PROJECT Design Documentation

> *The following template provides the headings for your Design Documentation. As you edit each section make sure you remove these commentary 'blockquotes'; the lines that start with a > character and appear in the generated PDF in italics.*

Team Information

- Team name: Back of the Bus
- Team members
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Executive Summary

WebCheckers is an online application that will allow multiple players to log in and play a game of checkers with one another. The game interface will support drag and drop browser capabilities for making moves. Beyond this basic set of features we plan to implement a system so that the players can spectate a game that is in progress as well as replay a game they recently played, so that they can further refine their checker playing skills.

Purpose

> The purpose of this project is to provide the players the ability to log in and play one another online wherever they are.

Glossary and Acronyms

Term	Definition
VO	Value Object
BV	BoardView
Player	A user who is signed in

Requirements

> This application allows users to play a game of checkers.

Definition of MVP

> The application will allow different users to sign in and play a game of checkers over the web. A user may choose an opponent from a list of available players, and the 2 players will be sent to a game of checkers. The game plays according to the American rules, except that the most complex move available must be made at each turn. Moving regular pieces and kings works the same as in the classic American rules. A winner is declared when one player captures all of their opponent's pieces or one player forces their opponent into a position where they have no valid moves available. Either player can resign from the game during their turn.

MVP Features

- Sign-In
- Sign-Out
- Resign
- Start Game
- Win Game
- Make a Move

Roadmap of Enhancements

- Spectator Mode
  - A third person may watch 2 other players play a game
- Replay Mode
  - Players may rewatch the games they just finished playing

