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Concepts of CS I

Little Man Computer

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Assembly Language

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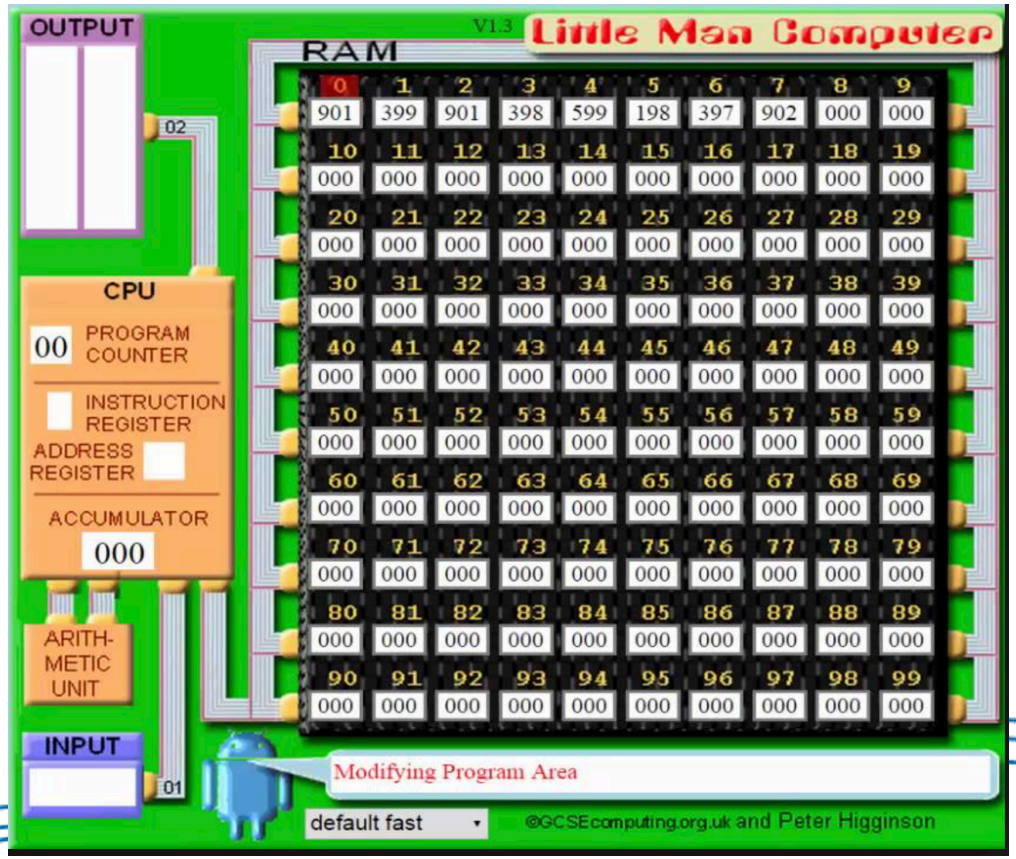
Little Man Computer is an assembly language simulator which gives an environment for users to program in an assembly language.



The Environment

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- **Accumulator** - This is the like the active memory of the simulator. The majority of our instructions will modify the contents of the accumulator.
- **Program Counter** - This shows the current memory location that the processor is running.
- **MEM Address** - The current instruction type.
- **MEM Data** - The data being used for the current instruction.
- **In-Box** - The input box.
- **Out-Box** - The output box.

Taking Input

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Name: Input
Mnemonic: INP
Code: *901*

Description:
The input instruction takes the value in the **In-Box** and puts the value into the **Accumulator**.

Next Action:
After the value has been copied the **Program Counter** will move onto the next (sequential) memory location.

Providing Output

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Name: Output
Mnemonic: OUT
Code: *902*

Description:
The output instruction takes the value in the **Accumulator** and puts the value into the **Out-Box**.

Next Action:
After the value has been copied the **Program Counter** will move onto the next (sequential) memory location.

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Stopping the Programming

Name: Halt
Mnemonic: HLT
Code: *000*

Description:
The halt instruction does not effect any of the memory locations and stop the program.

Next Action:
The execution of the program will stop.

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Exercise: Input and Output

- Create a program which takes in an input from the user and outputs it.
- Analysis the memory locations and write down the instruction codes your program generated.

LMC Code Summary

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___	**INP**	___	- Input
___	**OUT**	___	- Output
___	**HLT**	___	- Halt

Storing Data

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Name: Store
Mnemonic: STA *variable*
Code: *3* _ _

Description:
The store instruction will take the data from the **Accumulator** and store it into an allocated memory location which will be referred to by the variable name given.

