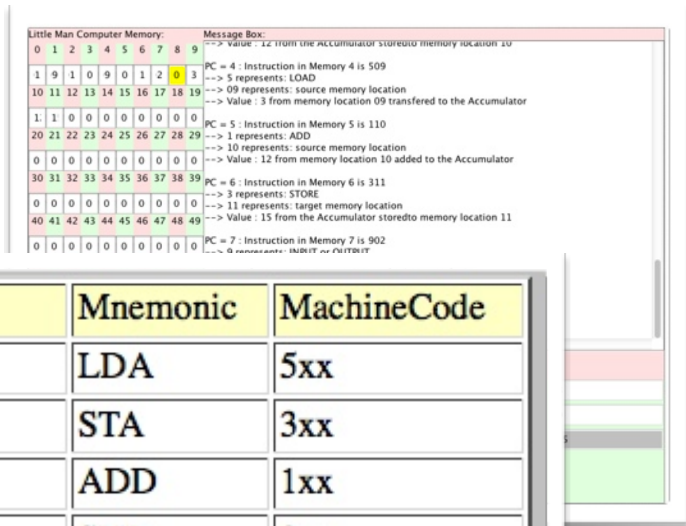
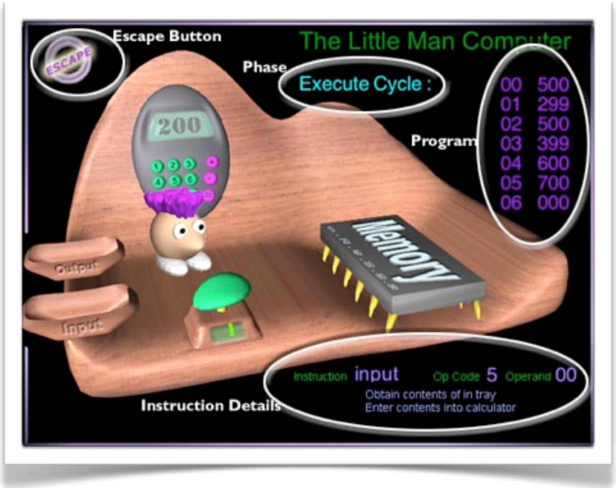
LMC Instruction Set

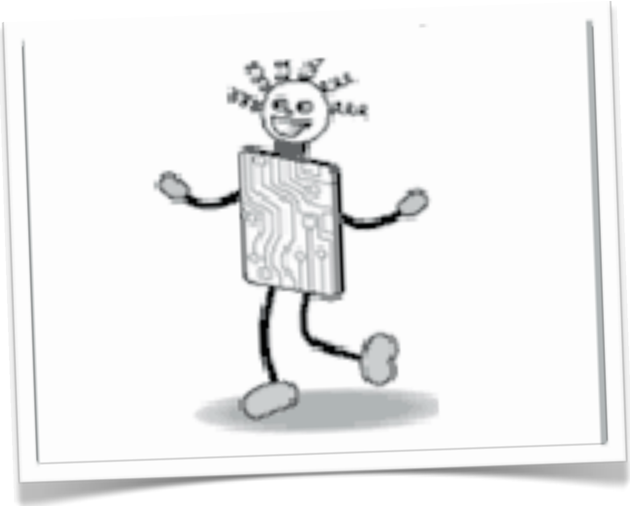


Instruction	Mnemonic	MachineCode
Load	LDA	5xx
Store	STA	3xx
Add	ADD	1xx
Subtract	SUB	2xx
Input	INP	901
Output	OUT	902
End	HLT	000
Branch if zero	BRZ	7xx
Branch if zero or positive	BRP	8xx
Branch always	BRA	6xx
Data storage	DAT	

Little Man Computer

A CAS Master Teacher CPD Session





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Your First Program

Some key points:

- **ALWAYS** copy your code before compiling, as you will lose it

- Remember readability:
    - LMC will ignore blank lines
    - LMC is not case sensitive, but good habits help

Message Box:

```
INP
STA numOne

INP
STA numTwo

LDA numOne
ADD numTwo

STA numThree

OUT

HLT

numOne DAT
numTwo DAT
numThree DAT
```

