Lecture-1 (Logistics and Introduction) CS422-Spring 2019

Biswa@CSE-IITK

Instructor

Biswa ~~(Biswabandan, Sir, Prof., Dr., Er., *-Biswa)~~, T.As: Arun and Prakhar

Sir/Prof./…… outlawed with CS422 and Biswa

Website: http://www.cse.iitk.ac.in/biswap

Contact: KD 203, biswap@cse.iitk.ac.in
Office Hours: Friday, 12 noon

Teaching and Research Interests:
Computer Architecture, Arch-OS interface, and Systems Security

Logistics

When: Mon/Tues. 12.00-13.15 Hrs & 9.00-10.15 Hrs
Where: KD 103, What: You know it

Course website: www.cse.iitk.ac.in/~biswap/CS422-19.html

Piazza: For online discussions

Submission of assignments: Canvas

Register/Drop ASAP (if interested/not interested)

What I Expect from You?

No open-screens (no nomophobics): No open smart-phones (phones) & laptops/tablets. Keep your phones in silent mode

Open-screens will affect (distract) you, your friends, and me

Ask questions & participate in in-class discussions (worth bonus points)

Paper reading and writing reviews/reports

Understand, implement, and analyze ideas (Hard work and honesty)

Slides will not contain everything. So attend lectures.

What I Expect from You?

Timing	Be on time
Cheating	In any form will lead to zero points. Grade will be capped down (one level). To prevent capping down, you have to build architectural tools.
Dropping CS422	Not allowed after Jan 21st 2019. Drop the course before that. Why? It will affect your group.

What I Expect from You?

Ditch your excuses.

Participate in class/Piazza regularly.
Do not fear about your doubts. Just communicate.
We (you, T.A., and me) will try our best to address it.

Just shout if you do not like something about me or about the course. However, be on the right side and then shout.

What Can you Expect From Me?

I will give my 100% in delivering lectures, clearing your doubts, helping you learning.

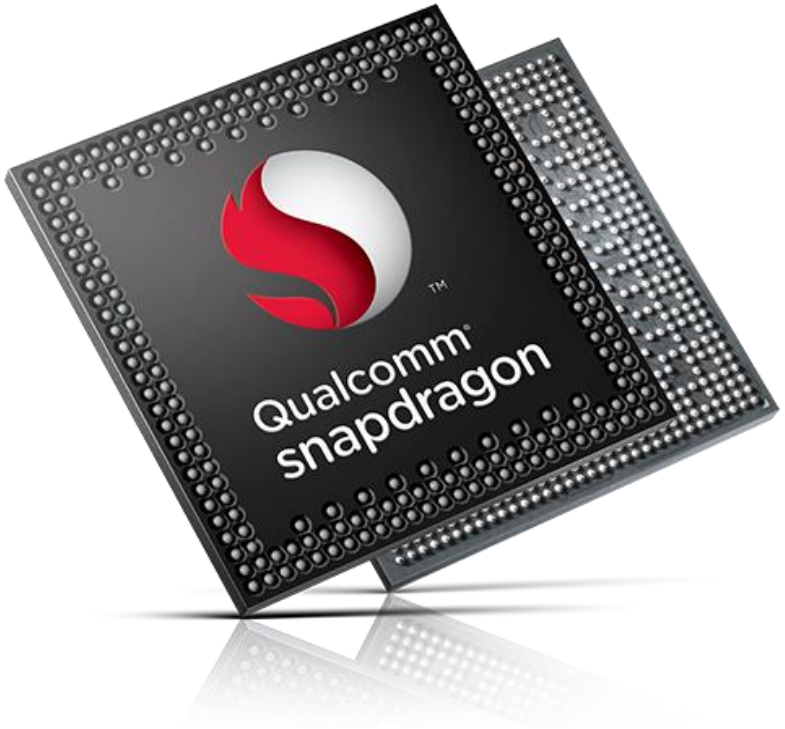
A relationship based on trust and respect. I will be lenient in terms of deadlines (others) for genuine cases.

Available for meetings regularly.

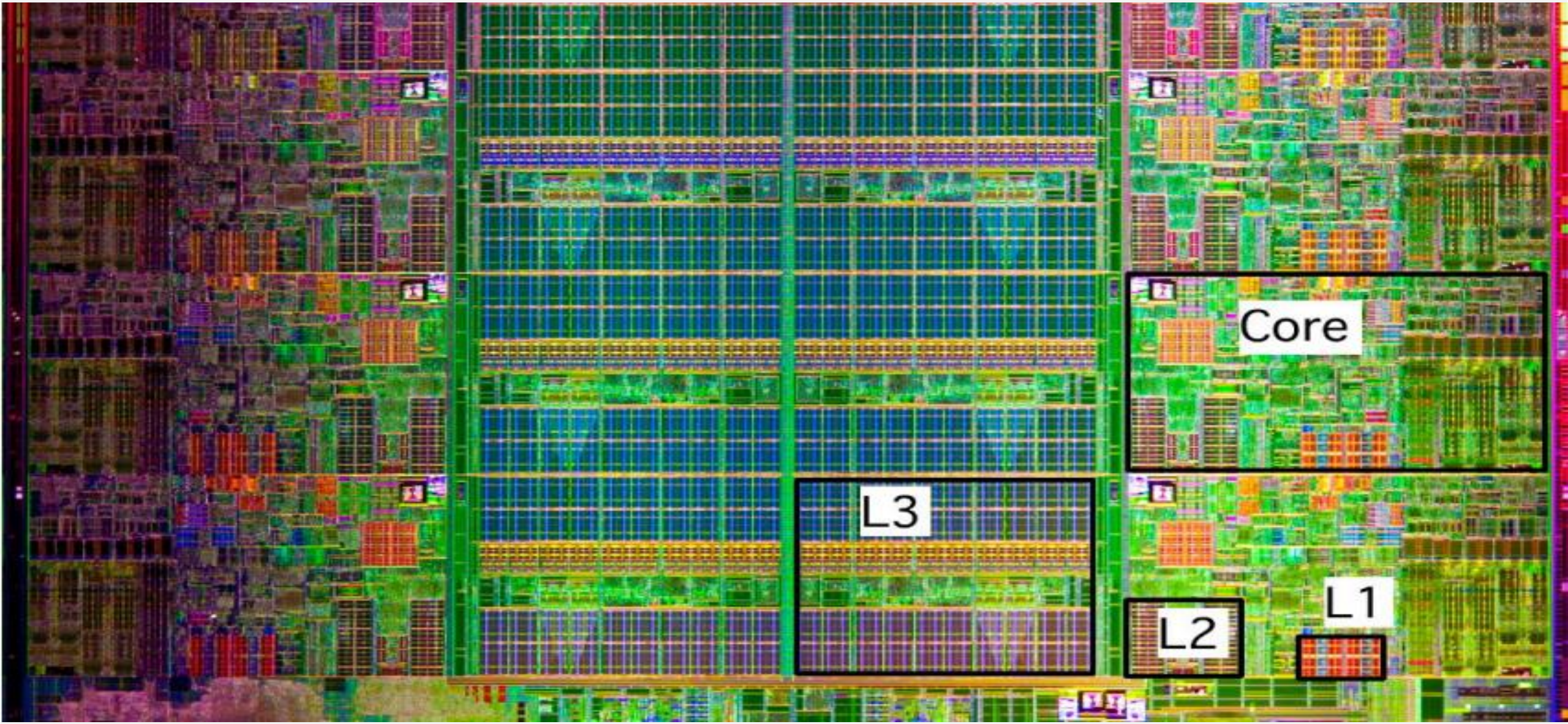
Reference letters in the future.

Questions ??

