoveTroops.place(x=1040,y=340)

#Add options for moving troops
Li_MoveTroops.delete(0,END)
for i in range(num_attacking_dice, map.troops_in_territory[game.attacking]):
    Li_MoveTroops.insert(i-1,i)

game.next_action = 'move troops'

#####
#####

def MoveTroops():
    try:
        num_troops_moving = Li_MoveTroops.get(Li_MoveTroops.curselection())
    except:
        return False

    if game.phase == 1:
        map.troops_in_territory[game.attacking] -= num_troops_moving
        map.troops_in_territory[game.defending] = num_troops_moving
        game.next_action = 'pick fight'

    elif game.phase == 2:
        map.troops_in_territory[game.sending_troops] -= num_troops_moving
        map.troops_in_territory[game.receiving_troops] += num_troops_moving

    #reset variables
    game.TurnReset()
    Li_MoveTroops.place_forget()
    B_MoveTroops.place_forget()

    map.DisplayMap()

def ConnectedTerritories(start,goal):
    #This implements a Breadth First Search, using a Queue data structure to check if
    there is a path between 2 territories
    visited = [start]
    queue = [start]
    while len(queue) != 0:
        parent = queue[0]
        for x in range(len(map.connections[parent])):
            if (map.connections[parent][x] == 1) and (x not in visited) and
            (map.player_in_territory[parent] == map.player_in_territory[x]):
                visited.append(x)
                queue.append(x)
            if x == goal:
                return True
        queue.pop(0)
    return False

def CalculateExtraTroops():
    temp = 0

```

## RISK

Candidate Number: 1318

Candidate Name: Alexander Mulcahy

```
for player_in_territory in map.player_in_territory:
    if player_in_territory == game.player_turn:
        temp += 1
territory_troops = max(temp,3) #this is usually //3 but there aren't enough
territories for this (or could be players[game.player_turn].num_troops//3)

#Region bonuses
for x in range(len(map.region_bonuses)):
    got_bonus = True
    for y in range(len(map.territory_regions)):
        if map.territory_regions[y] == x:
            #If player doesn't have one of the territories in bonus, they don't
get it
            if map.player_in_territory[y] != game.player_turn:
                got_bonus = False
    if got_bonus == True:
        territory_troops.append(map.region_bonuses[x])

cards = players[game.player_turn].cards
#ONE OF EACH CARDS
if cards[0] > 0 and cards[1] > 0 and cards[2] > 0:
    territory_troops += 10
    cards[0] -= 1
    cards[1] -= 1
    cards[2] -= 1
#THREE OF THE SAME CARD
elif cards[2] >= 3:
    cards[2] -= 3
    territory_troops += 8
elif cards[1] >= 3:
    cards[1] -= 3
    territory_troops += 6
elif cards[0] >= 3:
    cards[0] -= 3
    territory_troops += 4

return territory_troops

def CheckDead(player_num):
    own_territory = False
    for x in range(len(map.territory_names)):
        if map.player_in_territory[x] == player_num:
            own_territory = True

    #Player is out
    if own_territory == False:
        game.player_queue.remove(player_num)
        #Everyone is out
        if game.player_queue == []:
            return True

    #take cards from dead player
    for x in range(3):
        players[game.player_turn].cards[x] += players[player_num].cards[x]

return False

def NextPhase():
    if game.next_action != 'move troops' and game.next_action != 'quit' and
game.troops_to_add == 0:
```

```

#DEPLOY --> ATTACK
if game.phase == 0:
    game.phase = 1

#HIDE/SHOW WIDGETS
game.attacking = -1
game.defending = -1
L_Attacking.configure(text='Attacking: ')
L_Defending.configure(text='Defending: ')
L_Attacking.place(x=1040,y=250)
L_Defending.place(x=1040,y=280)
Li_Dice.place(x=1040,y=310)
B_Roll.place(x=1040,y=340)
L_DiceRolled.place(x=1040,y=380)
B_Next_Phase.configure(text='Finish Attack')

#ATTACK --> FORTIFY
elif game.phase == 1:
    if game.card_recieved == True:
        game.ReceiveCard()
    game.phase = 2

#HIDE/SHOW WIDGETS
L_Attacking.place_forget()
L_Defending.place_forget()
Li_Dice.place_forget()
B_Roll.place_forget()
B_Next_Phase.configure(text='Finish Turn')

L_SendingTroops.place(x=1040,y=250)
L_ReceivingTroops.place(x=1040,y=280)
Li_MoveTroops.delete(0,END)
Li_MoveTroops.place(x=1040,y=310)
B_MoveTroops.place(x=1040,y=340)

