PLC Test 2 - Jose Diaz

1. (20 points) Create code that allows you to create an ordered list of tokens. This code should take in a file as input and process that file for the following lexemes:

    - All of the code can be found here: https://github.com/joseishere/jose_test2
    - For all of these problems I wrote them in python and made one file that would read all of my test strings from a file
    - I have several files so here is all of the files with their respective code and the last file is the one that combines it all

```python
# tryFloat.py
import re

def floatChecker(arr):

    # I did this one with regex after people started to talk about
    # of course all of the other ones I didn't do with regex bc th
    # really wish i would have done everything with regex
    # also I used this website to help me build the regex string
    # it is really well made and you should donate to help keep it
    # the website is : https://regex101.com

    regexBase = r"(-)?(\d)*(.)?\d+(e|E)?(-)?\d(l|L|f|F)?"

    if(re.fullmatch(regexBase, arr)):
        # print('is valid')
        return True
    else:
        return False

def main():

    words = ["23.75", "0.59201E1", "1312221215e-2", "-2.5e-3", "15

    for word in words:
        if(floatChecker(word)):
            print(word + " is valid")
        else:
            print(word + " is not valid")

if __name__ == "__main__":
    main()
```

```python
# tryInt.py
hex_vals = {
    'a':'a',
    'A':'A',
    'b':'b',
    'B':'B',
    'c':'c',
    'C':'C',
    'd':'d',
    'D':'D',
    'e':'e',
    'E':'E',
    'f':'f',
    'F':'F',
}
def intChecker(arr):
    foundu = False
    foundU = False
    size = len(arr)
    try:
        letterFound = arr[2:].find(next(filter(str.isalpha, arr[2:]
    except:
        letterFound = -1
    #print(letterFound)
    if(size < 2):
        return False
    if(arr[0] == '0' and arr[1] == 'x' or arr[1] == 'X'):

        xo={
            'a' : 'u',
            'b' : 'U',
            'c' : 'l',
            'd' : 'L'
        }

        size = len(arr) - 1
        suffix = [None] * len(arr)

        while(size >= 0):
            #print(size)
            if(arr[size] in xo.values()):
                suffix[size] = arr[size]
            else:
                break
            size -= 1
        #print(suffix)
        temp = ''
        for each in suffix:
            if(each is not None):
                temp += each
        #print(temp)
        #print("final size : " + str(size))

        if(size != len(arr) - 1):
            for char in arr[2:size+1]:
```

```python
                #print(char)
                if(char.isnumeric() or char in hex_vals.values()):
                    #print('what')
                    pass
                else:
                    print('ere')
                    return False
            return (True and checkEnd(arr, size+1, 'hex'))
        else:
            return True

    elif(arr[0] == '0' and arr[1] < '8'):
        if(letterFound != -1):
            for char in arr[2:letterFound+2]:
                #print(char)
                if(char < '8'):
                    pass
                else:
                    #print('ere')
                    return False
            return (True and checkEnd(arr, letterFound+2, 'oct'))
        else:
            return True
    elif(arr[0] != 0):
        if(letterFound != -1):
            for char in arr[2:letterFound+2]:
                #print(char)
                if(char.isnumeric()):
                    pass
                else:
                    #print('ere')
                    return False
            return (True and checkEnd(arr, letterFound+2, 'dec'))
        else:
            return True
    else:
        return False

def checkEnd(arr, startLetter, type):
    endString = arr[startLetter:]
    #print(endString, "end string")
    dec_endings = {
        'u':'u',
        'l':'l',
        'ul':'ul',
        'LL':'LL',
        'ull':'ull',
    }
    hex_endings = {
        'u':'u',