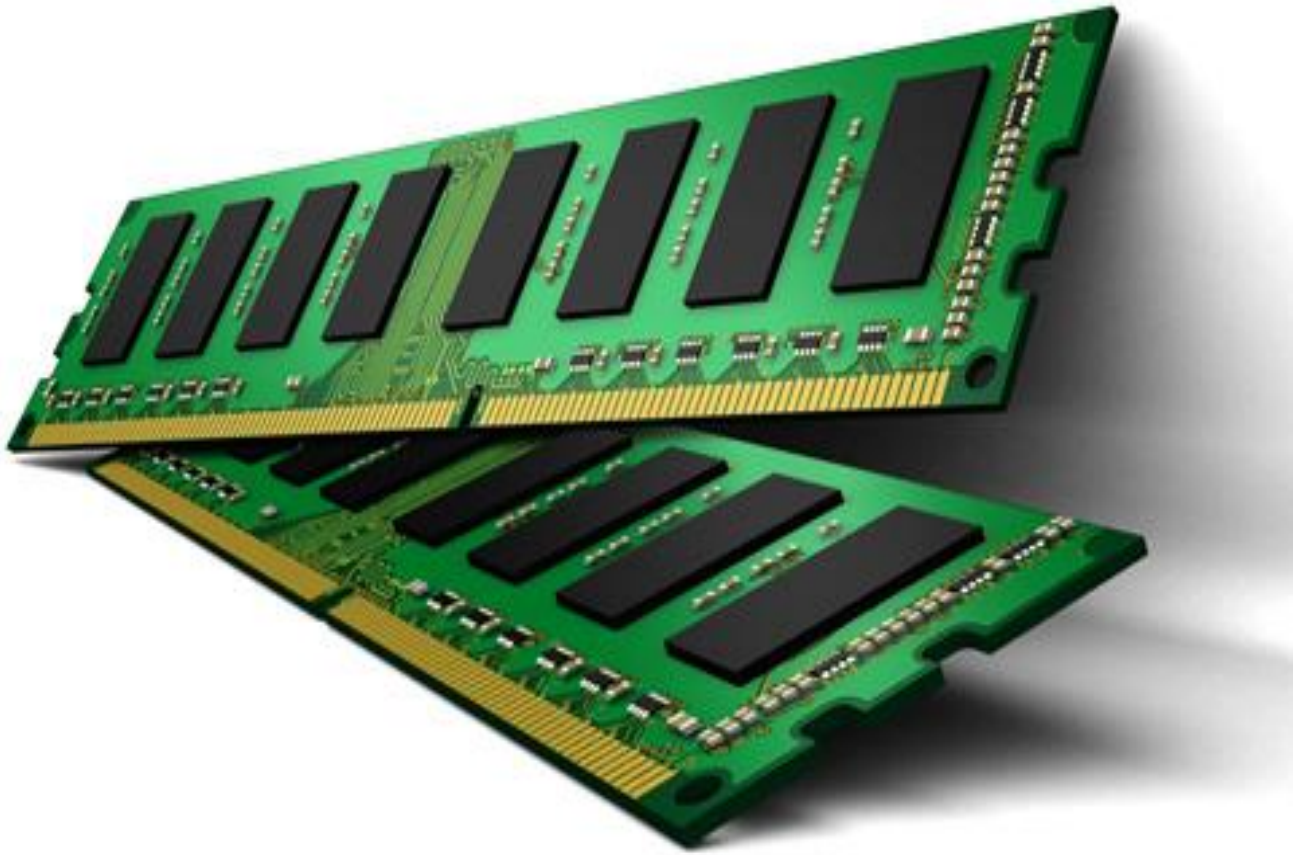
Processor [Source: Intel and Qualcomm]

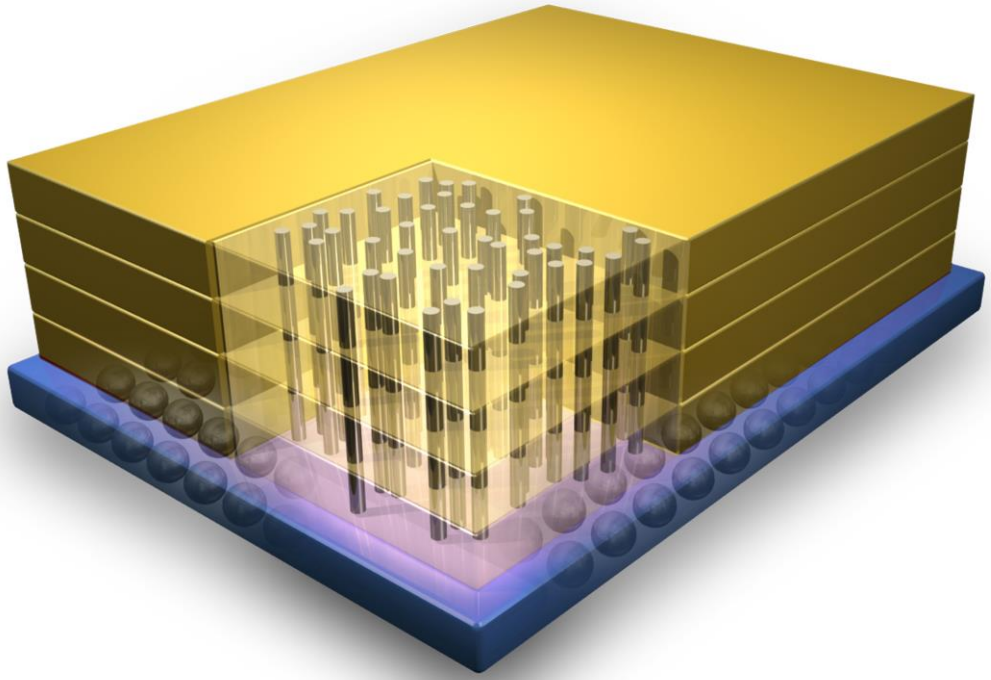


Caches [Source: Intel]

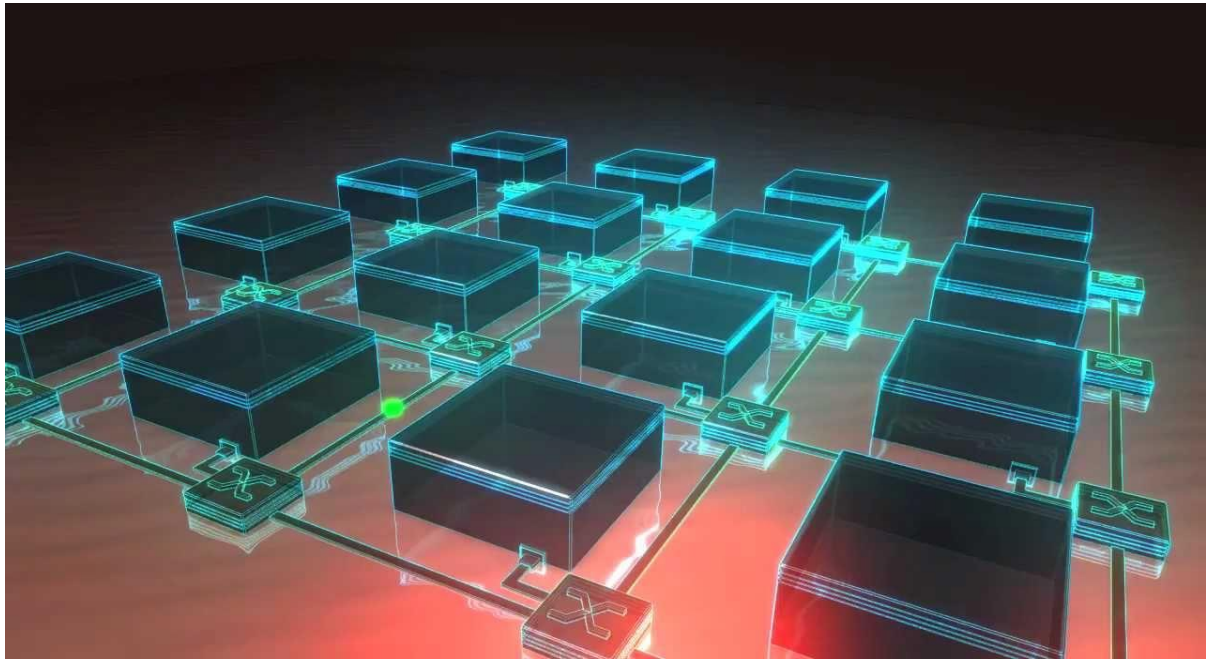


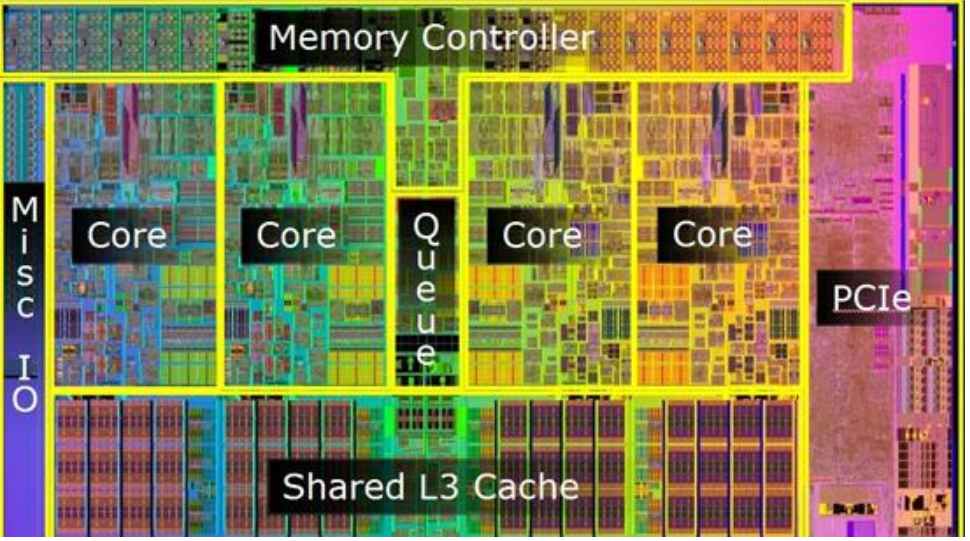
DRAM & DRAM Cache [Source: nist.gov]

