Design Document for the Robo Sport Software System

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Project Scope

The Robo Sport board game will serve a variety of purposes. First and foremost, Robo Sport is a game, and as such, it should serve to entertain and challenge the human players who use it. The game will consist of computer AI's developed by a collection of student software teams. The computer AI's will be obtainable from a server and the user will be able to view the AI's statistics and choose to play with or against any of them. The game will also provide a platform for multiple human players to face-off against each other. The emphasis on strategy will cater to a user who is interested in both entertainment and mental stimulation.

Implementing the Robo Sport board game as a software system will allow for advanced additional functionality that would not be possible on a real life game board. One major advantage is "the fog of war", which hides aspects of the game from the current player's field of view. This creates the additional challenge of locating the other team's robots on the game board. Gangs of robots must work together to "see" beyond each of their own visual ranges, allowing them to strategize together against the other robot gangs. Another major advantage that is offered by a software system is the ability to track and record game statistics. Some statistics will be displayed to the user during gameplay. All statistics will be uploaded to a server post game, allowing players to track the progress of different robots.

The use of computer AI's and "the fog of war" are two aspects which will make this game challenging. The wide range of computer AI's will each challenge the user in a different way based on their implementation. This improves strategic thinking in varying scenarios. A user can also improve their strategy against other human players. There may be two, three, or six players in a game, where any number of them may be controlled by computer AI's.

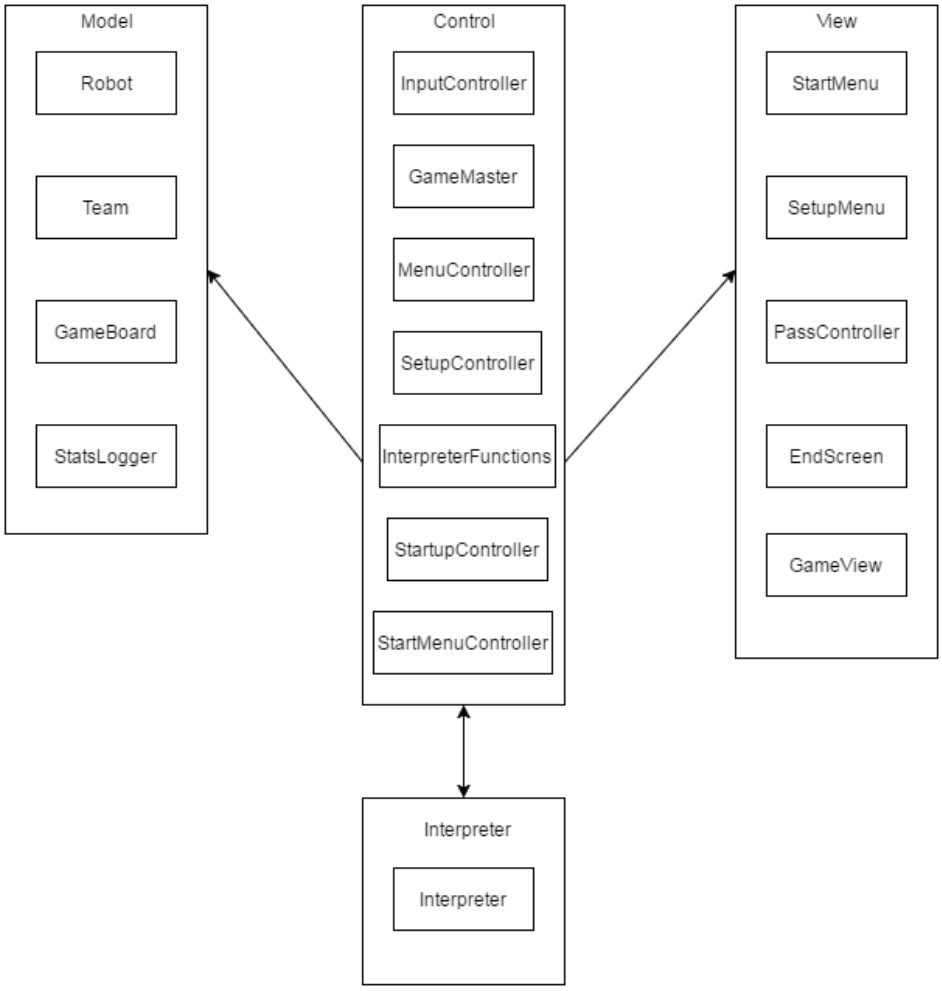
The game is designed for use by a variety of demographics. Firstly, the game will be limited to people who are somewhat familiar with computers. Secondly, it will target users who wish to improve their skills in strategic thinking. Thirdly, it will aim to engage people who play computer games for the purpose of entertainment.

