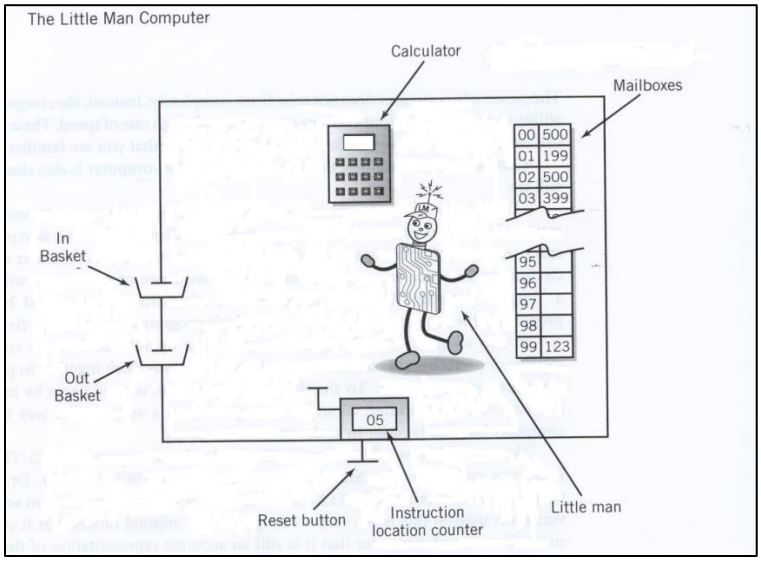
Consider this model of the LMC and answer the questions below.



Discussion Questions

Please refer to this table of op codes for the discussion questions

Opcode	Definition
0	Halt
1	ADD
2	SUBTRACT
3	STORE
5	LOAD
6	BRANCH UNCONDITIONALLY
7	BRANCH ON ZERO
8	BRANCH ON POSITIVE
901	INPUT

1) Using the LMC program below, add comments to explain what the result (value in the calculator) is after the completion of each instruction. The first one is completed as an example.

Mailbox	**Contents**	**Result after completion**
00	901	*Read contents from in basket and store in calculator*
01	319	
02	901	
03	320	
04	219	
05	709	
06	518	
07	902	

08	000
09	517
10	902
11	000
---	---
17	DAT
18	DAT
19	DAT
20	DAT

Sol:

Mailbox	**Contents**	**Result after completion**
00	**901**	**Read contents from in basket and store in calculator**
01	**319**	**Store value of calculator in mailbox 19**
02	**901**	**Read contents from in basket and store in calculator**
03	**320**	**Store value of calculator in mailbox 20**
04	**219**	**Subtract the value in calculator by value in mailbox 19**
05	**709**	**Branch to mailbox 09 if calculator is 0**
06	**518**	**Load value in mailbox 18 to calculator**
07	**902**	**Move value in calculator to out basket**
08	**000**	**Halt**
09	**517**	**Load value in mailbox 17 to calculator**
10	**902**	**Move value in calculator to out basket**
11	**000**	**Halt**
---	---	
17	**DAT**	
18	**DAT**	
19	**DAT**	
20	**DAT**	

2) Refer to the LMC program in question (1). Suppose the contents of mailbox 17 = 5; contents of mailbox 18 = 1.

a) What is the final value in out basket if the first in basket is 56 and second in basket is 89?
b) What is the final value in out basket if the first in basket is 75 and second in basket is 75?
c) What is the final value in out basket if the first in basket is 89 and second in basket is 56?

Sol: The order of input does not matter.

a) 5 (because 56 and 89 are different)
b) 1 (because 75 and 75 are same)
c) 5 (because 56 and 89 are different)

3) Describe what the LMC program in question (1) does. Suppose the contents of mailbox 17 = 5; contents of mailbox 18 = 1.

Sol: This program showcases to the out crate "5" if the data sources are unique, and a "1" on the off chance that they are same ; the request for input doesn't make a difference.

4) Refer to the LMC program below and the table of op codes given above.
a) What is the first number placed in the out basket?
b) What is the last number placed in the out basket?

Mailbox	**Contents**	
00	517	
01	218	
02	902	
03	705	
04	601	
05	000	
……..		
17	100	DAT
18	2	DAT

Sol:

a) 98
b) 0

5) Refer to the LMC program in question (4). Change DAT in mailbox 18 to 4.
a) What is the first number placed in the out basket?
b) What is the last number placed in the out basket?

Sol:

a) 96
b) 0

6) Describe what the LMC program in question (4) does.

Sol: This program shows even numbers to the out container tallying in reverse from 98.

The main number is show is 98, and the last number showed is 0.

7) Refer to the LMC program below. Write down what the calculator will hold after the instruction is complete in each loop. The first one is completed as an example.

Mailbox	**Contents**		**Calculator after instruction is complete**			
			Loop1	**Loop2**	**Loop3**	**Loop4**
00	517		*1*	*2*	*3*	*4*
01	118					
02	317					
03	219					
04	710					
05	600					
……..						
17	1	DAT				
18	1	DAT				
19	5	DAT				

Sol:

Mailbox	**Contents**		**Calculator after instruction is complete**			
			Loop1	**Loop2**	**Loop3**	**Loop4**
00	**517**		**1**	**2**	**3**	**4**
01	**118**		**2**	**3**	**4**	**5**
02	**317**		**2**	**3**	**4**	**5**
03	**219**		**-3**	**-2**	**-1**	**0**
04	**710**		**-3**	**-2**	**-1**	**0**
05	**600**		**-3**	**-2**	**-1**	**NA**
……..						
17	**1**	DAT				
18	**1**	DAT				
19	**5**	DAT				

8) Refer to the LMC program in question (7). How did the contents of mailboxes 17-19 change for each loop?