Next Action:
After the value has been copied the **Program Counter** will move onto the next (sequential) memory location.

Retrieving Data

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Name: Load
Mnemonic: LDA variable
Code: *5 _ _*

Description:
The load instruction will put the value stored at the variable location into the **Accumulator**.

Next Action:
After the value has been loaded into the **Accumulator** ,the **Program Counter** will move onto the next (sequential) memory location.

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Data Memory Locations

Name: Data
Mnemonic: *variable* DAT
Code: *(the data)*

Description:
The data instruction will reserve a memory location to store data. This location can then be referred to by the given name.

Next Action:
After the memory location has been reserved, the **Program Counter** will move onto the next (sequential) memory location.

Exercise: Storing and Loading

- Create a program which takes and stores in 2 inputs from the user and outputs the first input followed by the second input.

- Create a program which takes and stores 4 inputs from the user and always outputs the third input to the user.

LMC Code Summary

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___	**INP**	___	- Input
___	**OUT**	___	- Output
___	**HLT**	___	- Halt
___	**STA**	***var***	- *Store*
___	**LDA**	***var***	- Load
var	**DAT**	___	- Data

Addition

Name: Addition
Mnemonic: *ADD variable*
Code: 1 _ _

Description:

The add instruction adds the value stored in the given memory location to the accumulator.

Next Action:

After the value has been loaded into the **Accumulator** ,the **Program Counter** will move onto the next (sequential) memory location.

Subtraction

Name: Subtraction
Mnemonic: *SUB variable*
Code: *2 _ _*

Description:

The subtraction instruction subtracts the value stored in the given memory location away from the accumulator.

Next Action:

After the value has been loaded into the **Accumulator** ,the **Program Counter** will move onto the next (sequential) memory location.

Exercise: Addition Subtraction

- Create a program which takes and stores in 2 inputs from the user and outputs the sum of them.

- Create a program which take in three numbers and stores them and then outputs the sum of the first 2 numbers with the third subtracted.

LMC Code Summary

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___	**INP**	___	- Input
___	**OUT**	___	- Output
___	**HLT**	___	- Halt
___	**STA**	***var***	- *Store*
___	**LDA**	***var***	- Load
var	**DAT**	___	- Data
___	**ADD**	***var***	- Addition
___	**SUB**	***var***	- *Subtraction*

Go to (Branch Always)

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Name: Branch Always
Mnemonic: *BRA variable*
Code: *6 _ _*

Description:

Moves the **Program Counter** to the memory location stored within the variable memory location.

Next Action:

After the memory location has been loaded that memory location will be executed.

Exercise: Looping

- Create a program which allows the user to input numbers indefinitely and outputs the number which was entered last.
- Create a program which allows the user to input numbers indefinitely and outputs the running total after each entry.
- (Extension) Create a program which allows the user to input numbers indefinitely and outputs the sum at each entry.

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LMC Code Summary

___	**INP**	___	- Input
___	**OUT**	___	- Output
___	**HLT**	___	- Halt
___	**STA**	***var***	- *Store*
___	**LDA**	***var***	- Load
var	**DAT**	___	- Data
___	**ADD**	***var***	- Addition
___	**SUB**	***var***	- *Subtraction*
___	***BRA***	***var***	- Branch Always

Go to (Branch If Zero)

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Name: Branch If Zero
Mnemonic: *BRZ variable*
Code: *7 _ _*

Description:

Moves the **Program Counter** to the memory location stored within the variable memory location if the accumulator is equal to zero.

Next Action:

After the memory location has been loaded that memory location will be executed.

Go to (Branch If Zero or Positive)

Name: Branch If Zero or Positive
Mnemonic: *BRP variable*
Code: *8 _ _*

Description:

Moves the **Program Counter** to the memory location stored within the variable memory location if the accumulator is zero or positive.

Next Action:

After the memory location has been loaded that memory location will be executed.

LMC Code Summary

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___	**INP**	___	- Input
___	**OUT**	___	- Output
___	**HLT**	___	- Halt
___	**STA**	***var***	- *Store*
___	**LDA**	***var***	- Load
var	**DAT**	___	- Data
___	**ADD**	***var***	- Addition
___	**SUB**	***var***	- *Subtraction*
___	***BRA***	***var***	- Branch Always
___	***BRZ***	***var***	- Branch If Zero
___	***BRP***	***var***	- Branch If Positive

Exercise: Conditional Branching

- Create a program which allows the user to input two numbers and outputs the multiplication of the two numbers.

- Create a program which allows the user to input two numbers and outputs the smallest number.

  Hint: if you do a - b and the number is positive then a is bigger than b.