CMPT 370 Group A3

Implementation Document

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Implementation challenges

Implementing RoboSport is the largest project many of the team members have been involved with, and so it certainly brought along many challenges. The first challenge we came across was one of communication. Since all group members are students involved in a large number of other commitments, it was difficult for us to communicate well and get ourselves on the same page during this project. These communication problems manifested themselves in our implementation in several ways. Facing the reality that there were few times when we could all work together, we decided to divide the project as much as we could into distinct modules which could be linked together. This had the advantage that we could each work on our own designated module, and also meant that we could utilize unit testing more effectively in most cases.

We ran into some implementation issues in regards to the JSON library we've decided to use, (see more about the Gson library below). The biggest issue pertained to deserializing the 'code' portion of a robot because it is an array containing objects which correspond to different Java classes depending on the contents of the object, that is a 'variable' entry is different semantically from a 'word' entry. Luckily, after reading some library documentation we were able to write a custom deserializer which overcame these issues.

As we continued to work on the project, not only did some of the requirement specifications change (for instance having ground of different terrain difficulty) but also our understanding of different elements of the project evolved as we got further into our implementation. We had a very weak understanding of how much of the robot language worked when we started and have needed to adjust our expectations and implementation to fit our new understanding as we continue onwards. An example of this are the identify! and scan! keywords. These are meant to help identify nearby robots, however we realized that the notion of 'direction' is difficult on a hex grid. A robot may be in 'range' but still isn't addressable using our direction system. To solve this problem we decided that 'visible' means that a square must be some range in one of the 6 directions, and we adjusted our implementation of scan! and identify! to reflect this.

State of implementation

Unfortunately, due to time pressures, the complexity of the project, and unbalanced group dynamics we have not succeeded in implementing a version of RoboSport which fulfills our requirements. In accordance with Hofstadter's law, things took longer than expected and complexity arose along the way. Though we wish we could have succeeded in implementing more of the features, we learned a lot about how projects grow, and how interaction between multi-level systems with many parts can become complex quickly.

In the end, our version of RoboSport can successfully import several teams of robots from JSON robot files and can construct Robot models with the appropriate statistics. It can then allow them to fight in an arena, providing the user with a user interface that allows pausing, playing, and changing the speed of the fight. The game board shows the position of robots on the board and the number of robots on each square. We also created an “instant match” mode in which the game is played in the background, and the results are displayed to the user once the winner has been determined. Finally, we have a test-bench mode. In this mode, the user is able to import robots and execute commands to test the functionality of both the robot and the game.

We were able to assign different movement difficulties to each cell, though the robots currently do not pay attention to these difficulties. We simply ran out of time to fully implement it. However, the difficulties are dispalyed on the game board through the use of green, yellow, and red colourings on the hex tiles. We were also not able to implement the robot librarian software, though this was due to the fact that it was not available for testing and was not made available to groups within reasonable time. Our display leaves much to be desired and doesn’t clearly display stats about robots involved with the fight, and we would have added a lot of styling changes to the project if we had more time available.

Design deficiencies

Since we chose the MVC architecture we also came across some times where our design decisions made it tough to avoid crossing View->Controller boundaries. In some cases we had to sacrifice the purity of this abstraction because of time constraints, but we’ve learned more about how we could have designed the system to avoid the need to break our boundaries.

Overall we have discovered that our design document was lacking a few classes and methods which we have added to the final project. In most areas we were sufficiently accurate in our designs, however there were a few areas of oversight; for example the parsing and interpreting of robot language code was not given the necessary level of attention. As a result we have needed to add a Parser class which attaches to a Robot in order to interpret its robot language program.

While we had a basic understanding of how the MVC architecture would be implemented, a few of the more specific implementation details were forgotten in our design. Specifically the notion of how the view should be updated. We must choose between several options, such as updating it explicitly from the controller, using a thread to update the view based on underlying data every few seconds, or to use some form of event based triggering system. In the end we decided that for a project of this scope it is easiest to use an ‘update’ method on the view which we can call whenever the underlying data changes.

Due to time constraints and less-than-optimal planning, we often relied too heavily on public static variables rather than passing the object references to each module in our MVC architecture. Given more time, we would have cleaned up that code to ensure only specified modules have access to certain objects.