Architecture

The Architecture for the Robo Sport system is a combination of Model-View-Controller and Component-based Architecture.
In course of creating a complex software system, it is essential to find a common abstraction of the system on which all of its elements can be constructed. The architecture of our system will allow developers to understand the over-arching concepts and major functionality without the complexity of implementation.

Careful consideration of the different high-level components in the system led to the decision to combine two different architectures. The level of interaction between the system and the user make it necessary to have both a View component (for displaying game content to the user) and a Controller component (for gathering and reacting to user input). The Controller component is also responsible, to a degree, for the regulation of the computer AI's. The use of various robots, teams of robots, and the hexagonal game board also calls for a Model component, which will hold the basic structure of each of these objects. Due to the systems ability to access data via a network, it is convenient to include additional components to the overall architecture. The system requires a Forth environment for the computer AI's, as well as the ability to access JSON files from a server. Model-View-Controller fails to esthetically and efficiently encapsulate the needs of these unique mechanisms. Adding extra components to accommodate network access and the AI functionality will serve to create an architecture which is both practical and system specific. The two architectures in combination will accommodate each of the systems distinct, high-level components, including the Forth environment for the AI's and abstract server communication.

System Architecture Diagram using Model-View-Controller/Component Based Design:



The View component encompasses all classes that display information to the user. The Model component is responsible for data storage. Both the Model and the View interact with the Controller, which acts as an intermediary between them. The View sends the information it receives from the user to the Controller, and the Controller processes the data in some meaningful way. From there, the controller sends the processed information to the Model, which updates itself accordingly.

Architectural Components

Model Classes:

Robot Class:

The Robot class is responsible for enclosing all of the functions and attributes pertaining to each individual robot. This includes things like the robot's health, as well as its functions that are defined in Forth. The robot is constructed during setup of the game and it is instantiated by the SetUpController.

Interactions:

The GameMaster class interacts with the Robot to update its position on the GameBoard. The Gang Class stores a list three of Robots that are members of its Gang. The GameView stores hash-map of robots that are on a given coordinate, as well as a hash-map of coordinates that the various robots are on.

Variables:

- robotJSON : all of the information pertaining to a particular robot in a JSON object which comes from the Robot Librarian upon construction
- robotID: a combination of the robot's name + teamID + gangID
- gangID: an integer value assigned to each robot on a given team upon robot creation
- inbox: a stack used to hold messages sent from other robots
- movesRemaining: an integer tracking how many moves a robot has left in it's turn
- hasShot: a boolean variable to keep track of whether or not the robot can shoot
- health: an integer to store the health of the robot during gameplay
- robotStats: a JSON object provided by the RobotLibrarian that is sent during construction and is not edited during gameplay. Used for quickly accessing robots in the GameStats file.

Functions:

- Construction:
  - Robot(robotJSON, gangID): The robot constructor, takes a JSON file from the Robot Librarian and an integer value for the gangID and creates a robotID by combining the robots name + teamID + gangID
- Status:
  - setHealth(integer): Used to update the robot's health when it takes damage
  - getHealth( ): Returns an integer value holding the robot's health attribute
  - getType( ): Returns the type of a robot as an enum (scout, sniper, or tank)
  - isAlive( ): check if robots health is above 0, return true if yes
  - getStrength( ): returns the integer value holding the robots strength attribute
- Actions:
  - move(integer): Used to move the robot forward according to the integer parameter
  - move( ): Used to move the robot forward one space
  - movesRemaining( ): Returns the amount of moves a robot has remaining
  - canShoot( ): Returns true if the robot can still shoot, false otherwise
  - turn(integer): Turns the robot according to the integer parameter
  - turn( ): Turns the robot once clockwise
  - shoot( ): Shoots at a tile in a straight line from the robots current position
- Messaging:
  - receiveMsg( ): Grabs a message from the inbox stack and returns a string
  - sendMsg(string, robotID): Pushes a message to the receiver's inbox stack
- Miscellaneous:
  - getTeam( ): Gets the team of robots from JSON (scout, sniper, tank) and returns a string with the team name

