Name: Digvijay Jondhale
Roll No: PC-32
PRN: 1092201770
Panel: C

SSC Lab Assignment No. 1

Title : Design of Pass 1 of Two Pass Assembler.

Aim : Design suitable data structures and implement Pass 1 of 2 Pass Assembler for pseudo machine.

Objective: Design suitable data structures and implement Pass 1 of 2 pass Assembler for pseudo machine. Subset should consist of a few instructions from each category and few assembler directives.

Theory :

Design Specification of an Assembler :

An assembler is a software tool that translates assembly language code into machine code. The design specification of an assembler typically includes:

Input: The assembler should accept source code written in assembly language.

Output: It should generate machine code or an object file that can be executed by a computer.

Processing: The assembler should perform lexical analysis syntactic analysis, and generate symbol tables.

Symbol Resolution: It should resolve symbols (labels and variables) and calculate their addresses.

Error Handling: Proper handling of syntax errors and semantic errors.

Passes: Single-pass or two-pass processing based on design choice.

Design of a Two-Pass Assembler: A two-pass assembler is an assembler that goes through the source code in two passes. The first pass is usually responsible for creating a symbol table and identifying the memory locations of labels, while the second pass generates the actual machine code. The algorithm for Pass1 might look like this:

Algorithm for Pass 1:

Pass1 performs the following tasks:

Initialize location counter (LC) to the starting address.

Read the source code line by line.

Perform lexical and syntactic analysis.

Handle labels by adding them to the symbol table with their corresponding addresses.

Calculate and update LC for each instruction.

Generate an intermediate representation of the code (e.g. a symbol table).

Contents of OPTAB:

The OPTAB (operation code table) is a data structure that holds the operation codes (mnemonics) and their corresponding machine code representations. for example:

rust

copy code

```
OPTAB:
ADD -> 18
SUB -> 1C
MUL -> 20
---
```

When processing assembly instructions, the assembler uses the OPTAB to translate mnemonics into machine code.

Error Listing and Error Handling: Error handling is an assembler is crucial to ensure that the source code is valid and can be successfully translated into machine code. Common types of errors include syntax errors (e.g. invalid instructions), semantic errors (e.g. undefined symbols), and address errors (e.g. attempting to access a nonexistent memory location). Assemblers typically provide error messages and listings that help programmers identify and correct these errors.

Error Listing: An error listing is a report generated by the assembler, listing all detected errors in the source code, along with their line numbers and descriptions.

Error Handling: The assembler should terminate gracefully upon encountering a fatal error but continue processing to identify and report as many errors as possible. It should also provide meaningful error messages to assist programmers in debugging their code.