        'l':'l',
        'uL':'uL',
        'll':'ll',
        'uLL':'uLL',
    }
    oct_endings = {
        'u':'u',
        'l':'l',
        'UL':'UL',
        'll':'ll',
        'Ull':'Ull',
    }

    whereToLook = str(type) + "_endings"
    #print(whereToLook)
    if(type == 'dec'):
        if(endString in dec_endings.values()):
            #print('checkend returned true')
            return True
        else:
            return False
    elif(type == 'hex'):
        if(endString in hex_endings.values()):
            #print('checkend returned true')
            return True
        else:
            return False
    elif(type == 'oct'):
        if(endString in oct_endings.values()):
            #print('checkend returned true')
            return True
        else:
            return False
    else:
        return False

def main():

    words = ["28","4000000024u","2000000022l","4000000000ul","9000
```

```python
    for word in words:
        if(intChecker(word)):
            print(word + " is valid")
        else:
            print(word + " is not valid")

if __name__ == "__main__":
    main()
```

```python
# tryChar.py
symbols ={
    '~' : '~' ,
    '`' : '`' ,
    '!' : '!' ,
    '@' : '@' ,
    '#' : '#' ,
    '$' : '$' ,
    '%' : '%' ,
    '^' : '^' ,
    '&' : '&' ,
    '*' : '*' ,
    '(' : '(' ,
    ')' : ')' ,
    '-' : '-' ,
    '_' : '_' ,
    '+' : '+' ,
    '=' : '=' ,
    '{' : '{' ,
    '[' : '[' ,
    '}' : '}' ,
    ']' : ']' ,
    '|' : '|' ,
    ':' : ':' ,
    ';' : ';' ,
    '<' : '<',
    ',' : ',',
    '>' : '>',
    '.' : '.',
    '?' : '?',
}

after_slash = {
    'b':'b',
    'f':'f',
    'n':'n',
    'r':'r',
    '"':'"',
    '\\':'\\',
    "'":"'",
    'v':'v',
    'a':'a',
    '?':'?',
    'N':'N',
    'X':'X',
    't':'t',
}

def charChecker(arr):
    # this is very similar to the java string, so took the same al
    # i think we first need to handle the simplest case just makin
    size = len(arr)
    count = 0
    # need this to handle the /XN
    isX = False

    # we cant have an empty string or 'a
    # and we know we can't have anything more than 5
    if(size >= 5 or size < 3):
        return False
    # print(arr[0], arr[-1])

    if((arr[0] == '"' and arr[-1] == '"') or (arr[0] == "'" and ar

# don't need to check first letter since we know what it is
# now we need to loop through the string and if we have a slash
# we need to know that the next number, in this case arr[num] is a
# and we need to make sure that we only have an even number of sla
# is not valid even though you can have a \ after a \
        num = 1
        for letter in arr[1:-1]:
            #print(letter, "printing letter hereeee")
            num +=1
            if(letter.isalnum() or letter in symbols.values()):
                pass
            elif(letter == '\\'):
                count+=1
                # print(count)
                if(isX):
                    if(arr[num] != 'N'):
                        return False
                elif(arr[num] in after_slash.values()):
                    #print(str(size) + " size")
                    if(arr[num] == 'X'):
                        isX = True
                    if(num < size-1):
                        count+=-1
                        #print(count)
                elif(arr[num] not in after_slash.values()):
                    return False
            else:
                pass
    else:
        return False
    if(count == 0):
        return True

    return True

def main():

    words = ["\'1\'", "\'!\'", "\"$\"", "\'\t\'", "\'\?\'", "\'\\\

    for word in words:
        if(charChecker(word)):
            print(word + " is valid")
        else:
            print(word + " is not valid")

if __name__ == "__main__":
    main()
```

```
# tryJava.py
after_slash = {
    't':'t',
    'r':'r',
    'n':'n',
    'f':'f',
    '"':'"',
    '\\':'\\',

}

def javaChecker(arr):
```

```python
    # i think we first need to handle the simplest case just makin
