

Fantasy League Object Oriented Development (FLOOD)

Project Report

COMS W4115: Programming Languages & Translators

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Introduction

As defined on Wikipedia: *fantasy sport (also known as **rotisserie**, **roto**, or **owner simulation**) is a game where participants act as owners to build a team that competes against other fantasy owners based on the statistics generated by the real individual players or teams of a professional sport.*

The popularity of fantasy sports has exploded in recent years. A 2007 study by the *Fantasy Sports Trade Association (FSTA)* estimated nearly 30 million people in the U.S. and Canada, ranging in age from 12 and above, participated in organized fantasy sports leagues. In comparison, an estimated 3 million people played in the early 1990s, swelling to 15 million by the early 2000s. This impressive growth looks to continue since the study revealed teenagers in both the U.S. and Canada play fantasy sports at a higher rate than the national average, with 13 percent of teens playing in the U.S. and 14 percent playing in Canada.

The FSTA study also estimated the spending habits and overall economic impact of fantasy sports players. Consumers engaging in this ever growing hobby spent \$800 million directly on fantasy sports products and an additional \$3 billion worth of related media products (such as DirecTV's NFL Sunday Ticket and satellite radio's coverage of MLB). Moreover, the growing popularity of fantasy sports is not restricted to North America alone.

A recent 2008 study by a European-based market research company estimated the number of fantasy sports players in Britain range between 5.5 and 7.5 million and vary in age between 16-64, of which 80 percent participated in fantasy soccer. Fantasy gaming has become so entrenched in popular culture, there’s even an American comedy sitcom called *The League* in which the main characters obsess over winning their fantasy football league.

Thus, the **FLOOD** programming language is targeted to address a specific problem domain: the creation of fantasy gaming league applications. From the ground up, the language is designed to make it as straightforward as possible for programmers to create fantasy gaming applications. This task will entail defining a league and its type (sports, financial markets, election polls, etc.), establish the rules of governance, enumerate the users/teams and individual league players, and set various other control parameters.

In this sense, **FLOOD** is very much a “high-level” and “domain-specific” language. Such as **R** and **S** are languages designed specifically to perform statistics calculations, **SQL** for relational database queries, and **Mathematica** and **Maxima** for symbolic mathematics, **FLOOD** is dedicated to solving the particular problem of fantasy gaming. Given the ubiquity of fantasy sports as a recreational hobby for millions of people, the creation of a domain-specific language to attack this problem in a clear and concise native programming etymology, as opposed to the application of a general purpose language such as **C** and **Java**, is a challenging and worthwhile undertaking.

2

A Quick Tutorial

The goal of this tutorial is to jump into the **FLOOD** language by creating a simple fantasy league. We won't concern ourselves with implementation details just yet. The language is meant to be simple yet sufficiently extensible. However, the tutorial will not delve into the various features that make this possible.

Experienced Java programmers will be familiar with most of the syntax since it is a subset of the popular C-like syntax. In certain instances we have opted to use Python style syntax for improved readability or Pascal syntax for ease of use. Where possible we compare and contrast a specific feature with Java, Python or some other language which comprise the main influences of **FLOOD**.

Some examples which aren't strictly necessary for the sample program are included to clarify points of possible confusion. These are noted when used. Additionally, we repeat portions of the **FLOOD** standard library for ease of reading. The full library is included in the *Reference Manual* and *Appendix* where appropriate. Please be aware of the distinction made between programmer, the person actually writing a **FLOOD** program (most likely yourself if you are reading this), and *User*, the end-user of the application (which could be thought of as a team entity). Additionally, *Player* refers to a player of the fantasy league, either an actual person as in the case of a quarterback in football or a non-human entity

as is the case with *AAPL* (Apple) in the stock market.

2.1 Getting Started - The “Hello World” Program

FLOOD has a very specific application domain. It’s goal is to create fantasy leagues and thus, the ability to print to console is fruitless. However, the GUI will have a message box where messages can be displayed to the *User*. **FLOOD** hides the details of the user-interface so the programmer can concentrate on the rules of their specific fantasy league. While the first simple program may seem more complicated than the simple Java “hello world” example, most programs generally will not be any more elaborate than this case.

Since **FLOOD** is built on top of Java byte-code, the programmer will not need to worry about system compatibility issues. Heeding the eternal wisdom of Kernighan & Ritchie, we also point out that compilation will only succeed if the programmer hasn’t botched anything, such as missing characters, misspelled keywords, or some other mistake that can cause an error in compilation.

Let’s start by showing what the *main* class will look like. Defining the *main* class should look somewhat familiar to those who have programmed in Python.

Listing 2.1: Sample.fld

```
1  /*
2  * Define the league and configure various settings
3  */
4  DefineLeague
5      /* Set league parameters */
6      Set LeagueName("Happy League");
7      ...
8      ...
9      Set MinTeamSize(5);
10
11 /*
12 * Define custom functions
13 */
14 DefineFunctions
15     Void myFunction1(Str param1, Int param2)
```



```

16     {
17         ...
18         ...
19     }
20
21     ...
22
23     Void myFunction2 (Bool param1, Flt param2)
24     {
25         ...
26         ...
27     }

```

Let's now review the notable differences between Python, Java and **FLOOD**. First, the convention in **FLOOD** is to name each file with the *.fld* extension. In addition, each file is a self-contained program and unlike Java, there is no ability to add separate classes. The first letter of any keyword in **FLOOD** is capitalized.

The language was originally intended to be object-oriented in order to facilitate modularity and extensibility of code. However, due to time constraints, it was decided to reduce the scope of the language without losing the basic functionalities as originally promised. Therefore, the ability to add classes and inherit from pre-existing libraries was left for a possible future iteration of the language.

The entry point for a **FLOOD** program is to specify the `DefineLeague` keyword. Since there is no question of class scope within a file, code below this program block is considered part of the program while any code above (excluding comments, naturally) is an error. It is important to note the `DefineLeague` block is semantically equivalent to the `main` function in a standard Java program and all the parameters and settings specified within this block can be viewed as passing parameters via the constructor method in a Java program. Moreover, it is not possible to declare local variables here since meaningful computations do not exist in this section of a **FLOOD** program.

Listing 2.2: Defining the league and setting parameters.

```

1  /*
2  * Define the league and configure various settings

```

```

3  */
4  DefineLeague
5      /* Set league parameters */
6      Set LeagueName("Happy League");
7      Set MaxUser(10);
8      Set MinUser(2);
9      Set MaxTeamSize(10);
10     Set MinTeamSize(5);
11
12     /* Add Users */
13     Add User("Eli");
14     Add User("Dillen");
15     Add User("Anuj");
16     Add User("Tam");
17     Add User("Steph");
18
19     /* Add Actions */
20     Add Action("Field Goal Attempt", -0.45);
21     Add Action("Field Goal Made", 1.0);
22     Add Action("Free Throw Attempt", -0.75);
23
24     /* Add Players */
25     Add Player("Lebron James", "forward");
26     Add Player("Chris Bosh", "forward");
27     Add Player("Dwyane Wade", "guard");

```

Every **FLOOD** program implicitly instantiates a *League* object. The *League* object contains most of the other objects needed for the **FLOOD** program including *User*, *Player* and *Action* lists.

For the minimum program, it may be possible to leave the maximum and minimum user settings at their respective default values, but as an example, we set them above. In order to change certain attributes of the *League*, use the `Set` keyword with the attribute to be changed. Additionally, to create new *Users*, *Actions* and *Players* use the `Add` keyword. Since local variables can not be set in the *League* definition, all attributes must be literals. Note that *Users* and *Players* are simply a *string* representing a name, while *Action* is a name-value pair consisting of the name of the *Action* and the value that will be added to a *User's* points through that *Action*.

A **FLOOD** developer need not worry about passing any values to the back-end—**FLOOD** encapsulates the process of passing the *League* to the GUI and calling the GUI.

Listing 2.3: Defining functions.

```
1  /*
2  * Defining custom user functions
3  */
4  DefineFunctions
5      Void myFunction1(Str param1, Int param2)
6      {
7          ...
8          ...
9      }
10
11      ...
12
13      Void myFunction2(Bool param1, Flt param2)
14      {
15          ...
16          ...
17      }
```

Before custom functions can be defined, the keyword `DefineFunctions` must be specified. Certain **FLOOD** functions are built into the language and the compiler will check whether the programmer has overridden them. They are as follows:

Listing 2.4: Predefined **FLOOD** functions.

```
1  Int draftFunction(int turn) {...}
2  Bool draftPlayer(User u, Player p) {...}
3  Bool trade(User u1, Player[] p1, User u2, Player[] p2) {...}
4  Bool dropPlayer(User u, Player p) {...}
```

If one of the above-mentioned functions is defined in the source file, then **FLOOD** will simply use the programmer's defined function. However, if any of the functions are left out, then **FLOOD** will generate default code for them (*Note: the appendix has a full listing for reference). A function in **FLOOD** is similar to a method in Java or a function in C++. We call a function by using the function's name with an optional argument list in between mandatory parenthesis.

In the following example, assume the function was defined as:

Listing 2.5: Predefined FLOOD functions

```
1 Int draftFunction(Int turn)
2 {
3     /* Number of Users is 10 */
4     Int currentTurn;
5     currentTurn = turn % 10;
6     Return currentTurn;
7 }
```

There are several things to note in the above code snippet. **FLOOD** uses `/* ... */` comments similar to Java and can span multiple lines. Variables are declared before they are used and all variables are instantiated to default values. Using a variable that hasn't been instantiated will result in a logical error rather than a semantic error. All variable declarations must occur before any other code in the function body.

A Return must only occur at the end of the function and must match the stated return type. In the example above, `currentTurn` is declared as an `Int` and then instantiated. Only following the rest of the production body does `currentTurn` get returned.

A function can be called similarly to Java:

Listing 2.6: Function call.

```
1 draftFunction(10);
```

or in an assignment:

Listing 2.7: Function call in an assignment.

```
1 Int a;
2 a = draftFunction(10);
```

Hiding the GUI is one of the main features of **FLOOD**. There is no need to program any part of the user-interface. The GUI will know how to hook into the **FLOOD** source and connect the buttons on the interface to the actions defined by the programmer. The output will be a GUI window which will control the flow of the program and in turn, the flow will depend upon the user's interactions. For instance, the only way to update the scores of the

Users is by adding player-action files to the program. *Player-Action* files would contain new statistics of the format *Player, Action, Quantity* such as:

LeBron James, Rebound, 7
Lebron James, Assist, 4
Carmelo Anthony, Steal, 5
Carmelo Anthony, Point Scored, 25

This is everything needed to run a simple **FLOOD** program. This basketball league will mirror equivalent leagues in *Yahoo! Sports* or *ESPN Fantasy* without network connectivity. The minimum “Hello World” program is included below:

Listing 2.8: Minimal FLOOD program to create a basketball fantasy league.

```
1 DefineLeague
2   Set LeagueName("Basketball League");
3   Add User("Anuj");
4   Add User("Tam");
5   Add Action("Field Goal", 2.0);
6   Add Action("Rebound", 1.0);
7   Add Player("Lebron James", "forward");
8   Add Player("Kobe Bryant", "guard");
9   Add Player("Dwight Howard", "center");
10  Add Player("Kevin Durant", "forward");
11
12 DefineFunctions
13  /* None declared */
```

2.2 Variables & Arithmetic Expressions

Just as any robust programming language requires a comprehensive computational model, **FLOOD** provides the user with a set of arithmetic expressions and variable types to work with. To use a variable and work with it, the variable must be declared before it is used for the first time. A declaration defines the properties of the variables. A declaration is of the form *type name* where *type* is the data type of the variable and *name* is the identifier of the variable.

Listing 2.9: Variable declarations.

```
1 /* variable declarations */
2 Int i;
3 Bool b;
4 Flt f = 1.2; /* ...assigning value at point of declaration */
5 Str s;
6
7 /* ...or assigning values at a later point. */
8 i = 1;
9 b = True;
10 f = 2.1;
11 s = "Hello World";
```

Here, variables are declared before they are used. It's also possible to assign values to the variables in the declaration. An important distinction between **FLOOD** and a programming language like Java is the location of actual declaration which as noted *must be at the top* of the function body. Following the declarations, the variables can be used as needed. Note that there is no coercion between Flt and Int since **FLOOD** does not support implicit type coercions, as shown here:

Listing 2.10: Implicit type coercion is not supported.

```
1 Int i;
2 Flt f;
3 i = 2.0; /* Error since 2.0 is a Flt */
4 f = 1; /* Error since 1 is an Int */
```

More examples of assignment expressions which will throw errors due to mismatch types:

Listing 2.11: More errors due to mismatch type declarations and assignments

```
1 Int i;
2 Int f;
3 f = 1.0;
4 i = f / f; /* Error: Int assigned a Flt expression */
```

FLOOD offers the set of arithmetic expressions required to create a comprehensive fantasy league of the developer's choice. This set comprises of the standard addition, subtraction, multiplication, division and modulus operators. In addition, statements can include functions as in the case:

Listing 2.12: Function used in an arithmetic statement.

```
1 Int i;  
2 i = someFunction() + 10 * 4; /* someFunction() returns an Int  
   */
```

The above code snippet provides a glimpse of the arithmetic capabilities of **FLOOD**. The ‘+’, ‘-’, ‘/’, ‘*’, and ‘%’ operators are binary operators and can be used to add, subtract, divide, multiply and obtain the modulo of `Flt` (floats) and `Int` (integers).

2.3 Loops & Conditionals

Creating a fantasy league in **FLOOD** can range from simple computations to complex algorithms involved in drafts. To facilitate the latter, a **FLOOD** developer has the choice of using loops to make life easier.

The syntax for the *while* loop follows the standard convention:

Listing 2.13: *while* loop

```
1 While (total < 4)  
2 {  
3     centers = centers + 1;  
4     guards = guards - centers;  
5     forwards = forwards / 2;  
6     total + 1;  
7 };
```

The *while* loop operates as follows: the condition in parentheses is tested. If it is true (`total` less than 4), the body of the loop (the three statements enclosed in braces) is executed. Then the condition is checked again and if true, the body is executed again. When the test becomes false (`total` equals or exceeds 4) the loop ends and execution continues at the statement immediately following the loop.

FLOOD provides the developer with a conditional in the form of the *if* expression that is defined as follows:

Listing 2.14: *If* conditional

```

1 If (position == "center")
2 {
3     position = position + 1;
4 };

```

Here, the program checks the condition enclosed in the bracket. If this condition is met (in this case, if the person’s position is center, then the program executes the next statement. **FLOOD** also incorporates *if...else* conditional statements as follows:

Listing 2.15: *If...Else* conditional statement.

```

1 If (points > 100)
2 {
3     trade = True;
4 }
5 Else
6 {
7     trade = False;
8 };

```

If the first condition (`points > 100`) is not met, then the statement or statements enclosed in body of the Else condition will be executed i.e. assign False to the `trade` variable.

2.4 Functions & Scope

As in countless other programming languages, **FLOOD** employs the concept of a function (also referred to as a method, subroutine, or procedure), a logical grouping of code within the larger program which carries out a specific task and is relatively independent of the rest of the code base. The idea of a function is analogous to the notion of the “black box” when discussing the concept of encapsulation in object-oriented programming. For a well-designed function, the particulars of “how” the function performs its task(s) is not of critical importance and just knowing “what” it does suffices. Functions can be “called” or “executed” any number of times and from within other functions.

Listing 2.16: Syntax of a FLOOD function.

```
1 Bool evaluate(User u, Player p)
2 {
3     ...
4 }
```

An important requirement to remember is that functions *must be defined before* they are used, as shown here:

Listing 2.17: A function must be defined before being called.

```
1 Bool function1()
2 {
3     Return False;
4 }
5
6 ...
7
8 Bool function2()
9 {
10     Return function1();
11 }
```

In this example, function `function1()` is defined before `function2()` and therefore can be used in the body of `function2()`.

The scope of a variable is limited to the function it is declared in—*variables cannot be declared global*. In order to modify variables between functions they must be passed as parameters to the specific functions.

2.5 Users & Players (Arrays)

The types `User` and `Player` are specific to **FLOOD**. They can only be declared as a formal parameter in the argument lists of functions:

Listing 2.18: `User` and `Player` declared in function argument list

```
1 Bool draftPlayer(User u, Player p) {...}
2 Bool trade(User u1, Player[] p1, User u2, Player[] p2) {...}
3 Bool dropPlayer(User u, Player p) {...}
```

The GUI knows to look for these specific functions and populate them correctly. It is possible to define custom functions that take `User` and `Player` as arguments, though **FLOOD** convention recommends against it.

Within **FLOOD**, arrays exist only in the context of `User` and `Player`. Both types can be passed as single values or array types. The array declaration is similar to Java:

Listing 2.19: Passing `User` and `Player` arrays

```
1 Bool trade(User u1, Player[] p1, User u2, Player[] p2) {...}
```

Square brackets are placed after the type before the name of the variable. An array can be accessed in the body of the function using an `Int` index. Both of the examples below are correct:

Listing 2.20: Assessing array elements using index.

```
1 Int i = 5;
2 draft(a[1]);
3 draft(b[i]);
```

FLOOD has a few built-in functions that give the programmer more flexibility in writing functions. The functions are associated with `Users` and `Players` and as such are included in this section. The first function `ArrayLength` simply returns the length of the array that is passed to it. Note that Python similarly uses this kind of syntax to find the length of a list. The other two functions `AddPlayer()` and `RemovePlayer()` are functions that alert the GUI to the addition or removal of a `Player` from a `User`. For the full list of functions, see the *Reference Manual* section *Function Calls*. The syntax is as follows:

Listing 2.21: Some **FLOOD** utility functions and usage.

```
1 Int i;
2 i = ArrayLength(p); /* Where p is an array of Players */
3 AddPlayer(u, p); /* Where u is a User and p is a Player */
4 RemovePlayer(u, p); /* Where u is a User and p is a Player */
```

2.6 Alert & Error

FLOOD programs are run through a GUI so print statements conform to this interface. As an alternative to print streams to a console, **FLOOD** allows the programmer to display boxes of text. There are two kinds of boxes, `Alert` and `Error`:

Listing 2.22: Launching `Alert` and `Error` message boxes.

```
1 Alert("Alert Box Title", "Alert message.....");  
2 Error("Error Box Title", "Error message.....");
```

Both message boxes have the same structure. The keyword `Alert` or `Error` must be followed by the standard parenthesis with two arguments. Both arguments must be of type `Str`. The first argument will be the box's title while the second argument will be the message body. The alert message box displays a black exclamation point in a yellow triangle, while the error message box displays a white 'X' in a red circle.

3

Reference Manual

3.1 Introduction

The following is a brief Reference Manual for the **FLOOD** language. The reference manual is based on the K & R C manual which has for the most part inspired Java, the language **FLOOD** is based on. In certain instances, where there was no distinction between **FLOOD** and C, the C reference manual definition was used. Additionally, certain explanations were adapted from the Oracle (formerly Sun) online collection of tutorials.

Many parts of the manual should be familiar to the seasoned programmer. We were able to use **FLOOD** to experiment with ideas that have been born from our collective programming experience.

We begin with a high level view of the structure of a **FLOOD** program. It is divided into two logical blocks. The program begins with the very first block which sets the attributes of the *League*. This block needs to be present and is specified as follows:

Listing 3.1: DefineLeague

```
1 /*  
2  * Define the League and configure various settings  
3  */  
4 DefineLeague  
5     /* Set League parameters */
```

```

6   Set LeagueName("The League Name");
7   ...
8   ...
9   Set MinTeamSize(5);

```

In this block, various attributes and properties of the *League* are set such as the name of the *League*, the list of *Users*, the list of *Players*, etc. We enumerate the list of possible statements allowed in this block below:

Listing 3.2: Setting league name.

```

1 Set LeagueName("The League Name");

```

The above statement sets the name of the *League*.

Listing 3.3: Setting maximum number of *Users*.

```

1 Set MaxUser(10);

```

Sets a limit on the maximum number of *Users* of the *League*.

Listing 3.4: Setting minimum number of *Users*.

```

1 Set MinUser(2);

```

Sets a limit on the minimum number of *Users* of the *League*.

Listing 3.5: Setting maximum size of each team.

```

1 Set MaxTeamSize(10);

```

Places a limit on the size of each *User's* team.

Listing 3.6: Setting minimum size of each team.

```

1 Set MinTeamSize(2);

```

The minimum number of players that need to be in a *User's* team.

Listing 3.7: Adding a *User*.

```

1 Add User("Name of User");

```

Adds a *User* to the *League*.

Listing 3.8: Adding an **Action**.

```
1 Add Action("Name of Action", 10.0);
```

Adds an **Action** to the *League* and the number of points associated with it.

Listing 3.9: Adding a **Player**.

```
1 Add Player("Name of Player", "Position");
```

Adds the **Player** to the *League* object, along with the position of that **Player**.

The next logical block is comprised of defining functions and invoking functions within them if needed. This segment needs to begin with the `DefineFunctions` keyword as follows:

Listing 3.10: Defining functions.

```
1 DefineFunctions
2     Void myFunction1(Str param1, Int param2)
3     {
4         ...
5         ...
6     }
7
8     ...
9
10    Flt myFunction2(Bool param1, Flt param2)
11    {
12        ...
13        ...
14    }
```

The variables in a function have to be defined at the start of the function and a function needs to be defined before it can be invoked.

3.2 Lexical Conventions

The first phase in the interpretation of the source files is to do a low-level lexical transformation transforming every line to a series of tokens to be compiled in a later stage.

3.2.1 Tokens

There are 5 different types of tokens that exist: identifiers, keywords, string literals, operators and separators. White space and new line are inherently ignored and are merely used as a means of making code legible.

3.2.2 Comments

The sequence of characters initially starting with ‘/*’ and ending with ‘*/’ disqualify any of the surrounded characters from the lexical tokenization. Comments do not nest or occur within literals. There are no single-line comments however a single-line comment can be simulated using the above sequence on a single-line.

3.2.3 Identifiers

An identifier is a sequence of letters and digits beginning with a letter. Underscore is also considered a letter. Additionally, the language is case sensitive.

3.2.4 Keywords

The following words are reserved as keywords and may not be used as identifiers:

DefineLeague	DefineFunctions	LeagueName	Set	Add
MaxTeamSize	MinTeamSize	Action	Return	Str
MaxUser	MinUser	User	True	False
AddPlayer	RemovePlayer	Player	Void	While
GetUserName	GetNumPlayers	GetPlayerName	If	Else
GetPlayerPosition	GetPlayerPoints	ArrayLength	Int	Flt

3.2.5 String Literals

A character constant is a sequence of one or more characters enclosed in double quotes, as in “...” Character constants do not contain the ‘ character or newlines in order to represent them but rather use different escape characters. They are the following:

newline	NL	\n	backslash	\	\\
horizontal tab	HT	\t	double quote	“	”

3.3 Type Specifiers

FLOOD supports the following datatypes:

- **Void**: Indicates absence of type information.
- **Flt**: A number with decimal values precise up to 6 decimal places.
- **Int**: An integer number.
- **Str**: A String of characters.
- **Bool**: True/ False values.

type-specifier:

Void

Flt

Int

Str

Bool

3.4 Syntax Notation

3.4.1 Variable Declaration

Variables can be declared at the start of each function and must be declared before any statement. Variables can either be simply declared, or can be set to a value during definition as follows:


```
variable-declaration:
    type-specifier variable
    type-specifier variable = value
```

3.4.2 Expressions

Primary Expressions

Identifiers, constants, strings, or expressions in parentheses.

```
primary-expression:
    identifier
    constant
    string
    ( expression )
```

Arithmetic Expressions

FLOOD supports the arithmetic expressions of addition, subtraction, multiplication, division and modulus.

The addition ‘+,’ subtraction ‘-,’ multiplication ‘*’ and division ‘/’ operators are left associative. The modulus ‘%’ operator is non-associative.

The result of the ‘+’ operator is the sum of the operands. A string may also be added to another string. In this manner, concatenation is performed where the result is a string containing the first operand and then the second beginning at the end of the first.

The result of the ‘-’ operator is the difference of the operands. A string may not be subtracted from another string.

