Introduction

CEE3804: Computer Applications for Civil and Environmental Engineers

Course Goal and Objectives

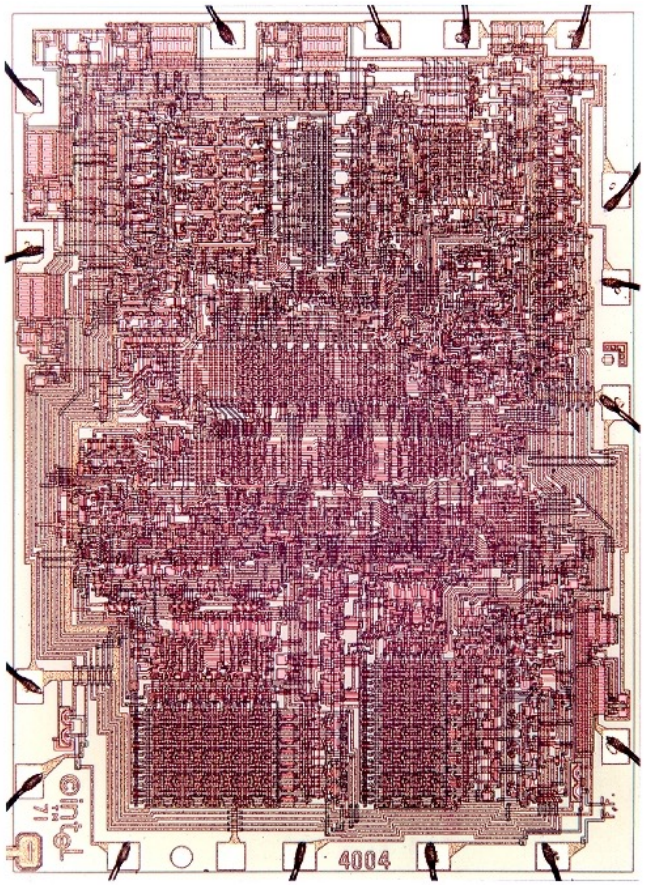
- **Course Goal:**
  - Develop a strong background in computer applications relevant to the civil engineering studies and profession
- **Course Objectives:**
  - Develop expertise using spreadsheets
  - Develop expertise using macro languages and programming
  - Develop an understanding of numerical computing languages (Matlab)

Specific Course Objectives:

- Perform linear algebra and matrix operations related to CEE systems.
- Determine roots of nonlinear equations and solve sets of linear equations
- Construct, interpret and solve simple optimization problems.
- Develop and program simple engineering analysis.
- Create user-defined functions in a programming environment.
- Create and modify simple user interfaces using a programming environment.
- Identify the operational features of computer programs.

