Class 1: Introduction

CS150 Spring 2007
University of Virginia
Computer Science

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What is Computer Science?

Let *AB* and *CD* be the two given numbers not relatively prime. It is required to find the greatest common measure of *AB* and *CD*.

If now *CD* measures *AB*, since it also measures itself, then *CD* is a common measure of *CD* and *AB*. And it is manifest that it is also the greatest, for no greater number than *CD* measures *CD*.

Euclid's Elements, Book VII, Proposition 2 (300BC)

The note on the *inflected* line is only difficult to you, *because it is so easy.* There is in fact nothing in it, but you think there must be some grand mystery hidden under that word *inflected*!

Whenever from any point *without* a given line, you draw a long to any point *in* the given line, you have *inflected* a line *upon a given line.*

Ada Byron (age 19), letter to Annabella Acheson (explaining Euclid), 1834

By the word operation, we mean any process which alters the mutual relation of two or more things, be this relation of what kind it may. This is the most general definition, and would include all subjects in the universe...
Supposing, for instance, that the fundamental relations of pitched sounds in the science of harmony and of musical composition were susceptible of such expression and adaptations, the engine might compose elaborate and scientific pieces of music of any degree of complexity or extent.

Ada Byron, 1843

What is the difference between Euclid and Ada?

"It depends on what your definition of 'is' is."
Bill Gates (at Microsoft's anti-trust trial)

Geometry vs. Computer Science

- Geometry (mathematics) is about *declarative* knowledge: "what is"

  If now *CD* measures *AB*, since it also measures itself, then *CD* **is** a common measure of *CD* and *AB*

- Computer Science is about *imperative* knowledge: "how to"

  Computer Science has little to do with beige (or translucent blue) boxes called "computers" and is not a real science.

Computer Science

"How to" knowledge:

- Ways of describing information processes (computations)   `Language`

- Ways of predicting properties of information processes   `Logic`

  What kinds of things do we want to predict?

## Science, Engineering, Other?

Science?

- Understanding Nature through Observation
  - About *real* things like bowling balls, black holes, antimatter, electrons, comets, etc.
- Math and Computer Science are about *fake* things like numbers, graphs, functions, lists, etc.
  - Computer Science is a useful tool for *doing* real science, but not a real science

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Engineering?

"Engineering is **design under constraint**… Engineering is synthetic - it strives to create what can be, but it is constrained by nature, by cost, by concerns of safety, reliability, environmental impact, manufacturability, maintainability and many other such 'ilities.' …"

William Wulf

Apollo Guidance Computer, 1969
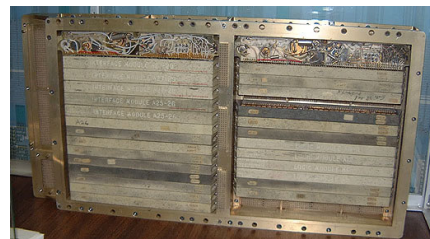
1 Cubic Foot

Why did they need to fit the guidance computer in the rocket?

Measuring Computers

- 1 bit = smallest unit of information
  - True or False
  - 0 or 1
  - If we start with 2 possible choices, and get 1 bit, we can eliminate one of the choices
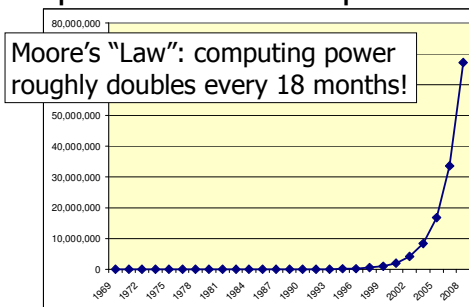
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How much power?

- Apollo Computer: 30720 bits of changeable memory
- Lab machines have 1 GB (RAM)
  - 1 Gigabyte = 1024 Megabytes,
    1 Megabyte = 1024 Kilobytes,
    1 Kilobyte = 1024 Bytes,
    1 Byte = 8 bits

> You will understand this notation soon…but don't worry if you don't now

> (* 1024 1024 1024 8)
  8589934592   ~ 8.6 Billion bits
> (round (/ (* 1024 1024 1024 8) 30720))
  279620   You have 105 404 times more power than AGC

If Apollo Guidance Computer power is 1 inch, you have 4.4 miles!

