CASPER

CS305: Computer Architecture

World of Instructions-I (The MIPS language)

https://www.cse.iitb.ac.in/~biswa/courses/CS305/main.html

https://www.cse.iitb.ac.in/~biswa/

Instructions

Programmers’ order/command to the processor

World of 18 instructions

A n Add the number in storage location n into the accumulator.
E n If the number in the accumulator is greater than or equal to zero execute next the order which stands in storage location n; otherwise proceed serially.
Z Stop the machine and ring the warning bell.

Wilkes and Renwick Selection from the List of 18 Machine Instructions for the EDSAC (1949)

2021: How many x86 instructions? Piazza

Why Instructions?

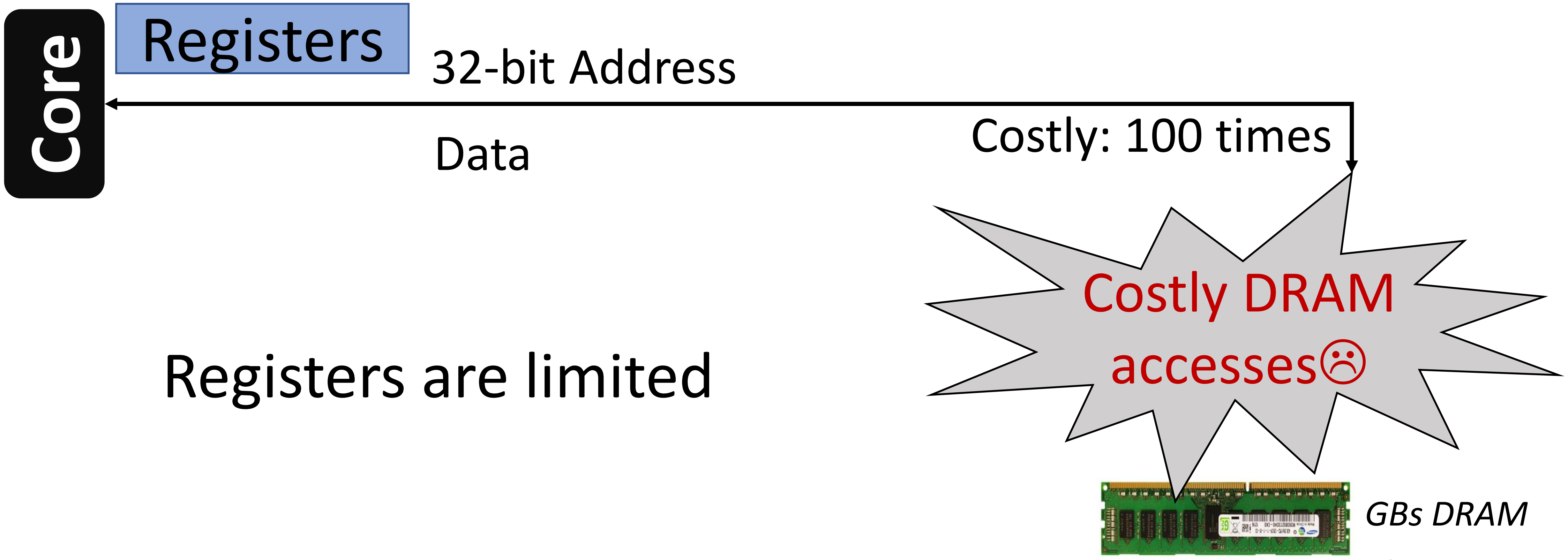
Programmer knows what it can/cannot
Processor knows what it should

Power of abstraction:
World with no instructions:
Programmers – communicate a sequence of 0s and 1s

World with no instructions

```
000000 00000 00000 00010 00000 100101
000000 00000 00101 01000 00000 101010
000100 01000 00000 00000 00000 000011
000000 00010 00100 00010 00000 100000
001000 00101 00101 11111 11111 111111
000010 00000 10000 00000 00000 000001
```