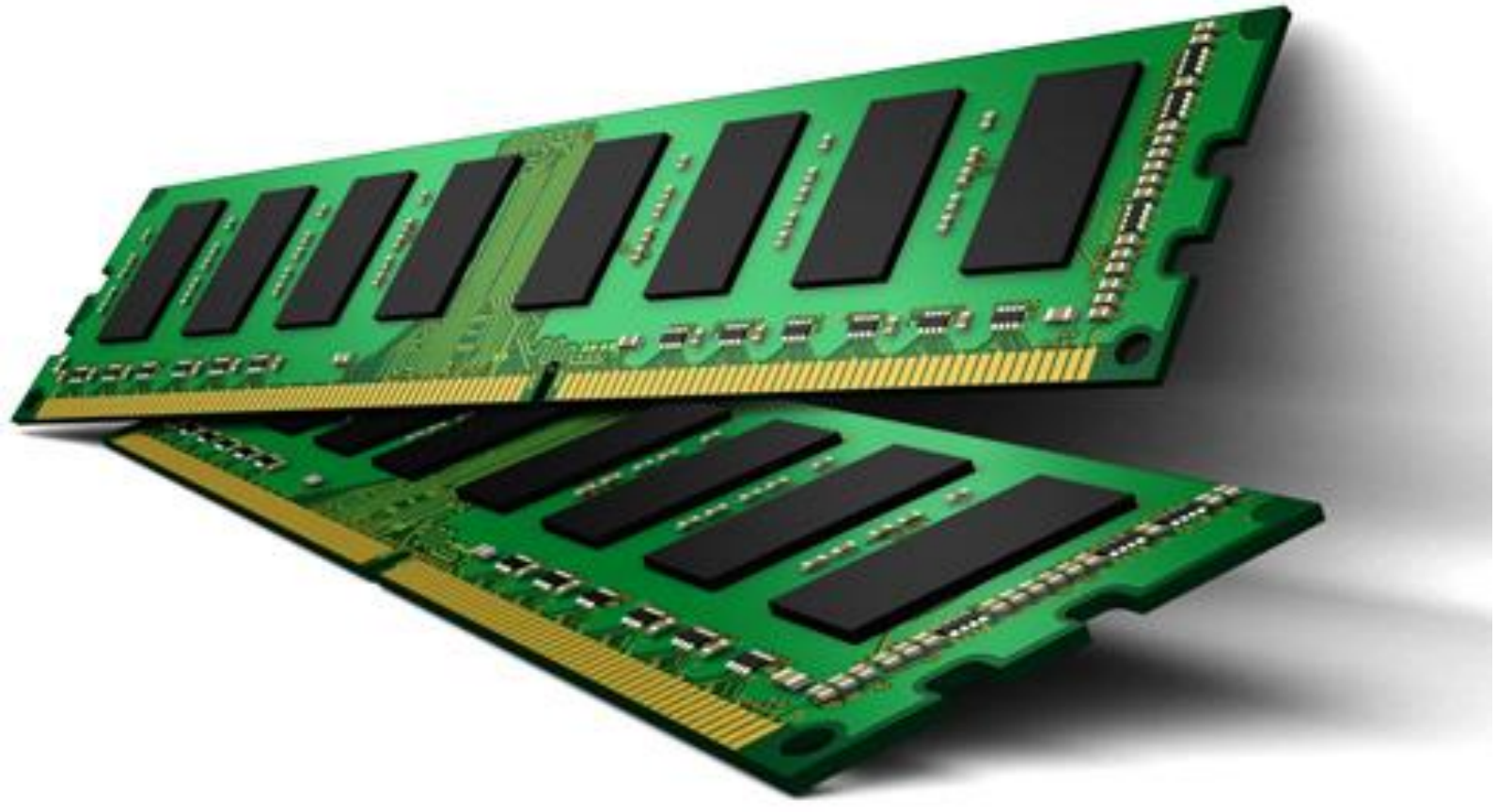




Others [Source: Youtube and NVIDIA]

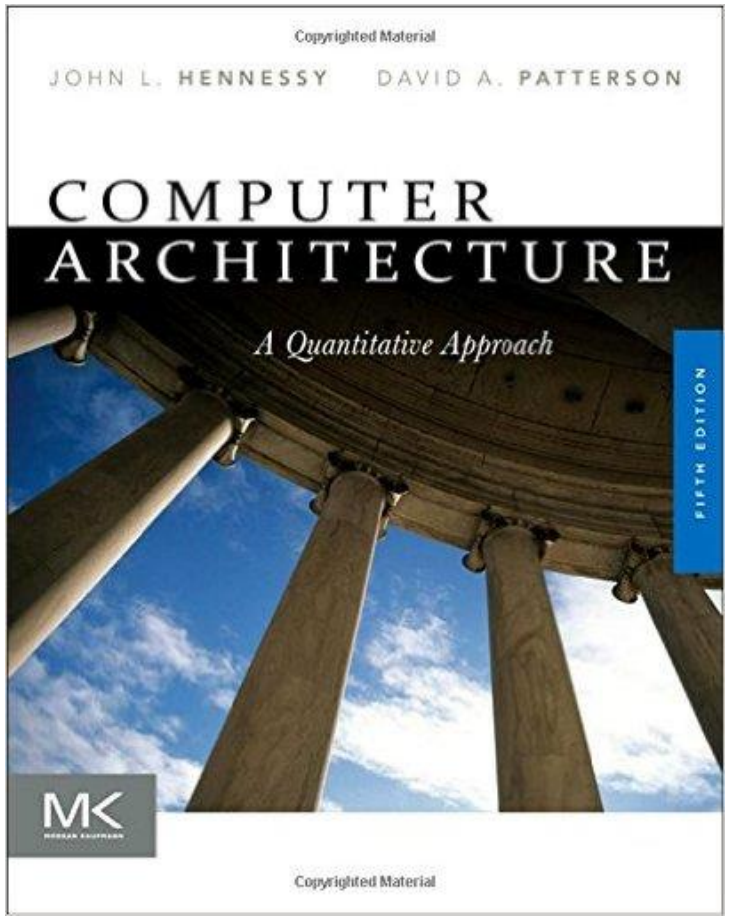






CS 422: Computer Architecture

Book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JOHN L. HENNESSY DAVID A. PATTERSON
COMPUTER ARCHITECTURE
A Quantitative Approach
FIFTH EDITION
MK
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The flow