- getGang( ): Returns the gangID
- getID( ): returns an ID for a single robot on a team
- getJSON( ): Returns the robotJSON object

Gang Class:

The Gang class provides a way to represent the teams of robots for both the View component and the GameMaster class inside of the Controller component. The Gang class makes it easy to provide each Gang of robots with a limited visual scope as per their visual range. This implementation enables “the fog of war”, which gives rise to new strategic possibilities.

Interactions:

The Gang class interacts with the GameMaster class which contains the list of all robot gangs currently in play, with the StatsLogger class which holds the robotJSON file, and with the SetUpMenuController which creates the various robot gangs at the start of the game.

Variables:

- robots[ ]: collection of three robots associated with the Gang (scout, sniper, tank)
- name: the name of the Gang, represented by an integer
- colour: the colour of the Gang

Functions:

- Gang(robots[ ], colour, name): returns a newly created and initialized Gang object
- getRobots( ): returns robots[ ], a collection of robots associated with the Gang
- getName( ): returns the name of the Gang as represented by an integer
- getColour( ): returns and integer representing the colour of the Gang

StatsLogger Class:

In order for the system to store game statistics, it requires a class which will log game events. Our system will download one JSON file for every robot entering the game; these files will be known as the robotJSON files. These files contain a record of robot statistics from previous games as well as functions for the robot behaviour. Our system will create one JSON file for an instance of the game; this file will be known as the statsJSON file. The statsJSON file will record robot statistics. The decision to store these statistics in a JSON file is a consequence of JSON’s fast look-up time and the notion that it is advantageous to store the data in one place.

Interactions:

The StatsLogger interacts with the SetUpMenuController which creates the various robot gangs at the start of the game, with the InputController which records data from the different user moves, and with the Interpreter class which records individual robot moves. It also interacts with the GameMaster, which passes the statsJSON file around to the various views.

Variables:

- statsJSON: a JSON file containing the key to the robotJSON of each individual robot

Functions:

All update functions will update individual statistics in a single instance of a statsJSON file which contains a key for each of the robotJSON files

robotID stores a unique identification tag for each robot

- StatsLogger( ): creates and initializes a statsJSON with a set of keys, each initialized to an individual robot in the game
- updateMatches(robotID): updates the number of times the robot has played
- updateWins(robotID): updates the number of times the robot has been on the winning team
- updateLosses(robotID): updates the number of times the robot has been on the losing team
- updateKilled(robotID): updates the number of times the robot has killed another team's robot
- updateAbsorbed(robotID): updates the number of times the robot has been hit by another team's robot
- updateLived(robotID): updates the number of times the robot has remained alive for the entire game
- updateDied(robotID): updates the number of times the robot has been killed
- updateMoved(robotID): updates the number of times the robot has moved from one space to another
- updateExecutions(robotID): updates the number of times a computer AI has been used

GameBoard Class:

The GameBoard class provides a system level game-board which will store the locations of all of the robots in play. Having a centralized location for the storage of robot positions reduces coupling in the system. It will make use of a hashmap to look up the coordinates of a given robot. This will promote fast look-up time, which is beneficial due to the frequent need to query a robot's position.

Interactions:

The GameBoard class interacts with the Robot class, specifically the collection of robots, the positions of which it will be storing, and the robot coordinates as it updates their positions on the board. It also interacts with the GameMaster, which will contain a copy of the game-board for the purpose of updating the view between plays. The Gameboard also interacts with the SetUpMenuController when it creates the initial game board.