Sol: The substance of address 17 goes: 2-3-4-5. The others don't change.

---

8) Refer to the LMC program in question (7). How did the contents of mailboxes 17-19 change for each loop?

Sol: The substance of address 17 goes: 2-3-4-5. The others don't change.

---

9) What instruction should be placed in mailbox 02 so the program loops 4 times? Refer to the table of op codes above.

Mailbox	**Contents**
00	**517**
01	**218**
02	**???**
03	**317**
04	**902**
05	**600**
06	**000**
……..	
17	**10**
18	**2**

Sol: The substance of address 02 ought to be 706 to circle multiple times.

---

10) Describe what the following LMC program does. Refer to the table of op codes above.

Mailbox	Contents
00	901
01	309
02	207
03	902
04	708
05	602
06	000
07	1
08	000
09	DAT

Sol: The program gets a number from the client. It at that point circles by that number showing the circle exclude to the bushel each time. Model: in container 4: Display to out bushel: 3 – 2 – 1–0.

11) The contents in memory occasionally have to be moved to another area of memory. When that happens, the mailbox references must be adjusted so that the program continues to function properly. Rewrite the LMC code in problem (10) so that it occupies mailboxes 05 through 14 only; mailboxes 01 through 04 will be used by another program, so they can't be used. Assume that instruction 605 remains in mailbox 00.

Mailbox	Contents
00	605
01	used by other program
02	used by other program
03	used by other program
04	used by other program
05	???
06	???
07	???
08	???
09	???
10	???
11	???
12	???
13	???
14	???

Sol:

Mailbox	**Contents**
00	**605**
01	**used by other program**
02	**used by other program**
03	**used by other program**
04	**used by other program**
05	**901**
06	**314**
07	**212**
08	**902**
09	**713**
10	**606**
11	**000**
12	**1**
13	**000**
14	**DAT**

---

12) Describe the LMC three-digit instruction format. How does the LMC know what part of the value is an instruction, and what part is an address?

Sol: The format of an instruction takes the form XYY
Where X is the op code (0-9) and YY is the address (00-99).
There is no op code X=4.

The LMC just needs to check the principal digit for the opcode; the staying 2 digits are a location.

13) How does the LMC "know" if a particular mailbox contains data or instructions?

Sol:-LMC doesn't have the foggiest idea whether the incentive in a post box is a guidance or not. The main guidance area is 00 and the following is controlled by the program counter. In the event that the LMC stumbles over a memory esteem that wasn't proposed to be a guidance, the LMC would attempt to execute it. Then again, if the program antitheses to a specific letter drop, it is accepted to contain a guidance, not information.

---

14) What happens if the LMC is executing a program and never encounters a "HALT" command?

Sol: The program will keep on executing until it experiences an area that contains "000" (the HALT guidance, even it's information) or an area that starts with a 4, which is an invalid activity code. This expect increasing the program counter past 99 returns it to zero.

---

15) Describe how the LMC is von Neumann architecture.

Sol:

1) **Memory holds the two projects and information; this is known as the put away program idea. The put away program idea permits projects to be changed without any problem.**
   Yes, LMC memory holds programs and data

2) **Memory is tended to directly; that is, there is a solitary successive numeric location for every single memory area.**

   Yes, LMC memory is addressed linearly

3) **Memory is tended to by the area number regardless of the information contained inside.**

   Yes, LMC memory is addressed without regard for the contents.

Section 6.6 A Note Regarding Computer Architectures

Alternative answer:

1. The computer consists of a CPU and memory, with facility for input and output
2. The memory holds both instructions and data

3. The instructions are executed sequentially, that is, one at a time.

Solutions

Problem	Answer	Section in text / comments
1	d	Section 6.2 Operation of the LMC
2	c	Section 6.2 Operation of the LMC
3	b	Section 6.2 Operation of the LMC
4	c	Section 6.2 Operation of the LMC
5	d	Section 6.2 Operation of the LMC
6	d	Section 6.2 Operation of the LMC
7	a	Section 6.2 Operation of the LMC
8	c	Section 6.2 Operation of the LMC
9	d	Section 6.2 Operation of the LMC
10	d	Section 6.2 Operation of the LMC
11	c	Section 6.2 Operation of the LMC
12	c	Section 6.2 Operation of the LMC
13	d	Section 6.2 Operation of the LMC
14	c	Section 6.2 Operation of the LMC
15	c	Section 6.4 An Extended Instruction Set
16	d	Section 6.4 An Extended Instruction Set
17	c	Section 6.4 An Extended Instruction Set
18	c	Section 6.4 An Extended Instruction Set
19	b	Section 6.5 The Instruction Cycle
20	d	Section 6.5 The Instruction Cycle
21	a	Multiple Sections 6.2, 6.4, 6.5
22	a	Multiple Sections 6.2, 6.4, 6.5
23	a	Multiple Sections 6.2, 6.4, 6.5
24	d	Multiple Sections 6.2, 6.4, 6.5
25	d	Multiple Sections 6.2, 6.4, 6.5
26	d	Multiple Sections 6.2, 6.4, 6.5
27	d	Multiple Sections 6.2, 6.4, 6.5
28	b	Multiple Sections 6.2, 6.4, 6.5
29	c	Multiple Sections 6.2, 6.4, 6.5
30	b	Multiple Sections 6.2, 6.4, 6.5
31	d	Multiple Sections 6.2, 6.4, 6.5
32	d	Multiple Sections 6.2, 6.4, 6.5
33	b	Multiple Sections 6.2, 6.4, 6.5
34	c	Section 6.6 A Note Regarding Computer Architectures
35	a	Section 6.6 A Note Regarding Computer Architectures