10,000 feet view in first three weeks

All three assignments will be up from Feb. 1

Projects will be up from Feb. 1

Assignment-0 and what is expected by January 25th

ISCA 19 Championship

Value Prediction @ISCA'18: IITK placed second

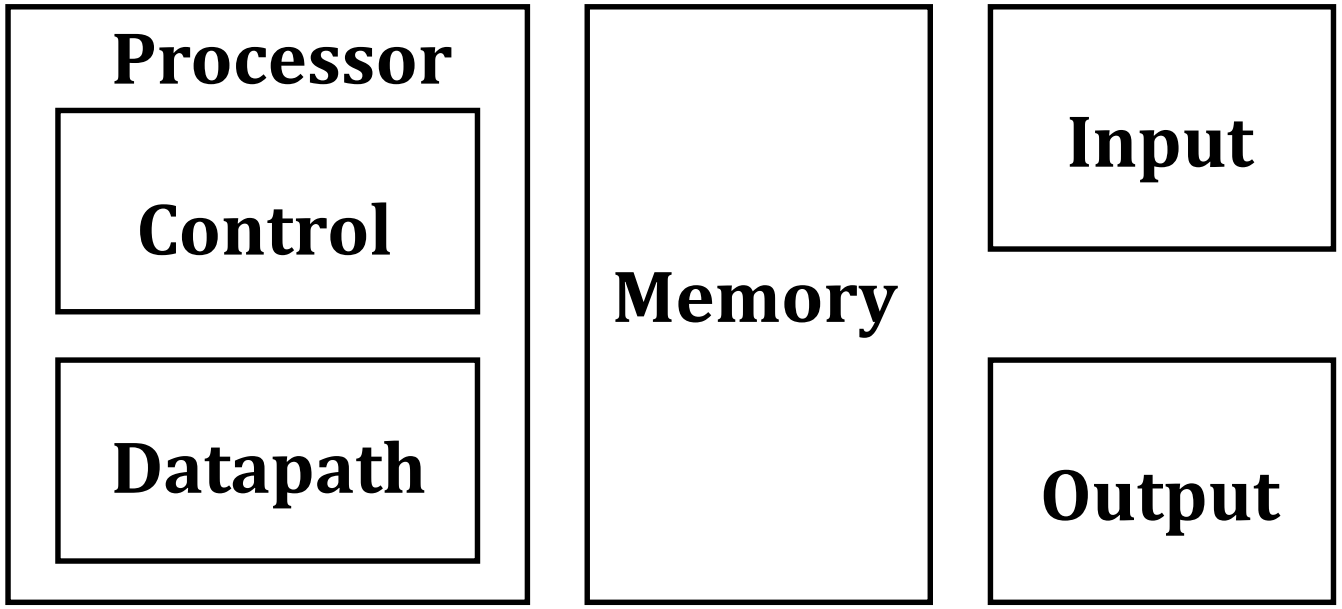
Round the year Championship

One more submission from IITK in the pipeline

Data Prefetching @ISCA'19: IITK ??

Computer Architecture ??

Since 1946 all computers have had 5 components



So What ?

Remember CS220

5-stage instruction pipeline

RISC/CISC

Caches

ISA

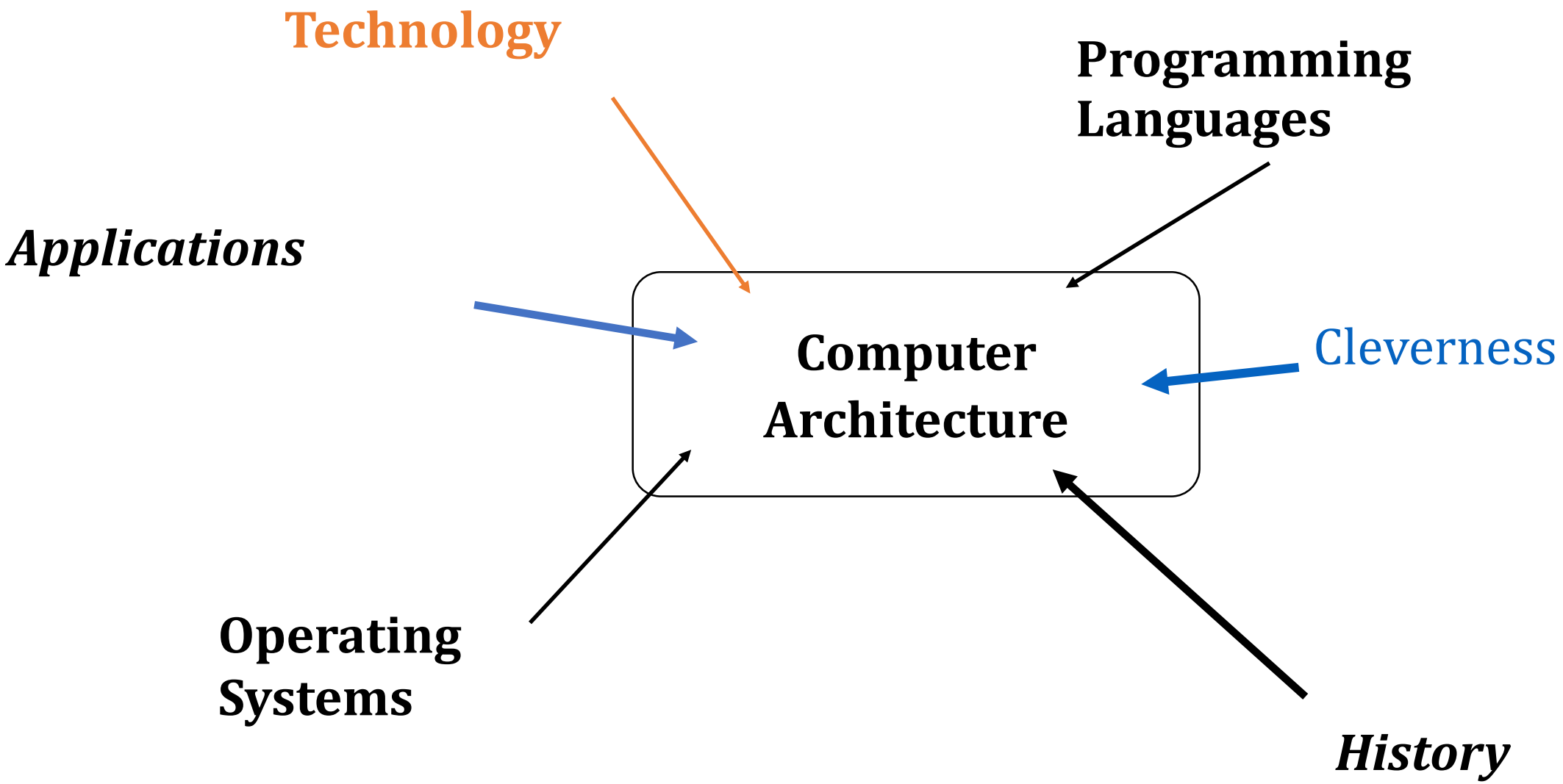
Addressing modes

CPI, IPC, MIPS Rating

Again, What is Computer Architecture?

- 1950s to 1960s: Computer Arithmetic
- 1970s to mid 1980s: Instruction Set Design, especially ISA appropriate for compilers
- 1990s: Design of CPU, memory system, I/O system, Multiprocessors, Networks
- 2010s: Self adapting systems? Self organizing structures? DNA Systems/Quantum Computing?

What is Computer Architecture?



Computer Architecture ??

VLSI++ or ++VLSI
Writing Verilog/VHDL code for designing a processor
Understanding how transistors work

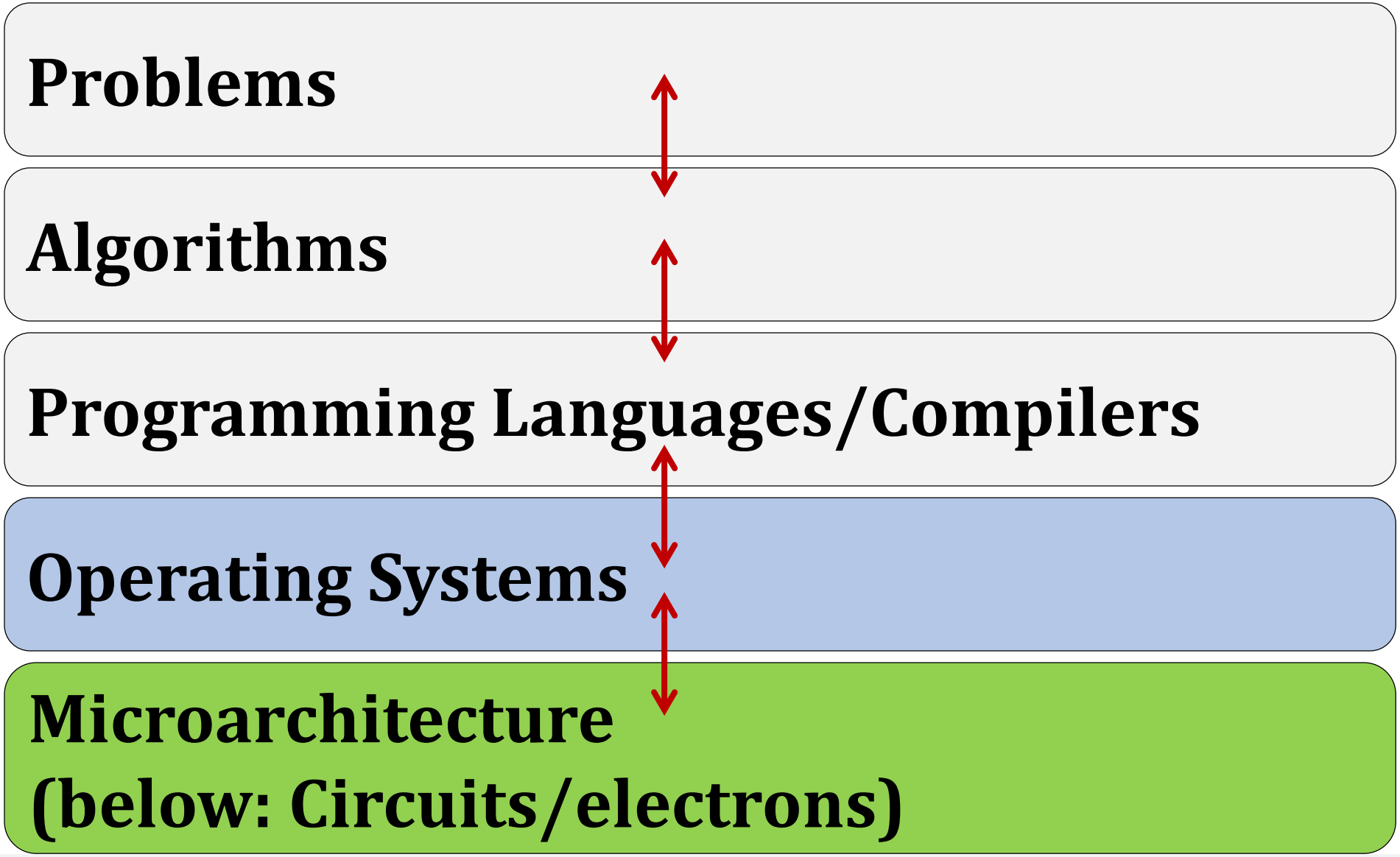
Computer theorists propose algorithms that solve important problems and analyze their asymptotic behavior (e.g., O(NlogN), O(N)). Computer architects (applicable to computer systems) set the constant factors of these algorithms – Christos Kozyrakis, Stanford

