Introduction

Lecture 1 – Monday February 20, 2017

Outline

- Approaching Computers

- Using Computers

- Exploring with Computers

- Emerging Technologies

Outline

- **<u>Approaching Computers</u>**

- Using Computers

- Exploring with Computers

- Emerging Technologies

Approaching Computers

- **What is a Computer?**

  A computer is a machine that is made up of combination of electronic and electromechanical electromechanical components. A computer system processes data into information according to instructions provided by the user.

  Input   Computer   Output
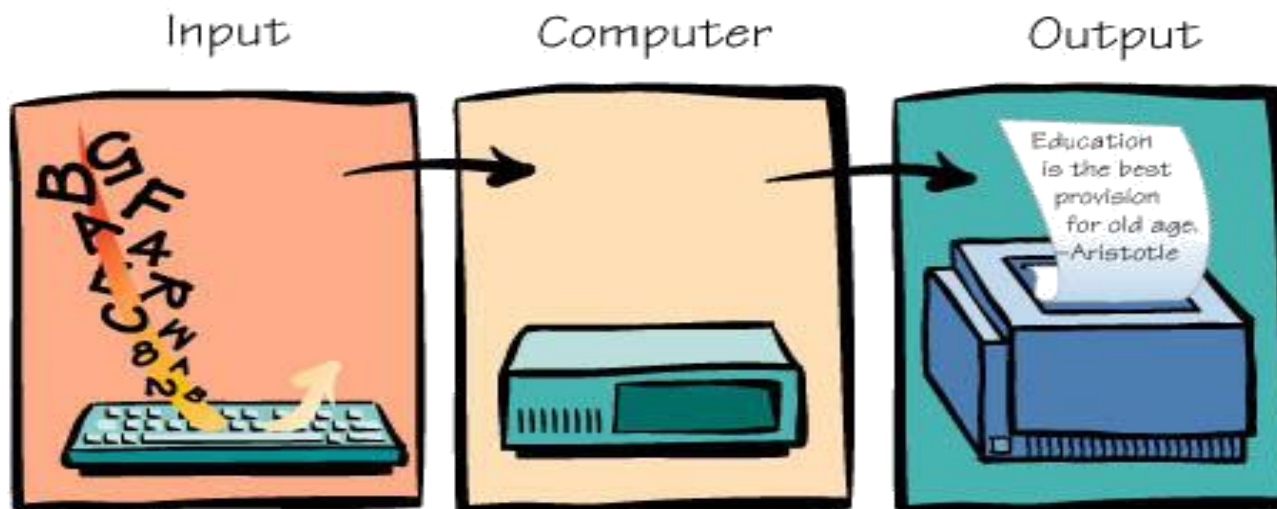
  Raw data:

  X,Y

  X=10, Y=5

  Mathematical Operation:

  X*Y

  Logical Operation:

  If X > Y Then Print "True"

  50

  True

Approaching Computers

- **What is a Computer?**

  ◇ **Data**: symbols

  ◇ **Information**: data that are processed to be useful; provides answers to "who", "what", "where", and "when" questions

  ◇ **Knowledge**: application of data and information; answers "how" questions

  ◇ **Understanding**: appreciation of "why"

  ◇ **Wisdom**: evaluated understanding.

Approaching Computers

- **What is a Computer?**

  A computer system processes data into information according to instructions provided by the user.

  - ☞ **Data** are raw facts that need to be processed.

  - ☞ **Information** is meaningful data

  - ☞ **Instructions** provided by the user tell the computer hardware how to perform a task (Software).
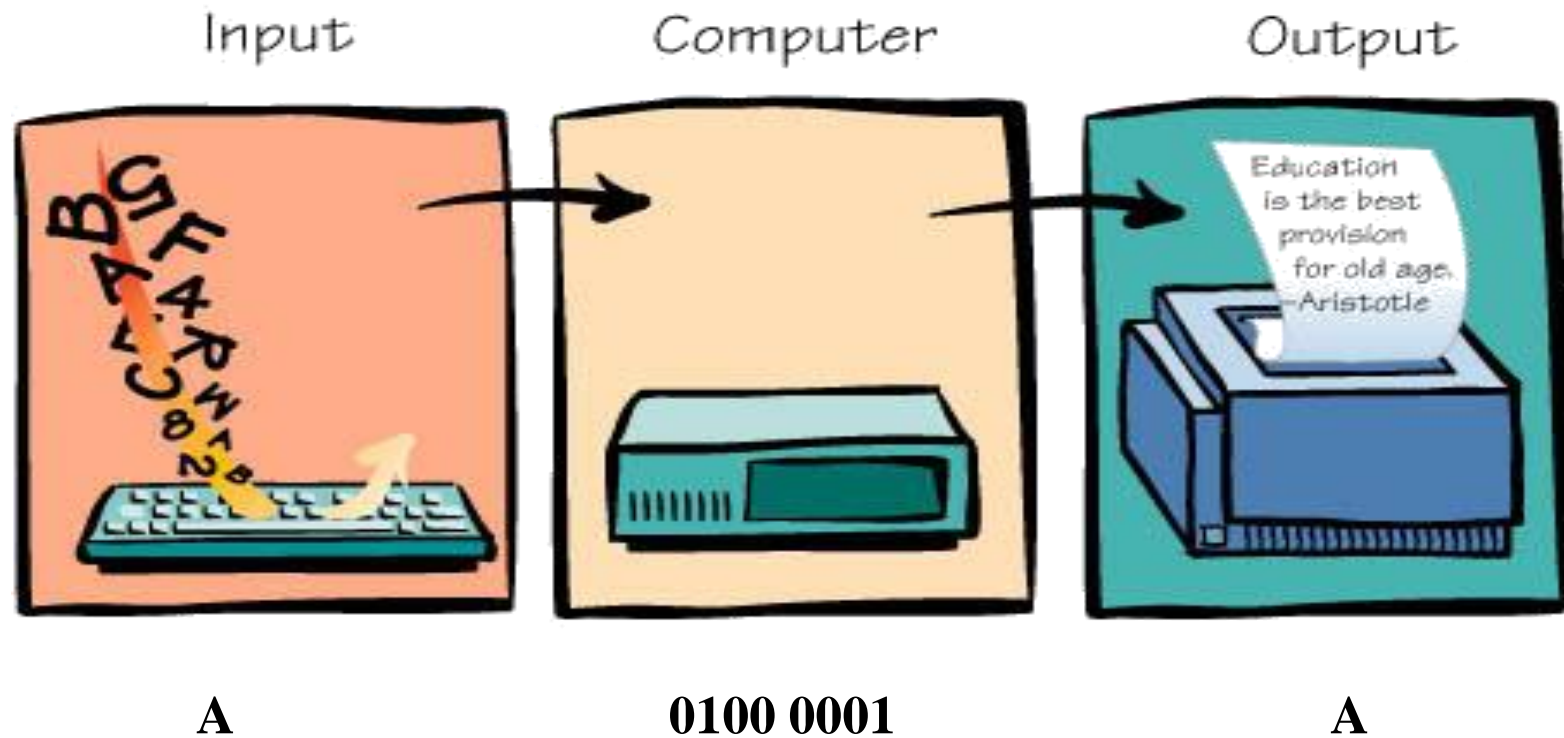
Approaching Computers