Multiplication and division can be performed only on `Int` and `Flt` types. Additionally, **FLOOD** does not enforce coercion of operand types. This means that any of the above operations can be performed only on operands of the same type. For example, an `Int` variable can only be added to an `Int` variable.

Relational Expressions

The relational operators group left-to-right. The relational expression returns a boolean value.

```
relational-expression:
    variable < variable-or-constant
    variable > variable-or-constant
    variable <= variable-or-constant
    variable >= variable-or-constant
    variable == variable-or-constant
    variable != variable-or-constant
    (relational-expression)
```

The operators ‘==’ and ‘!=’ have lower precedence than the operators ‘<,’ ‘>,’ ‘<=,’ and ‘>=.’ String comparisons are accomplished with the ‘==’ operator and are case sensitive.

Boolean Expressions

The three basic operators involved in boolean expressions are boolean *AND* (&&), boolean *OR* (||) and boolean *NOT* (!). The *AND* and *OR* operators group left-to-right. The *NOT* operator is right associative. The *AND* operator returns true if both operands compared are true, and false otherwise. The *OR* operator returns true if at least one operand is true, and false otherwise. The *NOT* operator returns true if the operand evaluates to false, and false otherwise.

```
boolean-expression:
    boolean-expression && boolean-expression
    boolean-expression || boolean-expression
    relational-expression && relational-expression
    relational-expression || relational-expression
    relational-expression && boolean-expression
    relational-expression || boolean-expression
    boolean-expression && relational-expression
    boolean-expression || relational-expression
    ! boolean-expression
    (boolean-expression)
```

3.4.3 Function Declaration

FLOOD allows the user to declare their own functions in addition to the default functions provided as follows:

```
function-declaration:
    returnType functionName (argumentList)
    {
        statements
    }
```

Now the function *functionName* can be invoked by any other function succeeding it in the program. It is important to note that the user needs to declare the function before invoking it. Another point worth noting is that all variables need to be declared at the start of the function declaration before they can be used.

3.4.4 Statements

Statements in **FLOOD** encompass conditionals, loops, assignments and function calls. Every statement needs to be succeeded by a semicolon.

Conditionals

A conditional statement in **FLOOD** is a statement which checks for a certain condition and processes the succeeding statements depending on the boolean value of the condition evaluated. The syntax is as follows:

```
If (expression)
{
    statements
};
```

```
If (expression)
{
    statements
```

```

    }
    Else
    {
        statements
    };

```

Here, *expression* can be a boolean expression or relational expression. If the value of the expression evaluates to True, then the statement is evaluated, otherwise control is passed to the next statement.

Loops

FLOOD provides the user with a looping structure in the form of the *while* loop. The syntax is as follows:

```

While (expression)
{
    statements
};

```

Here, *expression* can be either a relational expression or boolean expression. In the *while* body, *statements* is executed repeatedly as long as the value of *expression* remains true. The *expression* must have boolean type.

Function Calls

The programmer can invoke functions at any point in the DefineFunctions scope as long as the function has been declared before the function call.

```

functionName (parameterList);

```

There are additionally a number of built-in functions the users can invoke without needing to define them:

```

Void AddPlayer(user, player);

```

The above function adds the Player object *player* to the User object *user*.

```
Void RemovePlayer(user, player);
```

The above function removes the Player object *player* from the User object *user*.

```
Int ArrayLength(user, player);
```

The above function takes as an argument either a User or Player array object as the parameter and returns the length of the array.

```
Str GetUserName(user);
```

The above returns the name of the User object *user*.

```
Int GetNumPlayers(user);
```

The above returns the number of players of the User object *user*.

```
Str GetPlayerName(player);
```

The above returns the name of the Player object *player*.

```
Str GetPlayerPosition(player);
```

The above returns the position of the Player object *player*.

```
Flt GetPlayerPoints(player);
```

The above returns the points of the Player object *player*.

Assignments

Values can be assigned to variables depending on their type. For example, a `Bool` variable can be assigned a value of either `True` or `False`. Similarly, an `Int` variable can be assigned any integer value.

Listing 3.11: Assignments

```
1 var1 = True; /* if var1 is of type Bool */
2 var2 = 1; /* if var2 is of type Int */
3 var3 = 1.0; /* if var3 is of type Flt */
4 var4 = "string"; /* if var4 is of type Str */
```

Additionally, the return value of an invoked function can be assigned to a variable.

Listing 3.12: Function assignment.

```
1 var5 = function(); /* if the return type of the function
    matches the data type of var5 */
```

3.5 Scope

The scope to be considered while programming in **FLOOD** is lexical scope of a variable. Variables can only exist within a function, and need to be defined at the start of the function body. Therefore, the scope of a variable is limited to the function in which it is defined. Global variables are not supported in **FLOOD**.

3.6 Grammar

Below is a recapitulation of the grammar that was given throughout the earlier parts of this *Reference Manual*.

program: definitions functions

definitions: DefineLeague definitionlist

```

definitionlist: definitionlist definitionproductions
    empty

definitionproductions:
    Set LeagueName ( string-constant )
    Set MaxUser ( int )
    Set MinUser ( int )
    Set MaxTeamSize ( int )
    Set MinteamSize ( int )
    Add User ( string-constant )
    Add Action ( string-constant, float )
    Add Action ( string-constant, -float )
    Add Player ( string-constant, string-constant )

functions: DefineFunctions functionProductions

functionProductions:
    functionProductions returnType functionName ( argumentLists )
        { declarations statements returnProduction }
    functionProductions returnType functionName ( argumentLists )
        { empty }
    functionProductions returnType functionName ( argumentLists )
        { empty statements returnProduction }
    functionProductions returnType functionName ( argumentLists )
        { declarations empty returnProduction }
    empty

returnType:
    Void
    Str
    Bool
    Int
    Flt

functionName: identifier

argumentLists:
    argumentLists , argumentList
    argumentList
    empty

argumentList:
    returnType identifier
    User [ ] identifier
    Player [ ] identifier

```

```

    User identifier
    Player identifier

statements:
    statements statement
    statement

statement:
    conditionals
    loop
    relational-expression
    assignment
    functionCall

returnProduction:
    Return identifier
    Return string-constant
    Return int
    Return float
    empty

conditionals:
    If ( relational-expression ) { statements }
    If ( relational-expression ) { statements } Else { statements }
    If ( relational-expression ) { empty }
    If ( relational-expression ) { empty } Else { empty }
    If ( relational-expression ) { statements } Else { empty }
    If ( relational-expression ) { empty } Else { statements }
    If ( boolean-expression ) { statements }
    If ( boolean-expression ) { statements } Else { statements }
    If ( boolean-expression ) { empty }
    If ( boolean-expression ) { empty } Else { empty }
    If ( boolean-expression ) { statements } Else { empty }
    If ( boolean-expression ) { empty } Else { statements }

loop:
    While ( relational-expression ) { statements }
    While ( relational-expression ) { empty }
    While ( boolean-expression ) { statements }
    While ( boolean-expression ) { empty }

declarations:
    declarations declaration
    declaration

```


declaration:

```
Flt identifier
Int identifier
Bool identifier
Str identifier
Flt identifier = float
Int identifier = integer
Bool identifier = True
Bool identifier = False
Str identifier = string-constant
```

relational-expression:

```
identifier <= constant-or-variable
identifier >= constant-or-variable
identifier != constant-or-variable
identifier < constant-or-variable
identifier > constant-or-variable
identifier == constant-or-variable
( relational-expression )
```

boolean-expression:

```
boolean-expression && boolean-expression
boolean-expression || boolean-expression
relational-expression && relational-expression
relational-expression || relational-expression
relational-expression && boolean-expression
relational-expression || boolean-expression
boolean-expression && relational-expression
boolean-expression || relational-expression
( boolean-expression )
! boolean-expression
identifier
True
False
```

constant-or-variable:

```
float
integer
identifier
```

arithmetic-expression:

```
arithmetic-expression + arithmetic-expression
arithmetic-expression - arithmetic-expression
arithmetic-expression * arithmetic-expression
arithmetic-expression / arithmetic-expression
```

```

    arithmetic-expression % arithmetic-expression
    ( arithmetic-expression )
    identifier
    float
    integer

assignment: leftSide = rightSide

leftSide: identifier

rightSide:
    arithmetic-expression
    functionCall
    string-constant
    True
    False

functionCall:
    functionName ( parameterList )
    AddPlayer ( identifier , identifier )
    RemovePlayer ( identifier , identifier )
    ArrayLength ( identifier )
    GetUserName (identifier)
    GetNumPlayers (identifier)
    GetPlayerName (identifier)
    GetPlayerPosition (identifier)
    GetPlayerPoints (identifier)

parameterList:
    parameterList , parameterList
    identifier
    integer
    float
    string-constant
    identifier [ integer ]
    identifier [ identifier ]

empty:

```

4

Project Plan (Elliot)

4.1 Processes

Our team was a mix of three undergraduates majoring in Computer Engineering and the Computer Science *Applications* and *Vision and Graphics* tracks, as well as two graduates majoring in the Computer Science *Foundations* and *Systems* tracks. The team members hail from Vietnam, Nigeria, India, Israel and Switzerland with backgrounds in industry, the military and various international educational systems. As such, the team came in with very different ideas on development and team-work.

Our team decided early on that group working sessions and pair-programming would be an effective way to ensure constant communication among team members. We set out a schedule to meet every Monday night. Gradually we added Thursday night and then one weekend afternoon. Information was shared among team members through online documentation using **Google Docs** and a special **Google Group** alias. Every submission was drafted on **Google Docs** and every team member contributed. Additionally, the *Product Manager's* log and Bug Tracker were both available online and updated frequently. The code repository was hosted on **GitHub**.

Modules that were worked on by more than one team member would be pair-programmed

with one team member acting as the “driver” and the other as the “observer.” Additionally, the observer would act as a code reviewer which speed up development time. Working sessions were generally held in an open space where team members could work on their own sections but also communicate with each other in real-time.

Our team tried to ensure maximum development freedom for each member. There were no restrictions on development tools as long as it was tested and found consistent with the existing systems in place.

4.2 Roles and Responsibilities

Responsibilities for each team member were generally less defined than the roles listed below. Although a division is made, team members frequently contributed code and ideas to other parts of the product. Entire sections of code have evolved over the course of the project making it almost impossible to clearly discern the primary author.

- Elliot, *Product Manager* - Semantics and Error Checking.
- Anuj, *Languauge Guru* - Parser and Grammar.
- Tam, *System Architect* - Parser and Grammar.
- Dillen, *System Integrator* - Backend GUI and Error Checking.
- Stephanie, *System Tester* - Semantics and Unit Testing.

4.3 Style Sheet

Recognizing that every team member has a unique style of coding, only very specific recommendations were made where differences would change readability. Small issues (such as where to put curly brackets) were left to the team member who wrote the specific section of code.

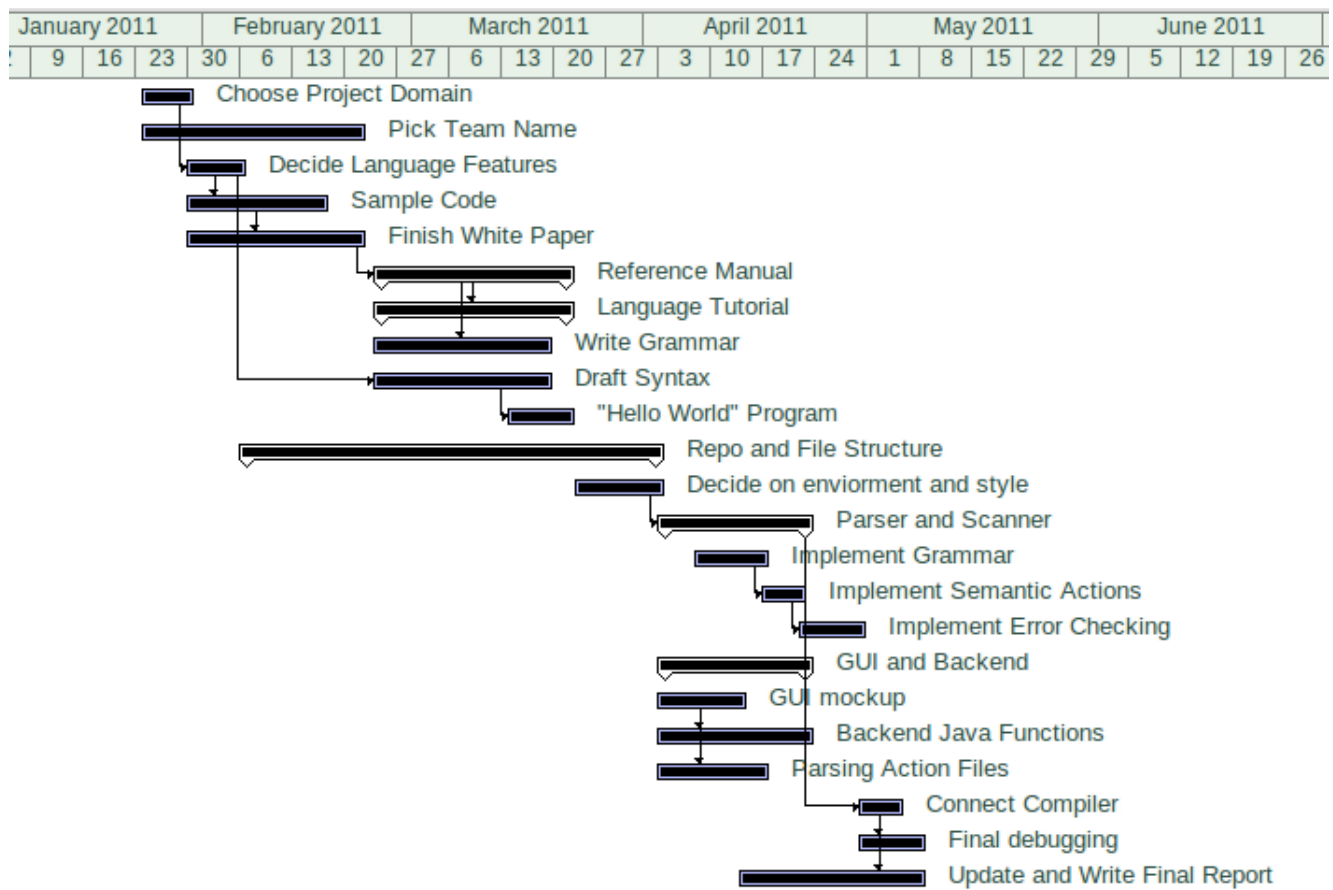
- Comments:
 - Every method must have a description above it.
 - Sophisticated functions must have comments within the body.
 - Comments should not include TODO messages.
- Bugs:
 - All bugs must be tracked using the Google Doc spreadsheet “Bug Tracker.”
 - If a bug was found in code that was added to the repo, the team member who found the bug must notify all team members by email.
 - When a bug is corrected, all unit tests regarding the specific section must be re-run to assure that no new code takes away from existing functionality.
- Repository:
 - Check in code to the repository after every major change.
 - Check in code after every session and every four hours within one session.
 - Do not check code in unless it has been tested and a unit test has been written for the functionality added.
 - Update from the repository before a commit to minimize conflicts.
- Code Style:
 - Variable and Function names should be clear and understandable.
 - White Space should be used liberally in order to make code easily readable.
 - The semantic checks exist with the semantic object. The backend runs through GUI. The grammar must treat each one as a blackbox.

- Java naming conventions are the preferred method for style (including but not limited to camel-case, indentation and programming practices) as appears in *Code Conventions for the Java Programming Language, Revised April 20, 1999*.

- Modules:

- Every module should exist within its own Java file and ideally its own folder.
- Unit tests should exist with the folder that includes the *makefile* and given names indicative of its use.

4.4 Project Timeline



4.5 Meeting Log

Meeting	Date	Minutes
1	Jan 24th	Brainstormed ideas for programming language. An idea that was discussed: we give users the option of using simple statements to design say maybe a Rubik cube game with a high degree of customisation; not only can the sides of the cubes be coloured, we can leave it to the imagination of the users to say, maybe use texts on the smaller cubes and come up with a creative game involving the Rubik cube or say even a sphere.
2	Jan 26th	More ideas discussed: The Programmer gets to upload the instrumental, type the lyrics in the code/upload the lyrics as well. They get to choose speed of highlighting for any given interval. The onus of syncing it with the corresponding part in the music is on the user. Another idea: Just graphics and the ability to build complex games from shapes. You could have enough power to build tower defense, Angry Birds, Asteroids etc. without the fancy pictures. Just with pure shapes.
3	Jan 30th	Settled on some sort of Fantasy League Game. Some questions discussed: Is there a problem with connecting to the Database? What kind of data-types? Will it be object-oriented? How extensible should our language be? How should we design the syntax? Started draft of white paper.
4	Feb 6th	Continued Working on white-paper. Agreed that language should contain OO and be similar to Java but take elements from Python. Created Git Repo. Created team google-group.
5	Feb 9th	Agreed on Language Breakdown A FLOOD program can: <ul style="list-style-type: none">• Create a league and define attributes such as team size.• Establish Rules for play using the existing libraries or overriding them.• Define features of the league such as draft and trade functions.• Connect the league to a database of the user's choice.• Trigger the build for the front end GUI and deploy the program to users.
6	Feb 13th	Continuing work on white-paper. Sketch of what a program would look like. Settled on possible name for project: FLOOD First Commit to new repo.
7	Feb 17th	Discussing feedback from language brainstorming session.

Meeting	Date	Minutes
8	Feb 21th	Final Meeting to finish white-paper. Finalized language features and highlights, data-types, keywords and control-flow. Discussed possible application of a FLOOD program.
9	Feb 23rd	Submitted White Paper.
10	Mar 5th	Discussed Feedback from White-Paper. Where is our computation? How do we want to implement OO?
11	Mar 14th	All day session to work on RM and LT.
12	Mar 17th	All day session to work on RM and LT.
13	Mar 19th	Finishing the grammar, continuing the reference manual. Updated the Language Tutorial to reflect changes in grammar.
14	Mar 23rd	Submitted LT and RM.
15	Apr 3rd	Discussed ways to implement OO and whether to alter to the language and simplify it. Discuss times for final presentation.
16	Apr 8th	Feedback on LT and RM. Beginning to scale down the language to make it easier to write a parser and scanner.
17	Apr 10th	Project File Structure finalised and committed to repo. Division of labor and initial deadlines drawn up. First files committed to repo. Java and FLOOD files used for testing created. Meeting times for the rest of the project: Monday 6:15 pm, Thursday 6:15 pm. One weekend day to be chosen by Thursday 1:00 pm - Longer meeting to work (in CLIC lab).
18	Apr 11th	Revamped Syntax and started sketching GUI mockups.
19	Apr 14th	Working meeting in CLIC lab (see commit comments).
20	Apr 21th	Progress Report. Basic FLOOD file can be parsed.
21	Apr 26th	Working Meeting in CLIC lab (see commit comments).
22	Apr 28th	Working Meeting in CLIC lab (see commit comments).
23	May 2nd	Working Meeting in CLIC lab (see commit comments).
24	May 4th	Putting the final product together. Finished updating the reference manual and language tutorial. Error Checking in place. File FLOOD program can be compiled.
25	May 6th	Last minute debugging. Adding more error productions. Last run-through of every unit test with whole team present.
26	May 8th	Preparing Presentation. Looking over Final Report last time.

5

Language Evolution (Anuj)

At the onset of our language development, we decided to provide the user with as much flexibility as possible. With this as the main focus, our language was aimed at providing object-oriented development to the users. Bearing this in mind, we began developing our language in an incremental manner. We first decided on what the output of the front-end should be, based on what the back-end would expect. In short, we settled on the rendezvous point for the front-end and back-end and worked our way towards it.

As we deliberated on what this intermediate Java code should be, we realized it would be sufficient if the back-end is object-oriented. We therefore decided that the onus of object-oriented programming should not be on the programmer, keeping in mind that users of **FLOOD** will most likely not be familiar with object-oriented concepts. Moreover, we concluded that given the nature of the domain, the programming language being object-oriented would make the learning curve steeper for the user with not much added value. Fully convinced along these lines and the ease-of-use for the programmer in mind, we decided to do away with the object-oriented paradigm.

With the face of the language now modified to provide the user with as much flexibility as needed, yet within the domain of the language as well as keeping it simple to program, we set out to decide the logical division of the program code to aid the user in programming. We

carefully analysed fantasy leagues and realized there exists a common denominator between all fantasy leagues. We decided to push this common denominator to the back-end, leaving the user with the bare minimum yet retain full flexibility to design a fantasy league with the rules of his/her choice.

The language now was developed with a logical division of the program the developer would have to write. The first would need to be the definition of the league; the programmer would need to specify details of the number of users, the names of the users, the players and their scores, valid actions and points associated with these valid actions. This allows the user to define rather quickly the parameters and setup the league.

The next logical block we decided on was defining functions and invoking them within other functions. This section needs to begin with the keyword `DefineFunction`. There are four default functions that each league needs to have which are: `draftPlayer`, `dropPlayer`, `trade`, `draftFunction`. The user can override these functions, although the user can choose not to define these functions, and the default function definitions for these functions will be invoked.

Over and above these four functions, the user can define custom functions and invoke them. In its first incarnation, functions could take any number of parameters of the following types: `Bool`, `Str`, `Int`, `Flt`. Variable declarations were allowed at the beginning of the function before any other statements. The language at this point also provided looping structures, arithmetic expressions, relational expressions as well as conditionals. The back-end required array constructs of objects of a couple of back-end classes, namely the `User` and `Player` classes. Since the programmer does not know the contents of the `User` and `Player` classes, we decided to introduce array constructs in the formal parameters and actual parameter list of functions as follows:

```
functionName (User[] u, Player[] p) { statements }
```

In this manner, when changes were made in the grammar they were incorporated in the back-end and conversely, when changes were made to the back-end, they were incorporated

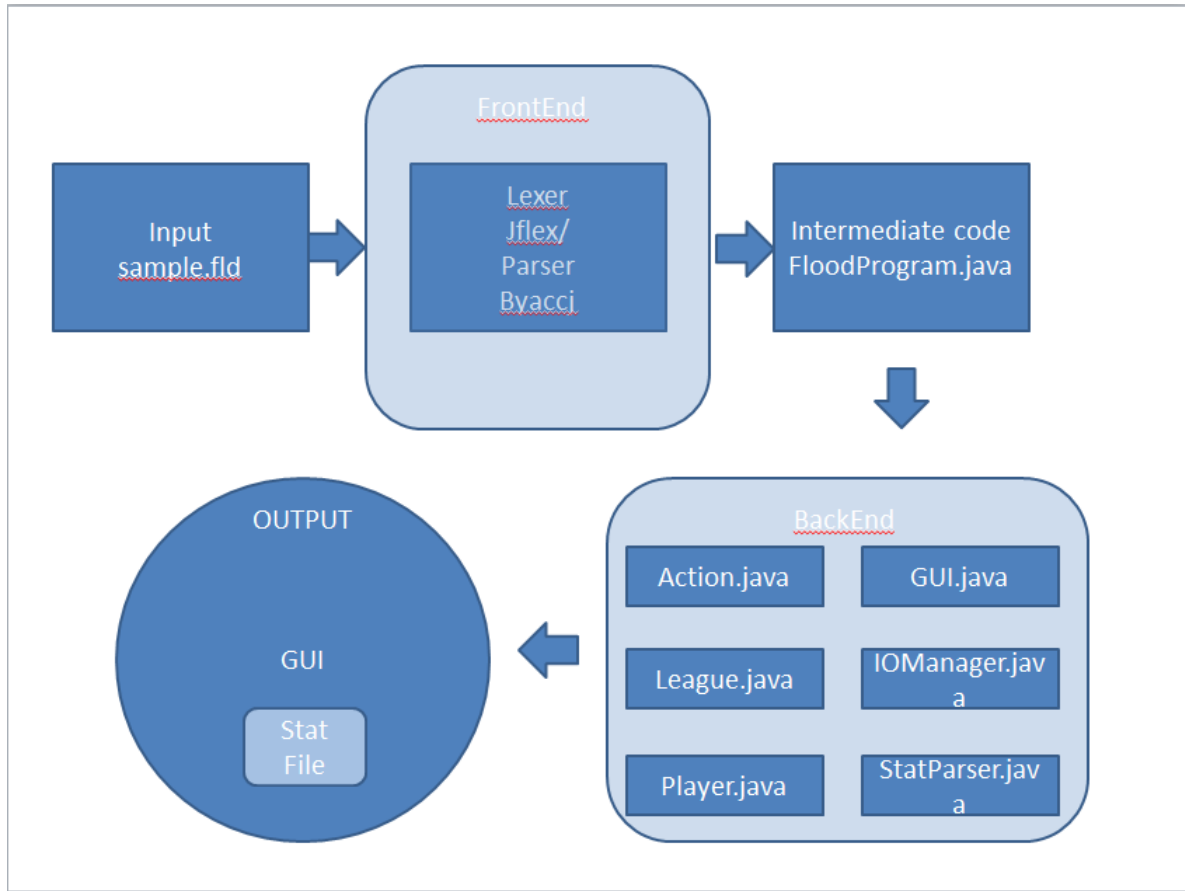
in the grammar. The evolution of the language thus meant the grammar and the back-end evolving in tandem and incrementally.

