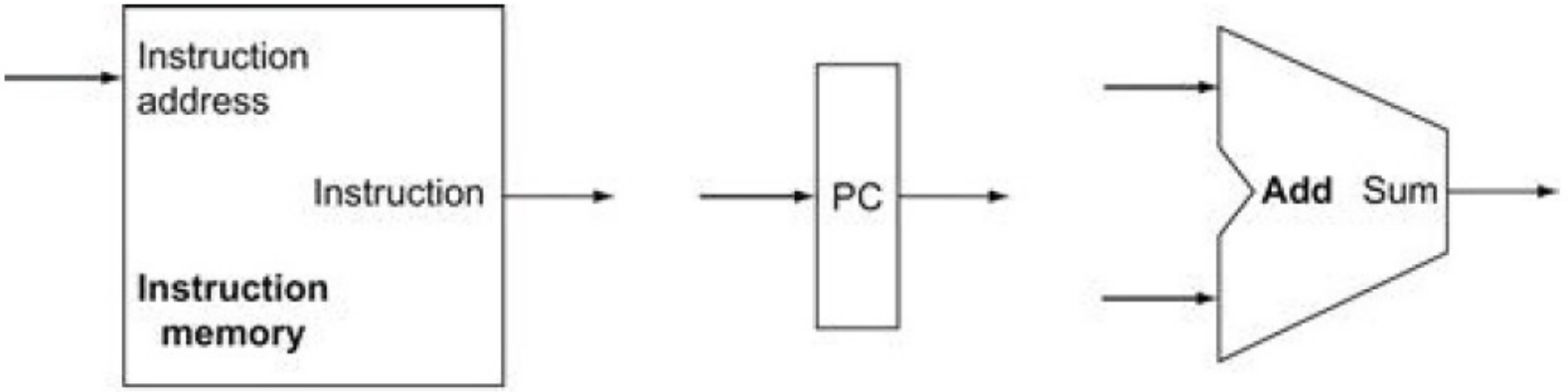
Building a Datapath

DATAPATH ELEMENT

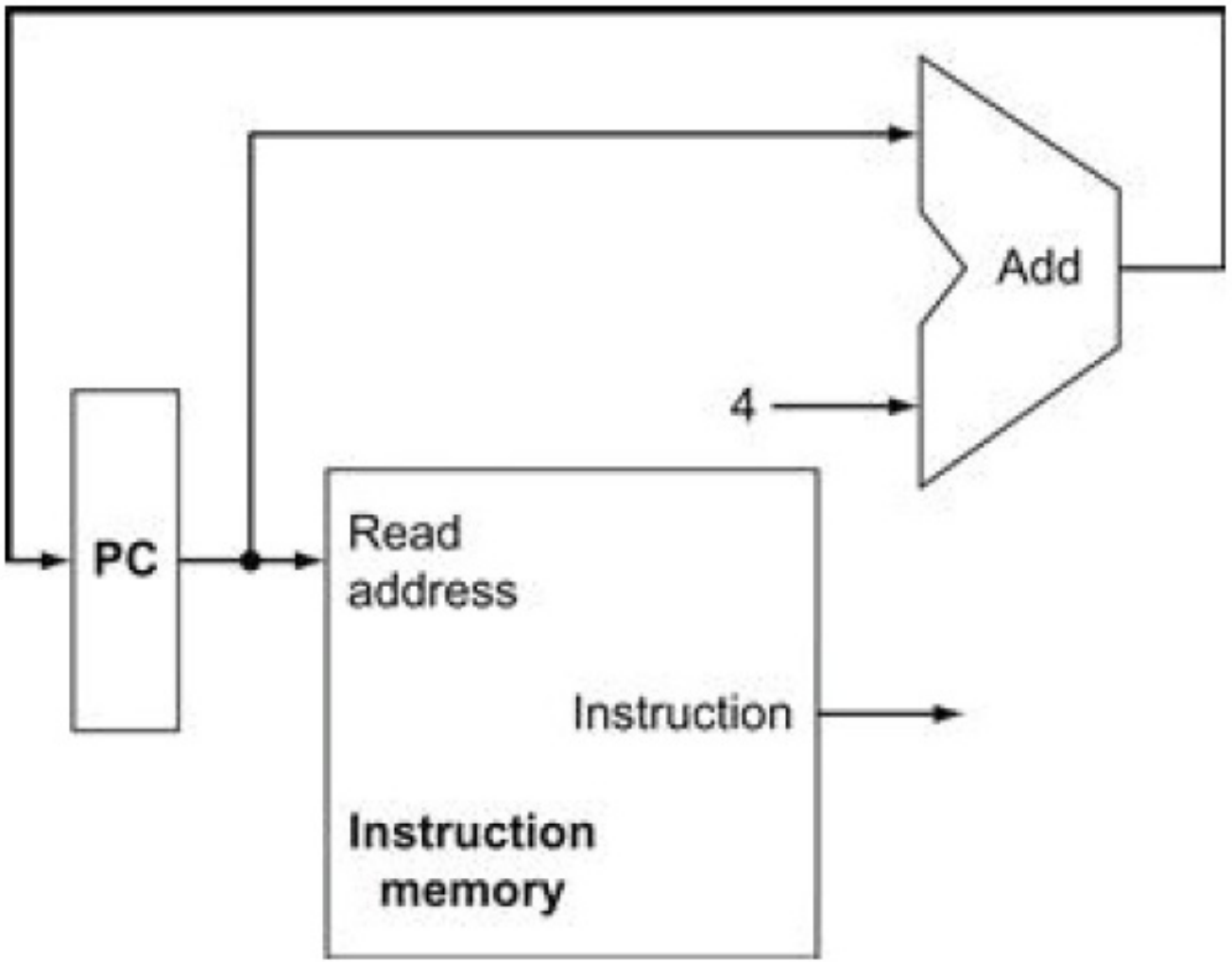
A unit used to operate on or hold data within a processor. In the MIPS implementation, the datapath elements include the instruction and data memories, the register file, the ALU, and adders.