• **What is a Computer?**

Computers store information in digital form
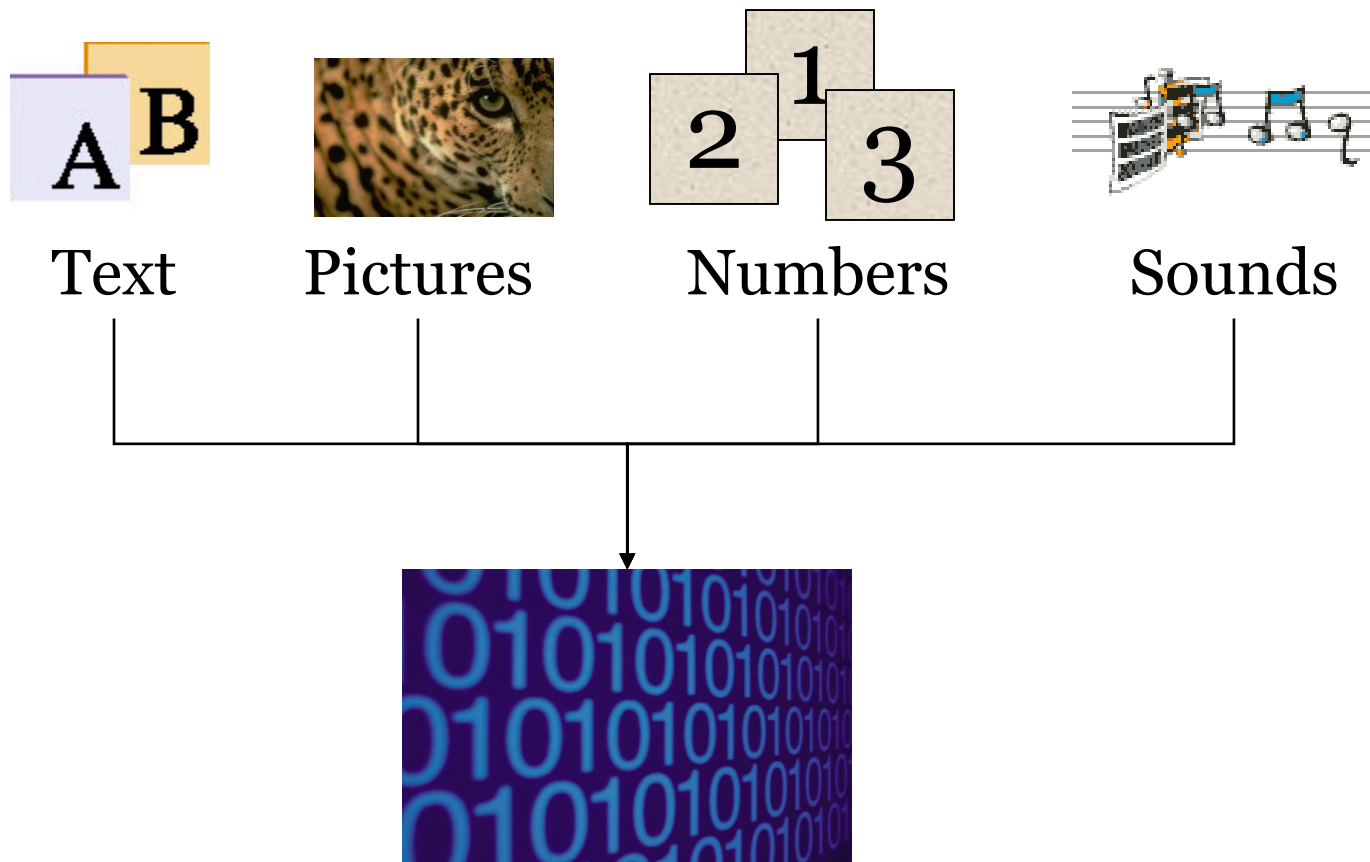
Text   Pictures   Numbers   Sounds

Approaching Computers

- **Data Representation**

Input	Computer	Output
A	**0100 0001**	**A**

Approaching Computers

- **Data Representation**

ASCII – American Standard Code for Information Interchange

It is Most widely used code, represents each character as a unique 8-bit code.

Unicode

A coding scheme that supports 65,000 unique characters

Character	ASCII binary code
A	0 1 0 0 0 0 0 1
B	0 1 0 0 0 0 1 0
C	0 1 0 0 0 0 1 1
D	0 1 0 0 0 1 0 0
E	0 1 0 0 0 1 0 1
F	0 1 0 0 0 1 1 0
G	0 1 0 0 0 1 1 1
H	0 1 0 0 1 0 0 0
I	0 1 0 0 1 0 0 1
J	0 1 0 0 1 0 1 0
K	0 1 0 0 1 0 1 1
L	0 1 0 0 1 1 0 0
M	0 1 0 0 1 1 0 1
N	0 1 0 0 1 1 1 0
O	0 1 0 0 1 1 1 1
P	0 1 0 1 0 0 0 0
Q	0 1 0 1 0 0 0 1
R	0 1 0 1 0 0 1 0
S	0 1 0 1 0 0 1 1
T	0 1 0 1 0 1 0 0
U	0 1 0 1 0 1 0 1
V	0 1 0 1 0 1 1 0
W	0 1 0 1 0 1 1 1
X	0 1 0 1 1 0 0 0
Y	0 1 0 1 1 0 0 1
Z	0 1 0 1 1 0 1 0
0	0 0 1 1 0 0 0 0
1	0 0 1 1 0 0 0 1
2	0 0 1 1 0 0 1 0
3	0 0 1 1 0 0 1 1
4	0 0 1 1 0 1 0 0
5	0 0 1 1 0 1 0 1
6	0 0 1 1 0 1 1 0
7	0 0 1 1 0 1 1 1
8	0 0 1 1 1 0 0 0
9	0 0 1 1 1 0 0 1

Approaching Computers

- **Data Representation**
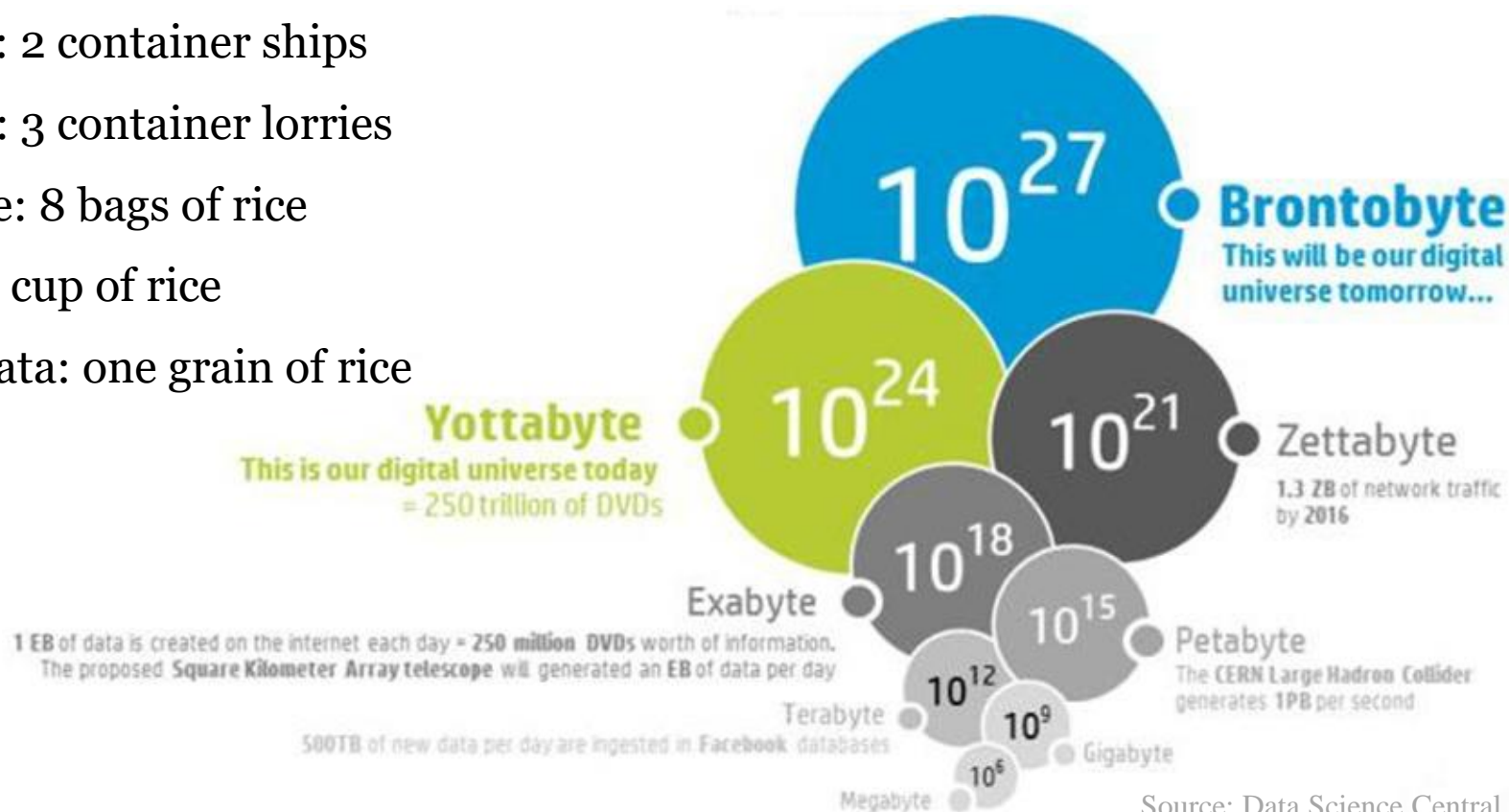
A character is represented in a computer by a byte
(1 byte = 8 bits)

