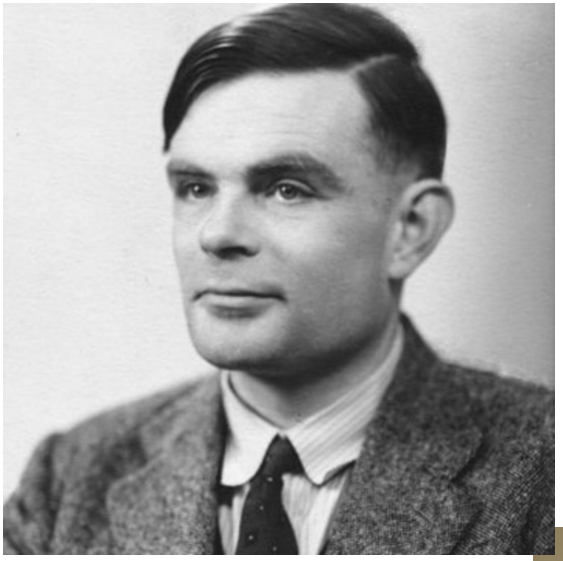
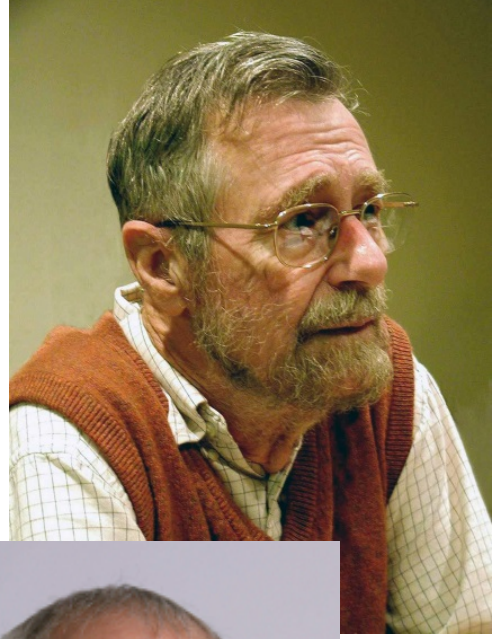
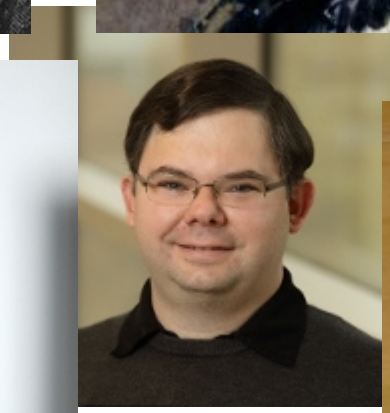
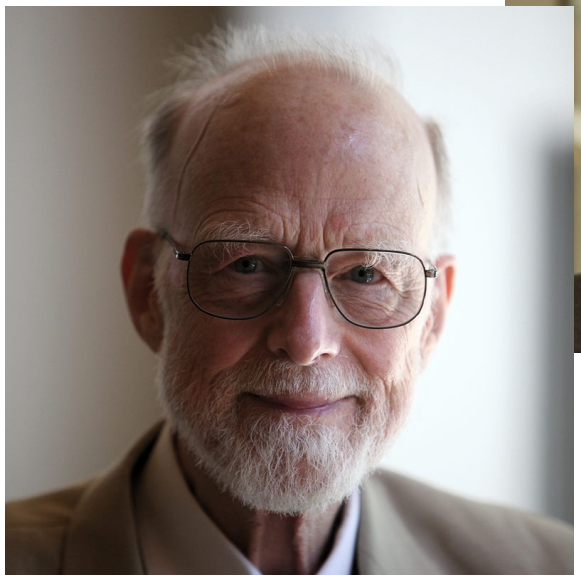
CS4102 Algorithms

