RAILROADINK

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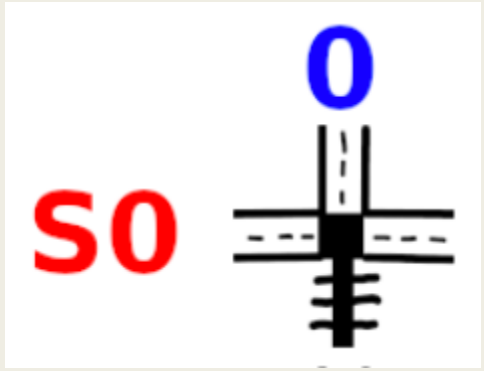
CONTEXT

Enum Tile (authored by Bojie Jia)

- Redefine the tiles with for numbers.
- The number represent the type of road on each side in a clockwise direction.
- “0” means no way.
- “1” means highway.
- “2” means railway.
- Ex: *S00(1, 1, 2, 1) means the situation of the **special tile S0** with the **orientation 0.***

  the northern, eastern and western way are highways.

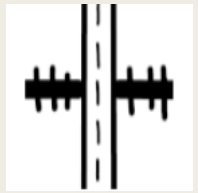
  the southern way is railway.



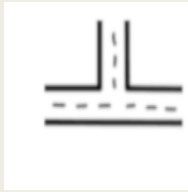
Enum Tile more examples

A10(2,0,2,0)

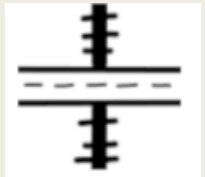
A36(1,1,1,0)



B22(1,2,1,2)



A33(1,1,0,1)



B27(2,1,2,1)

S45(2,1,1,2)

Enum Tile

partial code

```
public enum Tile {

    S00( north: 1, east: 1, south: 2, west: 1),
    S01( north: 1, east: 1, south: 1, west: 2),
    S02( north: 2, east: 1, south: 1, west: 1),
    S03( north: 1, east: 2, south: 1, west: 1),
    S04( north: 1, east: 1, south: 2, west: 1),
    S05( north: 1, east: 1, south: 1, west: 2),
    S06( north: 2, east: 1, south: 1, west: 1),
    S07( north: 1, east: 2, south: 1, west: 1),

    S10( north: 1, east: 2, south: 2, west: 2),
    S11( north: 2, east: 1, south: 2, west: 2),
    S12( north: 2, east: 2, south: 1, west: 2),
    S13( north: 2, east: 2, south: 2, west: 1),
    S14( north: 1, east: 2, south: 2, west: 2),
    S15( north: 2, east: 1, south: 2, west: 2),
    S16( north: 2, east: 2, south: 1, west: 2),
    S17( north: 2, east: 2, south: 2, west: 1),

    S20( north: 1, east: 1, south: 1, west: 1),
    S21( north: 1, east: 1, south: 1, west: 1),
    S22( north: 1, east: 1, south: 1, west: 1),
    S23( north: 1, east: 1, south: 1, west: 1),
    S24( north: 1, east: 1, south: 1, west: 1),
    S25( north: 1, east: 1, south: 1, west: 1),
    S26( north: 1, east: 1, south: 1, west: 1),
    S27( north: 1, east: 1, south: 1, west: 1),

    S30( north: 2, east: 2, south: 2, west: 2),
    S31( north: 2, east: 2, south: 2, west: 2),
    S32( north: 2, east: 2, south: 2, west: 2),
    S33( north: 2, east: 2, south: 2, west: 2),
    S34( north: 2, east: 2, south: 2, west: 2),
    S35( north: 2, east: 2, south: 2, west: 2),
    S36( north: 2, east: 2, south: 2, west: 2),
    S37( north: 2, east: 2, south: 2, west: 2),
```

isValidPlacementSequence

(authored by Bojie Jia)

Three methods used in this task

1. notCover:

    Check whether all the tiles are not coincident.

2. isExit:

    Check whether all the connections to exits are legal.

3.isNeighbor:

    Check whether the connections between adjacent tiles are legal.

isValidPlacementSequence
notCover

- *Purpose: check whether all the tiles are not coincident.*

  if they are, return true.

- *Method: 1.traversing all the tiles which the length is 5.*

  2. check if their 3rd and 4th characters are consistent, if they are, return false.

  3. if all the tiles are not coincident, return true.

```
public static boolean notCover(String boardString) {
    for (int i = 0; i < boardString.length(); i += 5) {
        for (int j = 0; j < boardString.length(); j += 5) {
            String s1 = boardString.substring(i, i + 5);
            String s2 = boardString.substring(j, j + 5);
            // trasversing all the tiles
            if (i != j && s1.charAt(2) == s2.charAt(2) && s1.charAt(3) == s2.charAt(3)) {
                return false;
            }
            //check if their 3rd and 4th characters are consistent
        }
    }
    return true;
}
```

isValidPlacementSequence
isExit

- - -	exit	-	h	-	r	-	h	-	exit
A	---	A0	A1	A2	A3	A4	A5	A6	---

- *Purpose: check whether all the connections to exits are legal, if they are, return true.*
- *Method: 1. Set a 'flag' haveExit and and initialize it to false.*

2. Seek the tiles which located at 'A1, A3, A5, B0, B6, D0, D6, F0, F6, G1, G3, G5'. Check if the tile type match the exit.

Ex: For A1, check if the northern number of tile which 3rd and 4th characters are 'A1' is '1' (According to Enum Tile).

```
for (int i = 0; i < boardString.length(); i += 5) {
    String s = boardString.substring(i, i + 5);
    String t = s.substring(0, 2) + s.charAt(4);
    Tile tile = Tile.valueOf(t);

    if (s.charAt(2) == 'A' && (s.charAt(3) == '1' || s.charAt(3) == '5')) {
        if (tile.north == 1) {
            haveExit = true;
        } else if (tile.north == 2) {
            return false;
        }
    }
```

isValidPlacementSequence
isExit

- *Method: 3. In the following 'if' statements, if the connections to exits are legal, assign true to haveExit.*
  If not, return false.

  4. return haveExit.

IMPORTANT: *If do not set haveExit as a flag, the methods would return true even if there is only one legal connections to exits and the others are illegal.*

isValidPlacementSequence
isNeighbor

- *Purpose: check whether the connections between adjacent tiles are legal.*

  if they are, return true.

- *Method: 1.traversing all the tiles in the boardString,*

  2. Seek adjacent tiles.

  3. check if the tile types in the four directions (northern, eastern, southern, western) match. If they are, return true.

  4. check if any tile have neighbour.

```
for (int i = 0; i < boardString.length(); i += 5) {
    String s = boardString.substring(i, i + 5);

    if (!connect[i] && !isExit(s)) {
        return false;
    }
}//check if any tile have neighbor
return true;
```

isValidPlacementSequence
isNeighbor one example Codes

```
for (int i = 0; i < boardString.length(); i += 5) {
    for (int j = 0; j < boardString.length(); j += 5) {
        String s1 = boardString.substring(i, i + 5);
        String s2 = boardString.substring(j, j + 5);
        String t1 = s1.substring(0, 2) + s1.charAt(4);
        String t2 = s2.substring(0, 2) + s2.charAt(4);
        Tile tile1 = Tile.valueOf(t1);
        Tile tile2 = Tile.valueOf(t2);
        char row1 = s1.charAt(2);
        char row2 = s2.charAt(2);
        char column1 = s1.charAt(3);
        char column2 = s2.charAt(3);
        if (row1 == row2 && (column1 - column2) == 1) {
            if (tile1.west != 0 && tile1.west == tile2.east) {
                connect[i] = true;
            }
            if (tile1.west != 0 && tile2.east != 0 && tile1.west != tile2.east) {
                return false;
            }
```

isValidPlacementSequence
isNeighbor

- ***IMPORTANT:*** *same as isExit, it needs a boolean array connect[] as 'flag', if not, the methods would return true even if there is only one legal connections to exits and the others are illegal.*

isValidPlacementSequence

Return true when all the three methods are true.

```
public static boolean isValidPlacementSequence(String boardString) {
    if (notCover(boardString) && isExit(boardString) && isNeighbor(boardStri
        return true;
    }
    return false;
```