Application Domain

This model shows the general domain of the project

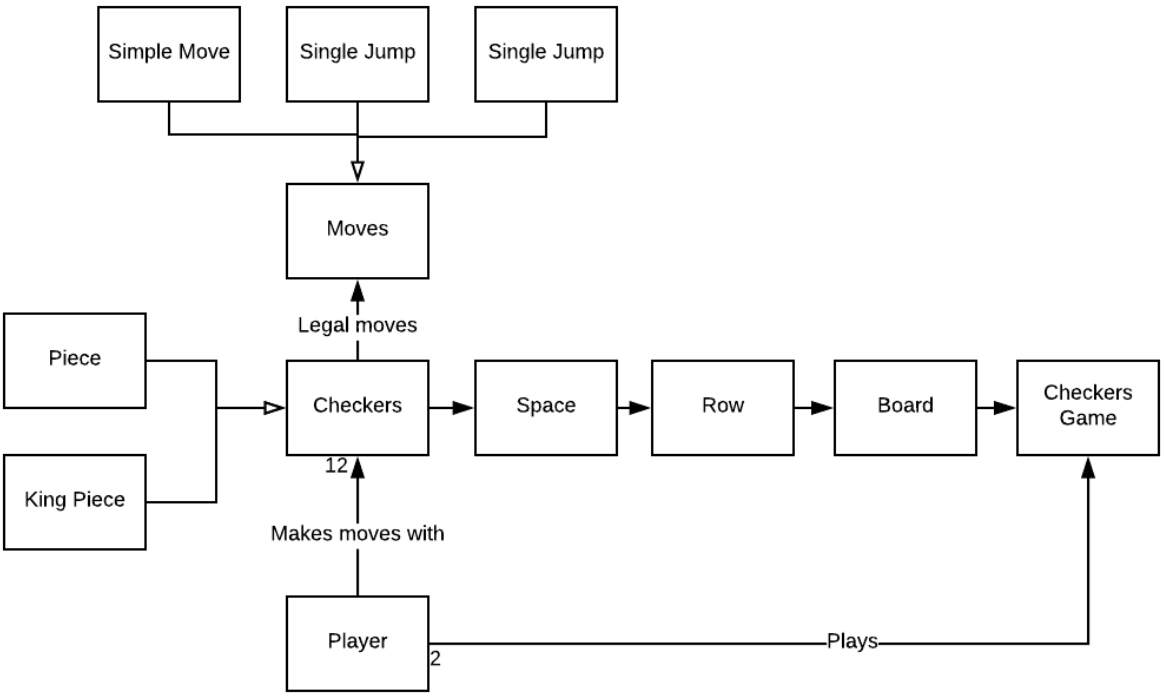


Figure 1: The WebCheckers Domain Model

The central entity of our application is the Checkers game, which is played on a board. The board is defined by Squares, which are in turn defined by their color and location. The checkers game is played with the pieces and played by the player. The player makes moves that can be defined by the type of piece that is being moved and the type of move that the piece is making.

Architecture and Design

This section describes the application architecture.

Summary

The following Tiers/Layers model shows a high-level view of the webapp's architecture.