Computer Architecture: My View

For non-CS/EE minds: Abstraction layer that enables computation in (running a C program and getting an output) hardware. The layer decides how/when/why of the enabler.

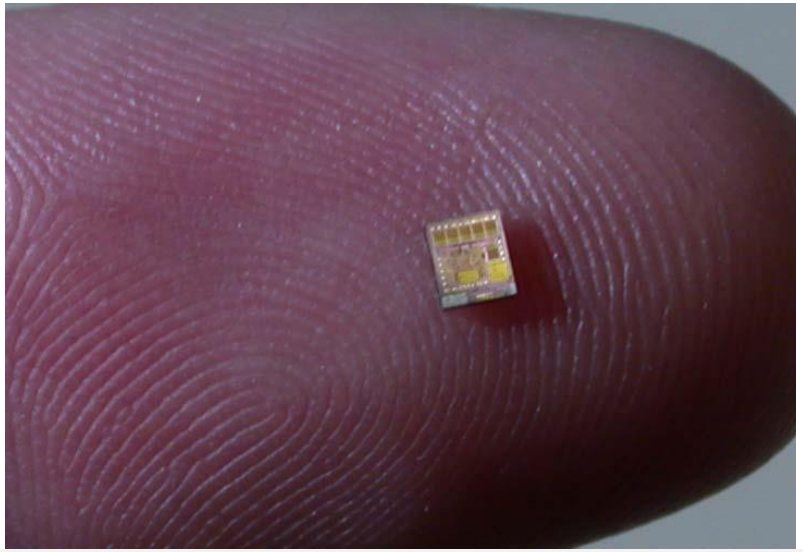
For CS/EE minds: Study of design trade-offs of different components (five) that are part of the abstraction layer. Trade-offs can be in terms of performance, power, energy, area, security, ……..

Computing Stack

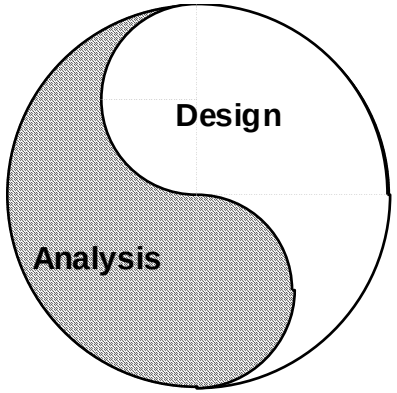


Why Study Computer Architecture ?

- CHANGE
- It's exciting!
- It has never been more exciting!
- It impacts every other aspect of electrical engineering and computer science

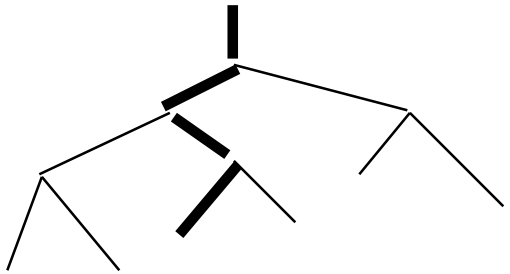


Architecture: Design Process



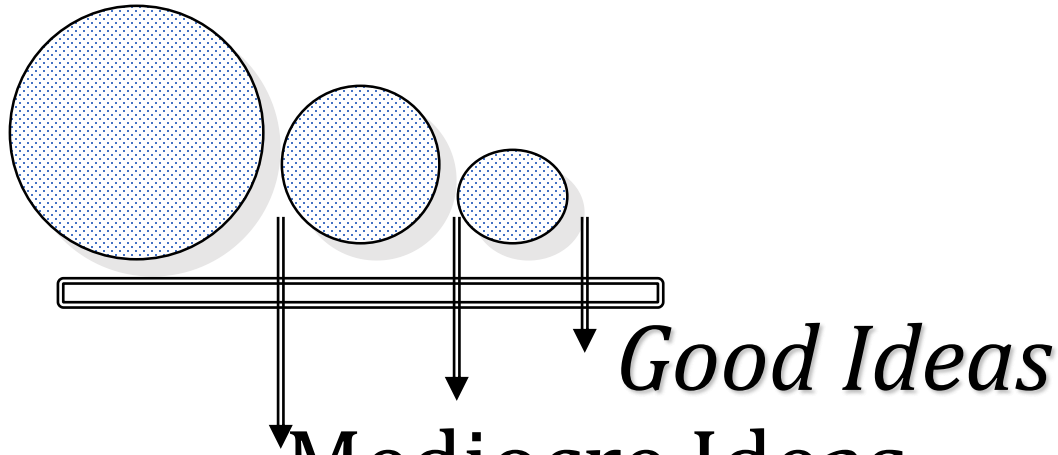
Architecture is an iterative process:

- Searching the space of possible designs
- At all levels of computer systems

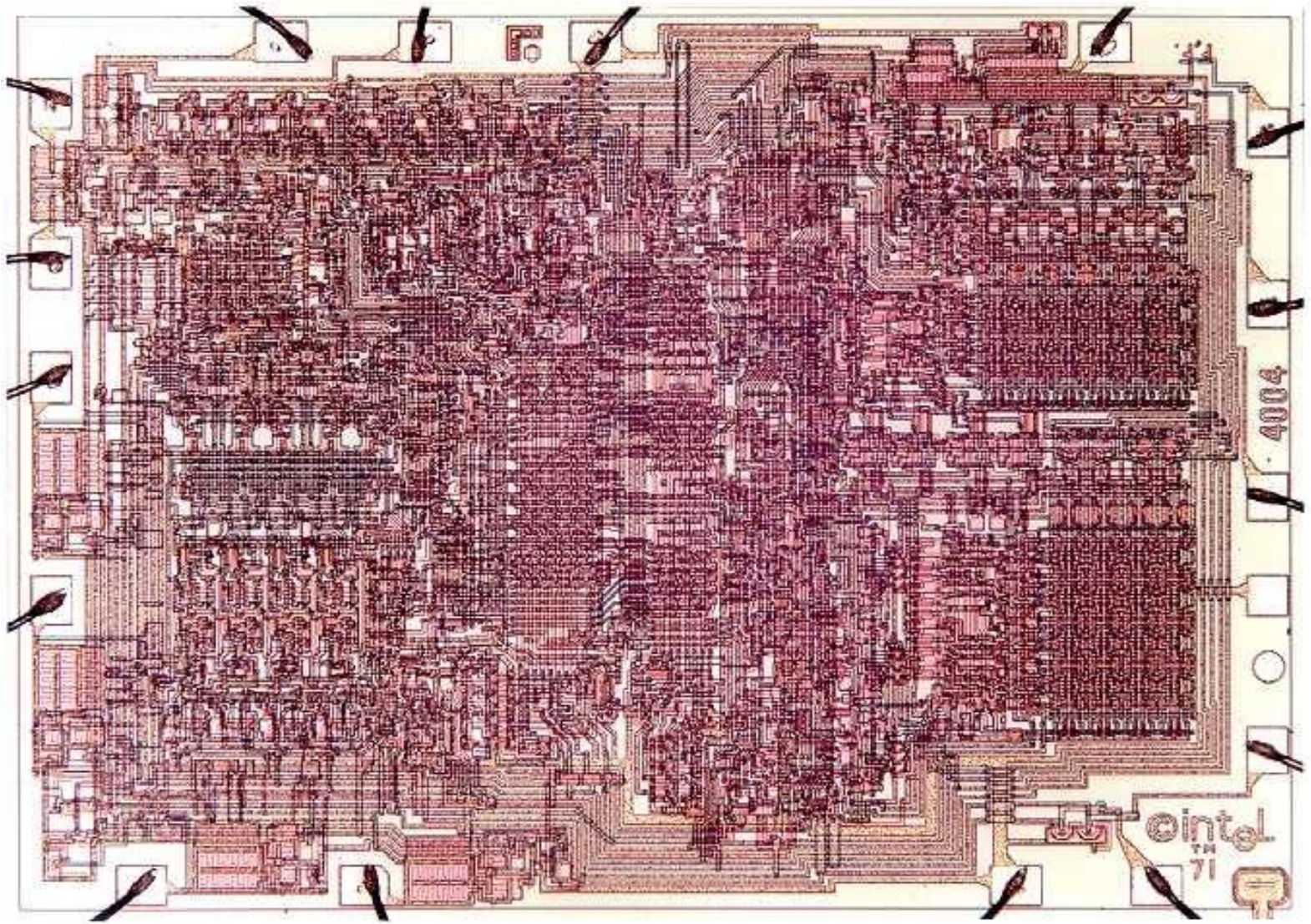


Creativity

Cost /Performance Analysis



First Microprocessor: Intel 4004, 1971

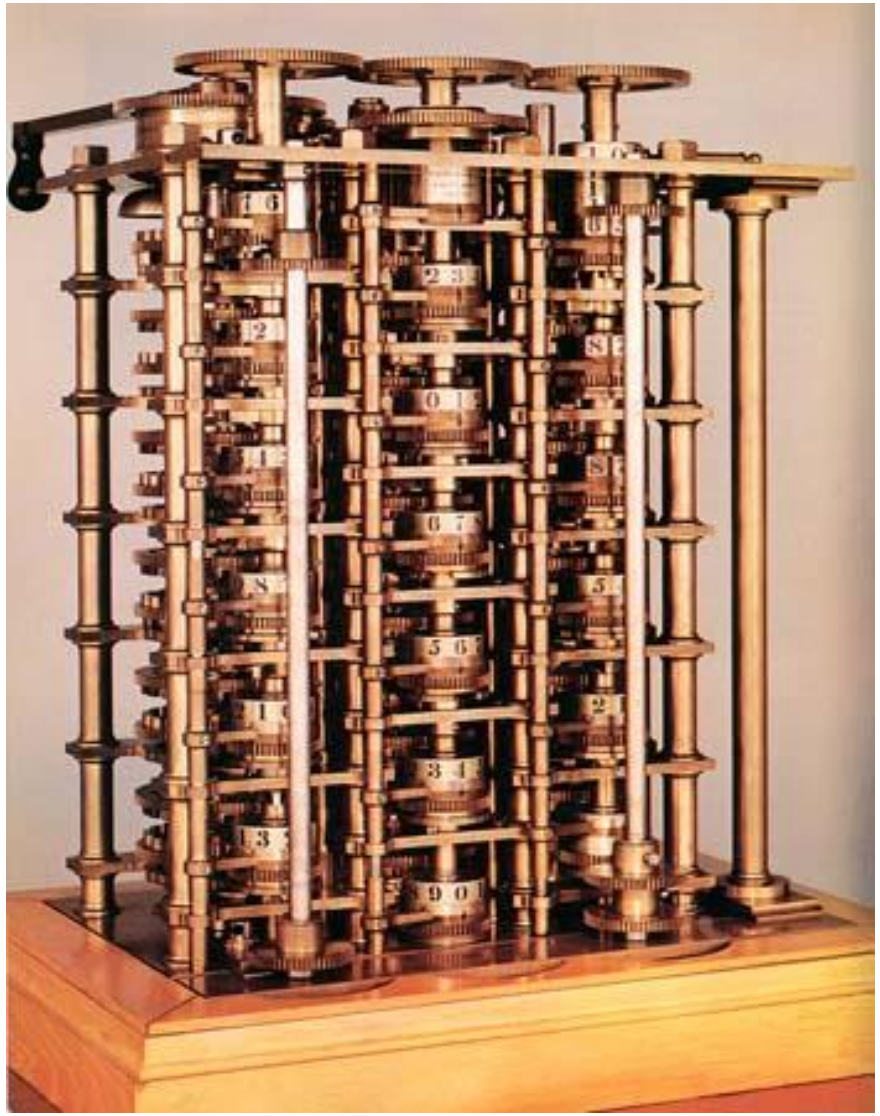


- 4-bit accumulator architecture
- 8µm pMOS
- 2,300 transistors
- 3 x 4 mm2
- 750kHz clock
- 8-16 cycles/inst.

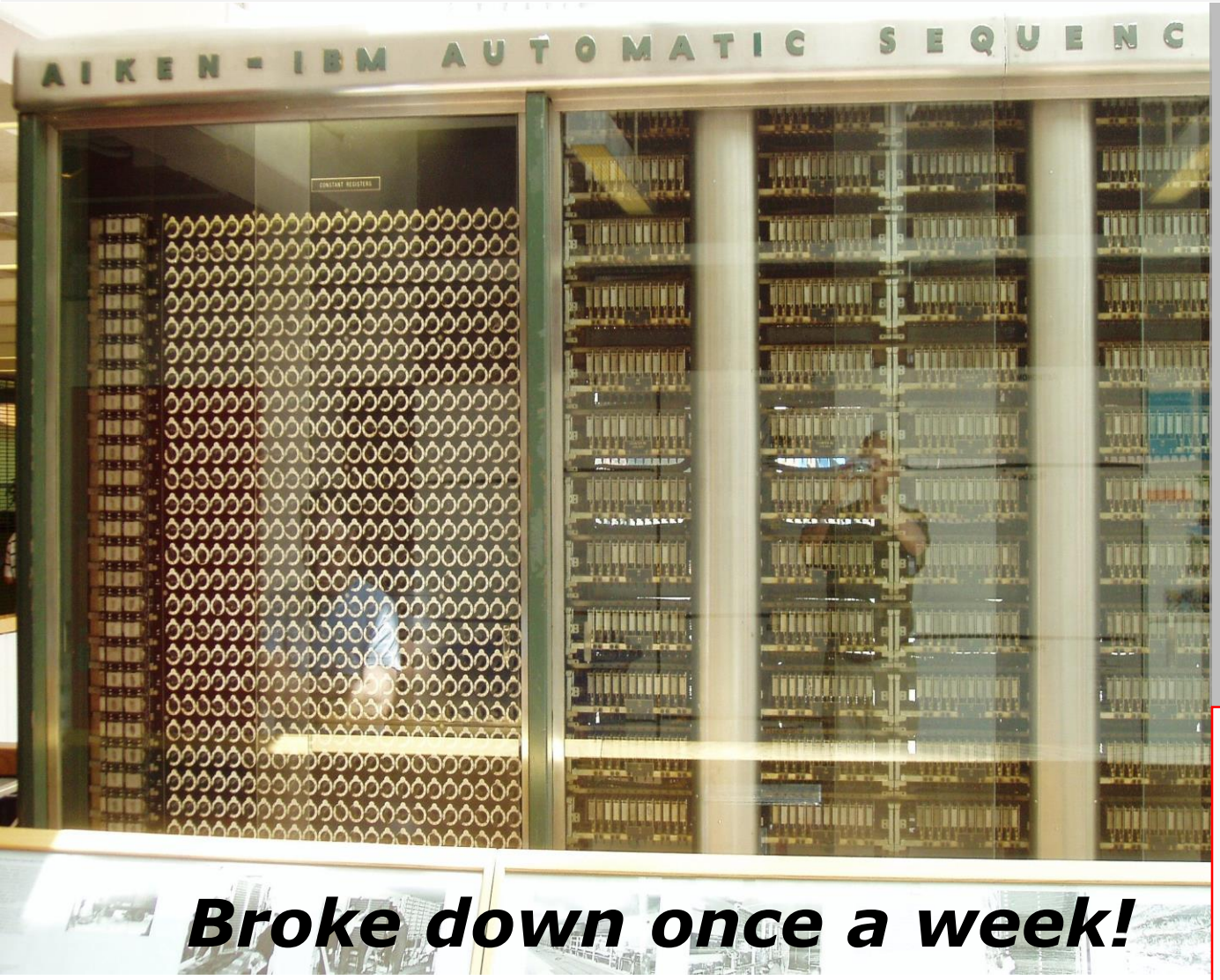
Before That: Difference Engine

1855. Can compute any 6th degree polynomial by calculating the difference between 2D matrix elements

Speed: 33 to 44 32-digit numbers per minute!