Computer History

- **Intel invents the single-chip microprocessor: 1971**



Intel's 4004 Microprocessor
Source: Intel

2,300 transistors

Intel 4004 Microprocessor

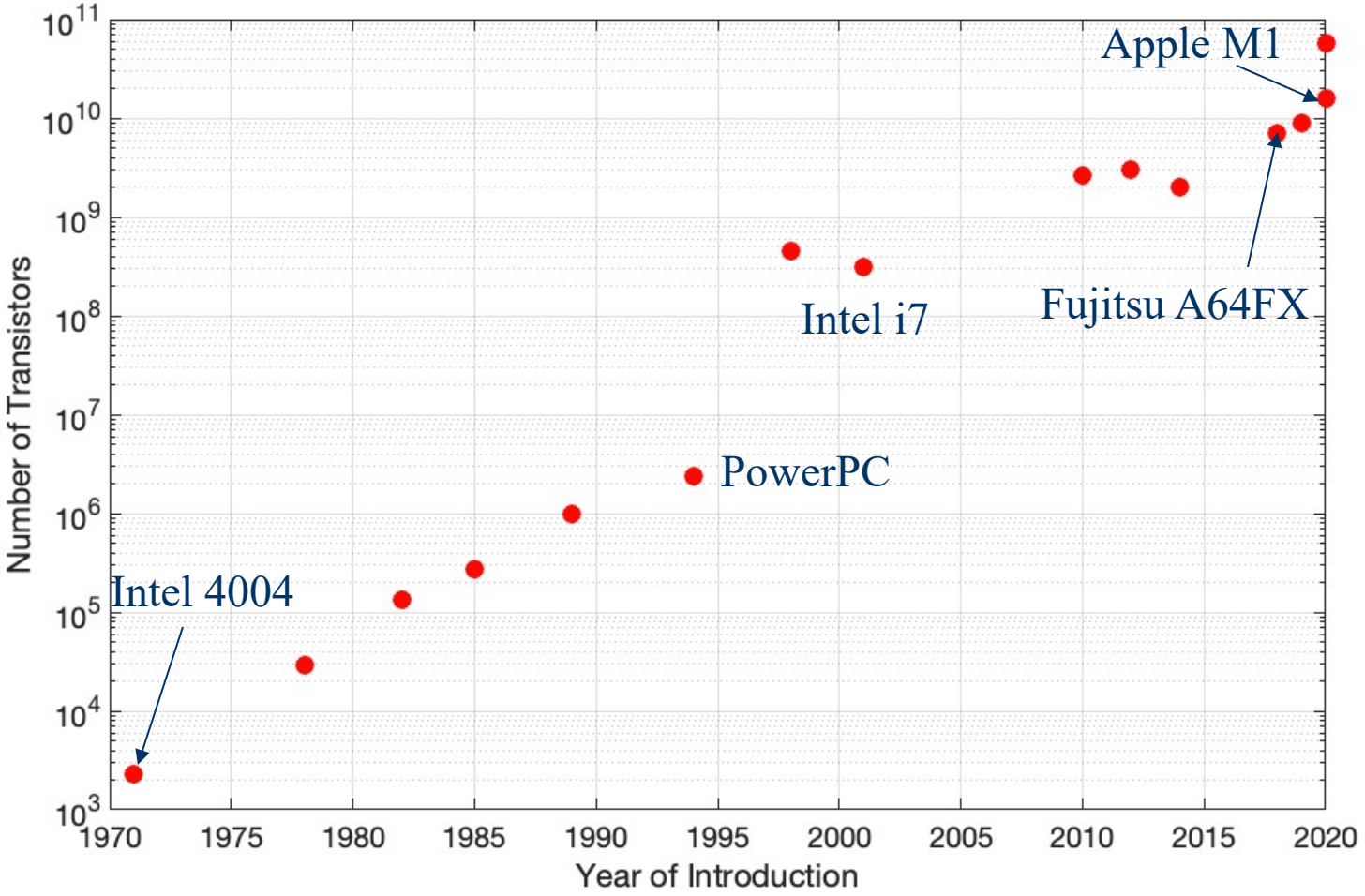
- In 1971, Intel develops the 4004, the first chip to contain all the components of a central processing unit. With just 2,300 transistors, the basic on/off switches of computing, the 4004 was pretty primitive, incapable of much more than simple arithmetic

- By contrast, a recent Intel Xeon Sandy Bridge chip has more than 312 million transistors (2.27 billion transistors in an 8-core chip implementation)

Moore's Law

- In 1965, Gordon Moore of Intel was preparing a speech and made a memorable observation When he started to graph data about the growth in memory chip performance, he realized there was a striking trend
- Each new chip contained roughly twice as much capacity as its predecessor, and each chip was released within 24 months of the previous chip
- If this trend continued, he reasoned, computing power would rise exponentially over relatively brief periods of time.

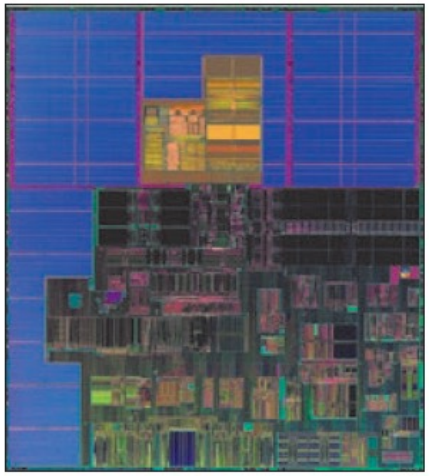
Moore's Law



Sources: Intel, Apple, Wikipedia

Computer History

- **Intel develops the Itanium Processor**



Itanium® 2 Processor
Introduced: **2002**
Initial clock speed: 1 GHz
Number of transistors: 220 million
Circuit line width: 0.18 micron

