Assignment 2

```
import java.util.*;
import java.io.*;
class Tuple {
String mnemonic, bin_opcode, type;
int length;
Tuple() {}
Tuple(String s1, String s2, String s3, String s4) {
mnemonic = s1;
bin_opcode = s2;
length = Integer.parseInt(s3);
type = s4;
}
}
class SymTuple {
String symbol, ra;
int value, length;
SymTuple(String s1, int i1, int i2, String s2) {
symbol = s1;
value = i1;
length = i2;
ra = s2;
}
}
class LitTuple {
String literal, ra;
int value, length;
LitTuple() {}
LitTuple(String s1, int i1, int i2, String s2) {
literal = s1;
value = i1;
length = i2;
ra = s2;
}
}
class TwoPassAssembler {
static int lc;
static List<Tuple> mot;
static List<String> pot;
static List<SymTuple> symtable;
static List<LitTuple> littable;
static List<Integer> lclist;
static Map<Integer, Integer> basetable;
static PrintWriter out_pass2;
static PrintWriter out_pass1;
static int line_no;
public static void main(String args[]) throws Exception {
initializeTables();
System.out.println("====== PASS 1 ======\n");
pass1();
```

```
System.out.println("\n====== PASS 2 ======\n");
pass2();
}
static void pass1() throws Exception {
BufferedReader input = new BufferedReader(new
InputStreamReader(new FileInputStream("input.txt")));
out_pass1 = new PrintWriter(new
FileWriter("output_pass1.txt"), true);
PrintWriter out_symtable = new PrintWriter(new
FileWriter("out_symtable.txt"), true);
PrintWriter out_littable = new PrintWriter(new
FileWriter("out_littable.txt"), true);
String s;
while((s = input.readLine()) != null) {
StringTokenizer st = new StringTokenizer(s, " ",
false);
String s_arr[] = new String[st.countTokens()];
for(int i=0 ; i < s_arr.length ; i++) {
s_arr[i] = st.nextToken();
}
if(searchPot1(s_arr) == false) {
searchMot1(s_arr);
out_pass1.println(s);
}
lclist.add(lc);
}
int j;
String output = new String();
System.out.println("Symbol Table:");
System.out.println("Symbol Value Length R/A");
for(SymTuple i : symtable) {
output = i.symbol;
for(j=i.symbol.length() ; j < 10 ; j++) {
output += " ";
}
output += i.value;
for(j=new Integer(i.value).toString().length() ; j < 7
; j++) {
output += " ";
}
output += i.length + " " + i.ra;
System.out.println(output);
out_symtable.println(output);
}
System.out.println("\nLiteral Table:");
System.out.println("Literal Value Length R/A");