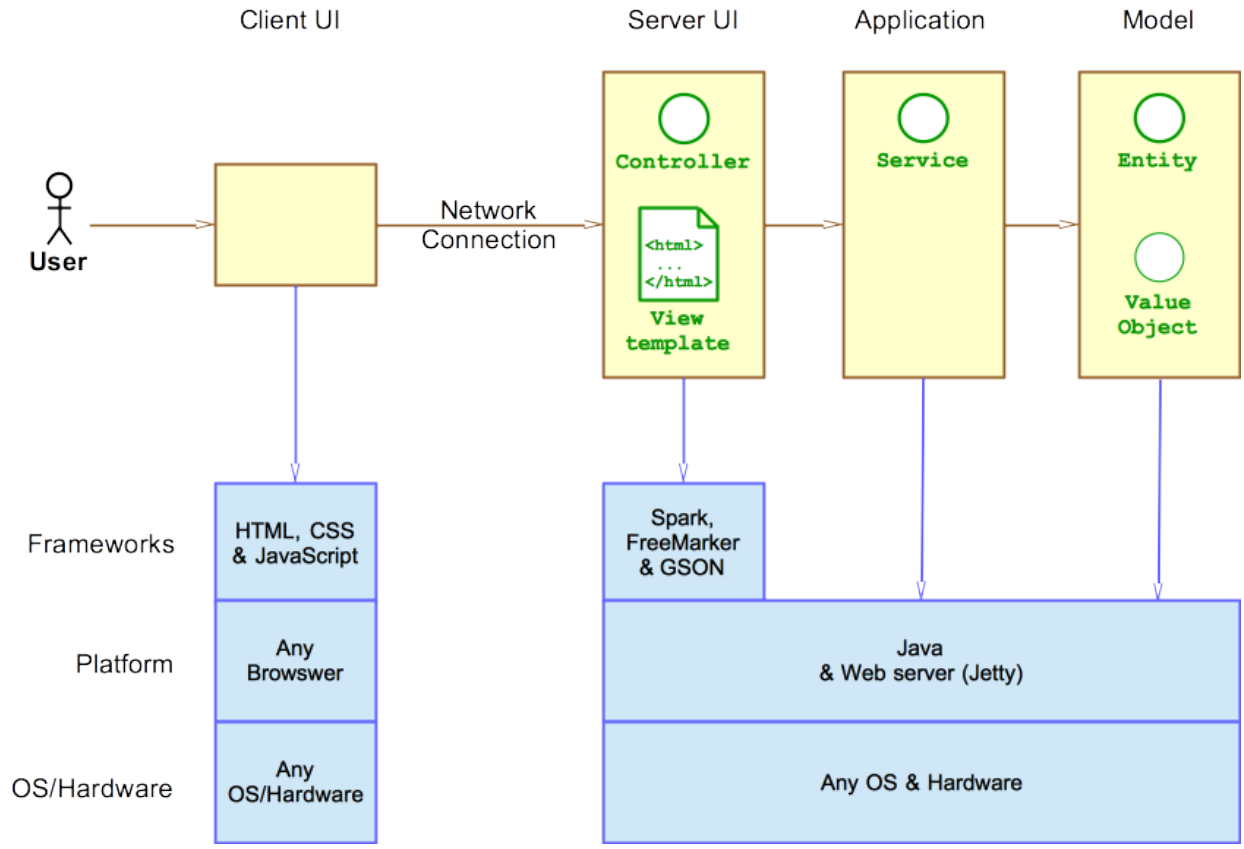


Figure 2: The Tiers & Layers of the Architecture

As a web application, the user interacts with the system using a browser. The client-side of the UI is composed of HTML pages with some minimal CSS for styling the page. There is also some JavaScript that has been provided to the team by the architect.

The server-side tiers include the UI Tier that is composed of UI Controllers and Views. Controllers are built using the Spark framework and View are built using the FreeMarker framework. The Application and Model tiers are built using plain-old Java objects (POJOs).

Details of the components within these tiers are supplied below.

Overview of User Interface

The flow of the web pages from the user's perspective is as follows: When the user opens the home page they first see a simple welcome message and a button to sign in, they will also be presented with the number of players who are signed in. When they click to sign in they will be redirected to the Signin page where they can post their username. They will then be redirected

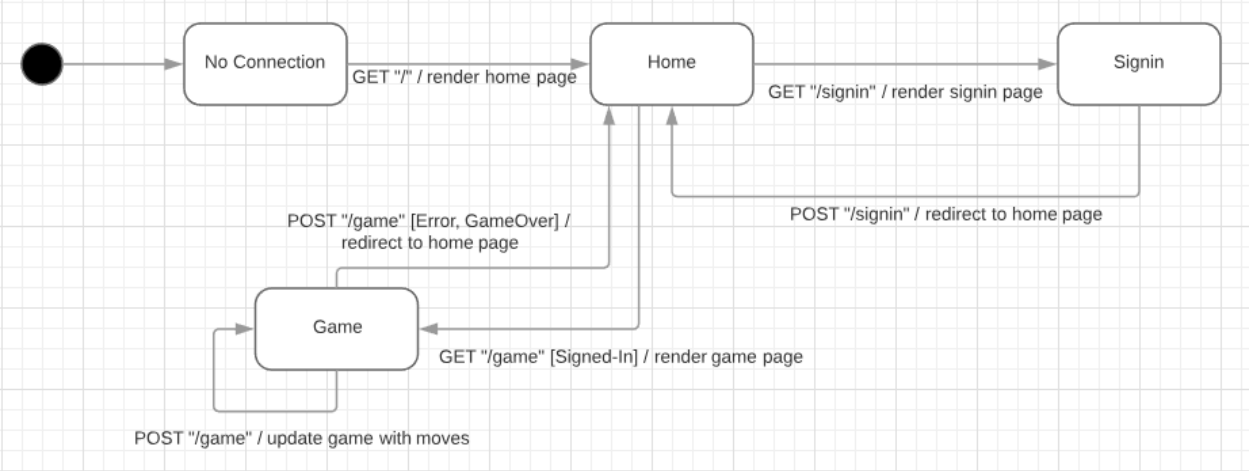


Figure 3: The WebCheckers Web Interface Statechart

to home. If they then click the name of another player then both players will be redirected to the game screen where they can play the game of checkers. Once a winner has been decided they will be redirected to the home screen.Inside of the game there will be the option to sign out or resign, both of which will result in that player forfeiting the game to the other player, returning them back to the home page. Additionally if there are other games going on they will be displayed on the homepage for a signed in user to see. Upon clicking on a game in the list the user will be redirected to the spectator page of the game between the two players, the user will be able to exit at any time by clicking the exit button._

