CASPER

CS230: Digital Logic Design and Computer Architecture

L1: Introduction

https://www.cse.iitb.ac.in/~biswa/courses/CS230/main.html

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

Phones (smart/non-smart) on silence plz, Thanks

Instructor

Biswa

Research Group: CASPER (https://casper-iitb.github.io/)

Research interests: Architecture performance/security

Office hours

Where: CC 217

When: Before and after the labs (1:30 PM to 5:30 PM)

Email: [CS230] in the subject line

Assessment Policies: CS230

- Option-I

Three Quizzes:	Best of Two (2 X 10) = 20 points
Summary of Two Talks:	(2 X 10) = 20 points
Group Projects:	50 points
Something different:	10 points

Quizzes: January/February/March

Assessment Policies: CS230

- Option-I

Three Quizzes:	Best of Two (2 X 10)	= 20 points
Summary of Two Talks:	(2 X 10)	= 20 points
End-sem exam:		50 points
Something different:		10 points

Quizzes: January/February/March

Coffee points

Answer a question or ask a question or

Provide honest feedback that can help the course

10 coffee points = 1 day extension in lab assignments

Real coffee with Biswa if you do not want to redeem your points.

Do inform Biswa “just” after the lectures

Projects

Leaderboard kinda

3 to 5 topics for the entire course

ISCA championships is a possibility too

Google Form responses

20: No Idea

45: End-term

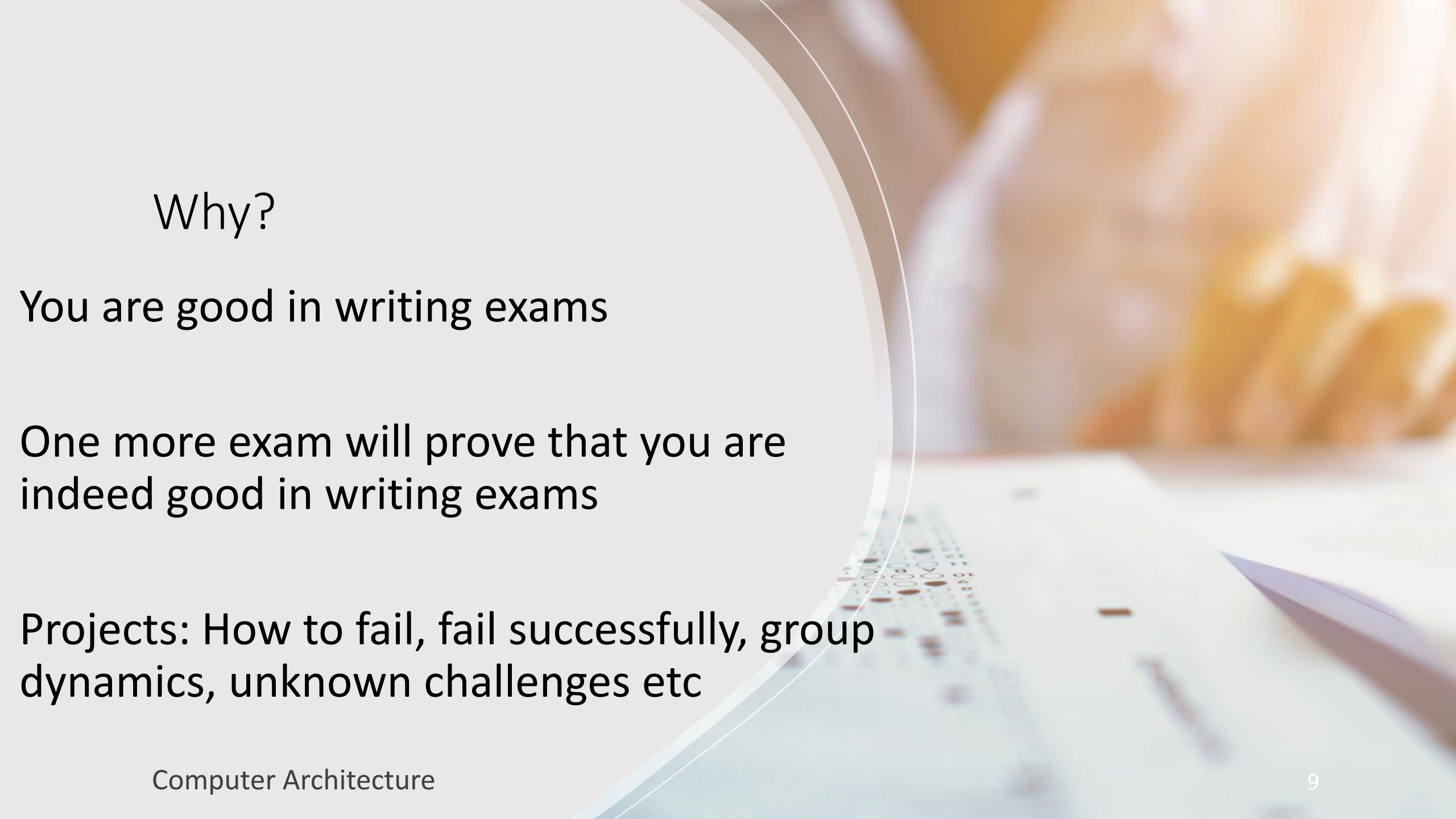
110: Project

Why?

You are good in writing exams

One more exam will prove that you are indeed good in writing exams

Projects: How to fail, fail successfully, group dynamics, unknown challenges etc



