EE2011 Computer Organization

Lecture 7_2: The Processor – Datapath Examples

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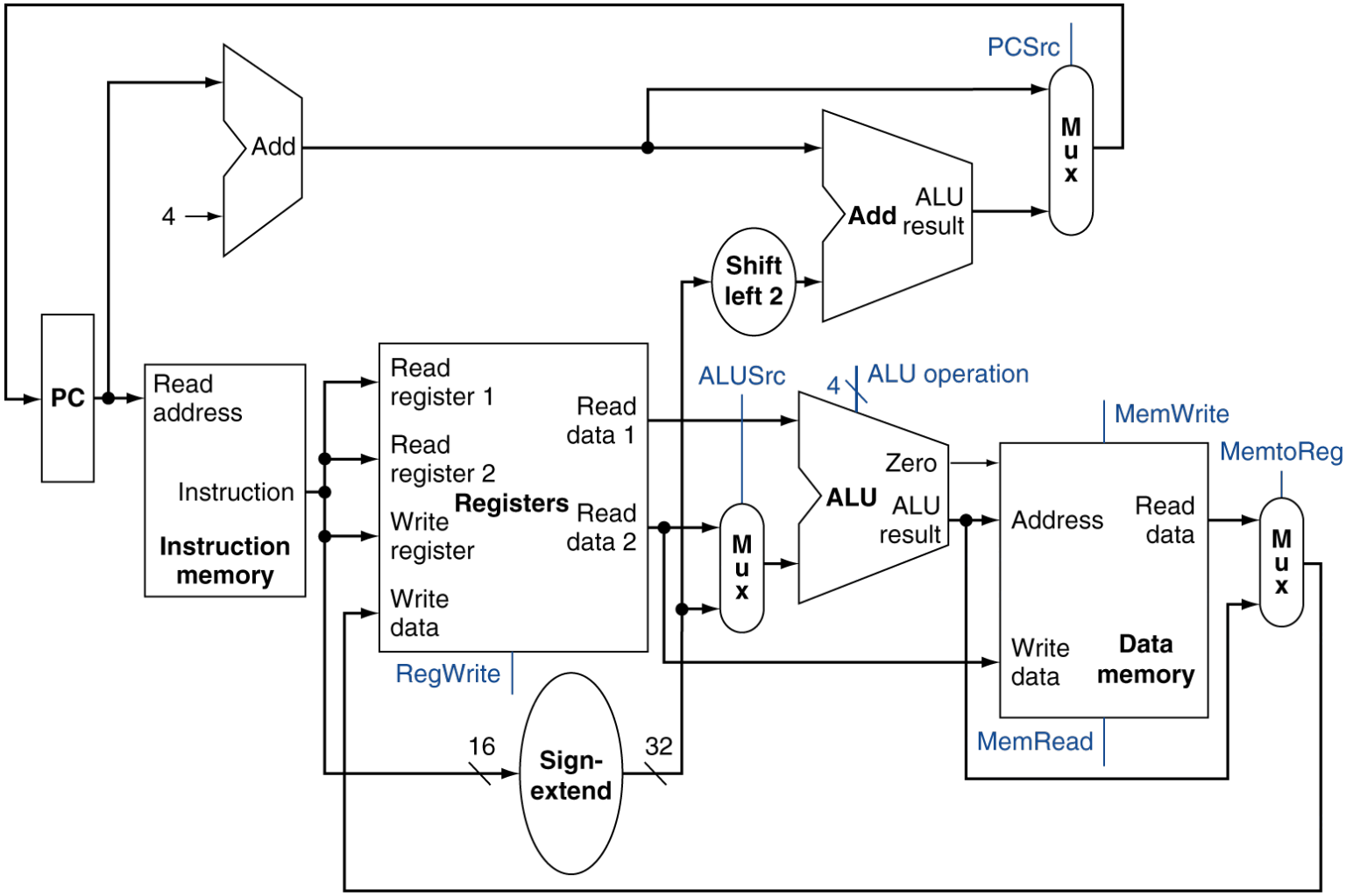
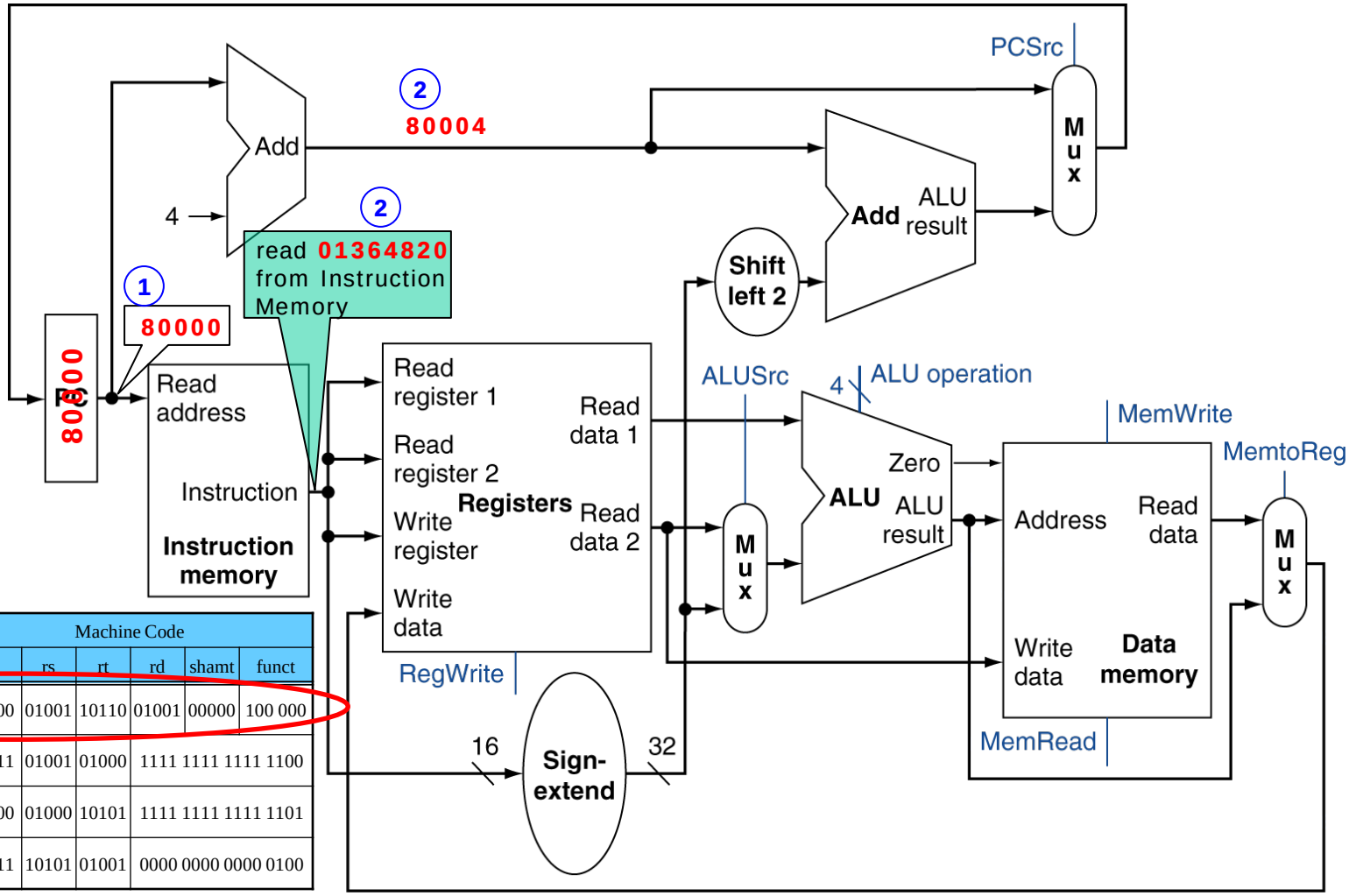
Putting All Together for the Datapath (Fig. 4.11)



How data flow through datapath
Example: R-type Instruction: add (I-Fetch)