CODE:

```
import java.util.*;
import java.util.regex.*;
import java.io.*;

class As1
{
	public static boolean isNum(String str)
	{
		try
		{
			Integer.parseInt(str);
		}
		catch(NumberFormatException e)
		{
			return false;
		}
		return true;
	}

	public static void main(String[] args) throws IOException
	{
		Hashtable<String,String> IS = new Hashtable<String, String>();
		Hashtable<String,String> AD = new Hashtable<String, String>();
		Hashtable<String,String> DL = new Hashtable<String, String>();
		Hashtable<String,String> Reg = new Hashtable<String, String>();
		Hashtable<String,String> BC_Cond = new Hashtable<String, String>();

		//Hashtables
		IS.put("STOP", "00");
		IS.put("ADD", "01");
		IS.put("SUB", "02");
		IS.put("MULT", "03");
		IS.put("MOVER", "04");
		IS.put("MOVEM", "05");
		IS.put("COMP", "06");
		IS.put("BC", "07");
		IS.put("DIV", "08");
		IS.put("READ", "09");
		IS.put("PRINT", "10");

		DL.put("DC", "01");
		DL.put("DS", "02");

		AD.put("START", "01");
		AD.put("END", "02");
		AD.put("ORIGIN", "03");
		AD.put("EQU", "04");
		AD.put("LTORG", "05");

		Reg.put("AREG", "1");
		Reg.put("BREG", "2");
		Reg.put("CREG", "3");
		Reg.put("DREG", "4");

		BC_Cond.put("LT", "1");
		BC_Cond.put("LE", "2");
		BC_Cond.put("EQ", "3");
		BC_Cond.put("GT", "4");
		BC_Cond.put("GE", "5");
```

```
             BC_Cond.put("ANY", "6");
             BC_Cond.put("NE", "6");

             ArrayList<String[]> sym_tab = new ArrayList<String[]>();
             ArrayList<String[]> lit_tab = new ArrayList<String[]>();
             ArrayList<Integer> pool_tab = new ArrayList<Integer>();
             int sym_ptr = 1, temp_ptr = 1, lit_ptr = 1;   //Initializing table pointers
             int pool_ptr = 0;
             pool_tab.add(0);
             int linenum = 0;

             //These flags are used to check which instruction is being executed
             boolean[] flags = {false,false,false,false,false,false,false,false,     false,   false};
             //Corresponds to= |start|ltorg|label|  ds |  dc | equ |  bc |sym tab|new line| END|

             File input = new File("input.asm");     //Input file containing Source Code
             input.createNewFile();
             File output = new File("intermediate.asm");   //Output file to contain Intermediate Code
             output.createNewFile();
             File tables = new File("tables.asm");  //File contains symbol and literal tables for use
in Pass 2
             tables.createNewFile();

             //Tokenizer
             Scanner fileReader = new Scanner(input);
             String i_str = "", temp_str[];
             String[] tokens;
             FileWriter fw = new FileWriter("intermediate.asm");
             BufferedWriter bw = new BufferedWriter(fw);
             while(fileReader.hasNextLine())
             {
                   i_str = fileReader.nextLine();
                   flags[8]=true;
                   tokens = i_str.split("[ \\n\\t,]");     //Splits the line into tokens
                   //Assembler Pass I
                   for(String str : tokens)
                   {
                          flags[9]=false;
                          //LABEL
                          if(!str.equals("") && !str.equals("START") && !str.equals("END") &&
str.equals(tokens[0]))    //Checks if token is label
                          {
                                 for(String[] str_arr : sym_tab)
                                 {
                                        if(str_arr[1].equals(str))//Checks if symbol already in table
                                        {
                                               temp_ptr = Integer.parseInt(str_arr[0])-1;
                                               flags[2] = true;
                                               if(str_arr[2]=="")  //Addresses unaddressed symbol
                                               {
                                                      sym_tab.set(temp_ptr, new String[]
{str_arr[0],str_arr[1],""+(linenum-1),"1"});
                                               }
                                        }
                                 }
                                 if(flags[2] == false)     //Adds new symbol to table
                                 {
                                        temp_str = new String[] {""+sym_ptr,str,""+(linenum),"1"};
                                        temp_ptr = sym_ptr++;
                                        sym_tab.add(temp_str);
                                        flags[2] = true;
```

```
                    }
                }
                else
                {
                    str = str.trim();
                }
                if(str=="")  //Skips blank tokens
                    continue;
                //OPCODE
                if(flags[8])
                {
                    flags[8]=false;
                    if(flags[2] && AD.containsKey(tokens[1]))
                    {
                        bw.write("\t");
                        flags[2]=false;
                        continue;
                    }
                    if(!AD.containsKey(str))  //Checks for Non-Assembler Directives
                    {
                        bw.write(linenum+")");
                    }
                    bw.write("\t");
                    linenum++;
                }
                if(AD.containsKey(str))   //Checks for Assembler Directives
                {
                    bw.write("\t");
                    if(str.equals("START")||str.equals("ORIGIN"))
                    {
                        flags[0]=true;
                        bw.write("(AD," + AD.get(str) + ") ");
                    }
                    else if(str.equals("LTORG")||str.equals("END"))
                    {
                        if(str.equals("END"))
                            flags[9]=true;
                        bw.write("(AD,"+AD.get(str)+")");
                        for(int i = pool_tab.get(pool_ptr); i < lit_tab.size(); i++)
                        {
                            bw.write("\n"+linenum+++")\t");
                            bw.write("(DL,01) (C,");
                            lit_tab.get(i)[2] = Integer.toString(linenum-1);

    bw.write(lit_tab.get(i)[1].substring(lit_tab.get(i)[1].indexOf('\'')+1,lit_tab.get(i)[1].length(
)-1)+") ");
                            flags[1]=true;
                        }
                        flags[1]=false;
                        if(pool_tab.get(pool_ptr) != lit_ptr-1)
                        {
                            pool_tab.add(lit_ptr-1);
                            pool_ptr++;
                        }
                    }
                    else if(str.equals("EQU"))
                    {
                        flags[5]=true;
                        bw.write("(AD," + AD.get(str) + ") ");
                    }
                    else
```

