# CSE 4714 / 6714 — Programming Languages
# Project Part 1

Our first programming assignment for the project is to write a lexical analyzer for a subset of the language TIPS, which itself is a subset of the Pascal programming language. TIPS stands for *Ten Instruction Pascal Subset*; see the attached book (which dates from the Pleistocene epoch of computing).

The job of a lexical analyzer is to return the lexemes (i.e., fundamental syntactical elements) in the input program to a parser for further analysis. You will use *C++* and *flex* for this assignment.

## Assignment

Use *flex* to generate the lexical analyzer using the language specification shown in the following table. A set of files that you will use as a starting point for your code is in the attached `Part_1_Starting_Point.zip` file.

Tables of the TIPS lexemes:

| Keyword Lexemes | Token Identifier Value | Token Constant |
|---|---|---|
| BEGIN | 1000 | TOK_BEGIN |
| BREAK | 1001 | TOK_BREAK |
| CONTINUE | 1002 | TOK_CONTINUE |
| DOWNTO | 1003 | TOK_DOWNTO |
| ELSE | 1004 | TOK_ELSE |
| END | 1005 | TOK_END |
| FOR | 1006 | TOK_FOR |
| IF | 1007 | TOK_IF |
| LET | 1008 | TOK_LET |
| PROGRAM | 1009 | TOK_PROGRAM |
| READ | 1010 | TOK_READ |
| THEN | 1012 | TOK_THEN |
| TO | 1013 | TOK_TO |
| VAR | 1014 | TOK_VAR |
| WHILE | 1015 | TOK_WHILE |
| WRITE | 1016 | TOK_WRITE |

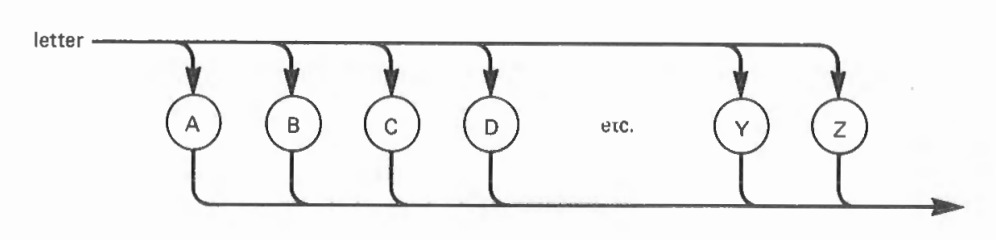
| Datatype Specifier Lexemes | Token Identifier Value | Token Constant |
|---|---|---|
| INTEGER | 1100 | TOK_INTEGER |
| REAL | 1101 | TOK_REAL |

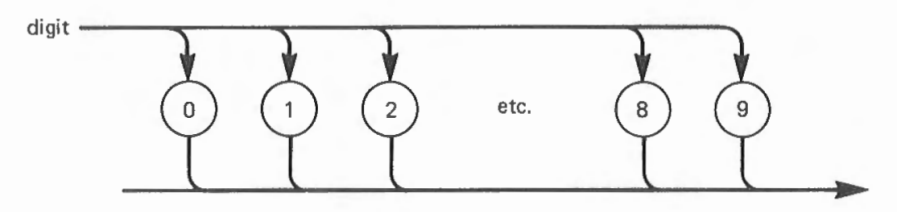
| Punctuation Lexemes | Token Identifier Value | Token Constant |
|---|---|---|
| ; | 2000 | TOK_SEMICOLON |
| : | 2001 | TOK_COLON |
| ( | 2002 | TOK_OPENPAREN |
| ) | 2003 | TOK_CLOSEPAREN |
| { | 2004 | TOK_OPENBRACE |
| } | 2005 | TOK_CLOSEBRACE |

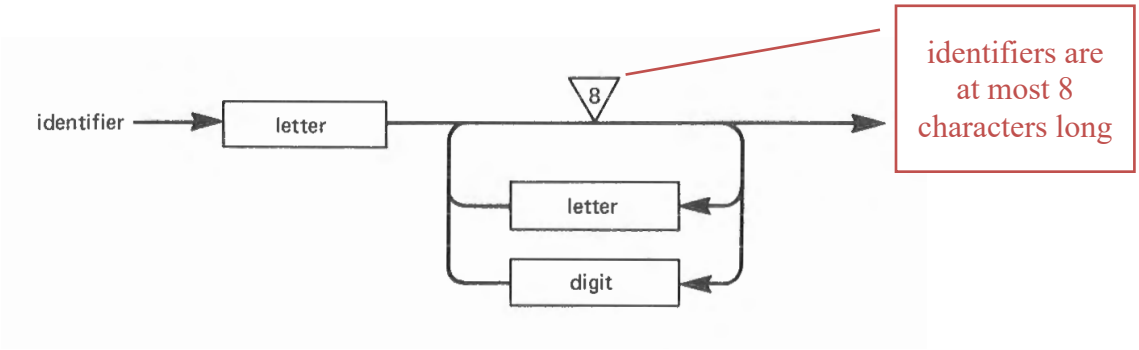
| Operator Lexemes | Token Identifier Value | Token Constant |
|---|---|---|
| + | 3000 | TOK_PLUS |
| - | 3001 | TOK_MINUS |
| * | 3002 | TOK_MULTIPLY |
| / | 3003 | TOK_DIVIDE |
| := | 3004 | TOK_ASSIGN |
| = | 3005 | TOK_EQUALTO |
| < | 3006 | TOK_LESSTHAN |
| > | 3007 | TOK_GREATERTHAN |
| <> | 3008 | TOK_NOTEQUALTO |
| MOD | 3009 | TOK_MOD |
| NOT | 3010 | TOK_NOT |
| OR | 3011 | TOK_OR |
| AND | 3012 | TOK_AND |