Variables:

- robotCoord<robotID, coord>: a hashmap keyed by robotID which returns the coordinate of the current robot's location
- robotOnCoord<coord, robots[ ]>: a hashmap that is keyed by a coordinate and returns a list of robots that are currently occupying that coordinate, if any

Functions:

- GameBoard(teams[ ]): Creates, initializes, and returns a new GameBoard object
- getRobotsAtCoord(coord): returns a list of robots at a given coordinate
- getRobotCoord(robotID): returns the current coordinate location of a given robot
- updateCoord(coord, robotID): update the coordinates of a given robot
- inRange(robotID): returns a list of robots in range of a given robot

View Classes:

StartScreen Class:

The StartScreen class is the portion of the View that displays information and user input options on the initial start-up of the program. It displays the Game Title, a background image, a Start button, an Instructions button, and an End button. The StartScreen requires its own class because it requires a unique set of event handlers.

Interactions:

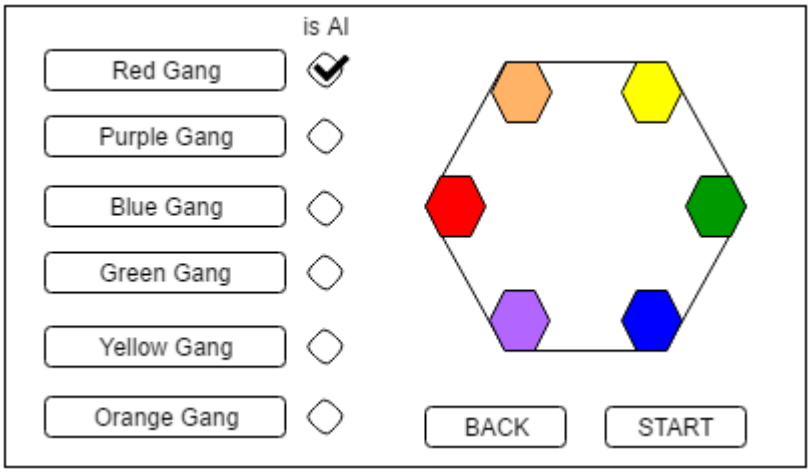
The StartScreen class will interact with the StartScreenController class, which calls the StartScreen class upon opening the game. Any time the user pushes any of the StartScreen buttons, the event handling is done by the StartScreenController Class.

Functions:

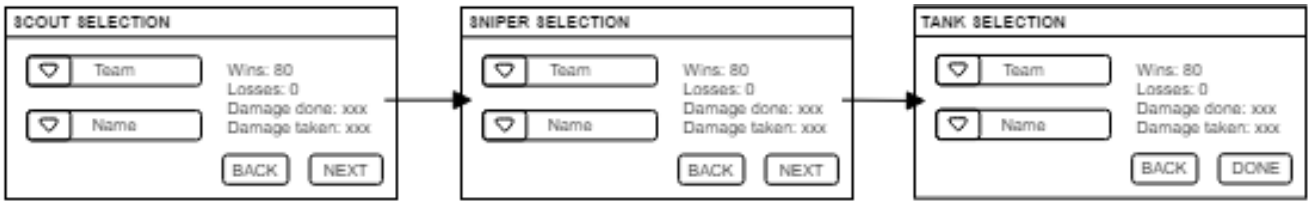
- constructor( ): Constructs the Game Title, image, and buttons upon initial opening of the StartScreen
- buttonListener( ): listens for button selection from the StartScreen class and calls the respective controller function from StartScreenController

SetUpMenu Class:

The SetUpMenu class is the portion of the View that displays information and user input options for match setup prior to the start of a new game. It displays a game-map graphic, a list of Gang buttons by colour, and a Start and Back button. All of the event handling for the buttons in the SetUpMenu view are handled by the SetUpMenuController. Due to the large number of unique inputs in the SetUpMenu, it requires its own class to handle this input.



Each button corresponds to a different Gang colour. The purpose of the Gang class is to give a grouping of 3 robots a unique number to differentiate them from other groupings of 3 robots. The player will use the toggle button to indicate whether the Gang will be controlled by a human or a computer AI. Once the player has selected a Gang Number, the SetUpMenuController will instantiate a SetUpMenuPopUp.