    size = len(arr)
    count = 0
    preCount = 0
    if(size < 3):
        return False
    for letter in arr:
        if(letter == '\\'):
            preCount+=1

    if(arr[0] == "'" and arr[1] != "\\" and arr[2] == "'" and len(
        return True
# this is so that we know that the string starts and ends with quo
    if(arr[0] == '"' and arr[-1] == '"'):
# don't need to check first letter since we know what it is
# now we need to loop through the string and if we have a slash
# we need to know that the next number, in this case arr[num] is a
# and we need to make sure that we only have an even number of sla
# is not valid even though you can have a \ after a \
        num = 1
        for letter in arr[1:-1]:
            num +=1
            if(letter == '\\'):
                count+=1
                # print(count)
                if(arr[num] in after_slash.values()):
                    if(num < size-1):
                        count+=-1
                        # print(count)
                if(arr[num] not in after_slash.values()):
                    return False
    if(count != 0):
        return False

    return True

def main():
    # the way this works is if you copy and paste my output into a
    # this is due to how the strings go into the function but it i
    words = ["'a'", '"string?"', '"string\t"', '"str\\"', '"stri\\

    for word in words:
        if(javaChecker(word)):
            print(word + " is valid")
        else:
            print(word + " is not valid")

if __name__ == '__main__':
    main()
```

```python
# tryOperator.py
def operatorChecker(op):
    # we need to make sure that we get an operator and not empty s
    # and that the length of the operator is never more than 4
    if(len(op) > 4):
        return False

    # now we just see what it is

    if (op == '+' ):
        return True
    elif (op == '-' ):
        return True
    elif (op == '='):
        return True
    elif (op == '-'):
        return True
    elif (op == '/'):
        return True
    elif (op == '*'):
        return True
    elif (op == '%'):
        return True
    elif (op == '{'):
        return True
    elif (op == '}'):
        return True
    elif (op == '('):
        return True
    elif (op == ')'):
        return True
    elif (op == '++'):
        return True
    elif (op == '--'):
        return True
    elif (op == '&&'):
        return True
    elif (op == '||'):
        return True
    elif (op == '!'):
        return True
    else:
        return False

def main():
    words = ['+', '-', '/', '%', '+-', '', 'faill', '$$', '1']

    for word in words:
        if(operatorChecker(word)):
            print(word + " is valid")
        else:
            print(word + " is not valid")

if __name__ == "__main__":
    main()
```

```python
# tryPerl.py
def perlChecker(word):
    if(len(word) < 2):
        return False
    foundStart = None
    for letter in word:
        if(letter.isalnum() or letter == '$' or letter == '@' or l
            if (foundStart == None):
                if( (letter == "$" or letter == "%" or letter == "
                    foundStart = letter
                else:
                    return False
            else:
                # now we just need numbers or underscore
                if( letter.isalnum() or letter == "_"):
                    pass
                else:
                    return False
        else:
            return False
    return True

def main():

    words = ['$var_sas', '@another2', '@test', '%another\s', '$tes
    for word in words:
        if(perlChecker(word)):
            print(word + " is valid")
        else:
            print(word + " is not valid")

if __name__ == "__main__":
    main()
```

```python
# getWords.py
# gets all of the words from a file
def fromFile(fileName):
    f = open(fileName, 'r')
    finalList = f.read().split('\n')
    return finalList

def main():
    print(fromFile('testInputs.txt'))

if __name__ == '__main__':
    main()
```