Intel's Itanium 2 Microprocessor
Source: Intel

Implications

- Current controversies
  - Digital rights management (music/video downloads, interoperability)
  - Licensing vs ownership
    - See software licensing problem http://www.wired.com/news/technology/0,71554-0.html?tw=wn_index_27
  - Security, viruses, spam, phishing (e.g. Sony root kit)
  - Digital divide
  - Patents for software
  - Open source vs. proprietary software
  - Net neutrality
- New technologies arising
  - Broadband, wireless, speech, nanotechnology, quantum computing, AI?
- Computer use requires lifelong learning

Evolution in Personal Computing

TECH TREND

State of the Art: Then and N

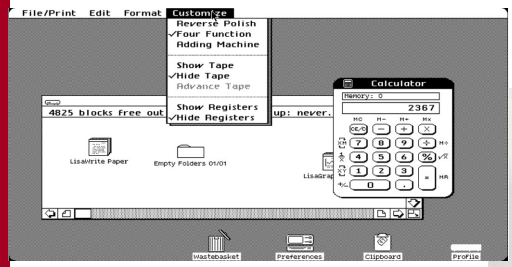
GIVEN THE PERFORMANCE and features of all levels of today's PCs, it's easy to be blasé about ho
pare them with those of powerhouses we tested in earlier years. This month's *Tech Trend* cranks the
over the past two decades. In 1983, businesses bought computers mainly for spreadsheets and word
beginning to attract consumers' attention, and software was starting to ship on CD-ROMs. In 2003
dle basic tasks like spreadsheets and Internet browsing. As computing evolves, you will always nee
cations, such as 3D gaming, video editing, or the latest operating system. Systems will surely evolv

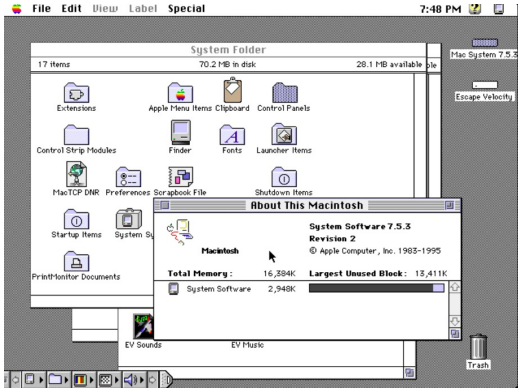
2013
Intel i7 and Xeon Chips
RAM 8 GB
Hard drive 1-2 TB
Price $2,100
Windows 7-8

FEATURE	1983 IBM Personal Computer XT	1993 Gateway 2000 4DX2-66V	2003 Dell Dimension 8250
Processor	Intel 4.77-MHz 8088	Intel 66-MHz 486DX2	Intel 3.06-GHz Pentium 4
RAM	128KB	8MB	512MB
Hard drive space	10MB	202MB	200GB
Removable storage	360KB, 5.25-inch floppy	1.44MB 3.5-inch and 1.2MB 5.25-inch floppy drives	Rewritable DVD drive
Monitor	11.5-inch monochrome green phosphor	15-inch SVGA	18-inch LCD
Modem	optional 1.2-kbps ($699)	optional 14.4-kbps ($195)	56-kbps (V.92)
Price	$4995	$2875	$3158
Operating system	DOS 2.0	Windows 3.1 over DOS	Windows XP Home
Best feature	Internal hard drive	CD-ROM drive	Rewritable DVD drive
Killer app	Lotus 1-2-3	AOL	3D gaming

Macintosh Side Evolution

Lisa OS 1.0
(1983)





System 7 (1991)

iMac i7
64-bit (2007)

Mac 8600
32-bit (1997)

Mac II
32-bit (1987)

Apple II
8-bit (1977)

Sources: Wikipedia and
www.guidebookgallery.org

Supercomputer Clusters

Supercomputer clusters are making possible large–scale Computations

ORNL Titan Cluster (Source: Wikipedia)