Harvard Mark -I



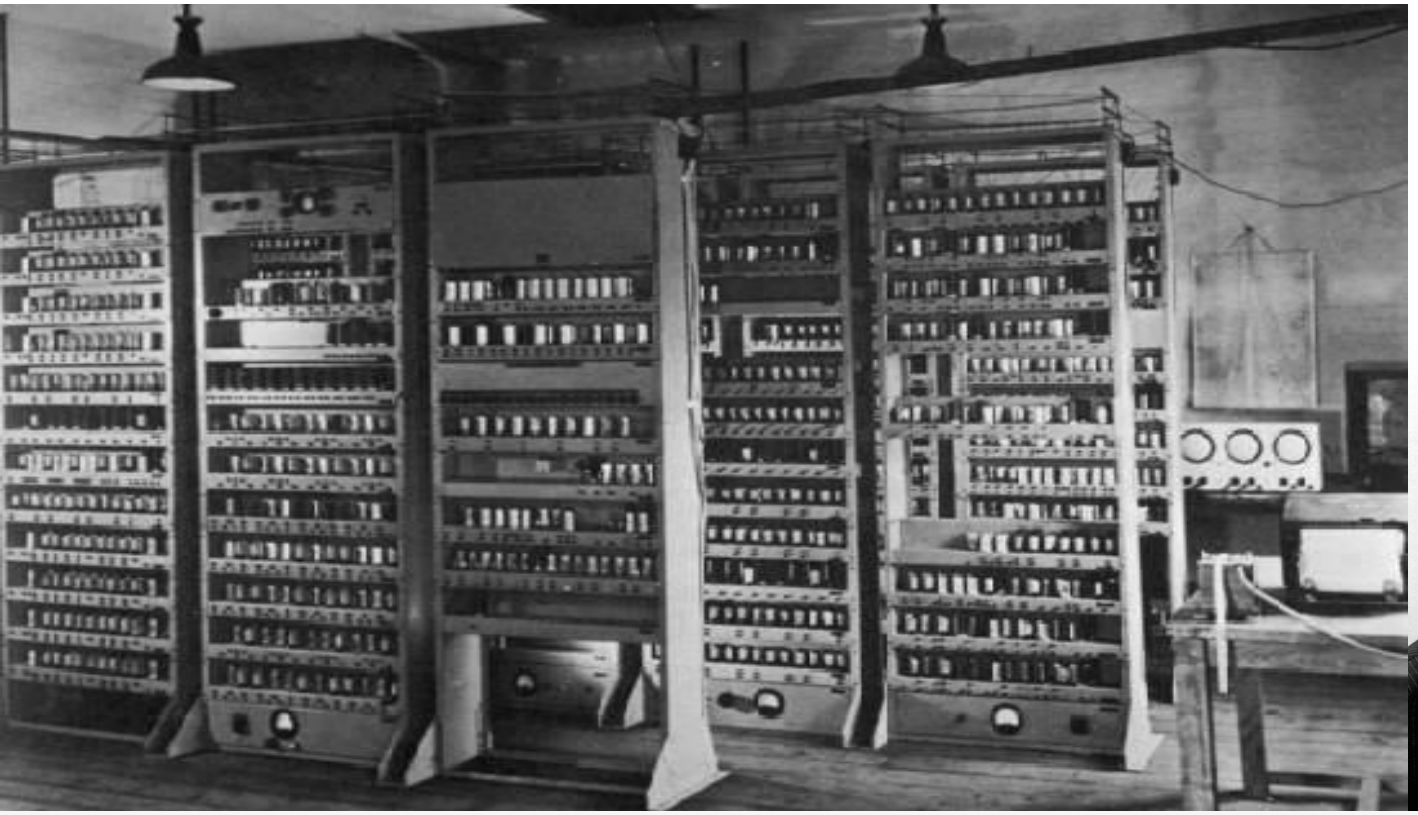
Broke down once a week!

- **Built in 1944 in IBM Endicott laboratories**
  - **Howard Aiken – Professor of Physics at Harvard**
  - **Essentially mechanical**
  - **Weighed *5 tons* and had *750,000* components**
  - **A synchronizing clock that beat every *0.015* seconds (66Hz)**
  - **Inspired by Charles Babbage's analytic engine**

Performance:

0.3 seconds for addition
6 seconds for multiplication
1 minute for a sine calculation

EDSAC in 1949 (EDVAC in 1944 By V. Newmann)



Electronic Delay Storage Automatic Calculator by Maurice Wilkes

Source: U. Cambridge

ACM SIGARCH Maurice Wilkes Award

The award of $2,500 is given annually for an outstanding contribution to computer architecture made by an individual whose computer-related professional career (graduate school or full-time employment, whichever began first) started no earlier than January 1st of the year that is 20 years prior to the year of the award.*

IBM 701

IBM 701 (1952)

30 machines sold by IBM in 1953-54

Why IBM entered so late into ..?

IBM revenues were doubling every 4 to 5 years in 1940/50s. Remember, this is without computers.

Intel's 8086

1978: Around 50 instructions

2017: Around 650 instructions

Personal Computing

Presenting the IBM® of Personal Computers.

IBM is proud to announce a product *you* may have a personal interest in. It's a tool that could soon be on your desk, in your home or in your child's schoolroom. It can make a surprising difference in the way you work, learn or otherwise approach the complexities (and some of the simple pleasures) of living.

It's the computer we're making for you.

In the past 30 years, the computer has become faster, smaller, less complicated and less expensive. And IBM has contributed heavily to that evolution.

Today, we've applied what we know to a new product we believe in: the IBM Personal Computer.

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*ADVANCED FEATURES FOR PERSONAL COMPUTERS

User Memory
16K - 256K bytes*
Permanent Memory
(ROM) 40K bytes*
Microprocessor
High speed, 8088*
Auxiliary Memory
2 optional internal diskette drives, 5¼", 160K bytes per diskette
Keyboard
83 keys, 6 ft. cord attaches to system unit*
10 funcuon keys*
10-key numeric pad
Tactile feedback*

Display Screen
High-resolution (720h x 350v)*
80 characters x 25 lines
Upper and lower case
Green phosphor screen*
Diagnostics
Power-on self testing*
Parity checking
Languages
BASIC, Pascal
Printer
Bidirectional*
80 characters/second
12 character styles, up to 132 characters/line*
9 x 9 character matrix*

Color/Graphics
Text mode:
16 colors*
256 characters and symbols in ROM*
Graphics mode:
4-color resolution: 320h x 200v*
Black & white resolution: 640h x 200v*
Simultaneous graphics & text capability*
Communications
RS-232-C interface
Asynchronous (start/stop) protocol
Up to 9600 bits per second

It's a computer that has reached a truly personal scale in size and in price: starting at less than $1,600† for a system that, with the addition of one simple device, hooks up to your home TV and uses your audio cassette recorder.

For flexibility, performance and ease of use, no other personal computer offers as many advanced features to please novice and expert alike (see the box).

Features like high resolution color graphics. Ten, user-defined function keys. The kind of expandability that lets you add a printer for word processing, or user memory up to 256KB. Or BASIC and Pascal languages that let you write your own programs. And a growing list of superior programs like VisiCalc,™ selected by IBM to match the quality and thoughtfulness of the system's total design.

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†This price applies to IBM Product Centers. Prices may vary at other stores.
VisiCalc is a trademark of Personal Software, Inc.

CIRCLE 3

[Personal Computing Ad, 11/81]

Do You Know What It Is ?

