Computer Science 1401: Lecture #2

Inside the Dream Machine

COMPUTERS: THE IMAGE

COMPUTERS: THE REALITY

COMPUTERS AT THE MOVIES: *Tron* (1982)

Computers: The Image

UNIVAC correctly predicts outcome of US Presidential Election (1952)

Computers: The Image (Cont'd)

Desk Set (1957)

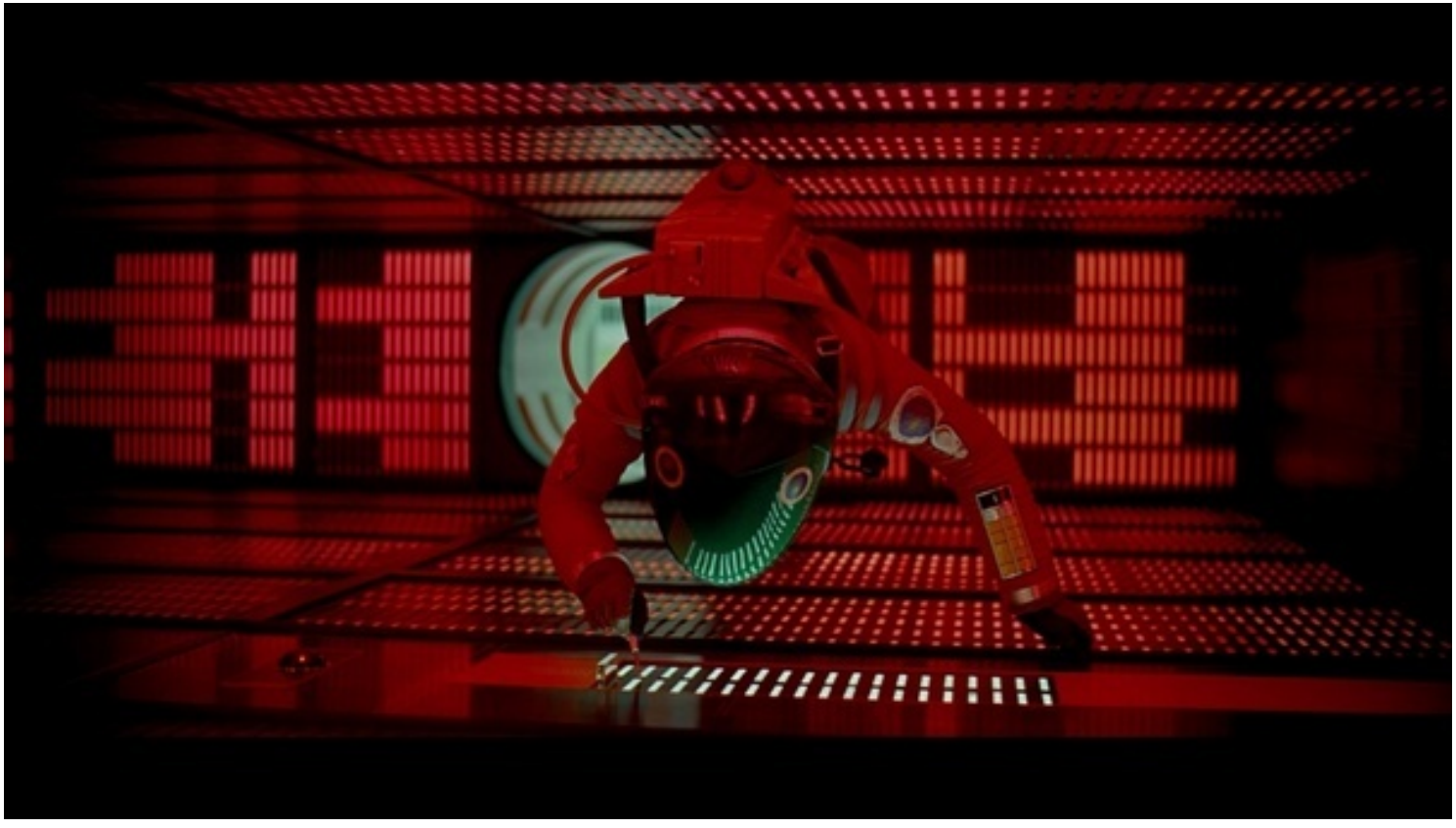
Computers: The Image (Cont'd)