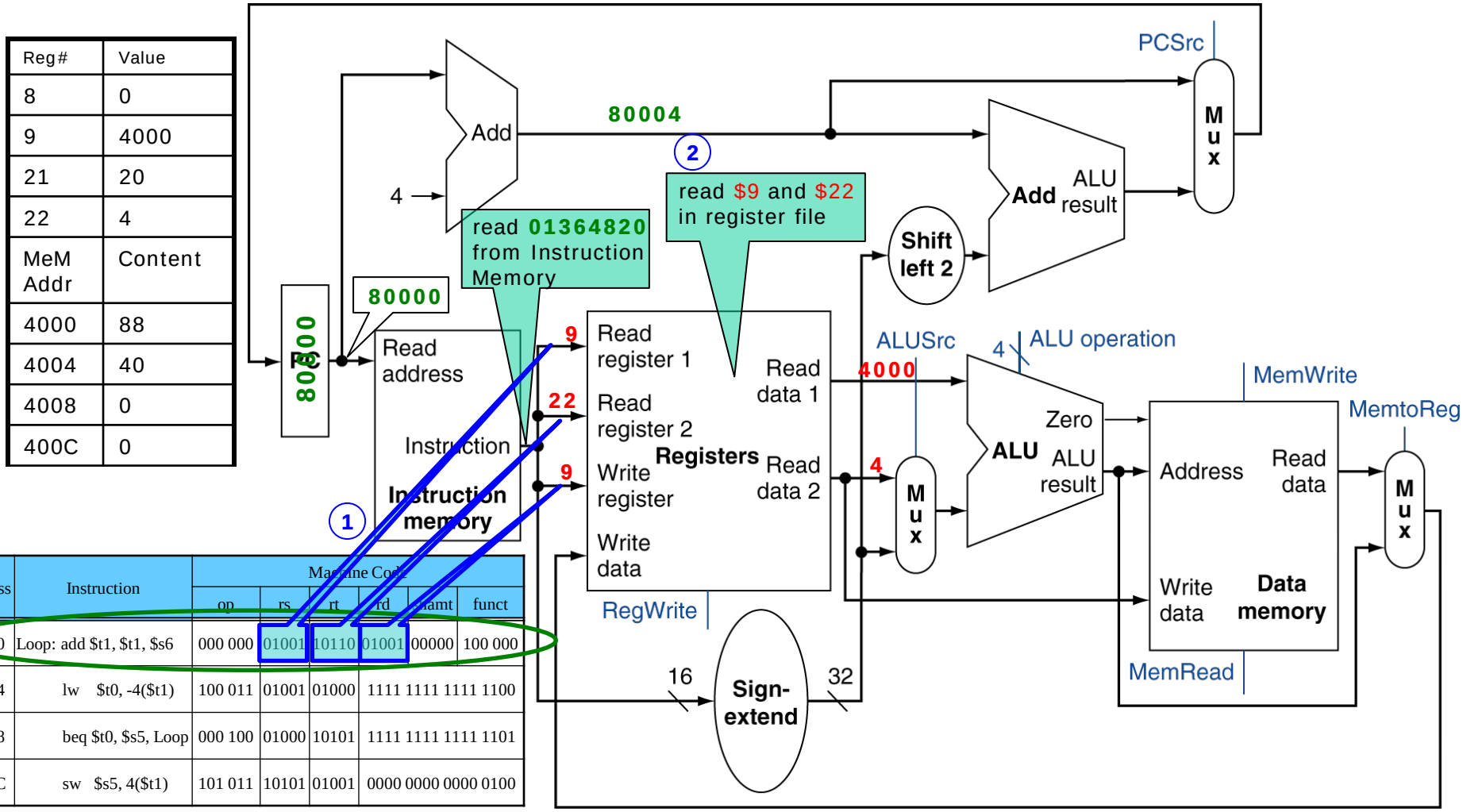
Reg#	Value
8	0
9	4000
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0



Address	Instruction	Machine Code					
		op	rs	rt	rd	shamt	funct
80000	Loop: add $t1, $t1, $s6	000 000	01001	10110	01001	00000	100 000
80004	lw $t0, -4($t1)	100 011	01001	01000	1111 1111 1111 1100		
80008	beq $t0, $s5, Loop	000 100	01000	10101	1111 1111 1111 1101		
8000C	sw $s5, 4($t1)	101 011	10101	01001	0000 0000 0000 0100		

How data flow through datapath
Example: R-type Instruction: add (R-Read)

Reg#	Value
8	0
9	4000
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0



Address	Instruction	Machine Code					
		op	rs	rt	rd	shamt	funct
80000	Loop: add $t1, $t1, $s6	000 000	01001	10110	01001	00000	100 000
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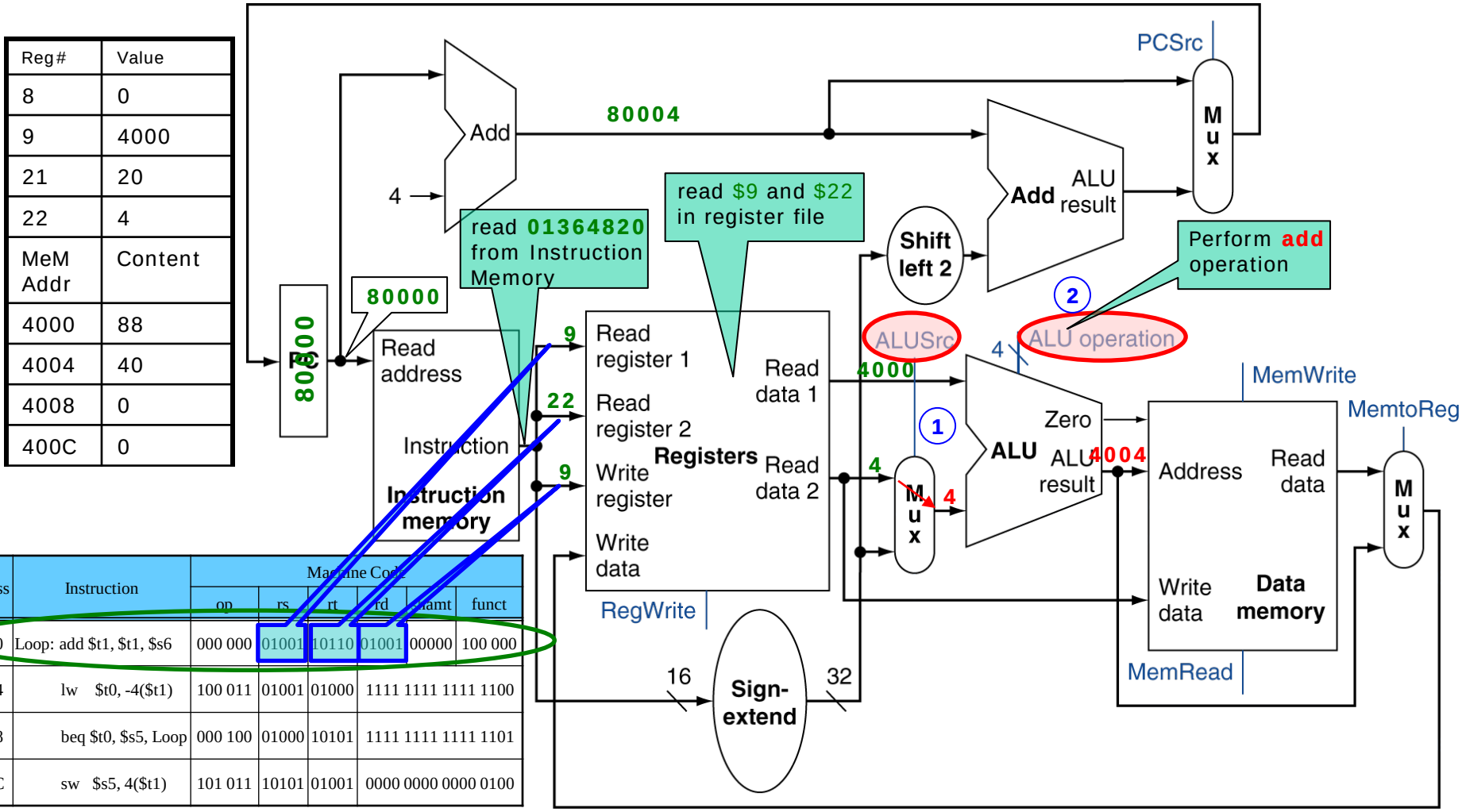
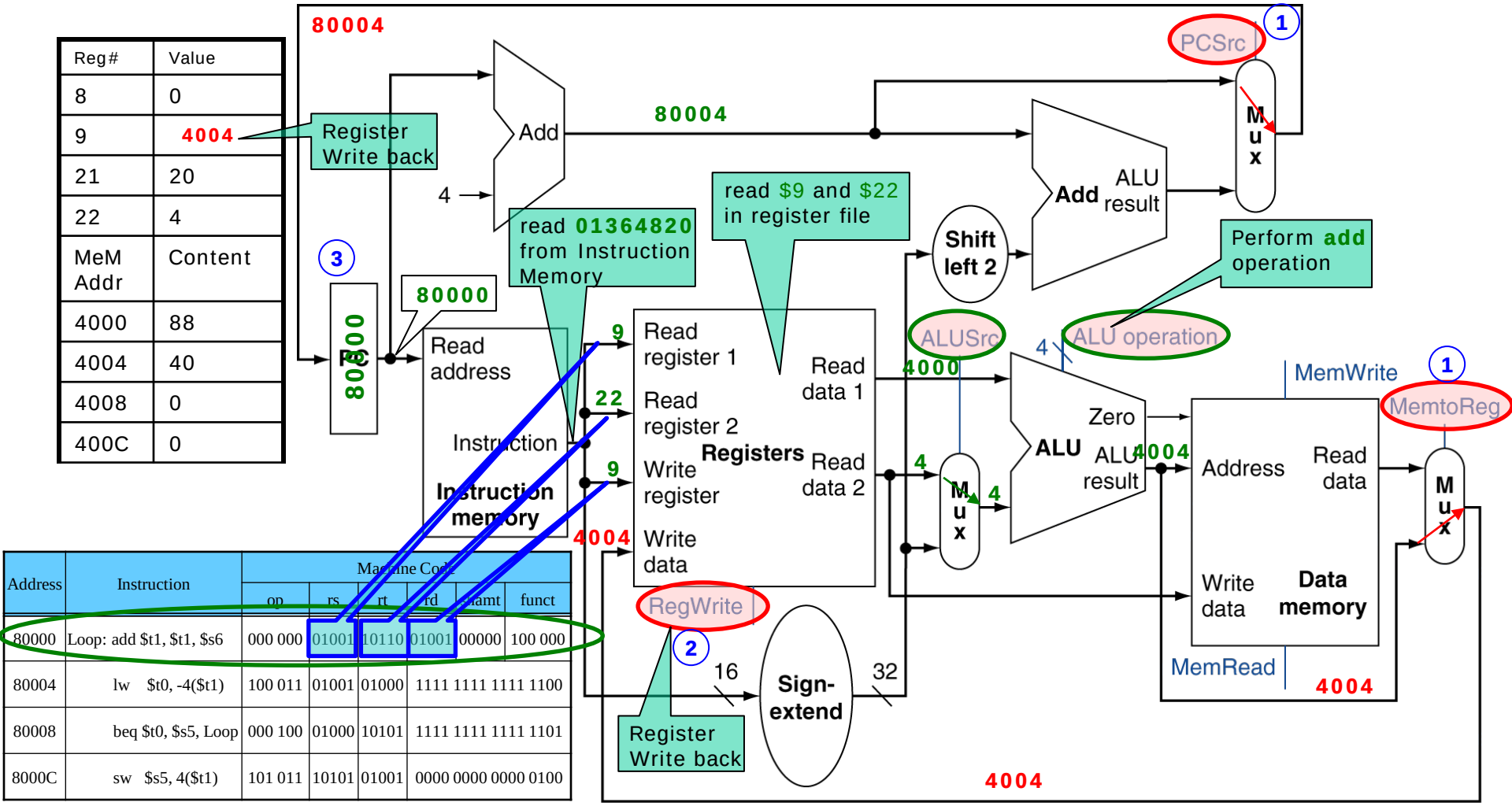
How data flow through datapath
Example: R-type Instruction: add (EXE)