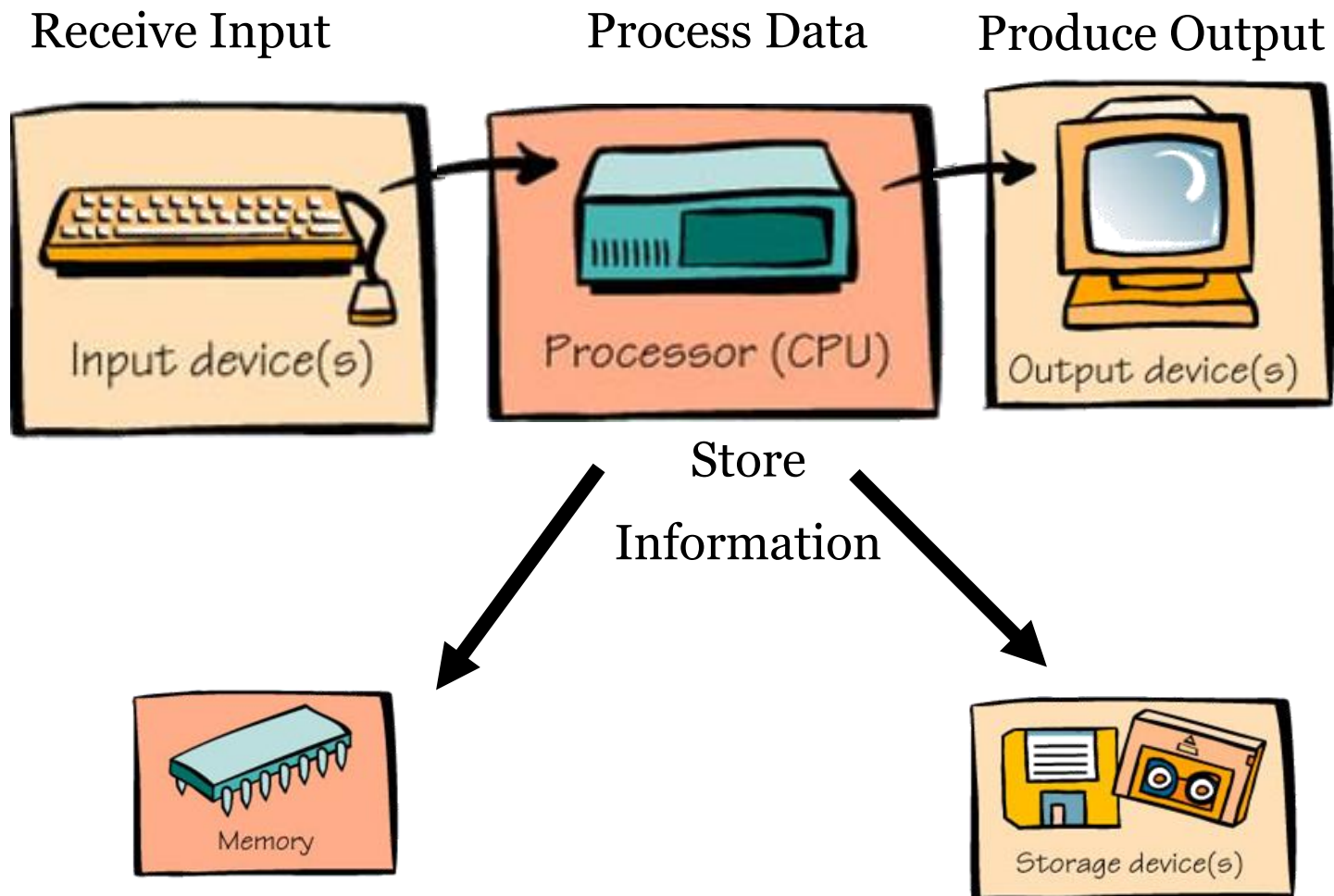| Kilobyte (KB)	2^{10} byte	1024 bytes	~ 1000 bytes
Megabyte (MB)	2^{20} byte	1.048.576 bytes	~ 1 million bytes
Gigabyte (GB)	2^{30} byte	1.073.741.824 bytes	~ 1 billion bytes
Terabyte (TB)	2^{40} byte	1.033.511.627.776 bytes	~ 1 trillion bytes

Approaching Computers

- ## Data Representation
  - Zettabyte: fills the Pacific ocean
  - Exabyte: covers Germany twice
  - Petabyte: covers Manhattan
  - Terabyte: 2 container ships
  - Gigabyte: 3 container lorries
  - Megabyte: 8 bags of rice
  - Kilobyte: cup of rice
  - Byte of data: one grain of rice

10^{27} **Brontobyte**
This will be our digital universe tomorrow...

Yottabyte 10^{24}
This is our digital universe today
= 250 trillion of DVDs

10^{21} Zettabyte
1.3 ZB of network traffic by 2016

10^{18}

10^{15}

Exabyte

Petabyte
The CERN Large Hadron Collider generates 1PB per second

1 EB of data is created on the internet each day = 250 million DVDs worth of information. The proposed Square Kilometer Array telescope will generated an EB of data per day

10^{12} 10^9

Terabyte Gigabyte
500TB of new data per day are ingested in Facebook databases

10^6

Megabyte

Source: Data Science Central

Approaching Computers

- ## What Computers Do?

Receive Input   Process Data   Produce Output

Store

Information

Approaching Computers

- **What Computers Do?: Receive Inputs**

  Purpose

  - entering data into a computer system

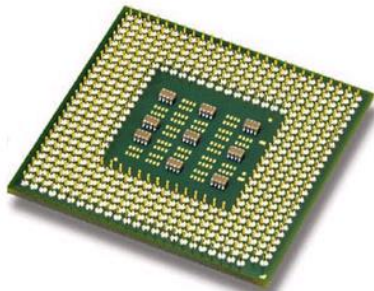 - issuing instructions (commands) to a computer

  Input device

  - transforms data from the user into a form that a computer system can process (together with appropriate software or device drivers).

Approaching Computers

- **What Computers Do?: Process Data**

  Process data: Perform arithmetic or logical (decision-making) operations on data

- The processor, or central processing unit (CPU), processes data and performs all the necessary arithmetic calculations.

- The CPU is like the "brain" of the computer.

Approaching Computers

- **What Computers Do?: Process Data**

  The CPU is a complex collection of electronic circuits.

  ◇ When all of those circuits are built into a single silicon chip, the chip is referred to as a *microprocessor*.

  ◇ The circuit board that contains a computer's CPU is called the *motherboard* or *system board*.
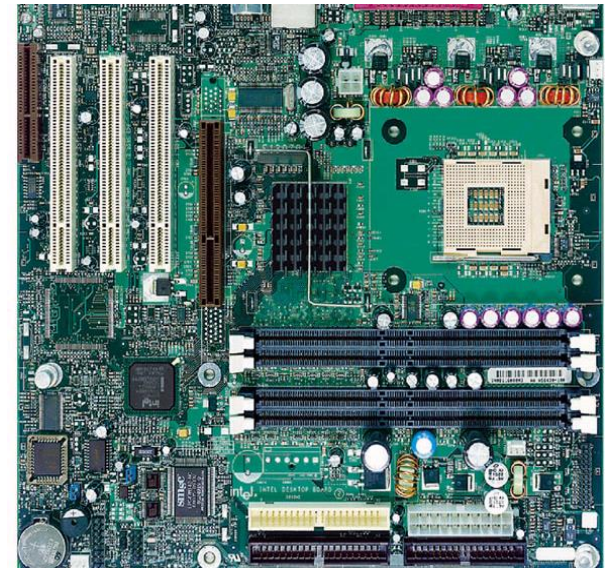
Approaching Computers

- **What Computers Do?: Process Data**

The **microprocessor** that makes up your personal computer's *central processing unit*, or CPU, is the **ultimate computer brain**, **messenger**, **ringmaster** and **boss**. All the other components— RAM, disk drives, the monitor— exist only to **bridge the gap** between you and the processor.

Ron White, in How Computers Work

Approaching Computers

- **What Computers Do?: Process Data**

Computers are fast, stupid machines:

◇ Perform arithmetic and comparisons capabilities

◇ Follow precise instructions to perform an operation

◇ Execute instructions quickly and accurately

Approaching Computers

- **What Computers Do?: Produce Output**
  convert information coming from a computer system into some form perceptible by humans

  - visual

  - auditory (non-speech, speech)

  - Tactile (tactile output for visually-impaired and blind users (e.g., Braille)
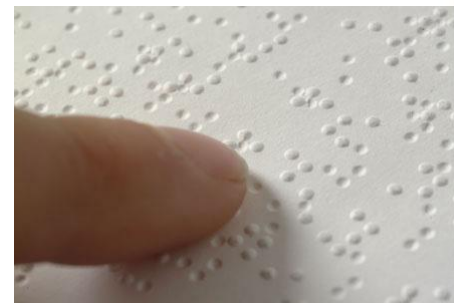
Approaching Computers