6

Language Architecture (Tam)

The basic tools used to design the translator are **JFlex** for lexical tokenization and **BYACC/C/J** for the compiler generator. The lexical tokens are listed in the **JFlex** file, *flood_lex.flex*. **JFlex** tokenizes the input and passes the input in the form of these tokens to the parser, **BYACC/J**.

The grammar that the language follows is defined in the **BYACC/J** file, *flood_grammar.y*. Once this file is compiled, the generated Java file, *Parser.java* is the parser generator for our language. The semantic actions to be performed on the input file given to our compiler are listed in the semantic action of each production in the *flood_grammar.y* file. These semantic actions involve type checking, arithmetic logic, function definitions and variable definitions. If any error is detected in the input file, our parser will not generate the output and will display the error. The high level view is illustrated in the following figure:



If the input is accepted by our strongly typed language, the front-end generates the intermediate code, *FloodProgram.java*. On compilation and execution, the back-end generates the output in the form of a GUI.

The back-end of the system consists of all the Java files that the intermediate code references to generate the output. The GUI of the system makes use of a *Statistics* file which holds the statistics of the proceedings of the league. Based on these statistics, the GUI generates the ranking of each user in the league which determines the winning user at any point.

6.1 Module Authors

- Grammar design and implementation : Tam and Anuj.

- Semantic actions: Dillen, Stephanie and Elliot.
- Backend: Dillen.

7

Development Enviornment (Dillen)

During the development of the **FLOOD** language, development was spread across two operating systems. The majority of the group developed with **Ubuntu** (10.04/10.10/11.04) while one other worked exclusively in **Windows** 7 which ended up working out rather smoothly despite some issues setting up the **Git** repo on **Windows** and maintaining multiple *makefiles*. Yet this cross system development also ensures that our language is not system dependent. In order to maintain a current version of all parts of the language, our group set up an on-line repository on **GitHub** where changes could be made at any time at the programmer's convenience.

The majority of Java code for the source files used in the intermediate code compilation level was written nearly exclusively in **Eclipse** 3.6 *Helios*. The majority of the back-end was written from scratch with a select few data structures to promote efficiency. Those libraries included primarily the Java API's `HashMap` and `ArrayList` classes when necessary so that looking up references to various *Users*, *Players* and *Actions* would all be $O(1)$. They were also used in a manner to prevent duplicate copies of any particular instance of class so that references (values of references since Java is pass-by-value) were used instead.

In addition to these source files, a GUI was also created to allow user interaction with the program during runtime, a key component of any fantasy league. The development of

the GUI was restricted to purely Java's **Swing** and **AWT** library components with the framework created using Google's **WindowBuilder Pro** web toolkit. With the assistance of the development environment provided by that plugin to **Eclipse**, the GUI's rough layout was generated with ease but was completely devoid of any functionality besides its good looks.

The remainder of the GUI was developed by hand adding various functionalities to different components and promoting ease of integration with files generated by the compiler. No other outside sources were used in the remainder of the production of the source files that integrate with the compiler output besides the occasional Google search on how some feature of **Swing** truly worked, disregarding one's intuition. The final features added to the GUI were the ability for the program to write its current state to a file that could be saved in a directory and then imported at a later date, so that a fantasy league could be easily maintained over the course of any sports season without leaving a program running for the entire duration.

The parser and grammar were implemented with **JFlex** and **BYACC/J** respectively. These are both the Java versions of **Lex** and **Yacc** that the language **FLOOD** compiles to in its intermediate code generation. The majority of the development of the parser and grammar were done in a combination of **Gedit**, **TextPad**, terminal along with some good ol' fashioned paper and pencil. Paper and pencil is really the best (and almost only) way to really work out and recognize shift/reduce conflicts which inevitably helped to understand in general their origins and prevent them. The only exclusion to this trend was the development of the semantic actions that enforced type checking and other semantic checks, such as determining if functions and variables had been previously declared, which were primarily developed in **Eclipse 3.6 Helios**. This was done due to the fact that it was exclusively written in Java in which instantaneous compilation helped with simple syntax errors that may have been overlooked.

The most important tool, however, used in the joint production of **FLOOD** was indu-

bitably **Google Docs**. The ability to jointly work on the *White Paper/Language Tutorial/Reference Manual* and watch them come together smoothly as opposed to very disjoint and extremely different written components was truly invaluable. The ability to share and jointly edit other's documents such as schedules, bug reports and other files simultaneously without the burden of constantly pulling and pushing vastly improved efficiency especially when every group member can just consult a checklist to see what components were still incomplete and most urgent. Additionally, the real time updating of files provided a great base for the conversion to **L^AT_EX** of the final reports. It was a crucial component in the merging of everyone's work throughout the process.

8

Test Plan (Stephanie)

In the early stages of developing the grammar for **FLOOD** most testing simply followed this scheme:

- Write a line of code.
- Test it.
- Does it work?
 - Yes
 - * Jump to first statement.
 - No
 - * Rewrite line of code.
 - * Jump to second statement.

This practice was less about writing production code, and more just to explore and understand **Lex** and **Yacc**.

Soon, the grammar began to take shape. As we developed the expressions and loops, fuller and more thorough unit test programs needed to be generated. As each complete production was made, at least two accompanying unit test programs were written to test

that production. The two unit tests would test for correctness as well as for failure, meaning that one unit test was meant to be successful, while the other was meant to fail. Often there was more than one unit test intended to fail, because there are multiple ways in which any single part of the program could fail.

Once the grammar reached a self sustainable level, semantic checks began to be implemented. These checks would cover errors that the grammar could not handle on its own. The testing therefore, became more rigorous in order to cover all possible bases. At this point, unit testing included the full team in order to be as thorough as possible. As each member wrote semantic checks or edited the grammar they were encouraged to think of unit tests to break whatever they just wrote. These tests would be written and compiled together as they applied to each specific part of the language, and tested against the compiler. As it became increasingly more difficult to come up with unit tests, we would move on to the next semantic check, determining that the current tests sufficiently checked all possible error and success cases.

8.1 Example Unit Tests

8.1.1 Unit Test 1

Listing 8.1: arithmetic_test.fld

```
1 DefineLeague
2   Set LeagueName("Happy League");
3   Set MaxUser(10);
4   Set MinUser(12);
5   Add User("Eli");
6   Add Action("Field Goal Attempt", 0.5);
7
8 DefineFunctions
9   Int myFunction(Int turn, Flt turn2)
10  {
11      Str a;
12      Str c;
```

```

13         Str d;
14         Bool b = True;
15
16         a = a + c + d;
17         Return a;
18     }

```

The above unit test was meant to test the concatenation of strings. It is a functioning simple **FLOOD** program.

Below is one of it's counterparts. This program is meant to fail because it tries to add a boolean to the strings.

Listing 8.2: arithmetic_test.fld

```

1 DefineLeague
2     Set LeagueName("Happy League");
3     Set MaxUser(10);
4     Set MinUser(12);
5     Add User("Eli");
6     Add Action("Field Goal Attempt", 0.5);
7
8 DefineFunctions
9     Int myFunction(Int turn, Flt turn2)
10    {
11        Str a;
12        Str c;
13        Str d;
14        Bool b = True;
15
16        a = a + c + b;
17        Return a;
18    }

```

8.1.2 Unit Test 2

Listing 8.3: array_var_index.fld

```

1 DefineLeague
2     Set LeagueName("Happy League");
3     Set MaxUser(10);
4     Set MinUser(12);

```

```

5   Add User("Eli");
6   Add Action("Field Goal Attempt", 0.5);
7
8   DefineFunctions
9     Bool random(Player p1)
10    {
11      Bool b;
12      b = True;
13      Return b;
14    }
15
16    Bool trade(User u1,Player[] p1, User u2, Player[] p2)
17    {
18      Int i = 1;
19      Bool b;
20      b = random(p1[i]);
21    }

```

The above unit test is meant to check user defined functions as well as array indexing. Two of its counterparts are shown below. The first fails because the function is defined after it is called.

Listing 8.4: array_var_index.fld

```

1   DefineLeague
2     Set LeagueName("Happy League");
3     Set MaxUser(10);
4     Set MinUser(12);
5     Add User("Eli");
6     Add Action("Field Goal Attempt", 0.5);
7
8   DefineFunctions
9     Bool trade(User u1,Player[] p1, User u2, Player[] p2)
10    {
11      Int i = 1;
12      Bool b;
13      b = random(p1[b]);
14    }
15
16    Bool random(Player p1)
17    {
18      Bool b;
19      b = True;
20      Return b;

```

```
21     }
```

The second fails because it attempts to use a boolean as the index of an array.

Listing 8.5: array_var_index.fld

```
1 DefineLeague
2   Set LeagueName("Happy League");
3   Set MaxUser(10);
4   Set MinUser(12);
5   Add User("Eli");
6   Add Action("Field Goal Attempt", 0.5);
7
8 DefineFunctions
9   Bool random(Player p1)
10  {
11    Bool b;
12    b = True;
13    Return b;
14  }
15
16  Bool trade(User u1, Player[] p1, User u2, Player[] p2)
17  {
18    Int i = 1;
19    Bool b;
20    b = random(p1[b]);
21  }
```

9

Conclusions

9.1 Lessons Learned as a Team

We feel that as a team we have a better understanding of the magnitude of large programming projects. We learned that initial ideas are seldom translated into the final product. When the project first began, we had intended to write a very large language with many features. At the time, none of us truly understood the work that went into implementing even a small language. As we progressed in the semester, the difficulty of the task became more apparent and we had to change our entire language. We feel that we learned a great deal about the more complex aspects of programming languages specifically because we were not able to implement what we had originally intended. Trying to brainstorm features like inheritance and polymorphism taught us about how those components work in popular programming languages.

We learned that teamwork doesn't mean everyone does their own part. It means that people help out and don't stay contained within their respective responsibilities. It means that if someone is having an off-week and/or has an exam the next day, other team members can carry the weight that meeting. We learned that work-schedules need to be implemented early and ambitiously so that deadlines can be stretched within reason if needed.

We each learned different ideas on programming and development from our teammates. Every session of programming there were arguments of proper programming practices or the design of the language. Team members contributed ideas to our language from a wealth of programming experience from languages such as Java, C++, Python and Pascal. We learned that every team member has particular strengths and those should be utilized as often as possible.

9.2 Lessons Learned by Each Team Member

9.2.1 Stephanie

1. The greatest lesson I learned from this assignment was to *start small and work your way up from there*. Designing a project that implements something you have no idea how to do is extremely difficult. It is all too easy to fall into a very complicated design when the process for creating the pieces is not yet known. In the beginning, my team and I were rather ambitious and naively so. We had dreams of an object-oriented language complete with inheritance, polymorphism, and encapsulation. We even wanted to expand the language onto the **Android** platform if we had time. Somehow we had forgotten what college was: four years of spending every minute of every hour wishing you had more time. We soon realized the we were in way over our heads, and that there was only so much weight Java would carry for us. And so, we had to significantly modify our approach to this project. We first started by simply making cuts to the language, but that left a convoluted and disorganized language. So instead we began anew. We identified all the bare minimum requirements needed for a fully functional language for generating fantasy leagues. From there we could build a base language and then add to that. This process takes away depressing decisions to remove ideas, and replaces it with the exciting realization that we can add things.

2. *Projects of this magnitude need to be constantly worked on.* You can't simply wait until a week before a deadline, put in endless hours of work and expect that to be sufficient. When a project spans four months work must be put into it every week of every month. By getting into lulls where no work is being done on the language, you risk losing focus and generating a bit of a learning curve, if you will, in order to return to the language. Right from the beginning, we made sure to meet regularly, regardless of how much we needed to do. There needed to, at the very least, be a constant reminder of the project, no time for the language to be forgotten.
3. While at times it may appear to be rather difficult, it is important to *always be aware of what each team member is working on.* Not in the sense that you know specifically what they are doing every minute they are working, but just where they are. Indeed, that is primarily the job of the project manager, but I found that it is rather helpful for each member of the team to communicate with the team what their next steps were and how they were going to go about completing their goals. This way there is minimal disconnect between the various parts of the language, especially between semantics and the grammar, where changes in one greatly affect the other. Our group maintained this awareness with the use of **GitHub**, **Google Docs**, and a **Google Group**, in addition to our frequent team meetings and coding sessions. This way, all changes were documented and spread throughout the entire group.
4. *The project is a not a group of people designing pieces of a puzzle that will fit together, after quite a bit of massaging and molding, to produced a result.* It is a team building block after block, each block being guided onto the last, until the structure is complete. The idea to split the group into 5 specific roles helps with ensuring that everyone has a part to do, however I find that this can actually create a disconnect. Instead of creating a strict line on who does what, I feel that having each person contribute to each part of the language builds a more continuous final product. Moreover, it makes

the process of merging the parts of the language significantly more efficient because each member of the teams understands the language and many errors are avoided or resolved quickly by simply just knowing what to look for. In summary it creates a cohesive team, with a thorough understanding of the language.

5. *Commitment is a vital key to any successful team project*, and for a project that has lasted as long as this, it is all too easy to feel overwhelmed. Over the course of the semester fluctuations in one's workload and personal life can take quite a toll on one's ability to function in a group. However, it is in these times that the true power of the group shines through. In the first couple weeks after I fractured my hand, the pain was enough to inhibit my ability to type. In that same time, I had a web site to build, an essay to write, and coding sessions for this project. Had it not been for my team, I would have likely given in to the stress and crumpled under the workload. However, my determination to not let my teammates down allowed me to continue pushing forward. This level of commitment can develop in a team regardless of whether or not the team member knew each other before the formation of the team. When the members of **FLOOD** were established, I only knew half of my teammates. However, in a team of only 5, it is hard to remain cliquish and as a result the team developed rather strongly. Throughout the course, I've have become rather close friends with my team members and will look forward to taking classes with them in the future.

9.2.2 Elliot

While this is not my first time as a project leader, it is my first time leading a software development project. The most important lesson I've learned is the need for constant communication among the team. At times though not often, information would be bottle-necked to a certain person and other team members would not be informed of important changes. The best way to deal with this situation is transparent documentation and meetings. I've also learned how difficult it can be for each team member's unique coding and work style to

be integrated into a cohesive unit. For instance, our version control choice was unfamiliar to some team members at first and it took some time for everyone to get used to working with it.

A project of this magnitude can easily overwhelm any group no matter how experienced. The main goal should be constant pressure. Constant pressure does not mean stress but rather always making progress regardless of the difficulty or clarity of the task. Tasks should be constantly broken down into smaller pieces and distributed as evenly as possible. When a task is assigned, it shouldn't be assumed that the team member will be able to complete it but rather teammates should look out for each other and help when needed. The role of a product manager is not to dictate and assign tasks as they please. Every team member should be given the opportunity to pick specific tasks that they find most interesting. Tasks that were deemed uninteresting were distributed evenly so that no one took more than their fair share of "grunt" work. Decisions should not only be democratic but accepted by the whole team. If even one team member didn't like an idea or an implementation detail, the team worked hard to come up with an alternative that was acceptable to everyone. A product manager should also keep accurate records and have awareness of every moving piece in the project. Ultimately, as the saying goes, the "The Buck Stops Here." This is a lesson every good product manager must learn and usually the hard way.

On a personal note, I feel comfortable saying I understand how a compiler works on a very applied level. I still don't feel comfortable with much of the theory that goes into compilers and in a way it has given me a healthy respect for theorists who have paved the way for modern programming languages. I learned to appreciate the intricacies of programming languages and notice subtle differences that were not obvious to me beforehand. I have already seen a difference in my code production in other projects. In my opinion, one of the most fascinating aspects of software development is the relationship among the developers. Working with other people, especially in an academic setting, is always challenging but it can also be very rewarding. I truly enjoyed the time spent working with my teammates

and regardless of the final outcome of this project or the class in general, I feel that I have learned a great deal from them.

9.2.3 Tam

Ah, the project post mortem. Having recently worked in industry, I have personally been an active (and at times, unwilling) participant of countless such “taking stock” couch sessions. More often than not, and especially after grueling projects which taxed the mind and body as well as the soul, my own thoughts inevitably turn towards alcohol—nothing like dousing the brain cells which served me so well during those sleepless nights of feverish coding!

But after a welcome, and hopefully pre-paid, happy hour courtesy of a sympathetic Project Manager, gathering one’s thoughts and indeed “taking stock” to formulate a list of lessons learned is an invaluable exercise, one which will yield far-reaching benefits down the line for both developers and project managers alike.

At this stage of the game, I find myself asking a similar set of questions:

1. **First and foremost, are you proud of the final product?**

I will not be so presumptuous as to answer for my fellow group members, but I can say without hesitation that yes, I am very proud of **FLOOD**. Admittedly, certain features and overall scope were made road kill on the highway to making delivery, but such are the vagaries of software development. In fact, I now recall with particular fondness our formative group meetings in which, undoubtedly pie-in-the-sky-ish in retrospect, we brainstormed and flung around countless ideas about what our language will be capable of once completed. An Android-enabled interface! A Facebook port! Automatic texting of scores and live updates to subscribed listeners! Object-orientation that will make Java blush!

Not surprisingly, the majority of these “nice to haves” fell by the wayside as the project progressed, but did we as a group accomplish what we set out to do originally, which was to write a language that made creating a fantasy gaming league relatively easy for

the programming novice? I would say the answer is a resounding *YES!*

And in undertaking this project, did I myself take away what is perhaps the most crucial aspect of completing the project and taking this class in the first place, which was to gain and learn from first-hand experience the inner workings of compilers and programming languages? Again, an unequivocal *YES!* Lexical analysis, semantic analysis and actions, code generation and optimization...nothing like rolling up one's sleeves and learning these concepts the hard way: by actually doing it.

2. What was the single most frustrating part of the project?

Hands down, tackling the lexical and semantic analysis of the grammar. Hours upon hours consumed in devising regular expressions that would do what we wanted it to do, then tracking down and eliminating with extreme prejudice countless shift/reduce/reduce errors. With my comrade in arms, Anuj, the two of us now feel like battle-hardened veterans returning from the front-line trenches in our seemingly never-ending battle against the Lexical/Semantic axis of power.

Did **FLOOD**'s grammar put up a valiant fight? Yes. Was it frustrating to slay this merciless dragon? Yup...Anuj and I certainly have the mental scars to show for it. But in the end, was it rewarding? Most definitely. I have been involved in few software development projects where the most frustrating part was also the most personally fulfilling. This was one of them.

3. How would you do things differently next time to avoid this frustration?

Start learning the concepts and obtaining the knowledge one will need as early in the project timeline as possible. I believe my biggest mistake was taking such a timid approach towards the grammar—instead of waiting for the material to be presented and covered in class, we (I'm certain Anuj would agree) should have been more proactive in acquiring the know-how and skill sets needed to write **FLOOD**'s grammar. And speaking for myself once more, there was also an intimidation factor at play since

the tools for creating the front-end components of a compiler seemed truly daunting to me to work with. It's difficult at times teaching an old dog new tricks.

4. **What was the most gratifying and personally satisfying part of the project?**

This old dog learned a new trick. I didn't know how to write a lexical parser and scanner before. Now I do.

5. **Which of the development methods or processes worked particularly well?**

The pair programming Anuj and I undertook in developing the grammar. Over time we developed a comfortable working style that proved to be most productive. I was skeptical at first regarding this programming paradigm since nearly all of my industry experience has been working and coding in isolation, but engaging in pair programming for the very first time was a truly eye-opening experience. Where before I would run into a dead-end in some coding dark alley, Anuj was often there to shine a flash light and lead the way out.

6. **If you could wave a magic wand and change anything about the project, what would you change?**

More time with my fellow **FLOOD**-ites. I was very blessed to have lucked into this group of highly motivated, extremely hard working, and very intelligent individuals. Sure, there were disagreements, some heated discussions, the occasional philosophical differences, but in the end we had a blast working together to give birth to **FLOOD**. I wish all of my future (and certainly several past) collaborative efforts will be as enjoyable and mutually beneficial as this one. I learned a great deal from my team and I hope I have reciprocated in kind—a true highlight of my academic career at Columbia.

9.2.4 Dillen

1. Choose your group members wisely.

Choosing the right people for a group is beyond the most important part of an assignment. Although it may seem unclear what everyone's exact roles may be for a given project, be sure to pick people who are passionate and have deep interest in different components as well as the overall idea of a project. Nothing can be more detrimental to a group than to have members who are unenthusiastic or not willing to pull their own weight, not due to a lack of ability (because let's be honest, no one knew how a compiler worked when we first started) but rather a lack of motivation. Our group functioned extremely well because we all split up the parts into relatively equal work loads and when one part "overflowed" due to unforeseen complexities, those with "easier" tasks jumped in to help. Another key part of our success was the general interest in our idea, which became my next lesson learned.

2. Thoroughly develop your idea, and then do it again.

It is important to spend adequate time to thoroughly develop an idea and delve past the surface challenges and really research potential dead-ends. Unlike most groups (I believe), we met every week from the moment our group was formed until the end of the semester, even when we all lacked any detailed view of how to complete the task. The first several meetings were literally 4+ hour long discussions on potential programming languages where everyone would express interest, play devil's advocate and expand on ideas. The most difficult part for us was to propose ideas feasible for a semester long project without simply creating a markup language. This was crucial in creating a thorough blueprint for our language and the writing of the *White Paper/Language Tutorial/Reference Manual*.

3. Don't reinvent the wheel.

One of the most valuable parts of any programming project is to utilize tools provided

online to ease the pain. Development tools such as **WindowBuilder Pro** for the GUI, **BYACC/J** and **JFlex** for the grammar and parser, **GitHub** for the online repository and **Google Docs** for the written portions provided greater ease and efficiency during the entire process. *USE THEM!*

4. **Pick a good project manager who can bring everyone together.**

It is easy to get lost in time when everyone is specializing on a specific part of a project and it's the product manager's job to keep bringing everyone together and making sure everything is running smoothly and no individual is lagging behind. Collaboration and communication are absolutely key in the software development world because otherwise, come submission time, everyone has a bunch of extremely well developed but independent portions of the project with integration being nearly impossible. I noticed that our group was exceptionally productive when we all worked in one long line in the CLIC lab, each with the *Google Bug Report Document* constantly asking questions, finding bugs and delegating work with various priority. I realize it is difficult for a bunch of college students to find time to all meet and work for a few hours but those hours spent working together are far more valuable than any work you will do by yourself.

9.2.5 Anuj

1. **Grammar design is not a walk in the park.**

Designing the grammar for a language is not easy. Designing a small grammar for small units, like say, just arithmetic expressions, is easy. As the grammar evolves, the complexity increases linearly. It helps to have a clear idea of what the language will look like and stub out a rough design of the grammar first. This methodology exposes the potential shift/reduce and reduce/reduce errors right from the beginning. It also helps to understand fully how these errors occur and how to eliminate them.

2. **Decide the scope of the language/project realistically.**

One of the most important lessons I learned from this project is to do a strong feasibility study before proposing a project. A thorough study should be performed to roughly estimate what problem statement the project proposes to tackle. It should neither be too ambitious nor too trivial. Getting the right balance is a tricky task and it seems safer to project the latter and extend the scope of the project if time permits. Another important lesson I learned is never to commit any major feature in the name of the project unless absolutely certain that the feature will be implemented!