Today: Datacenter @Google

Today: China's Sunway Taihulight

(more than 100K cores)

And We are Smart now ☺

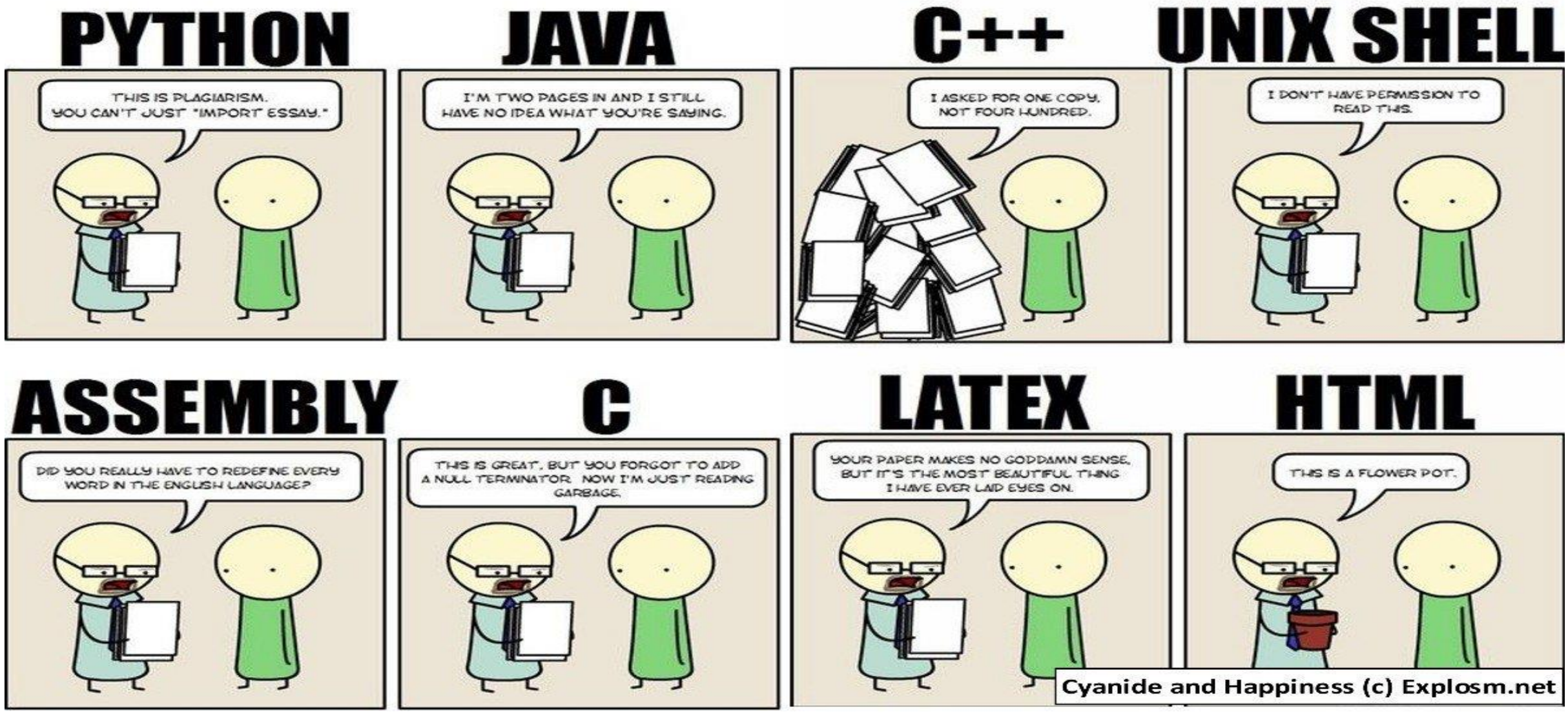
Source:
Truthseeker, UK

Hang on !! Why All This ?

You have to understand the past to understand the present: Carl Sagan

Let’s Look at the Other (Consumer) Side

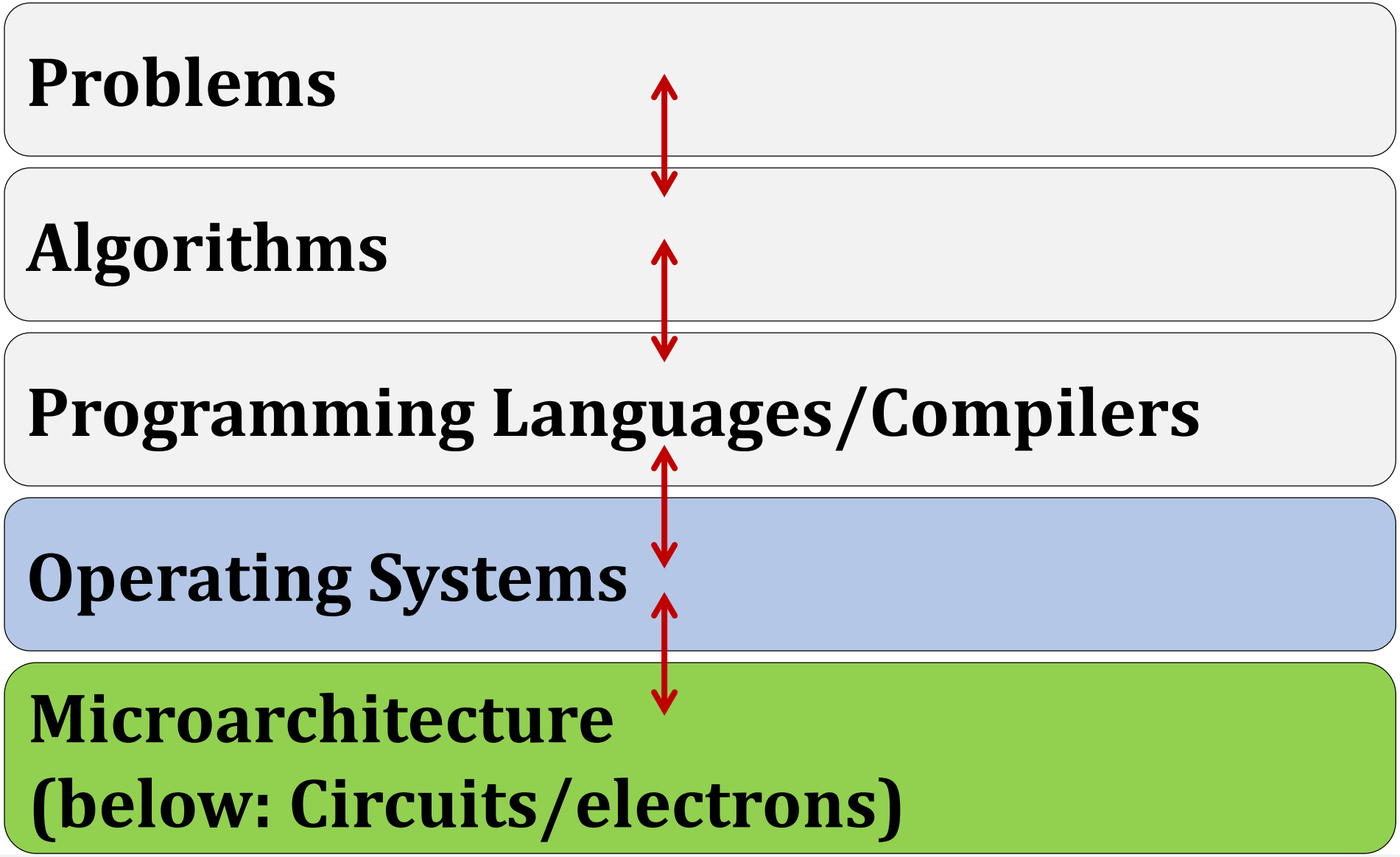
World of Programming Languages



What About Application domains ?

Look around you and think of it

Let's Revisit This



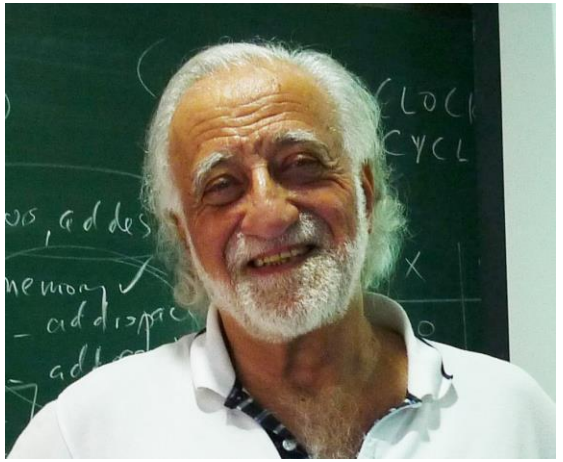
Mantra from Y. Patt [U.T. Austin]

Look Backward: Examine Old Code

Look Forward: New domains and new challenges

Look Up: Nature of Problems in the stack

Look Down: Technology (have EE friends)



Let’s Get Started Then

Assignment 0.0: Due tomorrow 8.55 AM
Link: Course Web-page
On-time submission: 0 point