UI Tier

It all starts at GetHomeRoute this is the first thing the user will see as it displays the homepage. Before even signing in users are able to see the number of current players. From the homepage the user is given the option to signin which will invoke GetSignInRoute. GetSignInRoute displays the signin.ftl page which has a user input box where they can input their username. Once the user inputs their username then PostSignInRoute is invoked. PostSignIn then requests the user input and checks to see that it meets the conditions. If it passes all of the conditions the player is added to the playerLobby and the page is redirected to GetHomeRoute again. In the homepage, if the user is signed in and there are other players in games, these games will be displayed on a list on the homepage, if the user clicks on the game it invokes GetSpectateGameRoute, which redirects them to the board view as a spectator. The spectator page is refreshed every five seconds by the PostSpectateGameRoute, which checks if a player has submitted a turn. Additionally the spectator can exit the game at any time by clicking the exit button which invokes the GetLeaveSpectateRoute which simply returns the Spectator back to the home page. Additionally at the homepage the user can see other players, and can click on their username to invoke GetRequestGameRoute, which checks if the requested player is already in a game or not, if so then it redirects to homepage, and returns an error message, otherwise a It calls to GetGameRoute with a hashmap of all the necessary information, inside of GetGameRoute the gameboard is displayed and it checks whether or not the player is in the game or has resigned. Inside of the game If the user chooses to resign, PostResignRoute is called, inside of Resign the player who initiates the resignation is set as the loser, and removed from the game, and redirected to GetHomeRoute and the opposing player is then set as the winner of the game, removed from the game and redirected to GetHomeRoute as well. Inside of a game when a player clicks signout PostResignGameRoute is also called, but the player is also removed from playerLobby therefore effectively deleting the instance of that player. If a player signs out from outside of a

homepage then GetSignOutRoute is also called upon in which the player is simply removed from the playerLobby and effectively removed from the server, then redirected to GetHomeRoute.

When a user signs in, they are directed back to the home screen, and they see a list of possible opponents. They are considered 'waiting for a game' until they select an opponent or they are selected as an opponent. Additionally, if there is an ongoing game, then a user who is signed in has the option to spectate a game. There will be a list of ongoing games with the game name being a concatenation of the two players names. The spectator will have the option to exit the game at any point. When 2 users enter a game, they take turns submitting moves. Moves are validated and submitted through their respective routes, and the player's turn is finished when a move is submitted successfully and reflected back to the user through the checkTurn route which is updated every 5 seconds.