#FORTIFY --> NEXT TURN DEPLOY
elif game.phase == 2:
    game.phase = 0
    game.next_action = 'move troops'
    #next player's turn using a queue structure
    game.player_queue.append(game.player_turn)

    game.player_turn = game.player_queue[0]
    game.player_queue.pop(0)
    cards = players[game.player_turn].cards
    L_PlayerTurn.configure(text='Player turn: ' +
info.players[game.player_turn] + ' (' + str(cards[0]) + ',' + str(cards[1]) + ',' +
str(cards[2]) + ')',background=info.colours[game.player_turn],foreground = 'white')

    #reset variables just in case
    game.TurnReset()
    Autosave()

#HIDE/SHOW WIDGETS
L_SendingTroops.place_forget()
L_ReceivingTroops.place_forget()
Li_MoveTroops.place_forget()
B_MoveTroops.place_forget()
B_Next_Phase.configure(text='Start Attack')

L_TroopsToDeploy.place(x=1040,y=250)
game.troops_to_add = CalculateExtraTroops()

```

**RISK**

Candidate Number: 1318

Candidate Name: Alexander Mulcahy

```
L_TroopsToDeploy.configure(text='Troops to deploy: ' +
str(game.troops_to_add))

L_Stage.configure(text=game.stages[game.phase])
L_DiceRolled.place_forget()
L_Help.place_forget()
map.DisplayMap()

def QuitGame():
    db_path = "./DataBase/ProjectDb.db"
    connection = sqlite3.connect(db_path)
    db_cursor = connection.cursor()

    sql = 'DELETE FROM CurrentGame WHERE UserID = ?'
    db_cursor.execute(sql, (info.userID,))

    connection.commit()
    connection.close()
    window.destroy()
    info.next_page = 'MenuPage'

    game.data = None

def Help():
    L_Help.place(x=200, y=800)
    if game.phase == 0:
        L_Help.configure(text='click your territories that you want to give more troops
to')
    elif game.phase == 1:
        L_Help.configure(text='choose a territory to attack. Must be adjacent to one of
your territories')
    elif game.phase == 2:
        L_Help.configure(text='move troops from one territory to another. Must be
connected through your territories')

def Win():
    game.next_action='Quit'
    L_PlayerTurn.configure(text=info.players[game.player_turn] + ' wins!')

    db_path = "./DataBase/ProjectDb.db"
    connection = sqlite3.connect(db_path)
    db_cursor = connection.cursor()

    sql = 'SELECT Games, Wins FROM Users WHERE UserID = ?'
    db_cursor.execute(sql, (info.userID,))
    games, wins = db_cursor.fetchall()[0]

    sql = 'UPDATE Users SET Games = ?, Wins = ?'
    db_cursor.execute(sql, (games+1,wins+1))

    connection.commit()
    connection.close()

def ListToString(list):
    temp_string = ''
    for x in list:
        temp_string += str(x) + '/'
    temp_string
    return temp_string[:-1]

def Close():
    #combine player cards into one array
```

```
cards = []
for i in range(len(players)):
    cards.append(players[i].cards)

#Connect to the database in order to save the current game data.
db_path = "./DataBase/ProjectDb.db"
connection = sqlite3.connect(db_path)
db_cursor = connection.cursor()

sql = 'DELETE FROM CurrentGame WHERE UserID = ?'
db_cursor.execute(sql,(info.userID,))

sql = 'INSERT INTO
CurrentGame(UserID,MapID,Players,Colours,Bot,PlayerTurn,PlayerQueue,PlayerInTerritory,T
roopsInTerritory,Cards) VALUES (?,?,?,?,?,?,?,?,?,?)'
data =
(info.userID,info.mapID,ListToString(info.players),ListToString(info.colours),ListToStr
ing(info.bot),game.player_turn,ListToString(game.player_queue),ListToString(map.player_
in_territory),ListToString(map.troops_in_territory),ListToString(cards))
db_cursor.execute(sql,data)

connection.commit()
connection.close()

info.next_page = 'Close'
window.destroy()

def Autosave():
    #combine player cards into one array
    cards = []
    for i in range(len(players)):
        cards.append(players[i].cards)

    #Connect to the database in order to save the current game data.
    db_path = "./DataBase/ProjectDb.db"
    connection = sqlite3.connect(db_path)
    db_cursor = connection.cursor()

    sql = 'DELETE FROM CurrentGame WHERE UserID = ?'
    db_cursor.execute(sql,(info.userID,))

    sql = 'INSERT INTO
CurrentGame(UserID,MapID,Players,Colours,Bot,PlayerTurn,PlayerQueue,PlayerInTerritory,T
roopsInTerritory,Cards) VALUES (?,?,?,?,?,?,?,?,?,?)'
    data =
(info.userID,info.mapID,ListToString(info.players),ListToString(info.colours),ListToStr
ing(info.bot),game.player_turn,ListToString(game.player_queue),ListToString(map.player_
in_territory),ListToString(map.troops_in_territory),ListToString(cards))
    db_cursor.execute(sql,data)

    connection.commit()
    connection.close()