Attendance Policy (Either attend/!attend)

Do not make it fuzzy, do come on time else ditch it

CS230: NO

CS232: Strict attendance policy

Feel free to come (!come), I would be happy if you attend all. As facad, I would request …

but I can understand, lectures can be boring ☹ too, do mention it whenever you feel like

Course means grades and grades are….
So we will take care, you take care of learning and earn your grades

CS230

Slides won't contain all

Attend lectures, take notes, ask questions,

Feel free to pause me if I go fast/slow/boring/engaging

Remember CS232 is a 4-credit course (not 3-credit)

Tutorial/doubt/query sessions during labs itself.

Labs wont be: finish in 3-hour kinda, instead we will provide one/two/three weeks

More once TA assignment is done. Still waiting ☹

CS230+232

Let’s have a dialogue and not monologue

Questions on Assessment

Join Piazza ASAP

All notifications on Piazza ONLY

Moodle: For Assignment submissions

Academic Stress

- Stop using smart-phones (smart devices) or reduce it by k hours
- Smart devices are making us ……
- Forget your JEE rank, past CPI etc Just focus on the courses, it is 2023
- Learn/study in groups

Academic dishonesty

k students have got a grade penalty in the last semester ☹

Let's not repeat that in CS230+CS232

Plz go through again:

https://www.iitb.ac.in/newacadhome/procedures201521July.pdf

https://www.iitb.ac.in/newacadhome/punishments201521July.pdf

CS230+232: Machine learning

Are you kidding me? Learning about machines ☺

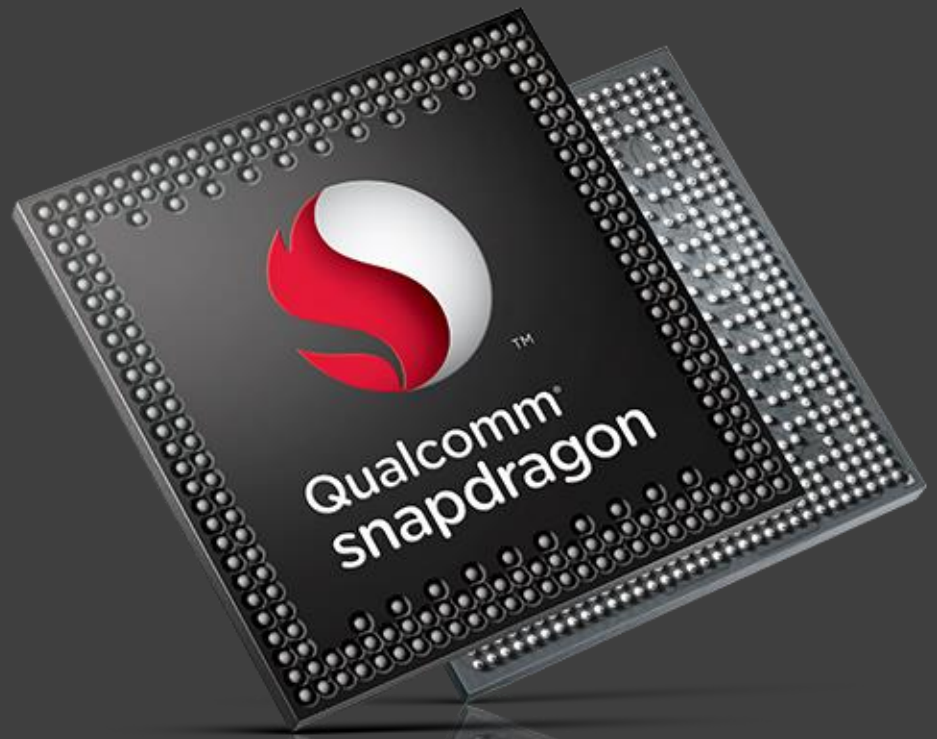
Are you kidding me?