Reg#	Value
8	0
9	4000
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0



Address	Instruction	Machine Code					
		op	rs	rt	rd	shamt	funct
80000	Loop: add $t1, $t1, $s6	000 000	01001	10110	01001	00000	100 000
80004	lw $t0, -4($t1)	100 011	01001	01000	1111 1111 1111 1100		
80008	beq $t0, $s5, Loop	000 100	01000	10101	1111 1111 1111 1101		
8000C	sw $s5, 4($t1)	101 011	10101	01001	0000 0000 0000 0100		

How data flow through datapath
Example: R-type Instruction: add (WB)



Reg#	Value
8	0
9	4004
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0

Address	Instruction	Machine Code					
		op	rs	rt	rd	shamt	funct
80000	Loop: add $t1, $t1, $s6	000 000	01001	10110	01001	00000	100 000
80004	lw $t0, -4($t1)	100 011	01001	01000	1111 1111 1111 1100		
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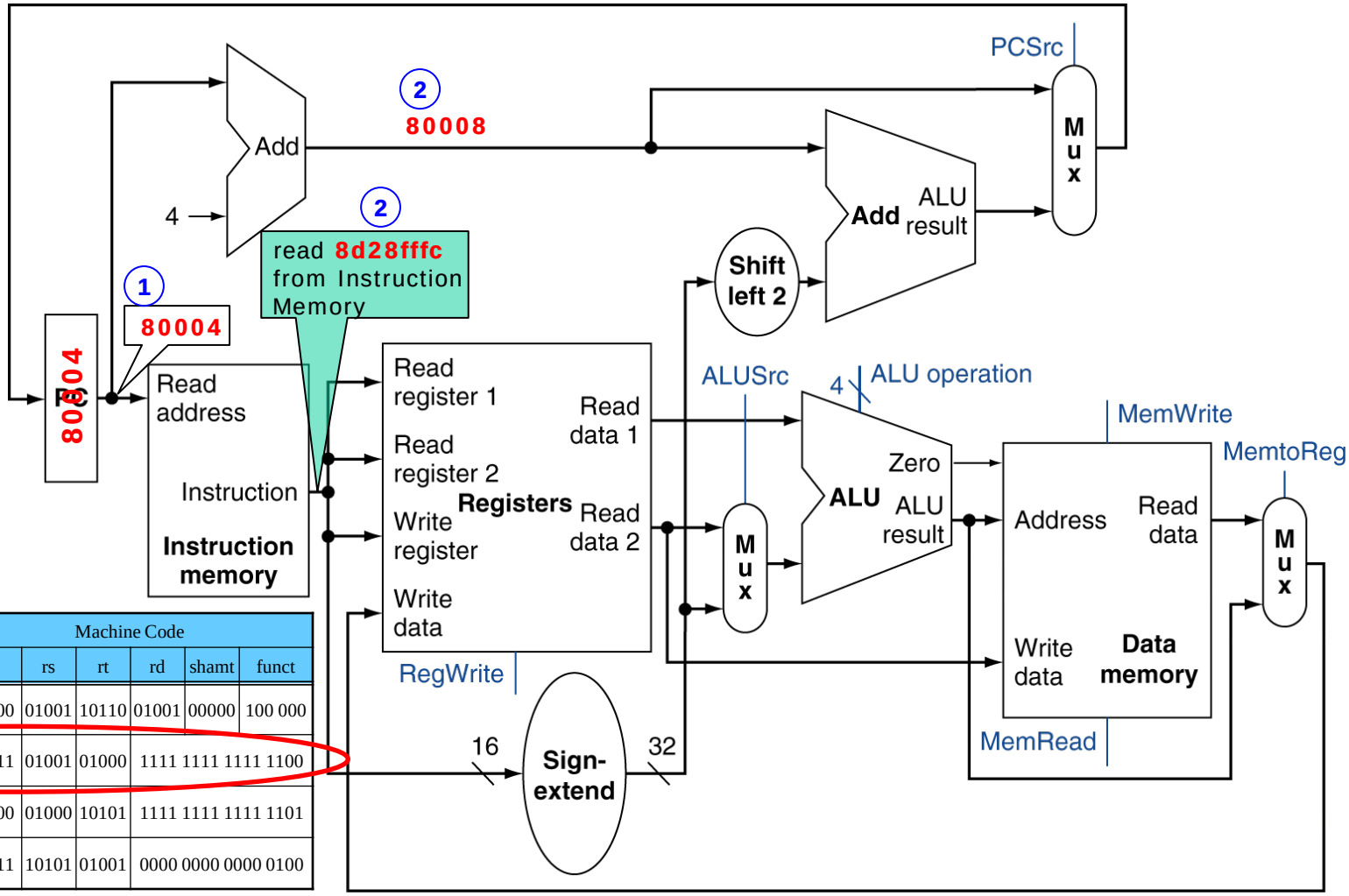
8000C	sw $s5, 4($t1)	101 011	10101	01001	0000 0000 0000 0100		

How data flow through datapath
Example: I-type Instruction: lw (I-Fetch)

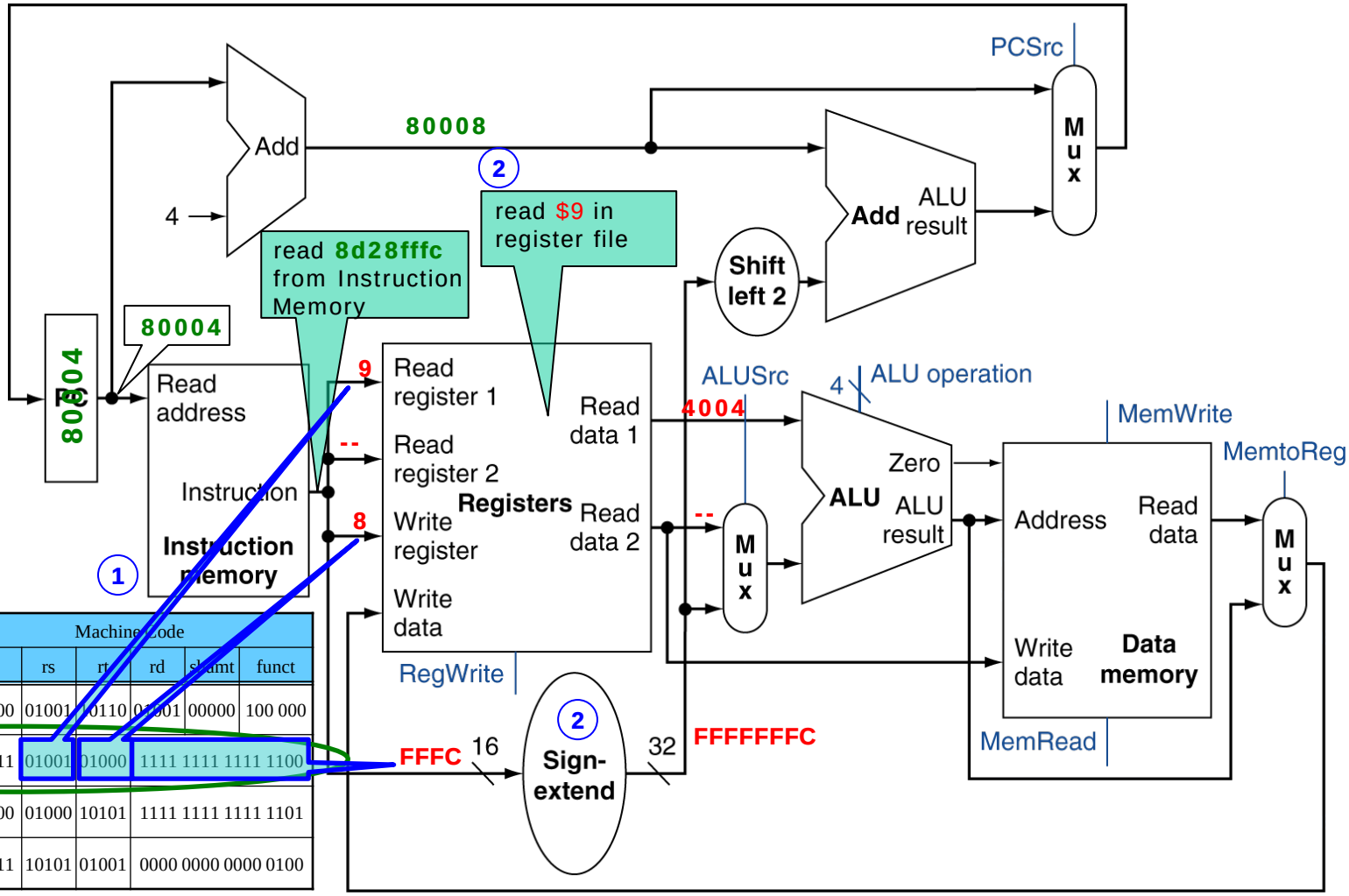
Reg#	Value
8	0
9	4004
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0