generateMove

- 1. consider the number of special tile (Actually, there is no corresponding test data about special tile in T10 GenerateMoveTest)

```
for(int s=0;s<specialTile.length&&specialNUmber<3&&haveAddedSpecial;s++){
    if(!specialTile[s]){
        if (specialTile[s]) {
            continue;
        }//whether the sth bit in specialTile has been used
        char t='0';
        t += s;
        String specialType="S"+t;

        for (char c = 'A'; c < 'H'; c++) {
            for (char j = '0'; j < '7'; j++) {
                for (char l = '0'; l < '8'; l++) {
                    String tailString=specialType+c+""+j+l;

                    if (isValidPlacementSequence( boardString: boardString + tailString) && !newTilesString[i]) {
                        boardString = boardString + tailString;
                        placementSequence = placementSequence + tailString;
                        newTilesString[i] = true;//
                        specialTile[s]=true;
                        haveAddedSpecial = true;
                    }
```

generateMove

- 2.Construct models of tileString based on the diceRoll

```
//Authored by Bojie and Harriet
public static String generateMove(String boardString, String diceRoll) {
    String tileString1 = diceRoll.toCharArray()[0] + "" + diceRoll.toCharArray()[1] + "A0" + "0";
    String tileString2 = diceRoll.toCharArray()[2] + "" + diceRoll.toCharArray()[3] + "A0" + "0";
    String tileString3 = diceRoll.toCharArray()[4] + "" + diceRoll.toCharArray()[5] + "A0" + "0";
    String tileString4 = diceRoll.toCharArray()[6] + "" + diceRoll.toCharArray()[7] + "A0" + "0";

    String placementSequence = "";

    String[] tileStringArray = {tileString1, tileString2, tileString3, tileString4};
```

generateMove

- 3.Find the available place for new tileString and reconstruct them.

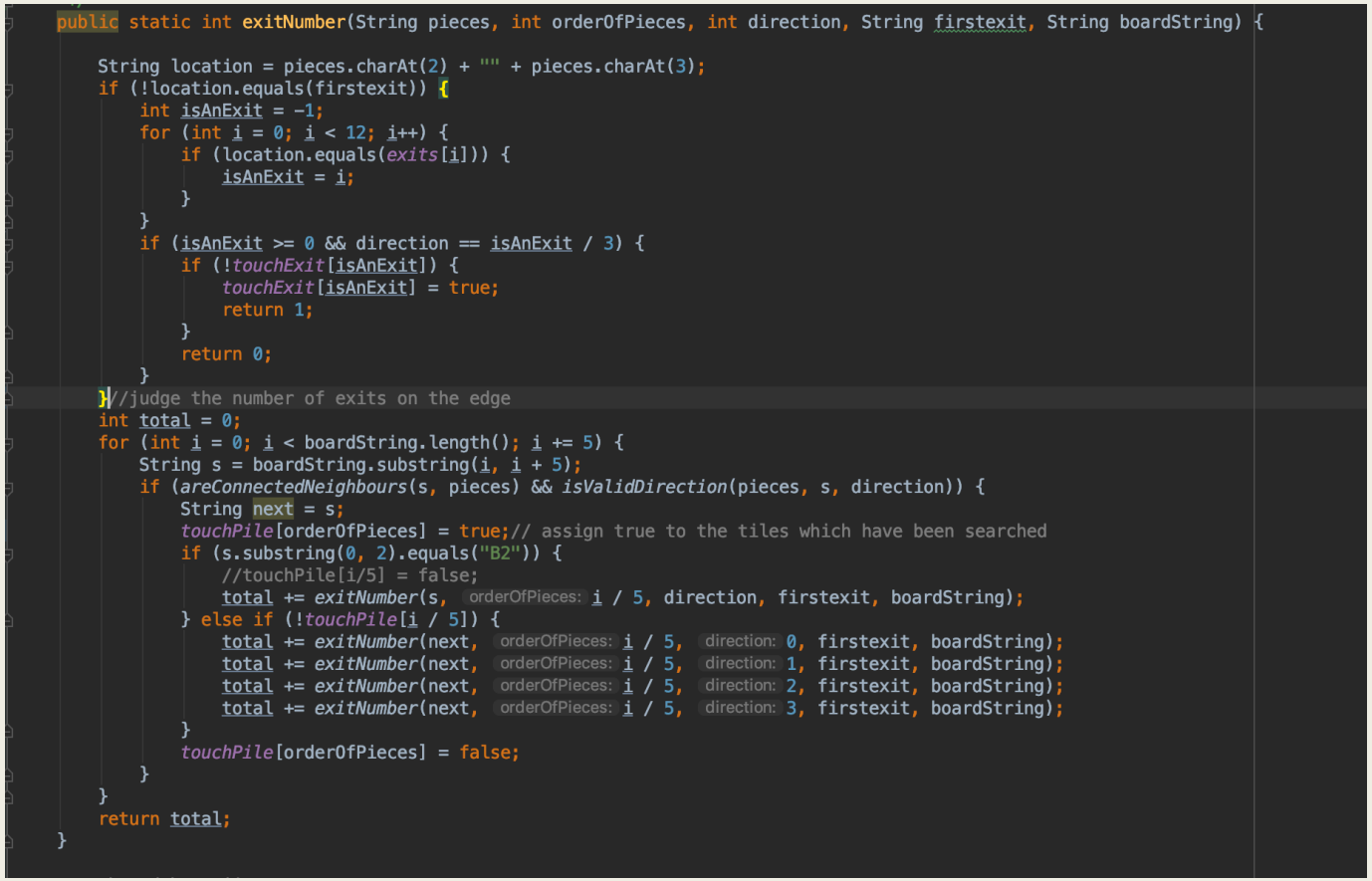
```
for (int i = 0; i < 5; i++) {
    for (int k = 0; k < 4; k++) {
        if (tiles[k]) {
            continue;
        }//whether the kth bit in diceroll has been used
        char[] tile = tileStringArray[k].toCharArray();
        for (char c = 'A'; c < 'H'; c++) {
            tile[2] = c;
            for (char j = '0'; j < '7'; j++) {
                tile[3] = j;
                for (char l = '0'; l < '8'; l++) {
                    tile[4] = l;
                    String tileString = "" + tile[0] + tile[1] + tile[2] + tile[3] + tile[4];
                    if (isValidPlacementSequence( boardString: boardString + tileString) && !newTilesString[i]) {
                        boardString = boardString + tileString;
                        placementSequence = placementSequence + tileString;
                        tiles[k]=true;
                        newTilesString[i] = true;
                    }
                }
            }
        }
    }
```

getBasicSocre

- exitNumber(*search the number of exits in the process of searching from the current tile)*
- centreGridNum(*Find the number of tiles which located at the centre grid)*
- *missEdges(FInd the number of unconnected edges in the boardString)*

getBasicSocre *exitNumber*

- *Use depth-first-search to search the number of exits in the process of searching from the current tile*
  ** **@param pieces** the current tile*
  ** **@param orderOfPieces** the order number of tile in the boardString*
  ** **@param direction** the direction of the next search*
  ** **@param firstexit** the fisrtexit in the route of searching*
  ** **@param boardString** a board string representing some placement sequence*
  ** **@return** the number of exits in the process of searching from the current tile*

