Computing’s Greatest Hits

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A Short History of Digital Info

- One goal of CS Principles is to understand how computers and digital information are “game changers,” how they create opportunities
- I start that by highlighting progress of “data processing” over last 120 years or so (it’s very incomplete)

- Think back to the days when we used quill pens and did everything by hand
We Consider only BIG Milestones

- Digitization – make information machine readable
- Electronic computers – a machine with “soft” programming
- Transistor – a switch with no moving parts
- Integrated circuits – logic + connective circuits created together by photolithography
- “Personal” computer make everyone digital
- Internet – connected computers are better
- WWW – one universal language (http) lets us communicate!
The Problem with Writing …

- Only **people** can read it … [Though recently, *some* progress in handwriting analysis has occurred; limited use.]
- First serious advance in digitization: punch cards
- Herman Hollerith develops idea for 1890 census

Hollerith Card, Courtesy IBM
Machines Process Digital Data

- Mechanical methods – sensing a hole in a card or not – allows machines to help w/work

Card Sorter
It’s not a computer!
No Computer Needed To Process Data

- A mechanical machine can “read” a card with a “metal brush” ... notice card motion
Sensing Punch Allows Some Action

- When the circuit closes, some mechanical action can happen
Suppose Hollerith coded men as 0, women as 1.

How many men and women in the population?

Machine Reads Cards,
  Puts women in this slot
  Puts men in this slot
... producing 2 piles
Run each pile through again
  just to count them -- done

Card counter

Census data
Meanwhile, w/o Digital Data

- Poor Kermit must go through census sheets, counting (and probably making mistakes)

The message: “Digitizing” makes information discrete, it’s either there (1) or not (0), and a machine can determine that fact using mechanical or electronic means. Once data is digital, it is just a matter for engineers to build more capable machines.
Next Big Things ... Very Big!

- Electronic computers came just after WWII
By Mid 20th Century ~ 1960

- Large and medium-size companies used card based digital data; **mechanical** processing
- Computers began to replace mechanical b/c a computer’s “processing instructions” (program) could be easily changed, & they perform more complex operations – flexibility
- Computers & memory much more expensive – this sets conditions for the “Y2K Problem”

Message: Computers take the task specification (program) and digital data as inputs, making them very versatile machines; one machine does it all! Programming becomes critical technology.
Next Big Things: Integrated Circuits

- Transistors – solid state switching
- Integrated Circuit – all circuit parts fabbed at once from similar materials
A transistor is a switch: If the gate (black bar) is neutral, charge cannot pass; if gate is charged, the wires are connected.
Transistors are smart, but “wiring them up” with other parts is labor intensive

**Integrated circuits** – transistors + resistors + capacitors – are created together in one long recipe – small, cheap, reliable

Key fabrication process is *photolithography* – the transistors are “printed” on the silicon!
Photolithography

1. Mask
2. Lens
3. Pattern repeated
4. Wafer with photoresist
5. Close-up of chip pattern with photoresist

Light
Integrated Circuits

Message: Transistors switch wires on and off in solid material (no moving parts to wear out) and ICs are fabbed as a unit (no wiring) by using photolithography – complexity of circuit doesn’t matter! We can all have a computer.
Next Big Thing: Personal Computers

- Ken Olsen, Founder of Digital Equipment, “There is no reason for any individual to have a computer in their home [1977]”
Computing Comes To Everyone

- Regular folks – not just government, military, scientists, banks and companies – could now apply computers to their interests
- Created a demand for digital data: news, pics, audio, video, books, etc., causing old technologies to digitize rapidly. Now it matters to everyone if a machine can “read” it
- From about 1985 most “new” information has been digital
- Quickly, people acquired enormous amounts of information
Message: Computers can be easily transformed to do new things, and being cheap, we can all have some, motivating us to want digital everything
Next Big Thing: Internet

- Invented in 1969, it took almost 20 years to get out of the lab and into public consciousness

“On the Internet, nobody knows you’re a dog.”
Connecting Up

- Computers are useful; connected computers are awesome
- If $n$ computers are connected, adding one more gives $n$ new connections!
- Communication with friends or businesses all over the world became easy and casual – some people even found out about time zones
- Digital media allows people to share each other’s information at no cost
Connectivity to Change the World

Message: The Internet is a general mechanism to communicate digital data – it doesn’t matter what it is: music, email, video ...
Today, all computers “speak” a common language: hyper-text transfer protocol
Two phenomena make the WWW brilliant

- All computers use one standard protocol (http) meaning for once all of the world’s people – who don’t speak the same natural language – have a surrogate that does

- Publishing and accessing information is completely decentralized – generally, no one limits what you put out or go after
Seeing Other People’s Digital Info

Message: WWW exploits one protocol, neutralizing differences at endpoints; the Internet’s universal medium lets us look at other people’s digital info.
In Summary

- Punch cards, first wide use of digitization
- Digital info can be processed by machines
- Computers are digital processing machines in which instructions are easily changed
- (Solid state) transistors give a “no moving parts” switch implementing computers
- Integrated circuits (ICs) make fab easy/cheap
- Photolithography allows ICs to be complex
- Networking – connecting computers is power
- WWW – unifies worlds with 1 protocol and access to “all” digital data