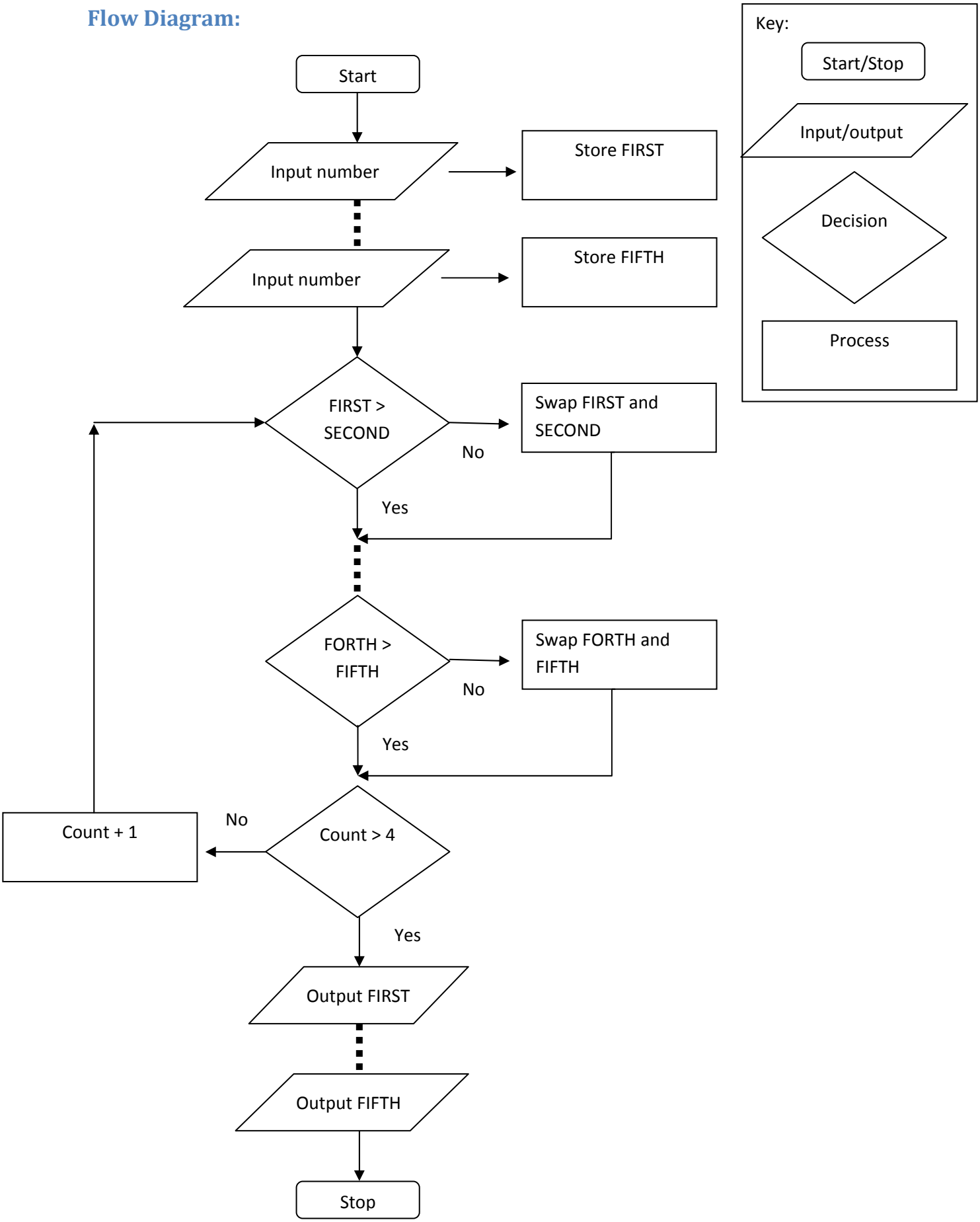
Problem 3: Input five numbers and output in descending order

Flow Diagram:



Algorithm (Pseudo Code):

- Set MAX as 4
- Set STEP as 1
- Input first number
- Store as FIRST
- Input second number
- Store as SECOND
- Input third number
- Store as THIRD
- Input forth number
- Store as FORTH
- Input fifth number
- Store as FIFTH
- STARTLOOP
- Load COUNT
- Add STEP
- Store COUNT
- Load FIRST in to accumulator
- Subtract SECOND
- If result is positive goto FIRSTBIGGER
- Load FIRST
- Store FIRST as TEMP
- Load SECOND
- Store as FIRST
- Load TEMP
- Store as SECOND