Two state elements are needed to store and access instructions, and an adder is needed to compute the next instruction address.

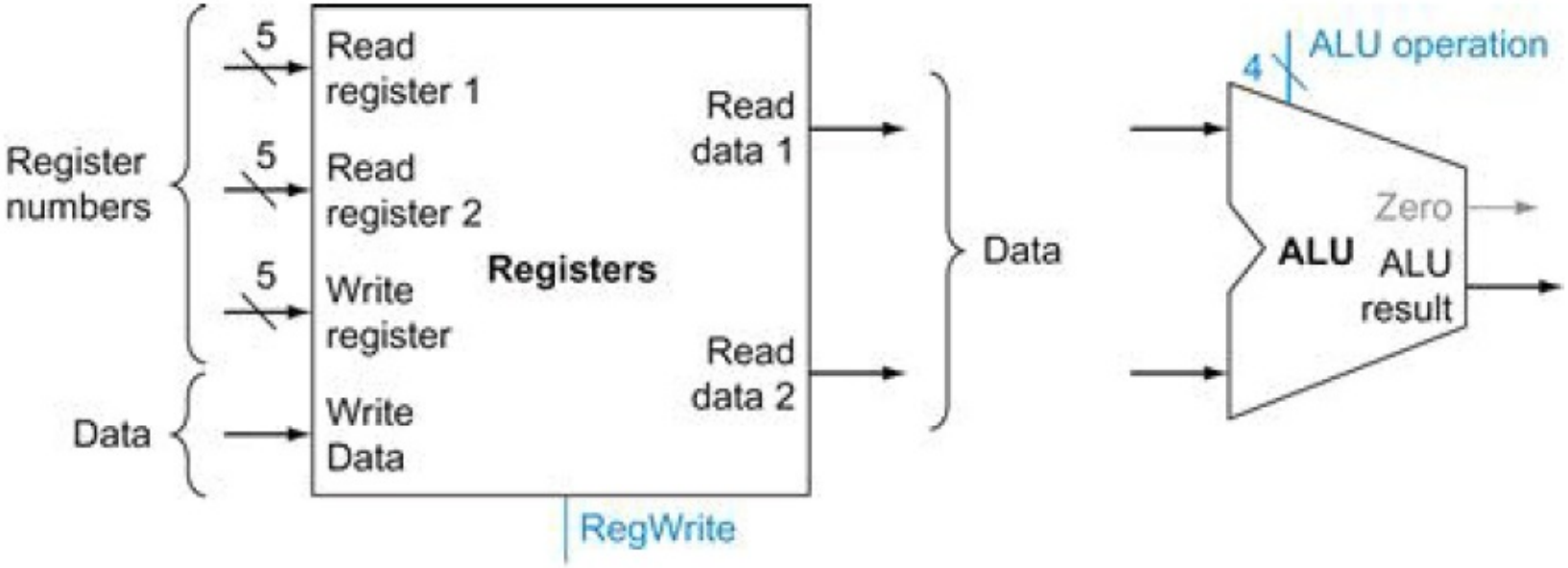


a. Instruction memory b. Program counter c. Adder

A portion of the datapath used for fetching instructions and incrementing the program counter.
The fetched instruction is used by other parts of the datapath.



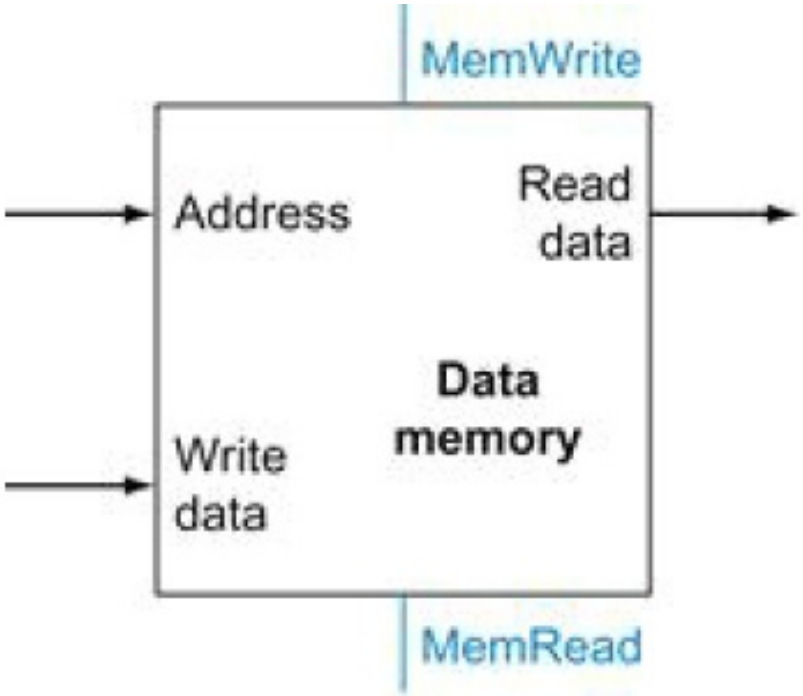
Name	Fields						Comments
Field size	6 bits	5 bits	5 bits	5 bits	5 bits	6 bits	All MIPS instructions are 32 bits long
R-format	op	rs	rt	rd	shamt	funct	Arithmetic instruction format
I-format	op	rs	rt	address/immediate			Transfer, branch, imm. format
J-format	op	target address					Jump instruction format



