COMPSCI 145

Representing, Storing, and Retrieving Information

LECTURE #2

ANALOG VS. DIGITAL

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Our First Lesson

- We all know how to perform addition, right?
- We've been trained from childhood that 1+1=2, 5+3=8, etc.
- We've also been trained with the rules about carries in addition.
- This is all ingrained by now, so we really don't think about it much.
- This is doubly true if you always use a calculator or computer.

Can you add without numbers?

(Discuss)

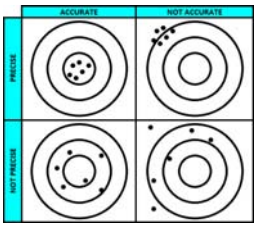
YES!

- Take two sticks,
- Trim each one to a length that *corresponds* to a value of interest,
- Place the two sticks end-to-end,
- The combined length represents the sum of the values.
- Were numbers involved?
- The lengths are analogous to the desired values.
- This is an example of ***analog*** computation.

Types of Computations

- There are two major forms of computation, ***analog*** and ***digital***.
- Analog computations use the physical properties of materials to ***directly represent*** the desired values.
- Digital computations use the physical properties of materials to ***represent numbers***, we then use the numbers to represent the desired values.
- To make sense of this, we need to first discuss accuracy vs. precision.

Accuracy vs. Precision



Analog

- Analog devices are ***continuous***.
- Analog devices typically have an ***infinite number*** of legal values (between fixed upper and lower limits).
- Analog devices are ***often accurate, but rarely precise***.
- Analog devices get a "good enough" answer quickly.
- Analog components can compute surprisingly complex operations directly (integration, inverse, logarithms, square roots, etc.)
- Analog computations are rarely repeatable exactly.
- Multiple Analog devices suffer from ***generation loss***.

Examples of Analog Devices

- Slide Rules
- Gear chains / Rack and Pinions
- Cams
- Differentials
- Component Solvers
- Mechanical Multipliers
- Hydraulics
- Transistor amplifiers
- Etc., etc., etc.

Where do you see Analog Devices?

- Volume and tuning controls on radios,
- Dial-based thermostats,
- Speedometers and odometers in older cars,
- Car transmissions and hydraulic brakes,
- Lamp dimmers,
- Electric motors,
- Older voltmeters,
- Etc., etc., etc.

Digital

- Digital devices are ***discrete***,
- Digital devices have a ***finite number*** of legal values (so they suffer from overflow and underflow),
- Digital devices are ***precise as well as accurate***,
- Digital components are simpler than analog components,
- Digital devices take far more hardware components than equivalent analog devices that compute the same things, but…
- Digital computations are always exactly repeatable, without generation loss.

How can you tell the difference?

- If it goes "hummmmmmmmm…" it is probably analog,
- If it goes "click-click-click…" it is probably digital!

An Exploration of Analog Devices

- Antikythera Machine
- U. S. Navy Fire Control Computers
- VHS Generation Loss
- Hand-Made Vacuum Tubes