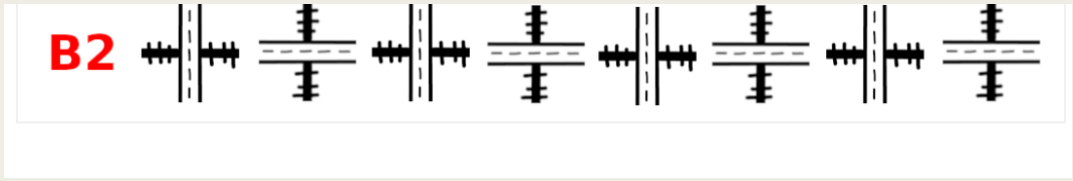


```
public static int exitNumber(String pieces, int orderOfPieces, int direction, String firstexit, String boardString) {

    String location = pieces.charAt(2) + "" + pieces.charAt(3);
    if (!location.equals(firstexit)) {
        int isAnExit = -1;
        for (int i = 0; i < 12; i++) {
            if (location.equals(exits[i])) {
                isAnExit = i;
            }
        }
        if (isAnExit >= 0 && direction == isAnExit / 3) {
            if (!touchExit[isAnExit]) {
                touchExit[isAnExit] = true;
                return 1;
            }
            return 0;
        }
    }//judge the number of exits on the edge
    int total = 0;
    for (int i = 0; i < boardString.length(); i += 5) {
        String s = boardString.substring(i, i + 5);
        if (areConnectedNeighbours(s, pieces) && isValidDirection(pieces, s, direction)) {
            String next = s;
            touchPile[orderOfPieces] = true;// assign true to the tiles which have been searched
            if (s.substring(0, 2).equals("B2")) {
                //touchPile[i/5] = false;
                total += exitNumber(s, orderOfPieces: i / 5, direction, firstexit, boardString);
            } else if (!touchPile[i / 5]) {
                total += exitNumber(next, orderOfPieces: i / 5, direction: 0, firstexit, boardString);
                total += exitNumber(next, orderOfPieces: i / 5, direction: 1, firstexit, boardString);
                total += exitNumber(next, orderOfPieces: i / 5, direction: 2, firstexit, boardString);
                total += exitNumber(next, orderOfPieces: i / 5, direction: 3, firstexit, boardString);
            }
            touchPile[orderOfPieces] = false;
        }
    }
    return total;
}
```

getBasicSocre
one important point

- About B2, due to its special construction, when *depth-first-search* through it , its direction wont change.




```
        touchPile[orderOfPieces] = true;// assign true to the tiles which have been searched
        if (s.substring(0, 2).equals("B2")) {
            total += exitNumber(next, orderOfPieces: i / 5, direction, firstexit, boardString);
        } else if (!touchPile[i / 5]) {
            total += exitNumber(next, orderOfPieces: i / 5, direction: 0, firstexit, boardString);
            total += exitNumber(next, orderOfPieces: i / 5, direction: 1, firstexit, boardString);
            total += exitNumber(next, orderOfPieces: i / 5, direction: 2, firstexit, boardString);
            total += exitNumber(next, orderOfPieces: i / 5, direction: 3, firstexit, boardString);
        }
        touchPile[orderOfPieces] = false;
    }
```

getBasicSocre

calculate the final score

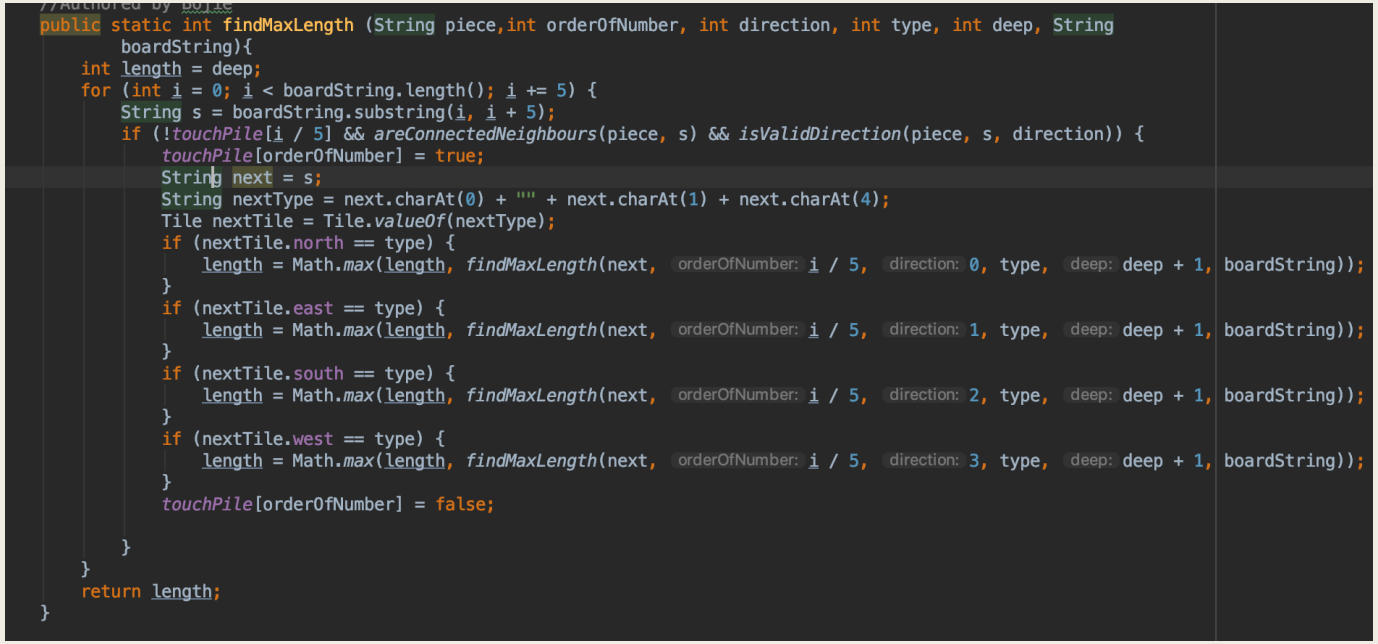
- Calculate the points which matches the number of exits, then
- score = score + *centreGridNum*(boardString) - *missEdges*(boardString);

getAdvancedScore

- Similar to getBasicScore, *use one Method "findMaxLength" (based on depth-first-search) to find the max length Railway and Highway.*
- return maxHighWay + maxRailWay + *getBasicScore*(boardString);

getAdvancedScore
findMaxLength

- *Find the maximum length of the road from the current piece*
  ** **@param piece** a given current piece*
  ** **@param orderOfNumber** the order of piece in the boardString*
  ** **@param direction** the direction of the next search.'0' means north, '1' means east, '2'means south, '3' means west*
  ** **@param type** the type of tile, '1' means highway, '2' means railway.*
  ** **@param deep** the depth of iterator function, the deep will be deep+1 after one iteration.*
  ** **@param boardString** a board string representing a completed game*
  ** **@return** the maximum length of the road from the current piece*



```
//Authored by Bojie
public static int findMaxLength (String piece,int orderOfNumber, int direction, int type, int deep, String
        boardString){
    int length = deep;
    for (int i = 0; i < boardString.length(); i += 5) {
        String s = boardString.substring(i, i + 5);
        if (!touchPile[i / 5] && areConnectedNeighbours(piece, s) && isValidDirection(piece, s, direction)) {
            touchPile[orderOfNumber] = true;
            String next = s;
            String nextType = next.charAt(0) + "" + next.charAt(1) + next.charAt(4);
            Tile nextTile = Tile.valueOf(nextType);
            if (nextTile.north == type) {
                length = Math.max(length, findMaxLength(next,  orderOfNumber: i / 5,  direction: 0, type,  deep: deep + 1, boardString));
            }
            if (nextTile.east == type) {
                length = Math.max(length, findMaxLength(next,  orderOfNumber: i / 5,  direction: 1, type,  deep: deep + 1, boardString));
            }
            if (nextTile.south == type) {
                length = Math.max(length, findMaxLength(next,  orderOfNumber: i / 5,  direction: 2, type,  deep: deep + 1, boardString));
            }
            if (nextTile.west == type) {
                length = Math.max(length, findMaxLength(next,  orderOfNumber: i / 5,  direction: 3, type,  deep: deep + 1, boardString));
            }
            touchPile[orderOfNumber] = false;

        }
    }
    return length;
}
```

getAdvancedScore
Iteration process

```
if (tile.north == 1) {
    maxHighWay = Math.max(maxHighWay, findMaxLength(piece, orderOfNumber: i / 5, direction: 0, tile.north, deep: 1, boardString));
}
if (tile.east == 1) {
    maxHighWay = Math.max(maxHighWay, findMaxLength(piece, orderOfNumber: i / 5, direction: 1, tile.east, deep: 1, boardString));
}
if (tile.south == 1) {
    maxHighWay = Math.max(maxHighWay, findMaxLength(piece, orderOfNumber: i / 5, direction: 2, tile.south, deep: 1, boardString));
}
if (tile.west == 1) {
    maxHighWay = Math.max(maxHighWay, findMaxLength(piece, orderOfNumber: i / 5, direction: 3, tile.west, deep: 1, boardString));
}
//calling the iterator function in for direction to calculate the maxHighway

if (tile.north == 2) {
    maxRailWay = Math.max(maxRailWay, findMaxLength(piece, orderOfNumber: i / 5, direction: 0, tile.north, deep: 1, boardString));
}
if (tile.east == 2) {
    maxRailWay = Math.max(maxRailWay, findMaxLength(piece, orderOfNumber: i / 5, direction: 1, tile.east, deep: 1, boardString));
}
if (tile.south == 2) {
    maxRailWay = Math.max(maxRailWay, findMaxLength(piece, orderOfNumber: i / 5, direction: 2, tile.south, deep: 1, boardString));
}
if (tile.west == 2) {
    maxRailWay = Math.max(maxRailWay, findMaxLength(piece, orderOfNumber: i / 5, direction: 3, tile.west, deep: 1, boardString));
}
//calling the iterator function in for direction to calculate the maxRailway
```