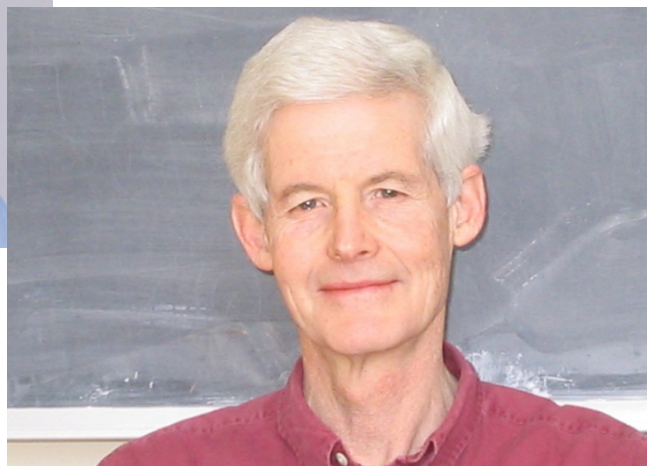
Spring 2019











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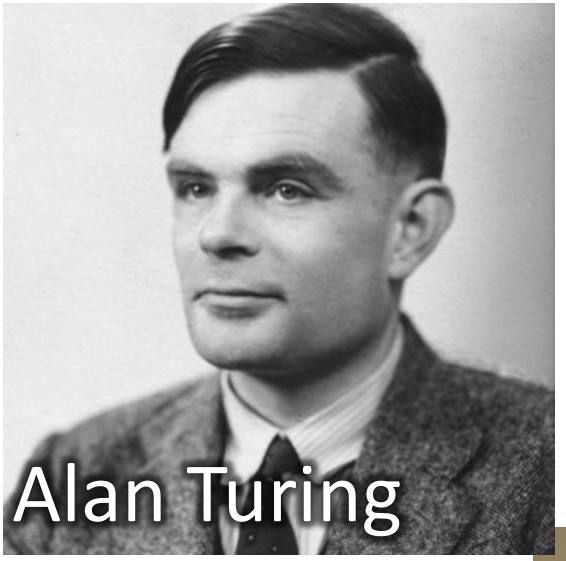
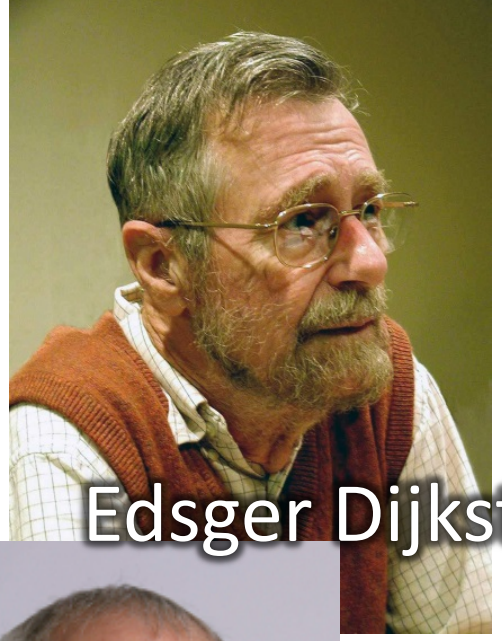
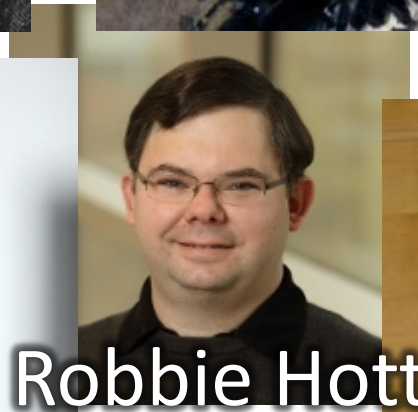
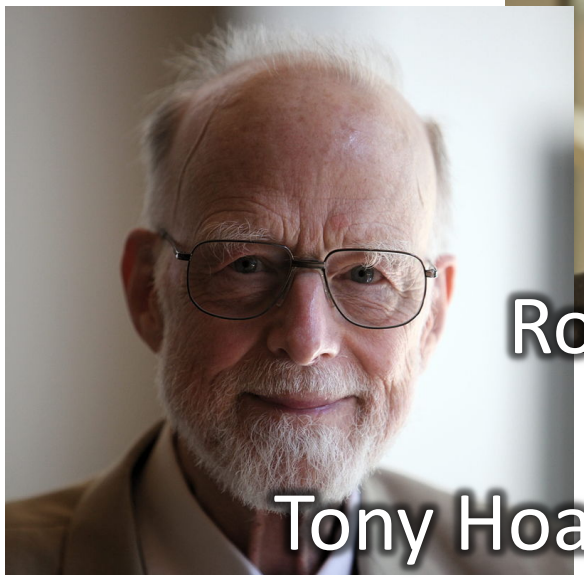