2. (9 points) Write three functions in C or C++: one that declares a large array statically, one that declares the same large array on the stack, and one that creates the same large array from the heap. Call each of the subprograms a large number of times (at least 100,000) and output the time required by each. Explain the results.

    - For this program I wrote mine in C. This question was actually not too hard and I enjoyed it because it had been a while since I programmed in C.
    - Anyways, for my program I created arrays that were of length/size 10000 and then I ran each function for 10,000,000. AKA 10 million times
    - After waiting for the execution the reults were the following:
    - the stack function was the quickest taking only .020545 seconds
    - Second quickest was the static function which took .021356 seconds
    - And finally the slowest by far was the heap function which took 15.688600 seconds
    - I belive that the reason the stack is the fastest is because pushing on to the stack is incredibly easy. It probably happens instantly. While when we are doing the heap we have to allocate space in memory and then deal with pointers and anytime we have to go to memory we are slowed down significantly.
    - The stack is better for anything short term that only needs to be there when the function is alive then we can use the stack.
    - But if we are dealing with big arrays or structs that can change in size then we should use the heap.
    - I have included the output in a txt file as well
    - And here is the source code
    - jose_question2.c

```c
// question2_jose.c

```

```
    #include <stdio.h>
    #include <stdlib.h>
    #include <time.h>

    int staticArr();
    int stackArr();
    int heapArr();

    int main() {

      // Now here I will try to get the amount of time that each fu
      // I will run it 10000000 times bc i don't want to blow up my

      // the code for finding out how long it takes to run is from
      // geeks for geeks
      // https://www.geeksforgeeks.org/how-to-measure-time-taken-by

       printf("Hello, World! \n");

       clock_t first;
       first = clock();

       for(int i = 0; i < 10000000; i++){
         staticArr();
       }

       first = clock() - first;
       double firstTime = ((double)first) / CLOCKS_PER_SEC;
       printf("staticArr() took %f seconds to execute \n", firstTi

       clock_t second;
       second = clock();

       for(int i = 0; i < 10000000; i++){
         stackArr();
       }

       second = clock() - second;
       double secondTime = ((double)second) / CLOCKS_PER_SEC;
       printf("stackArr() took %f seconds to execute \n", secondTi

       clock_t third;
       third = clock();

       for(int i = 0; i < 10000000; i++){
         heapArr();
       }

       third = clock() - third;
       double thirdTime = ((double)third) / CLOCKS_PER_SEC;
       printf("heapArr() took %f seconds to execute \n", thirdTime

       printf("---- Jose Diaz ----\n");
       return 0;
    }

    int staticArr() {

      // not sure if this is correct. have to declare 'statically'
      // keyword sooo. But I read that static means that the varia
      // from the file that created it but still shaky on this
      // i read the info from here: http://www.mathcs.emory.edu/~c

       static int balance[10000];

       // for(int i = 0; i < 1000; i++){
       //   balance[i] = i;
       //   //printf("%d", balance[i]);
       // }

       return 0;
    }

    int stackArr() {

      // this one is also weird bc whenever you make a variable in
      // sooooo
      // this is it???

      int stacked[10000];

      return 0;
    }

    int heapArr(){

      // Inspiration for this part came from:
      // https://gribblelab.org/CBootCamp/7_Memory_Stack_vs_Heap.h
      // this part showed that to do it in a heap you had to use
      // the malloc function
```

```

      int *heaped = malloc(10000 * sizeof(int));

  return 0;
}
```

- output is also here:

```
Hello, World!
staticArr() took 0.021356 seconds to execute
stackArr() took 0.020545 seconds to execute
heapArr() took 15.688600 seconds to execute
---- Jose Diaz ----
```