Pair programming and Code Reviews

An inevitable challenge when working with others is that of programming preferences and coding styles. Since the project is relatively small and there were few of us involved we have not been strict in enforcing a particular code formatting style, however since we have all been using the ‘eclipse’ IDE, and we all have similar backgrounds in Java programming (from our previous classes) we have found that our code style has been relatively consistent across the group. In Java there are several cases where there is more than one way to accomplish the same task (e.g. ‘for’ loops vs iterators vs ‘for each’ loops, etc.) In the cases where we have discovered inconsistencies we have done our best to rectify them.

As stated earlier, communication has been a challenge for us, one way that we were able to help with spreading our knowledge amongst the group was to pair program when possible, this was particularly useful whenever we were in the process of linking together modules we had written separately, as it allowed us to make sure we were connecting them appropriately and verify that they worked. When pair programming wasn’t possible due to scheduling conflicts, we could resort to asking questions in our team’s group chat.

Since we have done the majority of our work on a single master branch, we have not been able to do code review on individual ‘pull requests’ as we would have liked to do, we were able to use ‘git diff’ to some degree of success. As our project neared completion we looked over each other’s modules and pointed out areas where code could be improved, doing what we could to clean it up. At this point we realize that our overall code quality would be much improved if we had been using more pair programming and code review as we built the project.

Division of Labour

As stated above, our team decided primarily use a divide and conquer based approach to implementing our system. Each module involved in the system had one team member who was responsible for that module. That team member would implement that module and provide an interface for each of the other modules to use and we would pair program to link the modules together in a sensible way. The modules we decided on were as follows:

- Views and GUI - Erik
- Controller and game logic - Evan
- Forth Parser and Robot importer - Chris

Use of External Libraries

The vast majority of the project was implemented using the standard tools available as part of Java, however we decided to use an external library for the purpose of parsing incoming JSON robot files. The library we chose for this is Google's library called 'Gson'. Gson vastly simplifies the task of deserializing robot files into the Java classes we need. We have used it by defining a Robot model which matches the JSON Robot Schema we were provided with as closely as possible. We have written in a 'fromJson' static method into our Robot class as an alternative way to construct a Robot. This function wraps Gson's 'fromJson' method and utilizes a custom deserializer for the 'code' key within a Robot JSON file, then uses the resulting objects to initialize the robot object with the correct health, firepower, variables, words, etc. We found this library relatively easy to work with, though it does have complications when working with arrays containing multiple types of data. We would definitely utilize this library again in future projects and had a good experience with it.

We have used the JUnit testing library to iteratively test and in some cases TDD our implementation. This has been invaluable in preventing regressions in our code as we continue to build. It has also helped us to iterate quickly because after significant code changes we can simply run the tests for a given module and ensure that it is still behaving as we expect. JUnit has proven to be useful as a debugging tool as well, when there is a behaviour that is unexpected we can simply use the debugger in Eclipse to walk through the failing JUnit test and discover the error. TDD and JUnit was not used in implementing the Views because they are largely aesthetic in nature, the Controller is also untested because it glues many pieces of the code together and would require extensive mocking and stubbing to unit test. We've learned that designing our code in a way that is easy to test is important for future projects. The Robot model and the parser/interpreter implementations were developed largely using JUnit with TDD. Not everyone in the group wanted to use TDD, and so some portions of code remain untested.

Documentation

Since this application is meant to be used via a GUI by users there was not much in the way of API documentation, and the general use cases are covered in detail in our User Guide. For internal use many of our functions have javadocs associated with them to clarify how functions are to be used.

Please read the User Guide for more details on how to use the software.