CS230+232: Machine learning

Digital Computers everywhere

Architecture everywhere ☺

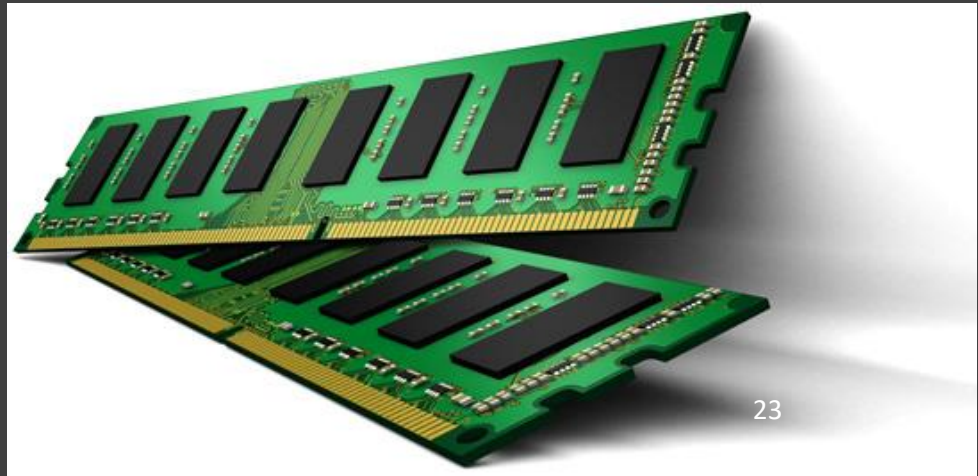
CS230+CS232


Qualcomm
snapdragon


intel
Xeon® 5500

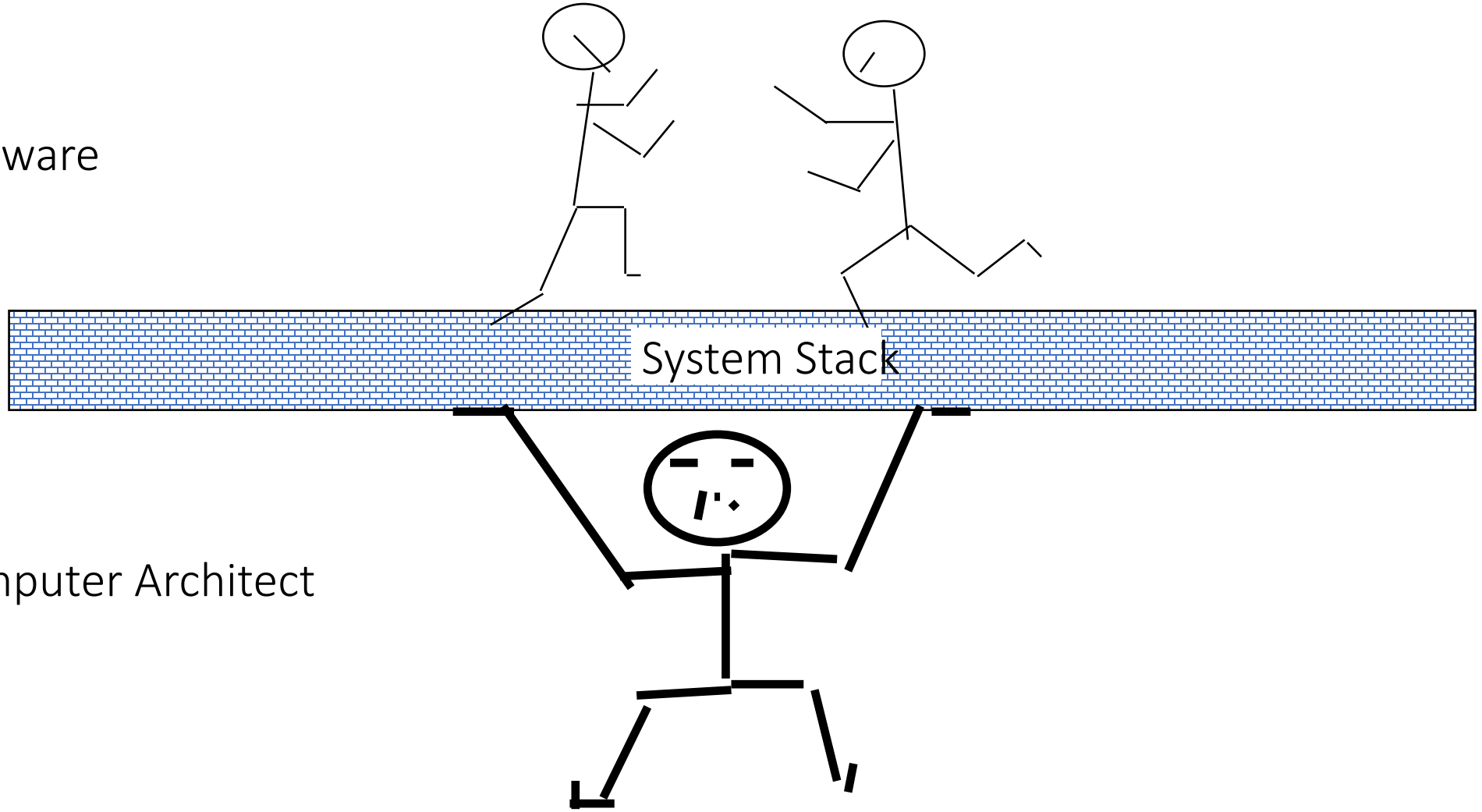

Titan X
VS
GTX 980
VS
Tesla M40
VS
Tesla K


intel
Core™ i7



Heavy Lifting

Software



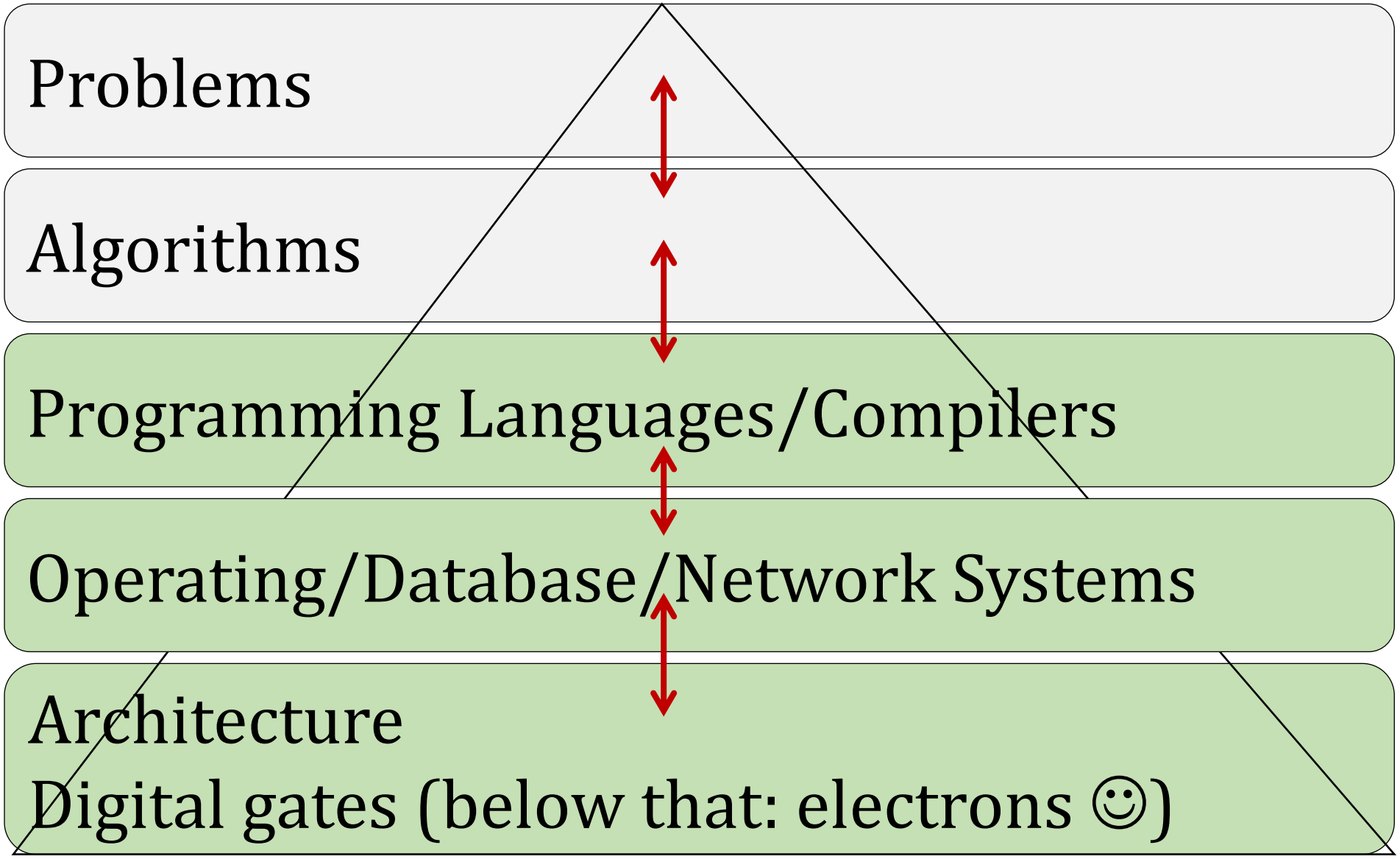
Computer Architect

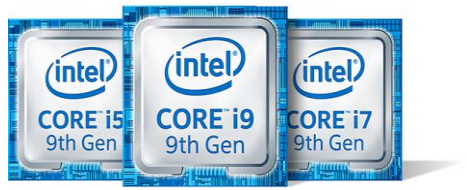
AI/ML in 1980

Why All the buzz in 2020s?

Computer architecture is the enabler!!

Computing Stack





All THE major Software Companies are now …

https://www.ai-startups.org/top/hardware/

NEWS > COMPANY NEWS

Facebook Is Reportedly Building its Own Chip

November 17, 2020

Meet the Microsoft Pluton processor – The security chip designed for the future of Windows PCs

