Computer Science

What it is,
What it's not,
and
How it is changing the world

Notes for CSC 100 - The Beauty and Joy of Computing
The University of North Carolina at Greensboro

Readings for Today

Article 1: Coding is Coming to Every Industry You Can Think Of…

Question 1: What are some areas of industry that computing impacts?
Question 2: Are there any particularly surprising things in this article?

Article 2: A Commencement Speech for Graduating 2013 CS Majors

Comment 1: You spend a lot of your life on your career - you better like it!
Comment 2: "Continuing Professional Development" is a part of every field

Question: Did anything strike you as particularly interesting/relevant in this article?

Coming Up in CSC 100

Start reading Chapter 1 in Blown to Bits

Reading Reflection due Tuesday, Sept 3 at 10:00am

What is a "reading reflection"?
….. There's a handout for that.

Question to Start the Day...

What year did people start talking about *computers*?

New York Times announces first Electronic Computer (ENIAC) in Feb 1946

Electronic Computer Flashes Answers, May Speed Engineering; NEW ALL-ELECTRONIC COMPUTER
New York Times (1857-Current file); Feb 15, 1946; ProQuest Historical Newspapers: The New York Times (1851-2008)
pg. 1

Electronic Computer Flashes Answers, May Speed Engineering

By T. R. KENNEDY Jr.
Special to THE NEW YORK TIMES.

PHILADELPHIA, Feb. 14—One of the war's top secrets, an amazing machine which applies electronic speeds for the first time to mathematical tasks hitherto too difficult and cumbersome for solution, was announced here tonight by the War Department. Leaders who saw the device in action for the first time heralded it as a tool with which to begin to rebuild scientific affairs on new foundations.

Such instruments, it was said, could revolutionize modern engineering, bring on a new epoch of industrial design, and eventually eliminate much slow and costly trial-and-error development work now deemed necessary in the fashioning of intricate machines. Heretofore, sheer mathematical difficulties have often forced designers to accept inferior solutions of their problems, with higher costs and slower progress.

The "Eniac," as the new electronic speed marvel is known, virtually eliminates time in doing such jobs. Its inventors say it computes a mathematical problem 1,000 times faster than it has ever been done before.

The machine is being used on a problem in nuclear physics.

The Eniac, known more formally as "the electronic numerical integrator and computer," has not a single moving mechanical part. Nothing inside its 18,000 vacuum tubes and several miles of wiring moves except the tiniest elements of matter-electrons. There are, however, mechanical devices associated with it which translate or "interpret" the mathematical language of man to terms understood by the Eniac, and vice versa.

Ceremonies dedicating the machine will be held tomorrow night at a dinner given a group of Government and scientific men at the University of Pennsylvania, after

... Column 3

Why does this say "Electronic Computer" rather than just "Computer"?

Before *Electronic* Computers, "Computers" were people!

NY Times "Want Ad" from 1892:

A COMPUTER WANTED.
New York Times (1857-1922); May 2, 1892;
ProQuest Historical Newspapers: The New York Times (1851-2008)
pg. 8

A COMPUTER WANTED.

WASHINGTON, May 1.—A civil service examination will be held May 18 in Washington, and, if necessary, in other cities, to secure eligibles for the position of computer in the Nautical Almanac Office, where two vacancies exist—one at $1,000, the other at $1,400.

The examination will include the subjects of algebra, geometry, trigonometry, and astronomy. Application blanks may be obtained of the United States Civil Service Commission.

From a book in 1855
(but reporting on writings from 1727)

From "Memoirs of the Life, Writings, and Discoveries of Sir Isaac Newton" by Sir David Brewster (1855)

Sir Isaac Newton's life: 1642 - 1727

We cannot find in the seven unpublished letters which Flamsteed wrote to Newton from February 7th to July 2d 1695, inclusive, any thing to justify this letter. Flamsteed begins his letter of February 7th with a long tirade against Halley, and promises that when they meet he will tell him his history, which is too foul and large for a letter: He mentions two different reports from London of Newton's death, which he was able to contradict: He tells him that his servant, his computer, has run away, and that he is teaching another: He sends him observations on refractions and on the eclipses of the moon in 1678 and 1682, and he complains of a report which, at his request, Newton succeeds in putting down, that Flamsteed refused to

His computer was his *servant*. Computing things was a menial task, working under the direction of the person who did the exalted problem-solving.