Voyage to the Bottom of the Sea (TV) (1964)

Computers: The Image (Cont'd)

HAL 9000 (console)
2001: A Space Odyssey (1968)

Computers: The Image (Cont'd)



HAL 9000 (internals)
2001: A Space Odyssey (1968)

Computing Movie Cliches
(#1 in a Series)

Intelligent Universal Operating System*: All computers in the movies use the same amazingly powerful operating system that accepts plain English commands. A character simply types OPEN PRIMARY FILE or ACCESS SECURITY SYSTEM. The computer immediately responds. Such computers are always connected to a massive global network, and can access any private file anywhere in the world. In addition, the operating system uses a gigantic, blocky font that is usually bright green on a black background, apparently for the benefit of visually impaired users.*

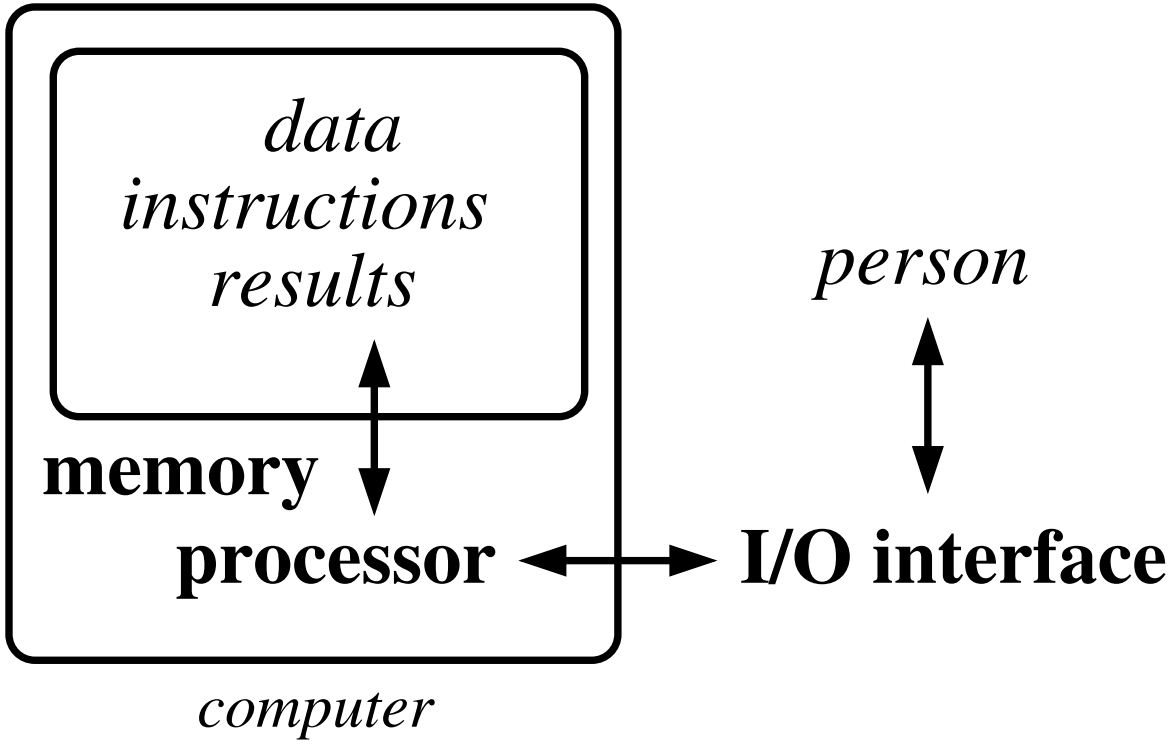
- Jim Collier (in Ebert (1994))

Computers: The Reality

A computer is a machine that

(1) stores a very, very large number of numbers and
(2) performs very, very long specified sequences of very simple operations on these numbers
(3) very, very fast.