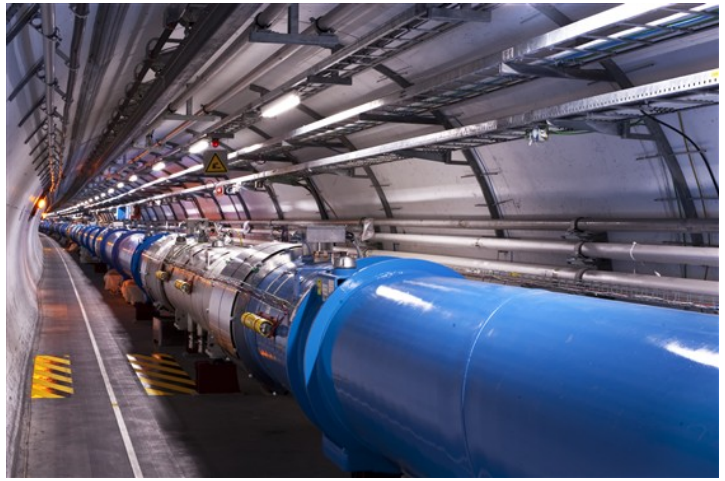




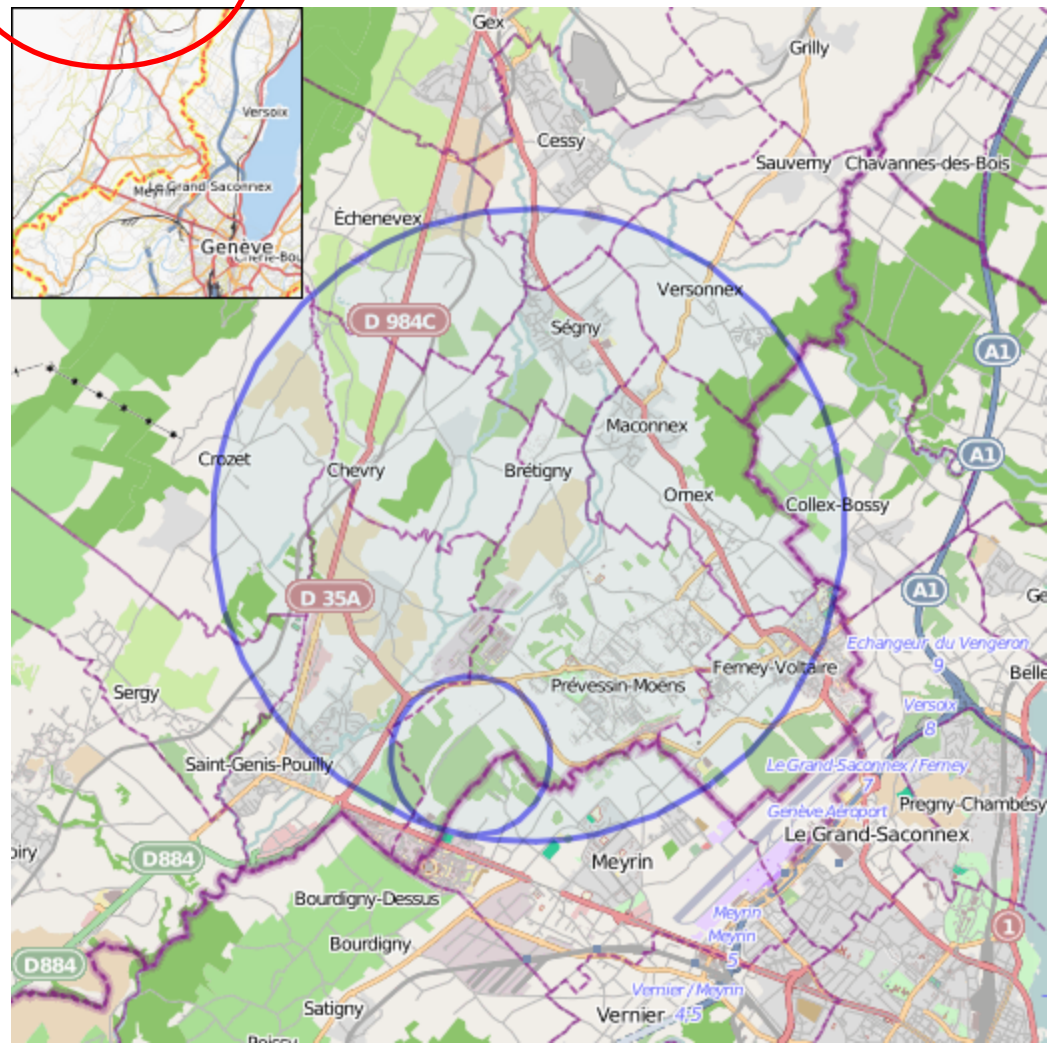
What is an algorithm?