Some ‘simple’ challenges

1. Ask the user for 3 numbers. Print them out in reverse order.

Test Data

Inputs	Outputs
7 , 8 , 9	9 , 8 , 7
8 , 16 , 32	32 , 16 , 8

Finished Code

Some 'simple' challenges

2. Ask the user for 3 numbers. Add them up and print out the answer.

Test Data

Inputs	Outputs
7 , 8 , 9	24
8 , 16 , 32	56

Finished Code

Some ‘simple’ challenges

3. Ask for 2 numbers.
   Print out the first - the second.
   Then the second - the first.

Test Data

Inputs	Outputs
7 , 3	4 , -4
5 , 12	-7 , 7

Finished Code

Phase 2 - branching

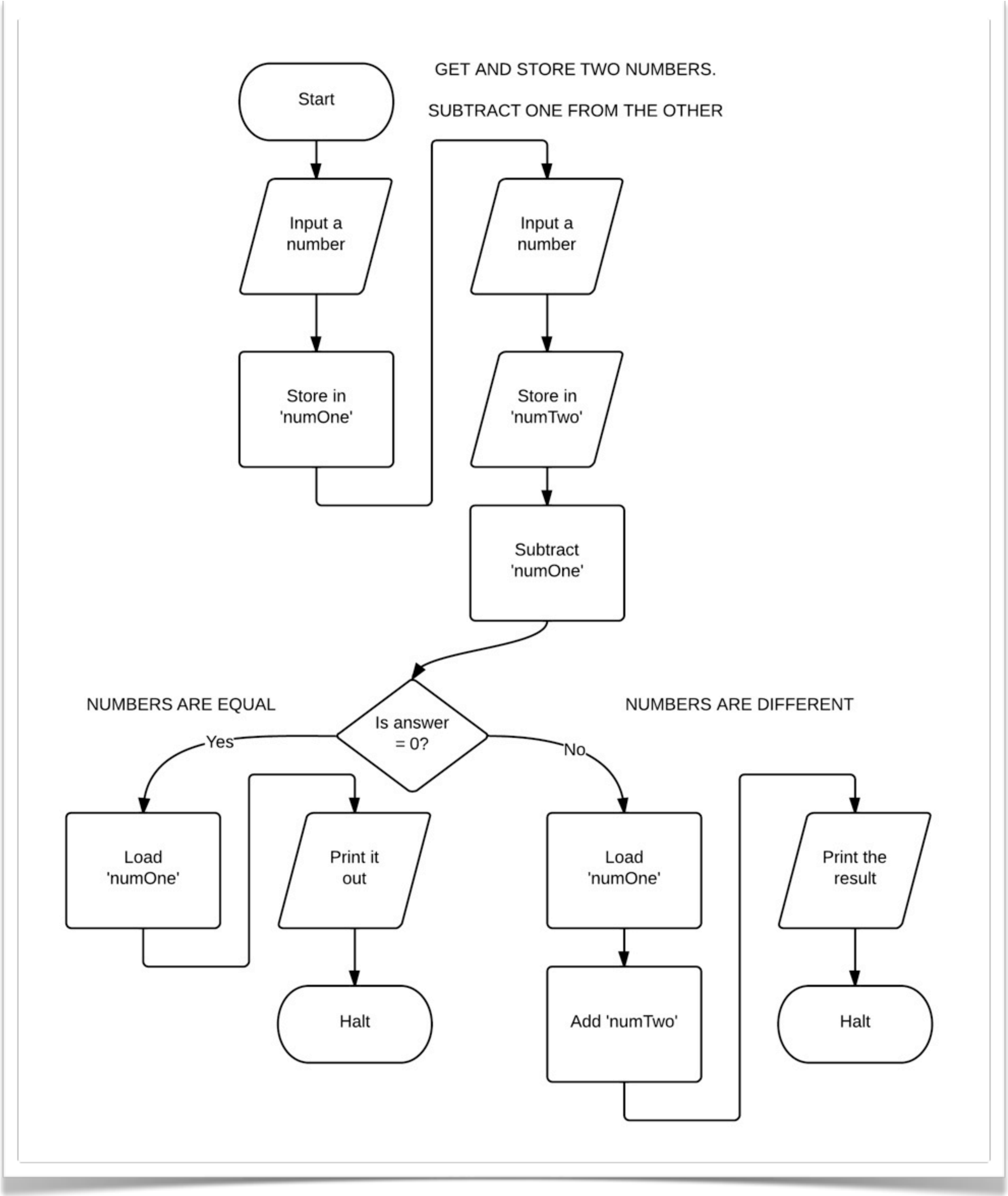
Branching allows you to take a program down 2 different paths.