for(LitTuple i : littable) {
output = i.literal;
for(j=i.literal.length() ; j < 10 ; j++) {
output += " ";
}
output += i.value;
```

```
for(j=new Integer(i.value).toString().length() ; j < 7
; j++) {
output += " ";
}
output += i.length + " " + i.ra;
System.out.println(output);
out_littable.println(output);
}
}
static void pass2() throws Exception {
line_no = 0;
out_pass2 = new PrintWriter(new
FileWriter("output_pass2.txt"), true);
BufferedReader input = new BufferedReader(new
InputStreamReader(new FileInputStream("output_pass1.txt")));
String s;
System.out.println("Pass 2 input:");
while((s = input.readLine()) != null) {
System.out.println(s);
StringTokenizer st = new StringTokenizer(s, " ",
false);
String s_arr[] = new String[st.countTokens()];
for(int i=0 ; i < s_arr.length ; i++) {
s_arr[i] = st.nextToken();
}
if(searchPot2(s_arr) == false) {
searchMot2(s_arr);
}
line_no++;
}
System.out.println("\nPass 2 output:");
input = new BufferedReader(new InputStreamReader(new
FileInputStream("output_pass2.txt")));
while((s = input.readLine()) != null) {
System.out.println(s);
}
}
static boolean searchPot1(String[] s) {
int i = 0;
int l = 0;
int potval = 0;
if(s.length == 3) {
i = 1;
}
s = tokenizeOperands(s);
if(s[i].equalsIgnoreCase("DS") ||
s[i].equalsIgnoreCase("DC")) {
potval = 1;
}
if(s[i].equalsIgnoreCase("EQU")) {
potval = 2;
}
```

```
if(s[i].equalsIgnoreCase("START")) {
potval = 3;
}
if(s[i].equalsIgnoreCase("LTORG")) {
potval = 4;
}
if(s[i].equalsIgnoreCase("END")) {
potval = 5;
}
switch(potval) {
case 1:
// DS or DC statement
String x = s[i+1];
int index = x.indexOf("F");
if(i == 1) {
symtable.add(new SymTuple(s[0], lc, 4,
"R"));
}
if(index != 0) {
// Ends with F
l = Integer.parseInt(x.substring(0,
x.length()-1));
l *= 4;
} else {
// Starts with F
for(int j=i+1 ; j<s.length ; j++) {
l += 4;
}
}
lc += l;
return true;
case 2:
// EQU statement
if(!s[2].equals("*")) {
symtable.add(new SymTuple(s[0],
Integer.parseInt(s[2]), 1, "A"));
} else {
symtable.add(new SymTuple(s[0], lc, 1,
"R"));
}
return true;
case 3:
// START statement
symtable.add(new SymTuple(s[0],
Integer.parseInt(s[2]), 1, "R"));
return true;
case 4:
// LTORG statement
ltorg(false);
return true;
case 5:
// END statement
```

```
ltorg(true);
return true;
}
return false;
}
static void searchMot1(String[] s) {