- In mathematics and computer science, an algorithm is a self-contained sequence of actions to be performed. Algorithms can perform calculation, data processing and automated reasoning tasks. [Wikipedia]
- In mathematics and computer science, an algorithm is an unambiguous specification of how to solve a class of problems. Algorithms can perform calculation, data processing and automated reasoning tasks. [Wikipedia]
- Motivating example

Need an accurate approximation → π



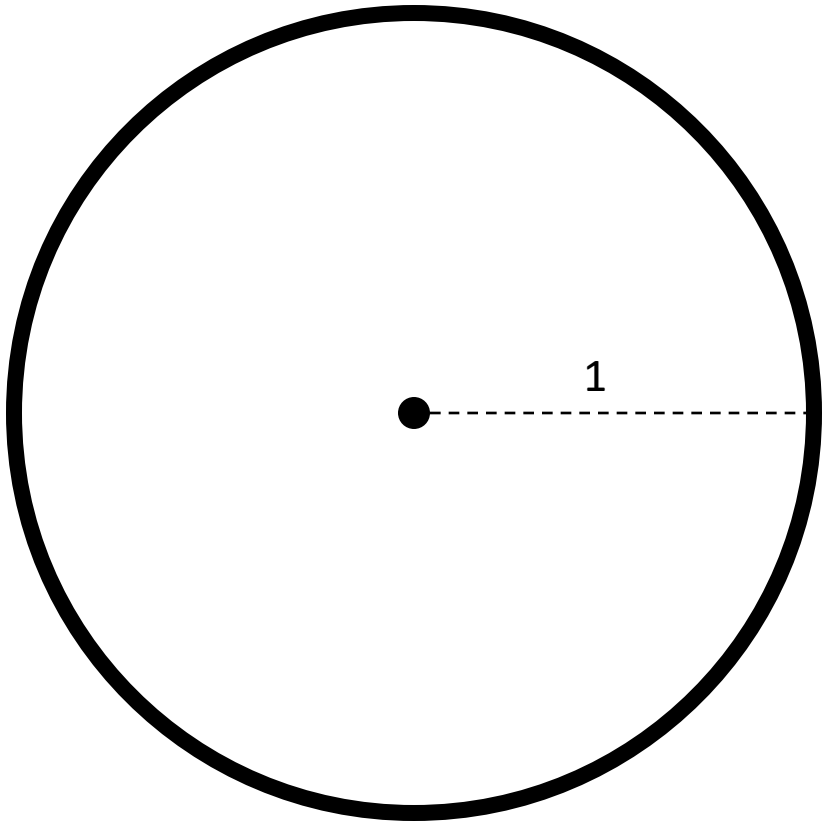
How much concrete do I need?