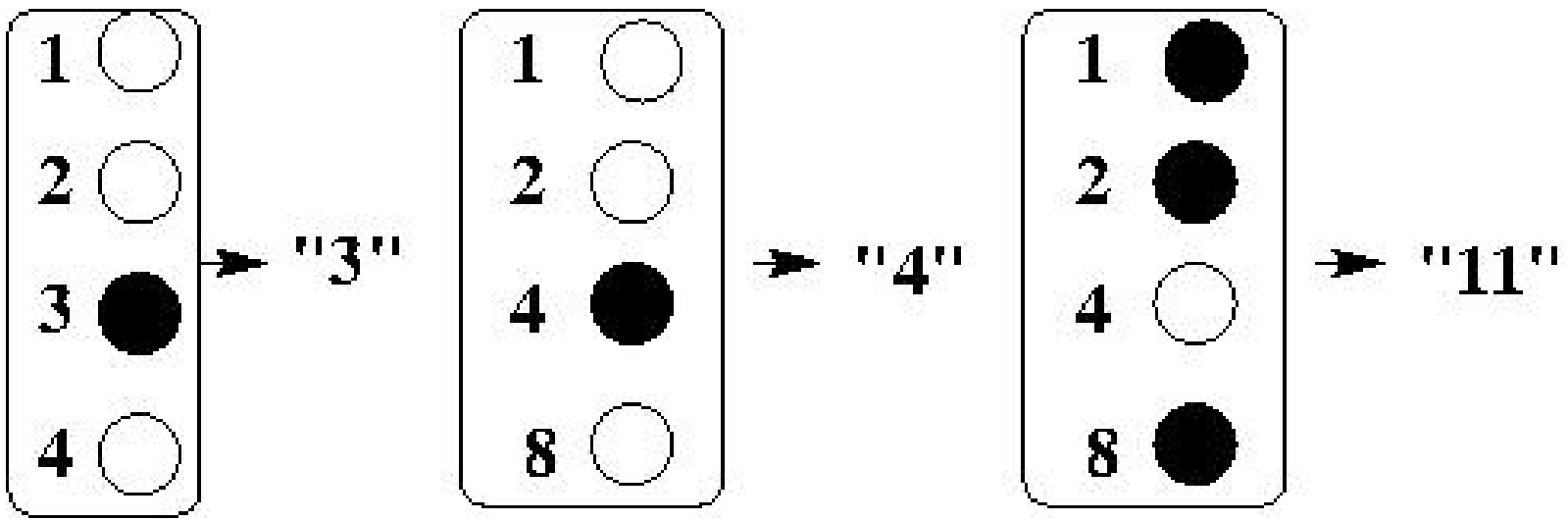
Computers: The Reality (Cont'd)
The Big Picture



von Neumann stored-program architecture (1945)

Computers: The Reality (Cont'd)
Computer Memory

- A **bit** is a 0/1 memory element; a **word** is a set of bits.
- Store numbers compactly in words using binary encoding.



Computers: The Reality (Cont'd)
Computer Memory (Cont'd)

- Computer memory consists of a set of words, each with its own unique numerical address.

1	2	3	4	5	6	7	8
9	10	11	12 15	13	14	15	16
17	18	19	20	21 X	22 Y	23 Z	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40

Computers: The Reality (Cont'd)
Computer Memory (Cont'd)

- Word-sizes standardized in terms of 8-bit chunks (**bytes**).
- Memory size stated in terms of number of bytes:

Kilobyte	(KB)	$= 10^3$ (thousand) bytes
Megabyte	(MB)	$= 10^6$ (million) bytes
Gigabyte	(GB)	$= 10^9$ (billion) bytes
Terabyte	(TB)	$= 10^{12}$ (trillion) bytes
Petabyte	(PB)	$= 10^{15}$ (quadrillion) bytes
Exabyte	(EB)	$= 10^{18}$ (quintillion) bytes
		$\vdots$

- What can you do with large amounts of digital memory?