#####
######
#START OF THE GAME
map = Map(map_data)

#Was there a current game for this user? If not, start the game by randomly assigning
territories and troops
if info.saved_game_data == None:
    players = []
    for x in range(len(info.players)):
```

```

players.append(Player(x,info.players[x],info.colours[x],0))
game.player_queue.append(x)

num_players = len(players)
game.player_queue.pop(0)
map.Deal()

starting_troops = 12//len(players)
for i in range(len(players)):
    players[i].num_troops = starting_troops
    x = starting_troops
    while x > 0:
        num = randrange(0,len(map.territory_names))
        if map.player_in_territory[num] == players[i].player_num:
            map.troops_in_territory[num] += 1
        x -= 1

#If so, import the saved data into the game
else:
    game_data = list(info.saved_game_data)
    #get rid of the /
    for x in range(len(game_data)):
        if type(game_data[x]) is int:
            pass
        elif '/' in game_data[x]:
            if '[' in game_data[x]:
                game_data[x] = game_data[x].split('/')
                #split up brackets
                for y in range(len(game_data[x])):
                    game_data[x][y] = game_data[x][y][1:-1].split(', ')
                    #make them integers
                    for z in range(len(game_data[x][y])):
                        game_data[x][y][z] = int(game_data[x][y][z])
            else:
                game_data[x] = game_data[x].split('/')

    #changing region bonuses and territory regions into integers
    if x == 6 or x == 7 or x == 8:
        game_data[x] = list(game_data[x])
        for y in range(len(game_data[x])):
            game_data[x][y] = int(game_data[x][y])

players = []
for x in range(len(game_data[2])):
    #add up total troops that a player has
    num_troops = 0
    for y in range(len(game_data[7])):
        if x == game_data[7][y]:
            num_troops += game_data[8][y]
    players.append(Player(x,game_data[2][x],game_data[3][x],num_troops))

game.player_turn = game_data[5]
game.player_queue = game_data[6]
map.player_in_territory = game_data[7]
map.troops_in_territory = game_data[8]
info.colours = game_data[3]
info.players = game_data[2]

#split up the cards
for i in range(len(game_data[9])):
    players[i].cards = game_data[9][i]

#also do something in Map instantiate bit because the troops will reset to 0
otherwise.

```

```
#First turn
game.troops_to_add = CalculateExtraTroops()

#####
##### window = Tk()
##### window.title('RISK')
##### window.geometry('1000x500')

#Start up fullscreen
screen_width= window.winfo_screenwidth()
screen_height= window.winfo_screenheight()
window.geometry("%dx%d" % (screen_width, screen_height))
window.wm_attributes('-fullscreen', 'true')

background = Canvas(window,width=screen_width,height=screen_height)
background.place(x=0,y=0)

img = ImageTk.PhotoImage(Image.open('GreyBackground.jpeg'))
background.create_image(0,0,image=img,anchor='nw')

background.create_text(1125,100, text='RISK', font = 'Ayuthaya 120 bold', fill ='#9A1111')

canvas = Canvas(window, width=700, height=700, background="#777777")
canvas.place(x=100,y=75)
map.DisplayMap()

### BUTTONS ###
L.Stage = Label(window,text=game.stages[game.phase], font = 'Helvetica 20 bold',
background='black', foreground = 'white')
L.Stage.place(x=1030,y=200)
L.PlayerTurn = Label(window,text='Player turn: ' + str(game.player_turn + 1) + ' '
(0,0,0)', font = 'Helevtica 20
bold',background=info.colours[game.player_turn],foreground='white')
L.PlayerTurn.place(x=400,y=30)

B.Quit = Button(window, text='Quit Game',foreground='#9A1111', font = 'Helvetica 20
bold', highlightbackground='#444444', borderwidth=0, command=QuitGame)
B.Quit.place(x=900,y=650)
B.Help = Button(window, text='Help',background='white', font = 'Helvetica 20 bold',
highlightbackground='#444444', borderwidth=0, command= Help)
B.Help.place(x=900,y=700)
L.Help = Label(window,text='', font = 'Helvetica 20 bold', background='black',
foreground = 'white')

#Close program
B.Close = Button(window, text = 'X', font = 'Arial 30 bold', foreground='#9A1111',
background = 'black',command=Close)
B.Close.place(x=0,y=0)

#DEPLOY
L.TroopsToDeploy = Label(window,text='Troops to deploy: ' +
str(game.troops_to_add),font = 'Helvetica 15 bold')
L.TroopsToDeploy.place(x=1040,y=250)

#ATTACK
L.Attacking = Label(window,text='Attacking: ', font = 'Helvetica 15 bold',
background='black', foreground = 'white')
L.Defending = Label(window,text='Defending: ', font = 'Helvetica 15 bold',
background='black', foreground = 'white')