3. **Working in a group.**

To begin with, I had an interesting time working with my group. It not only made working on a project of this magnitude seem effortless, but I also learned a lot from my group on various fronts. This made me realise how important team members are and the dynamics of the group can make or break a project. While it may seem more hands on deck means less work per person, I also realised it requires good management on the part of the Project Manager to coordinate and integrate the project well; something I was privy to during the course of this project.

9.3 Advice for Future Teams

- ***Never*** promise features of your programming language in its name. We tried very hard to come up with a “cool” name that described our language. The name is still “cool” but it doesn’t describe our language anymore.
- Start early and meet often. It may seem futile to meet when you have nothing to discuss but just by being in the same room you may start thinking of an idea that changes your project.
- Ask for help no matter how small of an issue. We utilized our TA, Hemanth, as much

as possible and we are truly indebted to him for all his valuable advice.

- Don't be scared of unfamiliar technology; free software is your friend. Our entire project was written and shared in **Google Docs**, the code will forever be saved on **GitHub** and the documentation lives beautifully in **L^AT_EX**.
- Revisit your idea as much as possible. Our language has morphed from an object-oriented language with Java-like features into a smaller, more compact version. If we had decided to go ahead with our original idea we would not have finished our project or it would have been poorly implemented.
- Pair programming may seem like a waste of time but it dramatically reduces net production time. Most of the code produced was written at one work station with two team members working at a time. Often code that seemed very difficult to one programmer was trivial to another. When a programmer was tired, they could switch and development continued.
- Pick a project that is interesting to you rather than trying to impress anyone. Every team member was truly interested in our project which made brainstorming more fun and productive.
- A team that eats together works better. It's better to work on a full stomach and it's more fun to brainstorm over dinner. We personally recommend the Dominoes 7-7-7 deal.

9.4 Suggestions for Future Improvement

It's very difficult to write this section as a team since each team member had different topics that they enjoyed. We all agree that the project was the highlight of the course and very much enjoyed working on it. Some of us feel that the classes were a little theory-heavy in what was originally expected to be a more applied course in compilers. Some of the theory,

especially the later topics such as code-generation and optimization as well as data-flow analysis might have been better served with more homework and possibly programming exercises.

The first homework gave everyone a taste of **Flex** and **Yacc** which helped both in understanding the theory and what was expected later in the project. Those of us who had taken *Computer Science Theory* enjoyed seeing how the theory we had previously learned applied in the “real-world.” We all feel that this was a difficult class but in the end truly rewarding.

Appendix A

FLOOD Source Code

Listing A.1: Action.java

```
1  /*
2   * Action.java
3   * This class handles the various actions in the fantasy
   * league
4   */
5
6  public class Action {
7      private String action;
8      private float points;
9
10     /**Constructor.
11      *
12      * @param String action
13      * @param float points
14      */
15     public Action(String action, double points) {
16         this.action=action;
17         this.points=(float)points;
18     }
19
20     /**Returns the string representation of the action
21      *
22      * @return String action
23      */
24     public String getAction() {
25         return action;
26     }
```

```

27
28  /**Sets the action
29  *
30  * @param String action
31  */
32  public void setAction(String action) {
33      this.action = action;
34  }
35
36  /**Return the points gained for completing the action
37  *
38  * @return float points
39  */
40  public float getPoints() {
41      return points;
42  }
43
44  /**Sets the points gained for completing the action
45  *
46  * @param float points
47  */
48  public void setPoints(int points) {
49      this.points = points;
50  }
51
52  /**Determines if two actions are equal by comparing
53  * the action and points received
54  *
55  * @return boolean isEqual
56  */
57  public boolean equals(Object obj){
58      if (this == obj) //Reference to self
59          return true;
60      if (obj == null) //Null reference
61          return false;
62      if (getClass() != obj.getClass()) //Not the same class
63          return false;
64      final Action other = (Action) obj;
65      if (action.equals(other.action) && points==other.points)
66          //Equal action and points
67          return true;
68      return false;
69  }
70
71  /**Returns a string representation of the action

```

```

71      *
72      * @return String representation
73      */
74      public String toString() {
75          return "Action [action=" + action + ", points=" + points
76              + " ]";
77      }
78  }

```

Listing A.2: flood_grammar.y

```

1  /* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
2  *
3  * flood_grammar.y
4  * FLOOD
5  * Syntactic/Semantic Analyzer
6  *
7  * Lasciate ogne speranza, voi ch'intrate.
8  *
9  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * */
10
11 % {
12     import java.lang.Math;
13     import java.io.*;
14     import java.util.Hashtable;
15     import java.util.ArrayList;
16     import java.util.Iterator;
17     import java.util.HashMap;
18     import java.util.*;
19 % }
20
21 /* YACC Declarations */
22 %token PLUS /* + */
23 %token OPEN_CURLY /* { */
24 %token CLOSE_CURLY /* } */
25 %token OPEN_PARAN /* ( */
26 %token CLOSE_PARAN /* ) */
27 %token OPEN_SQUARE /* [ */
28 %token CLOSE_SQUARE /* ] */
29 %token <dval> FLT /* Float */
30 %token <ival> INT /* Integer */
31 %token <sval> STRING_CONST /* String literal onstants */
32 %token COMMA /* , */
33 %token DOT /* . */

```

```

34 %token <sval> ID          /* Identifier */
35 %token EQUAL              /* = */
36 %token NOTEQUAL          /* != */
37 %token LESSEQUAL         /* <= */
38 %token GREATEREQUAL      /* >= */
39 %token ISEQUAL           /* == */
40 %token LESS              /* < */
41 %token GREAT             /* > */
42 %token PLUS              /* + */
43 %token MINUS             /* - */
44 %token MULT              /* * */
45 %token DIV               /* / */
46 %token NOT               /* ! */
47 %token AND               /* && */
48 %token OR                /* || */
49 %token MOD               /* % */
50 %token SEMICOLON         /* ; */
51
52 /* Keywords */
53 %token DefineLeague      /* Define the league */
54 %token DefineFunctions   /* Define functions */
55 %token LeagueName        /* Set league name */
56 %token MaxUser           /* Set the max user */
57 %token MinUser           /* Set the min user */
58 %token MaxTeamSize       /* Set the max team size */
59 %token MinTeamSize       /* Set the min team size */
60 %token Set               /* Set keyword */
61 %token Add               /* Add keyword */
62 %token Action            /* Action keyword */
63 %token Alert             /* Alert message */
64 %token Error             /* Error message */
65 %token User              /* User keyword */
66 %token Player            /* Player keyword */
67 %token Void              /* Void keyword */
68 %token Str               /* String keyword */
69 %token Bool              /* Boolean keyword */
70 %token Flt               /* Float keyword */
71 %token Int               /* Integer keyword */
72 %token Return            /* Return keyword */
73 %token If                /* If keyword */
74 %token Else              /* Else keyword */
75 %token While             /* While keyword */
76 %token True              /* True keyword */
77 %token False             /* False keyword */
78 %token RemovePlayer      /* Remove Player function */

```

```

79 %token AddPlayer          /* Add Player function */
80 %token ArrayLength        /* Length of an array */
81 %token GetUserName        /* Gets the name of the user object
    */
82 %token GetNumPlayers      /* Gets the number of players of
    the user*/
83 %token GetPlayerName      /* gets the name of the player
    object*/
84 %token GetPlayerPosition  /* Gets the position of the
    player*/
85 %token GetPlayerPoints    /* Gets the points of the player
    */

86
87 /* Associativity and Precedence */
88 %left MINUS PLUS COMMA
89 %left MULT DIV
90 %right NOT NEG
91 %nonassoc EQUAL NOTEQUAL LESSEQUAL GREATEQUAL ISEQUAL LESS
    GREAT AND OR MOD DOT
92
93 /* Types */
94 %type <sval> definitions
95 %type <sval> definitionlist
96 %type <sval> definitionproductions
97 %type <sval> functions
98 %type <sval> functionProductions
99 %type <sval> returnType
100 %type <sval> dataType
101 %type <sval> functionName
102 %type <sval> argumentLists
103 %type <sval> argumentList
104 %type <sval> empty;
105 %type <sval> returnProduction
106 %type <sval> returnProd
107 %type <sval> statement
108 %type <sval> statements
109 %type <sval> conditionals
110 %type <sval> loop
111 %type <sval> declarations
112 %type <sval> declaration
113 %type <sval> relationalExp
114 %type <sval> arithmeticExp
115 %type <sval> booleanExp
116 %type <sval> constOrVar
117 %type <sval> leftSide

```



```

118 %type <sval> rightSide
119 %type <sval> assignment
120 %type <sval> functionCall
121 %type <sval> parameterList
122
123 %%
124
125 /*****
126 * program
127 *****/
128 program: definitions functions
129 {
130     if (semantics.validProgram)
131     {
132         generateFloodProgram($1, $2);
133         System.out.println("Total number of lines in the input:
134             " + (yyline - 1));
135     }
136     else
137     {
138         System.out.println(semantics.printErrors());
139     }
140 };
141
142 definitions: DefineLeague definitionlist { $$ = $2; };
143
144 definitionlist: definitionlist definitionproductions { $$ = $1
145     + $2; }
146     | empty { $$ = $1; }
147     ;
148
149 definitionproductions: Set LeagueName OPEN_PARAN STRING_CONST
150     CLOSE_PARAN SEMICOLON { $$ = "myLeague = new League(" + $4 +
151     ");\n"; }
152     | Set MaxUser OPEN_PARAN INT CLOSE_PARAN
153     SEMICOLON { $$ = "myLeague.setMaxUser("
154     + $4 + ");\n"; }
155     | Set MinUser OPEN_PARAN INT CLOSE_PARAN
156     SEMICOLON { $$ = "myLeague.setMinUser("
157     + $4 + ");\n"; }
158     | Set MaxTeamSize OPEN_PARAN INT
159     CLOSE_PARAN SEMICOLON { $$ = "myLeague.
160     setMaxTeamSize(" + $4 + ");\n"; }
161     | Set MinTeamSize OPEN_PARAN INT
162     CLOSE_PARAN SEMICOLON { $$ = "myLeague.

```

```

152         setMinTeamSize(" + $4 + ");\n"; }
| Add User OPEN_PARAN STRING_CONST
  CLOSE_PARAN SEMICOLON { $$ = "myLeague.
    addUser(new User(" + $4 + "));\n";
    semantics.addUser($4, yyline); }
153 | Add Action OPEN_PARAN STRING_CONST
  COMMA FLT CLOSE_PARAN SEMICOLON { $$ =
    "myLeague.addAction(new Action(" + $4 +
      ", " + $6 + "));\n"; semantics.
    addAction($4, yyline); }
154 | Add Action OPEN_PARAN STRING_CONST COMMA MINUS
  FLT CLOSE_PARAN SEMICOLON %prec NEG { $$ = "
    myLeague.addAction(new Action(" + $4 + ", -" + $7
      + "));\n"; semantics.addAction($4, yyline); }
155 | Add Player OPEN_PARAN STRING_CONST
  COMMA STRING_CONST CLOSE_PARAN
  SEMICOLON { $$ = "myLeague.addPlayer(
    new Player(" + $4 + ", " + $6 + "));\n"
    ; semantics.addPlayer($4, yyline); }
156 ;
157
158 functions: DefineFunctions functionProductions { $$ = $2 +
  semantics.setFlags(); };
159
160 functionProductions: functionProductions returnType
  functionName OPEN_PARAN argumentLists CLOSE_PARAN OPEN_CURLY
  declarations statements returnProduction CLOSE_CURLY { $$
    = $1 + "public static " + $2 + " " + $3 + "(" + $5 + ")\n{\n"
    + $8 + $9 + $10 + "\n}\n"; this.scope = $3; semantics.
    addToFunctionTable($3, $2, $5, yyline); semantics.
    checkReturnTypeMatch($2, yyline); }
161 | functionProductions returnType
  functionName OPEN_PARAN argumentLists
  CLOSE_PARAN OPEN_CURLY empty
  CLOSE_CURLY { $$ = $1 + "public static " +
    $2 + " " + $3 + "(" + $5 + ")\n{\n}\n"
    ; this.scope = $3; semantics.
    addToFunctionTable($3, $2, $5, yyline);
    semantics.checkReturnTypeMatch($2,
      yyline); }
162 | functionProductions returnType
  functionName OPEN_PARAN argumentLists
  CLOSE_PARAN OPEN_CURLY empty
  statements returnProduction CLOSE_CURLY
  { $$ = $1 + "public static " + $2 + " " +

```

```

    $3 + "(" + $5 + ")\n{\n" + $8 + $9 +
    $10 + "\n}\n"; this.scope = $3;
    semantics.addToFunctionTable($3, $2, $5
    , yyline); semantics.
    checkReturnTypeMatch($2, yyline); }
163 | functionProductions returnType
    functionName OPEN_PARAN argumentLists
    CLOSE_PARAN OPEN_CURLY declarations
    empty returnProduction CLOSE_CURLY { $$
    = $1 + "public static " + $2 + " " + $3 +
    "(" + $5 + ")\n{\n" + $8 + $9 + $10 +
    "\n}\n"; this.scope = $3; semantics.
    addToFunctionTable($3, $2, $5, yyline);
    semantics.checkReturnTypeMatch($2,
    yyline); }
164 | functionProductions returnType
    functionName OPEN_PARAN argumentLists
    CLOSE_PARAN OPEN_CURLY returnProd
    CLOSE_CURLY { $$ = $1 + "public static " +
    $2 + " " + $3 + "(" + $5 + ")\n{\n" +
    $8 + "\n}\n"; this.scope = $3;
    semantics.addToFunctionTable($3, $2, $5
    , yyline); semantics.
    checkReturnTypeMatch($2, yyline); }
165 | empty { $$ = $1; }
166 ;
167
168 dataType: Str { $$ = "String"; }
169         | Bool { $$ = "boolean"; }
170         | Int { $$ = "int"; }
171         | Flt { $$ = "float"; }
172         ;
173
174 returnType: Void { $$ = "void"; }
175         | Str { $$ = "String"; }
176         | Bool { $$ = "boolean"; }
177         | Int { $$ = "int"; }
178         | Flt { $$ = "float"; }
179         ;
180
181 functionName: ID { $$ = $1; };
182
183 argumentLists: argumentLists COMMA argumentList { $$ = $1 + ",
    " + $3; }
184         | argumentList { $$ = $1; }

```

```

185         | empty { $$ = $1; }
186     ;
187
188     argumentList: dataType ID { $$ = $1 + " " + $2; semantics.
        addVar($2,$1,yyline); }
189         | User OPEN_SQUARE CLOSE_SQUARE ID { $$ = "User[]"
        " + $4; semantics.addVar($4,"User[]",yyline); }
190         | Player OPEN_SQUARE CLOSE_SQUARE ID { $$ = "
        Player[]" + $4; semantics.addVar($4,"Player[]",
        yyline); }
191         | User ID { $$ = "User " + $2; semantics.addVar($2
        ,"User",yyline); }
192         | Player ID { $$ = "Player " + $2; semantics.
        addVar($2,"Player",yyline); }
193     ;
194
195     statements: statements statement SEMICOLON { $$ = $1 + $2; }
196         | statement SEMICOLON { $$ = $1; }
197     ;
198
199     statement: conditionals { $$ = $1; }
200         | loop { $$ = $1; }
201         | relationalExp { $$ = $1; }
202         | assignment { $$ = $1; }
203         | functionCall { $$ = $1 + ";\n"; }
204     ;
205
206     returnProduction: Return ID SEMICOLON { $$ = "return " + $2 +
        ";\n"; semantics.setReturnProdType(semantics.getType($2)); }
207         | Return STRING_CONST SEMICOLON { $$ = "return
        " + $2 + ";\n"; semantics.setReturnProdType("
        String"); }
208         | Return INT SEMICOLON { $$ = "return " + $2 +
        ";\n"; semantics.setReturnProdType("int"); }
209         | Return FLT SEMICOLON { $$ = "return " + $2 +
        ";\n"; semantics.setReturnProdType("float");
        }
210         | Return True SEMICOLON { $$ = "return true;\n";
        semantics.setReturnProdType("boolean"); }
211         | Return False SEMICOLON { $$ = "return false;
        \n"; semantics.setReturnProdType("boolean"); }
212         | empty { $$ = $1; semantics.setReturnProdType
        ("void"); }
213     ;
214

```

```

215 returnProd: Return ID SEMICOLON { $$ = "return " + $2 + ";";
    semantics.setReturnProdType(semantics.getType($2)); }
216     | Return STRING_CONST SEMICOLON { $$ = "return
        " + $2 + ";"; semantics.setReturnProdType("
        String"); }
217     | Return INT SEMICOLON { $$ = "return " + $2 +
        ";"; semantics.setReturnProdType("int"); }
218     | Return FLT SEMICOLON { $$ = "return " + $2 +
        ";"; semantics.setReturnProdType("float");
        }
219     | Return True SEMICOLON { $$ = "return true;";
        semantics.setReturnProdType("boolean"); }
220     | Return False SEMICOLON { $$ = "return false;
        "; semantics.setReturnProdType("boolean"); }
221 ;
222
223 conditionals: If OPEN_PARAN relationalExp CLOSE_PARAN
    OPEN_CURLY statements CLOSE_CURLY { $$ = "if(" + $3 + ")\n{\n" +
    $6 + "}\n"; }
224     | If OPEN_PARAN relationalExp CLOSE_PARAN
        OPEN_CURLY statements CLOSE_CURLY Else
        OPEN_CURLY statements CLOSE_CURLY { $$ = "if(" +
        $3 + ")\n{\n" + $6 + "}\nelse\n{\n" + $10 + "}\n"
        "; }
225     | If OPEN_PARAN relationalExp CLOSE_PARAN
        OPEN_CURLY empty CLOSE_CURLY { $$ = "if(" + $3 +
        ")\n{\n}\n"; }
226     | If OPEN_PARAN relationalExp CLOSE_PARAN
        OPEN_CURLY empty CLOSE_CURLY Else OPEN_CURLY
        empty CLOSE_CURLY { $$ = "if(" + $3 + ")\n{\n}\n
        nelse\n{\n}\n"; }
227     | If OPEN_PARAN relationalExp CLOSE_PARAN
        OPEN_CURLY statements CLOSE_CURLY Else
        OPEN_CURLY empty CLOSE_CURLY { $$ = "if(" + $3 +
        ")\n{\n" + $6 + "}\nelse\n{\n}\n"; }
228     | If OPEN_PARAN relationalExp CLOSE_PARAN
        OPEN_CURLY empty CLOSE_CURLY Else OPEN_CURLY
        statements CLOSE_CURLY { $$ = "if(" + $3 + ")\n
        {\n}" + "\nelse\n{\n" + $10 + "}\n"; }
229     | If OPEN_PARAN booleanExp CLOSE_PARAN OPEN_CURLY
        statements CLOSE_CURLY { $$ = "if(" + $3 + ")\n
        {\n" + $6 + "}\n"; }
230     | If OPEN_PARAN booleanExp CLOSE_PARAN OPEN_CURLY
        statements CLOSE_CURLY Else OPEN_CURLY
        statements CLOSE_CURLY { $$ = "if(" + $3 + ")\n

```

```

    {\n" + $6 + "}\n\nelse\n{\n" + $10 + "}\n"; }
231 | If OPEN_PARAN booleanExp CLOSE_PARAN OPEN_CURLY
    empty CLOSE_CURLY { $$ = "if(" + $3 + ")\n{\n}\n
    "; }
232 | If OPEN_PARAN booleanExp CLOSE_PARAN OPEN_CURLY
    empty CLOSE_CURLY Else OPEN_CURLY empty
    CLOSE_CURLY { $$ = "if(" + $3 + ")\n{\n}\nelse\n
    {\n}\n"; }
233 | If OPEN_PARAN booleanExp CLOSE_PARAN OPEN_CURLY
    statements CLOSE_CURLY Else OPEN_CURLY empty
    CLOSE_CURLY { $$ = "if(" + $3 + ")\n{\n" + $6 +
    "}\nelse\n{\n}\n"; }
234 | If OPEN_PARAN booleanExp CLOSE_PARAN OPEN_CURLY
    empty CLOSE_CURLY Else OPEN_CURLY statements
    CLOSE_CURLY { $$ = "if(" + $3 + ")\n{\n}" + "\
    nelse\n{\n" + $10 + "}\n"; }
235 ;
236
237 loop: While OPEN_PARAN relationalExp CLOSE_PARAN OPEN_CURLY
    statements CLOSE_CURLY { $$ = "while(" + $3 + ")\n{\n" + $6
    + "}\n"; }
238 | While OPEN_PARAN relationalExp CLOSE_PARAN OPEN_CURLY
    empty CLOSE_CURLY { $$ = "while(" + $3 + ")\n{\n}\n"; }
239 | While OPEN_PARAN booleanExp CLOSE_PARAN OPEN_CURLY
    statements CLOSE_CURLY { $$ = "while(" + $3 + ")\n{\n" +
    $6 + "}\n"; }
240 | While OPEN_PARAN booleanExp CLOSE_PARAN OPEN_CURLY empty
    CLOSE_CURLY { $$ = "while(" + $3 + ")\n{\n}\n"; }
241 ;
242
243 declarations: declarations declaration SEMICOLON{ $$ = $1 + $2
    ; }
244 | declaration SEMICOLON{ $$ = $1; }
245 ;
246
247 declaration: Flt ID { $$ = "float " + $2 + ";\n"; semantics.
    addVar($2, "float", yyline); }
248 | Int ID { $$ = "int " + $2 + ";\n"; semantics.
    addVar($2, "int", yyline); }
249 | Bool ID { $$ = "boolean " + $2 + ";\n";
    semantics.addVar($2, "boolean", yyline); }
250 | Str ID { $$ = "String " + $2 + " = new String()
    ;\n"; semantics.addVar($2, "String", yyline); }
251 | Flt ID EQUAL FLT { $$ = "float " + $2 + " = " +
    $4 + ";\n"; semantics.addVar($2, "float", yyline

```

```

        ); }
252 | Int ID EQUAL INT { $$ = "int " + $2 + " = " + $4
      + "; \n"; semantics.addVar($2, "int", yyline); }
253 | Bool ID EQUAL True { $$ = "boolean " + $2 + " =
      true; \n"; semantics.addVar($2, "boolean", yyline
      ); }
254 | Bool ID EQUAL False { $$ = "boolean " + $2 + " =
      false; \n"; semantics.addVar($2, "boolean",
      yyline); }
255 | Str ID EQUAL STRING_CONST { $$ = "String " + $2
      + " = " + $4 + "; \n"; semantics.addVar($2, "
      String", yyline); }
256 ;
257
258 relationalExp: ID LESSEQUAL constOrVar { $$ = $1 + " <= " + $3
      ; semantics.checkRelExp($1, $3, yyline); semantics.
      checkRelationNumber($1, yyline); }
259 | ID GREATEREQUAL constOrVar { $$ = $1 + " >= " +
      $3; semantics.checkRelExp($1, $3, yyline);
      semantics.checkRelationNumber($1, yyline); }
260 | ID NOTEQUAL constOrVar { $$ = $1 + " != " + $3;
      semantics.checkRelExp($1, $3, yyline);
      semantics.checkRelationNotString($1, yyline); }
261 | ID LESS constOrVar { $$ = $1 + " < " + $3;
      semantics.checkRelExp($1, $3, yyline);
      semantics.checkRelationNumber($1, yyline); }
262 | ID GREAT constOrVar { $$ = $1 + " > " + $3;
      semantics.checkRelExp($1, $3, yyline);
      semantics.checkRelationNumber($1, yyline); }
263 | ID ISEQUAL constOrVar { if(semantics.
      isString($1, yyline)){ $$ = $1 + ".equals(" + $3
      + ")"; semantics.checkRelationString($1, yyline
      ); } else { $$ = $1 + " == " + $3; semantics.
      checkRelationNotString($1, yyline); } semantics
      .checkRelExp($1, $3, yyline); }
264 | OPEN_PARAN relationalExp CLOSE_PARAN { $$ = "(" + $2
      + ")"; }
265 ;
266
267 booleanExp: booleanExp AND booleanExp { $$ = $1 + " && " + $3;
      }
268 | booleanExp OR booleanExp { $$ = $1 + " || " + $3;
      }
269 | relationalExp AND relationalExp { $$ = $1 + " && "
      + $3; }

```

```

270         | relationalExp OR relationalExp { $$ = $1 + " || "
          + $3; }
271         | relationalExp AND booleanExp { $$ = $1 + " && " +
          $3; }
272         | relationalExp OR booleanExp { $$ = $1 + " || " +
          $3; }
273         | booleanExp AND relationalExp { $$ = $1 + " && " +
          $3; }
274         | booleanExp OR relationalExp { $$ = $1 + " || " +
          $3; }
275         | OPEN_PARAN booleanExp CLOSE_PARAN { $$ = "(" + $2
          + ")"; }
276         | NOT booleanExp { $$ = "!" + $2; }
277         | ID { $$ = $1; }
278         | True { $$ = "true"; }
279         | False { $$ = "false"; }
280     ;
281
282     constOrVar: FLT { $$ = "" + $1; }
283                 | INT { $$ = "" + $1; }
284                 | ID { $$ = "" + $1; }
285     | STRING_CONST { $$ = $1; }
286     ;
287
288     arithmeticExp: arithmeticExp PLUS arithmeticExp { $$ = $1 + "
          + " + $3 ; semantics.checkForBadAdditionType(yyline); }
289                 | arithmeticExp MINUS arithmeticExp { $$ = $1 + "
          - " + $3; semantics.checkForBadArithmeticType(
          yyline); }
290                 | arithmeticExp MULT arithmeticExp { $$ = $1 + "
          * " + $3; semantics.checkForBadArithmeticType(
          yyline); }
291                 | arithmeticExp DIV arithmeticExp { $$ = $1 + " /
          " + $3; semantics.checkForBadArithmeticType(
          yyline); }
292                 | arithmeticExp MOD arithmeticExp { $$ = $1 + " %
          " + $3; semantics.checkForBadArithmeticType(
          yyline); }
293                 | OPEN_PARAN arithmeticExp CLOSE_PARAN { $$ = "("
          + $2 + ")"; }
294                 | ID { $$ = $1; semantics.assignmentCheckVar($1,
          yyline); }
295                 | FLT { $$ = "" + $1; semantics.
          assignmentCheckLeftIsOfType("float", yyline); }
296                 | INT { $$ = "" + $1; semantics.