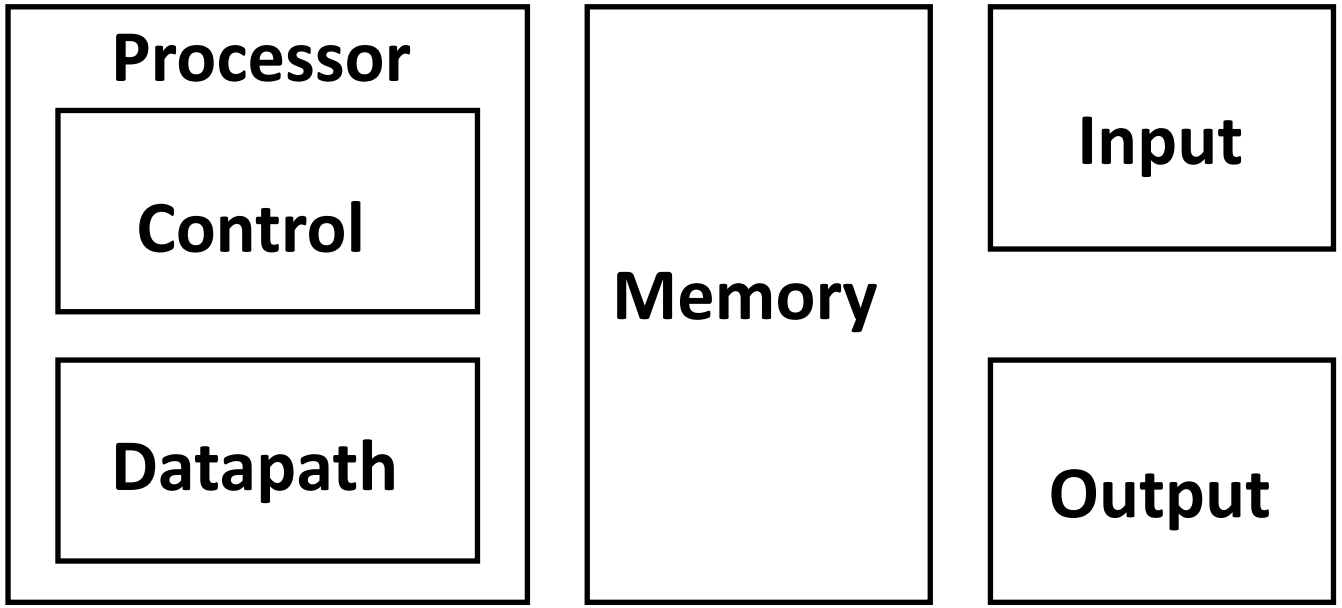
GOOGLE MOBILE TECH

Google is reportedly building its own processor for Pixels and Chromebooks

It could be used in Pixels as early as next year

Let’s get started

Since 1946 all computers have had 5 components



In those days

Why Study?

It is everywhere: the moment you wake up till you hit the bed

It is exciting

It is the enabler for all other areas ☺

It will make you a better programmer

PAUSE

Lost in Abstractions: 1st course to break it