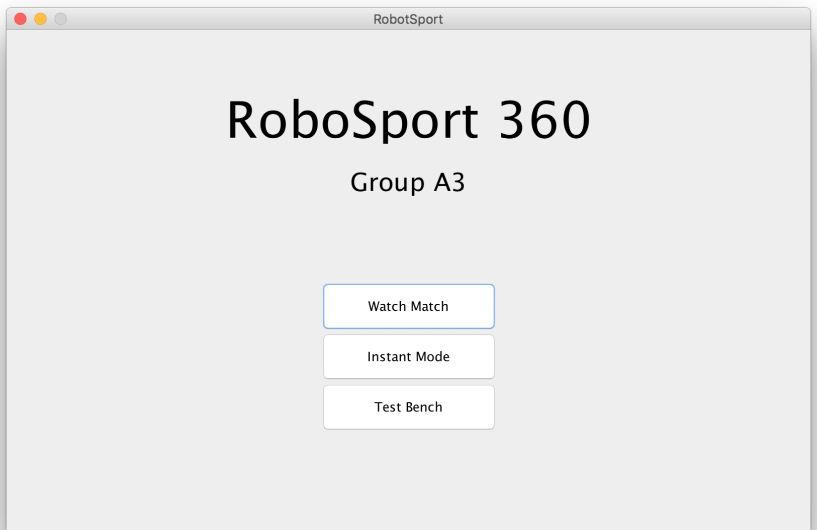
Final Implementation Statistics

- Total Lines of code: 3285
- Total # of classes: 22
- Total # of methods: 178

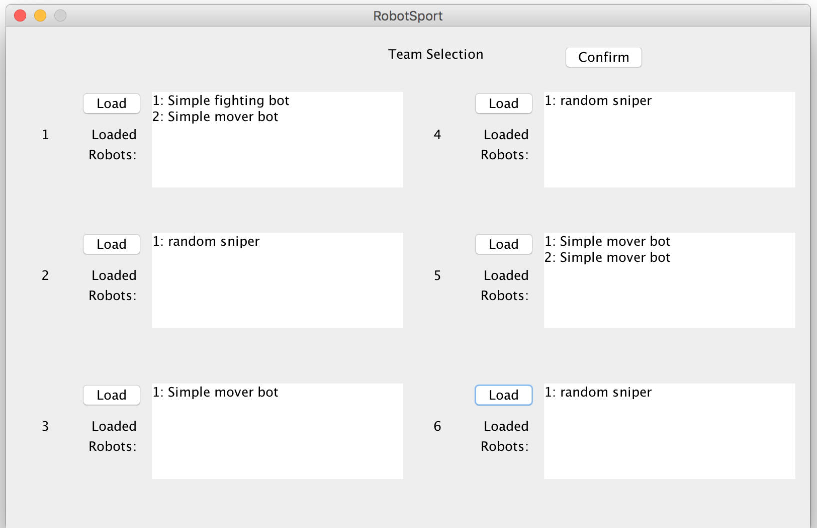
One member of the group decided to use TDD to develop his part of the application (Chris) and so both the Parser class and Robot class have a small suite of unit tests written using JUnit. These are not as comprehensive as we would have liked, but we definitely saw the value in having a way to notice regressions as soon as possible. The TDD method was invaluable when working with complex systems like the forth interpreter.

Screenshots

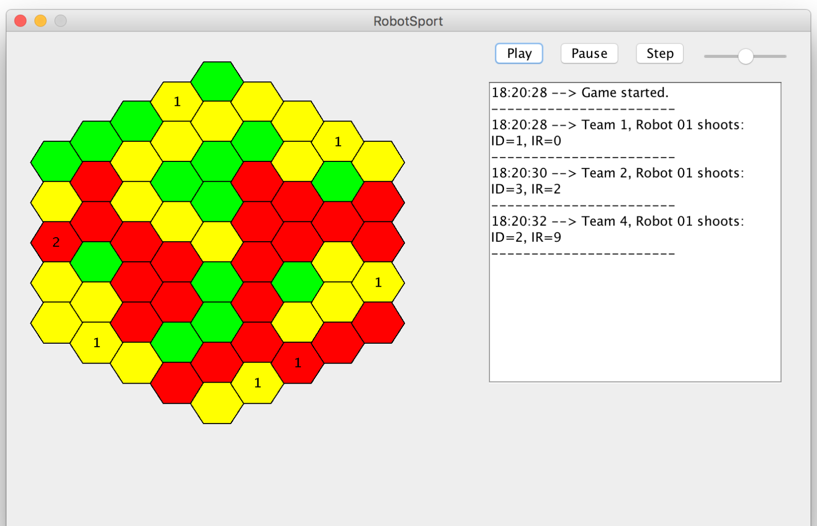
The following is our Main menu where the user can select which sort of game mode they'd like to try.



