Frogger Language Definition.

**VARIABLES:**

The only variable data types are double and string. Variables are defined at first use and are typed based on usage. If a variable is determined to be double it is initialized to 0, conversely the empty string (‘’) for string types. Variable identifiers are alpha with underscores starting with an alpha character. So, valid variable names (identifiers) follow the regex [a-zA-Z][a-zA-Z\_]\*, so numerical digits are not allowed.

**BUILT-IN COMMANDS:** (Commands have no return type)

end() - terminates the function’s execution, returns null.

end(<string>) - terminates the function’s execution, returns <string>.

end(<double>) - terminates the function’s execution, returns <double>.

display (<string>) - prints the argument to the user.

display (<double>) - prints the argument to the user.

openI(<string>) - opens the input file.

openO(<string>) - opens the output file.

write(<string>) - writes the argument to the output file.

closeI() - closes the input file.

closeO() - closes the output file.

**BUILT-IN FUNCTIONS:**

**Double functions:**

<double>:toString() - 65.9:toString() -> ’65.9’

<double>:toAscii() - 65.9:toAscii() -> ‘A’ (double is truncated)   
returns ‘’ if double is out of ascii range

retrieveDouble() - obtains a double value from the user.

random() - generates a new pseudo random number between 0 and 1.

**String functions:**

<string>:asciiAt(<double>) - returns the ascii value of the char at the given index in the string.   
Zero indexed. [e.g. ‘ABC’:asciiAt(0) -> 65]  
returns 0 if the index DNE

<string>:length() - returns the number of characters in the string.

<string>:parseDouble() - ‘65’:parseDouble() -> 65 (returns 0 if string is not parseable)

retrieveString() - obtains a string value from the user.

**File I/O functions:**

read() -reads a single ascii character from the input file as a string of len 1.   
(returns -1 ascii character for EOF)

**Argument functions:**

args:elementAt(<double>) - returns the argument at the given index in the arg list. Zero indexed.  
returns ‘’ if the index DNE.

args:size() - returns the number of arguments in the arg list.

**OPERATORS:**

**Arithmetic operators:** (listed in order of operations) [Left Operand – LO, Right Operand – RO]

exponentiation (^^) - LO is raised to the power of RO (5^^2 = 25)

rootation (##) - RO is rooted to the power of LO (3##8 = 2)

multiplication (\*\*) - Standard multiplication

division (//) - Standard division

integer division (\\) -

modulus division (%%) -

addition (++) - Standard addition

subtraction (--) - Standard subtraction

assignment (=) - RO is evaluated and assigned to LO as a double

**String operators:** (left associative)

string concatenation (++) - Standard concatenation between two strings

assignment (=) - RO is evaluated and assigned to LO as a string

**Boolean operators:** (All standard Boolean operators)

less than (<)

greater than (>)

equal (==)

less than or equal (<=)

greater than or equal (>=)

not (!)

**STRINGS:**

Strings include only printable characters and the listed escape characters enclosed within single quotes. Escape characters: &t (tab), &n (new line), &’ (single quote), and && (ampersand).

No control characters are allowed.

**Files:**

Frogger supports only simplex file operations; that is, one input and one output file at any given time. Writing to the output file is done through the write(<string>) command. If a number or ascii value is to be written to a file, the programmer must utilize double, string, and ascii conversion functions.

**KEYWORDS:**

if, then, and else.

**COMMENTS:**

Comments are enclosed within tildes (~) and are completely ignored.

**PROCESSING ORDER:**

Each FLOWSTMT is associated with a number (starting at 0 and incremented by 1 until the end of file linearly). Frogger is not a linear language; that is, code is not processed top to bottom. Instead, at the end of each JMPSTMT, control is passed to the FLOWSTMT corresponding to the number obtained by the following process:  
Add up all the printable characters’ ascii codes for the current JMPSTMT (excepting extraneous parens and subsequent spaces within string literals), mod this number by the total number of FLOWSTMTs in the source program. (Note ascii values for comment characters are ignored because comments do not carry over into the CFG. Note also that conditional structures themselves are not included in ascii summation because the JMPSTMTs are structures contained within the conditional structure.)

**PROGRAM STRUCTURE:**

A program is, at minimum, a single program entry function file; but can be as complex as a Project Folder (PF), a Structure Configuration File (SCF), a Program Entry Function File (PEFF), and multiple User-Defined Function Files (UDFFs).

**Project Folder (PF):**

The PF is named <projectName> and is the root directory for the project. It contains all files related to the project. The PF is optional if the project is a stand-alone PEFF.