- **What Computers Do?: Store Information**

  Store information: Move and store information in memory

  Store Information

  Primary Storage   Secondary Storage
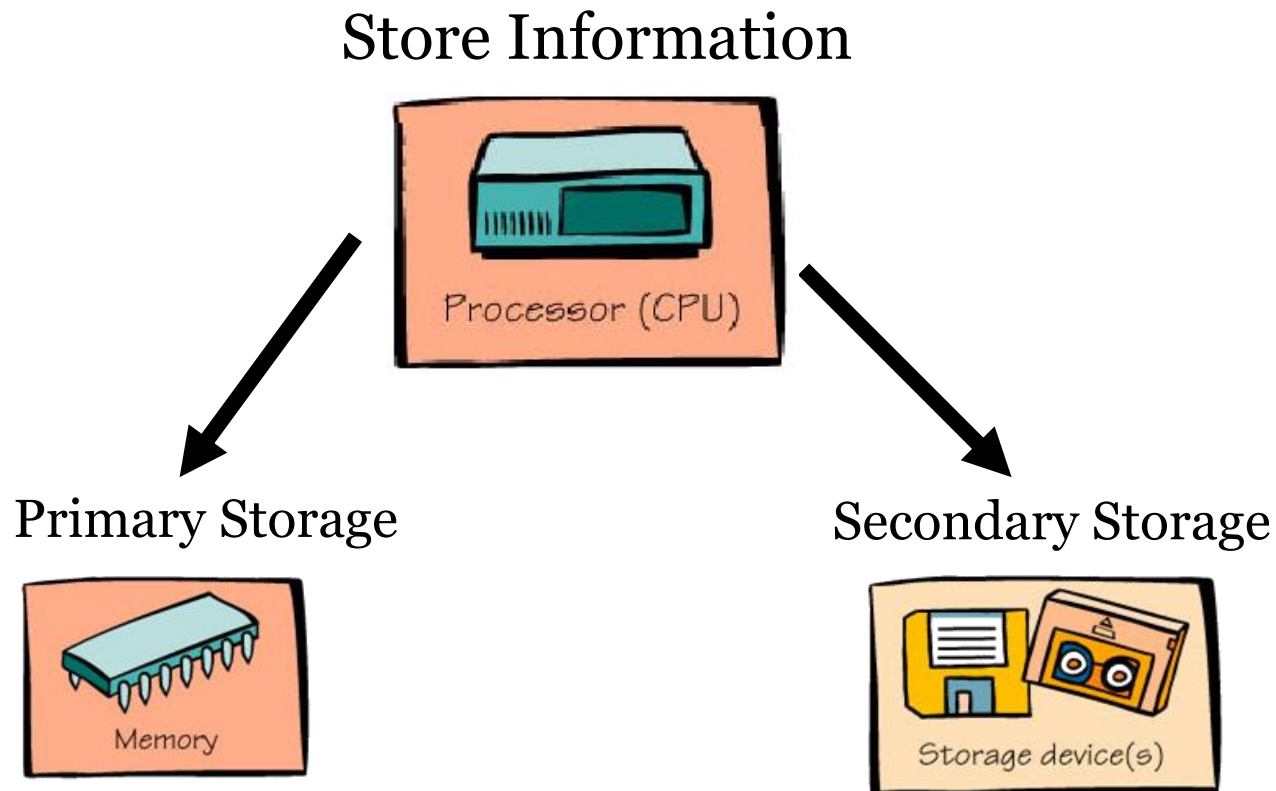
Approaching Computers

- **What Computers Do?: Store Information**

  RAM (random access memory):

  – is used to store program instructions and data temporarily

  – unique addresses and data can be stored in any location

  – can quickly retrieve information

  – will not remain if power goes off (volatile)

Volatile and Read/Write Memory

Approaching Computers

- **What Computers Do?: Store Information**

  ROM (read-only memory):

  – information is stored permanently on a chip.

  – contains startup instructions and other permanent data.
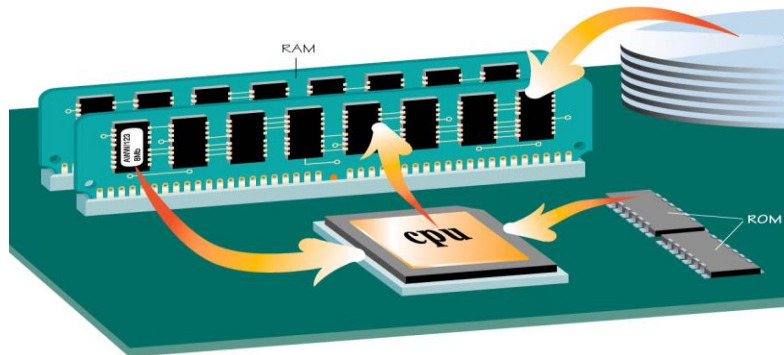
Non-volatile and Read Only Memory

Approaching Computers

- ## What Computers Do?: Store Information

  Cache Memory: cache is used to speed up data transfer and may be either temporary or permanent.
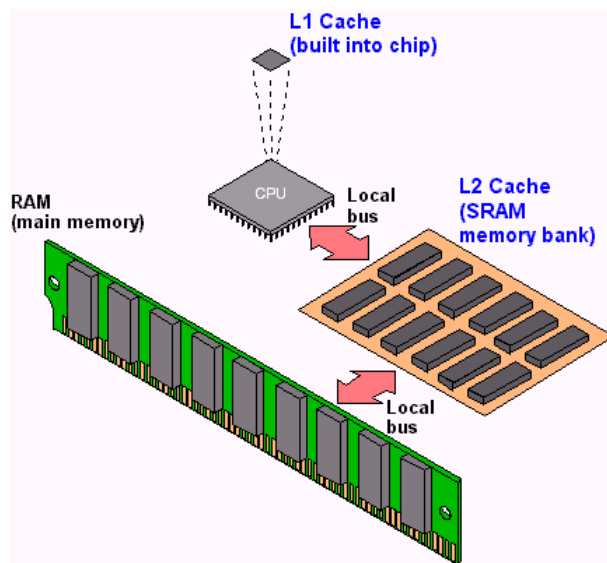
Memory Cache: The whole idea is to keep staging more instructions and data in a high-speed memory closer to the CPU memory caches (CPU caches) use higher-speed static RAM (SRAM) chips.
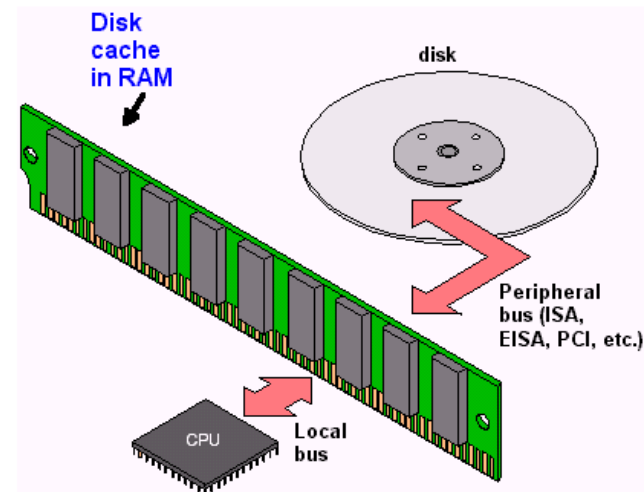
Disk caches: are usually just a part of main memory made up of common dynamic RAM (DRAM) chips, whereas

Source: Computer Desktop Encyclopedia

Approaching Computers

- **What Computers Do?: Store Information**

  Flash Memory:

  – Used for phones, pagers, portable computers, handheld computers, PDAs.

A USB Flash Memory Device

Non-volatile and Read/Write Memory

Approaching Computers

- **Buses, Ports, and Peripherals**
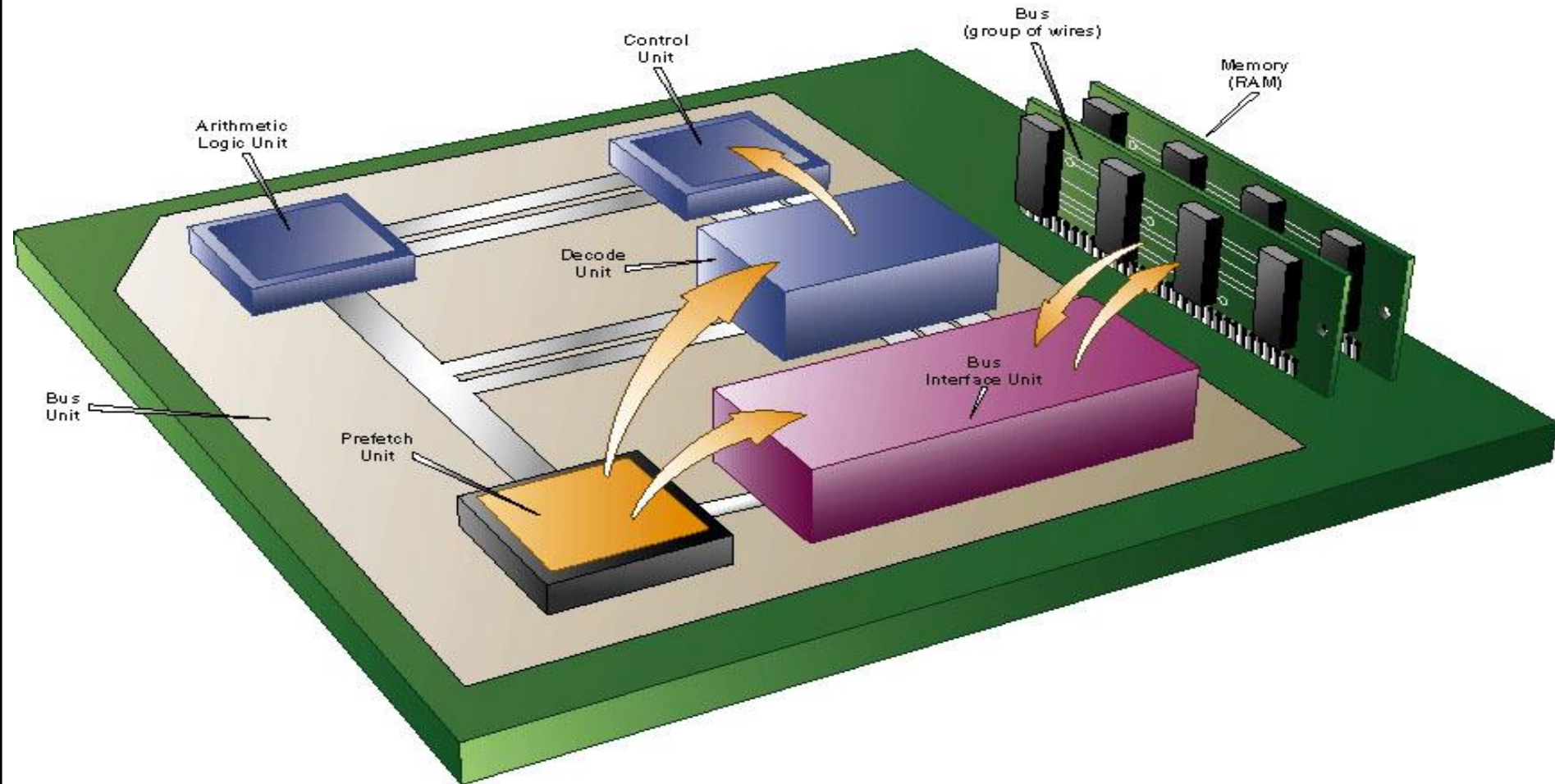
Source: G. Beekman and M. Quinn. Computer Confluence: Tomorrow's Technology and You. 7th Ed. ISBN: 013152531X , Prentice Hall, 2005.