Tuple t = new Tuple();
int i = 0;
if(s.length == 3) {
i = 1;
}
s = tokenizeOperands(s);
for(int j=i+1 ; j < s.length ; j++) {
if(s[j].startsWith("=")) {
littable.add(new LitTuple(s[j].substring(1,
s[j].length()), -1, 4, "R"));
}
}
if((i == 1) && (!s[0].equalsIgnoreCase("END"))) {
symtable.add(new SymTuple(s[0], lc, 4, "R"));
}
for(Tuple x : mot) {
if(s[i].equals(x.mnemonic)) {
t = x;
break;
}
}
lc += t.length;
}
static void ltorg(boolean isEnd) {
Iterator<LitTuple> itr = littable.iterator();
LitTuple lt = new LitTuple();
boolean isBroken = false;
while(itr.hasNext()) {
lt = itr.next();
if(lt.value == -1) {
isBroken = true;
break;
}
}
if(!isBroken) {
return;
}
if(!isEnd) {
while(lc%8 != 0) {
lc++;
}
}
lt.value = lc;
lc += 4;
while(itr.hasNext()) {
lt = itr.next();
```

```
lt.value = lc;
lc += 4;
}
}
static boolean searchPot2(String[] s) {
int i = 0;
if(s.length == 3) {
i = 1;
}
if(Collections.binarySearch(pot, s[i]) >= 0) {
if(s[i].equalsIgnoreCase("USING")) {
s = tokenizeOperands(s);
if(s[i+1].equals("*")) {
s[i+1] = lclist.get(line_no) + "";
} else {
for(int j=i+1 ; j<s.length ; j++) {
int value = getSymbolValue(s[j]);
if(value != -1) {
s[j] = value + "";
}
}
}
basetable.put(new Integer(s[i+2].trim()), new
Integer(s[i+1].trim()));
}
return true;
}
return false;
}
static void searchMot2(String[] s) {
Tuple t = new Tuple();
int i = 0;
int j;
if(s.length == 3) {
i = 1;
}
s = tokenizeOperands(s);
for(Tuple x : mot) {
if(s[i].equals(x.mnemonic)) {
t = x;
break;
}
}
String output = new String();
String mask = new String();
if(s[i].equals("BNE")) {
mask = "7";
} else if(s[i].equals("BR")) {
mask = "15";
} else {
mask = "0";
}
```

```
if(s[i].startsWith("B")) {
if(s[i].endsWith("R")) {
s[i] = "BCR";
} else {
s[i] = "BC";
}
List<String> temp = new ArrayList<>();
for(String x : s) {
temp.add(x);
}
temp.add(i+1, mask);
s = temp.toArray(new String[0]);
}
if(t.type.equals("RR")) {
output = s[i];
for(j=s[i].length() ; j<6 ; j++) {
output += " ";
}
for(j=i+1 ; j<s.length ; j++) {
int value = getSymbolValue(s[j]);
if(value != -1) {
s[j] = value + "";
}
}
output += s[i+1];
for(j=i+2 ; j<s.length ; j++) {
output += ", " + s[j];
}
} else {
output = s[i];
for(j=s[i].length() ; j<6 ; j++) {
output += " ";
}
for(j=i+1 ; j<s.length-1 ; j++) {
int value = getSymbolValue(s[j]);