- FIRSTBIGGER
- LOAD SECOND in to accumulator
- Subtract THIRD
- If result is positive goto SECONDBIGGER
- Load SECOND
- Store SECOND as TEMP
- Load THIRD
- Store as SECOND
- Load TEMP
- Store as THIRD
- SECONDBIGGER
- LOAD THIRD in to accumulator
- Subtract FORTH
- If result is positive goto THIRDBIGGER
- Load THIRD
- Store THIRD as TEMP
- Load FORTH
- Store as THIRD
- Load TEMP
- Store as FORTH

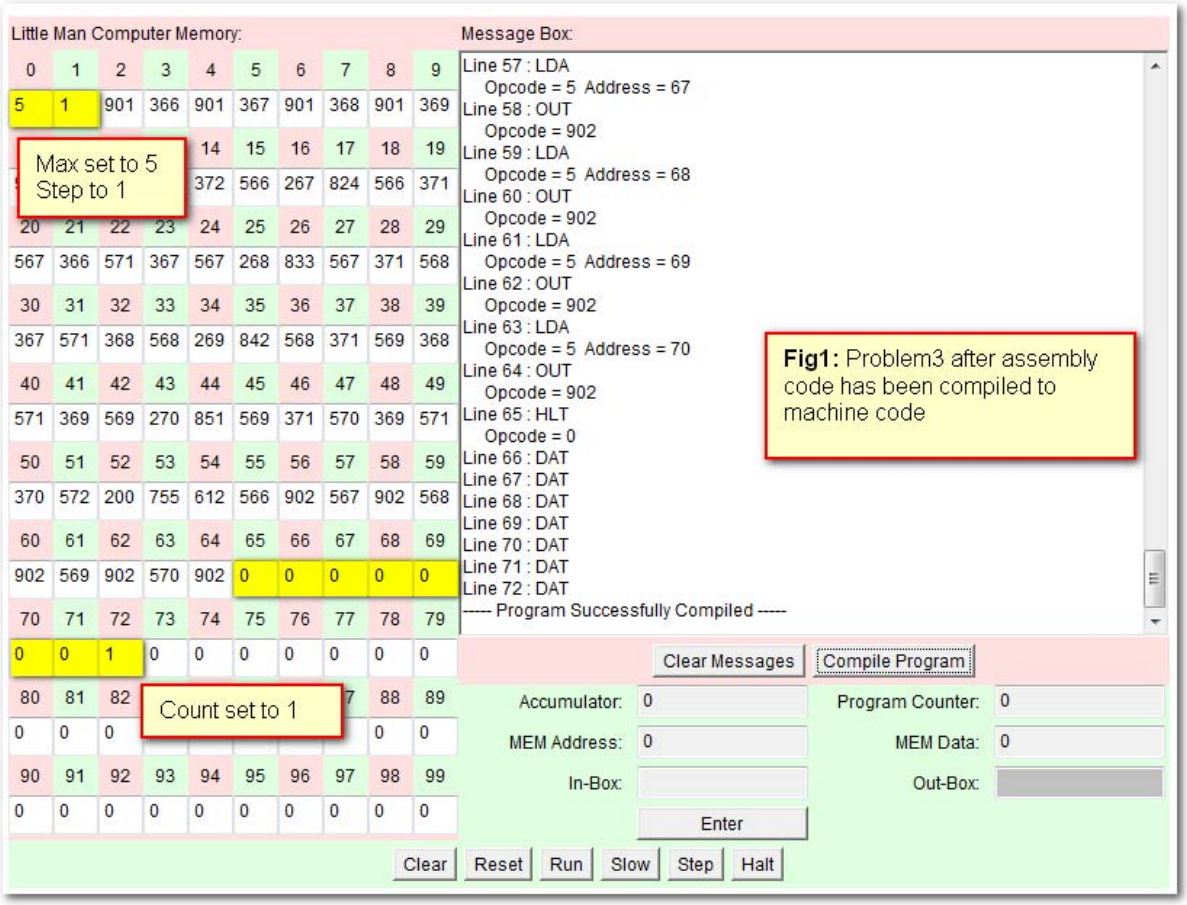
- THIRDBIGGER
- LOAD FOURTH in to accumulator
- Subtract FIFTH
- If result is positive goto FOURTHBIGGER
- Load FOURTH
- Store FOURTH as TEMP
- Load FIFTH
- Store as FOURTH
- Load TEMP
- Store as FIFTH
- FORTHBIGGER
- Load COUNT
- Subtract MAX
- Branch if Zero ENDLOOP
- Branch Always STARTLOOP
- **ENDLOOP**
- Output FIRST
- Output SECOND
- Output THIRD
- Output FORTH
- Output FIFTH
- Halt