Address	Instruction	Machine Code					
		op	rs	rt	rd	shamt	funct
80000	Loop: add $t1, $t1, $s6	000 000	01001	10110	01001	00000	100 000
80004	lw $t0, -4($t1)	100 011	01001	01000	1111 1111 1111 1100		
80008	beq $t0, $s5, Loop	000 100	01000	10101	1111 1111 1111 1101		
8000C	sw $s5, 4($t1)	101 011	10101	01001	0000 0000 0000 0100		

How data flow through datapath
Example: I-type Instruction: lw (R-Read)

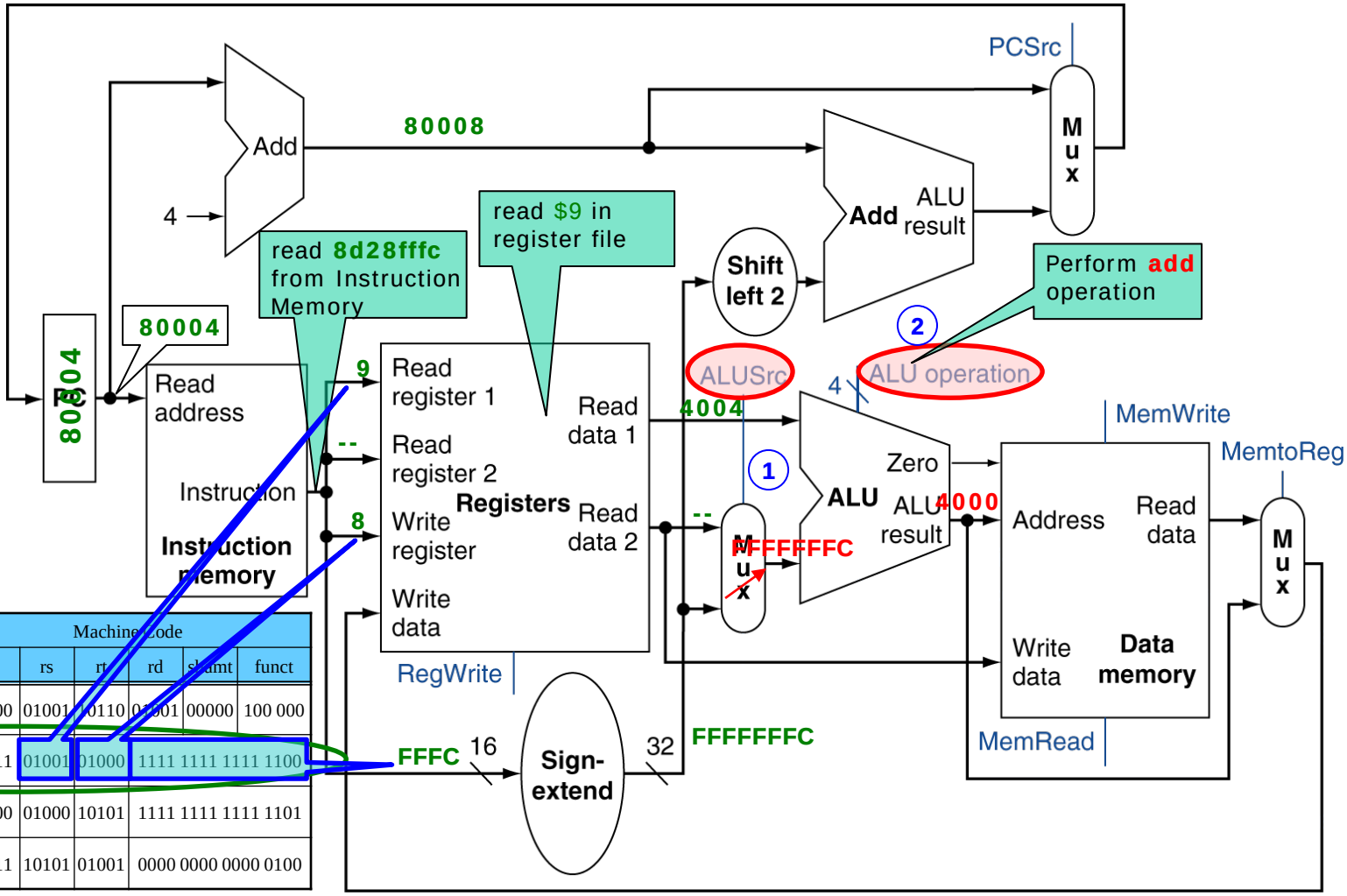
Reg#	Value
8	0
9	4004
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0



Address	Instruction	Machine Code					
		op	rs	rt	rd	shamt	funct
80000	Loop: add $t1, $t1, $s6	000 000	01001	10110	01001	00000	100 000
80004	lw $t0, -4($t1)	100 011	01001	01000	1111 1111 1111 1100		
80008	beq $t0, $s5, Loop	000 100	01000	10101	1111 1111 1111 1101		
8000C	sw $s5, 4($t1)	101 011	10101	01001	0000 0000 0000 0100		

How data flow through datapath
Example: I-type Instruction: lw (EXE)

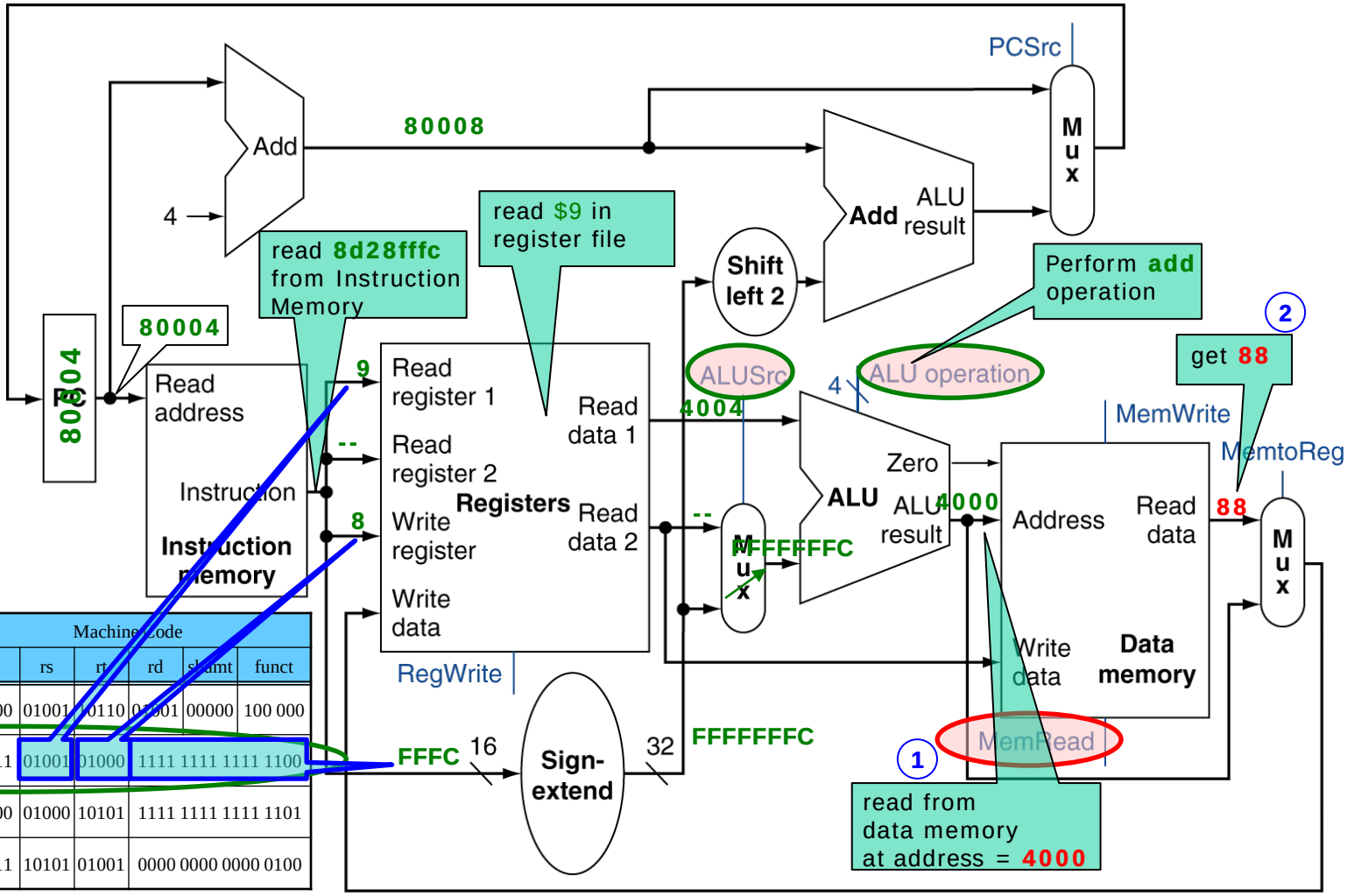
Reg#	Value
8	0
9	4004
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0