```



```

        assignmentCheckLeftIsOfType("int", yyline); }
297     ;
298
299 assignment: leftSide EQUAL rightSide { $$ = $1 + " = " + $3;
    semantics.funcReturnFlag=false;}
300
301 leftSide: ID { $$ = $1; semantics.assignmentCheckLeft($1,
    yyline); semantics.funcReturnFlag=true;}
302
303 rightSide: arithmeticExp { $$ = $1 + ";\n"; }
304     | functionCall { $$ = $1 + ";\n"; }
305     | STRING_CONST { $$ = $1 + ";\n"; semantics.
        assignmentCheckLeftIsOfType("String", yyline); }
306     | True { $$ = "true" + ";\n"; semantics.
        assignmentCheckLeftIsOfType("boolean", yyline); }
307     | False { $$ = "false" + ";\n"; semantics.
        assignmentCheckLeftIsOfType("boolean", yyline); }
308     ;
309
310 functionCall: functionName OPEN_PARAN parameterList
    CLOSE_PARAN { $$ = $1 + "(" + $3 + ")"; semantics.
        assignmentCheckFunction($1, yyline);}
311     | AddPlayer OPEN_PARAN ID COMMA ID CLOSE_PARAN {
        $$ = $3 + ".addPlayer(" + $5 + ")" ; semantics.
        checkIDagainstType($3,"User", yyline);semantics.
        checkIDagainstType($5,"Player", yyline);}
312     | RemovePlayer OPEN_PARAN ID COMMA ID CLOSE_PARAN
        { $$ = $3 + ".removePlayer(" + $5 + ")" ;
        semantics.checkIDagainstType($3,"User", yyline);
        semantics.checkIDagainstType($5,"Player", yyline)
        ); semantics.assignmentCheckLeftIsOfType("void",
        yyline); }
313     | ArrayLength OPEN_PARAN ID CLOSE_PARAN { $$ = $3
        + ".length"; semantics.checkArrayType($3,yyline)
        ; semantics.assignmentCheckLeftIsOfType("int",
        yyline); }
314     | GetUserName OPEN_PARAN ID CLOSE_PARAN { $$ = $3 + ".
        getName()"; semantics.checkIDagainstType($3,"User",
        yyline); semantics.assignmentCheckLeftIsOfType("
        String", yyline); }
315     | GetNumPlayers OPEN_PARAN ID CLOSE_PARAN { $$ = $3 + ".
        getNumPlayers()"; semantics.checkIDagainstType($3,"
        User", yyline); semantics.assignmentCheckLeftIsOfType
        ("int", yyline); }
316     | GetPlayerName OPEN_PARAN ID CLOSE_PARAN { $$ = $3 + "

```

```

        .getName();"semantics.checkIDagainstType($3,"Player",
        yyline); semantics.assignmentCheckLeftIsOfType("
        String", yyline); }
317 | GetPlayerPosition OPEN_PARAN ID CLOSE_PARAN { $$= $3
        + ".getPosition();"semantics.checkIDagainstType($3,"
        Player", yyline); semantics.
        assignmentCheckLeftIsOfType("String", yyline); }
318 | GetPlayerPoints OPEN_PARAN ID CLOSE_PARAN { $$=$3 +
        ".getPoints();"semantics.checkIDagainstType($3,"
        Player", yyline); semantics.
        assignmentCheckLeftIsOfType("float", yyline); }
319 | Alert OPEN_PARAN STRING_CONST COMMA STRING_CONST
        CLOSE_PARAN { $$="GUI.alert("+ $3+", "+ $5+)"";
        semantics.assignmentCheckLeftIsOfType("void", yyline)
        ;}
320 | Error OPEN_PARAN STRING_CONST COMMA STRING_CONST
        CLOSE_PARAN { $$="GUI.error("+ $3+", "+ $5+)"";
        semantics.assignmentCheckLeftIsOfType("void", yyline)
        ;}
321 ;
322
323 parameterList: parameterList COMMA parameterList { $$ = $1 + "
        , " + $3; }
324 | ID { $$ = $1; }
325 | INT { $$ = "" + $1; }
326 | FLT { $$ = "" + $1; }
327 | STRING_CONST { $$ = $1; }
328 | ID OPEN_SQUARE INT CLOSE_SQUARE { $$ = $1 + "["
        + $3 + "]" ; }
329 | ID OPEN_SQUARE ID CLOSE_SQUARE { $$ = $1 + "["
        + $3 + "]" ; semantics.checkIndex($3, yyline);}
330 | empty { $$ = $1; }
331 ;
332
333 empty: ; { $$ = ""; }
334
335 %%
336
337 /*****
338 * Variables
339 *****/
340 private Ylex lexer;
341 public int yyline = 1;
342 public int yycolumn = 0;
343 public boolean createPositionFile = false;

```

```

344 //Semantic Object
345 Flood_Sem semantics = new Flood_Sem();
346 String scope = "main";
347
348 /*****
349 * generateFloodProgram()
350 *****/
351 public void generateFloodProgram(String definitions, String
    functions)
352 {
353     String classStart = "public class FloodProgram\n{\n";
354     String staticDeclarations = "public static League myLeague;\n
        npublic static GUI run;\n";
355     String classEnd = "}\n";
356
357     String main_start = "public static void main(String[] args)\n
        n{\n";
358     String main_preEndAutogenerate = "run = new GUI(myLeague);\n
        nrun.drawBoard();\n";
359     String main_end = "}\n";
360
361     try
362     {
363         FileWriter writer = new FileWriter(new File("FloodProgram.
            java"));
364         String buffer = classStart + staticDeclarations +
            main_start + definitions + main_preEndAutogenerate +
            main_end + functions + classEnd;
365         writer.write(buffer);
366         writer.close();
367         System.out.println("Compilation successful.");
368     }
369     catch (IOException e)
370     {
371     }
372 }
373
374 /*****
375 * yylex()
376 *****/
377 private int yylex()
378 {
379     int yyl_return = -1;
380
381     try

```

```

382     {
383         yylval = new ParserVal(0);
384         yyl_return = lexer.yylex();
385     }
386     catch (IOException e)
387     {
388         System.err.println("IO error: " + e.getMessage());
389     }
390
391     return yyl_return;
392 }
393
394 /*****
395 * Parser()
396 *****/
397 public Parser(Reader r, boolean createFile)
398 {
399     lexer = new Yylex(r, this);
400     this.createPositionFile = createFile;
401 }
402
403 /*****
404 * getLocationInfo()
405 *****/
406 public String getLocationInfo(boolean justLine)
407 {
408     if(justLine)
409         return "Error on line(" + yyline + "): ";
410     else
411         return "Error on line(" + yyline + ") and column(" +
            yycolumn + "): ";
412 }
413
414 /*****
415 * yyerror()
416 *****/
417 public void yyerror(String error)
418 {
419     try{
420         if(stateptr > 0) {
421             System.out.print("Syntax " + getLocationInfo(true)
                );
422             System.out.println(": Illegal token '" + lexer.yytext
                () + "'");
423         }

```

```

424     }
425     catch (Exception ex) {
426     }
427 }
428
429 /*****
430 * main()
431 *****/
432 public static void main(String args[]) throws IOException
433 {
434
435     Parser yyparser;
436     boolean createFile = false;
437
438     if (args.length < 1)
439     {
440         System.out.println("Usage: java Parser <flood_progam.txt>"
441             );
442         return;
443     }
444     else if (args.length == 2)
445     {
446         createFile = Boolean.parseBoolean(args[1]);
447     }
448
449     // parse a file
450     yyparser = new Parser(new FileReader(args[0]), createFile);
451
452     System.out.println("\nCompiling ...\n");
453     yyparser.yyparse();
454 }

```

Listing A.3: flood_lex.flex

```

1  /* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
2  *
3  * flood_lex.flex
4  * FLOOD
5  * Lexical Analyzer
6  *
7  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * */
8
9  %%
10
11 %byaccj

```

```

12
13 %{
14     private Parser yyparser;
15
16     public Yylex(java.io.Reader r, Parser yyparser)
17     {
18         this(r);
19         this.yyparser = yyparser;
20     }
21 %}
22
23 ID      = [a-zA-Z"_" ] ([a-zA-Z"_" ] | [0-9]) *
24 NL      = \n | \r | \r\n
25 WP      = " "
26 INT     = [0-9]+ /*| "-" [0-9]+ */
27 FLT     = [0-9]+ ("." [0-9]+)? /*| "-" [0-9]+ ("." [0-9]+)? */
28 HT      = \t
29 COMMENTS = "/" * [^*] ~ "*" / " | "/" * " *" + "/"
30
31 %%
32
33 /* Keywords */
34 DefineLeague      { yyparser.yycolumn += yytext().length();
35                     return Parser.DefineLeague;      }
36 DefineFunctions   { yyparser.yycolumn += yytext().length();
37                     return Parser.DefineFunctions;    }
38 LeagueName        { yyparser.yycolumn += yytext().length();
39                     return Parser.LeagueName;         }
40 MaxUser           { yyparser.yycolumn += yytext().length();
41                     return Parser.MaxUser;            }
42 MinUser           { yyparser.yycolumn += yytext().length();
43                     return Parser.MinUser;            }
44 MaxTeamSize       { yyparser.yycolumn += yytext().length();
45                     return Parser.MaxTeamSize;        }
46 MinTeamSize       { yyparser.yycolumn += yytext().length();
47                     return Parser.MinTeamSize;        }
48 Set               { yyparser.yycolumn += yytext().length();
49                     return Parser.Set;                }
50 Add               { yyparser.yycolumn += yytext().length();
51                     return Parser.Add;                }
52 Action            { yyparser.yycolumn += yytext().length();
53                     return Parser.Action;             }
54 User              { yyparser.yycolumn += yytext().length();
55                     return Parser.User;              }
56 Void              { yyparser.yycolumn += yytext().length();

```

```

        return Parser.Void;
    }
46 Int      { yyparser.yycolumn += yytext().length();
    return Parser.Int;
    }
47 Bool     { yyparser.yycolumn += yytext().length();
    return Parser.Bool;
    }
48 Str      { yyparser.yycolumn += yytext().length();
    return Parser.Str;
    }
49 Flt      { yyparser.yycolumn += yytext().length();
    return Parser.Flt;
    }
50 Return   { yyparser.yycolumn += yytext().length();
    return Parser.Return;
    }
51 If       { yyparser.yycolumn += yytext().length();
    return Parser.If;
    }
52 Else     { yyparser.yycolumn += yytext().length();
    return Parser.Else;
    }
53 While    { yyparser.yycolumn += yytext().length();
    return Parser.While;
    }
54 Player   { yyparser.yycolumn += yytext().length();
    return Parser.Player;
    }
55 True     { yyparser.yycolumn += yytext().length();
    return Parser.True;
    }
56 False    { yyparser.yycolumn += yytext().length();
    return Parser.False;
    }
57 RemovePlayer { yyparser.yycolumn += yytext().length();
    return Parser.RemovePlayer;
    }
58 AddPlayer { yyparser.yycolumn += yytext().length();
    return Parser.AddPlayer;
    }
59 ArrayLength { yyparser.yycolumn += yytext().length();
    return Parser.ArrayLength;
    }
60 Alert    { yyparser.yycolumn += yytext().length(); return
    Parser.Alert;
    }
61 Error    { yyparser.yycolumn += yytext().length(); return
    Parser.Error;
    }
62 GetUserName { yyparser.yycolumn += yytext().length();
    return Parser.GetUserName;
    }
63 GetNumPlayers { yyparser.yycolumn += yytext().length();
    return Parser.GetNumPlayers;
    }
64 GetPlayerName { yyparser.yycolumn += yytext().length();
    return Parser.GetPlayerName;
    }
65 GetPlayerPosition { yyparser.yycolumn += yytext().length();
    return Parser.GetPlayerPosition;
    }
66 GetPlayerPoints { yyparser.yycolumn += yytext().length();
    return Parser.GetPlayerPoints;
    }
67
68

```

```

69
70 /* Comments */
71 {COMMENTS}          { /* ignore */ }
72
73 /* Identifier */
74 {ID}                {
75                     yyparser.yycolumn += yytext().length();
76                     yyparser.yylval = new ParserVal(yytext());
77                     return Parser.ID;
78                 }
79
80 /* Newline */
81 {NL}                {
82                     yyparser.yycolumn = 0;
83                     yyparser.yyline++;
84                 }
85
86 {WP}                {
87                     yyparser.yycolumn++;
88                 }
89
90 /* Integer */
91 {INT}                {
92                     yyparser.yycolumn += yytext().length();
93                     yyparser.yylval = new ParserVal(Integer.
94                         parseInt(yytext()));
95                     return Parser.INT;
96                 }
97
98 /* Float */
99 {FLT}                {
100                     yyparser.yycolumn += yytext().length();
101                     yyparser.yylval = new ParserVal(Double.
102                         parseDouble(yytext()));
103                     return Parser.FLT;
104                 }
105
106 [\t]+                { yyparser.yycolumn += yytext().length(); }
107
108 "\"\" [^\"]*\"\"      {
109                     yyparser.yycolumn += yytext().length();
110                     yyparser.yylval = new ParserVal(yytext());
111                     return Parser.STRING_CONST;
112                 }

```



```

112
113 ,                { yyparser.yycolumn++; return Parser.COMMA;
                        }
114
115 "."              { yyparser.yycolumn++; return Parser.DOT;
                        }
116
117 "+"              { yyparser.yycolumn++; return Parser.PLUS;
                        }
118
119 "{ "              { yyparser.yycolumn++; return Parser.
    OPEN_CURLY;      }
120
121 "}"              { yyparser.yycolumn++; return Parser.
    CLOSE_CURLY;     }
122
123 "("              { yyparser.yycolumn++; return Parser.
    OPEN_PARAN;       }
124
125 ")"              { yyparser.yycolumn++; return Parser.
    CLOSE_PARAN;      }
126
127 "=="             { yyparser.yycolumn++; return Parser.ISEQUAL
    ;                }
128
129 "="              { yyparser.yycolumn++; return Parser.EQUAL;
                        }
130
131 "!="             { yyparser.yycolumn++; return Parser.
    NOTEQUAL;         }
132
133 "<="             { yyparser.yycolumn++; return Parser.
    LESSEQUAL;        }
134
135 ">="             { yyparser.yycolumn++; return Parser.
    GREATEQUAL;       }
136
137 ">"              { yyparser.yycolumn++; return Parser.GREAT;
                        }
138
139 "<"              { yyparser.yycolumn++; return Parser.LESS;
                        }
140
141 "+"              { yyparser.yycolumn++; return Parser.PLUS;
                        }

```

```

142
143 "-"                { yyparser.yycolumn++; return Parser.MINUS;
                        }
144
145 "*"                { yyparser.yycolumn++; return Parser.MULT;
                        }
146
147 "/"                { yyparser.yycolumn++; return Parser.DIV;
                        }
148
149 "!"                { yyparser.yycolumn++; return Parser.NOT;
                        }
150
151 "&&"                { yyparser.yycolumn++; return Parser.AND;
                        }
152
153 "||"               { yyparser.yycolumn++; return Parser.OR;
                        }
154
155 "%"                { yyparser.yycolumn++; return Parser.MOD;
                        }
156
157 [;]+               {
158                     yyparser.yycolumn += yytext().length();
159                     return Parser.SEMICOLON;
160                 }
161
162 "["                { yyparser.yycolumn++; return Parser.
163                     OPEN_SQUARE;    }
164
165 "]"                { yyparser.yycolumn++; return Parser.
166                     CLOSE_SQUARE;   }
167
168 /* Error Fallback */
169 [^]                {
170                     System.err.println("Error: unexpected
171                                     character '" + yytext() + "'");
172                     return -1;
173                 }

```

Listing A.4: Flood_Sem.java

```

1  /*
2   * Flood_Sem.java
3   * This class handles semantics of the FLOOD language

```

```

4  */
5
6  import java.util.*;
7
8  public class Flood_Sem {
9
10     HashMap<String, Function> functionTable = new HashMap<
        String, Function>();
11     HashMap<String, String> varList = new HashMap<String,
        String>();
12     ArrayList<String> errorList=new ArrayList<String>();
13     String returnProductionType;
14     static boolean debugging = false,validProgram=true,
        funcReturnFlag=false;;
15     boolean draftFunFlag = false;
16     boolean draftPlayFlag = false;
17     boolean tradeFlag = false;
18     boolean dropPlayFlag = false;
19
20
21     //Add Variables
22     LinkedList<String> actionNames = new LinkedList<String>();
23     LinkedList<String> playerNames = new LinkedList<String>();
24     LinkedList<String> userNames = new LinkedList<String>();
25
26     //Assignment Variables
27     String leftSide = "";
28
29     public Flood_Sem(){
30         if(debugging)System.out.print("Starting Semantic Object
            Checker");
31     }
32
33     public String printErrors(){
34         String errors="";
35         for(String s:errorList){
36             errors+=s+"\n";
37         }
38         return errors;
39     }
40
41     /*Adds an Action */
42     public void addAction(String name, int line){
43         if (actionNames.contains(name)){
44             if (debugging){System.out.println(name + " already

```

```

        exists as an Action");}
45     validProgram=false;
46     errorList.add("Error at Line " + line + ": " +name+"
        has already been defined.");
47     return;
48 }
49 actionNames.add(name);
50 if (debugging){System.out.println(name + " was added as
    an Action");}
51 return;
52 }
53
54 /* Add a User */
55 public void addUser(String name, int line){
56     if (userNames.contains(name)){
57         if (debugging){System.out.println(name + " already
            exists as a User");}
58         validProgram=false;
59         errorList.add("Error at Line " + line + ": " +name+"
            has already been defined.");
60         return;
61     }
62     userNames.add(name);
63     if (debugging){System.out.println(name + " was added as
        a User");}
64 }
65
66 /* Add a Player */
67 public void addPlayer(String name, int line){
68     if (playerNames.contains(name)){
69         if (debugging){System.out.println(name + " already
            exists as a Player");}
70         validProgram=false;
71         errorList.add("Error at Line " + line + ": " +name+"
            has already been defined.");
72         return;
73     }
74     playerNames.add(name);
75     if (debugging){System.out.println(name + " was added as
        a Player");}
76 }
77
78 /* Adds a function to the function table. */
79 public void addToFunctionTable(String functionName, String
    returnType, String paramList, int line){

```

```

80     if (functionTable.containsKey(functionName)){
81         if (debugging){System.out.println(functionName + "
            already exists");}
82         validProgram=false;
83         errorList.add("Error at Line " + line + ": " +
            functionName+" has already been defined.");
84         return;
85     }
86     functionTable.put(functionName, new Function(
            functionName, returnType, paramList, line));
87     this.varList = new HashMap<String, String>();
88     if (debugging){System.out.println("Reinitializing
            variable list");}
89 }
90
91 /* Checks whether a given value is boolean true or false (
    note: case specific) */
92 public void isBooleanValue(String bool, int line){
93     if (bool.equals("true") || bool.equals("false")){
94         return;
95     }
96     if (debugging){System.out.println(bool + " is not a
        boolean value");}
97     validProgram=false;
98     errorList.add("Error at Line " + line + ": " +bool+" is
        not of type Bool.");
99 }
100
101 /* Adds a variable to the function's variable list. Checks
    if it exists first */
102 public void addVar(String varName, String varType, int line
    ){
103     if (varExists(varName)){
104         if (debugging){System.out.println(varName + " already
            exists");}
105         validProgram=false;
106         errorList.add("Error at Line " + line + ": " +varName
            +" has already been defined.");
107         return;
108     }
109     addVarToTable(varName, varType);
110 }
111
112 /* Check whether a variable used exists and is the same as
    its declared type */

```

```

113     public boolean varExists(String varName){
114         if (varList.containsKey(varName)) {
115             return true;
116         }
117         else{
118             return false;
119         }
120     }
121
122     /* AddtoCurrentVarList */
123     public void addVarToTable(String varName, String varType){
124         varList.put(varName, varType);
125         if (debugging){System.out.println("Added varName: " +
126             varName + ", type: " + varType);}
127
128     /* Checks the type of a variable against the left side of
129        an expression */
129     public void assignmentCheckVar(String right, int line){
130         if (varExists(right)){
131             if (varList.get(right).equals(leftSide)){
132                 if (debugging){System.out.println("Both are of
133                     type " + leftSide);}
134                 return;
135             }
136             if (debugging){System.out.println(right + " isn't of
137                 type " + leftSide);}
138             validProgram=false;
139             errorList.add("Error at Line " + line + ": " +right+"
140                 is not of type "+leftSide+".");
141             return;
142         }
143         if (debugging){System.out.println(right + " doesn't
144             exist");}
145         validProgram=false;
146         errorList.add("Error at Line " + line + ": " +right+"
147             has not been defined.");
148         return;
149     }
150
151     /* Preserves the type of the left side of an expression */
152     public void assignmentCheckLeft(String left, int line){
153         if (varExists(left)){
154             leftSide = varList.get(left);
155             if (debugging){System.out.println("Added " + left);}

```

```

151         return;
152     }
153     validProgram=false;
154     errorList.add("Error at Line " + line + ": " +left+" has
        not been defined.");
155 }
156
157 /* Check whether an arithmetic expression can be used with
    the kind of ID */
158 public void checkForBadAdditionType(int line){
159     if (leftSide.equals("float") || leftSide.equals("int")
        || leftSide.equals("String")){
160         if (debugging){System.out.println(leftSide + " can be
            used with add");}
161         return;
162     }
163     if (debugging){System.out.println(leftSide + " cannot be
        used in addition");}
164     validProgram=false;
165     errorList.add("Error at Line " + line + ": " +leftSide+"
        cannot be used in addition.");
166     return;
167 }
168
169 /* Check whether an arithmetic expression can be used with
    the kind of ID */
170 public void checkForBadArithmeticType(int line){
171     if (leftSide.equals("float") || leftSide.equals("int")){
172         if (debugging){System.out.println(leftSide + " can be
            used with add/sub/mul/div/mod");}
173         return;
174     }
175     if (debugging){System.out.println(leftSide + " cannot be
        used in an arithmetic expression");}
176     validProgram=false;
177     errorList.add("Error at Line " + line + ": " +leftSide+"
        cannot be used with arithmetic expressions.");
178     return;
179 }
180
181 /* Checks whether the left side of the expression is a TYPE
    */
182 public void assignmentCheckLeftIsOfType(String type, int
    line){
183     if(funcReturnFlag){