Design Approach

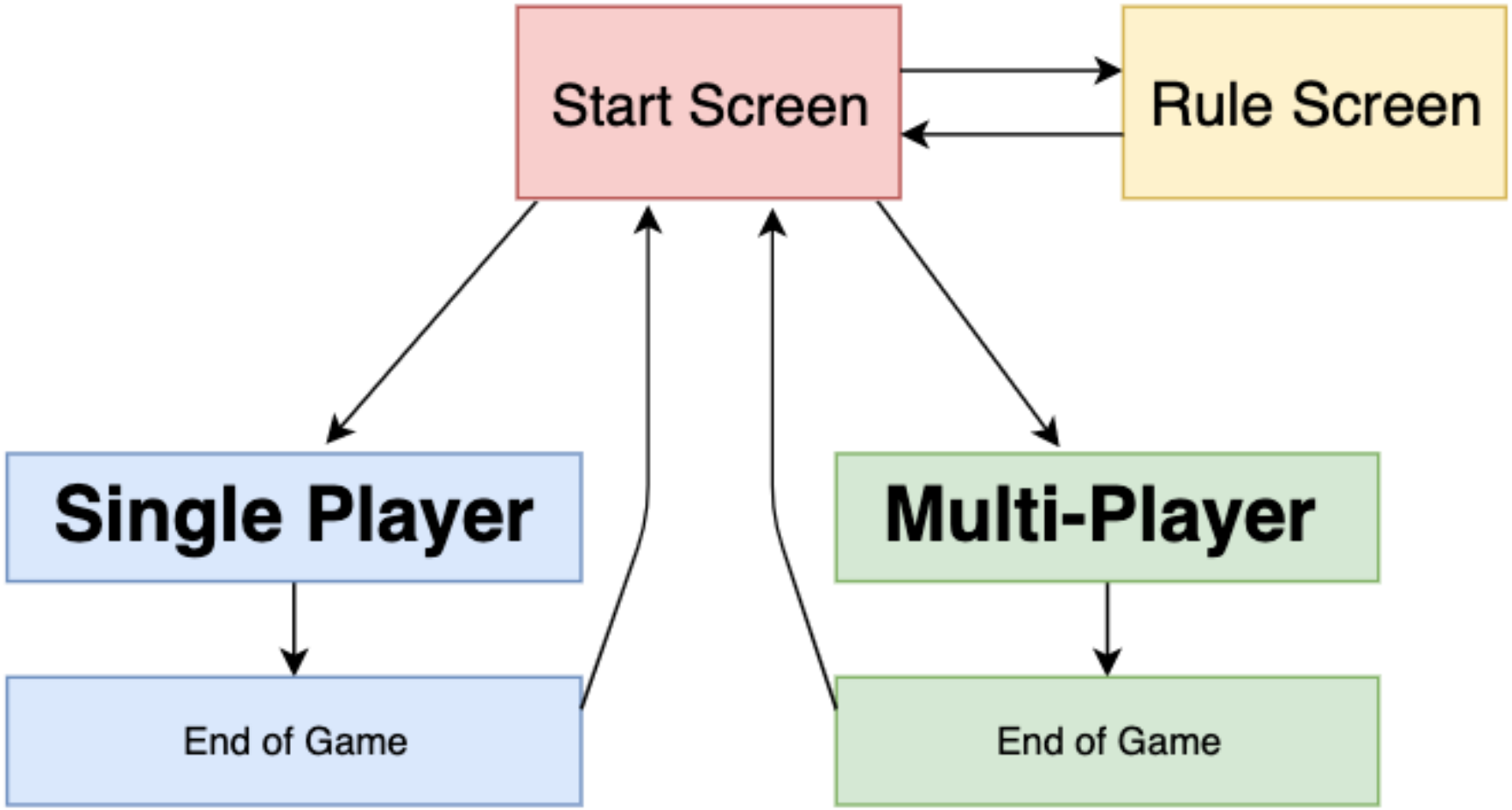
- Intuitive, “pick up and play” design
  - Easy to use drag and drop system
  - Labelled buttons that show exactly what they do
- Rule page so player doesn’t have to source outside information to learn how scoring, etc, works

Interesting Features

- Drag and drop system
- Start Screen
- Rules Page
- Ending

Game Operation

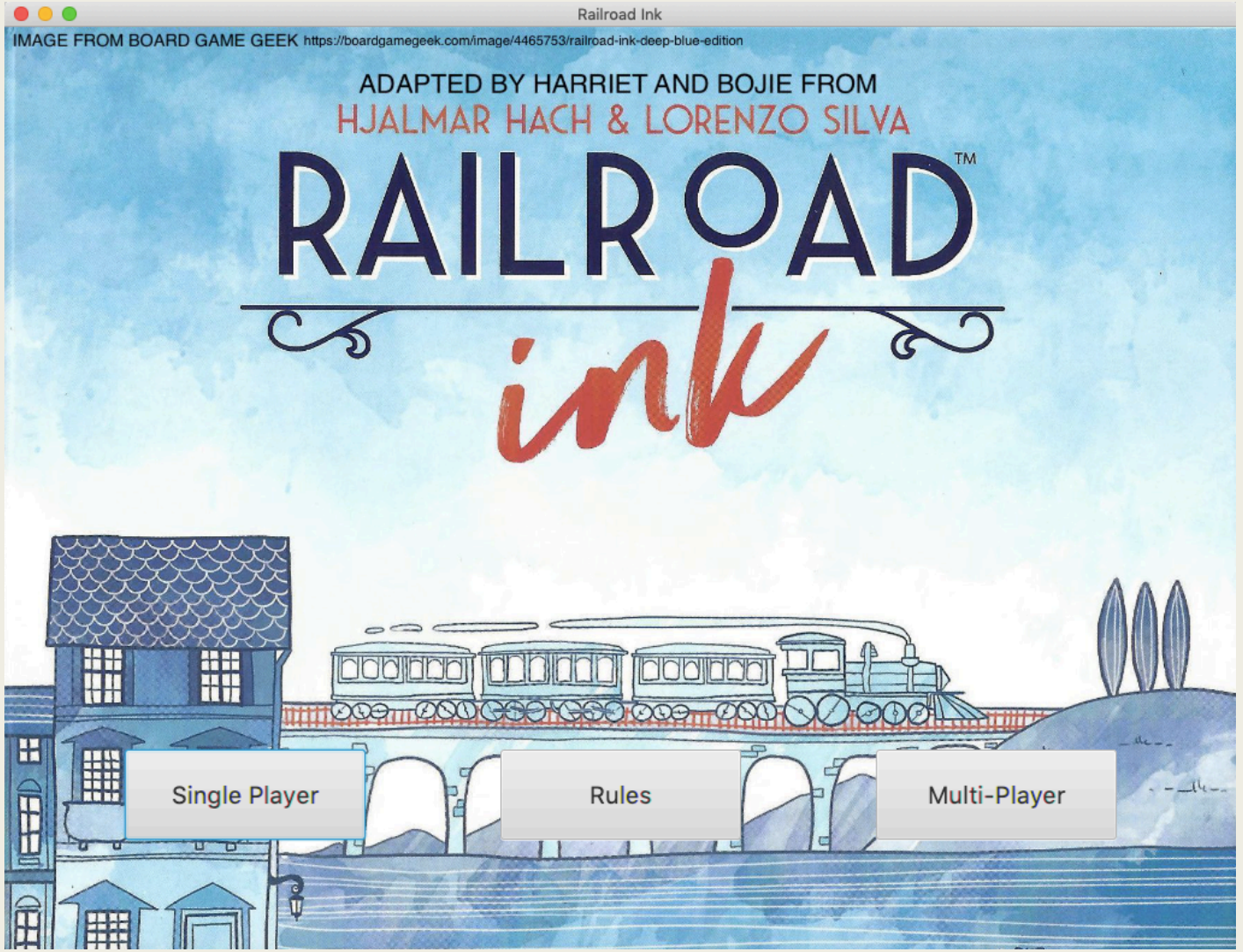
- 4 Components;
  - *Start Screen*
  - *Rules Screen*
  - *Single Player Game*
  - *Multi-player Game*