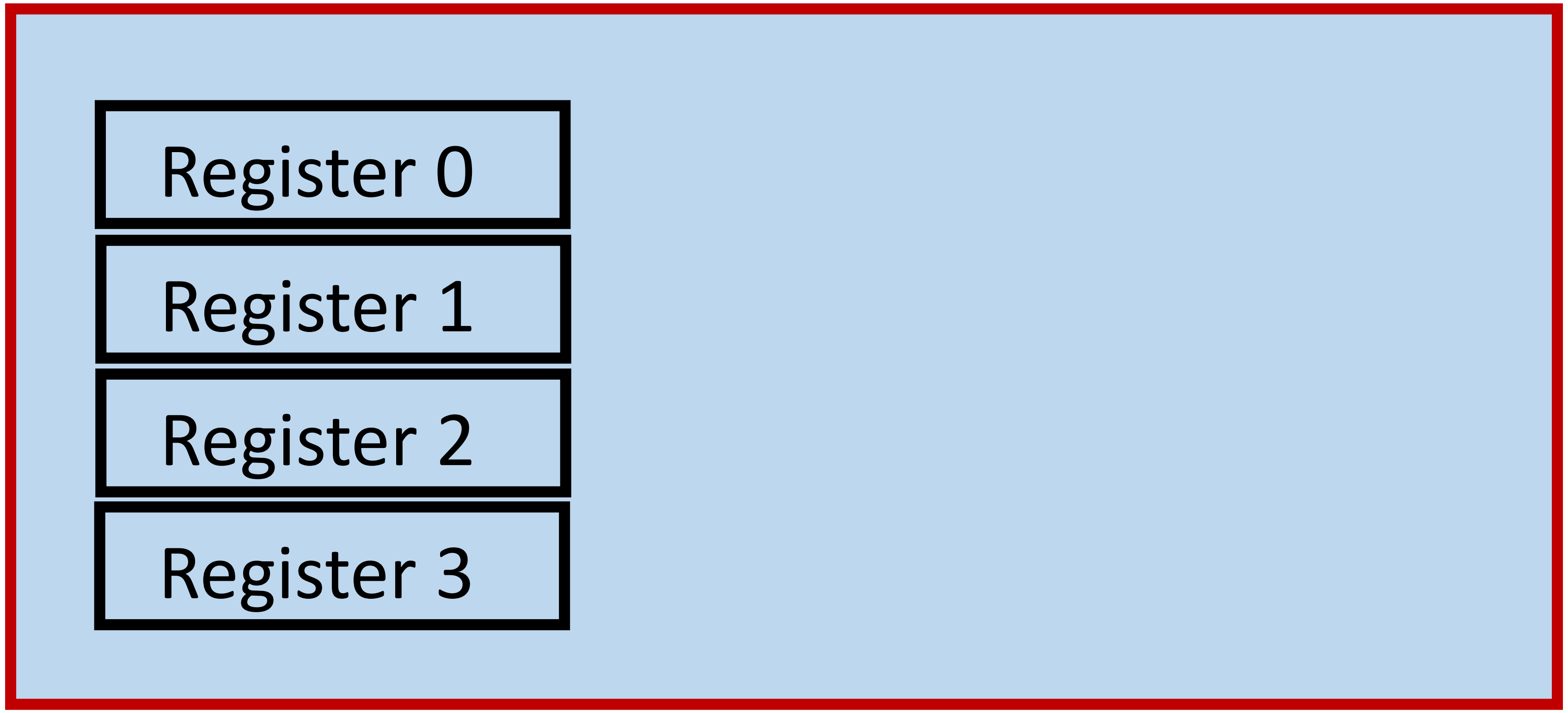
Last Lecture



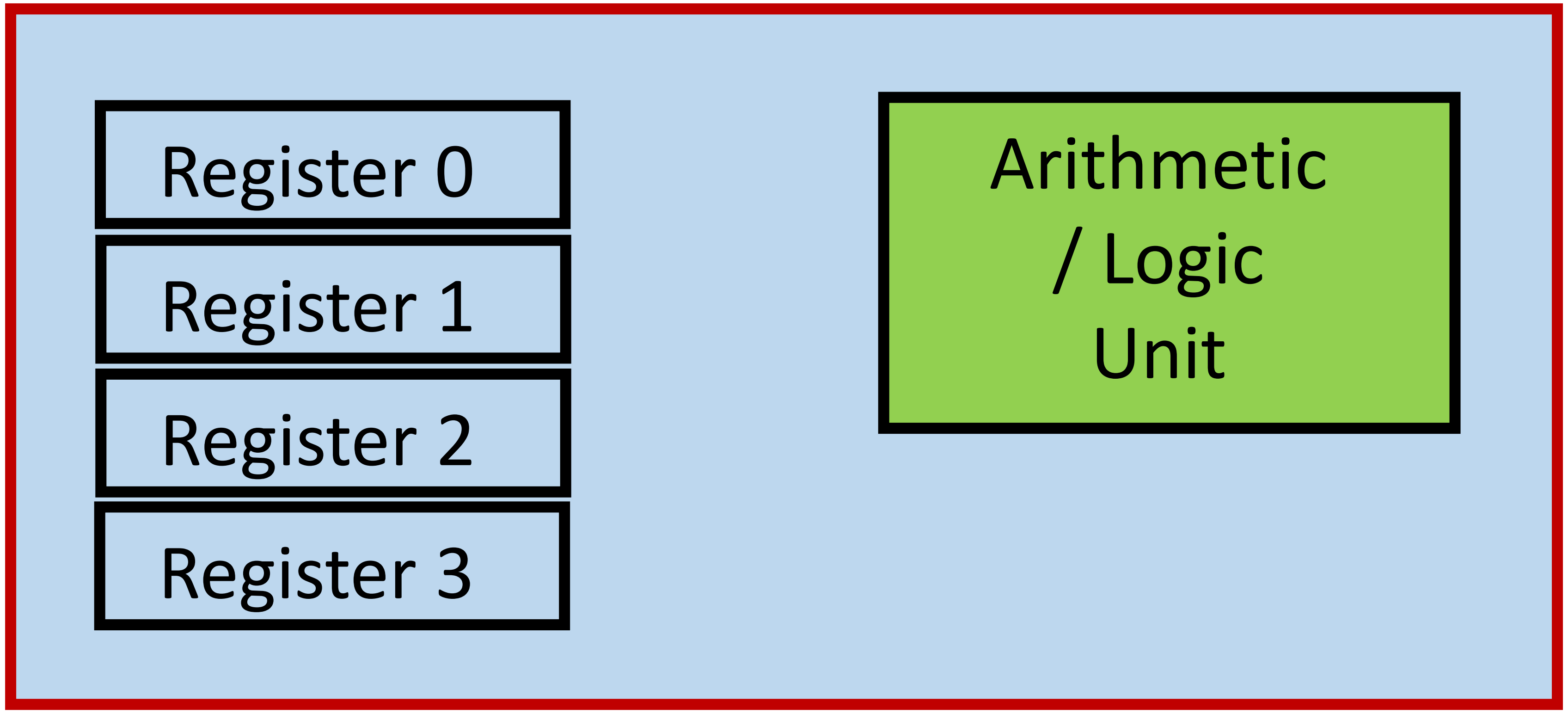
South pole ☹

Registers are limited

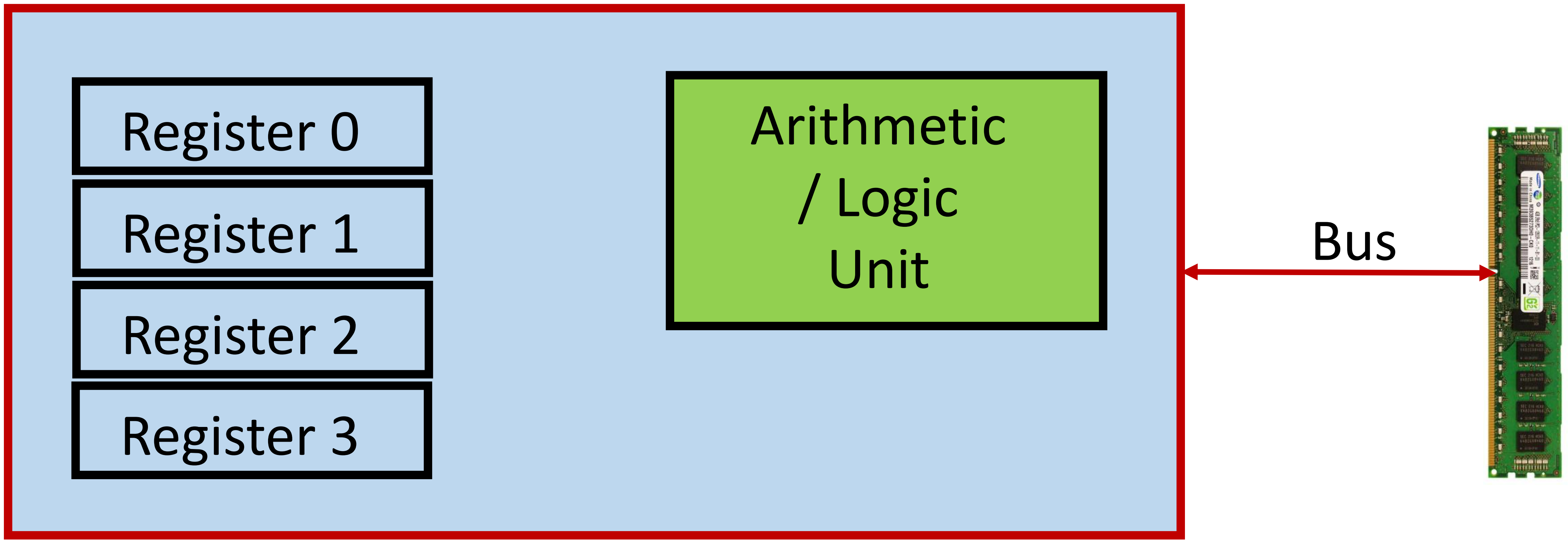
Let’s Open the Processor Core



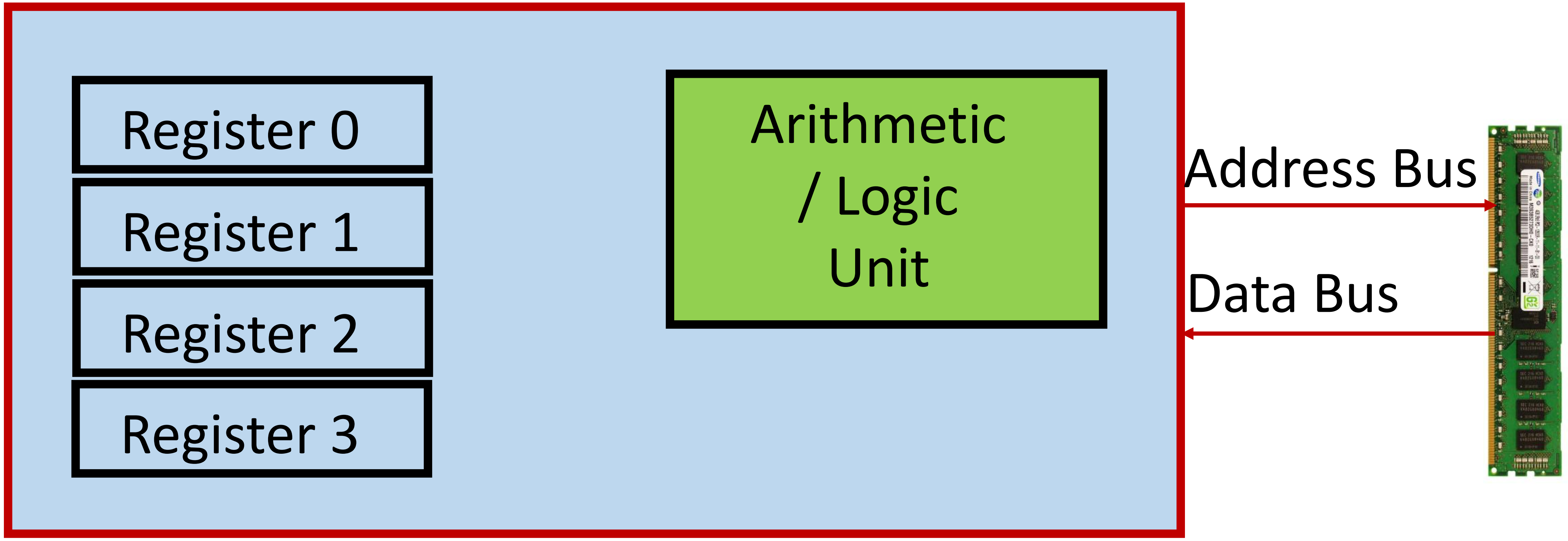
Let’s Open the Processor Core



Let’s put the Memory (not inside the core)



Let’s put the Memory (not inside the core)



MIPS Instructions: 101

add $0, $1, $2

add: operation, $0: Destination, $1 & $2: Source(s)

Most of the arithmetic/logical: two sources and one destination

What to do for “a=b+c-d”?

What to do for “a=b+c-d”?

```
add $t0, $s1, $s2      #$t = b+c
sub $s0, $t0, $s3      #$s = $t-d