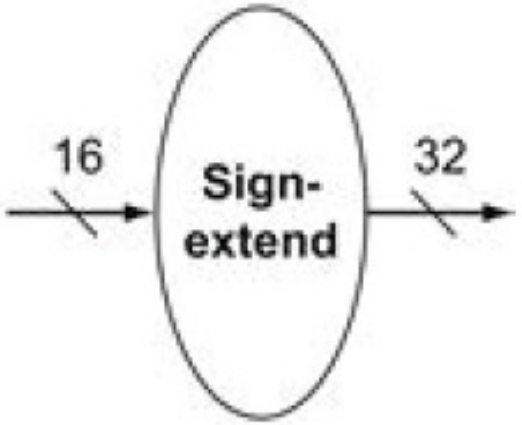
a. Registers

b. ALU

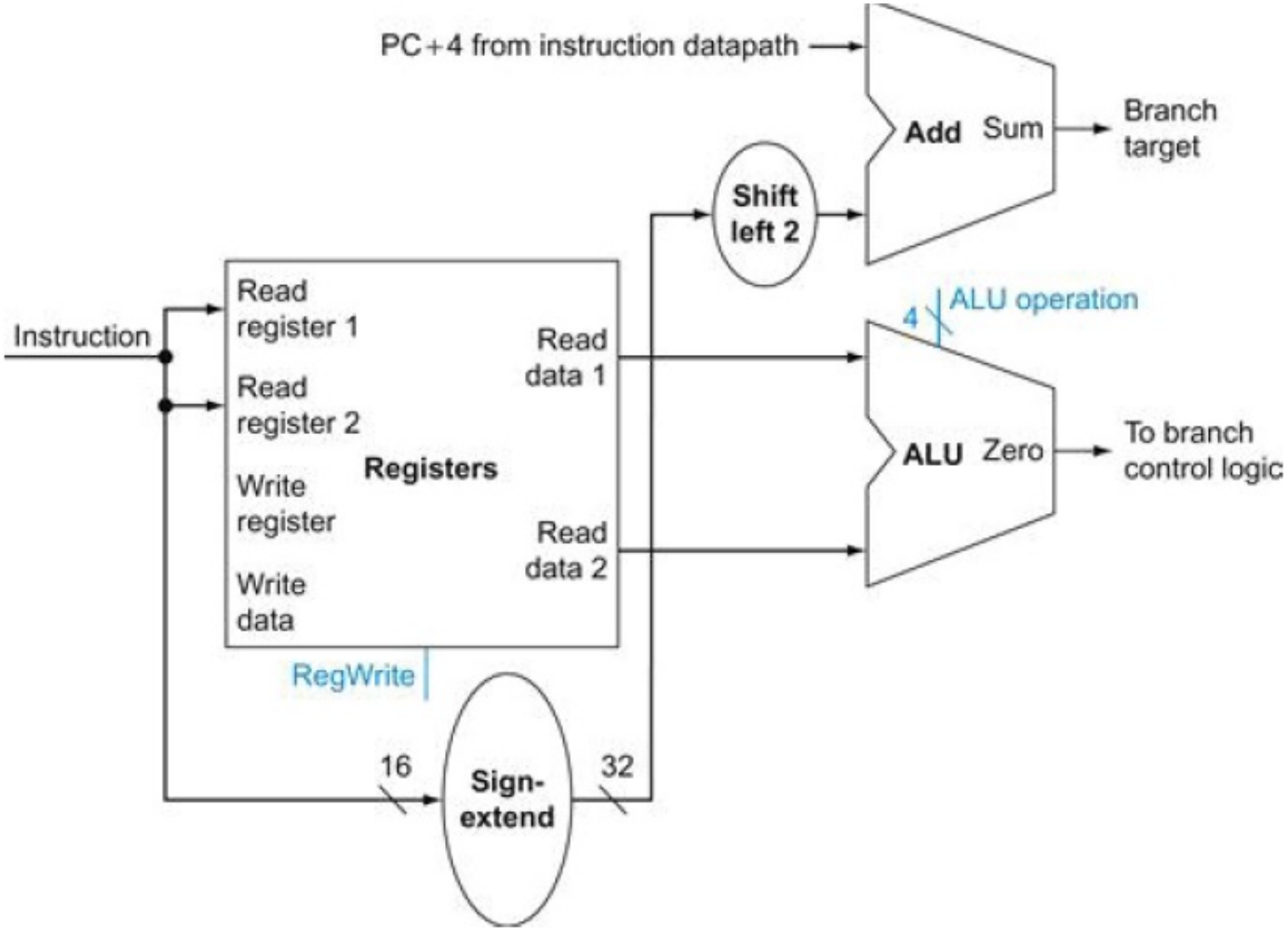
The two units needed to implement loads and stores, in addition to the register file and ALU of Figure 4.7, are the data memory unit and the sign extension unit.