Start Screen
Rule Screen
Single Player
Multi-Player
End of Game
End of Game

On Startup - Start Screen

Start screen consist of:

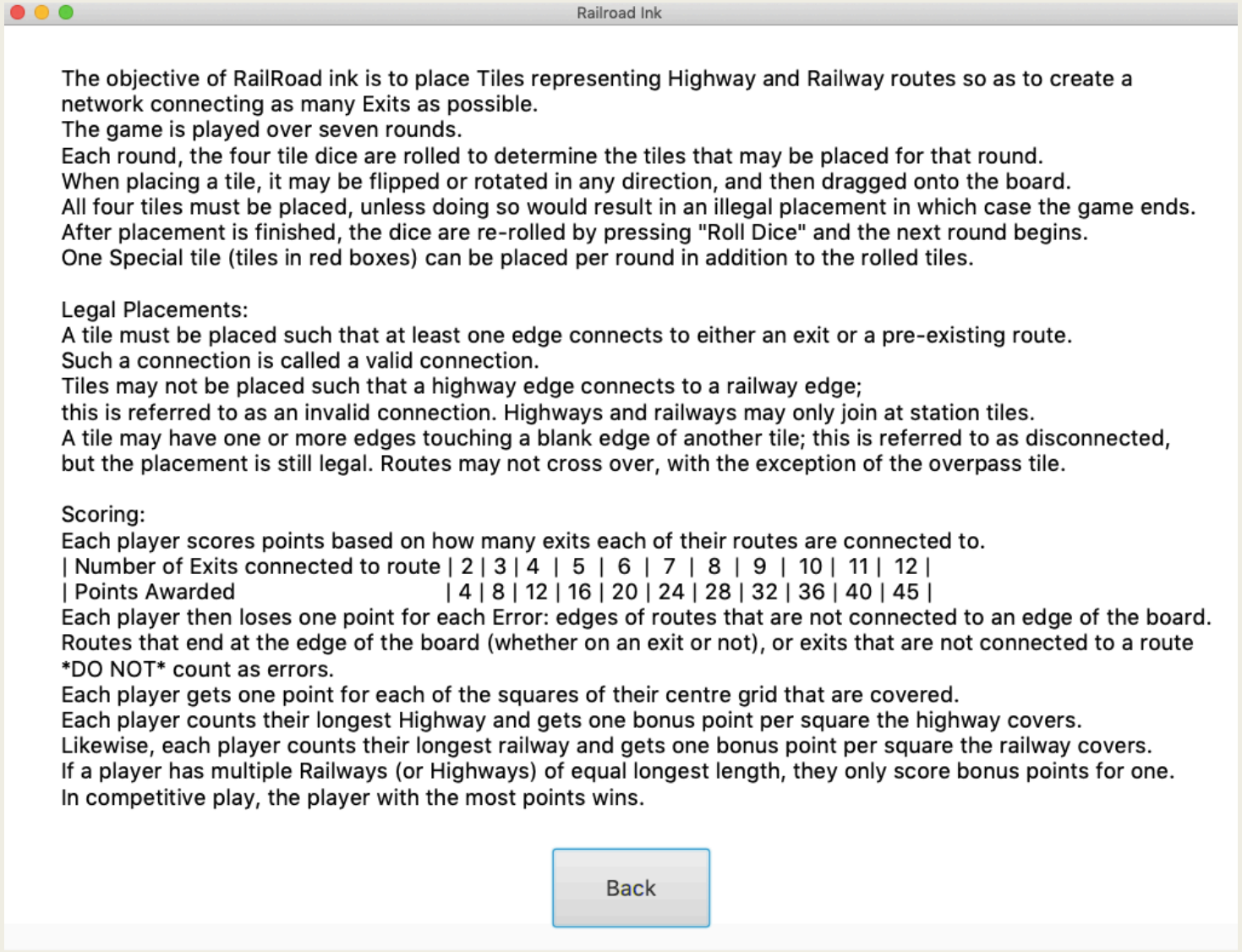
- Background ImageView
- 3 Buttons
  - Single Player
    - Launches a new instance of a Single Player stage and closes the start screen stage
  - Rules
    - Launches a new instance of a Rules stage and closes the start screen stage
  - Multiplayer
    - Launches a new instance of a Multi-Player stage and closes the start screen



Rules Screen

Consist of:

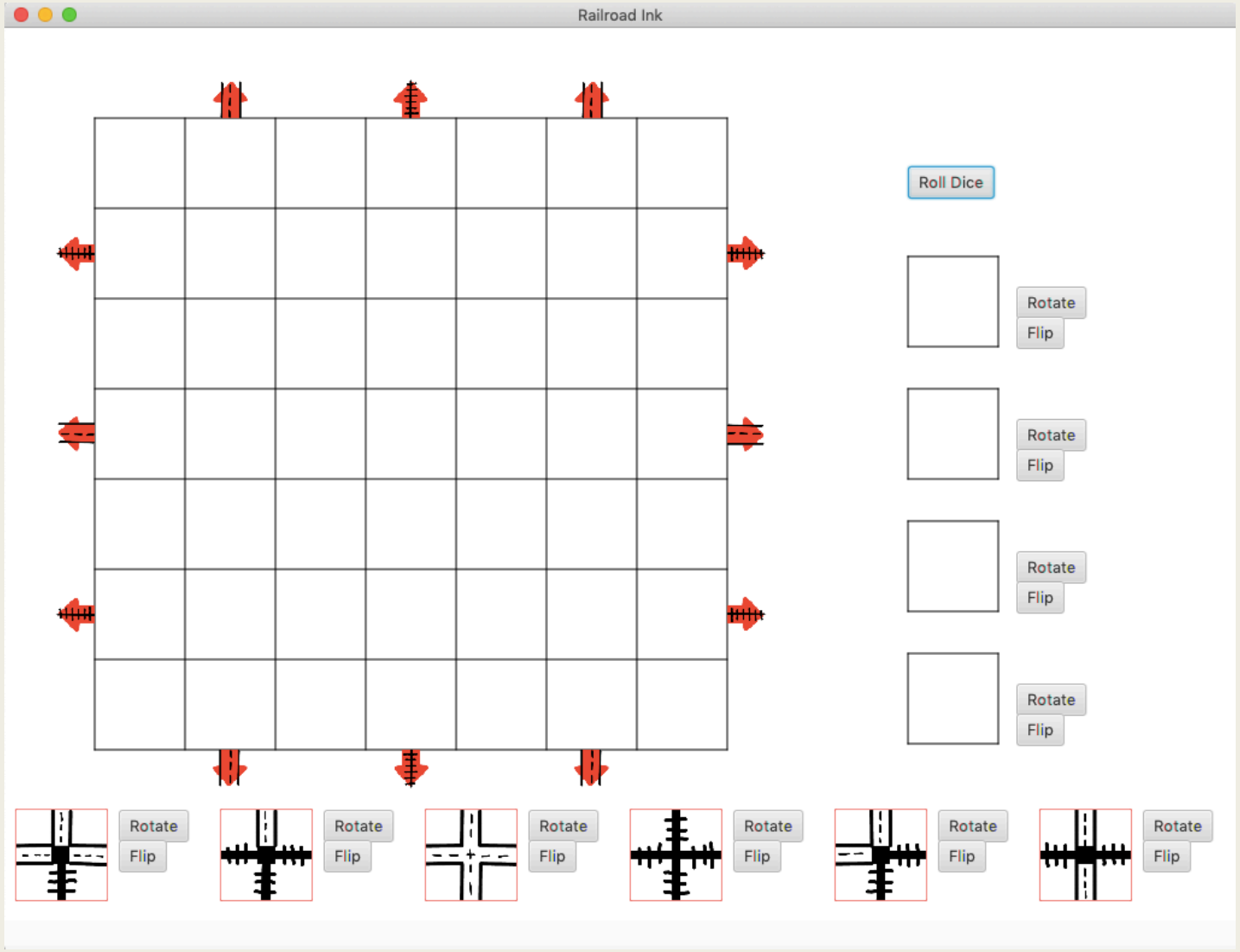
- Text object containing all the rules for the game
- Back button which closes this stage and creates a new instance of the start screen stage.