**Structure Configuration File (SCF):**

The SCF is named <projectName>.struct (where <projectName> matches the name of the PF), **must** be stored in the PF root, and allows for the use of UDFFs. The SCF is optional if the project’s only functional code is the PEFF.

The SCF ties all elements of the project together. The SCF contains function declaration records: one per line. A function declaration record is formatted as follows: *<functionName>*.fgr [argTypeList] -> *<returnType>*

**<functionName>** - the name of the function, and thus the name of the .fgr file (excluding the extension).

**[argTypeList]** - a comma-separated list of the arguments and their types: *<argName>* : *<type>*

**<argName>** - the name of the argument to be used as the local variable name within the function.

**<returnType>** - the data type to be returned by the function (“double”, “string”, or “null”).

**<type>** - the data type of the argument (“double”, “string”, or “null”).

**Program Entry Function (PEF) File (PEFF):**

The PEFF is named <projectName>.fgr, **must** be placed in the PF’s root (if a PF is used), and acts as the entry point to the project. The PEF can optionally have a corresponding record in the SCF, but is not required to where its existence, location, and name is implied from the PF (if a PF is used). The PEF’s SCF record must match: “<projectName>.fgr -> null” if it is to be used. Command line arguments are only accessible within the PEF and are not treated as arguments in the function record.

**User-Defined Function (UDF) Files (UDFF):**

Each UDF is defined in a separate file as <functionName>.fgr and must have a corresponding record in the SCF. PEFFs and UDFFs follow the Frogger syntax described throughout this document as they contain functional Frogger code. Command line arguments are only accessible within the PEF.

**CFG**:

1. PROG -> FLOWSTMT FLOWSTMTS
2. FLOWSTMTS -> FLOWSTMT FLOWSTMTS
3. |
4. FLOWSTMT -> IFSTMT
5. | JMPSTMT
6. NESTEDFLOWSTMT -> IFSTMT
7. |JMPSTMT

**Control:**

1. IFSTMT -> if ( BOOLEXP ) then NESTEDFLOWSTMT else NESTEDFLOWSTMT
2. BOOLEXP -> EXPR BOOLOP EXPR
3. | EXPR not BOOLOP EXPR
4. BOOLOP -> lt
5. | gt
6. | eq
7. | lte
8. | gte

**Action Statements:**

1. JMPSTMT -> id ( [ARGLIST] ); // TYPEDTERM:id ( ARGS );
2. | id assign EXPR ;
3. ARGLIST -> EXPR , ARGLIST
4. | EXPR

**Expressions:**

1. EXPR -> EXPR ADDOP ADDTERM
2. | ADDTERM
3. ADDTERM -> ADDTERM MULOP MULTERM
4. | MULTERM
5. MULTERM -> MULTERM EXPOP TYPEDTERM
6. | TYPEDTERM
7. TYPEDTERM -> TYPEDTERM : id ( [ARGLIST] )
8. | PRIMARY
9. PRIMARY -> dbl
10. | id
11. | id ( [ARGLIST] )
12. | string
13. | ( EXPR )

**Operators:**

1. ADDOP -> add
2. | sub
3. MULOP -> mul
4. | div
5. | mod
6. | idiv
7. EXPOP -> rt
8. | exp

**OBFUSCATION:**

Frogger offers in-line obfuscation if the programmer should choose to further confuse herself/himself. Including the first line of source code as strictly an even number of tildes(~) followed by a carriage return will trigger the de-obfuscator. Note: 0 is considered an even number so if the first character in the source code is a carriage return, the de-obfuscator will run.

Obfuscator Examples (<\n> denotes the new line character within the source code):   
<\n> ~~<\n> ~~~~<\n> ~~~~~~<\n>  
Non-Obfuscated Examples:  
~<\n> (odd number of tildes) ~a~<\n> (‘a’ is not a tilde character) ~~ <\n> (space is not a tilde)

Obfuscation is as follows:  
Each character within variable names should be ascii incremented based on the number of identifiers occurring prior in the source code. Similarly for each keyword and routine name (functions and commands are both routines) but based on the number previously occurring (each category is treated separately). The de-obfuscator will decrement by these counters. Valid symbols are restricted to alphanumeric and the underscore and are incremented in order of ascii value, so order is 0-9A-Z\_a-z. Then if a variable named x\_Dbl is to be used and 6 variables have been used between the start of file and the current location, x\_Dbl should be represented (+7) as 4gKis.