if(value != -1) {
s[j] = value + "";
}
}
s[j] = createOffset(s[j]);
output += s[i+1];
for(j=i+2 ; j<s.length ; j++) {
output += ", " + s[j];
}
}
out_pass2.println(output);
}
static String createOffset(String s) {
String original = s;
Integer[] key = basetable.keySet().toArray(new Integer[0]);
int offset, new_offset;
int index = 0;
```

```
int value = -1;
int index_reg = 0;
if(s.startsWith("=")) {
value = getLiteralValue(s);
} else {
int paranthesis = s.indexOf("(");
String index_string = new String();
if(paranthesis != -1) {
s = s.substring(0, s.indexOf("("));
index_string =
original.substring(original.indexOf("(")+1, original.indexOf(")"));
index_reg = getSymbolValue(index_string);
}
value = getSymbolValue(s);
}
offset = Math.abs(value - basetable.get(key[index]));
for(int i=1 ; i<key.length ; i++) {
new_offset = Math.abs(value - basetable.get(key[i]));
if(new_offset < offset) {
offset = new_offset;
index = i;
}
}
String result = offset + "(" + index_reg + ", " +
key[index] + ")";
return result;
}
static int getSymbolValue(String s) {
for(SymTuple st : symtable) {
if(s.equalsIgnoreCase(st.symbol)) {
return st.value;
}
}
return -1;
}
static int getLiteralValue(String s) {
s = s.substring(1, s.length());
for(LitTuple lt : littable) {
if(s.equalsIgnoreCase(lt.literal)) {
return lt.value;
}
}
return -1;
}
static String[] tokenizeOperands(String[] s) {
List<String> temp = new LinkedList<>();
for(int j=0 ; j<s.length-1 ; j++) {
temp.add(s[j]);
}
StringTokenizer st = new StringTokenizer(s[s.length-1], ",", false);
while(st.hasMoreTokens()) {
temp.add(st.nextToken());
```

```
}
s = temp.toArray(new String[0]);
return s;
}
static void initializeTables() throws Exception {
symtable = new LinkedList<>();
littable = new LinkedList<>();
lclist = new ArrayList<>();
basetable = new HashMap<>();
mot = new LinkedList<>();
pot = new LinkedList<>();
String s;
BufferedReader br;
br = new BufferedReader(new InputStreamReader(new
FileInputStream("mot.txt")));
while((s = br.readLine()) != null) {
StringTokenizer st = new StringTokenizer(s, " ",false);
mot.add(new Tuple(st.nextToken(), st.nextToken(),
st.nextToken(), st.nextToken()));
}
br = new BufferedReader(new InputStreamReader(new
FileInputStream("pot.txt")));
while((s = br.readLine()) != null) {
pot.add(s);
}
Collections.sort(pot);