Li.Dice = Listbox(window,height=1)
```

**RISK**

Candidate Number: 1318

Candidate Name: Alexander Mulcahy

```
B_Roll = Button(window, text='ROLL', background='white', font = 'Helvetica 15 bold', activebackground='#444444', borderwidth=0, command=RollDice)
L_DiceRolled = Label(window, text='', font = 'Helvetica 20 bold', background='black', foreground = 'white')

Li_MoveTroops = Listbox(window, height=1)
B_MoveTroops = Button(window, text='Move troops', font = 'Helvetica 15 bold', highlightbackground='#444444', borderwidth=0, command=MoveTroops)

B_Next_Phase = Button(window, text='Start Attack', font = 'Helvetica 20 bold', highlightbackground='#444444', borderwidth=0, command=NextPhase)
B_Next_Phase.place(x=1040, y=450)

#FORTIFY
L_SendingTroops = Label(window, text='Sending troops: ', font = 'Helvetica 15 bold')
L_ReceivingTroops = Label(window, text='Receiving troops: ', font = 'Helvetica 15 bold')
    #using Li_MoveTroops and B_MoveTroops

canvas.bind("<Button 1>", Click)
window.update_idletasks
window.update
window.mainloop()
```

## MODULE 5: SETUP PAGE

```
colours = ['orange', 'blue', 'red', 'green', 'pink', 'purple', 'yellow', 'brown']
info.player_text = ['NAME', 'COLOUR', 'BOT?']

#####
def Back():
    window.destroy()
    info.next_page = 'MenuPage'

def Start():
    try:
        map_name = Li_Maps.get(Li_Maps.curselection())
    except:
        return False

    db_path = "./DataBase/ProjectDb.db"
    connection = sqlite3.connect(db_path)
    db_cursor = connection.cursor()

    sql = 'SELECT MapID, Polygons FROM Maps WHERE Name = ?'

    db_cursor.execute(sql, [map_name])
    data = db_cursor.fetchone()
    info.mapID = data[0]
    num_territories = data[1].count('/') + 1

    connection.commit()
    connection.close()

    if len(info.players) < 2 or len(info.players) > num_territories:
        return False

    if 'computer' in info.bot:
        return False

    info.next_page = 'Gameplay'
    window.destroy()
```

```

def AddPlayer():
    try:
        name = E_PlayerName.get()
        colour = Li_Colours.get(Li_Colours.curselection())
        bot = Li_Bot.get(Li_Bot.curselection())
    except:
        return False

    if name == '' or name in info.players or colour in info.colours or bot == 'Computer':
        return False

    info.players.append(name)
    info.colours.append(colour)
    info.bot.append(bot)

    colours.remove(colour)
    Li_Colours.delete(0,END)
    for x in colours:
        Li_Colours.insert(END, x)

    info.player_text[0] += '\n'
    for x in range(min(len(name),10)):
        info.player_text[0] += name[x]
    info.player_text[1] += '\n' + colour
    info.player_text[2] += '\n' + bot

    L_Players.configure(text=info.player_text[0])
    L_Colours.configure(text=info.player_text[1])
    L_Bot.configure(text=info.player_text[2])

def RemovePlayer():
    if len(info.players) == 0:
        return False

    info.players.pop()
    colour = info.colours.pop()
    info.bot.pop()

    L_Players.configure(text=info.player_text[0])
    L_Colours.configure(text=info.player_text[1])
    L_Bot.configure(text=info.player_text[2])

    colours.append(colour)
    Li_Colours.insert(END, colour)

def Close():
    info.next_page = 'Close'
    window.destroy()

#####
#Get Map Names

db_path = "./DataBase/ProjectDb.db"
connection = sqlite3.connect(db_path)
db_cursor = connection.cursor()

sql = 'SELECT Name FROM Maps'

db_cursor.execute(sql)
map_names = db_cursor.fetchall()

```

```
connection.commit()
connection.close()

#####
def Import():
    info.players = ['Player1','Player2','Player3']
    info.colours = ['red','green','blue','yellow']
    info.bot = ['Human', 'Human', 'Human', 'Human']
    info.mapID = 3

window = Tk()
window.title('Setup')

#Start up fullscreen
screen_width= window.winfo_screenwidth()
screen_height= window.winfo_screenheight()
window.geometry("%dx%d" % (screen_width, screen_height))
window.wm_attributes('-fullscreen', 'true')

img = ImageTk.PhotoImage(Image.open('GreyBackground.jpeg'))

canvas = Canvas(window, width=screen_width, height=screen_height)
canvas.place(x=-1,y=-1)

canvas.create_image(0,0,image=img,anchor='nw')

canvas.create_text(300,150, text='Setup', font = 'Ayuthaya 150 bold',fill ='#9A1111')