Computers: The Reality (Cont'd)
Computer Memory (Cont'd)

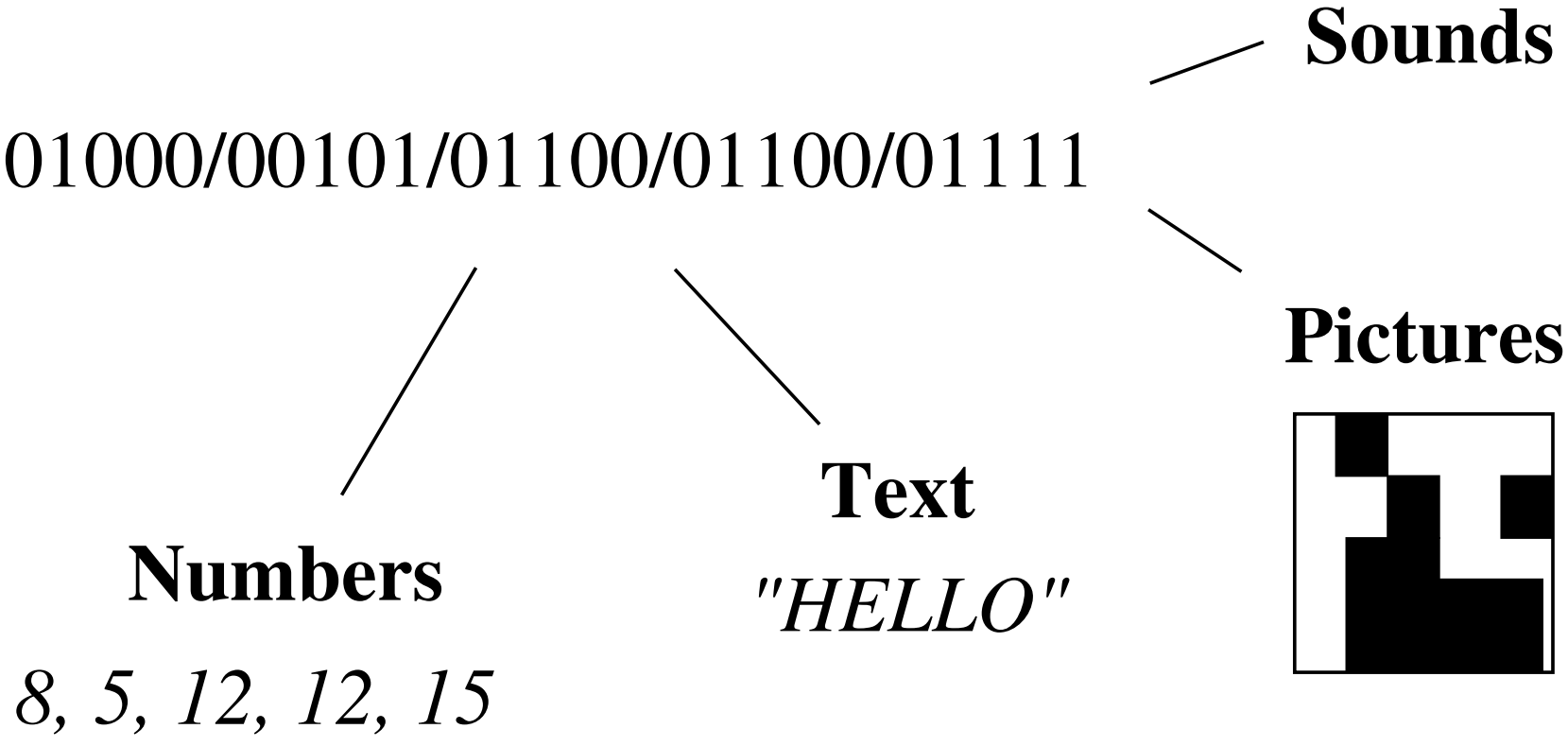
What does

01000001010110001110001111

mean?