```

```

184         if (leftSide.equals(type)){
185             if (debugging){System.out.println(leftSide + " IS
                of type " + type);}
186             return;
187         }
188         if (debugging){System.out.println(leftSide + " is not
                of type " + type);}
189         validProgram=false;
190         errorList.add("Error at Line " + line + ": " +
                leftSide + " is not of type " + type + ".");
191         return;
192     }
193     else{
194         if (debugging){System.out.println("Function with no
                return assignment");}
195         return;
196     }
197 }
198
199 /* Checks the Return Type of the Function Against the Left
    Side of an expression */
200 public void assignmentCheckFunction(String functionName,
    int line){
201     if (functionTable.containsKey(functionName)){
202         if(funcReturnFlag){
203             if (functionTable.get(functionName).getReturnType
                ().equals(leftSide)){
204                 if (debugging){System.out.println("Both are of
                    type " + leftSide);}
205                 return;
206             }
207             if (debugging){System.out.println(functionName + "
                doesn't return type " + leftSide);}
208             validProgram=false;
209             errorList.add("Error at Line " + line + ": " +
                functionName + " does not return a value of type
                    " + leftSide + ".");
210             return;
211         }
212         else{
213             if (debugging){System.out.println("Function with
                no return assignment");}
214             return;
215         }
216     }

```



```

217         if (debugging){System.out.println(functionName + " has
                not been defined.");}
218         validProgram=false;
219         errorList.add("Error at Line " + line + ": " +
                functionName + " has not been defined.");
220         return;
221     }
222
223     public void checkArrayType(String varName, int line){
224         if(varExists(varName)){
225             if(varList.get(varName).equals("User[]") || varList.
                get(varName).equals("Player[]")){
226                 if (debugging){System.out.println(varName+" is of
                        type "+varList.get(varName));}
227                 return;
228             }
229             if (debugging){System.out.println(varList.get(varName)
                )+" is not a valid array type.");}
230             validProgram=false;
231             errorList.add("Error at Line " + line + ": " +varList
                .get(varName)+" is not a valid array type.");
232             return;
233         }
234         if (debugging){System.out.println(varName+" has not been
                defined.");}
235         validProgram=false;
236         errorList.add("Error at Line " + line + ": " +varName+"
                has not been defined.");
237         return;
238     }
239     /* Check Divide by zero */
240     public void checkDivideByZero(String var, int line){
241         if (Double.parseDouble(var) == 0){
242             return;
243         }
244         validProgram=false;
245         errorList.add("Error at Line " + line + ": Cannot divide
                by zero.");
246         return;
247     }
248
249     /* Checks against an int */
250     public void checkRelExp(String left, String right, int line
        ){
251         if(right.matches("^-?\\d.*$")){

```

```

252         if(right.contains(".")){
253             checkRelationalExpAgainstType(left, "float", line)
254             ;
255         }
256         else{
257             checkRelationalExpAgainstType(left, "int", line);
258         }
259     else if(right.matches("^\".*\"$")){
260         checkRelationalExpAgainstType(left, "String", line);
261     }
262     else{
263         checkRelationalExp(left, right, line);
264     }
265 }
266
267 /* Checks against a declared variable */
268 private void checkRelationalExp(String left, String right,
269     int line){
270     if (varExists(right)){
271         checkRelationalExpAgainstType(left, varList.get(right
272             ), line);
273         return;
274     }
275     if (debugging){System.out.println(right + " doesn't
276         exist");}
277     validProgram=false;
278     errorList.add("Error at Line " + line + ": " +right+"
279         has not been defined.");
280     return;
281 }
282
283 /* Checks to make sure that relational expression don't
284     compare an invalid type */
285 public void checkRelationNumber(String left, int line){
286     if (varExists(left)){
287         String leftType = varList.get(left);
288         if (!leftType.equals("int") && !leftType.equals("
289             float")){
290             if (debugging){System.out.println(left + " cannot
291                 be used because it is of type " + leftType);}
292             validProgram=false;
293             errorList.add("Error at Line " + line + ": " +left
294                 + " cannot be used because it is of type " +
295                 leftType + ".");

```

```

287         return;
288     }
289 }
290 else{
291     validProgram=false;
292     errorList.add("Error at Line " + line + ": " +left+"
293         has not been defined.");
294     return;
295 }
296
297 /* Checks to make sure that relational expression don't
298    compare an invalid type */
299 public void checkRelationNotString(String left, int line){
300     if (varExists(left)){
301         String leftType = varList.get(left);
302         if (leftType.equals("String")){
303             if (debugging){System.out.println(left + " cannot
304                 be used because it is of type " + leftType);}
305             validProgram=false;
306             errorList.add("Error at Line " + line + ": " +left
307                 + " cannot be used because it is of type " +
308                 leftType + ".");
309             return;
310         }
311     }
312     else{
313         validProgram=false;
314         errorList.add("Error at Line " + line + ": " +left+"
315             has not been defined.");
316         return;
317     }
318 }
319
320 /* Checking known type of string */
321 public void checkRelationString(String left, int line){
322     if (varExists(left)){
323         String leftType = varList.get(left);
324         if (!leftType.equals("String")){
325             if (debugging){System.out.println(left + " cannot
326                 be used because it is of type " + leftType);}
327             validProgram=false;
328             errorList.add("Error at Line " + line + ": " +left
329                 + " cannot be used because it is of type " +
330                 leftType + ".");

```

```

323         return;
324     }
325 }
326 else{
327     validProgram=false;
328     errorList.add("Error at Line " + line + ": " +left+"
329         has not been defined.");
329     return;
330 }
331 }
332
333 public boolean isString(String left, int line){
334     if (varExists(left)){
335         String leftType = varList.get(left);
336         if (leftType.equals("String")){
337             return true;
338         }
339         return false;
340     }
341     else{
342         validProgram=false;
343         errorList.add("Error at Line " + line + ": " +left+"
344             has not been defined.");
345         return false;
346     }
347 }
348
349 /* Private method for checking a variable against an
350    unknown type */
351 private void checkRelationalExpAgainstType(String left,
352     String rightType, int line){
353     if (varExists(left)){
354         String leftType = varList.get(left);
355         if (leftType.equals(rightType)){
356             if (debugging){System.out.println("Both are of
357                 type " + rightType);}
358             return;
359         }
360         if (debugging){System.out.println(rightType + " is
361             not " + leftType);}
362         validProgram=false;
363         errorList.add("Error at Line " + line + ": " +
364             rightType + " is not of type " + leftType + ".");
365         return;
366     }

```

```

361     else{
362         if (debugging){System.out.println(left + " doesn't
363             exist");}
364         validProgram=false;
365         errorList.add("Error at Line " + line + ": " +left +
366             " has not been defined.");
367         return;
368     }
369 }
370 //check that array index is an int
371 public void checkIndex(String arrayIndex, int line){
372     //check if ID is a variable of type int
373     arrayIndex = arrayIndex.replaceAll(" ", "");
374     if(varList.containsKey(arrayIndex) && varList.get(
375         arrayIndex).equals("int")){
376         if (debugging){System.out.println(arrayIndex +"\n"+
377             varList.get(arrayIndex));}
378         return;
379     }
380     else{
381         if (debugging){System.out.println("Fail, invalid type
382             ");}
383         validProgram=false;
384         errorList.add("Error at Line " + line + ": " +
385             arrayIndex+" is an invalid type for an array index.
386             ");
387         return;
388     }
389 }
390
391 public String getType(String id){
392     if(varExists(id))
393         return varList.get(id);
394     if(debugging){System.out.println(id+" is a valid
395         variable!");}
396     return null;
397 }
398
399 public void setReturnProdType(String type){
400     returnProductionType=type;
401 }
402
403 public void checkReturnTypeMatch(String returnType, int
404     line){
405     if(returnProductionType!=null){
406         if(returnProductionType.equals(returnType)){

```

```

397         if (debugging){System.out.println(
398             returnProductionType + " return type matches "+
399             returnType);}
400         return;
401     }
402     if (debugging){System.out.println(
403         returnProductionType + " return type doesn't match
404         "+returnType);}
405     validProgram=false;
406     errorList.add("Error at Line " + line + ": " +
407         returnProductionType + " return type does not match
408         "+returnType+".");
409     return;
410 }
411 if (debugging){System.out.println(returnProductionType +
412     " is not a valid type");}
413 validProgram=false;
414 errorList.add("Error at Line " + line + ": " +
415     returnProductionType + " is not a valid type.");
416 return;
417 }
418
419 /* Check that an ID is of a certain type */
420 public void checkIDagainstType(String id, String type, int
421     line){
422     if (varExists(id)){
423         String idType = varList.get(id);
424         if (idType.equals(type)){
425             if (debugging){System.out.println(id + " IS of
426                 type " + type);}
427             return;
428         }
429         if (debugging){System.out.println(id + " is not " +
430             type);}
431         validProgram=false;
432         errorList.add("Error at Line " + line + ": " +id + "
433             is not of type " + type + ".");
434         return;
435     }
436     if (debugging){System.out.println(id + " doesn't exist")
437         ;}
438     validProgram=false;
439     errorList.add("Error at Line " + line + ": " +id + " has
440         not been defined.");
441     return;

```

```

428     }
429
430     //set flags for required functions
431     public String setFlags(){
432         //flag for draftFunction
433         Function fun;
434         if(functionTable.containsKey("draftFunction")){
435             fun = functionTable.get("draftFunction");
436             if(fun.returnType.equals("int")){
437                 if(fun.paramTypeList.length == 1 && fun.
438                     paramTypeList[0].equals("int")){
439                     if(debugging)System.out.print("Draft function
440                         found");
441                     draftFunFlag = true;
442                 }
443             }
444         }
445         if(functionTable.containsKey("draftPlayer")){
446             fun = functionTable.get("draftPlayer");
447             if(fun.returnType.equals("boolean")){
448                 if(fun.paramTypeList.length==2 && fun.
449                     paramTypeList[0].equals("User") && fun.
450                     paramTypeList[1].equals("Player")){
451                     if(debugging)System.out.print("Draft player
452                         found");
453                     draftPlayFlag = true;
454                 }
455             }
456         }
457         if(functionTable.containsKey("trade")){
458             fun = functionTable.get("trade");
459             if(fun.returnType.equals("boolean")){
460                 if(fun.paramTypeList.length==4 && fun.
461                     paramTypeList[0].equals("User")
462                     && fun.paramTypeList[1].equals("Player[]")
463                     && fun.paramTypeList[2].equals("User")
464                     && fun.paramTypeList[3].equals("Player[]")){
465                     if(debugging)System.out.print("Trade found");
466                     tradeFlag = true;
467                 }
468             }
469         }
470         if(functionTable.containsKey("dropPlayer")){
471             fun = functionTable.get("dropPlayer");
472             if(fun.returnType.equals("boolean")){

```

```

466         if(fun.paramTypeList.length==2 && fun.
           paramTypeList[0].equals("User")
467             && fun.paramTypeList[1].equals("Player")){
468             if(debugging)System.out.print("Drop player
           found");
469             dropPlayFlag = true;
470         }
471     }
472 }
473 return writeDefaultFuns();
474 }
475
476 //write default functions if needed
477 public String writeDefaultFuns(){
478     String functions = "";
479     if(!draftFunFlag){
480         //write draft function
481         functions += "public static int draftFunction(int
           turn){\nreturn turn%myLeague.getCurrentNumUsers();\n
           n}\n";
482     }
483     if(!draftPlayFlag){
484         //write draft player
485         functions += "public static boolean draftPlayer(User
           u, Player p){\nu.addPlayer(p);\nreturn true;\n}\n";
486     }
487     if(!tradeFlag){
488         //write trade
489         functions += "public static boolean trade(User u1,
           Player[] p1, User u2, Player[] p2){\n"+
490             "int i,j;\n"+
491             "boolean flag2=true;\n"+
492             "i=0;\n"+
493             "while(i<p1.length){\n"+
494             "flag2=dropPlayer(u1,p1[i]);\n"+
495             "if(!flag2){    //If the drop was
           unsuccessful\n"+
496             "j=i;\n"+
497             "while(j>=0){    //Add p1 back to u1\n
           "+
498             "draftPlayer(u1,p1[j]);\n"+
499             "j--;\n"+
500             "}\n"+
501             "return false;\n"+
502             "}\n";

```



```

503         "i++; \n"+
504     " } \n"+
505     "i=0; \n"+
506     "while(i<p2.length) { \n"+
507         "flag2=dropPlayer(u2,p2[i]); \n"+
508         "if(!flag2){      //If the drop was
                    unsuccessful\n"+
509             "j=i; \n"+
510             "while(j>=0){      //Add p2 back to u2\n
                    "+
511                 "draftPlayer(u2,p2[j]); \n"+
512                 "j--; \n"+
513             " } \n"+
514             "j=0; \n"+
515             "while(j<p1.length){      //Add p1 to u1
                    \n"+
516                 "draftPlayer(u1,p1[j]); \n"+
517                 "j++; \n"+
518             " } \n"+
519             "return false; \n"+
520         " } \n"+
521         "i++; \n"+
522     " } \n"+
523     "i=0; \n"+
524     "while(i<p1.length) { \n"+
525         "flag2=draftPlayer(u2,p1[i]); \n"+
526         "if(!flag2){      //If draft was
                    unsuccessful\n"+
527             "j=i; \n"+
528             "while(j>=0){      //Remove p1 from u2\n
                    "+
529                 "dropPlayer(u2,p1[j]); \n"+
530                 "j--; \n"+
531             " } \n"+
532             "j=0; \n"+
533             "while(j<p1.length){      //Add p1 to u1
                    \n"+
534                 "draftPlayer(u1,p1[j]); \n"+
535                 "j++; \n"+
536             " } \n"+
537             "j=0; \n"+
538             "while(j<p2.length){      //Add p2 to u2
                    \n"+
539                 "draftPlayer(u2,p2[j]); \n"+
540                 "j++; \n"+

```

```

541         "}\n"+
542         "return false;\n"+
543         "}\n"+
544         "i++; \n"+
545     "}\n"+
546     "i=0;\n"+
547     "while(i<p2.length){\n"+
548         "flag2=draftPlayer(u1,p2[i]);\n"+
549         "if(!flag2){    //If the drop was
        unsuccessful\n"+
550         "j=i;\n"+
551         "while(j>=0){    //Remove p2 from u1\n
        "+
552         "dropPlayer(u1,p2[j]);\n"+
553         "j--;\n"+
554     "}\n"+
555     "j=0;\n"+
556     "while(j<p1.length){    //Remove p1
        from u2\n"+
557         "dropPlayer(u2,p1[j]);\n"+
558         "j++; \n"+
559     "}\n"+
560     "j=0;\n"+
561     "while(j<p1.length){    //Add p1 to u1
        \n"+
562         "draftPlayer(u1,p1[j]);\n"+
563         "j++; \n"+
564     "}\n"+
565     "j=0;\n"+
566     "while(j<p2.length){    //Add p2 to u2
        \n"+
567         "draftPlayer(u2,p2[j]);\n"+
568         "j++; \n"+
569     "}\n"+
570     "return false;\n"+
571     "}\n"+
572     "i++; \n"+
573     "}\n"+
574     "return true;\n"+
575     "}\n";
576 }
577 if(!dropPlayFlag){
578     //write drop player
579     functions += "public static boolean dropPlayer(User u
        , Player p){\nu.removePlayer(p);\nreturn true;\n}\n";

```

```

        ";
580     }
581     return functions;
582 }
583 }

```

Listing A.5: Function.java

```

1  /*
2   * Function.java
3   * This class supports the FLOOD semantics on functions
4   */
5
6  import java.util.HashMap;
7  import java.util.Arrays;
8
9  public class Function {
10
11     String functionName;
12     String[] paramTypeList;
13     HashMap<String, String> argsList = new HashMap<String,
14         String>(); //name type
15     String returnType;
16     int lineNumber;
17     static boolean debugging = false;
18
19     /* Constructor sets a function's name, returnType and
20        parameters in the instance variables of the function */
21     public Function(String functionName, String returnType,
22         String paramList, int lineNumber){
23         this.functionName = functionName;
24         if (debugging){System.out.println("**Initializing " +
25             functionName + " function**");}
26         this.returnType = returnType;
27         if (debugging){System.out.println(functionName + "=
28             returnType: " + returnType);}
29         this.lineNumber = lineNumber;
30         if (!paramList.trim().isEmpty()){
31             String[] params = paramList.trim().split("\\s*,\\s*")
32                 ;
33             paramTypeList = new String[params.length];
34             for(int i=0; i<params.length; i++){
35                 //split
36                 String[] temp = params[i].split("\\s+");
37                 argsList.put(temp[1], temp[0]); //This is reversed

```

```

        in the argument list so reversing it back here
32         paramTypeList[i]=temp[0];
33         if (debugging) {System.out.println(functionName +
            "= argName: " + temp[1] + ", type: " + temp[0])
            ;}
34     }
35 }
36 else{
37     paramTypeList = new String[0];
38 }
39 }
40
41 public String getReturnType() {
42     return returnType;
43 }
44 }

```

Listing A.6: GUI.java

```

1  /*
2   * GUI.java
3   * This class the GUI for the fantasy league
4   */
5
6  import java.awt.BorderLayout;
7  import java.awt.Color;
8  import java.awt.Dimension;
9  import java.awt.event.ActionListener;
10 import java.awt.event.ActionEvent;
11 import java.io.File;
12 import java.text.DecimalFormat;
13
14 import javax.swing.JFrame;
15 import javax.swing.JOptionPane;
16 import javax.swing.JToolBar;
17 import javax.swing.JButton;
18 import javax.swing.JFileChooser;
19 import javax.swing.JLabel;
20 import javax.swing.JScrollPane;
21 import javax.swing.JTable;
22 import javax.swing.ListSelectionModel;
23 import javax.swing.JTabbedPane;
24 import javax.swing.JComboBox;
25 import javax.swing.JSplitPane;
26 import javax.swing.event.ChangeEvent;

```

```

27 import javax.swing.event.ChangeListener;
28 import javax.swing.table.DefaultTableModel;
29
30
31 public class GUI {
32     private League theLeague;
33     private static JFrame frmFloodFantasyLeague;
34     private MyTableModel homeTable,draftTable,tradeTable_1,
        tradeTable_2,dropTable,ruleTable;
35     private DefaultTableModel homeModel,draftModel,tradeModel_1
        ,tradeModel_2,dropModel,ruleModel;
36     private JLabel draftLabel;
37     private int currentTurn,pick;
38     private DecimalFormat twoDForm;
39     private final String[] homeHeader={"Rank","Team","Points"},
40         playerInfoHeader={"Player","Position","Points All Season
        "},
41         ruleHeader={"Action","Point Value"};
42
43     /**Constructor
44     *
45     * @param League game
46     */
47     public GUI(League game){
48         this.theLeague=game;
49         twoDForm = new DecimalFormat("0.00");
50         currentTurn=0;
51     }
52
53     /**Populates the home table assuming it has already been
        initialized.
54     *
55     */
56     private void populateHome(){
57         User[] rankedTeams= theLeague.getRankedUsers(); //Get
        all the teams in reverse ranked order
58         while(homeModel.getRowCount()>0) //Remove all the rows
        from the home table
59             homeModel.removeRow(0);
60         String[] tempHome=new String[3]; //Initialize a
        temporary row
61         for(int i=rankedTeams.length-1,j=1;i>=0;i--,j++){ //
        Iterate through the teams
62             tempHome[0]=Integer.toString(j); //Set the rank
63             tempHome[1]=rankedTeams[i].getName(); //Set the name

```

```

64         tempHome[2]=twoDForm.format(rankedTeams[i].getPoints
65             ()); //Set the points
66         homeModel.addRow(tempHome);    //Add the row
67     }
68 }
69 /**Populates the add table assuming it has already been
70     initialized.
71     */
72 private void populateDraft(){
73     pick=FloodProgram.draftFunction(currentTurn);    //
74     Determine who is picking next
75     draftLabel.setText(theLeague.getUser(pick).getName()+"'s
76         turn!"); //Figure out which user is picking next
77     Player[] rankedPlayers=theLeague.
78         getRankedAvailablePlayers(); //Get all the players in
79         reverse ranked order
80     while (draftModel.getRowCount()>0)    //Remove all the
81         rows from the add table
82         draftModel.removeRow(0);
83     String[] tempDraft=new String[3];    //Initialize a
84         temporary row
85     for(int i=rankedPlayers.length-1;i>=0;i--){ //Iterate
86         through the players
87         tempDraft[0]=rankedPlayers[i].getName(); //Set the
88             name
89         tempDraft[1]=rankedPlayers[i].getPosition(); //Set
90             the position
91         tempDraft[2]=twoDForm.format(rankedPlayers[i].
92             getPoints()); //Set the points scored all season
93         draftModel.addRow(tempDraft); //Add the row
94     }
95 }
96 /**Populates the add table assuming it has already been
97     initialized.
98     */
99 /**
100     */
101 private void populateRules(){
102     Action[] rules=theLeague.getActions(); //Get all the
103         players in reverse ranked order
104     while (ruleModel.getRowCount()>0) //Remove all the rows
105         from the add table
106         ruleModel.removeRow(0);

```

```

94     String[] tempRule=new String[2]; //Initialize a
        temporary row
95     for(int i=rules.length-1;i>=0;i--){ //Iterate through
        the players
96         tempRule[0]=rules[i].getAction();    //Set the name
97         tempRule[1]=twoDForm.format(rules[i].getPoints()); //
            Set the points scored all season
98         ruleModel.addRow(tempRule);    //Add the row
99     }
100 }
101
102 /**Display an error window with the title and message given
103  * as parameters.
104  *
105  * @param String title
106  * @param String message
107  */
108 public static void error(String title,String message){
109     JOptionPane.showMessageDialog(frmFloodFantasyLeague,
        message,title,JOptionPane.ERROR_MESSAGE);
110 }
111
112 /**Show a warning window with the title and message given
113  * as parameters
114  *
115  * @param String title
116  * @param String message
117  */
118 public static void alert(String title, String message) {
119     JOptionPane.showMessageDialog(frmFloodFantasyLeague,
        message,title,JOptionPane.WARNING_MESSAGE);
120 }
121
122 /**
123  * Initialize the contents of the frame.
124  */
125 public void drawBoard() {
126     //Set up the frame
127     frmFloodFantasyLeague = new JFrame();
128     frmFloodFantasyLeague.setBackground(new Color(0, 0, 205)
        );
129     frmFloodFantasyLeague.setTitle("FLOOD Fantasy League: "+
        theLeague.getName());
130     frmFloodFantasyLeague.setBounds(100, 100, 450, 300);
131     frmFloodFantasyLeague.setDefaultCloseOperation(JFrame.