#Proceed and Back
B_Start = Button(window, text = 'START', font = 'Helvetica 20 bold', foreground =
 '#9A1111', highlightbackground='#444444',borderwidth=0,command=Start)
B_Start.place(x=1200,y=700)

B_Back = Button(window, text = 'BACK', font = 'Helvetica 20 bold', foreground =
 '#9A1111', highlightbackground='#444444',borderwidth=0, command=Back)
B_Back.place(x=100,y=700)

#Choose Map
canvas.create_text(900,162, text='CHOOSE MAP', font = 'Ayuthaya 30 bold',fill ='white')

Li_Maps = Listbox(window, height = 1)
for x in map_names:
    Li_Maps.insert(END, x[0])
Li_Maps.place(x=1050,y=150)

#Add Players
B_AddPlayer = Button(window, text = 'ADD PLAYER', font = 'Helvetica 20 bold',
foreground = 'black', highlightbackground='#444444',borderwidth=0, command>AddPlayer)
B_AddPlayer.place(x=1000,y=500)

B_RemovePlayer = Button(window, text = 'REMOVE PLAYER', font = 'Helvetica 20 bold',
foreground = 'black', highlightbackground='#444444',borderwidth=0, command=RemovePlayer)
B_RemovePlayer.place(x=1000,y=550)

E_PlayerName = Entry(window)
E_PlayerName.place(x=1000,y=300)

Li_Colours = Listbox(window,exportselection=False, height=1)
for x in colours:
    Li_Colours.insert(END, x)
Li_Colours.place(x=1000,y=350)

Li_Bot = Listbox(window,exportselection=False, height=1)
```

```
Li_Bot.insert(END, 'Human')
Li_Bot.insert(END, 'Computer')
Li_Bot.place(x=1000,y=400)

L_Players = Label(window, text=info.player_text[0], font= 'TkFixedFont 20 bold',
foreground='white',background='#222222')
L_Players.place(x=100,y=300)
L_Colours = Label(window, text=info.player_text[1], font= 'TkFixedFont 20 bold',
foreground='white',background='#222222')
L_Colours.place(x=200,y=300)
L_Bot = Label(window, text=info.player_text[2], font= 'TkFixedFont 20 bold',
foreground='white',background='#222222')
L_Bot.place(x=300,y=300)

B_import = Button(text='import',command=Import)
#B_import.place(x=100,y=10)

#Close program
B_Close = Button(window, text = 'X', font = 'Arial 30 bold', foreground='#9A1111',
background = 'black',command=Close)
B_Close.place(x=0,y=0)