Rank (previous)	Rmax Rpeak (PFLOPS)	Name	Model	CPU cores	Accelerator (e.g. GPU) cores	Interconnect	Manufacturer	Site country	Year	Operating system
1 — (1)	442.010 537.212	Fugaku	Supercomputer Fugaku	158,976 × 48-core Fujitsu A64FX (ARM-based) @2.2 GHz	0	Tofu interconnect D	Fujitsu	RIKEN Center for Computational Science Japan	2020	Linux (RHEL)
2 — (2)	148.600 200.795	Summit	IBM Power System AC922	9,216 × 22-core IBM POWER9 @3.07 GHz	27,648 × 80 Nvidia Tesla V100	InfiniBand EDR	IBM	Oak Ridge National Laboratory United States	2018	Linux (RHEL 7.4)
3 — (3)	94.640 125.712	Sierra	IBM Power System S922LC	8,640 × 22-core IBM POWER9 @3.1 GHz	17,280 × 80 Nvidia Tesla V100	InfiniBand EDR	IBM	Lawrence Livermore National Laboratory United States	2018	Linux (RHEL)
4 — (4)	93.015 125.436	Sunway TaihuLight	Sunway MPP	40,960 × 260-core Sunway SW26010 @1.45 GHz	0	Sunway[35]	NRCPC	National Supercomputing Center in Wuxi China[35]	2016	Linux (RaiseOS 2.0.5)
5 — (5)	64.590 89.795	Perlmutter	HP	? × ?-core AMD Epyc 7763 64-core @2.45 GHz	? × 108 Nvidia Ampere A100	Slingshot-10	HPE	NERSC United States	2021	Linux (HPE Cray OS)
6 — (6)	63.460 79.215	Selene	Nvidia	1,120 × 64-core AMD Epyc 7742 @2.25 GHz	4,480 × 108 Nvidia Ampere A100	Mellanox HDR Infiniband	Nvidia	Nvidia United States	2020	Linux (Ubuntu 20.04.1)

Source: https://en.wikipedia.org/wiki/TOP500#TOP_500

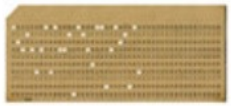
Learning More About Computers and History

- Visit the virtual Computer History Museum
- http://www.computerhistory.org/revolution/

Exhibition

Calculators

First Steps on the Path to Computers Banks calculating interest. Kids dividing up cookies. Engineers designing bridges. We make calculations every day. And for as long as we've juggled numbers greater than our fingers and toes, we've...



Punched Cards

From Math to Data People used calculators to manipulate numbers. But how do you make machines that also manipulate words or ideas? Punched cards, a mainstay of early office automation and computing, helped launch the transition from ...

Analog Computers

Analog and Digital: Different Ways to Measure and Model the World Our world is a symphony of infinite variations. Long before digital computers existed, engineers built models to simulate those real world nuances. Analog computers ...

Why Do Civil Engineers Need Computers?

- **Productivity**
  - One person today can do the work of “many” engineers five decades ago
  - One person can do more computations per unit of time solving more complex problems
- **Precision**
  - If used properly computers offer solutions to complex problems
  - More computations per second to validate a design
- **Better communication with client**
  - Visualization
- **Computers and computer languages evolve: requires requires a lifelong learning**

Why Do Civil Engineers Need to Program?

- To facilitate the execution of repetitive tasks
- To read and write large files (some beyond the ability of spreadsheets)
- Develops problem-solving skills
  - Not all problems are equal
  - Solving new challenging problems requires analytical and computer skills
- Not all engineering firms have specialized computer scientists in their staff
- This means YOU will have to get the work done in the company

Life Long Learning

- Applications used in CEE evolve with time
- ArcGIS
  - ArcGIS has supported VBA as a programming environment to extend the basic features of ArcGIS
  - However, ESRI – the company that makes this product is changing to Python
- AutoCAD
  - AutoCAD has an Application Programming Interface (API) that includes AutoLISP, VBA, .NET and ObjectARX
  - Companies that want to extend the power of AutoCAD need CEE engineers that understand such development environments