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Computing Power 1969-2008 (in Apollo Control Computer Units)

Moore's "Law": computing power roughly doubles every 18 months!

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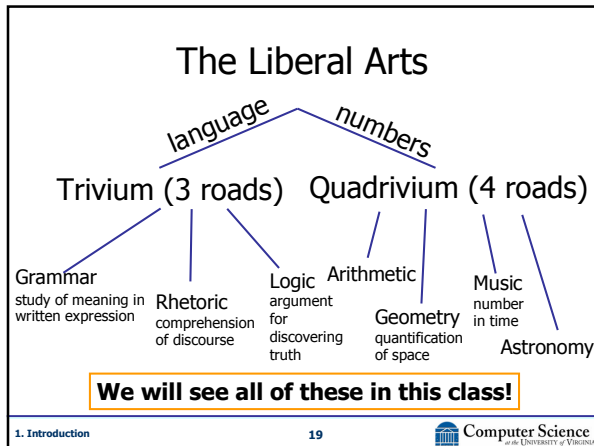## Constraints Computer Scientists Face

- Not like those for engineers:
  - Cost, weight, physics, etc.
  - If ~20 Million times what people had in 1969 isn't enough for you, wait until 2010 and you will have 80 Million times…
- More like those for Musicians and Poets:
  - Imagination and Creativity
  - Complexity of what we can understand

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So, what is computer science?

- ~~Science~~
  - No: its about fake things like numbers, not about observing and understanding nature
- ~~Engineering~~
  - No: we don't have to deal with engineering-type constraints
- Liberal Art

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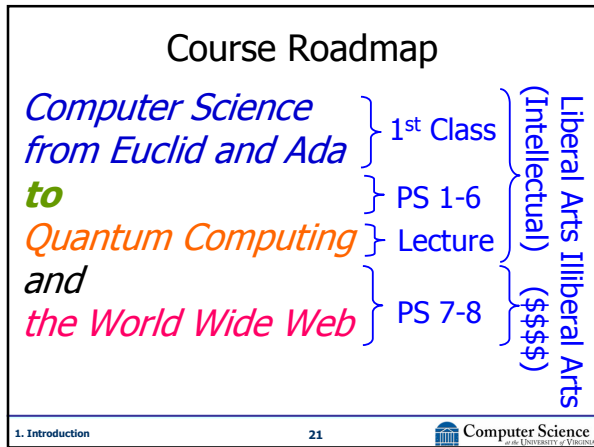

Liberal Arts: ~1100

- Illiberal Arts
  - arts for the non-free: pursued for economic reasons
- Liberal Arts
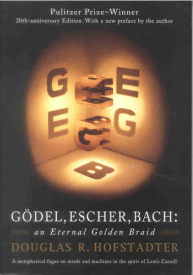 - arts for the *free*: pursued for intrinsic reasons

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The Liberal Arts

language   numbers

Trivium (3 roads)   **Quadrivium (4 roads)**

Grammar
study of meaning in
written expression

Rhetoric
comprehension
of discourse

Logic
argument
for
discovering
truth

Arithmetic

Geometry
quantification
of space

Music
number
in time

Astronomy

> **We will see all of these in this class!**

Course Expectations

Course Roadmap

Computer Science from Euclid and Ada   } 1st Class

to   } PS 1-6

Quantum Computing   } Lecture

and

the World Wide Web   } PS 7-8

Liberal Arts (Intellectual)

Iliberal Arts ($$$$)

Like Drinking from a Firehose

> Don't be overwhelmed!
> You will do fine.

It may hurt a little bit, and a lot of water will go by you, but you won't go away thirsty!