Address	Instruction	Machine Code					
		op	rs	rt	rd	shamt	funct
80000	Loop: add $t1, $t1, $s6	000 000	01001	10110	01001	00000	100 000
80004	lw $t0, -4($t1)	100 011	01001	01000	1111 1111 1111 1100		
80008	beq $t0, $s5, Loop	000 100	01000	10101	1111 1111 1111 1101		
8000C	sw $s5, 4($t1)	101 011	10101	01001	0000 0000 0000 0100		

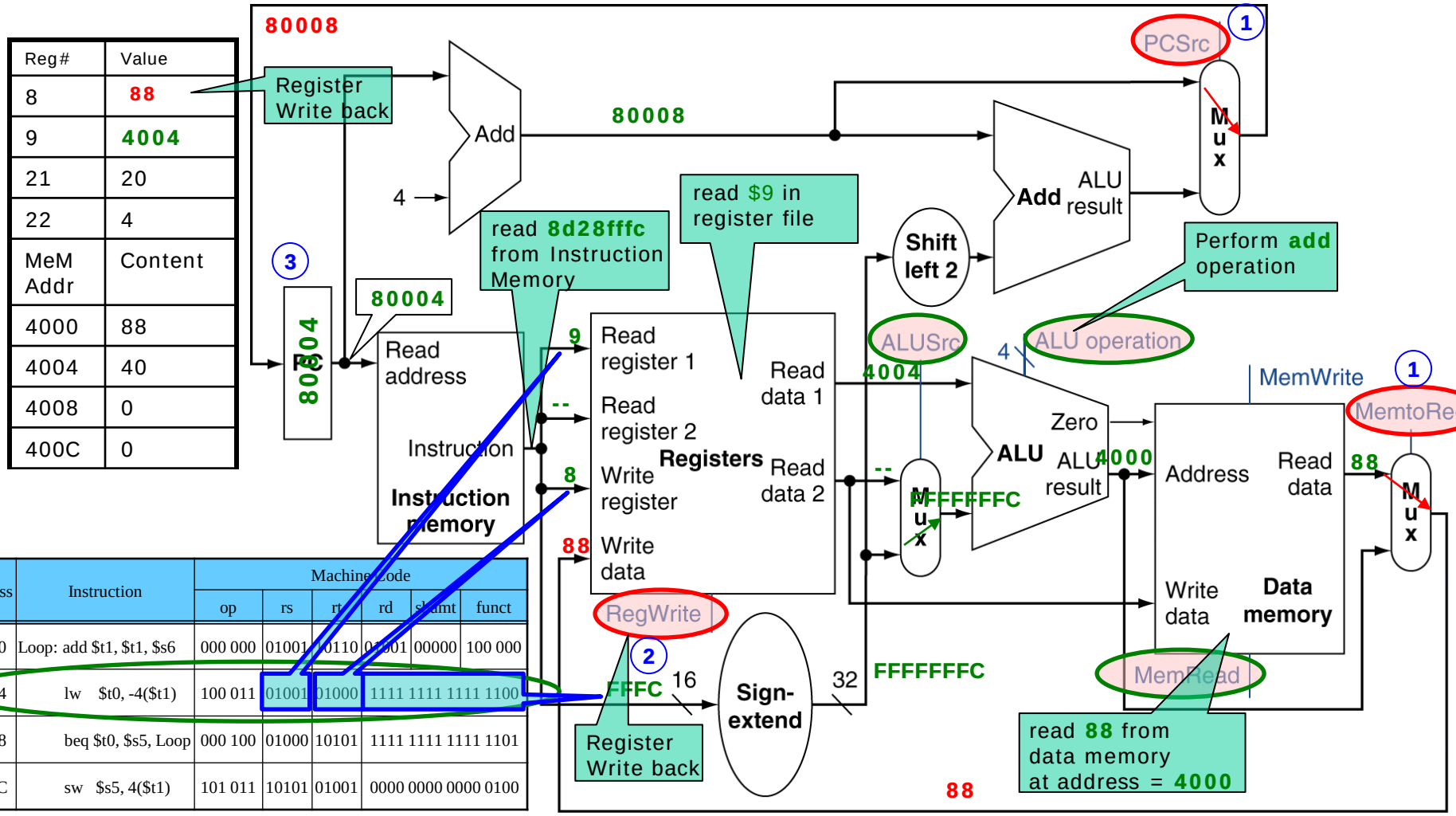
How data flow through datapath
Example: I-type Instruction: lw (MEM)

Reg#	Value
8	0
9	4004
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0



Address	Instruction	Machine Code					
		op	rs	rt	rd	shamt	funct
80000	Loop: add $t1, $t1, $s6	000 000	01001	10110	01001	00000	100 000
80004	lw $t0, -4($t1)	100 011	01001	01000	1111 1111 1111 1100		
80008	beq $t0, $s5, Loop	000 100	01000	10101	1111 1111 1111 1101		
8000C	sw $s5, 4($t1)	101 011	10101	01001	0000 0000 0000 0100		

How data flow through datapath
Example: I-type Instruction: lw (WB)