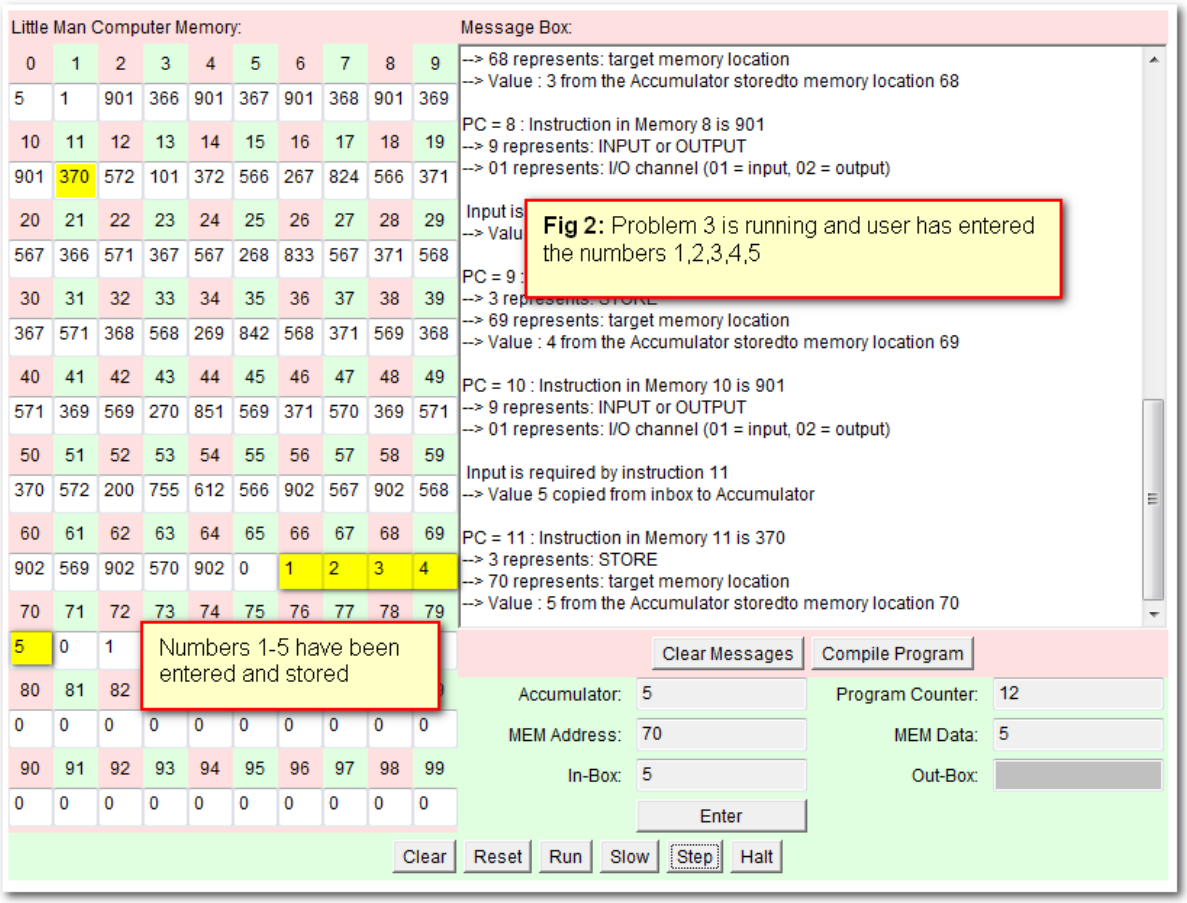
Assembly Code

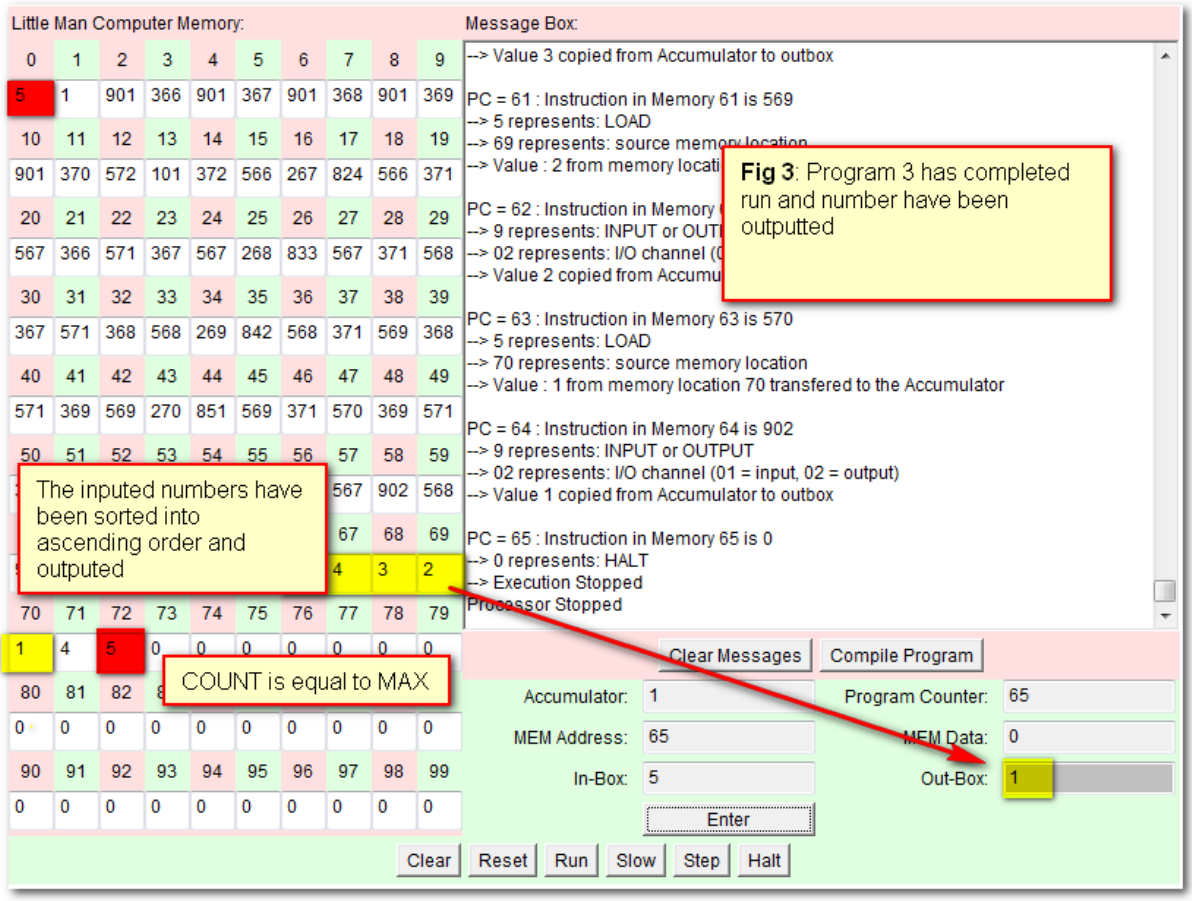
Assembly Code	*Explanation*
MAX DAT 5	The value of MAX is set to 5 to ensure program will loop 4 times
STEP DAT 1	The initial value of STEP is step to 1
INP	First input required from user
STA FIRST	Store input as FIRST
INP	Second input required from user
STA SECOND	Store input as SECOND
INP	Third input required from user
STA THIRD	Store input as THIRD
INP	Forth input required from user
STA FORTH	Store input as FORTH
INP	Fifth input required from user
STA FIFTH	Store input as FIFTH
STARTLOOP LDA COUNT	
ADD STEP	
STA COUNT	
LDA FIRST	