The SetUpMenuPopUp opens once a player has selected a Gang Number. For each type of robot in the Gang (Scout, Sniper, Tank), the user can select from various robots created by a given Software-Team. If the Back button is pressed, the Gang Number is deselected and the popup closes. Once the user selects a Software-Team, it can select a robot by name. Once a robot is selected by name, a list of statistics for that robot will appear on the right hand side of the SetUpPopUp screen. The Next button will take the user through the selection of all three robots, and once this selection is complete, the user can click done to close the SetUpMenuPopUp and return to the SetUpMenu.

Interactions:

The StartScreenController instantiates the SetUpMenuController when the Start button is pressed in the StartScreen view. The SetUpMenuController draws the view for the SetUpMenu. Once the user has selected their robot gangs, the user may press the Start button. Pressing Start is handled by the SetUpMenuController, which calls the GameMaster to draw the Game View. If the user decides to select the Back button, the SetUpMenuController passes back control to the StartScreenController which re-instantiates the StartScreen view.

Variables:

- roboStatsText: a string representing what is visible in the robot selection screen
- map: an image of the hexagonal game grid

Functions:

- Listeners:
  - buttonListener( ): listens for button selection from the SetUpMenu view and calls the respective controller function from SetUpMenuController
  - popUpButtonListener( ): listens for button selection from the SetUpMenuPopUp view and calls the respective controller function from SetUpMenuController
- Display:
  - SetUpMenu( ): Constructs and initializes the view of the SetUpMenu, called by the SetUpMenuController
  - displayRobotSelection( ): Displays the SetUpMenuPopUp for individual robot selection
  - redrawMap( ): Redraws the map on the SetUpMenu

GameScreen Class:

The most important feature of the game is the GameScreen itself. The GameScreen displays the hexagonal game board with a restricted view according to whose turn it is. The “fog of war” will be made possible by overlaying an image that displays only the hex tiles that are within the current player’s range of vision. Hovering over a game tile that is within the current players range of vision will reveal a display of all of the robots currently residing on that tile. The GameScreen also contains thee buttons to the side of the game-board: Move, Attack, and Forfeit. The GameScreen class uses several different Controller components to dictate its behaviour.

Interactions:

The GameScreen class interacts with the GameMaster, who receives coordinates of the tanks displayed on the board.

Functions:

- buttonListener( ): listens for button down events and calls the respective controller functions in the GameMaster

- tileListener( ): listens for tile selection and calls the appropriate controller functions in the GameMaster
- GameScreen(moveableCoord[ ], visibleCoord[ ], visibleRobots(<robotType, coord>, COLOUR)):
  - Creates a view with clickable hex tiles from moveableCoords[ ] (the set of all coordinates that a robot may move to), visible hex tiles from visibleCoords[ ] (the set of coordinates that are within the range of the current gang's vision, and all of the visibleRobots (queried from a dictionary containing the robots in the current game).
- redrawSprite(visibleRobots<robotType, coord>, COLOUR):
  - Redraws the sprites onto a map after each turn or movement.
  - Is called whenever a new tank comes into view or the turn changes from one player to another.
  - Uses DrawRobot subclass to draw the specific robot type of a given robot
- redrawSight(visibleCoord[ ], visibleRobots<robotType, coord>, COLOUR):
  - Redraws the sight overlay for all robots in the current gang.
  - Called upon a robot's movement or when the turn changes from one player to another
- redrawMove(moveableCoord[ ], visibleRobots<robotType, coord>, COLOUR):
  - Redraws the possible move overlay for all robots in the current player's gang.
  - Called upon robot movement or when the turn changes from one player to another.

PassTheControls Class:

Due to the fact that our game can only exist on one screen, a screen between turns is necessary to prevent the accidental viewing of one players screen by an opponent. This screen is only necessary when there is more than one human player in the game at a time. The PassTheControls screen will consist of a simple graphic, an instruction of whose turn it is, and an OK button. The user whose turn it is should click the OK button to confirm that the controls have been successfully passed over from the previous player.