```

```

        EXIT_ON_CLOSE);
132 frmFloodFantasyLeague.setSize(new Dimension(700, 400));
133 frmFloodFantasyLeague.setVisible(true);
134
135 //Initialize and add the tabbed pane
136 final JTabbedPane tabbedPane = new JTabbedPane(
        JTabbedPane.TOP);
137 frmFloodFantasyLeague.getContentPane().add(tabbedPane,
        BorderLayout.CENTER);
138
139 //Initialize the home tab
140 JSplitPane homeSplitPane = new JSplitPane();
141 homeSplitPane.setResizeWeight(0.99);
142 homeSplitPane.setOrientation(JSplitPane.VERTICAL_SPLIT);
143
144 //Initialize the home tab toolbar
145 JToolBar homeToolBar = new JToolBar();
146 homeToolBar.setFloatable(false);
147 homeSplitPane.setRightComponent(homeToolBar);
148
149 //Add the upload stats button to the toolbar
150 JButton uploadStatsButton = new JButton("Upload Stat
        File");
151 uploadStatsButton.setMaximumSize(new Dimension(32767,
        32767));
152 homeToolBar.add(uploadStatsButton);
153
154 //Add the create dump button to the toolbar
155 JButton createDumpButton = new JButton("Create Dump File
        ");
156 createDumpButton.setMaximumSize(new Dimension(32767,
        32767));
157 homeToolBar.add(createDumpButton);
158
159 //Add the import dump button to the toolbar
160 JButton importDumpButton = new JButton("Import Dump File
        ");
161 importDumpButton.setMaximumSize(new Dimension(32767,
        32767));
162 homeToolBar.add(importDumpButton);
163
164 //Initialize the home tab scrollpane
165 JScrollPane homePane = new JScrollPane();
166 homeSplitPane.setLeftComponent(homePane);
167

```



```

168 //Add the home tab to the tabbed pane
169 tabbedPane.addTab("Home", null, homeSplitPane, null);
170
171 //Initialize, format and add the home table
172 homeModel = new DefaultTableModel(homeHeader,0); //Add
    the header but no rows
173 homeTable = new MyTableModel(homeModel);
174 homeTable.setEnabled(false); //Make the rows
    unselectable
175 homeTable.setAutoCreateRowSorter(true); //Allow
    sorting
176 homePane.setViewportView(homeTable); //Put the table
    into the scroll pane
177
178 populateHome(); //Populate the home table
179
180 JSplitPane draftSplitPane = new JSplitPane(); //Add
    the draft split pane
181 draftSplitPane.setOrientation(JSplitPane.VERTICAL_SPLIT)
    ; //Split vertically
182 tabbedPane.addTab("Draft", null, draftSplitPane, null);
    //Add the split pane to the tabbed pane
183
184 //Initialize and add the draft scroll pane
185 JScrollPane draftScrollPane = new JScrollPane();
186 draftSplitPane.setRightComponent(draftScrollPane);
187
188 //Initialize, format and add the draft table
189 draftModel = new DefaultTableModel(playerInfoHeader,0);
    //Add the header but no rows
190 draftTable = new MyTableModel(draftModel);
191 draftTable.setRowSelectionAllowed(true); //Allow row
    selection
192 draftTable.setSelectionMode(ListSelectionModel.
    SINGLE_SELECTION); //Allow only one row selection at a
    time
193 draftTable.setAutoCreateRowSorter(true); //Allow
    sorting
194 draftScrollPane.setViewportView(draftTable); //Put the
    table into the scroll pane
195
196 //Initialize, format and add the draft tool bar
197 JToolBar draftToolBar = new JToolBar();
198 draftToolBar.setFloatable(false);
199 draftSplitPane.setLeftComponent(draftToolBar);

```

```

200
201 //Initialize, format and add the draft label
202 draftLabel = new JLabel();
203 draftLabel.setMinimumSize(new Dimension(600, 15));
204 draftLabel.setMaximumSize(new Dimension(32767, 15));
205 draftToolBar.add(draftLabel);
206
207 //Initialize, format and add the draft button
208 JButton btnDraft = new JButton("Draft");
209 btnDraft.setPreferredSize(new Dimension(100, 25));
210 btnDraft.setMaximumSize(new Dimension(100, 25));
211 btnDraft.setMinimumSize(new Dimension(100, 25));
212 draftToolBar.add(btnDraft);
213
214 //Initialize, format and add the trade split pane
215 JSplitPane tradeSplitPane = new JSplitPane();
216 tradeSplitPane.setOrientation(JSplitPane.VERTICAL_SPLIT)
    ; //Split vertically
217 tabbedPane.addTab("Trade", null, tradeSplitPane, null);
218
219 //Initialize, format and add the trade tool bar
220 JToolBar tradeToolBar = new JToolBar();
221 tradeToolBar.setFloatable(false);
222 tradeSplitPane.setLeftComponent(tradeToolBar);
223
224 //Initialize, format and add the first trade combo box
225 final JComboBox tradeComboBox_1 = new JComboBox();
226 tradeToolBar.add(tradeComboBox_1);
227
228 //Initialize, format and add the second trade combo bos
229 final JComboBox tradeComboBox_2 = new JComboBox();
230 tradeToolBar.add(tradeComboBox_2);
231
232 //Initialize and add the trade button
233 JButton btnTrade = new JButton("Trade");
234 tradeToolBar.add(btnTrade);
235
236 //Initialize, format and add the second trade split pane
237 JSplitPane tradeSplitPane_2 = new JSplitPane();
238 tradeSplitPane_2.setResizeWeight(0.5);
239 tradeSplitPane.setRightComponent(tradeSplitPane_2);
240
241 //Initialize and add the left trade scroll pane
242 JScrollPane tradeScrollPane_1 = new JScrollPane();
243 tradeSplitPane_2.setLeftComponent(tradeScrollPane_1);

```

```

244
245 //Initialize, format and add the left trade table
246 tradeModel_1 = new DefaultTableModel(playerInfoHeader,0)
    ; //Add the header but no rows
247 tradeTable_1 = new MyTableModel(tradeModel_1);
248 tradeTable_1.setRowSelectionAllowed(true); //Set
    selection of entire rows
249 tradeTable_1.setSelectionMode(ListSelectionModel.
    MULTIPLE_INTERVAL_SELECTION); //Allow multiple row
    selection
250 tradeTable_1.setAutoCreateRowSorter(true); //Allow
    sorting
251 tradeScrollPane_1.setViewportView(tradeTable_1); //Add
    table to scroll pane
252
253 //Initialize and add the right trade scroll pane
254 JScrollPane tradeScrollPane_2 = new JScrollPane();
255 tradeSplitPane_2.setRightComponent(tradeScrollPane_2);
256
257 //Initialize, format and add the right trade table
258 tradeModel_2 = new DefaultTableModel(playerInfoHeader,0)
    ; //Add the header but no rows
259 tradeTable_2 = new MyTableModel(tradeModel_2);
260 tradeTable_2.setRowSelectionAllowed(true); //Set
    selection of entire rows
261 tradeTable_2.setSelectionMode(ListSelectionModel.
    MULTIPLE_INTERVAL_SELECTION); //Allow multiple row
    selection
262 tradeTable_2.setAutoCreateRowSorter(true); //Allow
    sorting
263 tradeScrollPane_2.setViewportView(tradeTable_2); //Add
    table to scroll pane
264
265 //Initialize, format and add the drop split pane
266 JSplitPane dropSplitPane = new JSplitPane();
267 dropSplitPane.setOrientation(JSplitPane.VERTICAL_SPLIT);
    //Split vertically
268 tabbedPane.addTab("Drop", null, dropSplitPane, null);
269
270 //Initialize, format and add the drop toolbar
271 JToolBar dropToolBar = new JToolBar();
272 dropToolBar.setFloatable(false);
273 dropSplitPane.setLeftComponent(dropToolBar);
274
275 //Initialize and add the drop combo box

```

```

276     final JComboBox dropComboBox = new JComboBox();
277     dropToolBar.add(dropComboBox);
278
279     //Initialize and add the drop button
280     JButton btnDrop = new JButton("Drop");
281     dropToolBar.add(btnDrop);
282
283     //Initialize and add the drop scroll pane
284     JScrollPane dropScrollPane = new JScrollPane();
285     dropSplitPane.setRightComponent(dropScrollPane);
286
287     //Initialize, format and add the drop table
288     dropModel = new DefaultTableModel(playerInfoHeader,0);
289     //Add the header but no rows
290     dropTable = new MyTableModel(dropModel);
291     dropTable.setSelectionMode(ListSelectionModel.
292         SINGLE_SELECTION); //Allow single selection
293     dropTable.setAutoCreateRowSorter(true); //Allow
294         sorting
295     dropScrollPane.setViewportViewView(dropTable); //Add the
296         table to the scroll pane
297
298     //Initialize the home tab scrollpane
299     JScrollPane rulePane = new JScrollPane();
300
301     //Add the home tab to the tabbed pane
302     tabbedPane.addTab("Rules", null, rulePane, null);
303
304     //Initialize, format and add the home table
305     ruleModel = new DefaultTableModel(ruleHeader,0); //Add
306         the header but no rows
307     ruleTable = new MyTableModel(ruleModel);
308     ruleTable.setEnabled(false); //Make the rows
309         unselectable
310     ruleTable.setAutoCreateRowSorter(true); //Allow
311         sorting
312     rulePane.setViewportViewView(ruleTable); //Put the table
313         into the scroll pane
314
315     populateRules(); //Populate the home table
316
317     //Initialize the file chooser
318     final JFileChooser chooser=new JFileChooser();
319

```

```

313 //Populate both trade and the drop combo boxes
314 User[] rankedTeams= theLeague.getRankedUsers();
315 for(int i=0;i<rankedTeams.length;i++){
316     tradeComboBox_1.insertItemAt(rankedTeams[i].getName()
317         ,i);
318     tradeComboBox_2.insertItemAt(rankedTeams[i].getName()
319         ,i);
320     dropComboBox.insertItemAt(rankedTeams[i].getName(),i)
321         ;
322 }
323
324 //*****
325 //*****Action Listeners*****
326 //*****
327
328 //Action listener for changing tabs
329 tabbedPane.addChangeListener(new ChangeListener() {
330     public void stateChanged(ChangeEvent e) {
331         int selection = tabbedPane.getSelectedIndex(); //
332         Get selected tab
333         switch(selection){
334             case 0: //Populate home table
335                 populateHome();
336                 break;
337             case 1: //Populate draft table
338                 populateDraft();
339                 break;
340             case 4:
341                 populateRules();
342                 break;
343         }
344     }
345 });
346
347 //Stats upload action listener
348 uploadStatsButton.addActionListener(new ActionListener()
349     {
350         public void actionPerformed(ActionEvent arg0) {
351             int result = chooser.showOpenDialog(null); //
352             Determine what the user pressed
353             switch (result) {
354                 case JFileChooser.APPROVE_OPTION: //Opened file
355                     File file=chooser.getSelectedFile(); //Get
356                     the chosen file
357                     IOManager.uploadStats(theLeague,file.

```

```

        getAbsolutePath()); //Pass the file path to
        the parser method
351     populateHome();
352     break;
353     case JFileChooser.CANCEL_OPTION: //Canceled
354         break;
355     case JFileChooser.ERROR_OPTION: //Generated an
        error
356         GUI.error("Upload Error!", "Sorry, there was an
            error opening the stat file.");
357         break;
358     }
359 }
360 });
361
362 //Dump generator action listener
363 createDumpButton.addActionListener(new ActionListener()
364 {
365     public void actionPerformed(ActionEvent e) {
366         chooser.setSelectedFile(new File("flooddmp.txt"));
367         int result = chooser.showSaveDialog(null);
368         switch (result) {
369             case JFileChooser.APPROVE_OPTION: //Opened file
                File file=chooser.getSelectedFile(); //Get
                the chosen file
370                 if(file.exists()) {
371                     int overwrite = JOptionPane.
                        showConfirmDialog(
                            frmFloodFantasyLeague, "Do you want to
                                overwrite " + file.getName());
372                     if(overwrite == JOptionPane.YES_OPTION)
373                         {
                            IOManager.writeState(theLeague, file.
                                getAbsolutePath(), currentTurn); //
                                Pass the file path to the parser
                                method
374                             tabbedPane.setSelectedIndex(0);
375                         }
376                 }
377             else{
378                 IOManager.writeState(theLeague, file.
                    getAbsolutePath(), currentTurn); //Pass
                    the file path to the parser method
379                 tabbedPane.setSelectedIndex(0);
380             }

```

```

381         break;
382     case JFileChooser.CANCEL_OPTION: //Canceled
383         break;
384     case JFileChooser.ERROR_OPTION: //Generated an
385         error
386         GUI.error("Upload Error!", "Sorry, error
387             creating the dump file.");
388         break;
389     }
390 }
391 }
392 });
393
394 //Dump importer action listener
395 importDumpButton.addActionListener(new ActionListener()
396 {
397     public void actionPerformed(ActionEvent arg0) {
398         int result = chooser.showOpenDialog(null); //
399         Determine what the user pressed
400         switch (result) {
401             case JFileChooser.APPROVE_OPTION: //Opened file
402                 File file=chooser.getSelectedFile(); //Get
403                 the chosen file
404                 int temp=IOManager.importState(theLeague,file.
405                     getAbsolutePath()); //Pass the file path to
406                 the parser method
407                 if (temp!=-1){
408                     currentTurn=temp;
409                     populateDraft();
410                 }
411                 populateHome();
412                 break;
413             case JFileChooser.CANCEL_OPTION: //Canceled
414                 break;
415             case JFileChooser.ERROR_OPTION: //Generated an
416                 error
417                 GUI.error("Upload Error!", "Sorry, there was an
418                     error opening the stat file.");
419                 break;
420         }
421     }
422 }
423 });
424
425 //Determine which user is picking first
426 pick=FloodProgram.draftFunction(currentTurn); //Gets
427 the number representing the user's turn

```

```

416     draftLabel.setText(theLeague.getUser(pick).getName()+"'s
        turn!"); //Puts the user's name in the label
417
418     //Draft action listener
419     btnDraft.addActionListener(new ActionListener() {
420         public void actionPerformed(ActionEvent arg0) {
421             for(int i=0;i<draftModel.getRowCount();i++){ //
                Iterate through table entries
422                 if(draftTable.isCellSelected(i,0)){ //If it's
                    selected
423                     if(!FloodProgram.draftPlayer(theLeague.
                        getUser(pick),League.athletes.get(
                            draftModel.getValueAt(i,0))){ //If the
                            draft isn't successful
424                         GUI.error("Invalid draft!", "Sorry, your
                            draft violates rules of the league.");
425                         return;
426                     }
427                     int overwrite = JOptionPane.
                        showConfirmDialog(frmFloodFantasyLeague, "
                            Are you sure you want to draft: " + League
                                .athletes.get(draftModel.getValueAt(i,0)).
                                    getName());
428                     if(overwrite == JOptionPane.YES_OPTION)
                        {
429                         currentTurn++; //Increment the turn
430                         draftModel.removeRow(i); //Remove that
                            row from the draft table
431                         populateDraft();
432                         //Make all the combo boxes not select
                            anything
433                         tradeComboBox_1.setSelectedIndex(-1);
434                         tradeComboBox_2.setSelectedIndex(-1);
435                         dropComboBox.setSelectedIndex(-1);
436                         //Remove the current tables in all the
                            other tabs so that they are up to date
437                         while(tradeModel_1.getRowCount()>0){
438                             tradeModel_1.removeRow(0);
439                         }
440                         while(tradeModel_2.getRowCount()>0){
441                             tradeModel_2.removeRow(0);
442                         }
443                         while(dropModel.getRowCount()>0){
444                             dropModel.removeRow(0);
445                         }

```



```

446         return;
447     }
448     return;
449 }
450 }
451 //If no selection is found
452 GUI.error("Add error!", "Sorry, no player was
    selected!");
453 }
454 });
455
456 //Action listener for left trade combo box
457 tradeComboBox_1.addActionListener (new ActionListener ()
    {
458     public void actionPerformed(ActionEvent e) {
459         if(tradeComboBox_1.getSelectedIndex() != -1){ //If
            a user is selected
460             Player[] teamPlayers=League.teams.get(
                tradeComboBox_1.getSelectedItem()).getPlayers
                (); //Get the players the user has
461             while(tradeModel_1.getRowCount() > 0){ //Clear
                the current table
462                 tradeModel_1.removeRow(0);
463             }
464             for(int i=0; i < teamPlayers.length; i++){ //
                Populate the table with the new data
465                 String[] temp={teamPlayers[i].getName(),
                    teamPlayers[i].getPosition(), Float.
                        toString(teamPlayers[i].getPoints())}; //
                    Initialize the row
466                 tradeModel_1.addRow(temp);
467             }
468         }
469     }
470 });
471
472 //Action listener for the right trade combo box
473 tradeComboBox_2.addActionListener (new ActionListener ()
    {
474     public void actionPerformed(ActionEvent e) {
475         if(tradeComboBox_2.getSelectedIndex() != -1){ //If
            a user is selected
476             Player[] teamPlayers=League.teams.get(
                tradeComboBox_2.getSelectedItem()).getPlayers
                (); //Get the players the user has

```

```

477         while (tradeModel_2.getRowCount() > 0) { //Clear
            the current table
478             tradeModel_2.removeRow(0);
479         }
480         for (int i = 0; i < teamPlayers.length; i++) { //
            Populate the table with the new data
481             String[] temp = {teamPlayers[i].getName(),
                teamPlayers[i].getPosition(), Float.
                toString(teamPlayers[i].getPoints())}; //
                Initialize the row
482             tradeModel_2.addRow(temp);
483         }
484     }
485 }
486 });
487
488 //Action listener for the trade button
489 btnTrade.addActionListener(new ActionListener() {
490     public void actionPerformed(ActionEvent arg0) {
491         if (tradeComboBox_1.getSelectedIndex() == -1 ||
            tradeComboBox_2.getSelectedIndex() == -1) { //If
            either combo box doesn't have a user selected
492             GUI.error("Trade error!", "Must select two teams
                to trade between.");
493             return;
494         }
495         else if (tradeComboBox_1.getSelectedIndex() ==
            tradeComboBox_2.getSelectedIndex()) { //If the
            same user is selected in each combo box
496             GUI.error("Trade error!", "Must select two
                different teams to trade between.");
497             return;
498         }
499         int rows1[] = tradeTable_1.getSelectedRows(); //
            Get selected rows in the left table
500         int rows2[] = tradeTable_2.getSelectedRows(); //
            Get selected rows in the right table
501         if (rows1.length == 0 && rows2.length == 0) { //If no
            players are selected
502             GUI.error("Trade error!", "Must select at least
                one player to trade.");
503             return;
504         }
505         int overwrite = JOptionPane.showConfirmDialog(
            frmFloodFantasyLeague, "Are you sure you want to

```

```

trade?");
506     if(overwrite == JOptionPane.YES_OPTION) {
507         Player[] p1 = new Player[rows1.length];    //
            Initialize player array for the left table
            selection
508         Player[] p2 = new Player[rows2.length];    //
            Initialize player array for the right table
            selection
509         //Populate the player arrays
510         for (int i = 0; i < p1.length; i++) {
511             p1[i] = League.athletes.get(tradeModel_1.
                getValueAt(rows1[i],0));
512         }
513         for (int i = 0; i < p2.length; i++) {
514             p2[i] = League.athletes.get(tradeModel_2.
                getValueAt(rows2[i],0));
515         }
516         boolean success=FloodProgram.trade(League.teams
            .get(tradeComboBox_1 //Determine if it's a
            successful trade
517             .getSelectedItem()), p1, League.teams
518             .get(tradeComboBox_2.getSelectedItem()),
                p2);
519         if(!success){ //If unsuccessful
520             GUI.error("Invalid trade!","Sorry, your
                trade violates rules of the league.");
521             return;
522         }
523         //Repopulate the tables
524         Player[] teamPlayers = League.teams.get(
            tradeComboBox_1.getSelectedItem()).getPlayers
            ();
525         while (tradeModel_1.getRowCount() > 0) { //
            Clear the left trade table
526             tradeModel_1.removeRow(0);
527         }
528         for (int i = 0; i < teamPlayers.length; i++) {
            //Repopulate the left trade table
529             String[] temp = { teamPlayers[i].getName(),
530                 teamPlayers[i].getPosition(),
531                 Float.toString(teamPlayers[i].
                    getPoints()) };
532             tradeModel_1.addRow(temp); //Add the row
533         }
534         teamPlayers = League.teams.get(tradeComboBox_2.

```

```

535         getSelectedItem()).getPlayers();
        while (tradeModel_2.getRowCount() > 0) { //
            Clear the left trade table
536         tradeModel_2.removeRow(0);
537     }
538     for (int i = 0; i < teamPlayers.length; i++) {
        //Repopulate the left trade table
539         String[] temp = { teamPlayers[i].getName(),
540             teamPlayers[i].getPosition(),
541             Float.toString(teamPlayers[i].
                getPoints()) };
542         tradeModel_2.addRow(temp); //Add the row
543     }
544 }
545 }
546 });
547
548 //Action listener for drop combo box
549 dropComboBox.addActionListener (new ActionListener () {
550     public void actionPerformed(ActionEvent e) {
551         if(dropComboBox.getSelectedIndex() != -1){ //If a
            user is selected
552             Player[] teamPlayers=League.teams.get(
                dropComboBox.getSelectedItem()).getPlayers();
                //Get the user's players
553             while(dropModel.getRowCount()>0){ //Clear the
                table
554                 dropModel.removeRow(0);
555             }
556             for(int i=0;i<teamPlayers.length;i++){ //
                Repopulate the table
557                 String[] temp={teamPlayers[i].getName(),
                    teamPlayers[i].getPosition(),Float.
                        toString(teamPlayers[i].getPoints())};
558                 dropModel.addRow(temp); //Add the row
559             }
560         }
561     }
562 });
563
564 //Action listener for drop button
565 btnDrop.addActionListener(new ActionListener() {
566     public void actionPerformed(ActionEvent arg0) {
567         int index=dropTable.getSelectedRow();
568         if(index== -1){ //If no player is selected to drop

```

```

569         GUI.error("Drop error!", "Must select a team to
           drop a player from.");
570         return;
571     }
572     int overwrite = JOptionPane.showConfirmDialog(
        frmFloodFantasyLeague, "Are you sure you want to
        drop: " + League.athletes.get(dropModel.
        getValueAt(index, 0)).getName());
573     if(overwrite == JOptionPane.YES_OPTION) {
574         Player drop=League.athletes.get(dropModel.
            getValueAt(index, 0)); //Get player
575         boolean success=FloodProgram.dropPlayer(League.
            teams.get(dropComboBox.getSelectedIndex()),
            drop); //Determine if drop is successful
576         if(!success){
577             GUI.error("Invalid drop!", "Sorry, your drop
                violates rules of the league.");
578             return;
579         }
580         dropModel.removeRow(index); //Delete that row
581         //Make all the combo boxes not select anything
582         tradeComboBox_1.setSelectedIndex(-1);
583         tradeComboBox_2.setSelectedIndex(-1);
584         while(tradeModel_1.getRowCount()>0){
585             tradeModel_1.removeRow(0);
586         }
587         while(tradeModel_2.getRowCount()>0){
588             tradeModel_2.removeRow(0);
589         }
590     }
591 }
592 });
593
594     tabbedPane.setSelectedIndex(0);
595 }
596 }
597 class MyTableModel extends JTable {
598     /**
599     *
600     */
601     private static final long serialVersionUID = 1L;
602     public MyTableModel(){
603         super();
604     }
605     public MyTableModel(DefaultTableModel model){

```

```

606         super(model);
607     }
608     public MyTableModel(Object[][] data, Object[] columnNames){
609         super(data, columnNames);
610     }
611     public boolean isCellEditable(int row, int col) {
612         return false;
613     }
614 }

```

Listing A.7: IOManager.java

```

1  /*
2   * IOManager.java
3   * This class handles the input and output of the FLOOD GUI
4   */
5
6  import java.io.BufferedReader;
7  import java.io.BufferedWriter;
8  import java.io.DataInputStream;
9  import java.io.FileInputStream;
10 import java.io.FileNotFoundException;
11 import java.io.FileWriter;
12 import java.io.IOException;
13 import java.io.InputStreamReader;
14 import java.util.ArrayList;
15
16 /*
17  * Stats Parser
18  */
19 public class IOManager {
20
21     /**Write the current state of the league to a text file so
22      that the program
23      * may be exited and resumes from the place it left off.
24      *
25      * @param League myLeague
26      * @param String filePath
27      * @param int turn
28      */
29     public static void writeState(League myLeague, String
30         filePath, int turn){
31         try {
32             FileWriter fstream = new FileWriter(filePath); //
33                 Create the file