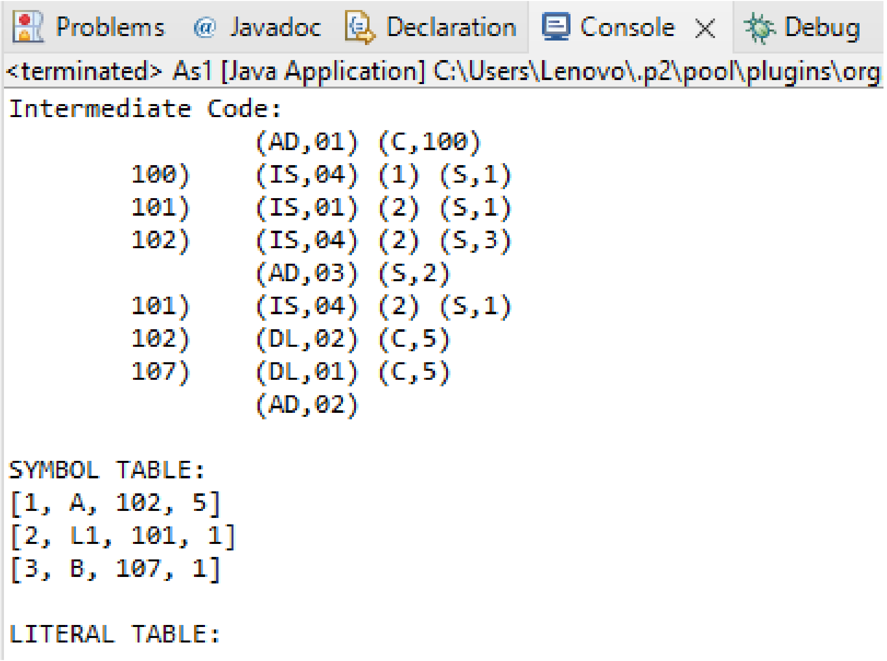
```
                                        bw.write("(AD," + AD.get(str) + ") ");
                        }
                        else if(IS.containsKey(str))     //Checks for Imperative Statements
                        {
                                bw.write("(IS," + IS.get(str) + ") ");
                                if(str.equals("BC"))
                                        flags[6] = true;
                        }
                        else if(DL.containsKey(str))     //Checks for Declaration Statements
                        {
                                bw.write("(DL," + DL.get(str) + ") ");
                                sym_tab.get(temp_ptr)[2]=Integer.toString(linenum-1);
                                if(str.equals("DS"))
                                {
                                        flags[3]=true;
                                }
                                else if(str.equals("DC"))
                                {
                                        flags[4]=true;
                                }
                        }
                        else if(Reg.containsKey(str))    //Checks for register name
                                bw.write("(" + Reg.get(str) + ") ");
                        else if(Pattern.matches("[=]?[']\\d*[']",str))      //Checks for literal
                        {
                                lit_tab.add(new String[]
{""+lit_ptr,"='"+str.substring(str.indexOf('\'')+1,str.lastIndexOf('\''))+"'",""});
                                bw.write("(L,"+(lit_ptr++)+") ");
                        }
                        else if(Pattern.matches("[']*[0-9]+[']*",str))      //Checks for number
                        {
                                bw.write("(C,"+str+") ");
                                if(flags[0] == true)
                                {
                                        linenum = Integer.parseInt(str);
                                        flags[0] = false;
                                }
                                if(flags[3]==true)
                                {
                                        sym_tab.get(temp_ptr)[3]=str;
                                        flags[3]=false;
                                        linenum = linenum + (Integer.parseInt(str)-1);
                                }
                                if(flags[4]==true)
                                {
                                        sym_tab.get(temp_ptr)[3]="1";
                                        flags[4]=false;
                                }
                                if(flags[5]==true)
                                {
                                        sym_tab.get(temp_ptr)[2]=str;
                                        sym_tab.get(temp_ptr)[3]="1";
                                        flags[5] = false;
                                }
                        }
                        else if(flags[2]==false)  //For handling miscelaneous operands
                        {
                                flags[7]=false;
                                if(flags[6]==true)  //Writes OpCode of BC Condition
                                {
                                        bw.write("("+BC_Cond.get(str)+") ");
                        flags[6]=false;
                    }
                    else    //For handling symbols in operand place
                    {
                        for(String[] str_arr : sym_tab)
                        {
                            if(str_arr[1].equals(str))
                            {