4.3km (2.7mi) diameter

π Approximation Algorithm

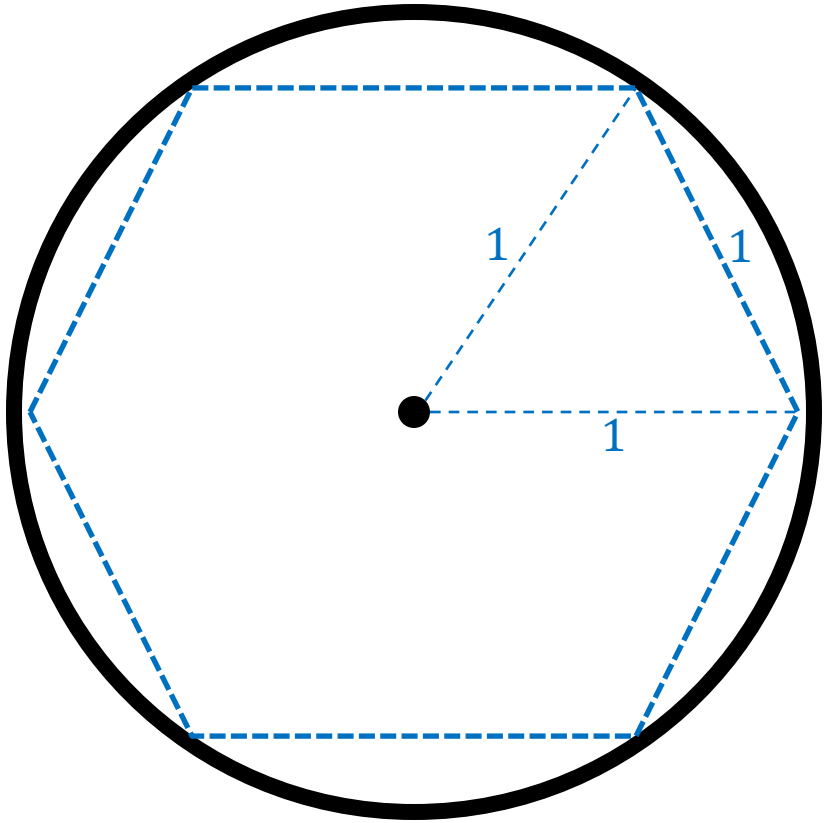
$\pi = 3.14159265359\ldots$



Circumference = 2π

π Approximation Algorithm

$\pi = 3.14159265359\ldots$



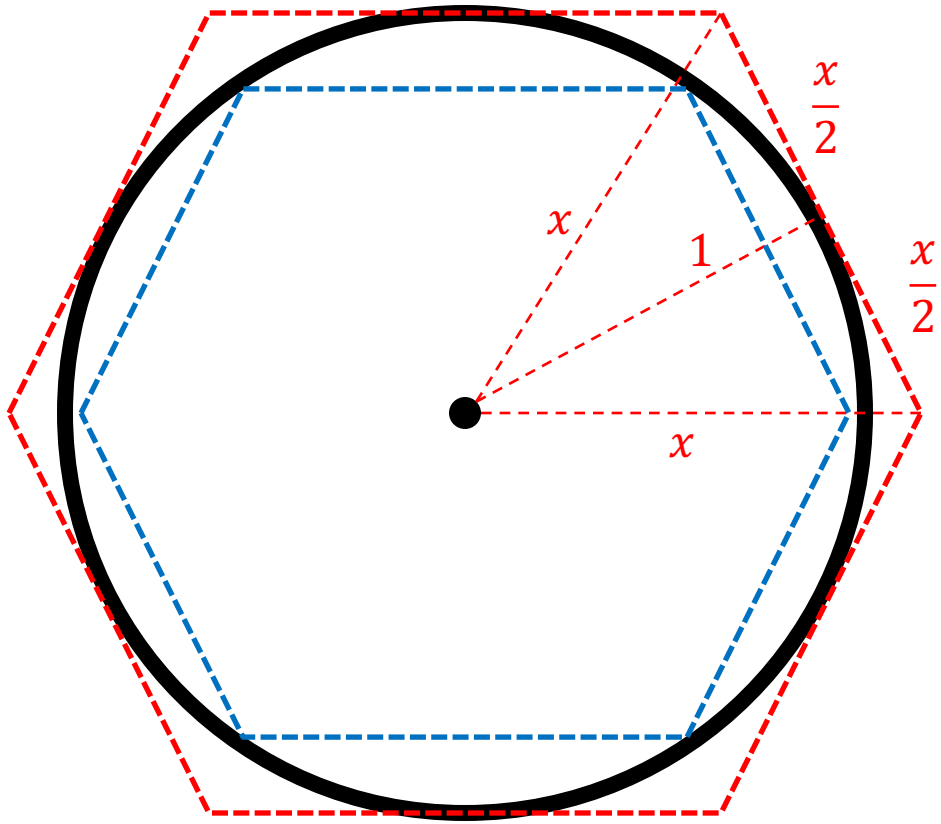
$2\pi >$ Perimeter $= 6$

π Approximation Algorithm

$\pi = 3.14159265359\ldots$ 1 digit correct

Solve for x

$$x = \frac{2}{\sqrt{3}}$$

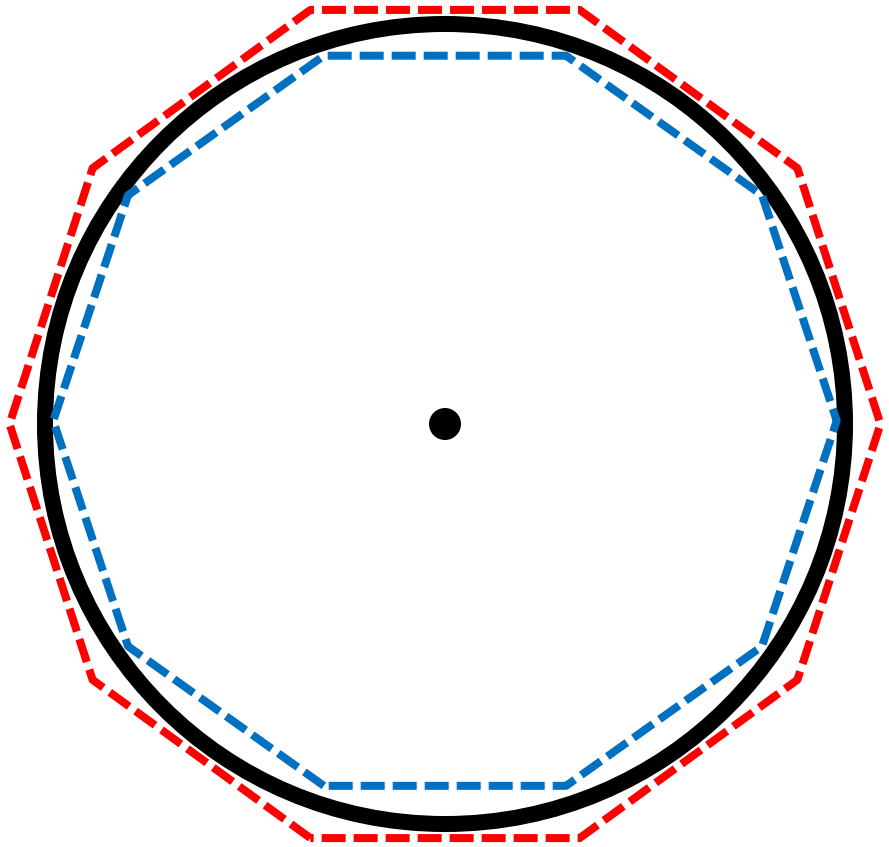


$$\frac{12}{\sqrt{3}} = \text{Perimeter} > 2\pi > \text{Perimeter} = 6$$

$$3.46 > \pi > 3$$

π Approximation Algorithm

$\pi = 3.14159265359\ldots$ 3 digits correct



$$6 + \frac{20}{70} = \text{Perimeter} > 2\pi > \text{Perimeter} = 6 + \frac{20}{71}$$

$$3.14285 > \pi > 3.14084$$

How to analyze this approach?

- How fast do we “converge?”
- How much work is needed to do better?

Another Algorithm

- https://youtu.be/HEfHFsfGXjs
- Extra Credit!