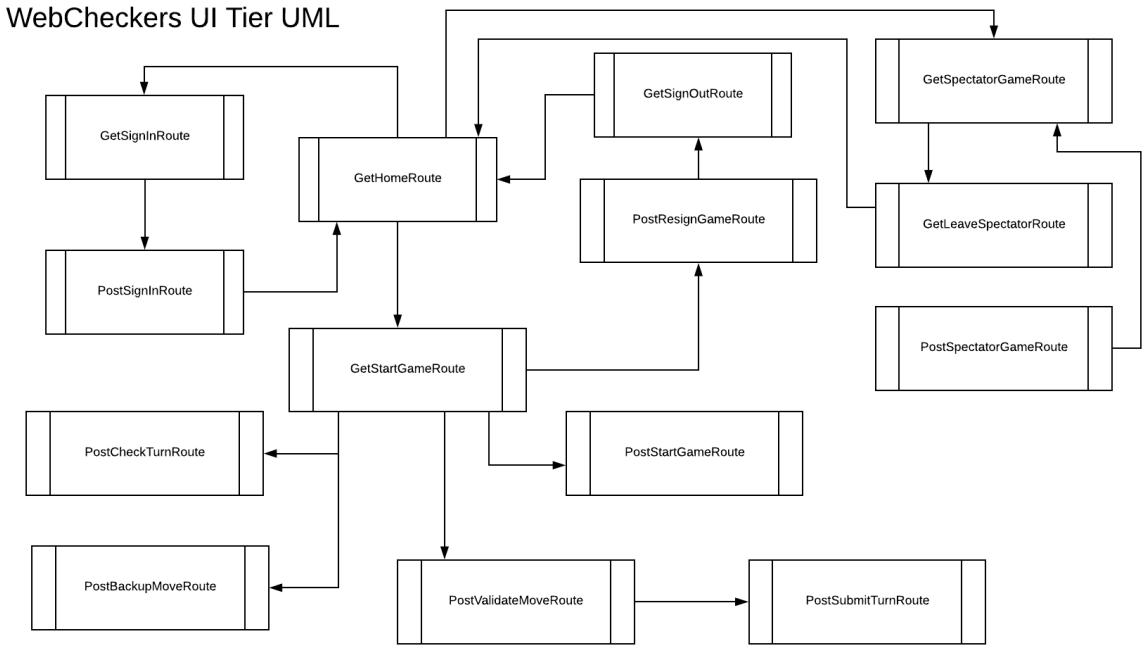
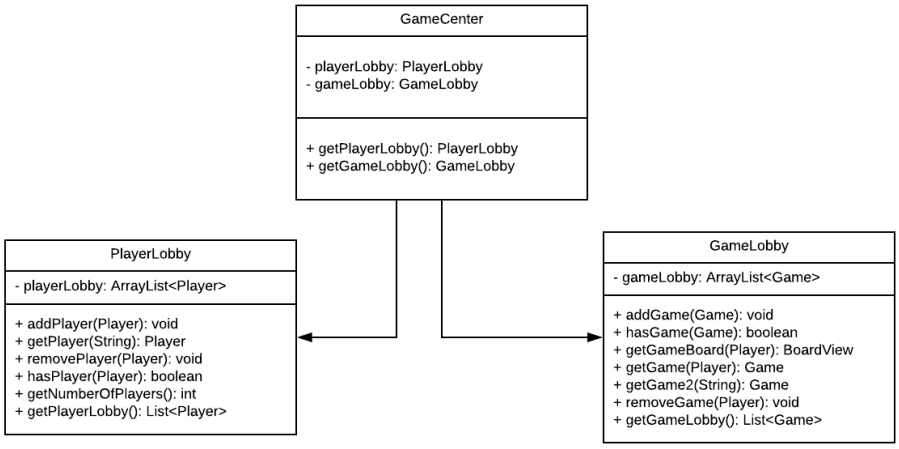


Figure 4: UI Tier UML

Application Tier

Our application tier is made up of three different classes: GameCenter, GameLobby, and PlayerLobby. GameLobby is where the game objects are stored and we can access the games, searching by player etc. The playerLobby is where the Player objects are stored we can use this to access and store players. GameCenter is a unification of both PlayerLobby and GameLobby so that you can access all the methods under both from just one Class.