Approaching Computers

- **Buses**

  Information travels between components through groups of wires called **buses**.

  Buses

  - Typically have 32 or 64 wires
  - Connect to storage devices in bays
  - Connect to expansion slots
  - Connect to external buses and ports

Approaching Computers

- **Slots and Ports**

  Make it easy to add external devices, called peripherals

PS/2 Keyboard — PS/2 Mouse
S/PDIF In
S/PDIF Out
Serial Port — Parallel Port
— Firewire Port
USB Ports
— RJ-45 Gigabit LAN
Microphone — Line In / Line Out
Side Right/Left — Center/Subwoofer / Rear Left/Right
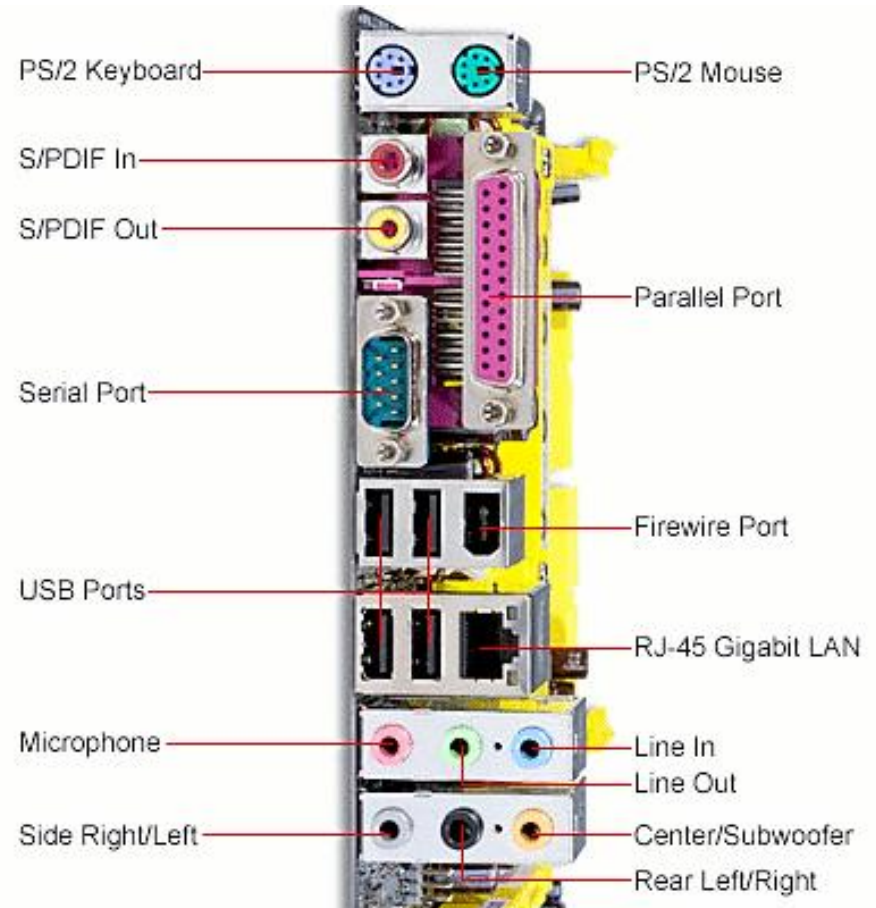
Approaching Computers

- **Peripherals**

- Slots and ports also allow external devices called peripherals to be added to the system (keyboard, monitor, and mouse).

- Without peripherals, the CPU and memory are like a brain without a body.

Approaching Computers

- **Types**

Supercomputers

Mainframe Computers

Minicomputers

Microcomputers

Processing Speed	Physical Size	Costs
+	+	+
↑	↑	↑
−	−	−
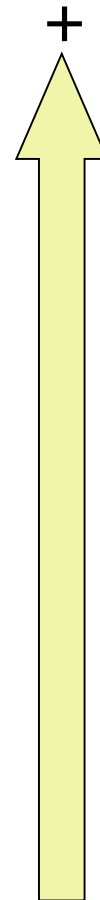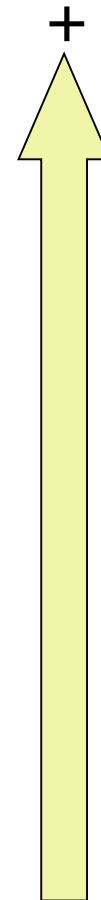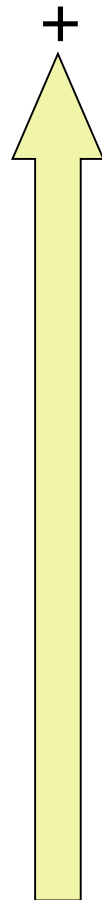
Approaching Computers

- **Supercomputers**

Supercomputers...

the fastest, most powerful computers

Approaching Computers

- **Mainframes**

    many users can access computer resources simultaneously

- **Minicomputers**

    smaller and less expensive than mainframes
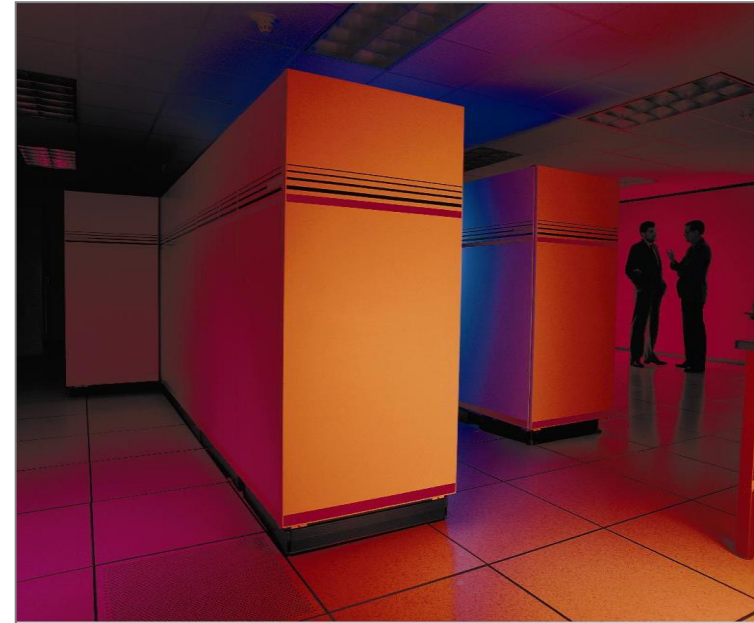
Approaching Computers

- ## **Microcomputers**

Personal Computers (PCs)

Desktop Computers	Laptop Computers	Notebook Computers	Palmtop Computers

Tablet

PDA (Personal Digital Assistant)

Desktop	Laptop	Notebook	Palmtop
Non-portable computers that fit on the top of a desk	Portable computers that weight 4.5 to 5.4 Kg	Portable computers but weight less than a laptop computer (2.7 to 3.6 kg).	Smaller than both laptop and notebook computers but have reduced computing capabilities.