}
}
```

input.txt:

```
PRGAM2 START 0
 USING *,15
 LA 15,SETUP
 SR TOTAL,TOTAL
AC EQU 2
INDEX EQU 3
TOTAL EQU 4
DATABASE EQU 13
SETUP EQU *
 USING SETUP,15
 L DATABASE,=A(DATA1)
 USING DATAAREA,DATABASE
 SR INDEX,INDEX
LOOP L AC,DATA1(INDEX)
 AR TOTAL,AC
 A AC,=F'5'
 ST AC,SAVE(INDEX)
 A INDEX,=F'4'
 C INDEX,=F'8000'
 BNE LOOP
 LR 1,TOTAL
 BR 14
```

```
 LTORG
SAVE DS 3F
DATAAREA EQU *
DATA1 DC F'25,26,27'
 END
```

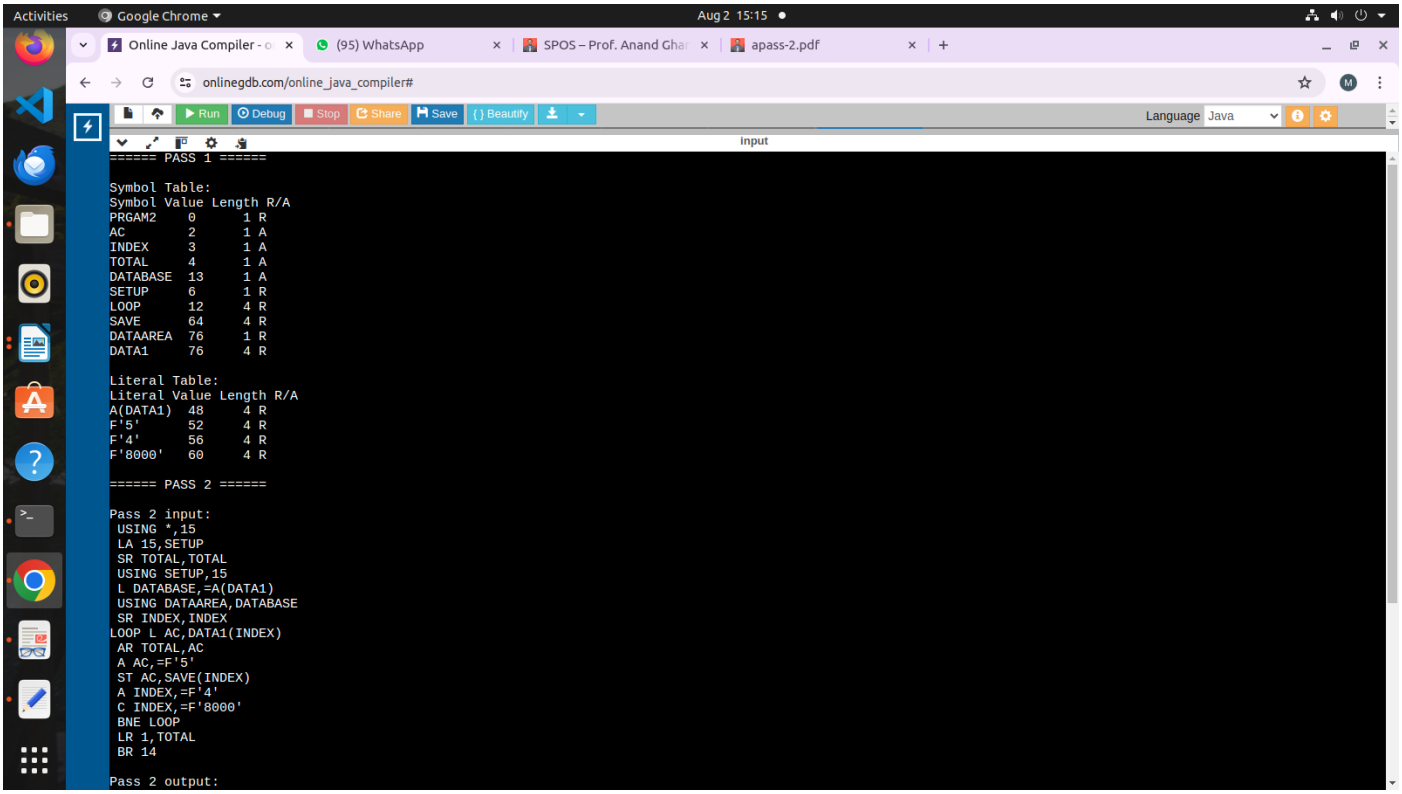
mot.txt:

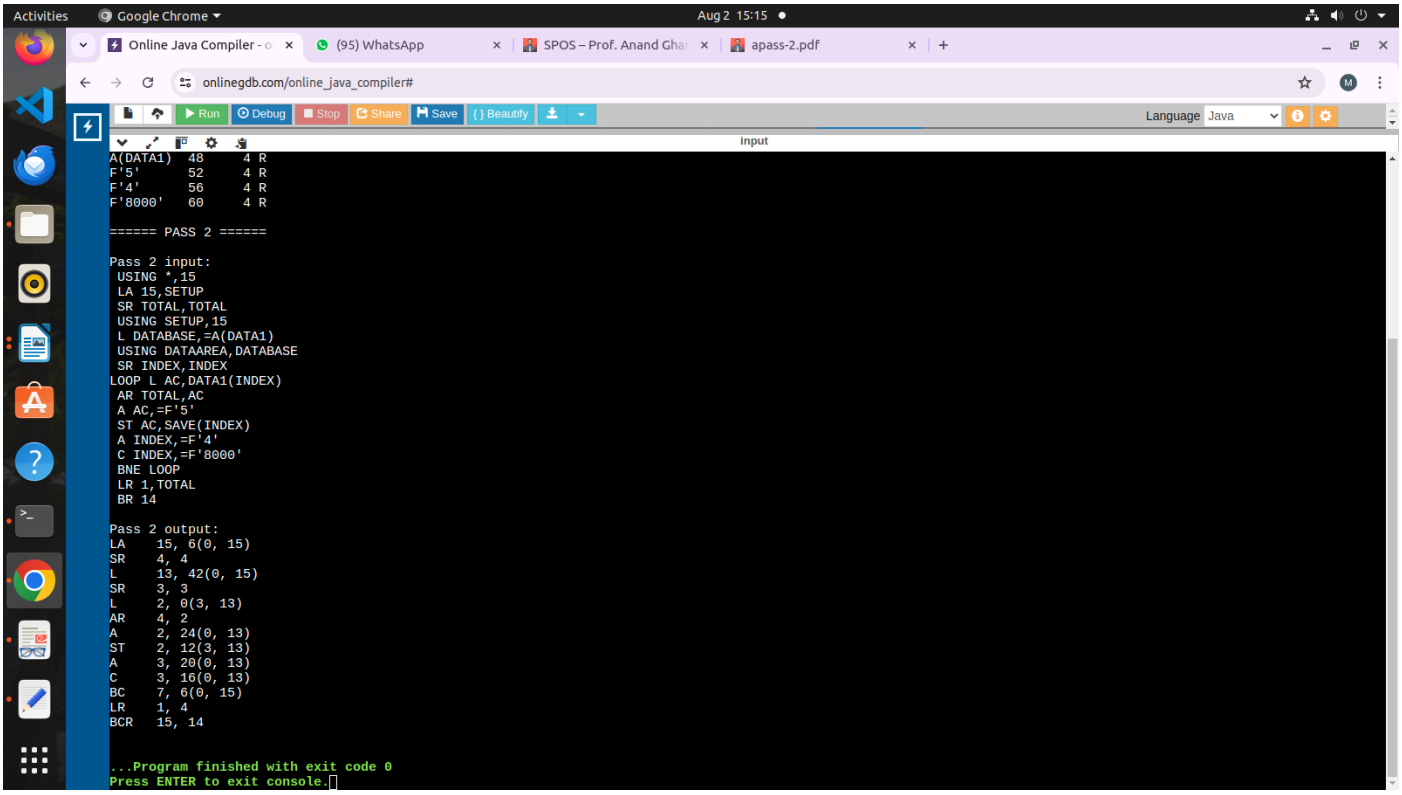
```
LA 01h 4 RX
SR 02h 2 RR
L 03h 4 RX
AR 04h 2 RR
A 05h 4 RX
C 06h 4 RX
BNE 07h 4 RX
LR 08h 2 RR
ST 09h 4 RX
BR 15h 2 RR
```

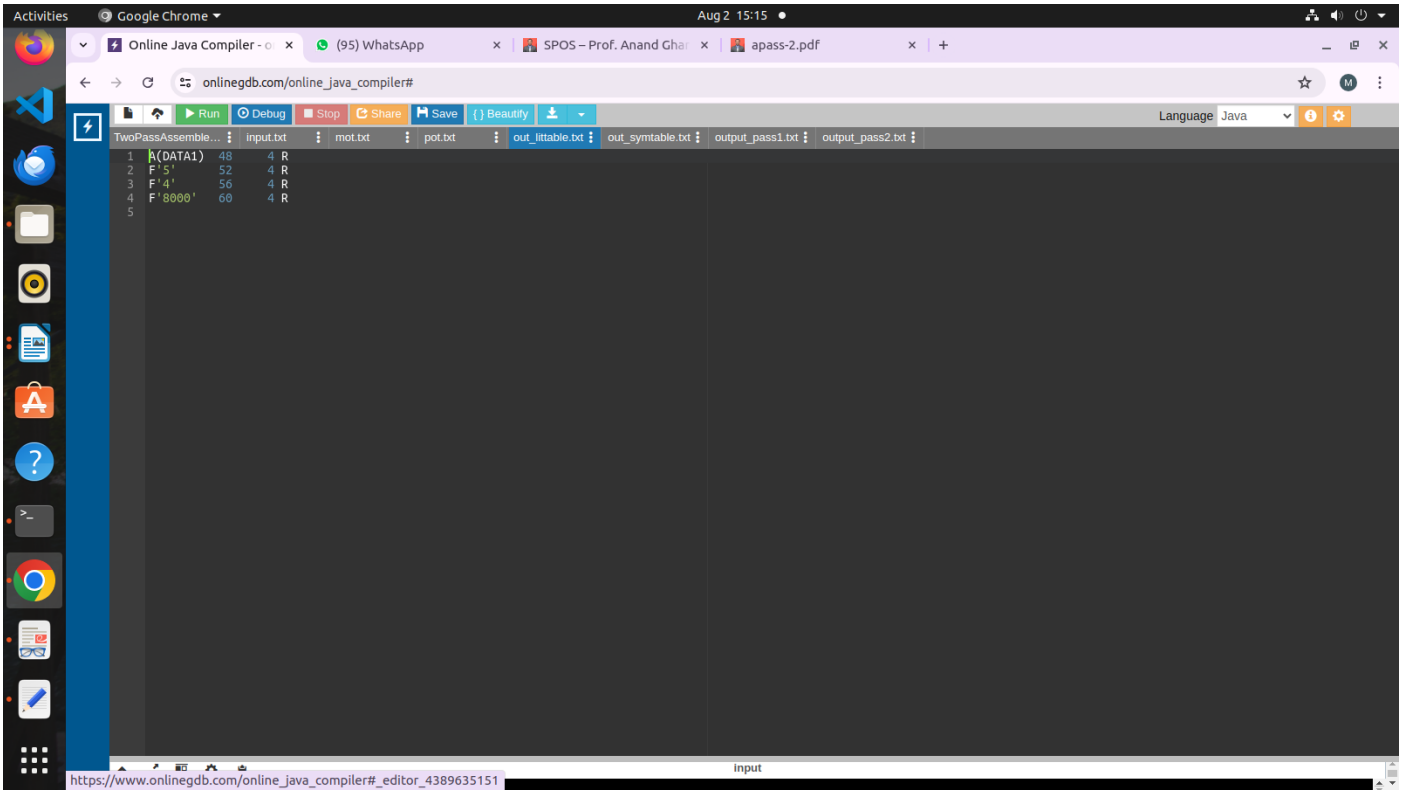
pot.txt:

```
START
END
LTORG
DC
DS
DROP
USING
EQU
```

Output:


Activities
Google Chrome
Aug 2 15:15
Online Java Compiler -
(95) WhatsApp
SPOS – Prof. Anand Gha
apass-2.pdf
onlinegdb.com/online_java_compiler#
Run
Debug
Stop
Share
Save
{ } Beautify
Language
Java
input
====== PASS 1 ======
Symbol Table:
Symbol Value Length R/A
PRGAM2 0 1 R
AC 2 1 A
INDEX 3 1 A
TOTAL 4 1 A
DATABASE 13 1 A
SETUP 6 1 R
LOOP 12 4 R
SAVE 64 4 R
DATAAREA 76 1 R
DATA1 76 4 R
Literal Table:
Literal Value Length R/A
A(DATA1) 48 4 R
F'5' 52 4 R
F'4' 56 4 R
F'8000' 60 4 R
====== PASS 2 ======
Pass 2 input:
USING *,15
LA 15,SETUP
SR TOTAL,TOTAL
USING SETUP,15
L DATABASE,=A(DATA1)
USING DATAAREA,DATABASE
SR INDEX,INDEX
LOOP L AC,DATA1(INDEX)
AR TOTAL,AC
A AC,=F'5'
ST AC,SAVE(INDEX)
A INDEX,=F'4'
C INDEX,=F'8000'
BNE LOOP
LR 1,TOTAL
BR 14
Pass 2 output:


Activities
Google Chrome
Aug 2 15:15
Online Java Compiler -
(95) WhatsApp
SPOS – Prof. Anand Gha
apass-2.pdf
onlinegdb.com/online_java_compiler#
Run
Debug
Stop
Share
Save
{ } Beautify
Language
Java
input
A(DATA1) 48 4 R
F'5' 52 4 R
F'4' 56 4 R
F'8000' 60 4 R
====== PASS 2 ======
Pass 2 input:
USING *,15
LA 15,SETUP
SR TOTAL,TOTAL
USING SETUP,15
L DATABASE,=A(DATA1)
USING DATAAREA,DATABASE
SR INDEX,INDEX
LOOP L AC,DATA1(INDEX)
AR TOTAL,AC
A AC,=F'5'
ST AC,SAVE(INDEX)
A INDEX,=F'4'
C INDEX,=F'8000'
BNE LOOP
LR 1,TOTAL
BR 14
Pass 2 output:
LA 15, 6(0, 15)
SR 4, 4
L 13, 42(0, 15)
SR 3, 3
L 2, 0(3, 13)
AR 4, 2
A 2, 24(0, 13)
ST 2, 12(3, 13)
A 3, 20(0, 13)
C 3, 16(0, 13)
BC 7, 6(0, 15)
LR 1, 4
BCR 15, 14
...Program finished with exit code 0
Press ENTER to exit console.