SUB SECOND	
BRP 1STBIGGER	
LDA FIRST	
STA TEMP	
LDA SECOND	
STA FIRST	
LDA TEMP	
STA SECOND	
1STBIGGER LDA SECOND	
SUB THIRD	
BRP 2NDBIGGER	
LDA SECOND	
STA TEMP	
LDA THIRD	
STA SECOND	
LDA TEMP	
STA THIRD	
2NDBIGGER LDA THIRD	
SUB FORTH	
BRP 3RDBIGGER	
LDA THIRD	
STA TEMP	
LDA FORTH	
STA THIRD	
LDA TEMP	
STA FORTH	
3RDBIGGER LDA FORTH	
SUB FIFTH	
BRP 4THBIGGER	
LDA FORTH	

```
STA TEMP
LDA FIFTH
STA FORTH
LDA TEMP
STA FIFTH
4THBIGGER LDA COUNT
SUB MAX
BRZ ENDLOOP
BRA STARTLOOP
ENDLOOP LDA FIRST
OUT
LDA SECOND
OUT
LDA THIRD
OUT
LDA FORTH
OUT
LDA FIFTH
OUT
HLT
FIRST DAT
SECOND DAT
THIRD DAT
FORTH DAT
FIFTH DAT
TEMP DAT
COUNT DAT 1
```

