PROJECT ④ ML

(A) INSTRUCTION

@[VALUE]

0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0

A instruction OPCODE · [VALUE] MAX $2^{15}-1$

(C) INSTRUCTION

[optional DESTINATION] = [COMPUTATION] ; [optional JUMP]   ← COMPARE TO ZERO

unused, set to 1

1 1 1 a c1 c2 c3 c4 c5 c6 d1 d2 d3 j1 j2 j3

c instruction OPCODE · comp (7 bits) · dest (3 bit) · JUMP (3 bit)

COMP (7 bit)

a=0	a=1	c_1	c_2	c_3	c_4	c_5	c_6
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	M	1	1	0	0	0	0
!D		0	0	1	1	0	1
!A	!M	1	1	0	0	0	1
-D		0	0	1	1	1	1
-A	-M	1	1	0	0	1	1
D+1		0	1	1	1	1	1
A+1	M+1	1	1	0	1	1	1
D-1		0	0	1	1	1	0
A-1	M-1	1	1	0	0	1	0
D+A	D+M	0	0	0	0	1	0
D-A	D-M	0	1	0	0	1	1
A-D	M-D	0	0	0	1	1	1
D&A	D&M	0	0	0	0	0	0
D|A	D|M	0	1	0	1	0	1

DEST (3 bit)

DEST	d_1	d_2	d_3	Comment
NULL	0	0	0	NO VALUE STORED
M	0	0	1	TO M
D	0	1	0	TO D
MD	0	1	1	TO BOTH M,D
A	1	0	0	TO A
AM	1	0	1	TO BOTH A,M
AD	1	1	0	" " A,D
AMD	1	1	1	TO A,M,D

JUMP (3 bit)

JUMP	j_1	j_2	j_3	Comment
NULL	0	0	0	NO JUMP
JGT	0	0	1	IF COMP >0
JEQ	0	1	0	" " =0
JGE	0	1	1	" " ≥0
JLT	1	0	0	" " <0
JNE	1	0	1	" " ≠0
JLE	1	1	0	" " ≤0
JMP	1	1	1	UNCONDITIONAL

CPU REGISTERS:

- **A** → "Address register" its value is the current "pointed" RAM Register (A instruction or A=... sets it)
- **M** → Its value is the CONTENT of the currently "pointed" RAM Register
- **D** → General purpose register

SCREEN = 16384 (..24575)   KBD = 24576

512 × 256

RAM → SCREEN
(16384) 0 0 .. 16 0 TOP ROW
31
16×8191 rows
8191 (24575)

EACH PIXEL CORRESPONDS TO A BIT OF A RAM WORD

IN ORDER TO CHANGE PIXEL x (COL, ROW) I HAVE TO MODIFY RAM[SCREEN + i] = SCREEN[i]

$$i = 32 \cdot ROW + \frac{COL}{16}$$

AND INSIDE THIS RAM WORD THE BIT N°

$$BIT\ N° = COL \% 16$$

KBD = 24576

Contains the scancode of the key currently being pressed.

Key	Scancode	Key	Scancode	Key	Scancode	Key	Scancode
0	48	A	65	[space]	32		
1	49	B	66	!	33	newline	128
2	50	C	67	"	34	backspace	129
3	51	D	68	#	35	←	130
4	52	E	69	$	36	↑	131
5	53	F	70	%	37	→	132
6	54	G	71	&	38	↓	133
7	55	H	72	'	39	home	134
8	56	I	73	(	40	end	135
9	57	J	74	)	41	pg ↑	136
:	58	K	75	*	42	pg ↓	137
;	59	L	76	+	43	insert	138
<	60	M	77	,	44	del	139
=	61	N	78	-	45	esc	140
>	62	O	79	.	46	f1	141
?	63	P	80	/	47	f2	142
@	64	Q	81			f3	143
		R	82			f4	144
		S	83			f5	145
[	91	T	84			f6	146
\	92	U	85			f7	147
]	93	V	86			f8	148
^	94	W	87			f9	149
_	95	X	88			f10	150
		Y	89			f11	151
		Z	90			f12	152

OTHER ACCEPTED SYMBOLS

SP	0
LCL	1
ARG	2
THIS	3
THAT	4

VIRTUAL REGISTERS

R0	0
⋮	⋮
R15	15