Activities
Google Chrome
Aug 2 15:15
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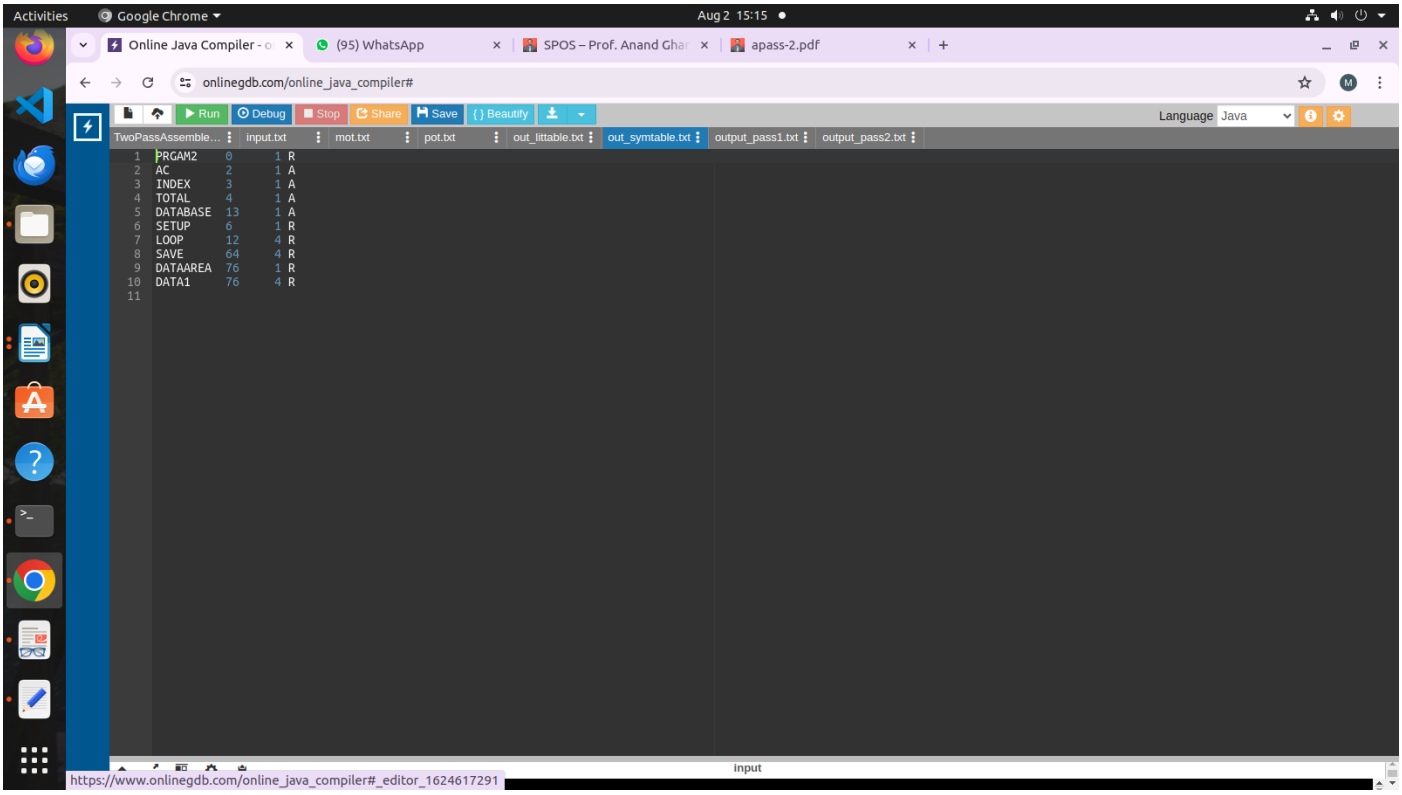
SPOS – Prof. Anand Gha
apass-2.pdf
onlinegdb.com/online_java_compiler#
Run
Debug
Stop
Share
Save
{ } Beautify
Language
Java
TwoPassAssemble...