Single Player

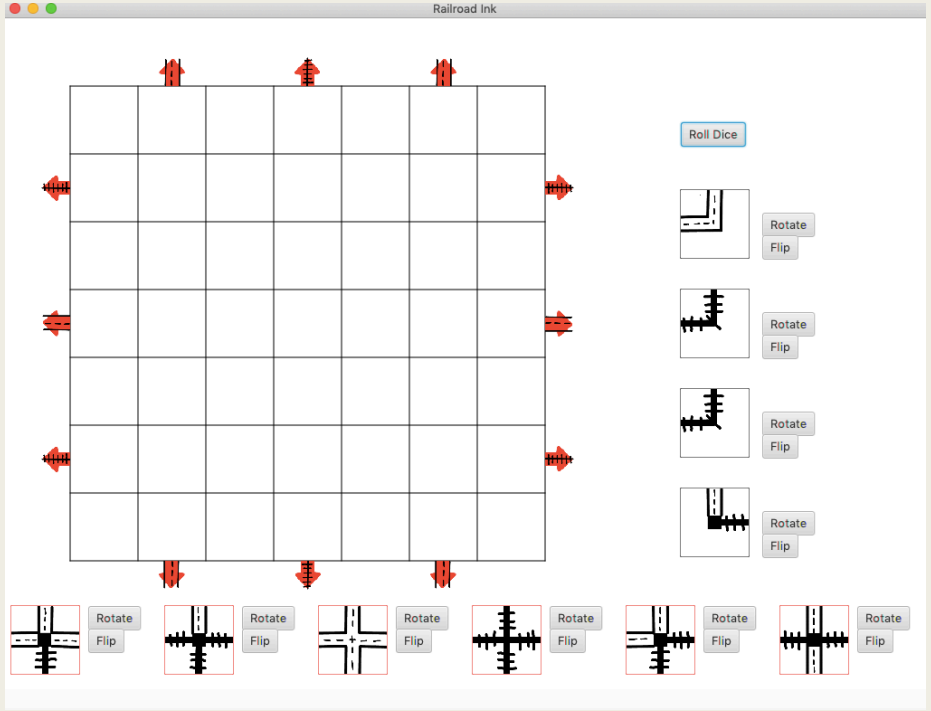
Consist of:

- Board and tile starting placement boxes drawn using Line objects
- The Image View highway and railway exits
- Dragable Image View Special Tiles
- The “Roll Dice” button which generates tiles for each round
- “Rotate” and “Flip” buttons for each tile



How a Single Player Game Works

- The game starts with special tiles being unplayable
  - If the player attempts to play one it will snap back to it's original position
- Once the "Roll Dice" button has been pressed, the round number is incremented, if > 7 calls endGame else the method drawNewTiles() is called.

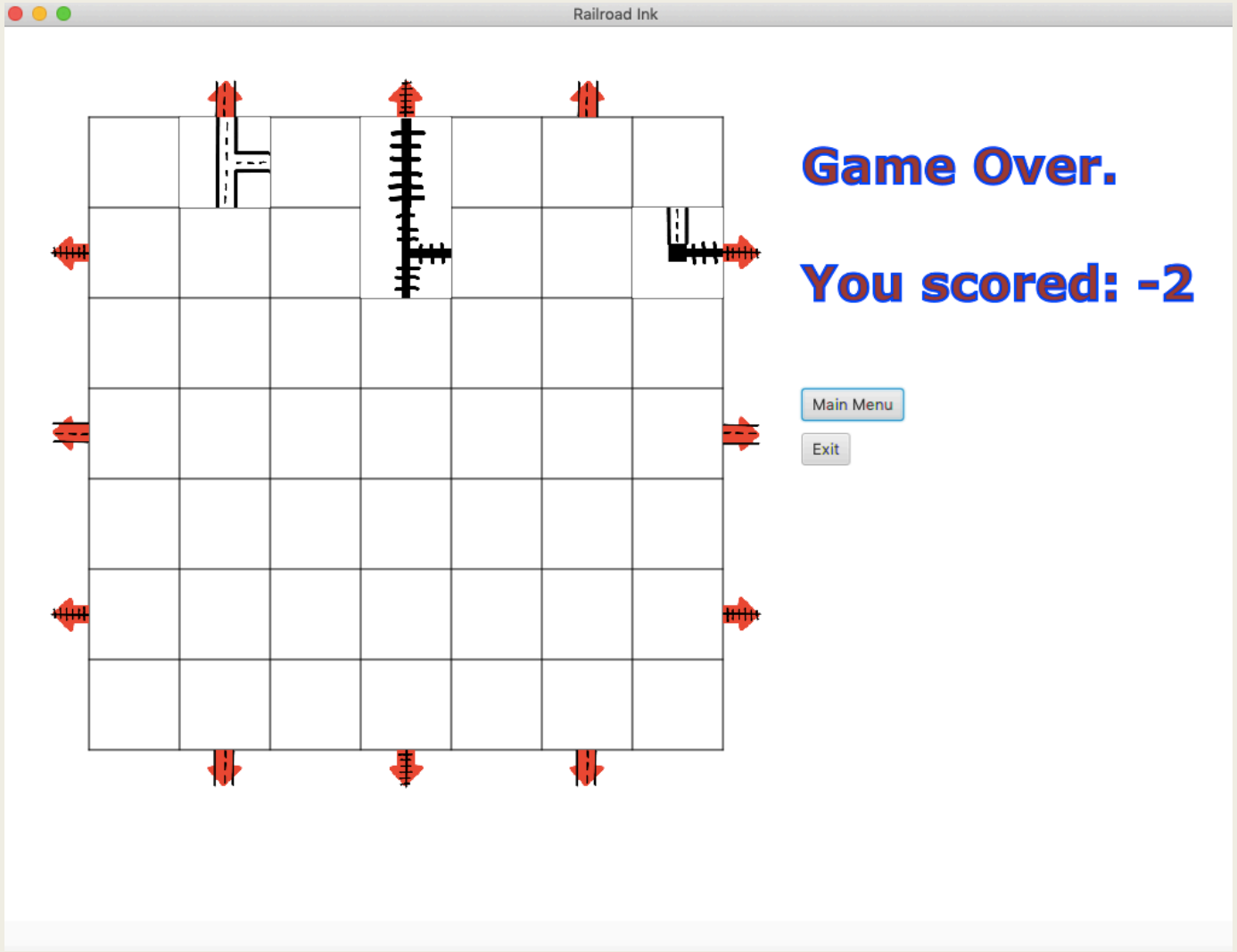


Single Player Game cont'd

- drawNewTiles() generates a dice roll, checks that all the tiles can be played (if not, calls endGame()), and then creates a dragable TileImageView object for each tile generated.
- Tiles then become playable. Dragging and dropping a tile calls drawTile(double x, double y, String tileName, int rotation, int orientation), where x a,d y are is the location the mouse was at when released, rotation is the tile's rotation and orientation is the tile's orientation.
- If a tile placement is invalid, drawTile returns false and the tile is then returned to its origin
- If the tile placement is valid, the dragable ImageView is deleted and a new ImageView is created with the same specifications of the dragable tile. The x and y locations are found by the method snapToGrid(double x, double y) which finds where the tile was dropped on the board and snaps it's location to it.
- drawTile then checks if each of the remaining tiles can be played, and if not, calls endGame().