Approaching Computers

- **Special-purpose Computers**

  - often attached to sensors to measure and/or control the environment

  - programs etched in silicon so they can't be altered (firmware)

- **Embedded Computers**

  - enhance consumer goods

  - control a variety of hardware devices, including robots

Approaching Computers

- **PDAs and Smartphones**
  - ◇ PDAs feature touch-screens, that are usually used with the help of a stylus.
  - ◇ Smartphone's operating systems (as Mobile 5.0) don't support touch-screen interaction.
  - ◇ Smartphones are designed to provide phone functions first (and data second).
  - ◇ PDAs are more data-centric.
  - ◇ Pocket PC Phone is a PDA with phone functionality.
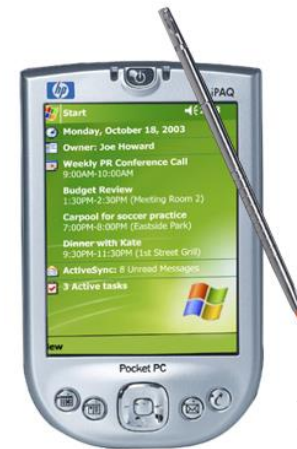
PDA or Pocket PC

Pocket PC Phone

Smartphone

Source: Windows Middle East. November 2006.

Outline

- Approaching Computers

- **<u>Using Computers</u>**

- Exploring with Computers

- Emerging Technologies

Using Computers

- Word processing and desktop publishing

- Spreadsheets and databases

- Computer graphics, multimedia and hypermedia

- Telecommunication and networking

- Artificial intelligence

- General problem-solving.

Using Computers

- **Revolution in Writing**

    ◊ Word processors are growing in sophistication and absorbing the features of page-layout software.

    ◊ Paperless electronic media will replace desktop publishing.

    ◊ Groupware for writing and editing

    ◊ Electronic dictation

    ◊ Intelligent Word Processors

GLENDOWER: I can call spirits from the vasty deep

HOTSPUR: Why, so can I, or so can any man; But will they come when you do call for them?

Henry IV, Part 1 Act III Scene 1
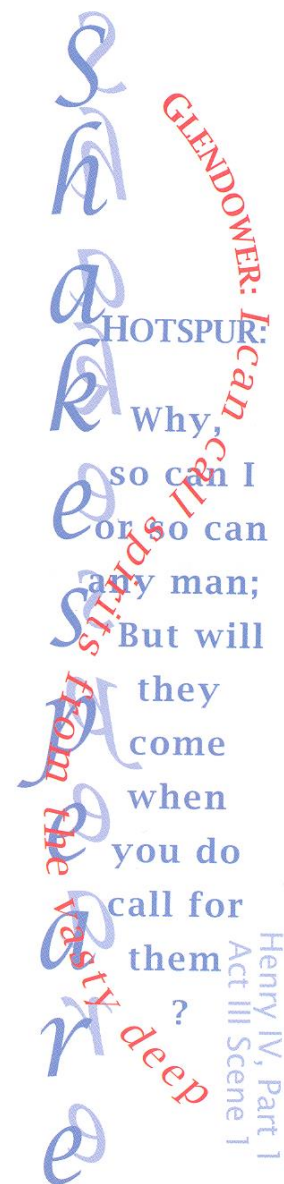
Using Computers

- **Revolution in Writing**

    ◊ Entering Text, Formatting Text, Character Formatting, Paragraph Formatting

    ◊ Synonym Finders

    ◊ Digital References

    ◊ Spelling Checkers, Grammar and Style Checkers

    ◊ Collaborative Writing Tools

    ◊ Form Letter Generators, Desktop Publishing
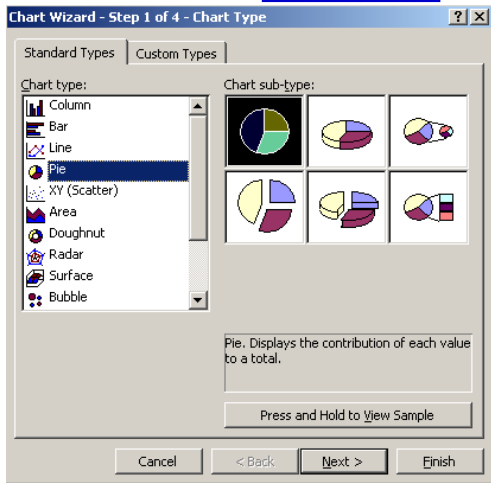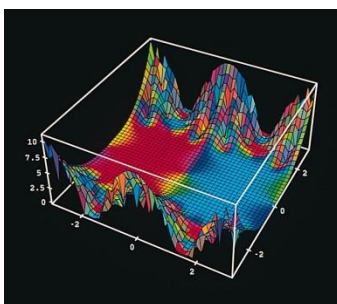
    ◊ Electronic Books and Digital Paper
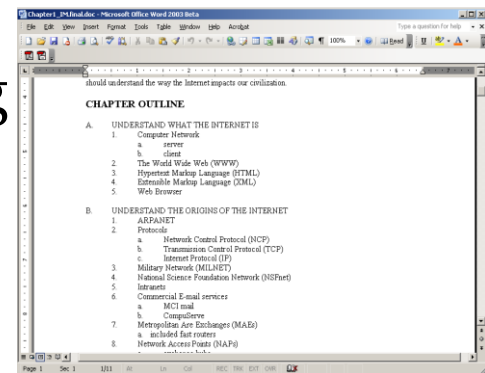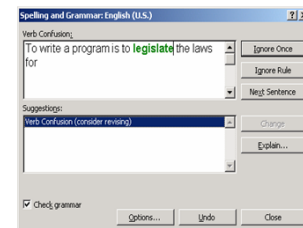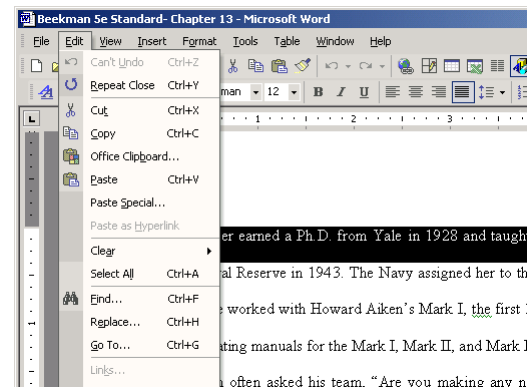
Using Computers

- **Calculation, Visualization and Simulation**

    ◊ The Spreadsheet: Software for Simulation and Speculation

    ◊ Statistical Software: Beyond Spreadsheets

    ◊ Statistics and Data Analysis

    ◊ Scientific Visualization

    ◊ Calculated Risks: Computer Modeling and Simulation
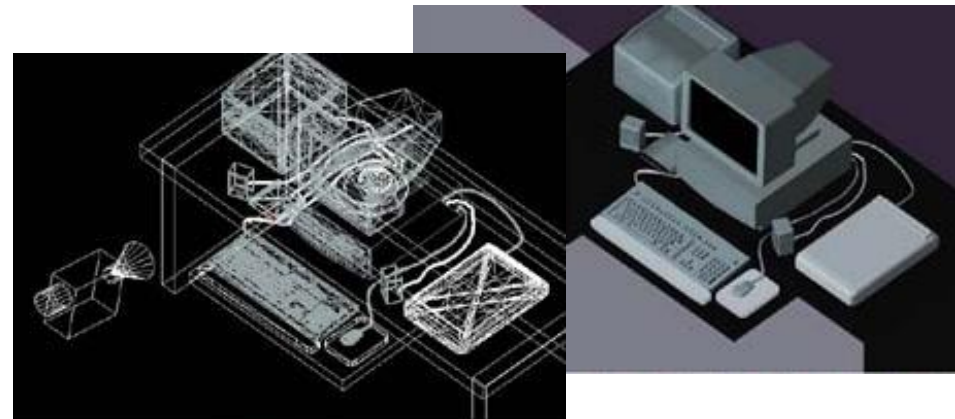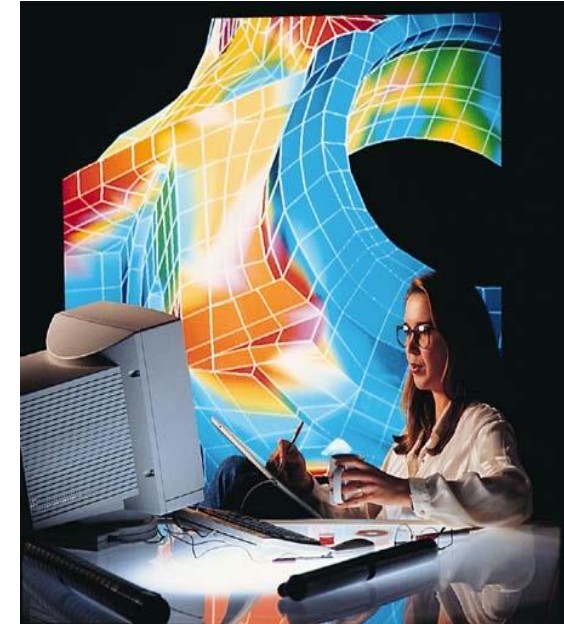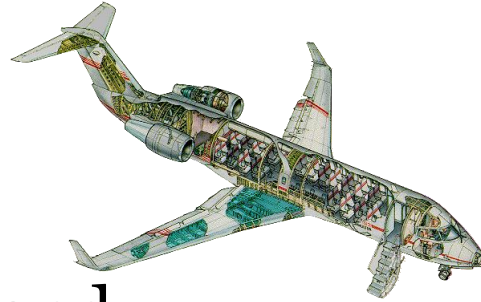
Using Computers