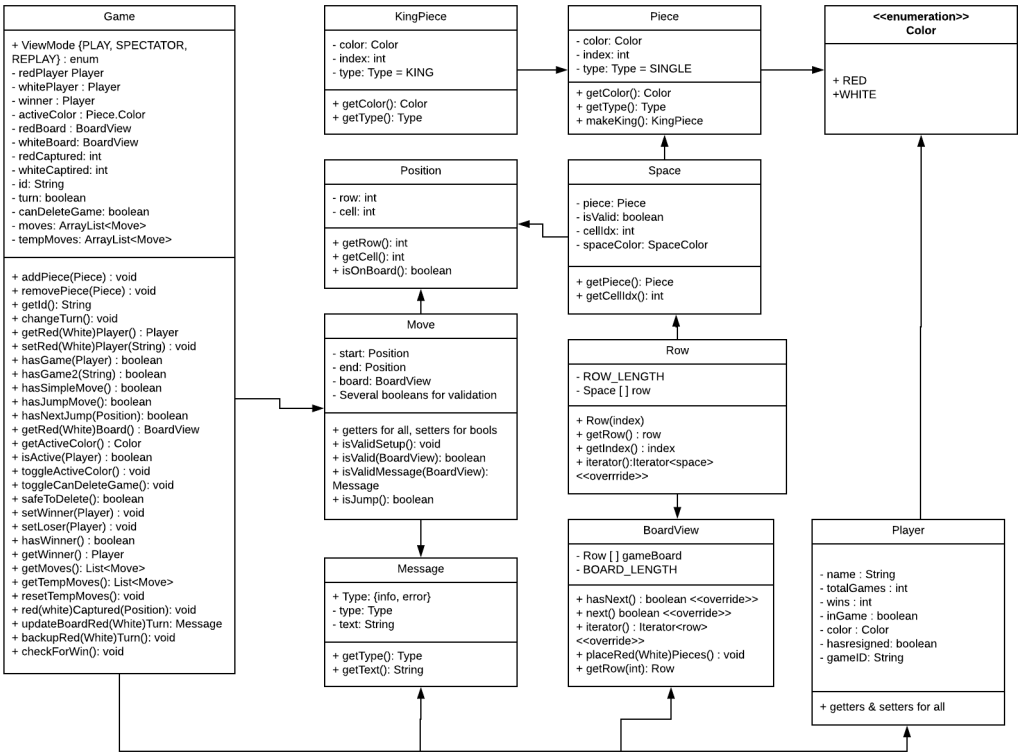
WebCheckers Application Tier
UML



Model Tier

Our Model tier is the meat of this project. It includes eleven classes. Boardview is what actually displays and puts together the board it puts both the spaces and pieces into the gameboard effectively making the board which the player sees. Color is an enumeration class that is used when instantiating a color for both Players and Pieces. Game requires two players to instantiate Game holds all of the information pertaining to the game, it holds the two players and their colors it is also where a loser and winner are declared. KingPiece changes a piece to the status of a king piece, it enables that piece to have more functionality over other pieces in the game. Message is used for return types inside of the UI tier when sending Json information. It requires a Type (error or info) and a string identifying what was happening Move controls the movement of the various pieces in the gameboard. It has a start and end index being where the piece started and where it ends up after the move will be made. The piece class make the piece object that is being moved by the player. It can be identified with a color and type ie. RED,KING. The Player class makes a player object. The player object represents the player making the moves and controlling all of the actions. The player type stores the number of wins, name of the player, total number of games and a boolean value representing whether or not the player is in a game or not. Position is needed for the move class. It is the index of a specific place on the gameboard it stores the row and cell of a certain place. Row makes the row object which is what the gameboard is made out of. The rows are made up of spaces. Space represents the smallest measurement unit in the gameboard. It is a single square in the gameboard Spaces store a piece and a color of the specific space.

WebCheckers Model Tier UML



Design Improvements

Originally, we had the Piece and Player classes implementing their own Color enumerations which made comparisons difficult in the long run. We switched to a public enumeration in the model package because the player's color was essentially the color of pieces they were assigned. There should be some abstractions in the Model tier which have not yet been flushed out, but would absolutely contribute to the effectiveness of the design. There were many architectural improvements done over the course of sprint 3. We used to have 3 routes that all functioned together in handling the refreshing and creation of a game: GetGameRoute, GetRequestGameRoute, and GetStartGameRoute. This caused some redundancy and was sloppy coding,we decided to condense the functionality of these three routes into a singular route being GetStartGameRoute. By combining the functionality into a single route we were better able to track down various bugs and errors, this was a very large restructuring and helped us tremendously. We also revamped our Resign routes by deleting PostResignRoute. This route was also rather redundant and served no viable purpose.

Testing

Our unit testing strategy has essentially been to broadly test all of the class's methods first, creating mock Objects to test with and creating real objects only when necessary. Once those methods have been guaranteed to work, we isolated specific user stories and use cases. For example, we tested the game logic of edge cases for the Red and White players throughout many of the classes, since we wanted to guarantee that all of the logic worked for both players.

