Information and Information Technology

CSC121, Introduction to Computer Programming I

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computational problems = informational problems

- to understand computational processes, we must understand the nature of **information**
  - how it is represented
- along the way, we will examine
  - communication systems
  - information technologies
  - digital vs. analog data (i.e., representations of information

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What is information?

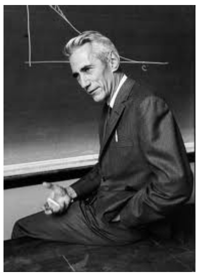
What is information?

the primacy of the concept 'information'

examples:

- *knowledge* means to acquire information
- *facts* are the contents of information
- *data* are the representation of information

Claude Shannon



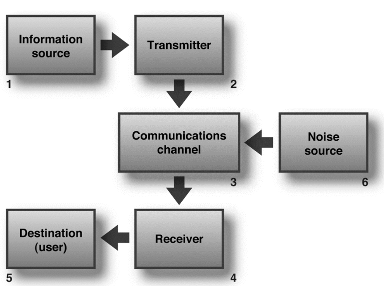
- M.S. Thesis (1937), digital circuit design
- modern cryptography (1949)
- along with Ed Thorp, developed applications of game theory ("Kelly's Criterion") for gambling
- "A Mathematical Theory of Communication" (1949)

communication system

- signal
- message
- information

information → message → signal

communication system



technology

- a **technology** is an artificial instrument, process or system that extends human capabilities to perform some task
- artificial
- extensions of natural or customary methods

information technology

- information **technologies** extend our capabilities for gathering, storing, managing, and distributing information
  - written language is one of the earliest and remains one of the most significant forms
  - helps us extend the natural boundaries of space and time

digital data

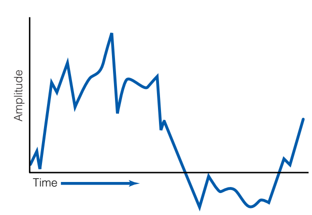
- "**data**" is a physical (symbolic) representation of information
- "**digital**" refers to numbers
- digital data has two important properties
  - each symbol or token is **discrete**
  - each symbol or token is **precise**

digital data

INFORMATION	DATA	DIGITAL DATA
understood by humans	a physical representation	encoded using a finite numeric representation
thoughts, ideas, concepts, etc.	*speech, writing, video, etc.*	*bits, bytes, etc.*

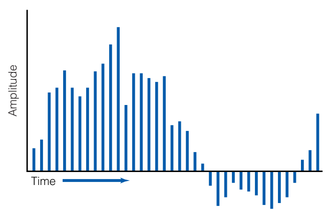
digital vs. "analog" data

- **analog data** is represented continuously as variations (of values) over time and/or space
  - e.g., sound, air pressure, light, electrical signals



digital vs. "analog" data

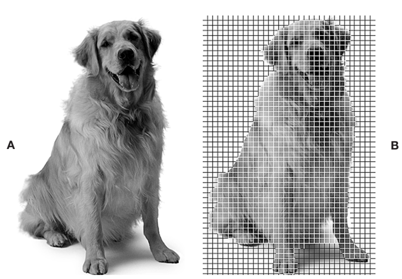
- **digital data** is represented by discrete samples of variations (of values) over time and/or space.



digitizing data

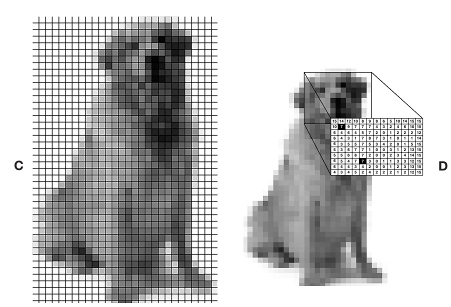
- **sampling** renders a continuous signal as discrete data
- **quantizing** converts samples to a specific numeric value

digitizing data

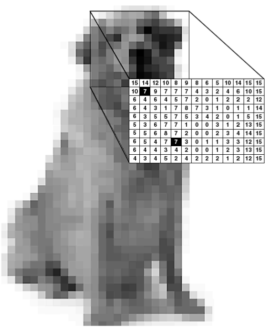


A. the original grey-level image; B. the image is sampled spatially

digitizing data



C. the samples are made discrete; B. the samples are quantized quantizing



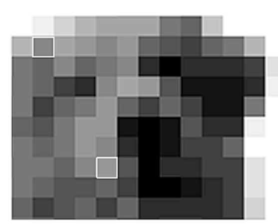
- each pixel is encoded using a number to represent its relative brightness
- here, the **scale** is 0 – 15 or 16 shades of brightness
- scale affects the **sensitivity** of the digitization

two sources for error

- **undersampling**.
  – too few samples contributes to poor resolution and inaccuracies
- **quantizing errors**.
  – if the scale is too small, poor dynamic range can result

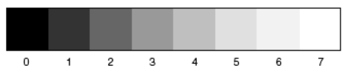
advantages of the digital domain

- precision
- ordinality
- more efficient storage
- faster transfer
- absolute replication
- compression
- integrative capabilities
- content analysis and synthesis potential



15	14	12	10	8	9	8	6	5	10	14	15	15
10	7	9	7	7	7	4	3	2	4	6	10	15
6	4	6	4	5	7	2	0	1	2	2	2	12
6	4	3	1	7	8	7	3	1	0	1	1	14
6	3	5	5	7	5	3	4	2	0	1	5	15
5	3	6	7	7	1	0	0	3	1	2	13	15
5	5	6	8	7	2	0	0	2	3	4	14	15
6	5	4	7	7	3	0	1	1	3	3	12	15
6	4	4	3	4	2	0	0	1	2	3	13	15
4	3	4	5	2	4	2	2	2	1	2	12	15

digital **precision** makes it easier to compare items that may otherwise be difficult to discern



digital **ordinality** makes it easier to do relative comparisons