CS323 Documentation

1. **Problem Statement**

This program is a simple lexer that reads a file and identifies the different tokens in the file. It uses several functions to perform different tasks such as opening and closing files, initializing and finalizing the output file, checking if a value in an array matches the value passed to the function, and defining finite state machines (FSMs) for different token types.

2. **How to use Our program**

   Step1) Click on lexer.exe
   Step2) The input file (test1.rat23s)
   Step3) The output file (output1.txt)
   Or
   Step 1) go to command line
   Step 2) type lexer.exe < test1.rat23s > < output1.txt >
   Step 3) Hit the CR

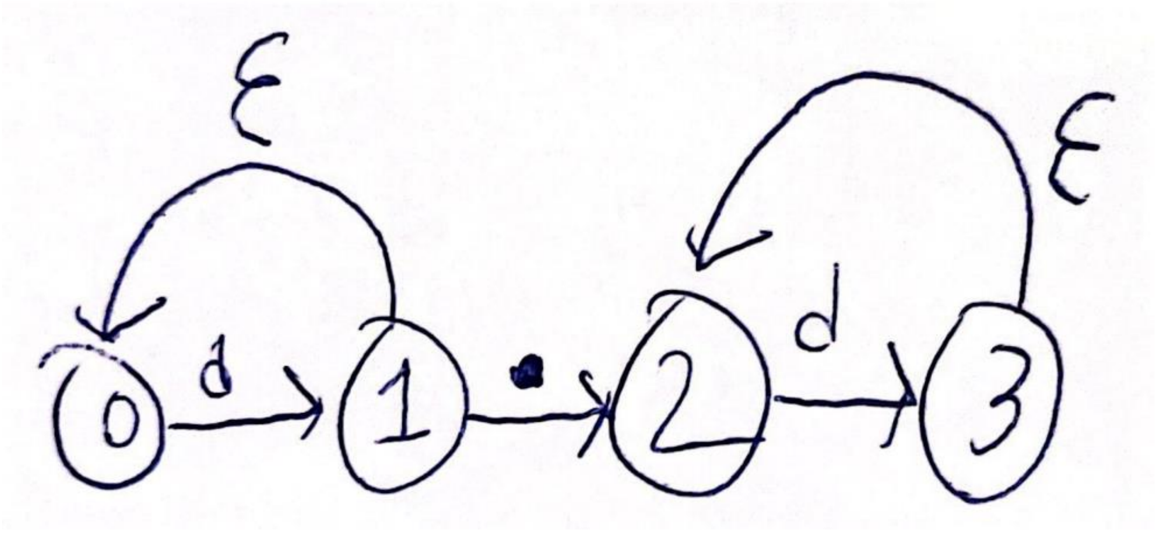
3. **Design of Our program**

Repository: https://github.com/MichaelR13/cpsc323.Project

Regular Expressions:

- **Real: [d]+ [.] [d]+**
- **Integers: [d]**

Thompson NFSM:



$$\begin{tikzcd}
0 \arrow[r, "d"] & 1 \arrow[l, bend right, "\varepsilon"'] \arrow[r, "\bullet"] & 2 \arrow[r, "d"] & 3 \arrow[l, bend right, "\varepsilon"']
\end{tikzcd}$$

Our NFSM consisted of 4 states:

- **0: Starting state -> state 1 on [d]**
- **1: Integer state -> state 2 on [.]**

- **1: Integer state -> state 1 on [d]**
- **2: Real state -> state 3 on [d]**
- **3: Error state -> state 3 on [d]**

Functions:

- function openFiles() to prompt the user for the input and output file names, and then open the input and output files. If there is an error opening the files, the program exits.
- function initPrint() to print a header for the output file.
- function checkArr() to check if a given value is in a given array.
- function endPrint() to print a footer for the output file.
- function intRealFSM() to implement a finite state machine for recognizing integers and real numbers.
- function isKeyword() to check if a given identifier is a keyword.
- function lexer() to tokenize the input file and output the tokens to the console. The function uses a series of if statements to identify and handle different types of tokens, including identifiers, keywords, integers, real numbers, operators, and separators.

The primary data structure used in this program is a two-dimensional array that represents a finite state machine (FSM) used to identify whether a number is an integer or a real number. Additionally, two one-dimensional character arrays, ops and seps, are used to store operators and separators.

Algorithm:

The algorithm used in this program is a finite state machine. For example, intRealFSM uses a finite state machine with three states to determine whether a given number is an integer or a real number. The function isKeyword checks if the identifier is a keyword by comparing it to a list of predefined keywords.

4. **Any Limitation**
   Being able to align each token/lexeme pair when printing/writing.

5. **Any shortcomings**
   Implementation of a potential use of 2 finite state machines; We had previously attempted to utilize 2 finite state machines and use their determined states to tokenize. This approach provided too many issues, so we reworked the lexer to use 1 finite state machine for integers and reals.

Samples:

Here is an example input and the corresponding output that can be produced using the functions in the provided code:

lexeme	token
while	keyword
(	seperator
true	identifier
)	seperator
{	seperator
cout	identifier
<	operator
<	operator
"	seperator
Hello	identifier
,	seperator
world	identifier
!	operator
"	seperator
<	operator
<	operator
endl	identifier
;	seperator
string	identifier
name	identifier
;	seperator
int	identifier
age	identifier
,	seperator
birthYear1	identifier
,	seperator
birthYear2	identifier
;	seperator
cout	identifier
<	operator
<	operator
"	seperator
What	identifier
is	identifier
your	identifier
name	identifier
?	seperator
"	seperator
;	seperator
cin	identifier
>	operator
>	operator
name	identifier
;	seperator
cout	identifier

<	operator
<	operator
"	seperator
How	identifier
old	identifier
are	identifier
you	identifier
?	seperator
"	seperator
;	seperator
cin	identifier
>	operator
>	operator
age	identifier
;	seperator
birthYear1	identifier
=	operator
2023	integer
-	seperator
age	identifier
;	seperator
birthYear2	identifier
=	operator
2022	integer
-	seperator
age	identifier
;	seperator
cout	identifier
<	operator
<	operator
"	seperator
You	identifier
were	identifier
born	identifier
in	identifier
"	seperator
<	operator
<	operator
birthYear1	identifier
<	operator
<	operator
"	seperator
or	identifier
"	seperator
<	operator
<	operator

birthYear2	identifier
<	operator
<	operator
endl	identifier
;	seperator
cout	identifier
<	operator
<	operator
"	seperator
Do	identifier
you	identifier
want	identifier
to	identifier
continue	keyword
?	seperator
(	seperator
y	identifier
/	seperator
n	identifier
)	seperator
"	seperator
;	seperator
char	identifier
answer	identifier
;	seperator
cin	identifier
>	operator
>	operator
answer	identifier
;	seperator
if	keyword
(	seperator
answer	identifier
==	operator
'	seperator
n	identifier
'	seperator
)	seperator
{	seperator
break	keyword
;	seperator
}	seperator
}	seperator
return	identifier
0	integer
;	seperator