Acceptance Testing

We achieved a code coverage of 98% for the application tier, 84% for the UI tier, and 82% for the model tier. We were initially planning on aiming a bit higher for the UI tier and especially the model tier, but due to time constraints and the complicated logic in the Move mode object in particular, we fell slightly short of our initial coverage targets.

Unit Testing and Code Coverage

Our initial coverage targets were to have 90%+ coverage for the UI tier and 95%+ coverage for the model tier. Since the model objects are used extensively throughout the application and most of our business logic fell in this tier, we felt it was important to most thoroughly test the model tier. Despite falling slightly short of our original goals, the code coverage meets our targets fairly well. In the model tier, it is mostly the Move object lacking some coverage and we will improve on this drastically in upcoming development.

Code Metrics

In order to calculate class metrics and further analyze our code, we used the IntelliJ plugin MetricsReloaded. Several findings from this are important to highlight. The cyclomatic complexity metrics pointed out three classes as outliers: BoardView, GetHomeRoute, and GetStartGameRoute.

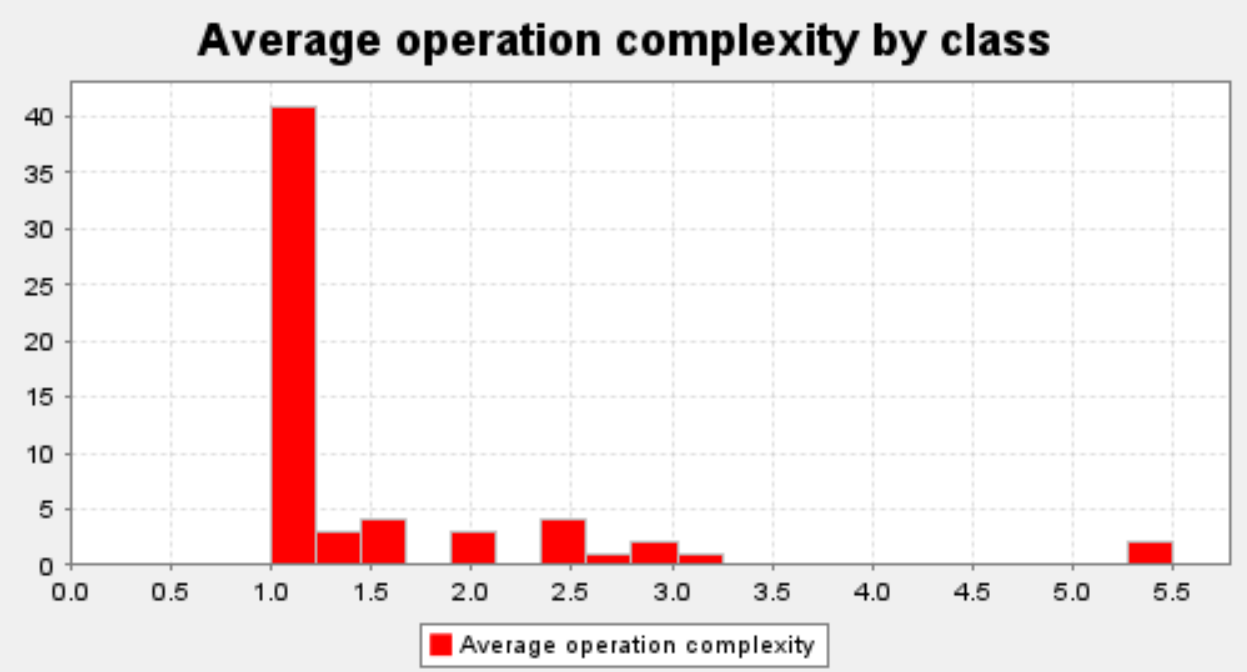


Figure 5: Class Complexity Histogram

As this histogram shows, the majority of our classes are well within reasonable values of complexity. BoardView, upon further examination, has many execution paths because the for each loops used for board set-up iterate through each space and check for space color repeatedly. The complexity could be decreased by adjusting these loops to be plain for loops that step through every other space. As far as the routes go, these simply need to have some functionality moved elsewhere rather than checking game status through many if blocks.