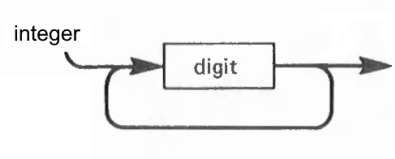
| Useful Abstraction Lexemes | Token Identifier Value | Token Constant |
|---|---|---|
| identifier | 4000 | TOK_IDENT |
| integer literal | 4001 | TOK_INTLIT |
| floating-point literal | 4002 | TOK_FLOATLIT |
| string literal | 4003 | TOK_STRINGLIT |
| end of file | 5000 | TOK_EOF |
| | 6000 | TOK_UNKNOWN |

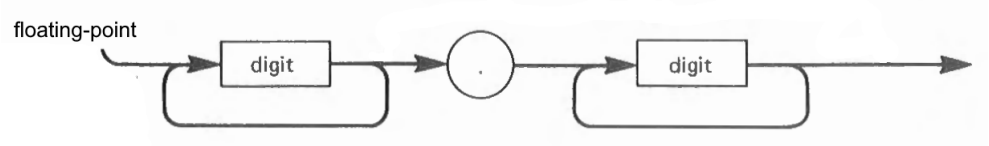
Syntax diagrams for some of the *Useful Abstractions* lexemes:



## Notes

(1) Identifiers and keywords only consist of uppercase letters.

(2) Identifiers can be at most 8 characters long. This length limit can be determined during lexical analysis by measuring the length of the `yytext` variable. In the flex file, the code block can contain C code in addition to `return TOK_IDENT`.

(3) Integer literals only consist of digits. A negative integer literal should lexically scan as a minus sign followed by an integer literal. The issue of the maximum and minimum allowed integer literal is not handled during lexical analysis. Similar comments apply to floating point literals.

(4) Sequences of letters called strings (`TOK_STRINGLIT`) are enclosed between single quote marks. The maximum length of a string is 80 characters. Examples are:

```
'THE BANK BALANCE IS:'
'HAPPY BIRTHDAY TO YOU'
'WHAT CHARACTERS ARE PERMISSIBLE IN character STRINGS?'
''    (the empty string)
```

Any character may appear in a string, including whitespace. *Except:* a single quote mark may not appear in a string, and a newline may not appear in a string.

(5) Other than separating lexemes, whitespace (space, tab, newline) should be ignored by your lexical analyzer (except for spaces and tabs in a string).

(6) Ambiguity is resolved in favor of longer lexemes; therefore, the word `IFFINESS` in the input stream should create an identifier token, and not an `IF` keyword token followed by an identifier token.

(7) The driver program implements the following behavior: If started with no arguments, the program runs interactively, which allows easy testing. If started with a file name, the program processes that file. If a lexical error is found, the lexical analyzer prints an error message and keeps running.

(8) Place the following header in your `rules.l` file. Modify the header to use your name, etc.

```
/*****************************************************************
  Name: Any Student             NetID: as3
  Course: CSE 4714              Assignment: Part 1
  Programming Environment:
  Purpose of File: Contains the ....
*****************************************************************/
```

(9) See the provided sample inputs and outputs for examples of the completed program's execution.

## Helpful Tips

(1) The following command runs the lexical analyzer on the file `input1.in,` and then uses a Unix *pipe* to compare the output to the file `input1.correct`. This is easier than saving the output to a temporary file.

```
$ ./tips_lex input1.in | diff - input1.correct
```

(2) The following command runs the lexical analyzer on the file `input1.in,` and then uses a Unix *pipe* to print the output up to the first error, and then stops. This allows that error to be investigated. *How it works:* The *grep* command searches for the word *ERROR* (which itself is a regular expression!); when found, it prints up to 1000 preceding lines of context (`-B 1000`), and stops after one match (`-m 1`). Check it out!

```
$ ./tips_lex input1.in | grep -B 1000 -m 1 ERROR
```

## Deliverables

Place all of the source files (including files that you did not modify) needed to build your program using `make` in a zip file named *`yournetid`*`_part_1.zip` . For example, my submission would be named jec570`_part_1.zip` .

Do NOT include object files (`*.o`), generated source code files (`lex.yy.c`), or executable files (`*.exe`) .

Upload your zip file to the assignment.