

# PASS - Computer Systems

## Week 4 part 2

### 1. Instruction set

a. What kind of instructions does HACK CPU have?

A instructions - set address  $PC$

C instructions - manipulate data

b. What are the registers in HACK CPU?

A - address

D - data

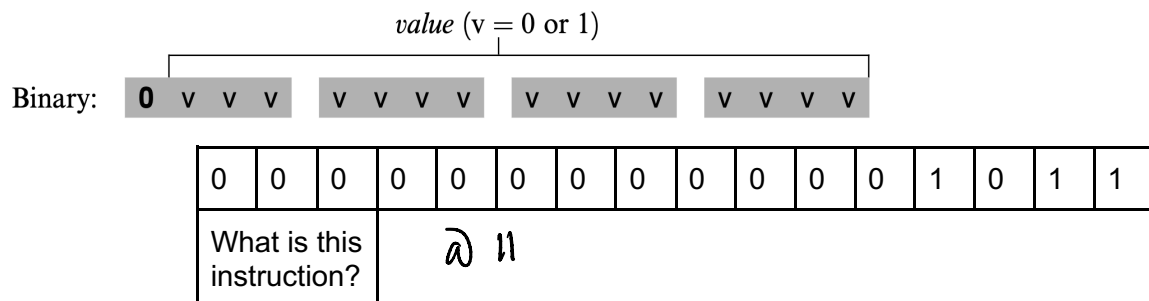
c. What is the data memory

RAM

d. What is the instruction memory

ROM

A-instruction:  $@value$  // Where *value* is either a non-negative decimal number  
// or a symbol referring to such number.

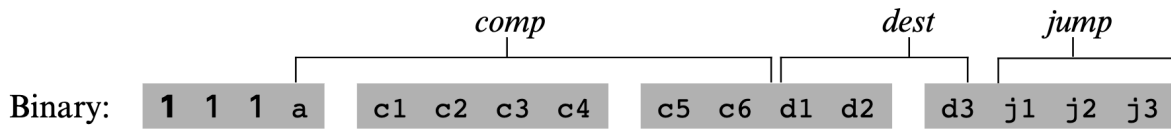


0 - A instruction

v - convert to decimal

$@11$

C-instruction: *dest=comp;jump* // Either the *dest* or *jump* fields may be empty.  
 // If *dest* is empty, the “=” is omitted;  
 // If *jump* is empty, the “;” is omitted.



1	1	1	0	1	1	1	0	1	0	0	1	0	0	1	1
What is this instruction?				D = -1 ; JGE											

(when a=0) <i>comp</i>	c1	c2	c3	c4	c5	c6	(when a=1) <i>comp</i>
0	1	0	1	0	1	0	
1	1	1	1	1	1	1	
-1	1	1	1	0	1	0	
D	0	0	1	1	0	0	
A	1	1	0	0	0	0	M
!D	0	0	1	1	0	1	
!A	1	1	0	0	0	1	!M
-D	0	0	1	1	1	1	
-A	1	1	0	0	1	1	-M
D+1	0	1	1	1	1	1	
A+1	1	1	0	1	1	1	M+1
D-1	0	0	1	1	1	0	
A-1	1	1	0	0	1	0	M-1
D+A	0	0	0	0	1	0	D+M
D-A	0	1	0	0	1	1	D-M
A-D	0	0	0	1	1	1	M-D
D&A	0	0	0	0	0	0	D&M
D A	0	1	0	1	0	1	D M

C-instruction (starts with 1)

a=0

111010

-1

2. Translate below instruction/code into Assembly

Q1	Set D to A-1	$\omega A$ $D = A$ $D = D - 1$
Q2	Set both A and D to A + 1	$\omega A$ $A = A + 1$ $D = A$
Q3	Set D to 19	$\omega 19$ $D = A$
Q4	Set RAM[53] to 171	$\omega 171$ $D = A$ $\omega 53$ $M = D$
Q5	Add 1 to RAM[7] and store the result in D	$\omega 7$ $D = M + 1$
Q6	x=arr[y]	$\omega y$ $D = A$ $\omega arr$ $A = M + D$ $D = M$ $\omega x$ $M = D$

Q7	arr[j] = 17	<p> <math>\omega J</math>  <math>D = A</math>  <math>\omega ARR</math>  <math>A = M + D</math>  <math>D = A</math>  <math>\omega 16</math>  <math>M = D</math>  <math>\omega 17</math>  <math>D = A</math>  <math>\omega 16</math>  <math>A = M</math>  <math>M = 0</math> </p>
Q8	<pre> int i=1; int sum=0;  while (i &lt;= 100) {     sum += i;     i++; } </pre>	Done on next worksheet