LMC Screenshots




Little Man Computer Memory:
Message Box:
--> 68 represents: target memory location
--> Value : 3 from the Accumulator storedto memory location 68
PC = 8 : Instruction in Memory 8 is 901
--> 9 represents: INPUT or OUTPUT
--> 01 represents: I/O channel (01 = input, 02 = output)
--> 69 represents: target memory location
--> Value : 4 from the Accumulator storedto memory location 69
PC = 10 : Instruction in Memory 10 is 901
--> 9 represents: INPUT or OUTPUT
--> 01 represents: I/O channel (01 = input, 02 = output)
Input is required by instruction 11
--> Value 5 copied from inbox to Accumulator
PC = 11 : Instruction in Memory 11 is 370
--> 3 represents: STORE
--> 70 represents: target memory location
--> Value : 5 from the Accumulator storedto memory location 70
Fig 2: Problem 3 is running and user has entered the numbers 1,2,3,4,5
Numbers 1-5 have been entered and stored
Clear Messages
Compile Program
Accumulator: 5
Program Counter: 12
MEM Address: 70
MEM Data: 5
In-Box: 5
Out-Box:
Enter
Clear
Reset
Run
Slow
Step
Halt



Output:

LMC Output	Explanation
PC = 0 : Instruction in Memory 0 is 5 Invalid Instruction	Set the value of memory location 0 to 5 this called MAX
PC = 1 : Instruction in Memory 1 is 1 Invalid Instruction	Set the value of memory location 1 to 1
PC = 2 : Instruction in Memory 2 is 901 --> 9 represents: INPUT or OUTPUT --> 01 represents: I/O channel (01 = input, 02 = output)	Requests input from user
Input is required by instruction 3 --> Value 1 copied from inbox to Accumulator	User input is 1
PC = 3 : Instruction in Memory 3 is 366 --> 3 represents: STORE --> 66 represents: target memory location --> Value : 1 from the Accumulator storedto memory location 66	User input is stored in memory location 66 (FIRST)

PC = 4 : Instruction in Memory 4 is 901 --> 9 represents: INPUT or OUTPUT --> 01 represents: I/O channel (01 = input, 02 = output)	Requests input from user
Input is required by instruction 5 --> Value 2 copied from inbox to Accumulator	User input is 2
PC = 5 : Instruction in Memory 5 is 367 --> 3 represents: STORE --> 67 represents: target memory location --> Value : 2 from the Accumulator storedto memory location 67	User input is stored in memory location 67 (SECOND)
PC = 6 : Instruction in Memory 6 is 901 --> 9 represents: INPUT or OUTPUT --> 01 represents: I/O channel (01 = input, 02 = output)	Requests input from user
Input is required by instruction 7 --> Value 3 copied from inbox to Accumulator	User input is 3
PC = 7 : Instruction in Memory 7 is 368 --> 3 represents: STORE --> 68 represents: target memory location --> Value : 3 from the Accumulator storedto memory location 68	User input is stored in memory location 68 (THIRD)
PC = 8 : Instruction in Memory 8 is 901 --> 9 represents: INPUT or OUTPUT --> 01 represents: I/O channel (01 = input, 02 = output)	Requests input from user
Input is required by instruction 9 --> Value 4 copied from inbox to Accumulator	User input is 4
PC = 9 : Instruction in Memory 9 is 369 --> 3 represents: STORE --> 69 represents: target memory location --> Value : 4 from the Accumulator storedto memory location 69	User input is stored in memory location 69 (FORTH)
PC = 10 : Instruction in Memory 10 is 901 --> 9 represents: INPUT or OUTPUT --> 01 represents: I/O channel (01 = input, 02 = output)	Requests input from user
Input is required by instruction 11 --> Value 5 copied from inbox to Accumulator	User input is 5