input.txt
mot.txt
pot.txt
out_littable.txt
out_symtable.txt
output_pass1.txt
output_pass2.txt
1 A(DATA1) 48 4 R
2 F'5' 52 4 R
3 F'4' 56 4 R
4 F'8000' 60 4 R
5
input
https://www.onlinegdb.com/online_java_compiler#_editor_4389635151


Activities
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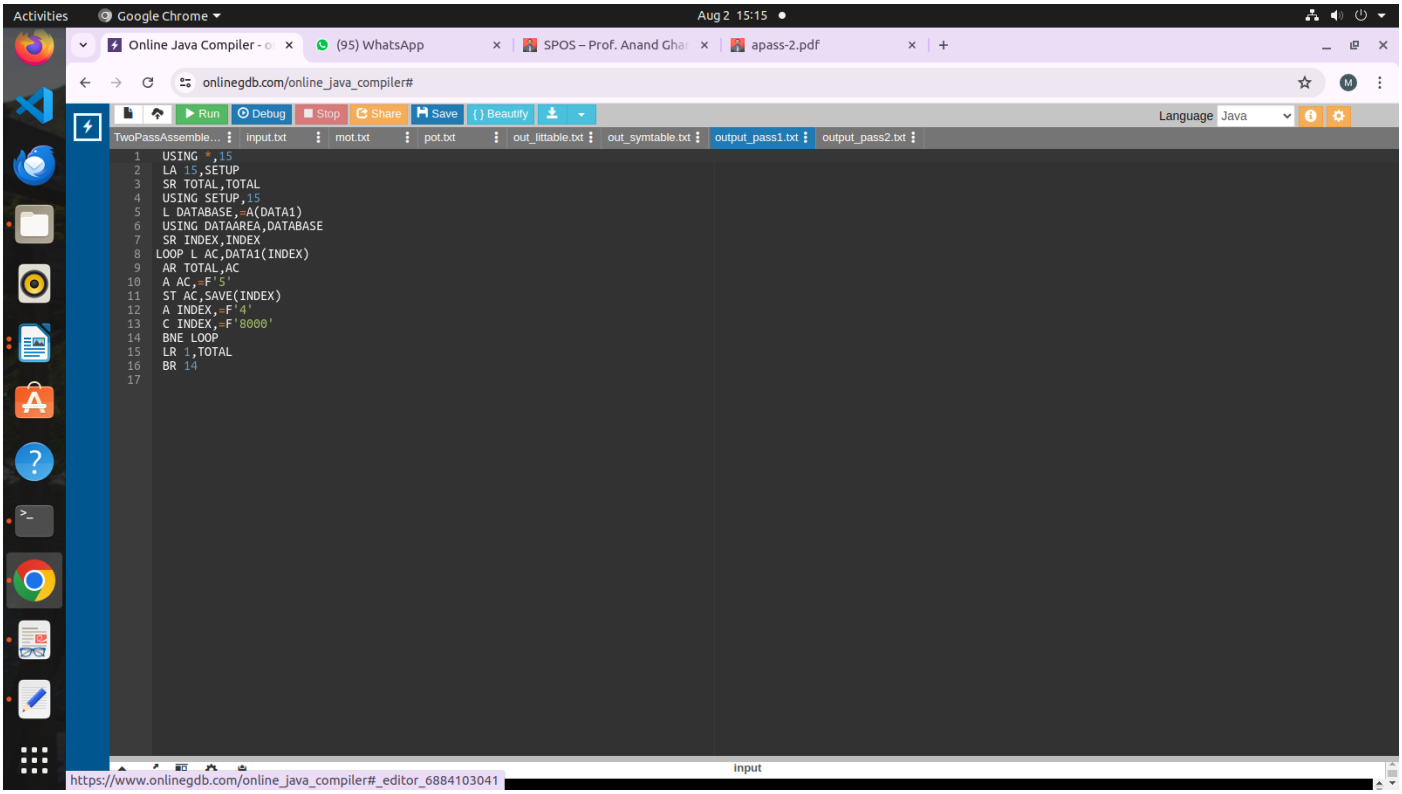
apass-2.pdf
onlinegdb.com/online_java_compiler#
Run
Debug
Stop
Share
Save
{ } Beautify
Language
Java
TwoPassAssemble...