- **Graphics and Hypermedia**

  ◇ Focus on Computer Graphics

  ◇ Dynamic Media: Beyond the Printed Page

  ◇ Interactive Multimedia: Eye, Ear, Hand, & Mind
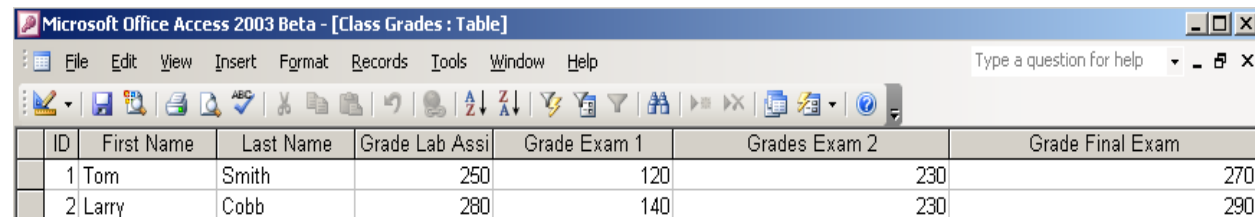
  ◇ Data Compression – How and Why

Using Computers

- **Databases Applications**

  Advantages offered by computerized databases:

  ◇ Make it easier to store large quantities of information

  ◇ Make it easier to retrieve information quickly and flexibly

  ◇ Make it easy to organize and reorganize information

  ◇ Make it easy to print and distribute information in a variety of ways

Outline

- Approaching Computers

- Using Computers

- **<u>Exploring with Computers</u>**

- Emerging Technologies

Exploring with Computers

- **Local Area Networks (LAN)**

  - resource sharing allow communication between users (in the same building or cluster of buildings)

- **Wide Area Networks (WAN)**

  - resource sharing allow communication between users (across the country or the world)

  "There are three kinds of death…there's heart death, there's brain death, and there's being off the network."

Exploring with Computers

- **The Internet Explosion**
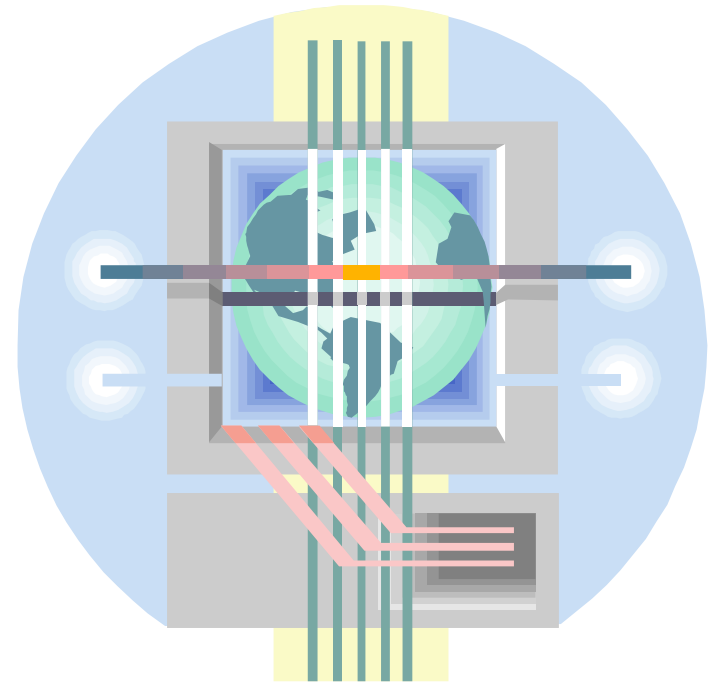
    ◊ A network of networks

    ◊ World Wide Web for usability

    ◊ Electronic mail

    ◊ Multimedia content

    ◊ Self-publishing

    ◊ On-line transactions

    ◊ Intranets

    ◊ Network computers

Exploring with Computers

- **World Wide Web**

  ◇ Web browsers are portals into the Web

  ◇ Web pages are interlinked documents

  ◇ Web sites are web pages grouped together

Exploring with Computers

- **Electronic Mail (e-mail)**

The primary use of the Internet today is for communications:

– E-mail is easy to use

– Messaging is quick

"The great success of the Internet is not technical, but its human impact"

Dave Clark

Exploring with Computers

- ## Social Networking

  Social network is a social structure made up of individuals (or organizations) called "nodes", which are tied (connected) by one or more specific types of interdependency, such as friendship, kinship, common interest, financial exchange, dislike, or relationships of beliefs, knowledge or prestige.

  Source: Wikipedia
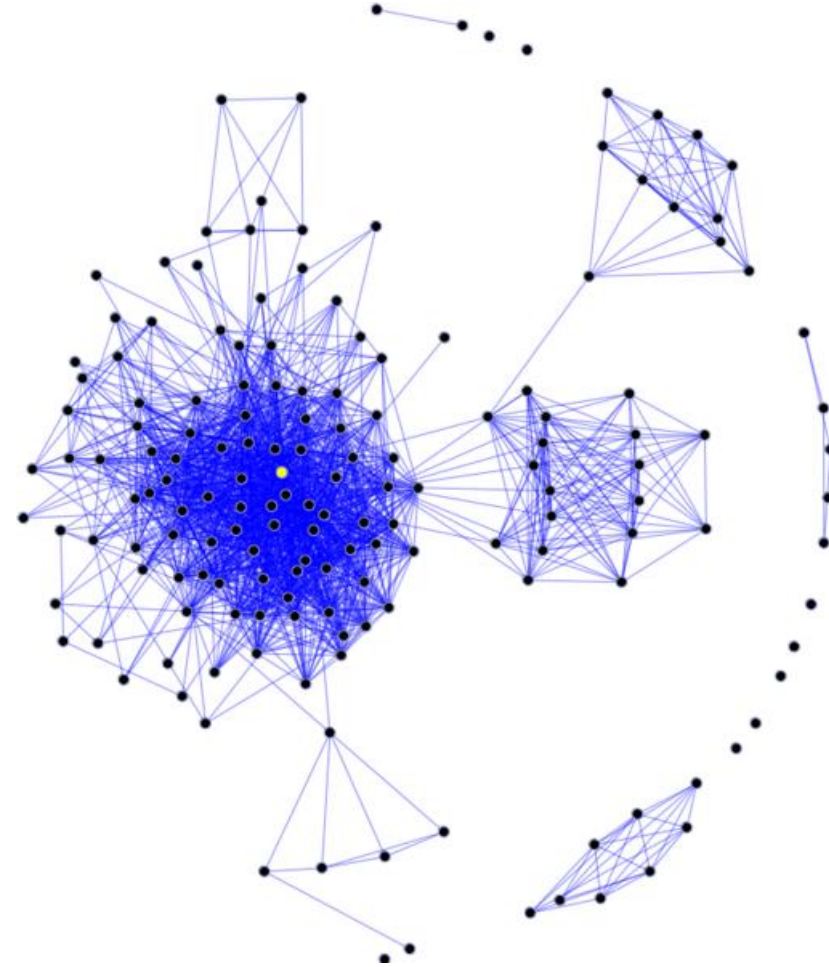
facebook.

twitter

Linked in

myspace.com

Outline

- Approaching Computers

- Using Computers

- Exploring with Computers

- **Emerging Technologies**

Emerging Technologies
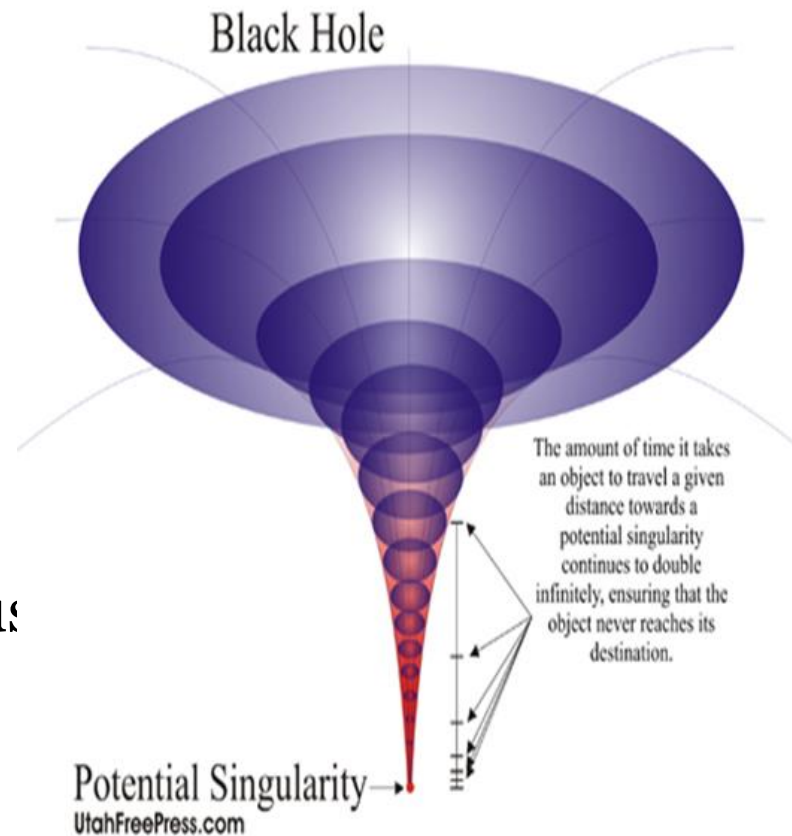
- **Technological Singularity**

  Technological singularity hypothesis is that accelerating progress in technologies will cause a **runaway effect** wherein artificial intelligence will exceed human intellectual capacity and control, thus radically changing or even ending civilization in an event called the **singularity** [10].