PC = 11 : Instruction in Memory 11 is 370 --> 3 represents: STORE --> 70 represents: target memory location --> Value : 5 from the Accumulator storedto memory location 70	User input is stored in memory location 70 (FIFTH)
PC = 12 : Instruction in Memory 12 is 572 --> 5 represents: LOAD --> 72 represents: source memory location --> Value : 1 from memory location 72 transfered to the Accumulator	The Variable COUNT is loaded from location 72 to the accumulator
PC = 13 : Instruction in Memory 13 is 101 --> 1 represents: ADD --> 01 represents: source memory location --> Value : 1 from memory location 01 added to the Accumulator	The Variable STEP is added to the accumulator
PC = 14 : Instruction in Memory 14 is 372 --> 3 represents: STORE --> 72 represents: target memory location --> Value : 2 from the Accumulator storedto memory location 72	The result replaces COUNT at location 72
PC = 15 : Instruction in Memory 15 is 566 --> 5 represents: LOAD --> 66 represents: source memory location --> Value : 1 from memory location 66 transfered to the Accumulator	FIRST is loaded to the accumulator
PC = 16 : Instruction in Memory 16 is 267 --> 2 represents: SUBTRACT --> 67 represents: source memory location --> Value : 2 from memory location 67 subtracted from the Accumulator	SECOND is subtracted from FIRST
PC = 17 : Instruction in Memory 17 is 824 --> 8 represents: BRANCH ON POSITIVE --> 24 represents: target memory location --> BRANCH on POSITIVE to 24 Testing Accumulator... --> Accumulator -1 < 0, BRANCH not performed.	IF the result is +ve program jumps to Location 24 (1STBIGGER) In this case the result is –ve so the program doesn't jump
PC = 18 : Instruction in Memory 18 is 566 --> 5 represents: LOAD --> 66 represents: source memory location --> Value : 1 from memory location 66 transfered to the Accumulator	FIRST is loaded to the accumulator

PC = 19 : Instruction in Memory 19 is 371 --> 3 represents: STORE --> 71 represents: target memory location --> Value : 1 from the Accumulator storedto memory location 71	FIRST is stored as TEMP (Location 71)
PC = 20 : Instruction in Memory 20 is 567 --> 5 represents: LOAD --> 67 represents: source memory location --> Value : 2 from memory location 67 transfered to the Accumulator	SECOND is loaded to accumulator
PC = 21 : Instruction in Memory 21 is 366 --> 3 represents: STORE --> 66 represents: target memory location --> Value : 2 from the Accumulator storedto memory location 66	SECOND is stored as FIRST
PC = 22 : Instruction in Memory 22 is 571 --> 5 represents: LOAD --> 71 represents: source memory location --> Value : 1 from memory location 71 transfered to the Accumulator	TEMP is loaded to the accumulator
PC = 23 : Instruction in Memory 23 is 367 --> 3 represents: STORE --> 67 represents: target memory location --> Value : 1 from the Accumulator storedto memory location 67	TEMP is stored as SECOND
PC = 24 : Instruction in Memory 24 is 567 --> 5 represents: LOAD --> 67 represents: source memory location --> Value : 1 from memory location 67 transfered to the Accumulator	SECOND is loaded to the accumulator
PC = 25 : Instruction in Memory 25 is 268 --> 2 represents: SUBTRACT --> 68 represents: source memory location --> Value : 3 from memory location 68 subtracted from the Accumulator	THIRD is subtracted from SECOND
PC = 26 : Instruction in Memory 26 is 833 --> 8 represents: BRANCH ON POSITIVE --> 33 represents: target memory location --> BRANCH on POSITIVE to 33 Testing Accumulator... --> Accumulator -2 < 0, BRANCH not performed.	IF the result is +ve program jumps to Location 33 (2^{nd} BIGGER) In this case the result is –ve so the program doesn't jump