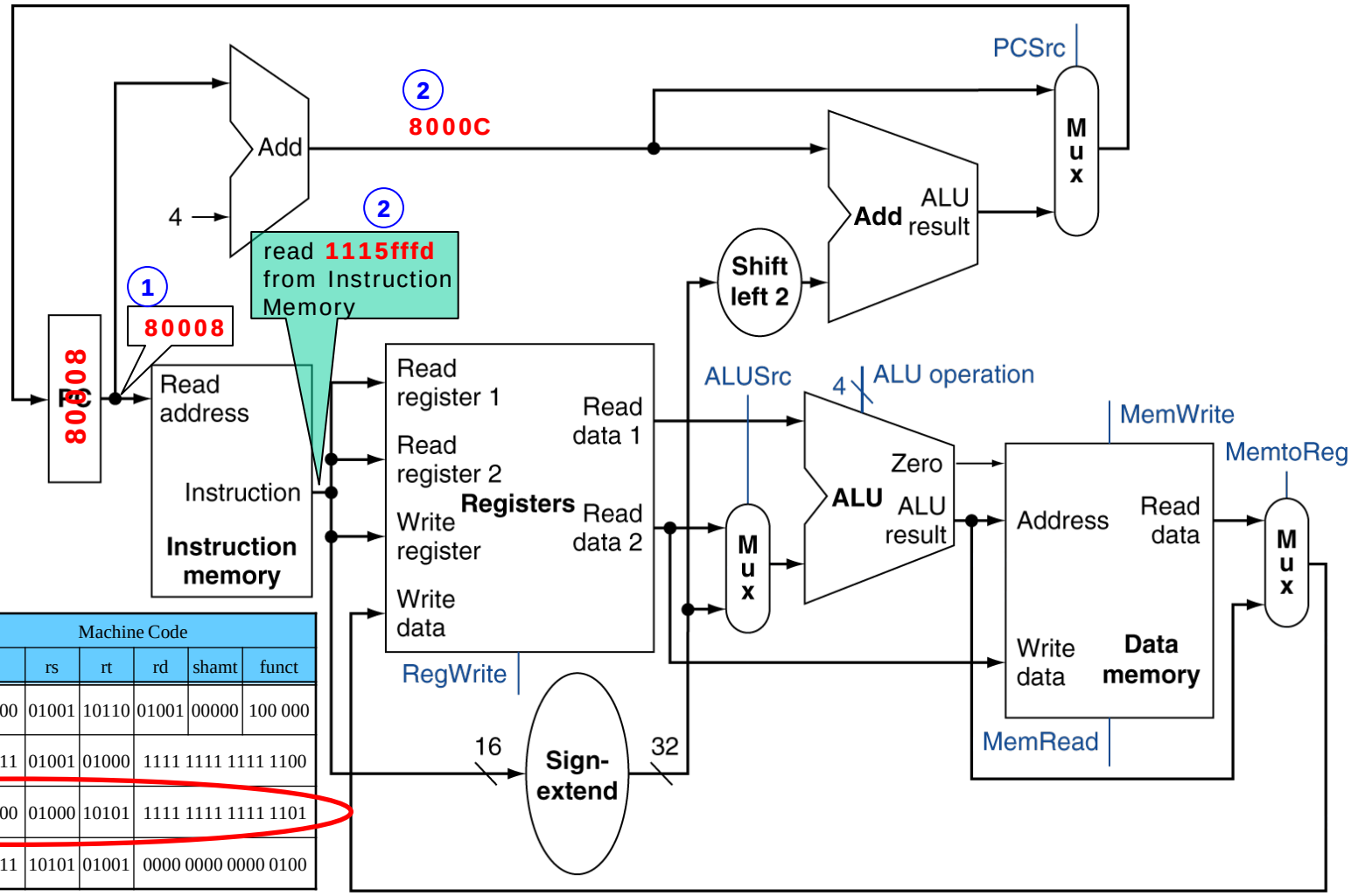


Reg#	Value
8	88
9	4004
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0

Address	Instruction	Machine Code					
		op	rs	rt	rd	shamt	funct
80000	Loop: add $t1, $t1, $s6	000 000	01001	10110	01001	00000	100 000
80004	lw $t0, -4($t1)	100 011	01001	01000	1111 1111 1111 1100		
80008	beq $t0, $s5, Loop	000 100	01000	10101	1111 1111 1111 1101		
8000C	sw $s5, 4($t1)	101 011	10101	01001	0000 0000 0000 0100		

How data flow through datapath
Example: I-type Instruction: beq (I-Fetch)

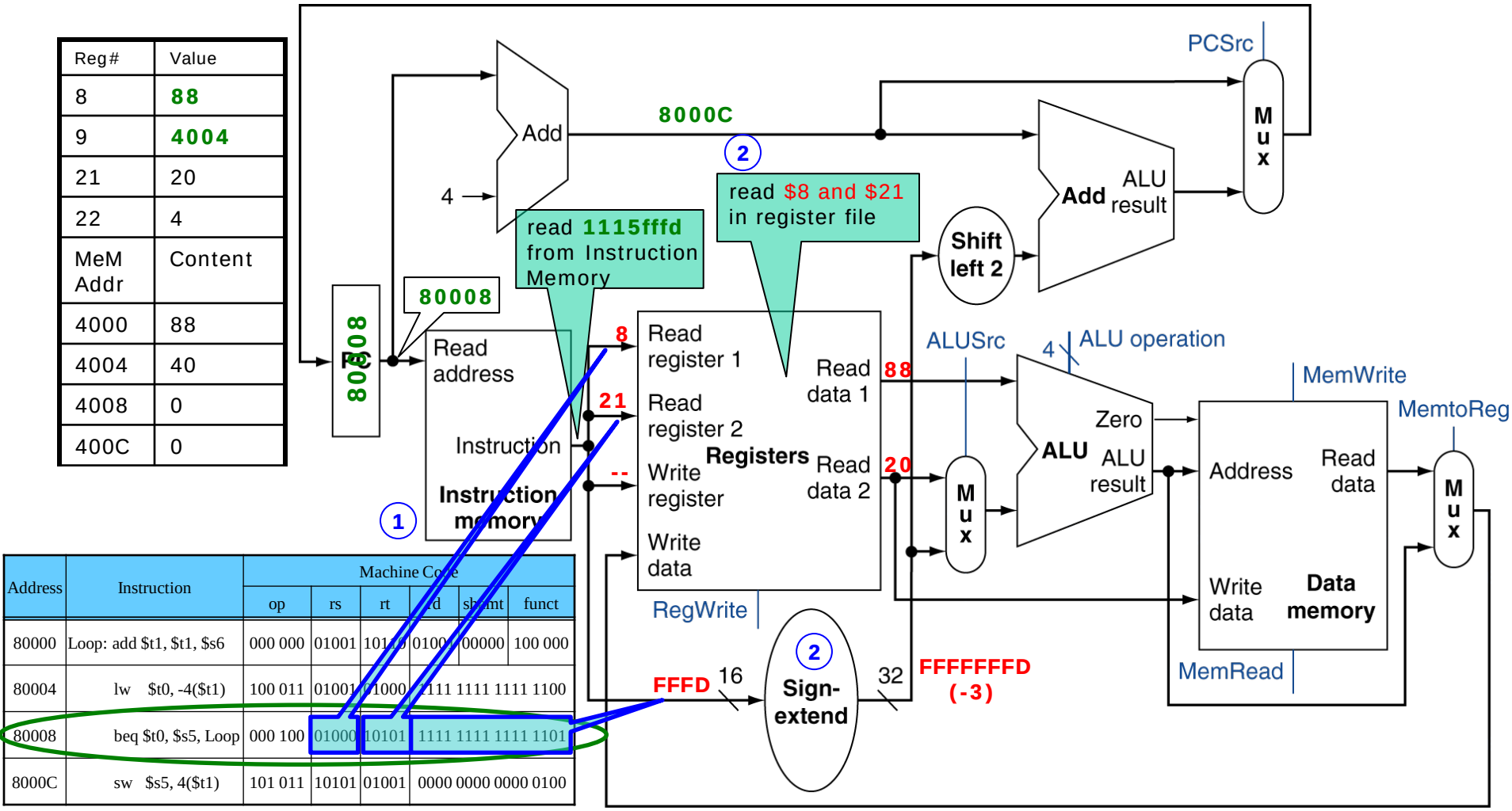
Reg#	Value
8	88
9	4004
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0



Address	Instruction	Machine Code					
		op	rs	rt	rd	shamt	funct
80000	Loop: add $t1, $t1, $s6	000 000	01001	10110	01001	00000	100 000
80004	lw $t0, -4($t1)	100 011	01001	01000	1111 1111 1111 1100		
80008	beq $t0, $s5, Loop	000 100	01000	10101	1111 1111 1111 1101		
8000C	sw $s5, 4($t1)	101 011	10101	01001	0000 0000 0000 0100		

How data flow through datapath
Example: I-type Instruction: beq (R-Read)