```

Temporary register

Try out:

f=(g+h) – (i+j)

Constants and Immediate

x=x+10

No need of a register

addi $s0, $s0, 10

i: immediate, for constants, constant: 2s complement

Constants and Immediate

x=x+10

No need of a register

addi $s0, $s0, 10

Do we need a subi ? ☺

i: immediate, for constants

constant: 16 bits, 2s complement form

Constants and Immediate

x=x+10

$\searrow$ No need of a register

addi $s0, $s0, 10

Do we need a subi ? ☺ NO

i: immediate, for constants, constant: 2s complement form

Special treatment for zero

$0 or $zero is a special register that contains ZERO

a=b   becomes add $s1 $s2 $zero

Why add if we can move?

Pseudo Instruction 101

a=b

move $S0, $s1

Not an actual instruction.
It is used for programming convenience

Logical Operations

Bitwise operations and shifts (Refer Section 2.6 P&H)

sll, srl, and, or, nor, andi, ori etc

No not instruction ☺, well not is nor with one operand=0

32 raw bits instead of a 32-bit number.

Trivia? How to store a 32-bit constant into a 32-bit register?

For example, 10101010 10101010 11110000 11110000

Trivia? How to store a 32-bit constant into a 32-bit register?

For example, 10101010 10101010 11110000 11110000

lui $t0, 0xAAAA #1010101010101010, lower bits all 0s.

ori $t0, $t0, 0xF0F0 #1111000011110000

Thanks