No different from today, except menial tasks are done by machines rather than servants - the thinkers that direct the computations are still doing the creative and interesting work.

One of the earliest recorded English-language uses of "Computer" - from 1692

From "A Tale of a Tub" by Jonathan Swift written around 1692

Now the method of growing wise, learned, and sublime, having become so regular an affair, and so established in all its forms; the number of writings must needs have increased accordingly, and to a pitch that has made it of absolute necessity for them to interfere continually with each other. Besides, it is reckoned, that there is not at this present a sufficient quantity of new matter left in nature, to furnish and adorn any one particular subject, to the extent of a volume. This I am told by a very skilful computer, who has given a full demonstration of it from rules of arithmetic.

Definition from the *Current* Oxford English Dictionary

computer, *n.*

1. A person who makes calculations or computations; a calculator, a reckoner; *spec.* a person employed to make calculations in an observatory, in surveying, etc. Now chiefly *hist.*

2. A device or machine for performing or facilitating calculation.

   a. An electronic device (or system of devices) which is used to store, manipulate, and communicate information, perform complex calculations, or control or regulate other devices or machines, and is capable of receiving information (data) and of processing it in accordance with variable procedural instructions (programs or software); esp. a small, self-contained one for individual use in the home or workplace, used *esp.* for handling text, images, music, and video, accessing and using the Internet, communicating with other people (e.g., by means of email), and playing games.

   b. ***by (also on) computer***: by means of a computer or computers.

What's the Point?

Broaden your perspective!!

A computer is something that computes.

It can be:

- *An electronic device*
- *A mechanical machine*
- *A person*

Next Question....

What is science?

A definition from dictionary.com

Science

noun

1. a branch of knowledge or study dealing with a body of facts or truths systematically arranged and showing the operation of general laws: *the mathematical sciences.*
2. systematic knowledge of the physical or material world gained through observation and experimentation.
3. any of the branches of natural or physical science.
4. systematized knowledge in general.
5. knowledge, as of facts or principles; knowledge gained by systematic study.

Question: Which of these apply to computer science?

Applied to Computers (of any kind)

We care about "body of facts or truths" and "general laws"

- Core focus is not on "studying" computers
  - *However: The electronic computer is our main tool, so we learn how to use them very effectively!*
- Computer science is what makes computers useful!
- Computer science truths are independent of technology
  - *Held 2000 years ago and will hold 2000 years from now*
  - *Why study computer technology when you can study computer science?*

Computer science is about the fundamental truths and general laws that govern computing, whether the computer is electronic, mechanical, or human.

> "*Computer science is no more about computers than astronomy is about telescopes.*"
> - Edsger Dijkstra

Some core computer science questions

Science is about asking questions - what kind of questions do we ask?

- Is it possible to compute some function? [Computability Theory]
- What is the most efficient way to compute this function? [Computational Complexity]
- How do we express how to compute something clearly and unambiguously? [Programming Languages]
- How can we organize a large amount of information so it can be used in our computations? [Data structures and Databases]
- How can we make machines/devices that can compute things quickly? [Computer Architecture]
- How can we coordinate multiple computations that might require the same resources [Operating Systems]

Sample computational problem

How do we find the greatest common divisor (GCD) of 135 and 210?

Euclid figured out how to do this efficiently ... around 300 BC!

Euclid was solving a computer science problem 2400 years ago!!!

Differences:

His computer was the human mind - dealing with maybe dozens of operations in an involved calculation.

He didn't have a clean way to express his algorithm.

He didn't have the background to understand "efficient computation" in the way we do today (Euclid's algorithm first analyzed in 1844).

Fast Forward to Today...

We still use Euclid's algorithm in cryptographic operations!

Example: What is the GCD of 153103965093671035918341035160983 and 98135871350196802948609581340609 15?

Those are 33 and 34 digit numbers. In cryptography we routinely work with *600 digit numbers* (and longer!).

> Question: If your computer does a billion computations a second, how long would it take to find the GCD of these numbers doing "trial division" (testing all possible divisors by division)?

How Fast Can People Compute?

We are going to have a calculation race - how fast are you?