Reg#	Value
8	88
9	4004
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0



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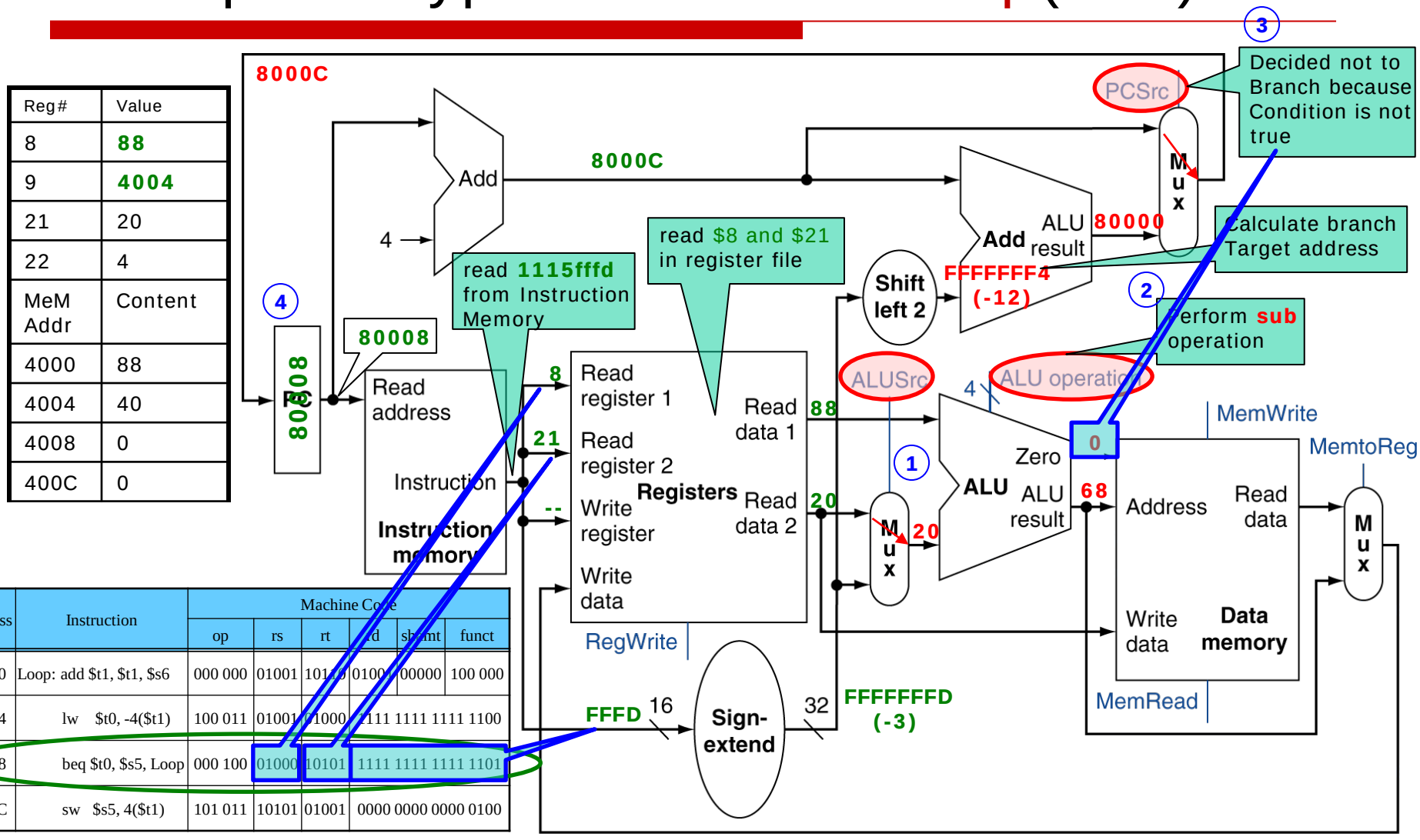
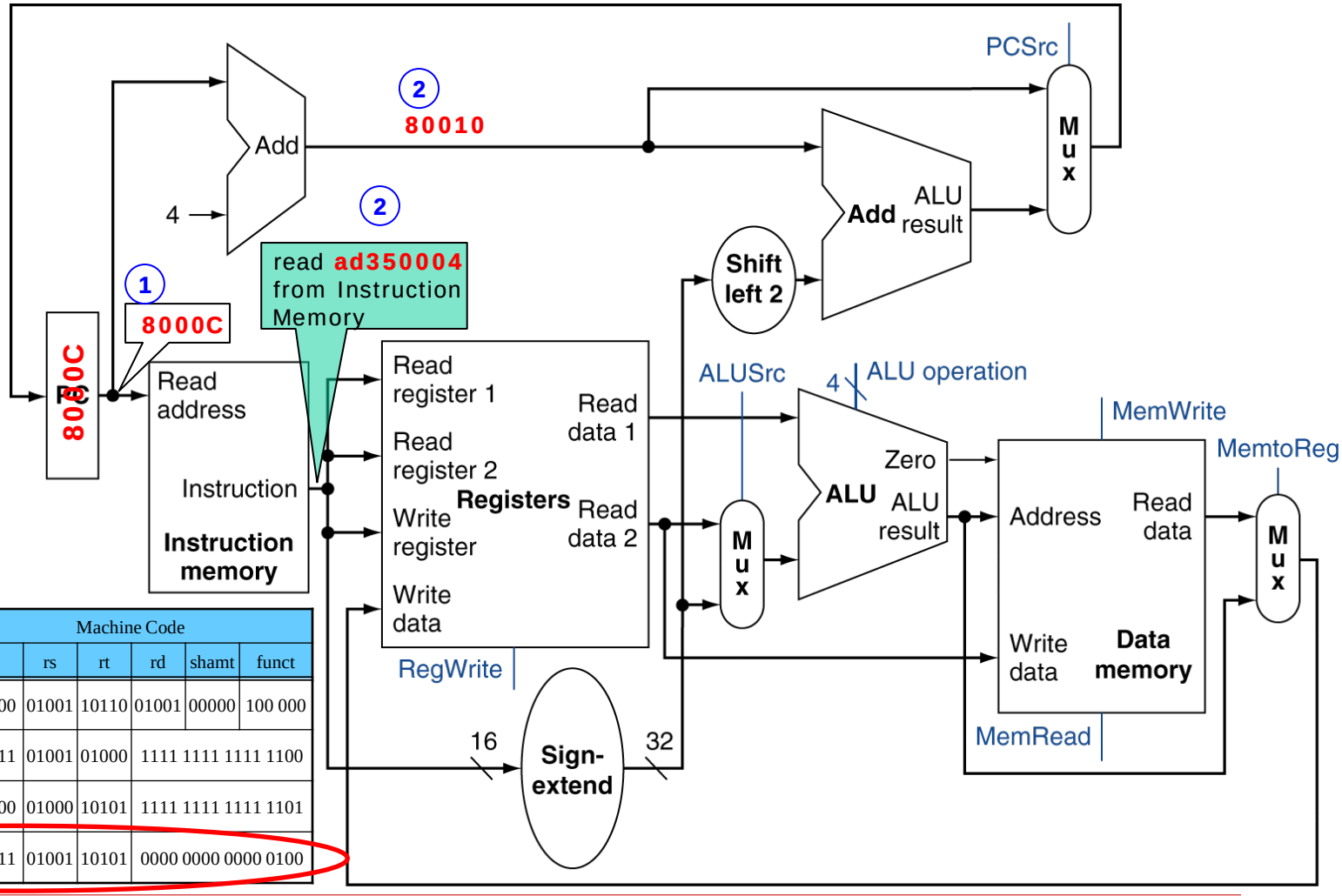
		op	rs	rt	rd	shamt	funct
80000	Loop: add $t1, $t1, $s6	000 000	01001	10110	01001	00000	100 000
80004	lw $t0, -4($t1)	100 011	01001	01000	1111 1111 1111 1100		
80008	beq $t0, $s5, Loop	000 100	01000	10101	1111 1111 1111 1101		
8000C	sw $s5, 4($t1)	101 011	10101	01001	0000 0000 0000 0100		

How data flow through datapath
Example: I-type Instruction: beq (EXE)



How data flow through datapath
Example: I-type Instruction: sw (I-Fetch)

Reg#	Value
8	88
9	4004
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0



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80004	lw $t0, -4($t1)	100 011	01001	01000	1111 1111 1111 1100		
80008	beq $t0, $s5, Loop	000 100	01000	10101	1111 1111 1111 1101		
8000C	sw $s5, 4($t1)	101 011	01001	10101	0000 0000 0000 0100		

How data flow through datapath
Example: I-type Instruction: sw (R-Read)

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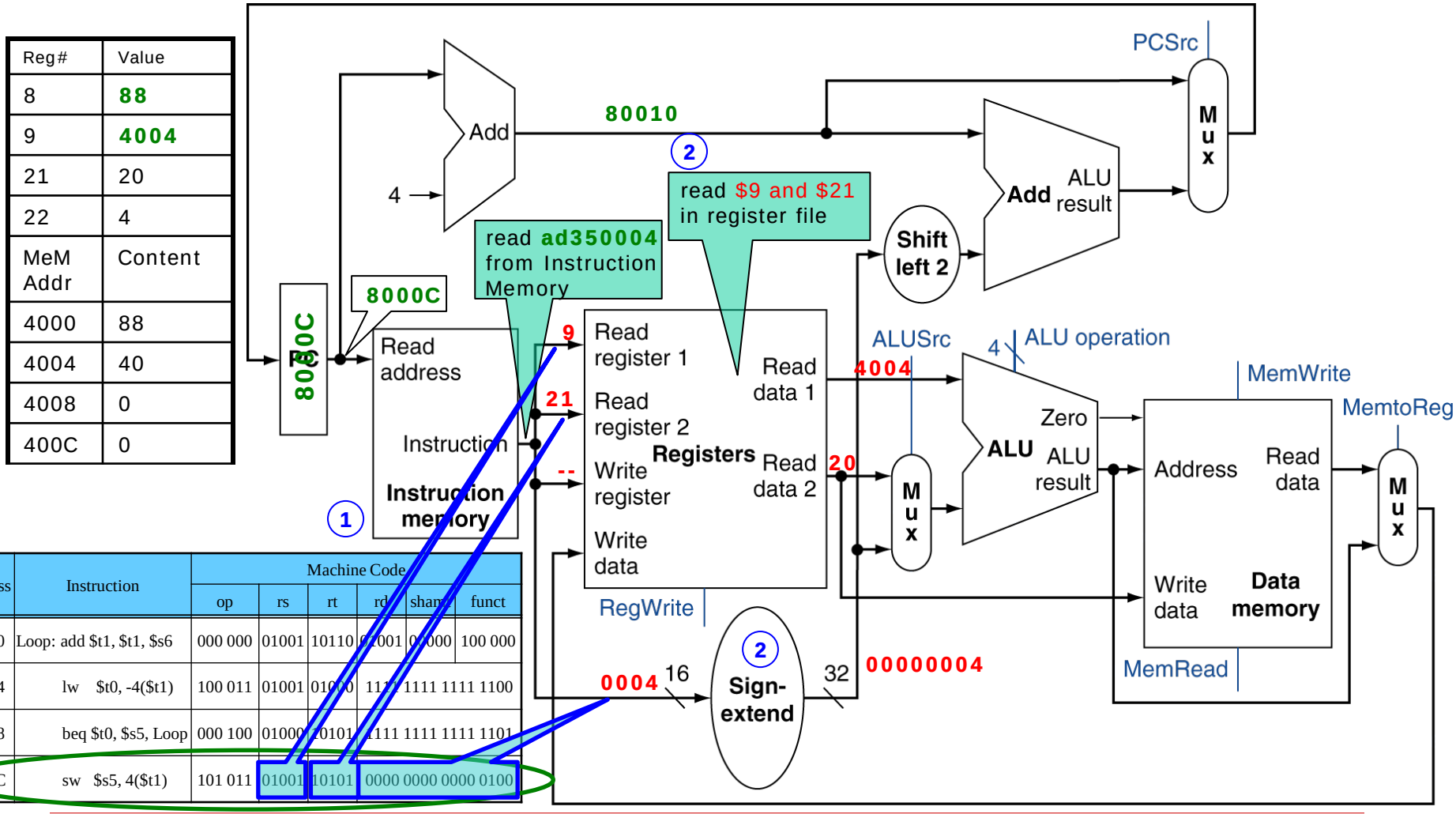
21	20
22	4
MeM Addr	Content
4000	88
4004	40
4008	0
400C	0