Computers: The Reality (Cont'd)
Computer Memory (Cont'd)

Things that digital memory does well:



Computers: The Reality (Cont'd)
Computer Memory (Cont'd)

Things that digital memory doesn't do so well:

Floating–point Numbers

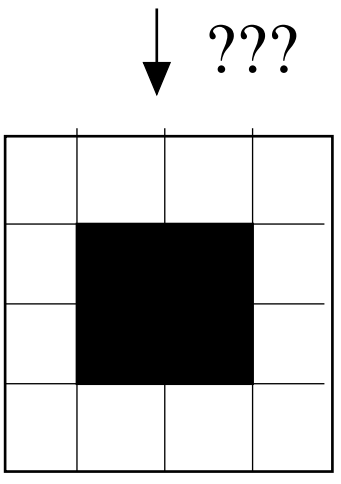
$$1/3 \longrightarrow 0.33$$

$$1/3 \longrightarrow 0.33$$

$$+\ 1/3 \longrightarrow 0.33$$

$$1 \neq 0.99$$

Detailed Pictures



Computers: The Reality (Cont'd)
Computer Memory (Cont'd)

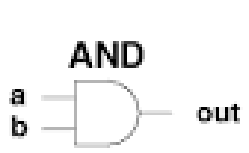
Paper card / tape (1940s)

Magnetic tape (1951)

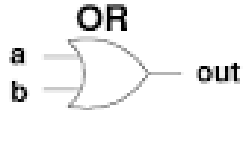
Magnetic disk (1956)

Computers: The Reality (Cont'd)
Computer Processor

Claude Shannon
(1916-2001)

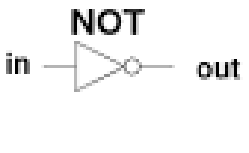


a	b	out
0	0	0
0	1	0
1	0	0
1	1	1



a	b	out
0	0	0
0	1	1
1	0	1
1	1	1

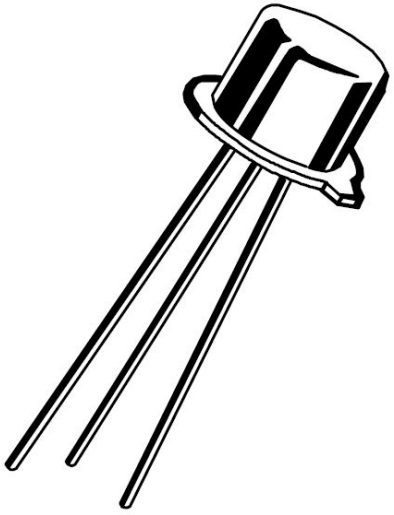
a	b	out
0	0	0
0	1	1
1	0	1
1	1	0



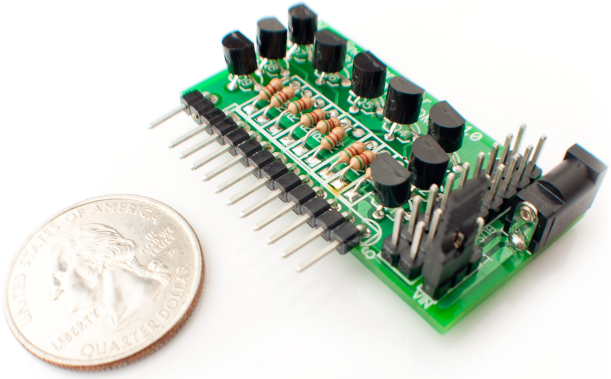
in	out
0	1
1	0

Boolean logic gates
(Shannon MSc (1937))

Computers: The Reality (Cont'd)
Computer Processor (Cont'd)