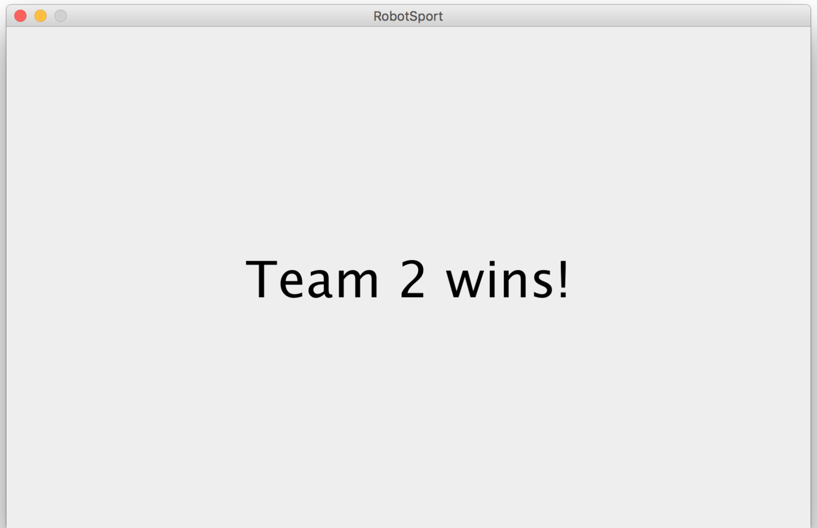
The following is where a user can load Robots onto teams via json files.



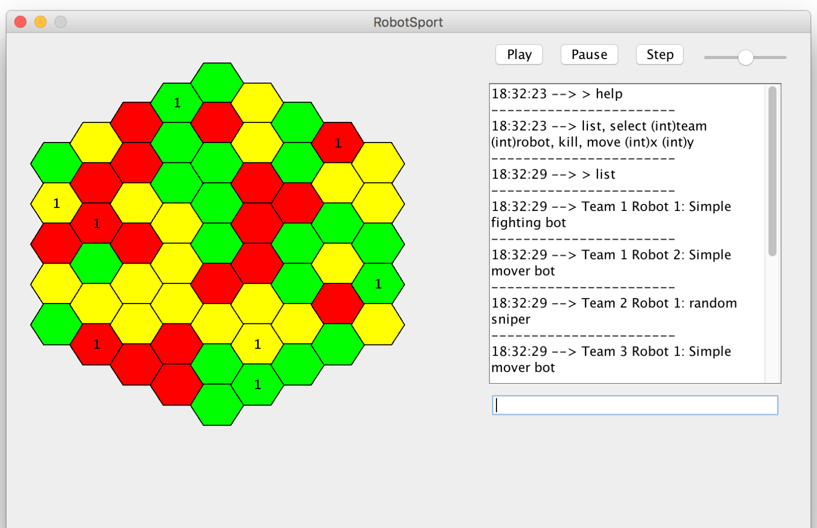
The following is a view of a gameboard in action where Robots are fighting.



The following is the results screen, which shows the winner of the match after completion.



The following is the test-bench screen, which allows the user to execute commands on a robot to test the gameplay.



How to compile

Since we have developed this project using the Eclipse IDE we recommend using Eclipse to build and manage the project. Firstly you must import the project by clicking 'File > import' and choosing 'existing projects into workspace'. Follow the dialog to import this project into your workspace. Next it is important to make sure that the external libraries which we used are present on your build path. This can be accomplished within Eclipse by looking inside the 'lib' folder in the project explorer and choosing 'add to build path' for both of the JUnit and Gson jars there. From this point it should be sufficient to locate the 'Main.java' file in the 'main' package in the package explorer, right click it and choose 'Run As > Java Application'.

Robot tests

You can find several of our testing robots in the src/misc directory of the java project. We've used different types of robots for testing different portions of development. For instance there is a "simplemover.json" robot which just moves itself in small circles, this was useful for testing movement and giving a target for shooting robots. One other robot we used is the "basicfighter.json" which scans for robots and if it finds one will attempt to chase and shoot it. This one has logic which uses 'if' and 'loop' statements and is a good candidate for testing our parser and also the shooting/scanning functions.