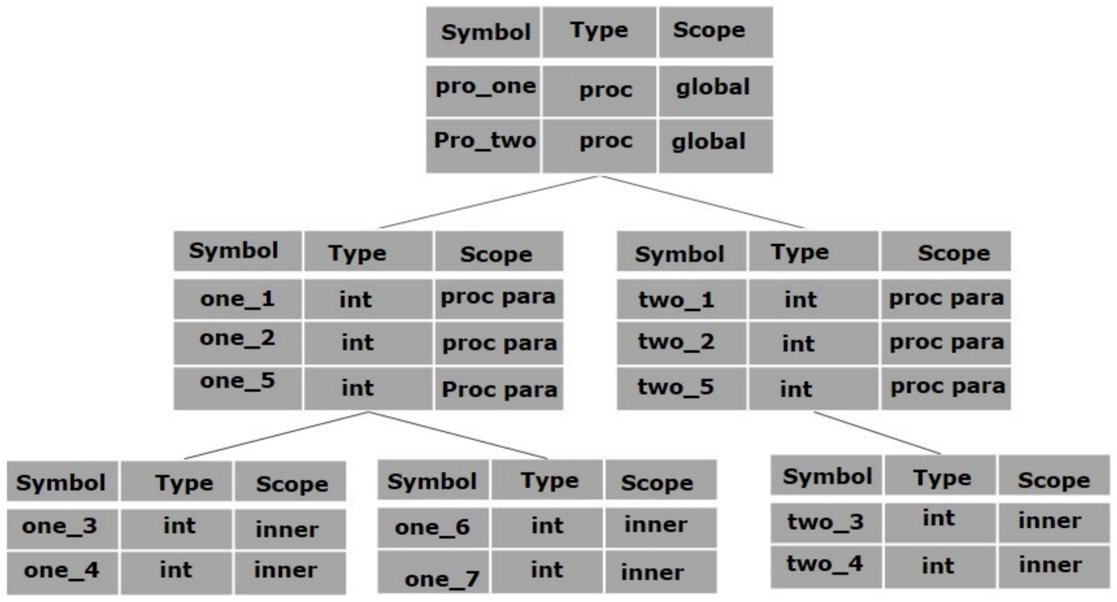
3. (11 points) Write an EBNF or CFG that while handle prefix/preorder Arithmetic Operations (addition, subtraction, multiplication, division, modulo) with the proper order of operations? What all types of parsers can be used to show the syntax for this? Justify your answer.

   - <statement> := <statment>\ '*' <term> | <statment>\ '/' <term> | <statment>\ '%' <term> |
   - <term> := <term> '+' <var> | <term> '-' <var> | <var>
   - <var> := [<letter> | <number>]
   - <letter> := [A-Z | a-z]
   - <num> := [0-9]
   - All top down parsers can work with this CFG because they all build the parse tree from the top down and then you read left to right
   - This CFG I based off of the one from the PLC textbook. I believe this will work because in the textbook they build the derivation from the top down and it works and precedence is maintained I beleive

4. (10 points) What features of the compilation process allow us to determine the reference environment for any at any given line of code in the program. Answer this question for both dynamic and static scoping? Does the type of scoping change this answer? Explain why?

   - The symbol table is the part of the compilation process that will help us determine the scope of a variable. This is because "it stores information about the occurence of various entities such as variable names, function names, objects, classes, interfaces, etc" from Tutorials Point. Found here: https://www.tutorialspoint.com/compiler_design/compiler_design_symbol_table.htm
   - And this makes perfect sense because if you look at the graphic found on the same page, the symbol table also holds information on the scope of the variables. So no

matter what scope we have, the symbol table will know exactly where the scope is and what the reference environment is. This would not change given the type of scope. The symbol table knows everything about a variable