Abstraction is good if you don't care about the performance of underlying entities.

What?

ABSTRACTION BARRIER

How? Why?

How many of you can drive a bike ?

How many of you know how a bike works?

Lost in Abstractions

Abstraction is good if you don't care about the performance of underlying entities.

What?

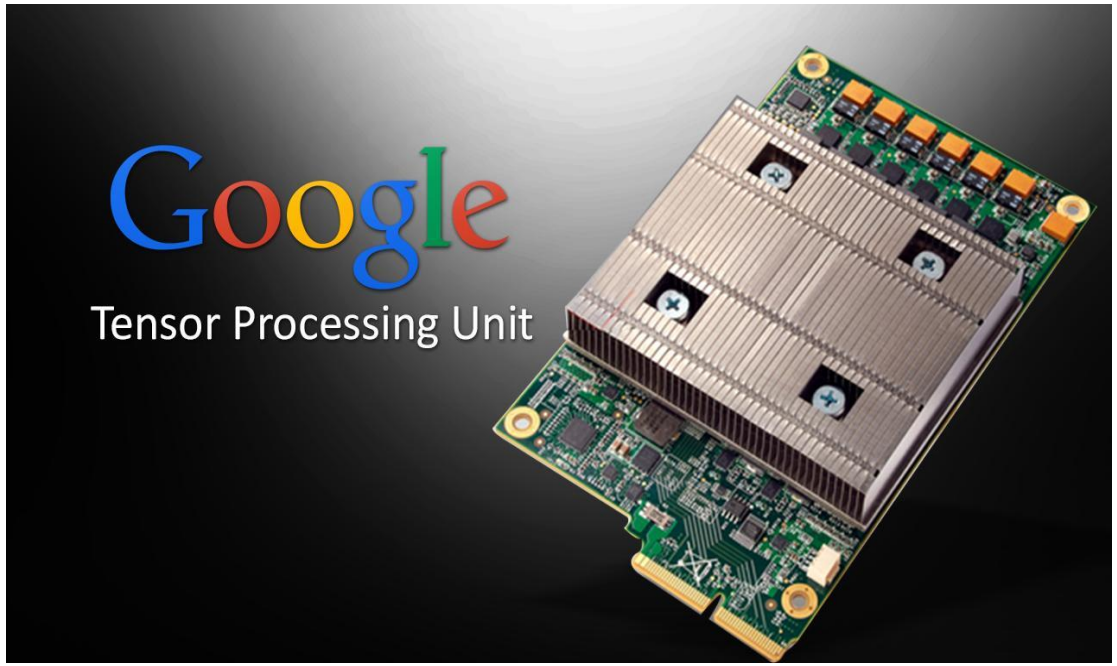
ABSTRACTION BARRIER

How? Why?

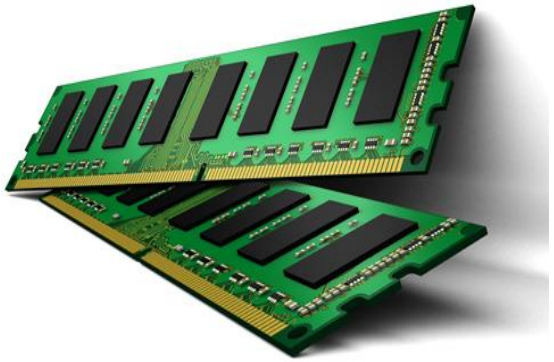
How many of you use a computer ? ☺

How many of you know how a computer works?