Our Javadoc method coverage illuminated a few spots needing improvements as well.

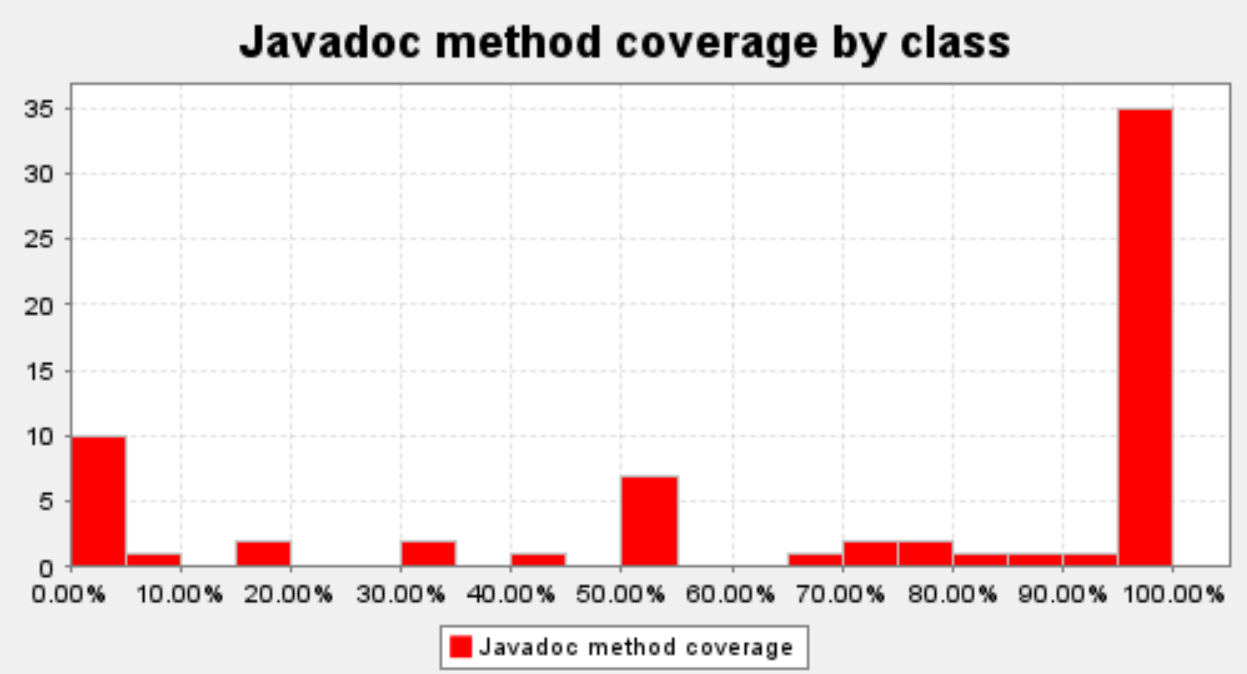


Figure 6: Javadoc Method Coverage Histogram

Every class which has 0% javadoc method coverage is a test class. Many of these classes are highly readable on their own. Additionally, the handful of classes with 50% or so coverage has comments for accessor and mutator methods. However, it is important to have standard, formal method javadocs for each method for accessibility, so this should be fixed in further updates, including test classes.

Another valuable set of metrics that we examined was the Martin package metrics. This showed mainly average values. One outlier was the efferent coupling value for the UI package: 85 classes within the UI tier depended on outside classes. This would be an issue with high-level design that could provide difficulty with future maintainability as well as re-usability if left alone. However, with full MVP functionality, we would not recommend over-turning the current overall design of the program. Unless a great deal of further work would need to be completed, the effort would outweigh the benefits.