```

```

31     BufferedWriter out = new BufferedWriter(fstream);    //
        Initialize the output stream
32     out.write(turn+", "+myLeague.getMaxTeamSize()+" "+
        myLeague.getMinTeamSize()+" "+myLeague.getMaxUser()
        +", "+myLeague.getMinUser()+"\n");    //Write the
        first line of the file
33     //Write the actions
34     out.write("ACTIONS:\n");
35     Action[] actions=myLeague.getActions();    //Get the
        actions
36     for(int i=0;i<actions.length;i++){    //Iterate through
        the actions
37         out.write(actions[i].getAction()+" "+actions[i].
            getPoints()+"\n");    //Write each action
38     }
39     //Write the players
40     out.write("PLAYERS:\n");
41     Player[] players=myLeague.getPlayers();    //Get the
        players
42     for(int i=0;i<players.length;i++){    //Iterate through
        the players
43         out.write(players[i].getName()+" "+players[i].
            getPosition()+" "+players[i].getPoints()+"\n");
            //Write each players
44     }
45     //Write the teams
46     out.write("TEAMS:\n");
47     User[] teams=myLeague.getUsers();    //Get the teams
48     for(int i=0;i<teams.length;i++){    //Iterate through
        the teams
49         Player[] teamPlayers=teams[i].getPlayers();    //Get
            the players of each team
50         out.write(", "+teams[i].getName()+" "+teams[i].
            getPoints()+"\n");    //Write each team
51         for(int j=0;j<teamPlayers.length;j++){    //Iterate
            through the players
52             out.write(teamPlayers[j].getName()+"\n");    //
                Write the player's name as a reference to the
                above players
53         }
54     }
55     //Write the free agent
56     out.write("FREE AGENT:\n");
57     User free=League.freeAgent;    //Get the free agen
58     Player[] freePlayers=free.getPlayers();    //Get the

```

```

        players of the free agent
59     for(int i=0;i<freePlayers.length;i++){ //Iterate
        through the players
60         out.write(freePlayers[i].getName()+"\n"); //Write
        the player's name as a reference to the above
        players
61     }
62     out.close();    //Close the output stream
63 } catch (IOException e) {
64     GUI.alert("Stat Dump Error!", "Error creating the
        dump file! Please try again.");
65 }
66 }
67
68 /**Read a file representing the state of a program and
    restore that state
69  * to the current program.
70  *
71  * @param League myLeague
72  * @param String filePath
73  * @return int turn
74  */
75 public static int importState(League myLeague,String
    filePath){
76     try {
77         myLeague.clear(); //Clear the current league
78         FileInputStream fstream = new FileInputStream(
            filePath); //Open the file
79         DataInputStream in = new DataInputStream(fstream); //
            Get the object of DataInputStream
80         BufferedReader br = new BufferedReader(new
            InputStreamReader(in)); //Initialize the buffered
            reader
81         //Initialize variables
82         String str="",team="";
83         int turn=-1;
84         str=br.readLine(); //Read the first line
85         String[] data=str.split(",\\s*"); //Split on commas
86         if(data.length!=5){
87             in.close();
88             myLeague.clear();
89             GUI.alert("Dump Import Error!", "Invalid dump file
                !");
90             return -1;
91         }

```



```

92         //Store the data
93         turn=Integer.parseInt(data[0]);
94         System.out.println("Parsed: "+data[0]+" to "+turn);
95         myLeague.setMaxTeamSize(Integer.parseInt(data[1]));
96         myLeague.setMinTeamSize(Integer.parseInt(data[2]));
97         myLeague.setMaxUser(Integer.parseInt(data[3]));
98         myLeague.setMinUser(Integer.parseInt(data[4]));
99
100         boolean teamFlag=false,playerFlag=false,actionFlag=
           false,freeFlag=false;
101         while((str = br.readLine()) != null){ //Read File
           Line By Line
102             if(str.equalsIgnoreCase("ACTIONS:")){ //Actions
               reached
103                 actionFlag=true;
104                 playerFlag=false;
105                 teamFlag=false;
106                 freeFlag=false;
107             }
108             else if(str.equalsIgnoreCase("PLAYERS:")){ //
               Players reached
109                 playerFlag=true;
110                 actionFlag=false;
111                 teamFlag=false;
112                 freeFlag=false;
113             }
114             else if(str.equalsIgnoreCase("TEAMS:")){ //Teams
               reached
115                 teamFlag=true;
116                 actionFlag=false;
117                 playerFlag=false;
118                 freeFlag=false;
119             }
120             else if(str.equals("FREE AGENT:")){ //Free agent
               reached
121                 teamFlag=false;
122                 actionFlag=false;
123                 playerFlag=false;
124                 freeFlag=true;
125             }
126             else{ //Data
127                 if(actionFlag){ //If currently looking at
                   actions
128                     String[] parts=str.split(",\\s*"); //Split
                       on commas

```

```

129         if(parts.length!=2){ //Validate that it's an
130             action
131             in.close();
132             myLeague.clear();
133             GUI.alert("Dump Import Error!", "Invalid
134                 dump file!");
135             return -1;
136         }
137         myLeague.addAction(new Action(parts[0].trim
138             (),Float.parseFloat(parts[1].trim())));
139         //Add action to league
140     }
141     else if(playerFlag){ //If currently looking at
142         players
143         String[] parts=str.split(",\\s*"); //Split
144         on commas
145         if(parts.length!=3){ //Validate that it's a
146             player
147             in.close();
148             myLeague.clear();
149             GUI.alert("Dump Import Error!", "Invalid
150                 dump file!");
151             return -1;
152         }
153         myLeague.addPlayer(new Player(parts[0].trim
154             (),parts[1].trim(),Float.parseFloat(parts
155             [2].trim()))); //Add player to league
156     }
157     else if(teamFlag){ //If currently looking at
158         teams
159         String[] parts=str.split(",\\s*"); //Split
160         on commas
161         if(str.charAt(0)==' '){ //If it's a team
162             name
163             if(parts.length!=3){ //Validate that it's
164                 a team name
165                 in.close();
166                 myLeague.clear();
167                 GUI.alert("Dump Import Error!", "
168                     Invalid dump file!");
169                 return -1;
170             }
171             team=parts[1].trim(); //Trim white
172                 space
173             myLeague.addUser(new User(team,Float.

```

```

        parseFloat(parts[2].trim()))); //Add
        team to league
158     }
159     else{ //If it's a team player
160         if(parts.length!=1){ //Validate that it's
            a player name
161             in.close();
162             myLeague.clear();
163             GUI.alert("Dump Import Error!", "
                Invalid dump file!");
164             return -1;
165         }
166         myLeague.getTeam(team).addPlayer(myLeague
            .getPlayer(parts[0].trim())); //Get
            reference to player and add to team
167     }
168 }
169 else if(freeFlag){ //If currently looking at
    free agent
170     String[] parts=str.split(",\\s*"); //Split
        on commas
171     if(parts.length!=1){ //Validate that it's a
        player name
172         in.close();
173         myLeague.clear();
174         GUI.alert("Dump Import Error!", "Invalid
            dump file!");
175         return -1;
176     }
177     myLeague.getFreeAgent().addPlayer(myLeague.
        getPlayer(parts[0].trim())); //Get
        reference to player and add player to free
        agent
178 }
179 }
180 }
181 in.close(); //Close input stream
182 if(!freeFlag){ //If the free agent was never reached
183     in.close();
184     myLeague.clear();
185     GUI.alert("Dump Import Error!", "Invalid dump file
        !");
186     return -1;
187 }
188 return turn; //Return current turn

```

```

189     } catch (FileNotFoundException e) {
190         myLeague.clear();
191         GUI.alert("Dump Import Error!", "File not found!");
192         return -1;
193     } catch (IOException e) {
194         myLeague.clear();
195         GUI.alert("Dump Import Error!", "Error writing file!"
196             );
197         return -1;
198     } catch (IndexOutOfBoundsException e){
199         myLeague.clear();
200         GUI.alert("Dump Import Error!", "Invalid dump file!")
201             ;
202         return -1;
203     }
204 }
205
206 /**Upload the statistics from a file.
207 *
208 * @param League myLeague
209 * @param String fileName
210 */
211 public static void uploadStats(League myLeague,String
212     filePath){
213     try {
214         ArrayList<String[]> statsAL = new ArrayList<String
215             []>();
216         FileInputStream fstream = new FileInputStream(
217             filePath); //Open the file
218         DataInputStream in = new DataInputStream(fstream); //
219             Get the object of DataInputStream
220         BufferedReader br = new BufferedReader(new
221             InputStreamReader(in));
222         String str;
223         String[] stats;
224         boolean valid=true;
225         while((str = br.readLine()) != null){ //Read File
226             Line By Line
227             stats=str.split(",\\s*");
228             valid=valid && myLeague.getPlayer(stats[0])!=null;
229             //Check if the athlete exists
230             if(!valid){ //If the athlete doesn't exist
231                 in.close();
232                 GUI.error("Athelete doesn't exist! ",stats[0]+"
233                     is not a valid athlete.");

```

```

224         return;
225     }
226     valid=valid && myLeague.getAction(stats[1])!=null;
        //Check if the action exists
227     if(!valid){ //If the athlete doesn't exist
228         in.close();
229         GUI.error("Action doesn't exist! ",stats[1]+"
            is not a valid action.");
230         return;
231     }
232     valid=valid && Integer.parseInt(stats[2])>0; //
        Check if the quantity is greater than zero
233     if(!valid){ //If the quantity is less than or
        equal to zero
234         in.close();
235         GUI.error("Quantity must be positive! ",stats
            [2]+" is not a positive number greater than
            zero.");
236         return;
237     }
238     statsAL.add(stats); //Split on commas
239 }
240 in.close(); //Close
241 for(int i=0;i<statsAL.size();i++){ //Iterate through
    the stats
242     float pts=myLeague.getAction(statsAL.get(i)[1]).
        getPoints() * Integer.parseInt(statsAL.get(i)
        [2]); //Compute the points
243     Player temp=myLeague.getPlayer(statsAL.get(i)[0]);
        //Get the player
244     temp.addPoints(pts); //Add the points to the
        player and thereby the team they're one
245 }
246 } catch (FileNotFoundException e) {
247     GUI.alert("Stat Parsing Error!","File not found!");
248 } catch (IOException e) {
249     GUI.alert("Stat Parsing Error!","Error opening the
        file!");
250 } catch (IndexOutOfBoundsException e){
251     GUI.alert("Stat Parsing Error!","Invalid stat file!")
        ;
252 }
253 }
254 }

```

Listing A.8: League.java

```
1  /*
2   * League.java
3   * This class handles the the League elements in the fantasy
   league
4   */
5
6  import java.util.ArrayList;
7  import java.util.Arrays;
8  import java.util.HashMap;
9
10
11 public class League {
12     private String name;
13     private int maxTeamSize,minTeamSize,maxUsers,minUsers;
14     public static HashMap<String,User> teams;
15     public static HashMap<Player,User> playerToTeam;
16     public static HashMap<String,Player> athletes;
17     public static HashMap<String,Action> ptsDist;
18     public static ArrayList<User> indexedTeams;
19     public static User freeAgent;
20
21     /**Constructor for League.
22     *
23     * @param String name
24     */
25     public League(String name){
26         this.name=name;
27         //Initialize data structures
28         teams=new HashMap<String,User>();
29         indexedTeams=new ArrayList<User>();
30         athletes=new HashMap<String,Player>();
31         ptsDist=new HashMap<String,Action>();
32         playerToTeam= new HashMap<Player,User>();
33         freeAgent=new User("Free Agent");
34     }
35
36     /**Add an action to the league.
37     *
38     * @param Action a
39     */
40     public void addAction(Action a){
41         ptsDist.put(a.getAction(),a);
42     }
```

```

43
44  /**Add a user to the league.
45      *
46      * @param User u
47      */
48  public void addUser(User u){
49      teams.put(u.getName(),u);
50      indexedTeams.add(u); //Store the indexed user
51  }
52
53  /**Add a player to the league.
54      *
55      * @param p
56      */
57  public void addPlayer(Player p){
58      athletes.put(p.getName(),p); //Add to the list of
59      players
60      freeAgent.addPlayer(p); //Add to the free agent
61  }
62
63  /**Get a user based on an index.
64      *
65      * @param int index
66      * @return User u
67      */
68  public User getUser(int index){
69      return indexedTeams.get(index);
70  }
71
72  /**Get the max team size.
73      *
74      * @return int maxTeamSize
75      */
76  public int getMaxTeamSize() {
77      return maxTeamSize;
78  }
79
80  /**Set the max team size.
81      *
82      * @param int maxTeamSize
83      */
84  public void setMaxTeamSize(int maxTeamSize) {
85      this.maxTeamSize = maxTeamSize;
86  }

```

```

87     /**Get the min team size.
88     *
89     * @return int minTeamSize
90     */
91     public int getMinTeamSize() {
92         return minTeamSize;
93     }
94
95     /**Set the min team size.
96     *
97     * @param int minTeamSize
98     */
99     public void setMinTeamSize(int minTeamSize) {
100         this.minTeamSize = minTeamSize;
101     }
102
103     /**Get the max number of users
104     *
105     * @return int maxUsers
106     */
107     public int getMaxUser() {
108         return maxUsers;
109     }
110
111     /**Set the max number of users
112     *
113     * @param int maxUsers
114     */
115     public void setMaxUser(int maxUsers) {
116         this.maxUsers = maxUsers;
117     }
118
119     /**Get the min number of users
120     *
121     * @return int minUsers
122     */
123     public int getMinUser() {
124         return minUsers;
125     }
126
127     /**Set the min number of users.
128     *
129     * @param int minUsers
130     */
131     public void setMinUser(int minUsers) {

```



```

132         this.minUsers = minUsers;
133     }
134
135     /**Get the name of the league.
136     *
137     * @return String name
138     */
139     public String getName() {
140         return name;
141     }
142
143     /**Get the current number of users in the league.
144     *
145     * @return int numUsers
146     */
147     public int getCurrentNumUsers(){
148         return teams.size();
149     }
150
151     /**Get the current number of players in the league.
152     *
153     * @return int numPlayers
154     */
155     public int getCurrentNumPlayers(){
156         return teams.size();
157     }
158
159     /**Get the current number of actions in the league.
160     *
161     * @return int numActions
162     */
163     public int getCurrentNumActions(){
164         return athletes.size();
165     }
166
167     /**Get a user from their name.
168     *
169     * @param String name
170     * @return User u
171     */
172     public User getTeam(String name){
173         return teams.get(name);
174     }
175
176     /**Get a player from their name.

```

```

177     *
178     * @param String name
179     * @return Player p
180     */
181     public Player getPlayer(String name){
182         return athletes.get(name);
183     }
184
185     /**Get an action from the rule.
186     *
187     * @param String action
188     * @return Action a
189     */
190     public Action getAction(String action){
191         return ptsDist.get(action);
192     }
193
194     /**Get the free agent.
195     *
196     * @return User freeAgent
197     */
198     public User getFreeAgent(){
199         return freeAgent;
200     }
201
202     /**Get the users in reverse ranked order based on
203     * the number of points they have.
204     *
205     * @return Users[] rankedTeams
206     */
207     public User[] getRankedUsers(){
208         User[] ranked=teams.values().toArray(new User[teams.size
209         ()]);
210         Arrays.sort(ranked);
211         return ranked;
212     }
213
214     /**Get the players that are still in the draft in reverse
215     * ranked order.
216     *
217     * @return Player[] availablePlayers
218     */
219     public Player[] getRankedAvailablePlayers(){
220         return freeAgent.getPlayers();
221     }

```

```

221
222  /**Get all the players in the league.
223   *
224   * @return Player[] allPlayers
225   */
226  public Player[] getPlayers(){
227      return athletes.values().toArray(new Player[athletes.
          size()]);
228  }
229
230  /**Get all the actions in the league.
231   *
232   * @return Action[] allActions
233   */
234  public Action[] getActions(){
235      return ptsDist.values().toArray(new Action[ptsDist.size
          ()]);
236  }
237
238  /**Get all the users in the correct indexed order.
239   *
240   * @return User[] users
241   */
242  public User[] getUsers(){
243      return indexedTeams.toArray(new User[indexedTeams.size()
          ]);
244  }
245  /**Clear all the data structures.
246   *
247   */
248  public void clear(){
249      teams.clear();
250      playerToTeam.clear();
251      athletes.clear();
252      ptsDist.clear();
253      indexedTeams.clear();
254      freeAgent.clear();
255  }
256
257  /**Get a string representation of the league's statistics.
258   *
259   * @return String league
260   */
261  public String toString() {
262      return "League [name=" + name + ", maxTeamSize=" +

```

```

        maxTeamSize
263         + ", minTeamSize=" + minTeamSize + ", maxUser=" +
            maxUsers
264         + ", minUser=" + minUsers + "]" );
265     }
266
267 }

```

Listing A.9: makefile

```

1  # makefile to generate the FLOOD compiler frontend
2
3  JFLEX      = jflex
4  JAVAC      = javac
5  JAR        = jar -cf
6  DELETE    = rm -rf
7  BYACCJ    = byaccj -J
8
9  # targets:
10
11 all: flood_frontend.jar
12
13 run: flood_frontend.jar
14     java Parser
15
16 build: clean flood_frontend.jar
17
18 clean:
19     $(DELETE) *.*~ *.class
20     $(DELETE) ParserVal.java
21     $(DELETE) Parser.java
22     $(DELETE) Yylex.java
23     $(DELETE) flood_front.jar
24     $(DELETE) FloodProgram.java
25
26 flood_frontend.jar: Parser.class
27     $(JAR) flood_front.jar *.class
28
29 Parser.class: Yylex.java Parser.java
30     $(JAVAC) Parser.java
31
32 Yylex.java: flood_lex.flex
33     $(JFLEX) flood_lex.flex
34
35 Parser.java: flood_grammar.y

```

Listing A.10: Player.java

```

1  /*
2   * Player.java
3   * This class handles an individual player in the league
4   */
5
6  public class Player implements Comparable<Player>{
7      private String name, position;
8      private float totalPoints;
9
10     /**Constructor with just the name and position.
11      *
12      * @param String name
13      * @param String position
14      */
15     public Player(String name, String position){
16         this.name=name;
17         this.position=position;
18         totalPoints=0;
19     }
20
21     /**Constructor with the name and points. Used for importing
22      * dump files.
23      *
24      * @param String name
25      * @param String position
26      * @param float totalPoints
27      */
28     public Player(String name, String position, float
29         totalPoints){
30         this.name=name;
31         this.position=position;
32         this.totalPoints=totalPoints;
33     }
34
35     /**Get the player's name.
36      *
37      * @return
38      */
39     public String getName() {
40         return name;
41     }

```

```

41
42  /**Return a string representation of the player.
43   *
44   * @return String player
45   */
46  public String toString() {
47      return "Player [name=" + name + ", position=" + position
48          + ", totalPoints=" + totalPoints + "];"
49  }
50
51  /**Get the player's position.
52   *
53   * @return String position
54   */
55  public String getPosition() {
56      return position;
57  }
58
59  /**Add points to the player and the team they are on.
60   *
61   * @param float pts
62   */
63  public void addPoints(float pts){
64      totalPoints+=pts; //Add pts to players points
65      User temp=League.playerToTeam.get(this); //Get team
        they are on
66      if(temp!=null) //Free agent
67          temp.addPoints(pts); //Add the points to the team
68  }
69
70  /**Get the player's total points.
71   *
72   * @return float totalPoints
73   */
74  public float getPoints(){
75      return totalPoints;
76  }
77
78  /**Determine if two players are equal.
79   *
80   * @return boolean areEqual
81   */
82  public boolean equals(Object obj){
83      if (this == obj) //Same reference
84          return true;

```

```

85         if (obj == null)    //Other is null
86             return false;
87         if (getClass() != obj.getClass())    //Not the same class
88             return false;
89         final Player other = (Player) obj;    //Cast other object
90         if (name.equals(other.name) && position.equals(other.
            position))    //Same name and position
91             return true;
92         return false;
93     }
94
95     /**Compare two players based on their total points scored.
96     *
97     * @return int compared
98     */
99     public int compareTo(Player o) {
100         if(totalPoints>o.getPoints())
101             return 1;
102         else if(totalPoints==o.getPoints())
103             return 0;
104         return -1;
105     }
106
107 }

```

Listing A.11: run.sh

```

1  #!/bin/bash
2  java Parser $1
3  javac FloodProgram.java
4  java FloodProgram

```

Listing A.12: User.java

```

1  /*
2   * User.java
3   * This class handles the users in the league
4   */
5
6  import java.util.Arrays;
7  import java.util.HashMap;
8
9
10 public class User implements Comparable<User>{

```

```

11     private float totalPoints;
12     private String name;
13     private HashMap<String,Player> teamAthletes;
14
15     /**Constructor with just the name.
16      *
17      * @param String name
18      */
19     public User(String name){
20         this.name=name;
21         totalPoints=0;
22         teamAthletes=new HashMap<String,Player>();
23     }
24
25     /**Constructor with the name and points. Used for
26      importing
27      * dump files.
28      *
29      * @param String name
30      * @param float totalPoints
31      */
32     public User(String name,float totalPoints){
33         this.name=name;
34         this.totalPoints=totalPoints;
35         teamAthletes=new HashMap<String,Player>();
36     }
37
38     /**Add a player to the team and if the team is not the
39      free agent,
40      * remove the player from the free agent.
41      *
42      * @param Player athlete
43      */
44     public void addPlayer(Player athlete){
45         teamAthletes.put(athlete.getName(),athlete); //Add
46         player to this team
47         if(!name.equals("Free Agent")){ //If it's not the free
48         agent team
49         League.playerToTeam.put(athlete,this); //Add the
50         association of player to team mapping
51         League.freeAgent.removePlayer(athlete); //Remove
52         this player from the free agent
53     }
54 }

```



```

50     /**Remove a player from a team and if the team is not the
        free agent,
51     * add the player to the free agent.
52     *
53     * @param Player athlete
54     */
55     public void removePlayer(Player athlete){
56         teamAthletes.remove(athlete.getName());    //Remove
            athlete from this team
57         if(!name.equals("Free Agent")){    //If it's not the free
            agent
58             League.playerToTeam.remove(athlete);    //Remove the
                association of player to team
59             League.freeAgent.addPlayer(athlete);    //Add the
                player to the free agent
60     }
61 }
62
63 /**Add points to the team.
64 *
65 * @param float points
66 */
67 public void addPoints(float points){
68     totalPoints+=points;
69 }
70
71 /**Get the user's points.
72 *
73 * @return float totalPoints
74 */
75 public float getPoints() {
76     return totalPoints;
77 }
78
79 /**Get the name of the user.
80 *
81 * @return String name
82 */
83 public String getName() {
84     return name;
85 }
86
87 /**Get the number of players on the user's team.
88 *
89 * @return int numPlayers

```

```

90     */
91     public int getNumPlayers(){
92         return teamAthletes.size();
93     }
94
95     /**Get the player on the user's team in reverse ranked
96     * order.
97     *
98     * @return Player[] rankedPlayers
99     */
100    public Player[] getPlayers(){
101        Player[] ranked=teamAthletes.values().toArray(new Player
102            [teamAthletes.size()]);
103        Arrays.sort(ranked);
104        return ranked;
105    }
106
107    /**Determine if two users are the same.
108    *
109    * @return boolean areEqual
110    */
111    public boolean equals(Object obj){
112        if (this == obj) //Same reference
113            return true;
114        if (obj == null) //Other is null
115            return false;
116        if (getClass() != obj.getClass()) //Not the same class
117            return false;
118        final User other = (User) obj; //Cast object
119        if (name.equals(other.name)) //If the names are equal
120            return true;
121        return false;
122    }
123
124    /**Compare one user to another based on their number of
125    points.
126    *
127    * @return int compared
128    */
129    public int compareTo(User o) {
130        if(totalPoints>o.getPoints())
131            return 1;
132        else if(totalPoints==o.getPoints())
133            return 0;
134        return -1;

```

```

133     }
134
135     /**Return a string representation of the user.
136     *
137     * @return String user
138     */
139     public String toString() {
140         return "User [name=" + name + ", points=" + totalPoints
141             + " ]";
142     }
143
144     /**Clear the data structures.
145     *
146     */
147     public void clear(){
148         teamAthletes.clear();
149     }

```