Symbol	Type	Scope
pro_one	proc	global
Pro_two	proc	global

Symbol	Type	Scope
one_1	int	proc para
one_2	int	proc para
one_5	int	Proc para

Symbol	Type	Scope
two_1	int	proc para
two_2	int	proc para
two_5	int	proc para

Symbol	Type	Scope
one_3	int	inner
one_4	int	inner

Symbol	Type	Scope
one_6	int	inner
one_7	int	inner

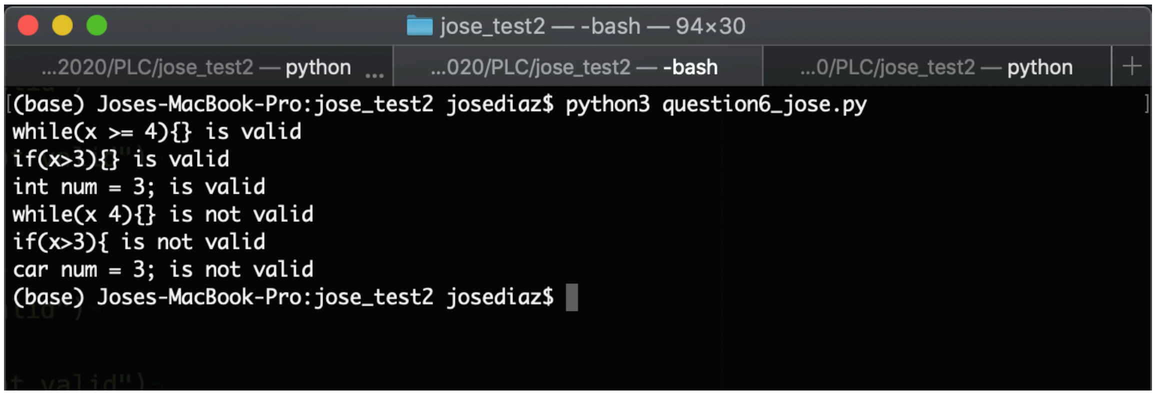
Symbol	Type	Scope
two_3	int	inner
two_4	int	inner

5. (10 points) Detail how you would go about adding reserved words into the problem where you are designing your own lexical analyzer? How would you have to change your code? What would you have to add to let users choose a reserve word word as an identifier?

    - If I wanted to add reserved words to my lexical analyzer from problem 1 the way I would go about is that before passing in my word into all of the functions, I would first check to see if the word is in a dictionary or hash-map of reserved words. If it is then we do not pass that word into all of the functions.
    - This way we very quickly and easily find if a word is a reserved word and that way it is also not mistaken as some other type of word
    - This also means that we can very easily just add words to our reserved words dictionary if we ever need to
    - And if we wanted to let users use a reserved word as an identifier than I would put an if statement in my code from question 1 to be able to identify that this reservedWord with a '*' attached to the end will not be used as a reserved word and instead will be used as an identifier.
    - Something like this, this is far from done but you get the gist of it:

```
incomingWord = 'string*'
reserved_words = {
    'string':'string',
}
if(incomingWord[-1] == '*'):
    lexicalAnalizer(incomingWord[:-1]
else:
    # check if word is in reserved_words
    # if so then it doesn't go to lexical analizer
```

6. (20 points) Write a recursive decent algorithm for a java while statement, a Javas if statement , an logical/mathematical expression based on the rules you created in your lexical analyzer, and an mathe- matical assignment statement , where statement may be an empty function. Supply the EBNF rule for each.

    - For this problem I did it very similarly to how I did question 1
    - Here is a screenshot of the output that this program gives
    - 