Black Hole

The amount of time it takes an object to travel a given distance towards a potential singularity continues to double infinitely, ensuring that the object never reaches its destination.

Potential Singularity
UtahFreePress.com

Emerging Technologies

[11]

Emerging Technologies

Humanity's artificial-intelligence capabilities begin to upstage our human intelligence at the end of the 2030$_s$ [1].
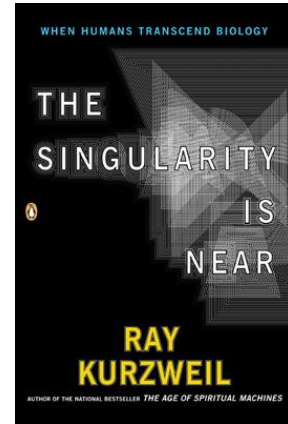
Emerging Technologies

Genetics

Accelerating progress in biotechnology will enable us to reprogram our genes and metabolic processes.

Nano-technology

Nanotechnology promises the tools to rebuild the physical world, our bodies, and our brains, molecular fragment by molecular fragment and potentially atom by atom.

Robotics

Creation of machine thinking ability that exceeds the thinking ability of humans.

Immortality by 2045!

Emerging Technologies

- ## Social Impact

Innovation in business: 73 / 2
Ability to start a new business: 70 / 3
Education: 69 / 5
Productivity: 68 / 5
Economic opportunity: 66 / 4
Quality of life: 62 / 6
Competitiveness (economy): 61 / 5
Arts and culture: 59 / 5
Health and healthcare: 58 / 7
Transportation: 58 / 4
Ability to make a good living: 58 / 5
Employment (number of jobs): 58 / 8
Social bonds: 57 / 10
Personal freedom: 54 / 11
Political expression: 53 / 8
Literacy: 48 / 19
Human rights: 47 / 8
Family bonds: 43 / 16
Personal safety/security: 36 / 23
Privacy: 19 / 47

■ Mostly positive impact
■ Mostly negative impact

Source: global Microsoft poll, 2014

Emerging Technologies

- **Social Impact: Privacy**

  Collecting data happens invisibly and passively, as a by product of another service.

Emerging Technologies

- **Social Impact: Impact on human skills**

"In my day the schools taught two things, love of country and **penmanship** — now they don't teach either."

Cleveland Amory (1917-1998)
American Author

Research is needed to answer the following open questions:

- How does machine intelligence affect **human cognitive processes** and reduce our overall intelligence?

- Does machine intelligence hurt the development of our **hippocampus**, impact our **critical thinking** skills, hinder knowledge **acquisition**, and harm our ability to **concentrate**?

Emerging Technologies

- **Social Impact: Changing Social Norms**

Physical activities

Face-to-face interaction

NO Wifi
Talk to each other!
Call your MoM!
Pretend it's 1993!
Live

BEDJO'S

SORRY, NO Wi-Fi AVAILABLE

SO YOU MAY EAT WELL
and SOCIALIZE LIKE
THE WAY IT USED
TO BE

- **Social Impact: Employment**
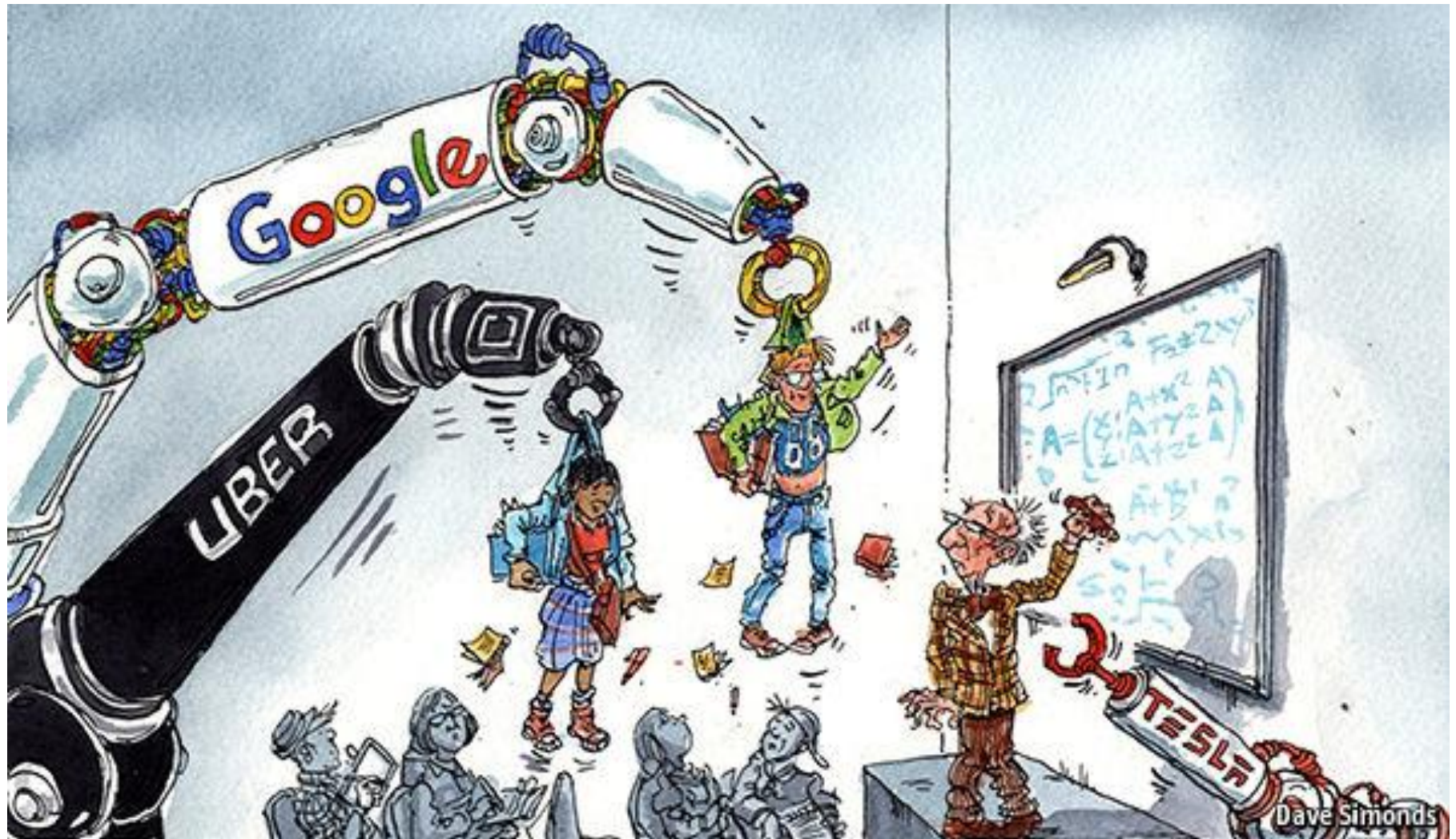
Emerging Technologies

- **Social Impact: Employment**

  We can expect a wave of structural unemployment to spring from the technology in the medium term.

  A study out of **Oxford University** in **2014** found that in the near future **artificially intelligent technology could take over <u>nearly half </u>of all U.S. jobs**.

Emerging Technologies

- ## Social Impact: Employment

Robotenomics research headcount analysis sample

	2014	2013	2012	2011	2010	2009	Increase	Increase %
Audi	77 247	71 781	67 231	62 806	59 513	58 011	19 236	33,16
BMW	116 324	110 351	105 876	100 306	95 453	96 230	20 094	20,88
Daimler	279 972	274 616	274 605	267 274	258 120	256 407	23 565	9,19
Fiat	228 690	225 587	214 836	197 021	199 924	190 014	38 676	20,35
Peugeot Citroen	189 786	196 885	202 108	209 000	198 220	186 220	3 566	1,91
Porsche	22 401	19 456	17 502	15 307	13 159	12 100	10 301	85,13
Volkswagen AG	112 561	107 559	101 794	97 691	94 787	95 164	17 397	18,28
	1 026 981	**1 006 235**	**983 952**	**949 405**	**919 176**	**894 146**	**132 835**	14,86
Nissan	160 530	160 530				155 659	4 871	3,13
Toyota	338 875	338 875				320 590	18 285	5,70
Honda	198 561	198 561				176 815	21 746	12,30
	1 724 947	**1 704 201**				**1 547 210**	**177 737**	