PC = 27 : Instruction in Memory 27 is 567 --> 5 represents: LOAD --> 67 represents: source memory location --> Value : 1 from memory location 67 transfered to the Accumulator	SECOND is loaded to the accumulator
PC = 28 : Instruction in Memory 28 is 371 --> 3 represents: STORE --> 71 represents: target memory location --> Value : 1 from the Accumulator storedto memory location 71	SECOND is stored as TEMP (Location 71)
PC = 29 : Instruction in Memory 29 is 568 --> 5 represents: LOAD --> 68 represents: source memory location --> Value : 3 from memory location 68 transfered to the Accumulator	THIRD is loaded to accumulator
PC = 30 : Instruction in Memory 30 is 367 --> 3 represents: STORE --> 67 represents: target memory location --> Value : 3 from the Accumulator storedto memory location 67	THIRD is stored as SECOND
PC = 31 : Instruction in Memory 31 is 571 --> 5 represents: LOAD --> 71 represents: source memory location --> Value : 1 from memory location 71 transfered to the Accumulator	TEMP is loaded to the accumulator
PC = 32 : Instruction in Memory 32 is 368 --> 3 represents: STORE --> 68 represents: target memory location --> Value : 1 from the Accumulator storedto memory location 68	TEMP is stored as THIRD
PC = 33 : Instruction in Memory 33 is 568 --> 5 represents: LOAD --> 68 represents: source memory location --> Value : 1 from memory location 68 transfered to the Accumulator	THIRD is loaded to the accumulator
PC = 34 : Instruction in Memory 34 is 269 --> 2 represents: SUBTRACT --> 69 represents: source memory location --> Value : 4 from memory location 69 subtracted from the Accumulator	FORTH is subtracted from THIRD

PC = 35 : Instruction in Memory 35 is 842 --> 8 represents: BRANCH ON POSITIVE --> 42 represents: target memory location --> BRANCH on POSITIVE to 42 Testing Accumulator... --> Accumulator -3 < 0, BRANCH not performed.	IF the result is +ve program jumps to Location 42 (3rdBIGGER) In this case the result is –ve so the program doesn't jump
PC = 36 : Instruction in Memory 36 is 568 --> 5 represents: LOAD --> 68 represents: source memory location --> Value : 1 from memory location 68 transfered to the Accumulator	THIRD is loaded to the accumulator
PC = 37 : Instruction in Memory 37 is 371 --> 3 represents: STORE --> 71 represents: target memory location --> Value : 1 from the Accumulator storedto memory location 71	THIRD is stored as TEMP (Location 71)
PC = 38 : Instruction in Memory 38 is 569 --> 5 represents: LOAD --> 69 represents: source memory location --> Value : 4 from memory location 69 transfered to the Accumulator	FORTH is loaded to accumulator
PC = 39 : Instruction in Memory 39 is 368 --> 3 represents: STORE --> 68 represents: target memory location --> Value : 4 from the Accumulator storedto memory location 68	FORTH is stored as THIRD
PC = 40 : Instruction in Memory 40 is 571 --> 5 represents: LOAD --> 71 represents: source memory location --> Value : 1 from memory location 71 transfered to the Accumulator	TEMP is loaded to the accumulator
PC = 41 : Instruction in Memory 41 is 369 --> 3 represents: STORE --> 69 represents: target memory location --> Value : 1 from the Accumulator stored to memory location 69	TEMP is stored as FORTH
PC = 42 : Instruction in Memory 42 is 569 --> 5 represents: LOAD --> 69 represents: source memory location --> Value : 1 from memory location 69 transfered to the Accumulator	FORTH is loaded to the accumulator