jose_test2 — -bash — 94×30
...2020/PLC/jose_test2 — python
...020/PLC/jose_test2 — -bash
...0/PLC/jose_test2 — python

```
(base) Joses-MacBook-Pro:jose_test2 josediaz$ python3 question6_jose.py
while(x >= 4){} is valid
if(x>3){} is valid
int num = 3; is valid
while(x 4){} is not valid
if(x>3){ is not valid
car num = 3; is not valid
(base) Joses-MacBook-Pro:jose_test2 josediaz$
```

```

types = {
    'byte':'byte',
    'short':'short',
    'int':'int',
    'long':'long',
    'float':'float',
    'double':'double',
    'boolean':'boolean',
    'char':'char',
}

def startChecker(arr):
    haveWhile = False
    haveIf = False
    # print(arr[:2])
    # print(arr[:5])
    if(arr[:5] == 'while'):
        # print('we have while at the start')
        haveWhile = True
        return True and checkBool(arr[5:])
    elif(arr[:2] == 'if'):
        # print('we have an if')
        haveIf = True
        return True and checkBool(arr[2:])
    else:
        # lets find if we have an =
        equalSign = arr.find('=')
        if(equalSign != -1):
            # need to see if we have variable type and a value and
            return True and checkVar(arr, equalSign)
        else:
            return False
    return False

def checkBool(end):
    parenCount = 0
    curlyCount = 0
    startBool = False
    totalBool = False
    for char in end:
        if(char == '('):
            parenCount += 1
        elif(char == ')'):
            parenCount -= 1
        elif(char == '{'):
            curlyCount += 1
        elif(char == '}'):
            curlyCount -= 1
        elif(char == '>' or char == '<' or char == '='):
            startBool = True
        if(startBool and char == '='):
            totalBool = True
            startBool = False
    return (startBool or totalBool) and (curlyCount == 0) and (par

def checkVar(arr, equalSign):
    done = False
    #print(arr[equalSign+1: ])
    wordsBefore = arr[:equalSign].split()
    #print(wordsBefore)
    if(wordsBefore[0] in types.values()):
        for char in arr[equalSign+1:]:
            #print(char)
            if(done):
                return False
            if(char == ';'):
                done = True
            elif(char == '='):
                return False
            else:
                pass
    if(done):
        return True
    return False

def main():
    validStrings = ['while(x >= 4){}', 'if(x>3){}', 'int num = 3;'
    nonvalidStrings = ['while(x 4){}', 'if(x>3){', 'car num = 3;']

    for string in validStrings:
        if(startChecker(string)):
            print(string + " is valid")
        else:
            print(string + " is not valid")

    for string in nonvalidStrings:
        if(startChecker(string)):
            print(string + " is valid")
        else:
            print(string + " is not valid")

if __name__ == '__main__':
    main()
```

7. (10 points) Given the natural constraints of an RDA explain how you would go about the creation of a Statement function in your RDA that would allow statement to either be a while statement, an if statement or an assignment statement.

    - So to check to see if a statement is either a while, if, or an assignment you would have to check for each case.
    - So first if it is a while we could check for a 'while' keyword, if we find it then we know it is a while and we must have some sort of '(' + + ')'
    - Then if we do not find a 'while' keyword we would check to see if we have an 'if'

keyword. If we do, then again we would check to have '(' + + ')'
- And then if we want to know if it is an assignment statement then we must assume that none of the keywords were found and instead we have a variable name that is valid, not a float or a reserved word or anything like that, followed be a '=' and then a valid value. This is so that we do not have something like 'var = @##$' which would be totally incorrect
- And eventually if we want to know what type of variable it is we would take whatever value it has and run it through our lexical analyzer

8. (10 points) Perl allows both static and a kind of dynamic scoping. Write a Perl program that uses both and clearly shows the difference in effect of the two. Explain clearly the difference between the dynamic scoping described in this chapter and that implemented in Perl.

    - In my program you can see that when we dynamically scope we are grabbing the value from the closest place the variable was declared.
    - When we statically scope we are actually grabbing the value from the parent function
    - In my program I also explain in the comments

```

# so from geeks for geeks in order to get dynamically scoped varib
# my keyword defines a statically scoped local variable
# and local defines dynamically scoped local variable
#
# link: https://www.geeksforgeeks.org/static-and-dynamic-scoping/

print "Hello World!\n";
$mainVar = 100;
$mainVar2 = 100;

sub showVar1
{
  return $mainVar;
}
sub dynamic
{
  # use local which gives us dynamically scoped var
  # here since we are dynamic we are grabbing from the closest pla
  local $mainVar = 1;
  return showVar1();
}

sub showVar2
{
    return $mainVar2;
}
sub static
{
    # use my which gives us the statically scoped var
    # here instead of grabbing what is closest to us we are grabbi
    my $mainVar2 = 1;
    return showVar2();
}

print dynamic()." ------ DYNAMIC\n";
print static()." ------ STATIC\n";
print "---- Jose Diaz ----";
```

- Output is also in txt file and here

```
Hello World!
1 ------ DYNAMIC
100 ------ STATIC
---- Jose Diaz ----
```