window.mainloop()
```

## SQL TABLES

# Tables (4)

Name	Type	Schema
<b>CurrentGame</b>		<pre>CREATE TABLE "CurrentGame" (     "UserID" INTEGER, "MapID" INTEGER, "Players" TEXT,     "Colours" TEXT, "Bot" TEXT, "PlayerTurn" INTEGER,     "PlayerQueue" TEXT, "PlayerInTerritory" TEXT,     "TroopsInTerritory" TEXT, "Cards" TEXT, FOREIGN     KEY("MapID") REFERENCES     "Maps"("MapID"), FOREIGN     KEY("UserID") REFERENCES     "Users"("UserID") )</pre>
UserID	INTEGER	"UserID" INTEGER
MapID	INTEGER	"MapID" INTEGER
Players	TEXT	"Players" TEXT
Colours	TEXT	"Colours" TEXT
Bot	TEXT	"Bot" TEXT
PlayerTurn	INTEGER	"PlayerTurn" INTEGER
PlayerQueue	TEXT	"PlayerQueue" TEXT
PlayerInTerritory	TEXT	"PlayerInTerritory" TEXT
TroopsInTerritory	TEXT	"TroopsInTerritory" TEXT
Cards	TEXT	"Cards" TEXT
<b>Maps</b>		<pre>CREATE TABLE "Maps" ( "MapID"     INTEGER, "Name" TEXT,     "TerritoryNames" TEXT,     "Polygons" TEXT, "Coordinates"     TEXT, "RegionNames" TEXT,     "RegionBonuses" TEXT,     "TerritoryRegions" TEXT,     "LabelCoordinates" TEXT,     "Connections" TEXT, PRIMARY     KEY("MapID" AUTOINCREMENT) )</pre>