Interactions:

The PassTheControls view interacts with the InputController, as well as the GameMaster when the user clicks the OK button. The InputController handles the input and the GameMaster re-opens the GameScreen.

Functions:

PassTheControlsView(Gang Number): Creates a window containing a graphic, a message telling the user to pass the controller to the next player, and an OK button.

EndScreen Class:

The EndScreen class displays statistics from the current game upon its conclusion. Additionally, it provides options for how a user can proceed. The EndScreen contains a stats table that displays individual statistics for robots, a single column showing the wins and losses of the participating teams, and three buttons: A Back button, a Save-Stats button, and a Quit button.

Interactions:

EndScreen interacts with the StatsLogger to display information in it's tables. All of the EndScreen's input is handled by the EndGame controller.

Functions:

- EndScreen(string array):
  - Initializes the EndScreen with buttons and stats tables. Passes the string array to the statsTable( ) function which parses the strings and displays them in the stats tables.
- statsTable(string array): parses the strings array and populates the stats tables

- buttonListener( ): listens for any button down evens and signifies the appropriate controller function in the EndGameController

DrawRobot Class:

The DrawRobot class is an abstract class that helps facilitate the redrawing of robots upon turning or movement. DrawRobot is extended by the three robot draw classes (DrawScout, DrawTank, and DrawSniper) who provided sprite specific redrawing functions.

Interactions:

The DrawRobot class is extended by DrawTank, DrawSniper, and DrawScout.

Functions:

- DrawRobot(coord, COLOUR, turns): abstract stub for implementation in subclasses.

DrawScout Class:

The DrawScout class is a subclass of DrawRobot that redraws the scout robot sprite upon turning or movement to reflect the action taken. DrawScout draws the scout robot sprite to face the direction given (on the event of a turn) or redraws the scout robot sprite onto a new tile (on the event of movement).

Interactions:

The DrawScout class interacts with the GameScreen, who would call DrawScout functions when appropriate for the redrawing of a scout robot sprite.

Functions:

- DrawRobot(coord, COLOUR, turns): draws a scout robot sprite at the given coordinates, facing the calculated direction. The direction the scout robot sprite front should be facing is determined by its given colour position relative to the center at the beginning of the game and the number for the edge currently being pointed at by the robot (and the side the sprite must now face).

DrawSniper Class:

The DrawSniper class is a subclass of DrawRobot that redraws the sniper robot sprite upon turning or movement to reflect the action taken. DrawSniper draws the sniper robot sprite to face the direction given (on the event of a turn) or redraws the sniper robot sprite onto a new tile (on the event of movement).

- Interactions:

  The DrawSniper class interacts with the GameScreen, who would call DrawSniper functions when appropriate for the redrawing of a sniper robot sprite.

- Functions:
  - DrawRobot(coord, COLOUR, turns): draws a sniper robot sprite at the given coordinates, facing the calculated direction. The direction the sniper robot sprite front should be facing is determined by its given colour position relative to the center at the beginning of the game and the number for the edge currently being pointed at by the robot (and the side the sprite must now face).

DrawTank Class:

The DrawTank class is a subclass of DrawRobot that redraws the tank robot sprite upon turning or movement to reflect the action taken. DrawTank draws the tank robot sprite to face the direction given (on the event of a turn) or redraws the tank robot sprite onto a new tile (on the event of movement).

Interactions:

The DrawTank class interacts with the GameScreen, who would call DrawTank functions when appropriate for the redrawing of a tank robot sprite.

Functions:

- DrawRobot(coord, COLOUR, turns): draws a tank robot sprite at the given coordinates, facing the calculated direction. The direction the tank robot sprite front should be facing is determined by its given colour position relative to the center at the beginning of the game and the number for the edge currently being pointed at by the robot (and the side the sprite must now face).

Controller Classes:

StartScreenController Class:

The StartScreenController is responsible for the control of the StartScreen view component. Each view component has its own controller component to reduce the size of the main controller (the GameMaster) and to reduce coupling.