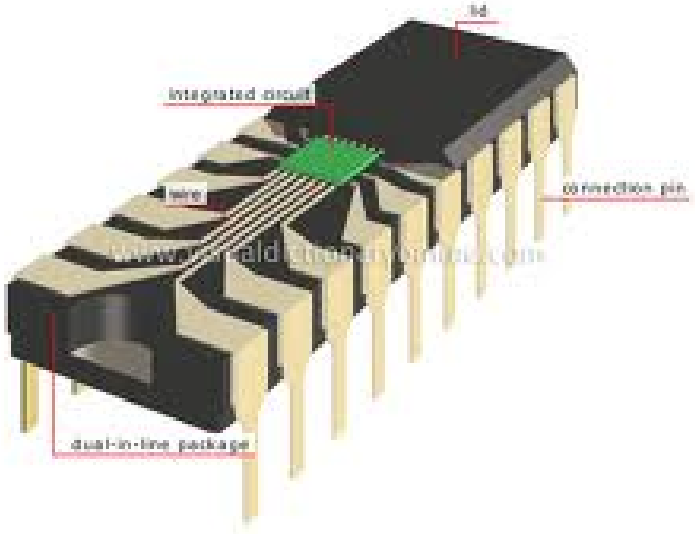


Transistor (1947)

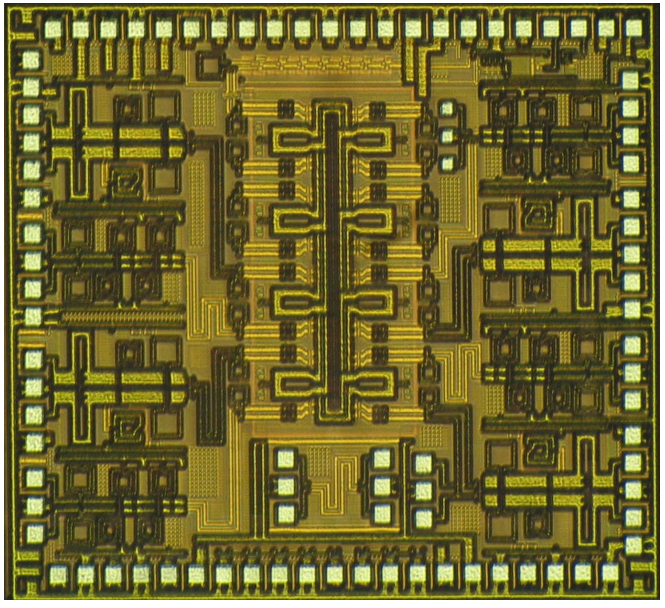


Transistor Board

Computers: The Reality (Cont'd)
Computer Processor (Cont'd)



Integrated Circuit (IC) (1959)



IC Internals ("Chip")

Moore's Law (1965): 2x transistor density every 18 months

Computers: The Reality (Cont'd)
Computer I/O Interface

Punch card / tape
(1940s)

Teletype
(1940s)

CRT Display
(1940s)

Early I/O devices known as **terminals**.

Computers: The Reality (Cont'd)
Computer Types

- Several types of computers based on increasingly smaller processor, memory, and I/O devices:
  1. **mainframe**, e.g., UNIVAC I (building / room size) (1945+)
  2. **minicomputer**, e.g., DEC PDP-I (refrigerator size) (1960+)
  3. **microcomputer**, e.g., Apple II (double-arm size) (1975+)
  4. **handheld**, e.g., tablet or smartphone (hand size) (2000+)
- Modern large computer installations are often not mainframes but networked collections of powerful minicomputers, e.g., server farms, data centers.

Computers: The Reality (Cont'd)
Computer Software

- A **program** is a sequence of computer instructions.
- Three main types of programs:
  - **Application**: Performs a task, e.g., calculating taxes.
  - **Compiler**: Translates a program written in one language into a behaviorally equivalent program in another language, e.g., Python $\Rightarrow$ assembler, assembler $\Rightarrow$ microcode.
  - **Operating System** (e.g., Android, Linux, MS Windows): Co-ordinates all communications between memory, processors, other devices, and human beings.
- Writing software that correctly performs complex tasks is **very** difficult to do, i.e., "No Silver Bullet" (Brooks (1995)).

Computers At The Movies: *Tron* (1982)

- Development started in 1976; after rejection by other studios, picked up by Disney in 1980.
- Disney at the Crossroads.
- First major use of Computer Generated Imagery (CGI).
- Though only 15-20 minutes of CGI in movie, took years to produce.
- Was box office failure on release; is now a cult movie.

Computers at the Movies: *Tron* (1982) (Cont'd)

. . . FYI, *this* is a logic probe . . .