MapID	INTEGER	"MapID" INTEGER
Name	TEXT	"Name" TEXT

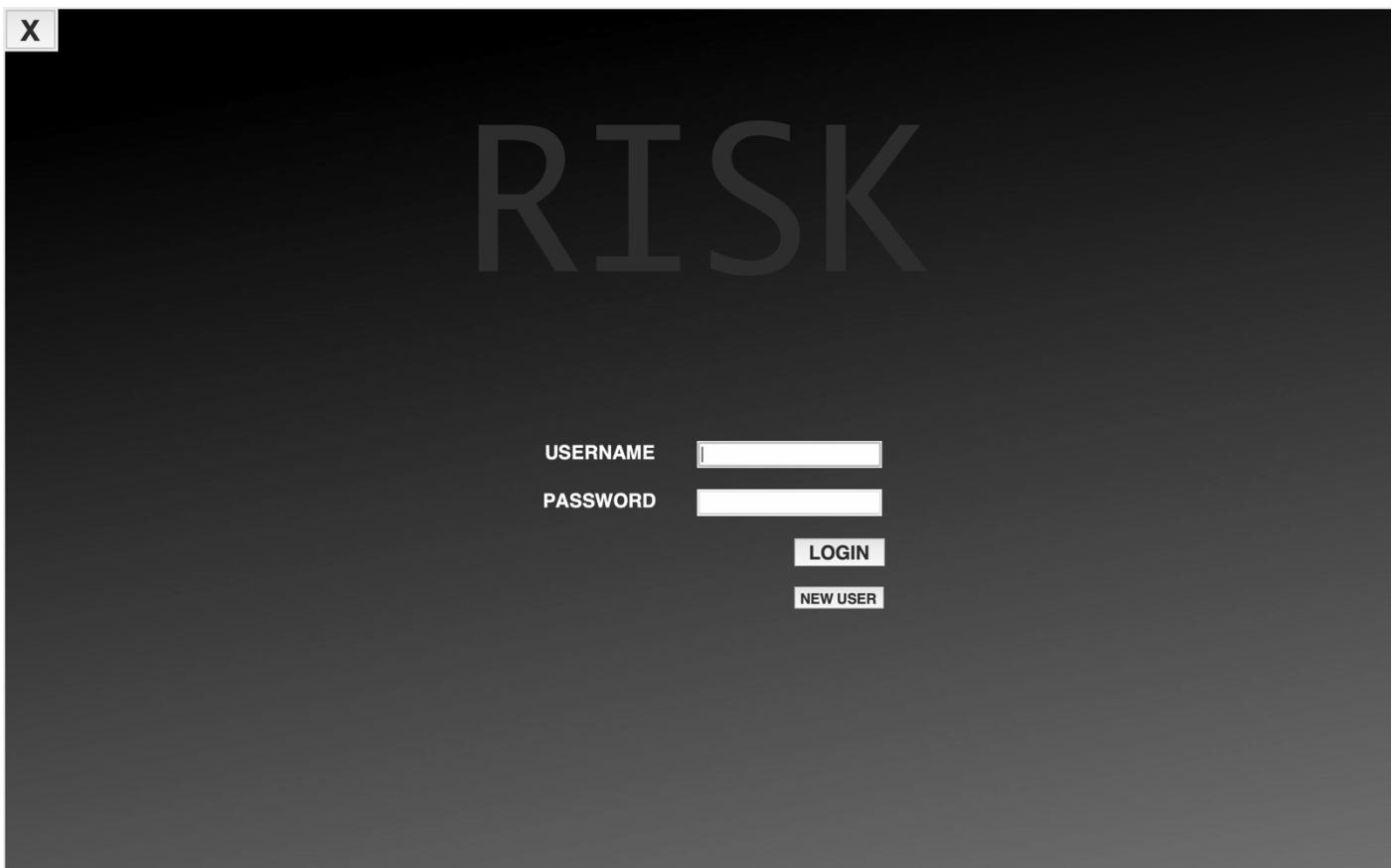
Name	Type	Schema
TerritoryNames	TEXT	"TerritoryNames" TEXT
Polygons	TEXT	"Polygons" TEXT
Coordinates	TEXT	"Coordinates" TEXT
RegionNames	TEXT	"RegionNames" TEXT
RegionBonuses	TEXT	"RegionBonuses" TEXT
TerritoryRegions	TEXT	"TerritoryRegions" TEXT
LabelCoordinates	TEXT	"LabelCoordinates" TEXT
Connections	TEXT	"Connections" TEXT
<b>Users</b>		CREATE TABLE "Users" ( "UserID" INTEGER, "Username" TEXT, "Password" INTEGER, "Games" INTEGER, "Wins" INTEGER, "Losses" INTEGER, PRIMARY KEY("UserID" AUTOINCREMENT) )
UserID	INTEGER	"UserID" INTEGER
Username	TEXT	"Username" TEXT
Password	INTEGER	"Password" INTEGER
Games	INTEGER	"Games" INTEGER
Wins	INTEGER	"Wins" INTEGER
Losses	INTEGER	"Losses" INTEGER
<b>sqlite_sequence</b>		CREATE TABLE sqlite_sequence(name,seq)