Books

GÖDEL, ESCHER, BACH:
an Eternal Golden Braid
DOUGLAS R. HOFSTADTER

"GEB"

Computational Thinking
A Whirlwind Introduction
to the Third Millennial Liberal Art
from Ada and Euclid
to Quantum Computing
and the World Wide Web

New Book!: written for course
Chapters 2 and 3 out today
Bonuses for helping me improve it:
 - Less pretentious title (?)
 - More exciting cover
 - Notice any mistakes
 - Improve the writing or presentation

"Course Book"

Help Available

- Me: David Evans (Call me "Dave" or "Coach")
  - Office Hours will be posted (after your surveys)
  - Always available by email, if I don't reply in 24 hours, send again and complain
- Assistant Coaches: Richard Hsu and Kinga Dobolyi
  - Staffed lab hours in Small Hall
  - Upcoming lab hours: Thursday 6-9pm; Friday after class
- Web site: http://www.cs.virginia.edu/cs150
  - **Everything** goes on the web, you should visit it often
- **Your classmates** (read the course pledge carefully!)

What I Expect of You

1. Everything on the Course Pledge
   - You should actually **read it** not just sign it (you will lose points on PS1 if your submission reveals that you didn't read it!)
2. You are a "Jeffersonian Student"
   1. Believe knowledge is powerful
   2. Interested in lots of things, ahead of your time
   3. Want to use what you learn to do good things
   4. Care more about what you learn than grades and degree requirements

Background Expected

- Language:
  - Reasonable reading and writing in English
  - Understanding of subject, verb and object
- Math:
  - Numbers, add, subtract, multiply, divide
  - Exponentiation, logarithms (we will review)
- Logic: *and*, *or*, *not*
- Computer Literacy: read email, browse web

If I ever appear to expect anything else, stop me!

A Course for Everyone!

- CLAS, SEAS, Commerce, Arch, etc.
- 1st, 2nd, 3rd, 4th, 5th Years, Community Scholars, Faculty
- No background expected…but challenging even for students with lots of previous CS courses
- Computer Science (future-) majors…but worthwhile even if you don't take another CS course

First Main Theme: Recursive Definitions

What is the longest word in the English language?

According to Guinness

floccipoccinihilipilification
the act of rendering useless

Making Longer Words

antifloccipoccinihilipilification
the act of rendering not useless

antiantifloccipoccinihilipilification
the act of rendering   useless

Language is *Recursive*

No matter what word you think is the longest word, I can always make up a longer one!

word ::= **anti-**word

If you have a word, you can always make up a new word by adding **anti** in front. Since the result is a word, you can make a longer new word by adding **anti-** in front again.

Recursive Definitions

- We can define things in terms of themselves
- Recursive definitions are different from circular definitions: they eventually end with something real

word ::= **anti-**word

word ::= **floccipoccinihilipilification**

Recursive Definitions

Allow us to express infinitely many things starting with a few.

This is powerful!
We will see **lots** of examples in this course.

Charge

- Before 11:59pm Thursday:
  – Registration survey (see course web site)
- Reading Before Friday:
  – Read Course Book Chapters 2 and 3
  – GEB p. 3-41
    - Anyone who can produce "MU", gets an automatic A+ in the course
- Don't floccipoccinihilipilificate

Thanks!

- 2004, 2005 CS150 students, 2003 CS 200 students, 2002 CS200 students, 2001 CS655 students
- 2002 Assistant Coaches: Jon Erdman, Dante Guanlao, Stephen Liang, Portman Wills
- 2003 Assistant Coaches: Rachel Dada, Jacques Fournier, Spencer Stockdale, Katie Winstanley
- 2004 Assistant Coaches: Sarah Bergkuist, Andrew Connors, Patrick Rooney, Katie Winstanley
- 2005 Assistant Coaches: David Faulkner, Dan Upton
- Guest Speakers: Radhika Nagpal (2002), Tim Koogle (2003); Alan Kay (2005)
- Spring 2006: Greg Humphreys; Kristen Walcott, Gillian Smith
- Teaching Resource Center: Marva Barnett, Freda Fretwell
- 2001-2 UTF Fellows: Phoebe Crisman, John Lach, Debra Lyon, Emily Scida, Brian Smith, David Waldner; UTF Mentor: Judith Shatin
- 6.001 teachers: Gerry Sussman, Bob Berwick
- CS Department: Jim Cohoon, Ginny Hilton, Tom Horton, Greg Humphreys, Anita Jones, John Knight, Worthy Martin, Chris Milner, Brenda Perkins, Gabe Robins, Mary Lou Soffa, Jack Stankovic
- Anna Chefter, Chris Frost, Thad Hughes, Jerry McGann, Shawn O'Hargan, Mike Peck