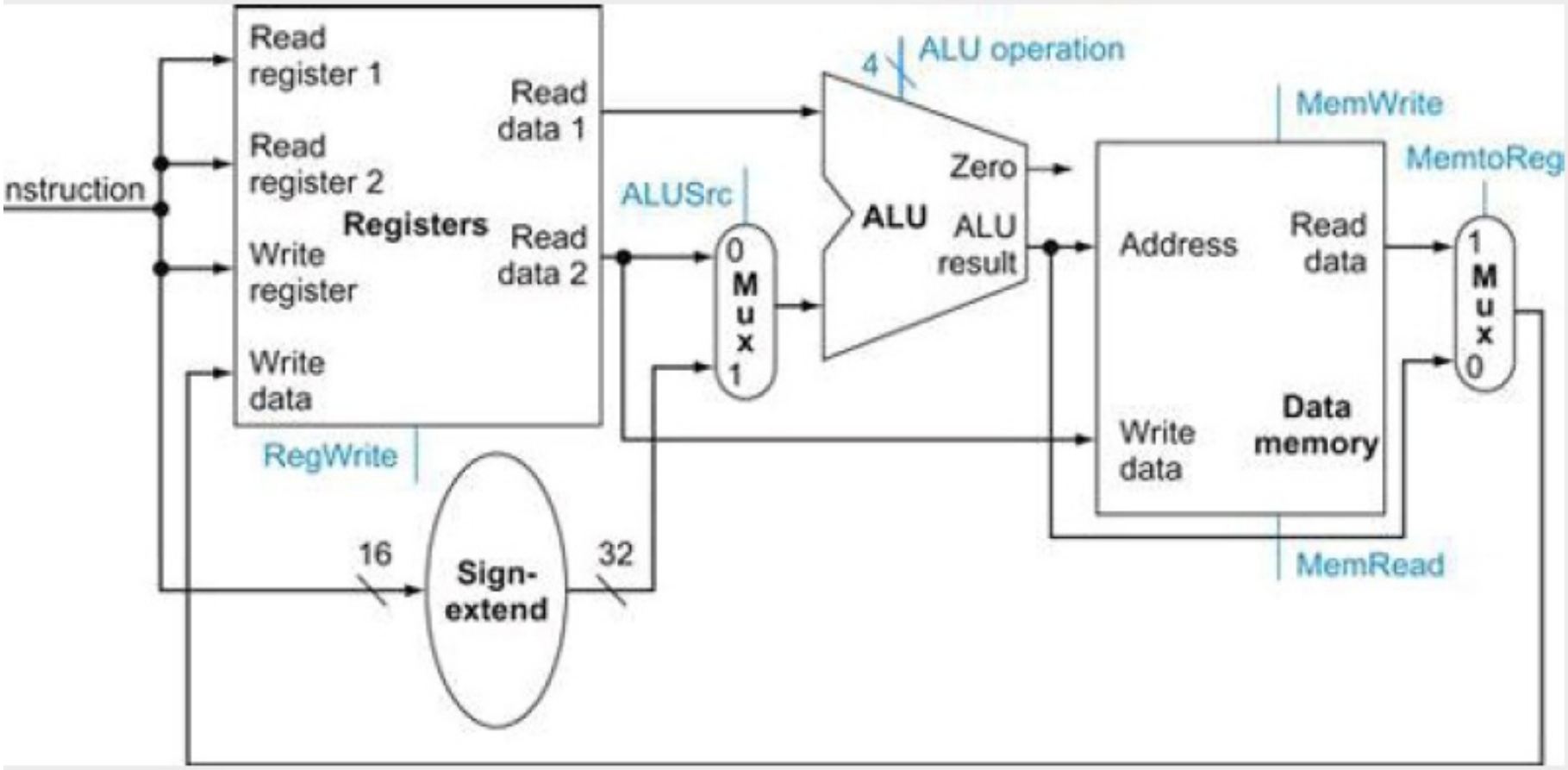


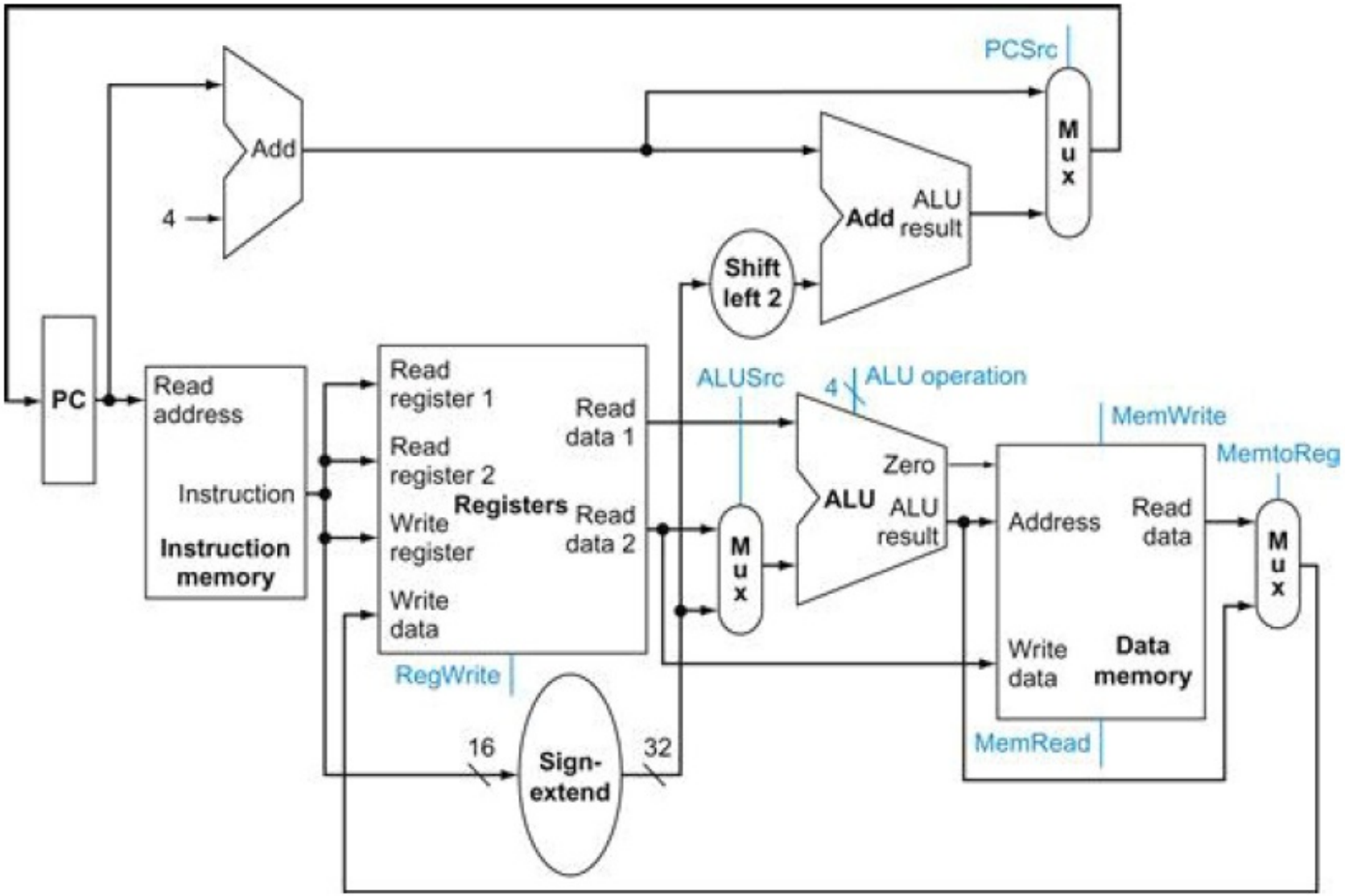
a. Data memory unit



b. Sign extension unit


PC+4 from instruction datapath
Add
Sum
Branch target
Shift left 2
Instruction
Read register 1
Read register 2
Registers
Write register
Write data
Read data 1
Read data 2
4
ALU operation
ALU
Zero
To branch control logic
RegWrite
16
Sign-extend
32


Read register 1
Read register 2
Registers
Write register
Write data
Read data 1
Read data 2
RegWrite
nstruction
ALUSrc
0
M
u
x
1
4
ALU operation
ALU
Zero
ALU result
MemWrite
MemtoReg
Address
Read data
Write data
Data memory
1
M
u
x
0
MemRead
16
Sign-extend
32


PCSrc
Add
4
M
u
x
Add
ALU
result
Shift
left 2
PC
Read
address
Instruction
Instruction
memory
Read
register 1
Read
register 2
Registers
Write
register
Write
data
Read
data 1
Read
data 2
RegWrite
ALUSrc
4
ALU operation
M
u
x
ALU
Zero
ALU
result
MemWrite
MemtoReg
Address
Read
data
Write
data
Data
memory
MemRead
M
u
x
16
Sign-
extend
32