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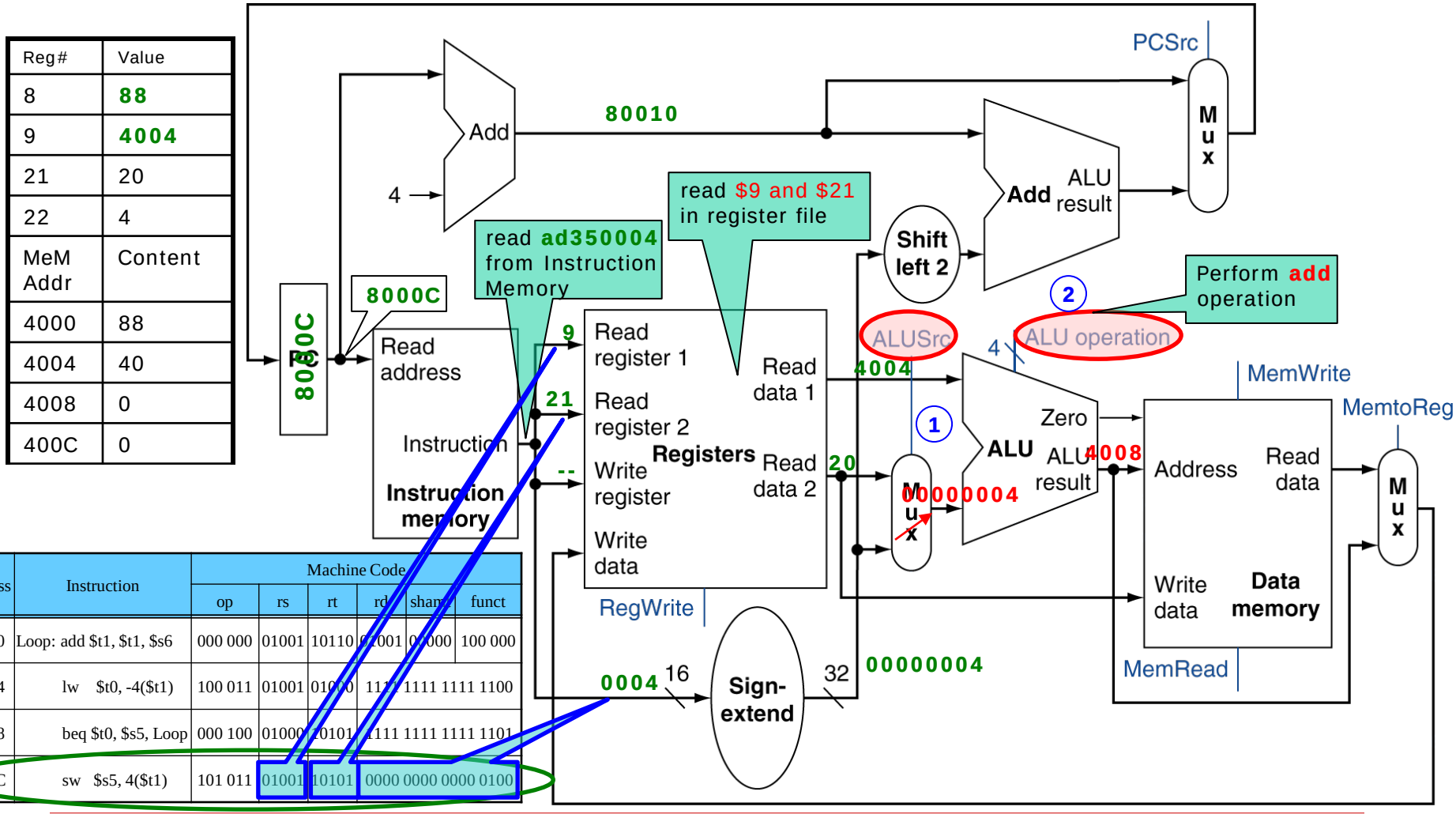

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		op	rs	rt	rd	shamt	funct
80000	Loop: add $t1, $t1, $s6	000 000	01001	10110	01001	00000	100 000
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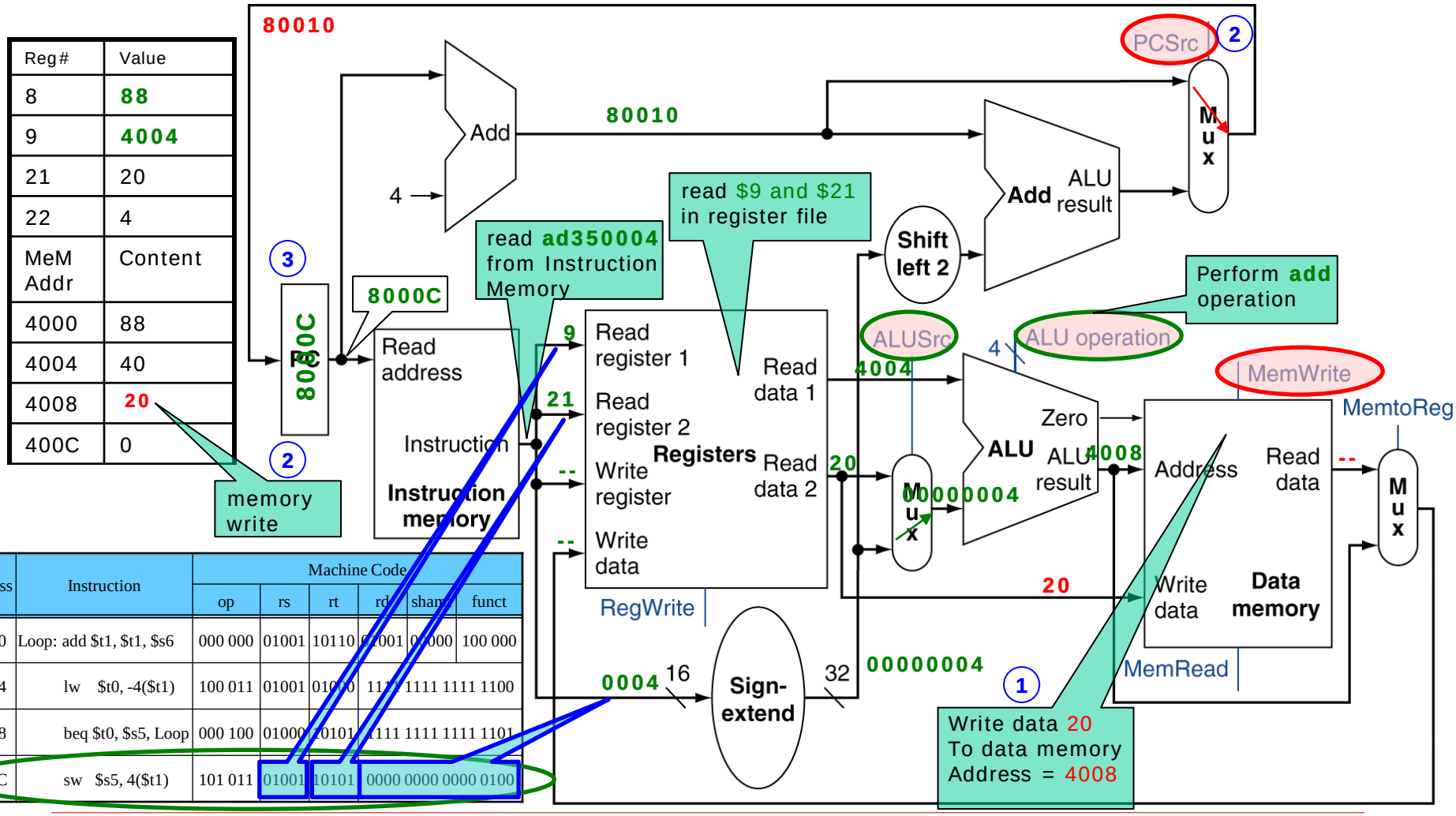
80008	beq $t0, $s5, Loop	000 100	01000	10101	1111 1111 1111 1101		
8000C	sw $s5, 4($t1)	101 011	01001	10101	0000 0000 0000 0100		

How data flow through datapath
Example: I-type Instruction: sw (MEM)



Reg#	Value
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8000C	sw $s5, 4($t1)	101 011	01001	10101	0000 0000 0000 0100		