name		"name"
seq		"seq"

## Indices (0)

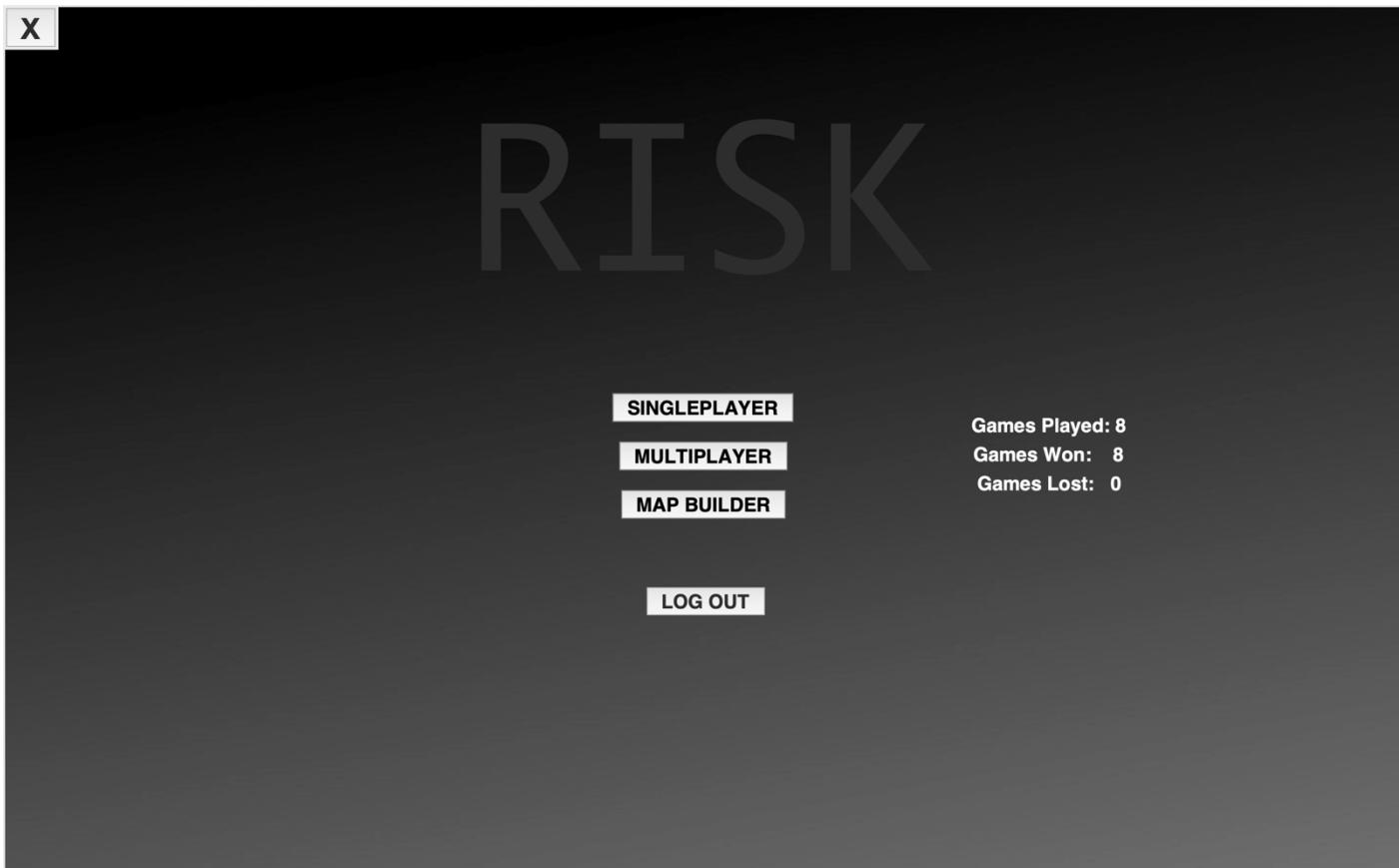
Name	Type	Schema

## Views (0)

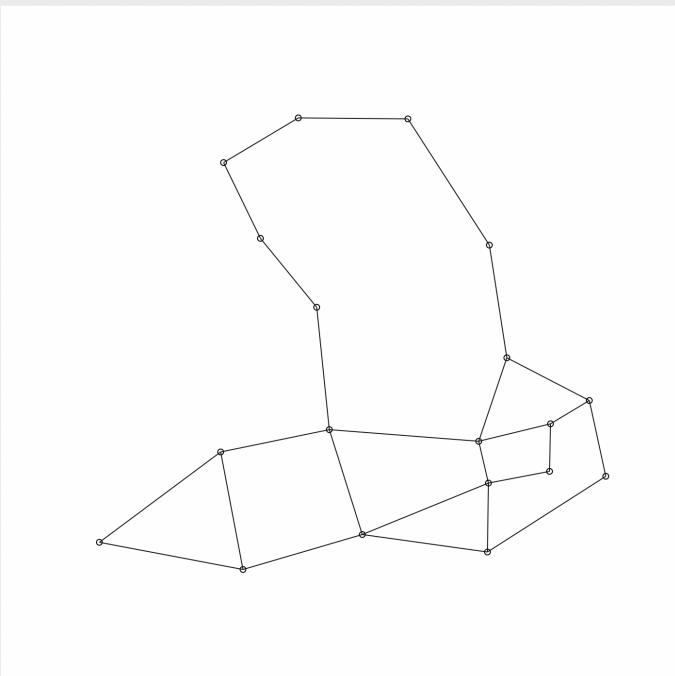
Name	Type	Schema

Additional Screenshots of program

Login Page



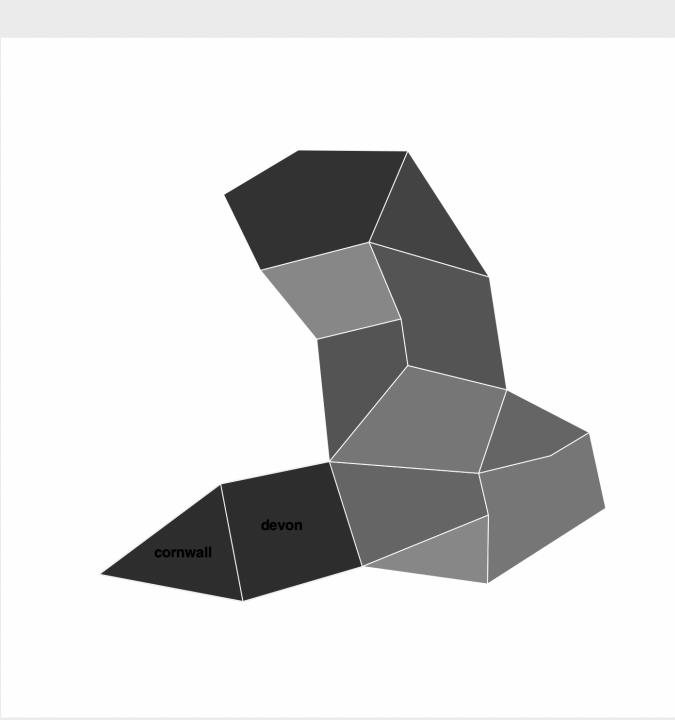
Menu Page

**X**

## Map Builder

**UNDO****FINISH DRAWING****BACK**

Map Builder during line drawing.

**X**

## Map Builder

**Territory** **Region** **Add Region****SUBMIT****ClickOnTerritory****BACK****FINISH**

Map Builder during territory naming.

# Setup

CHOOSE MAP

Original

NAME	COLOUR	BOT?
player1	orange	Human
player2	blue	Human
player3	red	Human
player4	yellow	Human

player5

pink

Human

ADD PLAYER

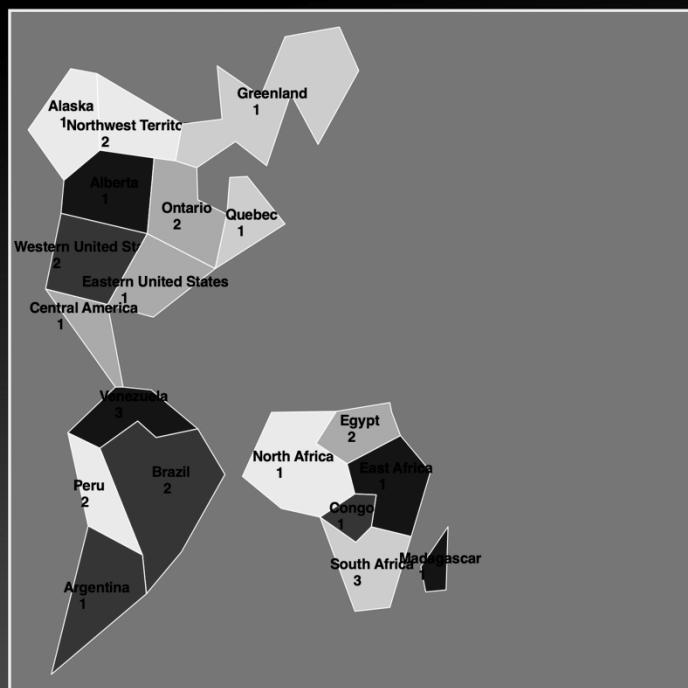
REMOVE PLAYER

BACK

START

Setup page with new colours.

Player turn: 1 (0,0,0)



# RISK

STAGE: DEPLOY

Troops to deploy: 4

Start Attack

Quit Game

Help

Gameplay page with new colours on a new smaller version of the original map.