Interactions:

Interacts with the StartScreen view

Functions:

- StartMenuController( ): constructs the StartScreenController and initializes the StartScreen view
- onButtonPress(Start button): closes the StartScreen view and instantiates the SetUpMenuController
- closeView( ): closes the StartScreen view

SetUpMenuController Class:

The SetUpMenuController is responsible for all changes made within the SetUpMenu view. Its primary purpose is to ensure that the gangs of robots are set up correctly and instantiated.

Interactions:

The SetUpMenuController interacts with the SetUpMenu view, with the Gang model to instantiate the Gangs of robots, with the Robot Librarian to select the robots for a given Gang, and with the GameMaster, which is instantiated by the SetUpMenuController. The SetUpMenuController itself is instantiated by the StartMenuController.

Variables:

- basicStatsJSON: holds the basic stats of all the robots in the Robot Librarian
- maps[ ]: the set of images for various styles of the game-board (depending on number of Gangs)
- gangs[ ]: hold the set of robots in a given Gang

Functions:

- SetUpMenuController( ): initializes the SetUpMenuController and downloads the basicStatsJSON file from the Robot Librarian
- getNamesInCriteria( ): returns an array of the robot names in the basicStatsJSON file that match the current "Created-by" criteria selected in the SetUpMenu view
- sortWins( ): returns an array of robots sorted by wins
- makeGangs():
- getGangs( ):
- getStats(robotName, gangID): returns a string of stats pertaining to a given robot

  Example Stats as returned by getStats( ):

```
--------------------------
 Team: A1 Name: Killer Class: 0
 Wins: 80
 Losses: 0
 Damage done: xxx
 Damage taken: xxx
--------------------------
```

GameMaster Class:

The GameMaster is the main controller for the system. It is responsible for managing and calling the necessary views required by the system. Those views, in turn, call their own controller classes. The GameMaster is also responsible for keeping track of whose turn it is and for detecting when the game is over. Although the GameMaster is the main controller and coordinator of the other controller components, our system splits the controller into smaller components to reduce coupling, increase cohesion, and to keep related functionality in a compact package.

Interactions:

The GameMaster interacts with the StatsLogger model by passing it to various controller components, with the GameBoard model by passing its data to the view components, and with the Gang class by acquiring a list of Gangs which it uses to handle turn-order and pass Gang info to the view components. The GameMaster is also responsible for calling the Forth Interpreter when a Gang is being controlled by computer AI's. Lastly, it handles the instantiation of the PassTheControls view, the GameScreen view, and the EndScreen view.

Variables:

- teams[ ]: a circular collection of robot gangs, used to track turn order amongst robot gangs
- robots[ ]: a collection of robots, used to track turn order amongst individual robots

Functions:

- getNextRobot( ): determines which robot and which team is up next in the turn-order
- gameOver( ): determines when the game has ended

- isAI(robotID): determines if a robot is being controlled by a computer AI
- moveAIRobot(robotID): calls computer AI move function
- updateTurnList( ): removes dead robots from turn-order list

InputController Class:

The InputController class is another controller component, specifically responsible for handling input from both the Forth Interpreter and the user. It translates any user generated events into function calls on other parts of the system. Should handle illegal input.

Interactions:

The InputController interacts with the Robot class, the GameScreen model, and the Gang class. There should be more.

Functions:

- move(coord, robotID): calls the robot's move function with a coordinate parameter
- shoot(coord, robotID): calls the robot's shoot function with a coordinate parameter
- concede(gangID): kills all of the player's robots and removes them from the game

EndScreen Controller:

The EndScreenController is responsible for the control of the EndScreen view which is displayed at the end of a game. It is instantiated by the GameMaster when only one gang of robots has one or more robots remaining. It also instantiates the StartScreen view if the Back button is pressed by the user.

Interactions:

The EndScreenController is instantiated by the Game Master. It accesses the StatsLogger and can both close the game window and re-instantiate the StartScreen controller.

Functions:

- EndScreenController(JSON object): The constructor of the EndScreenController. Instantiates the EndScreen and passes it the game statistics of the current game
- udapteStats( ): Passes the statistics to the RobotLibrarian
- closeView( ): closes the game window
- onButtonClick(Back/Close button): Begins by updating all game statistics and then closes game window or instantiates StartScreenController depending on button pressed