Single Player - endGame()

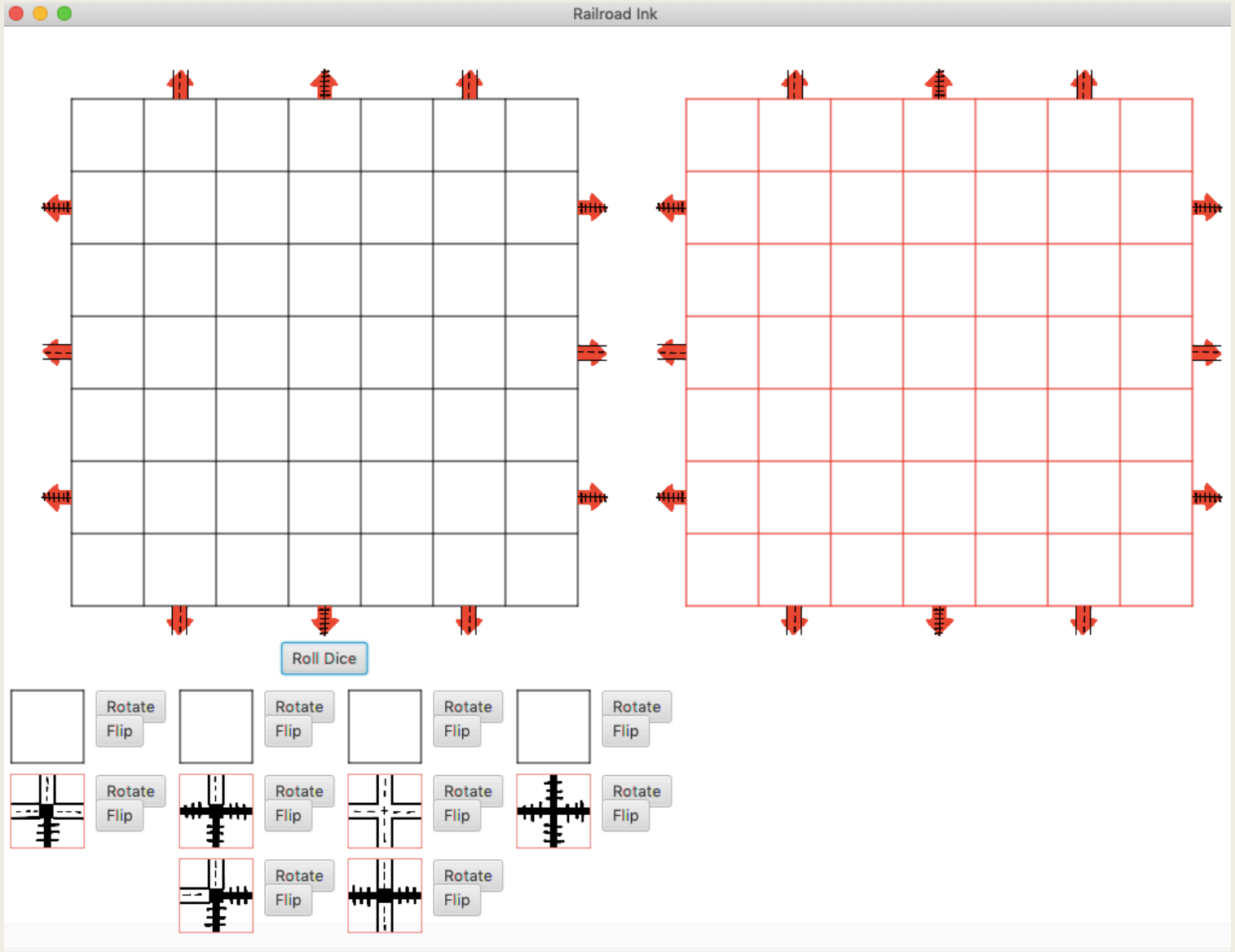
- Removes everything from the root excluding the board and played tiles
- Creates a Text object displaying the player's score
- Creates 2 buttons;
  - *Main Menu – Closes the stage and creates an instance of the start screen stage*
  - *Exit – Closes the stage*



Multi-Player

Consist of:

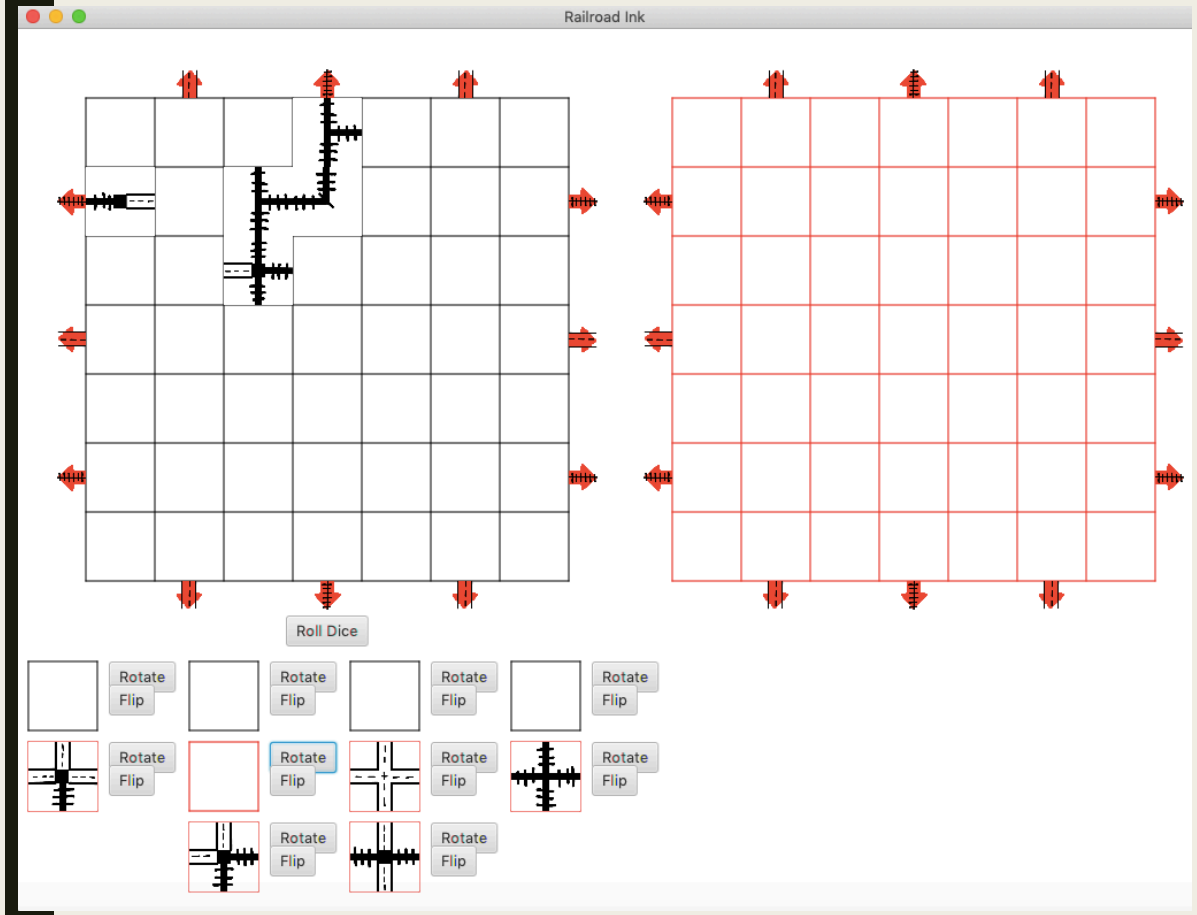
- Player and computer Boards and tile starting placement boxes drawn using Line objects
- The Image View highway and railway exits
- Dragable Image View Special Tiles
- The “Roll Dice” button which generates tiles for each round
- “Rotate” and “Flip” buttons for each tile