CS230+232


Google
Tensor Processing Unit


intel
Xeon® 5500




Titan X
GTX 980
Tesla M40
Tesla K80

Let’s get started: One Step at a time

World of Digital computers

Not Analog

Digital: World of TRUE/FALSE or 1/0

World of binary variables

Logic circuits performing operations on binary variables: Logic gates

Digits vs bits

- Digits = powers of 10

  … 100, 10, 1, $^1/_{10}$, $^1/_{100}$, $^1/_{1000}$ …

  … 10^2, 10^1, 10^0, 10^{-1}, 10^{-2}, 10^{-3} …

  Ex: $(36.25)_{10} = 3*10 + 6*1 + 2*^1/_{10} + 5*\ ^1/_{100}$

- Bits = powers of 2

  … 8, 4, 2, 1, $^1/_2$, $^1/_4$, $^1/_8$ …

  … 2^3, 2^2, 2^1, 2^0, 2^{-1}, 2^{-2}, 2^{-3} …

  Ex: $(100100.01)_2 = 1*32 + 1*4 + 1*^1/_4$

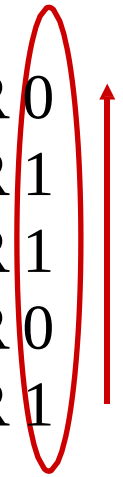
Decimal to binary

- Left of decimal point
  - Repeatedly divide integer part by 2 until you get 0
  - Read remainders bottom to up

$22 = (?)_2 \quad (10110)_2$

22

11 R 0
5 R 1
2 R 1
1 R 0
0 R 1



Decimal to binary

- Right of decimal point
  - Repeatedly multiply fractional part by 2 until you get 1
  - Read integer portion top to bottom

$$0.8125 = (0.1101)_2$$

0.8125
1.6250
1.25
0.5
1.0

Both?

- What if there are both left and right of the decimal point?
  - Do them separately and combine

- **22.8125 = $(10110.1101)_2$**

up down

22

11 R 0
5 R 1
2 R 1
1 R 0
0 R 1

0.8125

1.6250
1.25
0.5
1.0

Binary Number System

1's column
10's column
100's column
1000's column

$$9742_{10} = 9 \times 10^3 + 7 \times 10^2 + 4 \times 10^1 + 2 \times 10^0$$

nine thousands; seven hundreds; four tens; two ones

1's column
2's column
4's column
8's column
16's column

$$10110_2 = 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 22_{10}$$

msb lsb

one sixteen; no eight; one four; one two; no one

Convert 84_{10} to binary

Convert 84_{10} to binary

- 1010100_2
- Similarly hexadecimal (base 16)
- $2ED_{16}$
- Convert this to decimal and binary

So far unsigned, what about signed

most significant bit denotes sign and remaining N-1 bits denote value (Sign/magnitude numbers)

5_{10}: 0101_2

-5_{10}: 1101_2

Binary addition does not make sense

5 + (-5) = 0 BUT NOT IN SIGNED/MAGNITUDE

BTW, ZERO HAS TWO REPRESENTATIONS IN SIGN MAGNITUDE +0 AND -0 , WHICH IS SO CONFUSING

SOLUTION? 2'S COMPLEMENT

The 2's complement way for negative numbers

Take the complement of a binary number and add 1 to the lsb (least significant bit)

-5_{10}: $?_2$

5_{10}: 0101, complement: 1010, 2's complement: 1011

Binary addition

Simple

1 + 0 = 1

0 + 0 = 0

1 + 1 = 0 with carry 1

Range of Numbers

System	Range
Unsigned	$[0, 2^N - 1]$
Sign/Magnitude	$[-2^{N-1} + 1, 2^{N-1} - 1]$
Two's Complement	$[-2^{N-1}, 2^{N-1} - 1]$

Remember sign/magnitude has two zeros ☺

Textbooks

Section 1.4 of Harris&Harris

Summary: Refer Piazza

Coffee credits

Arnab, 210050018 ☺

bonne journée