Make sure you have a sheet of paper and pencil/pen

On the following screen are three arithmetic problems

When I change slides, start working on these and solve them as fast as you can - I'll time you!

Raise your hand when you have the answers.

The Problems

```
 132831        942
+476884       x837

 412856
-304158
```

The Answers

```
 132831          942
+476884         x837
 609715        788454

 412856
-304158
 108698
```

How Fast?

If t is the fastest time, then t/3 seconds per calculation (or 3/t calculations per second)

Obviously, computers can do this faster, but...

> In June 2012 the most powerful computer on earth could do 16,320,000,000,000,000 calculations per second (16.32 petaflops).
>
> See http://www.top500.org/

Thinking about computations on this scale is incredibly different from thinking about computations at a few calculations per minute.

Thus..... Computer Science becomes an active field of its own.

Some Other Questions...

How accurate were you?

Were all the calculations the same difficulty?

- *What makes some calculations harder than others? A fundamental computer science question!*

What about cost?

- *How much would it cost to do 1 calculation per second non-stop for a year, paying $10/hour?*

The value of tools...

Tools often enhance human capabilities

enhances...

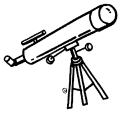
movement!

enhances...

lifting!

More tools...

Tools often enhance human capabilities



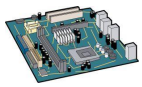
enhances...

vision!

And the electronic computer?

Electronic Computer as a tool...

Tools often enhance human capabilities



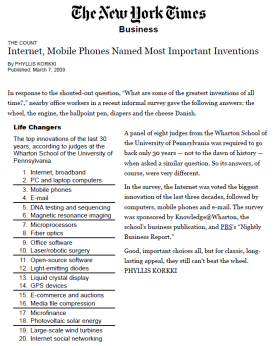
enhances...

information processing!

or...
... analysis
... thinking

"Thought enhancement" enables many things that were never possible before!

"Information tool" opens many possibilities



The New York Times
Business

THE COUNT
Internet, Mobile Phones Named Most Important Inventions

By PHYLLIS KORKKI
Published: March 7, 2009

In response to the shouted-out question, "What are some of the greatest inventions of all time?," nearby office workers in a recent informal survey gave the following answers: the wheel, the engine, the ballpoint pen, diapers and the cheese Danish.

Life Changers

The top innovations of the last 30 years, according to judges at the Wharton School of the University of Pennsylvania

1. Internet, broadband
2. PC and laptop computers
3. Mobile phones
4. E-mail
5. DNA testing and sequencing
6. Magnetic resonance imaging
7. Microprocessors
8. Fiber optics
9. Office software
10. Laser/robotic surgery
11. Open-source software
12. Light-emitting diodes
13. Liquid crystal display
14. GPS devices
15. E-commerce and auctions
16. Media file compression
17. Microfinance
18. Photovoltaic solar energy
19. Large-scale wind turbines
20. Internet social networking

A panel of eight judges from the Wharton School of the University of Pennsylvania was required to go back only 30 years -- not to the dawn of history -- when asked a similar question. So its answers, of course, were very different.

In the survey, the Internet was voted the biggest innovation of the last three decades, followed by computers, mobile phones and e-mail. The survey was sponsored by Knowledge@Wharton, the school's business publication, and PBS's "Nightly Business Report."

Good, important choices all, but for classic, long-lasting appeal, they still can't beat the wheel.

PHYLLIS KORKKI

Which of these innovations involved computer scientists?

Consider "Grand Challenges"

Selected by the National Academy of Engineering

These are "game changers" for the future - how many can computing impact?

1. Make solar energy economical
2. Provide energy from fusion
3. Develop carbon sequestration methods
4. Manage the nitrogen cycle
5. Provide access to clean water
6. Restore and improve urban infrastructure
7. Advance health informatics
8. Engineer better medicines
9. Reverse-engineer the brain
10. Prevent nuclear terror
11. Secure cyberspace
12. Enhance virtual reality
13. Advance personalized learning
14. Engineer the tools of scientific discovery

No End in Sight...

What does the future hold?

I'm not bold enough to predict the future, but leave you with this:

"The best way to predict the future is to invent it."
-- Alan Kay, 1971

You can be part of creating the future!