There are 3 types of branch:

Code	Meaning
BRZ	Branch if zero
BRP	Branch if positive (or zero)
BRA	Branch always (used for looping)

Branching Example

Branching allows you to take a program down 2 different paths.



If Statements…

Human logic works like this:

```
If the two numbers are the same then print one of them out.
Otherwise, add them together and print the result.
```

We work through the positive result first, then the negative one. In LMC it doesn't work like that.

```
If the two number are the same then jump to 'same'.
Otherwise, add them together and print the result.
Same: Load the first number and print it out.
```

The easiest workflow is like this:

```
INP
STA numOne
INP
STA numTwo
SUB numOne
```

First, write your opening instructions.

In this case, input and store two numbers and then subtract them.

...continued

if answer IS zero...	...otherwise...	& declarations
INP STA numOne INP STA numTwo SUB numOne BRZ same same LDA numOne OUT HLT	INP STA numOne INP STA numTwo SUB numOne BRZ same LDA numOne ADD numTwo OUT HLT same LDA numOne OUT HLT	INP STA numOne INP STA numTwo SUB numOne BRZ same LDA numOne ADD numTwo OUT HLT same LDA numOne OUT HLT numOne DAT numTwo DAT
Add the branch if zero to the label 'same'. Leave some empty space. Then write the "same" instructions	Next, add in the "otherwise" instructions. Remembering to include a HLT	Finally, add the DAT declarations at the very end (only once)

Intermediate challenges

1. Ask the user for 2 numbers. If they are the same then double the number and print it out. If they are different then print them both out individually.

Test Data

Inputs	Outputs
15 , 15	30
12 , 9	12 , 9

Finished Code

Intermediate challenges

2. Ask the user for 2 numbers. Print out biggest, then the smallest.

Test Data

Inputs	Outputs
12 , 15	15 , 12
7 , 2	7 , 2

Finished Code

Intermediate challenges

3. Ask the user for 2 numbers, print out the result of the biggest number minus the smallest number

Test Data

Inputs	Outputs
7 , 3	4
5 , 12	7

Finished Code

Loops!

Looping in LMC involves using one or more branches that repeats a set of instructions.

Predict what the following code will do:
(Hint: BRA means Branch Always)

```
INP
STA numOne
looptop ADD numOne
OUT
BRA looptop
HLT
numOne DAT
```

Prediction

Now try it out and see for yourself.

In order to make it better, we need an escape clause.

```
INP
STA bigNum
INP
STA littleNum
looptop LDA bigNum
SUB littleNum
STA bigNum
OUT
BRZ end
BRA looptop
end HLT
bigNum DAT
littleNum DAT
```

Use a **trace table** to follow this problem through.

Try it with 20 and 4 as the inputs

The BRZ is a conditional escape from the loop

`If the answer is zero, escape, otherwise keep looping.`

This is just like a WHILE loop.

Advanced challenges

1. Ask the user for a big number, then a small number. Using only a BRP to loop round, keep subtracting the smaller number until you get past zero, then output the result.

Test Data

Inputs	Outputs
20 , 3	-1
16 , 4	-4

Finished Code

Advanced challenges

2. You can declare a constant at the end of the program like this:
   `one DAT 1` (this will give the variable 'one' the value 1)
   Using this, add to your previous program to count the number of times you can successfully subtract the smaller number.

Test Data

Inputs	Outputs
20 , 3	6
16 , 4	4

Finished Code

Advanced challenges

3. Write a program that will ask for 2 numbers and then multiply them. While this may be tricky, you should now know enough to do it!

4. How about a program that will divide two numbers and give the DIV and MOD. DIV is the whole number result of a division. MOD is the remainder.

   e.g. 17 ÷ 5 = 3 remainder 2

5. Try writing a program that will check if two numbers are a factor of each other. First enter a big number, then a small number. If the small number is a factor then it should divide with no remainders.

6. Try improving program 5 so that it doesn't matter which way round you enter the numbers.