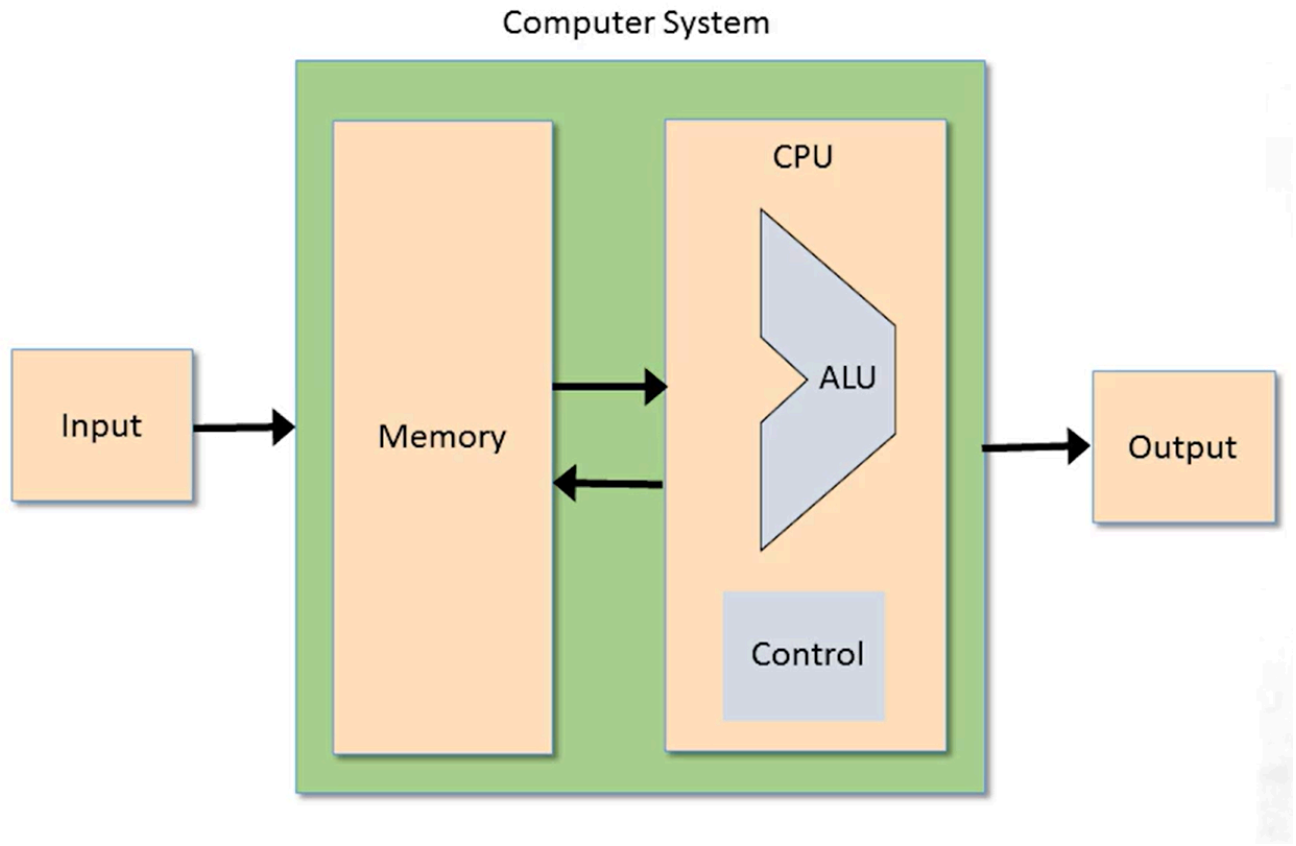
Module 2 - Binary and Arithmetic Logic Unit (ALU)

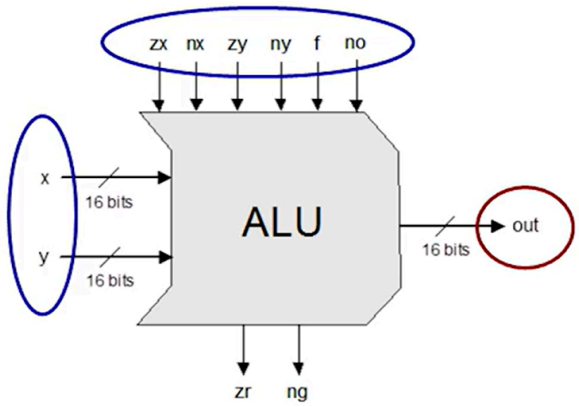
Von Neumann Architecture



Hack ALU

- Operates on two 16-bit, two's complement values
- Output a 16-bit, two's complement value
- Which function to compute is set by 6 1-bit inputs
- Computes one out of a family of 18 functions

- Also compute two 1-bit control outputs (zr and ng)



control bits

zx	nx	zy	ny	f	no	out
1	0	1	0	1	0	0
1	1	1	1	1	1	1
1	1	1	0	1	0	-1
0	0	1	1	0	0	x
1	1	0	0	0	0	y
0	0	1	1	0	1	!x
1	1	0	0	0	1	!y
0	0	1	1	1	1	-x
1	1	0	0	1	1	-y
0	1	1	1	1	1	x+1
1	1	0	1	1	1	y+1
0	0	1	1	1	0	x-1
1	1	0	0	1	0	y-1
0	0	0	0	1	0	x+y
0	1	0	0	1	1	x-y
0	0	0	1	1	1	y-x
0	0	0	0	0	0	x&y
0	1	0	1	0	1	x|y

- Control bits:

pre-setting the x input		pre-setting the y input		selecting between computing + or &	post-setting the output	Resulting ALU output
zx	nx	zy	ny	f	no	out
if zx then x=0	if nx then x=!x	if zy then y=0	if ny then y=!y	if f then out=x+y else out=x&y	if no then out=!out	out(x,y)=

  - The operations are performed from left to right.
  - `zx, zy` is zero `x` or `y` respectively
  - `nx, ny` is negate `x` or `y` respectively
  - `f` is function
  - `no` is negate output
- Output control bits
  - `zr` is 1 if output is zero
  - `ng` is 1 if output is negative