                                if(flags[5]==true)  //used when A EQU B
                                {
                                    sym_tab.get(--temp_ptr)[2]=str_arr[2];
                                    sym_tab.get(temp_ptr)[3]=str_arr[3];
                                    bw.write("(S,"+str_arr[0]+") ");
                                }
                                temp_ptr=Integer.parseInt(str_arr[0]);
                                flags[7]=true;
                                if(flags[5]==false)
                                    bw.write("(S,"+temp_ptr+") ");
                                if(flags[0]) //used when ORIGIN A
                                {
                                    linenum = Integer.parseInt(str_arr[2]);
                                    flags[0] = false;
                                }
                            }
                        }
                        if(flags[7]==false) //Used to handle non-label symbols
                        {
                            if(flags[2]==true)
                                sym_tab.add(new String[]
{""+sym_ptr,str,""+(linenum-1),"1"});
                            else
                            {
                                sym_tab.add(new String[] {""+sym_ptr,str,"",""});
                                bw.write("(S,"+sym_ptr+") ");
                            }
                            temp_ptr=sym_ptr;
                            sym_ptr++;
                        }
                    }
                }
                flags[5] = false;
                flags[2] = false;
            }
            if(flags[0])
            {
                bw.write("(C,0) ");
                linenum = 0;
                flags[0]=false;
            }
            if(!flags[9])
                bw.newLine();
        }
        bw.close();
        fileReader.close();

        fileReader = new Scanner(output);
        System.out.println("Intermediate Code:");
        while(fileReader.hasNextLine())
        {
            i_str = fileReader.nextLine();
            if(i_str.charAt(0)!='\t')
```

```
                System.out.print("\t");
            System.out.println(i_str);
        }
        fileReader.close();

        System.out.println("\nSYMBOL TABLE: ");
        for(String[] arr : sym_tab)
            System.out.println(Arrays.toString(arr));
        System.out.println("\nLITERAL TABLE: ");
        for(String[] arr : lit_tab)
            System.out.println(Arrays.toString(arr));

        //Writing tables to a file
        fw = new FileWriter("tables.asm");
        bw = new BufferedWriter(fw);
        bw.write("[SYMBOL_TABLE]\n");
        for(String[] arr : sym_tab)
        {
            for(String str : arr)
                bw.write(str+" ");
            bw.write("\n");
        }
        bw.write("[LITERAL_TABLE]\n");
        for(String[] arr : lit_tab)
        {
            for(String str : arr)
                bw.write(str+" ");
            bw.write("\n");
        }
        bw.close();
        fw.close();
    }
}
```

INPUT:

```
      START 100
      MOVER AREG, A
L1    ADD BREG, A
      MOVER BREG, B
      ORIGIN L1
      MOVER BREG,A
A     DS 5
B     DC 5
END
```

OUTPUT:



```
<terminated> As1 [Java Application] C:\Users\Lenovo\.p2\pool\plugins\org
Intermediate Code:
                (AD,01) (C,100)
        100)    (IS,04) (1) (S,1)
        101)    (IS,01) (2) (S,1)
        102)    (IS,04) (2) (S,3)
                (AD,03) (S,2)
        101)    (IS,04) (2) (S,1)
        102)    (DL,02) (C,5)
        107)    (DL,01) (C,5)
                (AD,02)

SYMBOL TABLE:
[1, A, 102, 5]
[2, L1, 101, 1]
[3, B, 107, 1]

LITERAL TABLE:
```