PC = 43 : Instruction in Memory 43 is 270 --> 2 represents: SUBTRACT --> 70 represents: source memory location --> Value : 5 from memory location 70 subtracted from the Accumulator	FIFTH is subtracted from FORTH
PC = 44 : Instruction in Memory 44 is 851 --> 8 represents: BRANCH ON POSITIVE --> 51 represents: target memory location --> BRANCH on POSITIVE to 51 Testing Accumulator... --> Accumulator -4 < 0, BRANCH not performed.	IF the result is +ve program jumps to Location 51 (4THBIGGER) In this case the result is –ve so the program doesn't jump
PC = 45 : Instruction in Memory 45 is 569 --> 5 represents: LOAD --> 69 represents: source memory location --> Value : 1 from memory location 69 transfered to the Accumulator	FORTH is loaded to the accumulator
PC = 46 : Instruction in Memory 46 is 371 --> 3 represents: STORE --> 71 represents: target memory location --> Value : 1 from the Accumulator storedto memory location 71	FORTH is stored as TEMP (Location 71)
PC = 47 : Instruction in Memory 47 is 570 --> 5 represents: LOAD --> 70 represents: source memory location --> Value : 5 from memory location 70 transfered to the Accumulator	FIFTH is loaded to accumulator
PC = 48 : Instruction in Memory 48 is 369 --> 3 represents: STORE --> 69 represents: target memory location --> Value : 5 from the Accumulator storedto memory location 69	FIFTH is stored as FORTH
PC = 49 : Instruction in Memory 49 is 571 --> 5 represents: LOAD --> 71 represents: source memory location --> Value : 1 from memory location 71 transfered to the Accumulator	TEMP is loaded to the accumulator
PC = 50 : Instruction in Memory 50 is 370 --> 3 represents: STORE --> 70 represents: target memory location --> Value : 1 from the Accumulator storedto memory location 70	TEMP is stored as FIFTH

PC = 51 : Instruction in Memory 51 is 572
--> 5 represents: LOAD
--> 72 represents: source memory location
--> Value : 2 from memory location 72 transfered to the Accumulator

PC = 52 : Instruction in Memory 52 is 200
--> 2 represents: SUBTRACT
--> 00 represents: source memory location
--> Value : 5 from memory location 00 subtracted from the Accumulator

PC = 53 : Instruction in Memory 53 is 755
--> 7 represents: BRANCH ON ZERO
--> 55 represents: target memory location
--> BRANCH on ZERO to 55 : Testing Accumulator...
--> Accumulator -3 not equal to 0,Branch NOT performed.

PC = 54 : Instruction in Memory 54 is 612
--> 6 represents: BRANCH
--> 12 represents: source memory location
--> BRANCH to 12 : PC adjusted.

PC = 55 : Instruction in Memory 55 is 566
--> 5 represents: LOAD
--> 66 represents: source memory location
--> Value : 5 from memory location 66 transfered to the Accumulator

PC = 56 : Instruction in Memory 56 is 902
--> 9 represents: INPUT or OUTPUT
--> 02 represents: I/O channel (01 = input, 02 = output)
--> Value 5 copied from Accumulator to outbox

PC = 57 : Instruction in Memory 57 is 567
--> 5 represents: LOAD
--> 67 represents: source memory location
--> Value : 4 from memory location 67 transfered to the Accumulator

PC = 58 : Instruction in Memory 58 is 902
--> 9 represents: INPUT or OUTPUT
--> 02 represents: I/O channel (01 = input, 02 = output)
--> Value 4 copied from Accumulator to outbox

PC = 59 : Instruction in Memory 59 is 568 --> 5 represents: LOAD --> 68 represents: source memory location --> Value : 3 from memory location 68 transfered to the Accumulator PC = 60 : Instruction in Memory 60 is 902 --> 9 represents: INPUT or OUTPUT --> 02 represents: I/O channel (01 = input, 02 = output) --> Value 3 copied from Accumulator to outbox PC = 61 : Instruction in Memory 61 is 569 --> 5 represents: LOAD --> 69 represents: source memory location --> Value : 2 from memory location 69 transfered to the Accumulator PC = 62 : Instruction in Memory 62 is 902 --> 9 represents: INPUT or OUTPUT --> 02 represents: I/O channel (01 = input, 02 = output) --> Value 2 copied from Accumulator to outbox PC = 63 : Instruction in Memory 63 is 570 --> 5 represents: LOAD --> 70 represents: source memory location --> Value : 1 from memory location 70 transfered to the Accumulator PC = 64 : Instruction in Memory 64 is 902 --> 9 represents: INPUT or OUTPUT --> 02 represents: I/O channel (01 = input, 02 = output) --> Value 1 copied from Accumulator to outbox PC = 65 : Instruction in Memory 65 is 0 --> 0 represents: HALT --> Execution Stopped Processor Stopped	