input.txt
mot.txt
pot.txt
out_littable.txt
out_symtable.txt
output_pass1.txt
output_pass2.txt
1 PRGAM2 0 1 R
2 AC 2 1 A
3 INDEX 3 1 A
4 TOTAL 4 1 A
5 DATABASE 13 1 A
6 SETUP 6 1 R
7 LOOP 12 4 R
8 SAVE 64 4 R
9 DATAAREA 76 1 R
10 DATA1 76 4 R
11
input
https://www.onlinegdb.com/online_java_compiler#_editor_1624617291


Activities
Google Chrome
Aug 2 15:15
Online Java Compiler -
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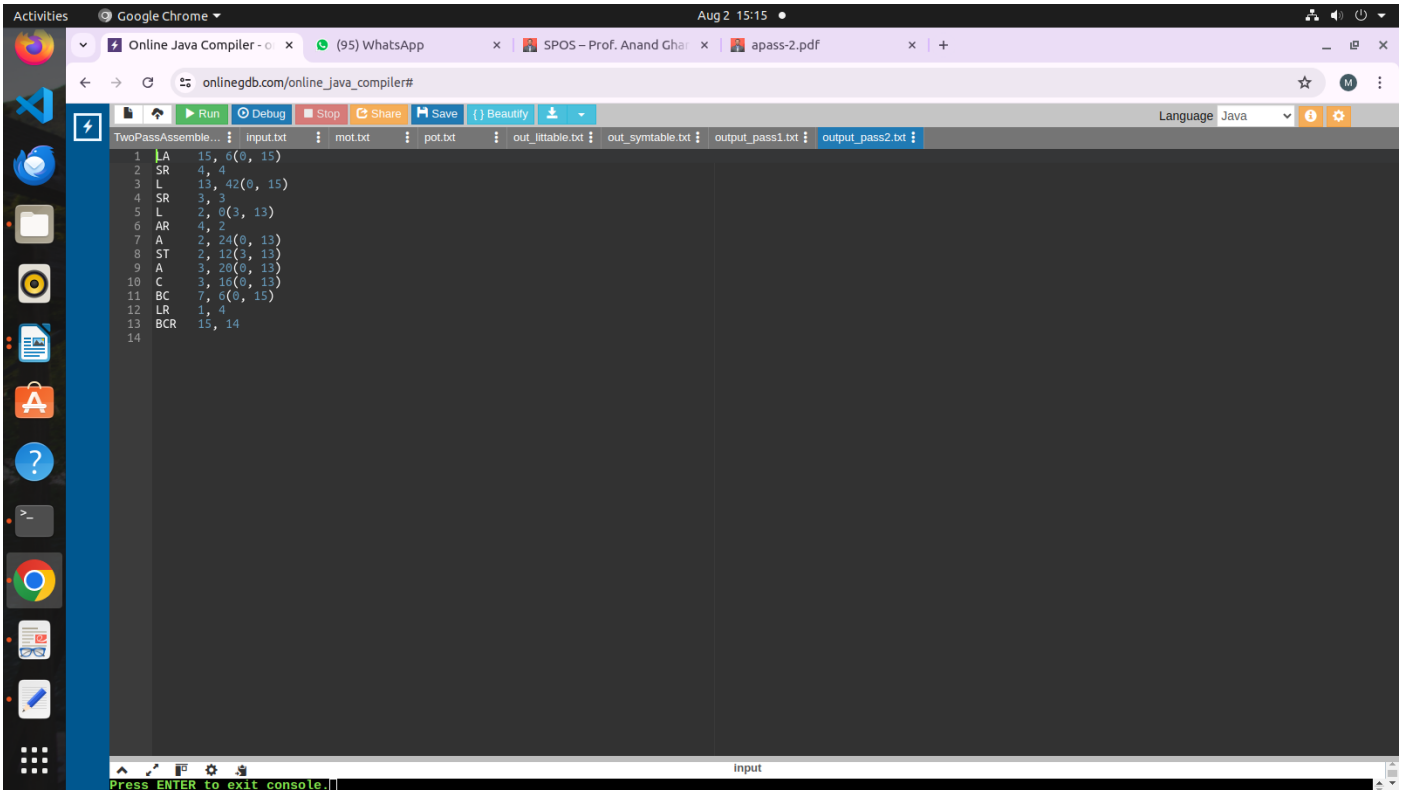
SPOS – Prof. Anand Gha
apass-2.pdf
onlinegdb.com/online_java_compiler#
Run
Debug
Stop
Share
Save
{ } Beautify
Language
Java
TwoPassAssemble...
input.txt
mot.txt
pot.txt
out_littable.txt
out_symtable.txt
output_pass1.txt
output_pass2.txt
1 USING *,15
2 LA 15,SETUP
3 SR TOTAL,TOTAL
4 USING SETUP,15
5 L DATABASE,=A(DATA1)
6 USING DATAAREA,DATABASE
7 SR INDEX,INDEX
8 LOOP L AC,DATA1(INDEX)
9 AR TOTAL,AC
10 A AC,=F'5'
11 ST AC,SAVE(INDEX)
12 A INDEX,=F'4'
13 C INDEX,=F'8000'
14 BNE LOOP
15 LR 1,TOTAL
16 BR 14
17
input
https://www.onlinegdb.com/online_java_compiler#_editor_6884103041


Activities
Google Chrome
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apass-2.pdf
onlinegdb.com/online_java_compiler#
Run
Debug
Stop
Share
Save
{ } Beautify
Language
Java
TwoPassAssemble...
input.txt
mot.txt
pot.txt
out_littable.txt
out_symtable.txt
output_pass1.txt
output_pass2.txt
1 LA 15, 6(0, 15)
2 SR 4, 4
3 L 13, 42(0, 15)
4 SR 3, 3
5 L 2, 0(3, 13)
6 AR 4, 2
7 A 2, 24(0, 13)
8 ST 2, 12(3, 13)
9 A 3, 20(0, 13)
10 C 3, 16(0, 13)
11 BC 7, 6(0, 15)
12 LR 1, 4
13 BCR 15, 14
14
input
Press ENTER to exit console.