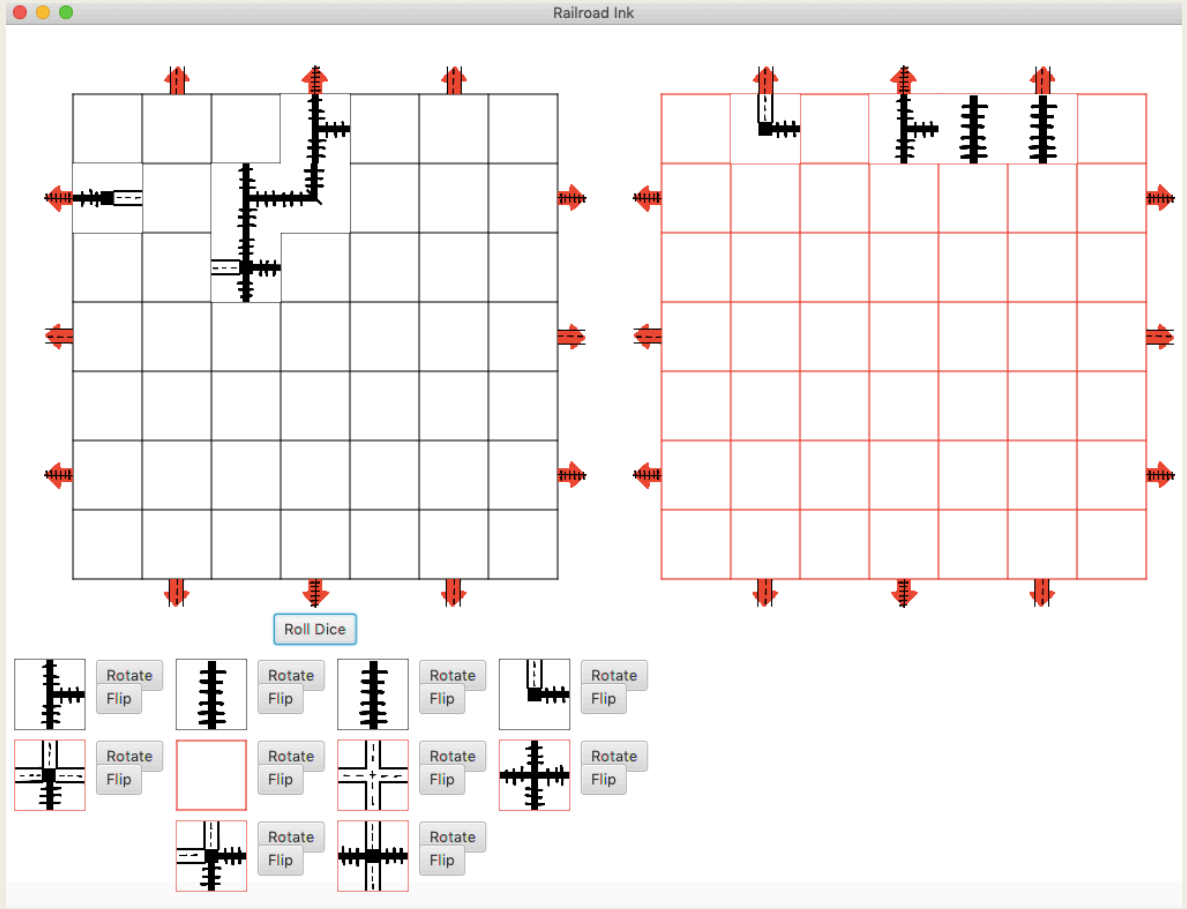
How a Multi-Player Game Works

- Very similar to a Single Player game, with a few adjustments;
  - When a new Round begins, if there was a previous round, the Computer plays the tiles from that round.
  - If the computer cannot make valid placements for each tile, it plays the ones it can but does not continue to play in further rounds.

End of first round – player has played all of their tiles

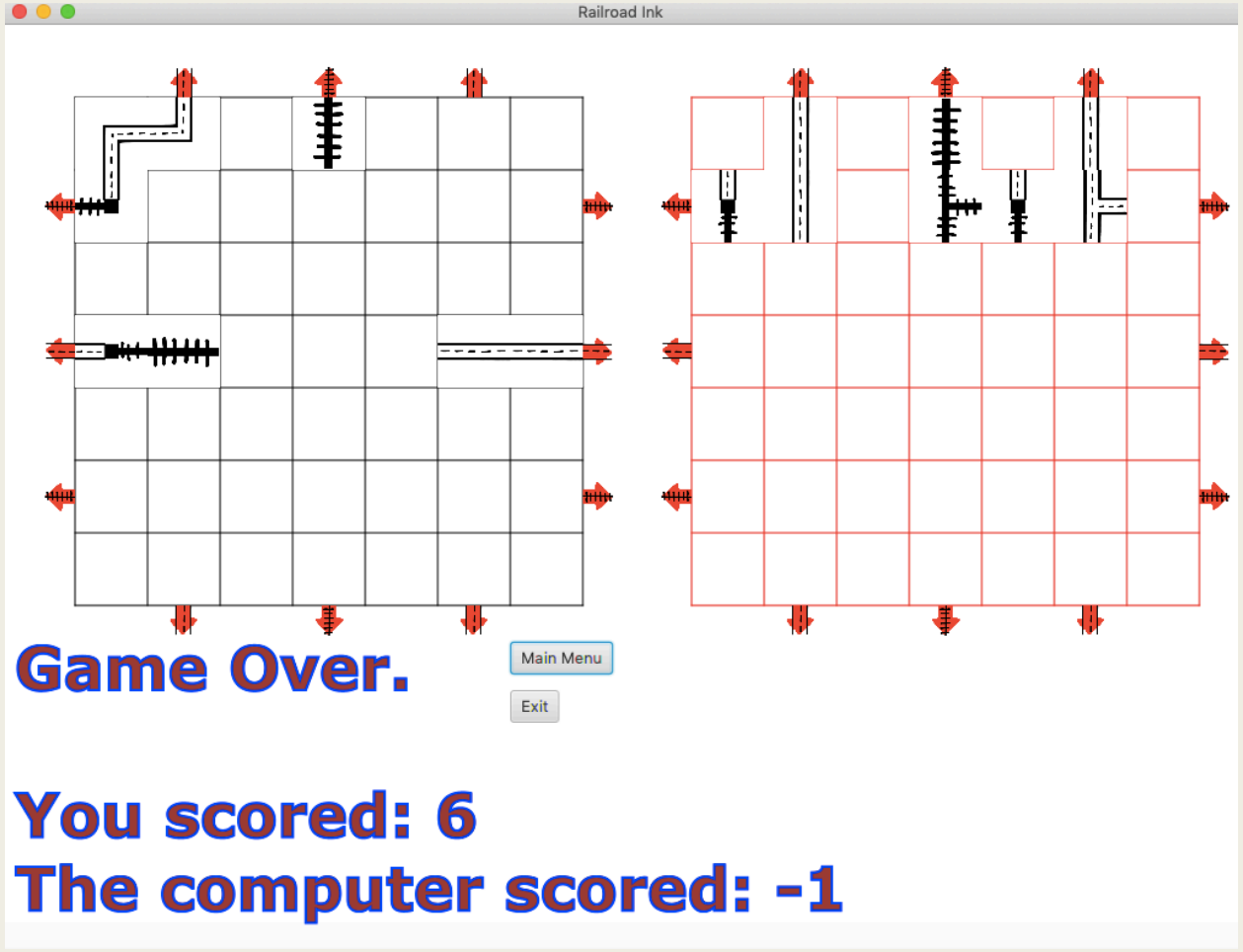


Start of second round – Computer plays Round 1 tiles



End of Multiplayer Game

- The end of a multiplayer game is the same as a single player game except that it shows the computer's score as well as the player's game.



Pseudo Code

```
Start() {
        Add board to root
        Add controls to root
        drawBoard();
        makeControls();
        drawSpecial();

}
makeControls() {
        Button rollDice {
        If(clicked) {
                //if multiplayer
                if (Round > 0 and computer is in play) {
                        place tiles from previous round
                        if (computer hasn't player all tiles) {
                                computer out of play
                        }
                }

                drawNewTiles();

                Round ++

                If(all rounds played) {
                        End game
                }
}
}
for(all tiles) {
        Button rotate {
                If(clicked) {
                        Change tile rotation;
                }
}
Button flip {
                If(clicked) {
                        Flip tile;
                }
}
}
}
drawNewTiles() {
        Roll = generateDiceRoll();
        For (each tile in Roll) {
                New draggable tile(image tileImage, origin x, origin y);
        }
}

Mouse Event Click {
        get origin x;
        get origin y;
}

Mouse Event Drag {
        Move tile with mouse
}
```

Pseudo Code Cont'd

```
Mouse Event Drop {
        Boolean draw = drawTile(tile, x, y);

        If(!draw) {
                Return to origin
        }
}

Boolean draw tile(x, y, tile) {
        If (placement is valid) {
                Draw non dragable tile on board
                Return true;
        } else {
return false;
        }
}

endgame() {
        remove everything but played tiles and board(s)
        show score(s)
        Menu Button {
                Exit;
                Launch start screen;
        }
```

```
Menu Button {
        Exit;
        }

}
```

Questions?