Better π Approximation (Ramanujan)

$$\frac{1}{\pi} = \frac{2\sqrt{2}}{9801}\sum_{k=0}^{\infty}\frac{(4k)!\,(1103+26390k)}{(k!)^4\,396^{4k}}$$

$\pi = 3.14159265358979323846264338327950288419716939937510582097494459$

$k = 0$

$\pi \approx 3.1415927$

8 digits per iteration!

$k = 1$

$\pi \approx 3.141592653589793 8$

Goals

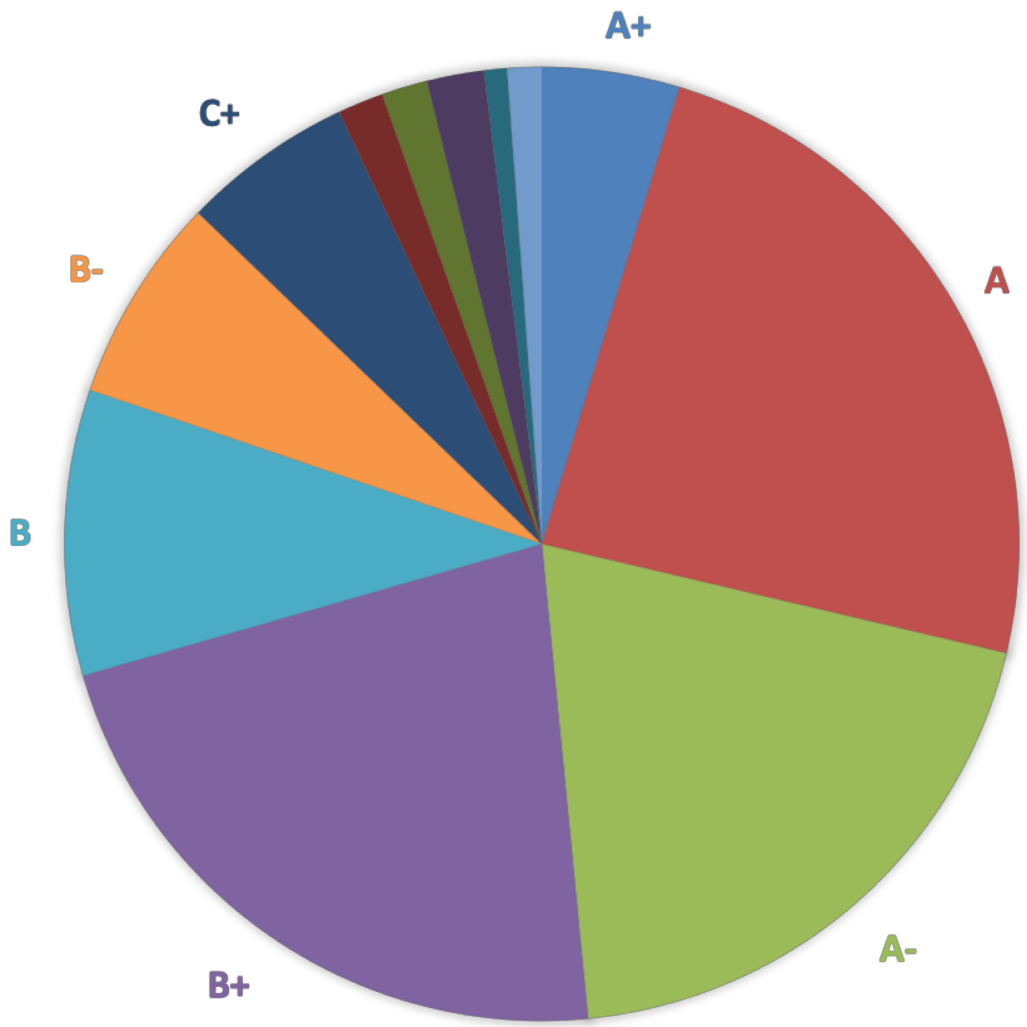
- Create an awesome learning experience
- Instill enthusiasm for problem solving
- Give broad perspective on Computer Science
- Have fun!

Warning

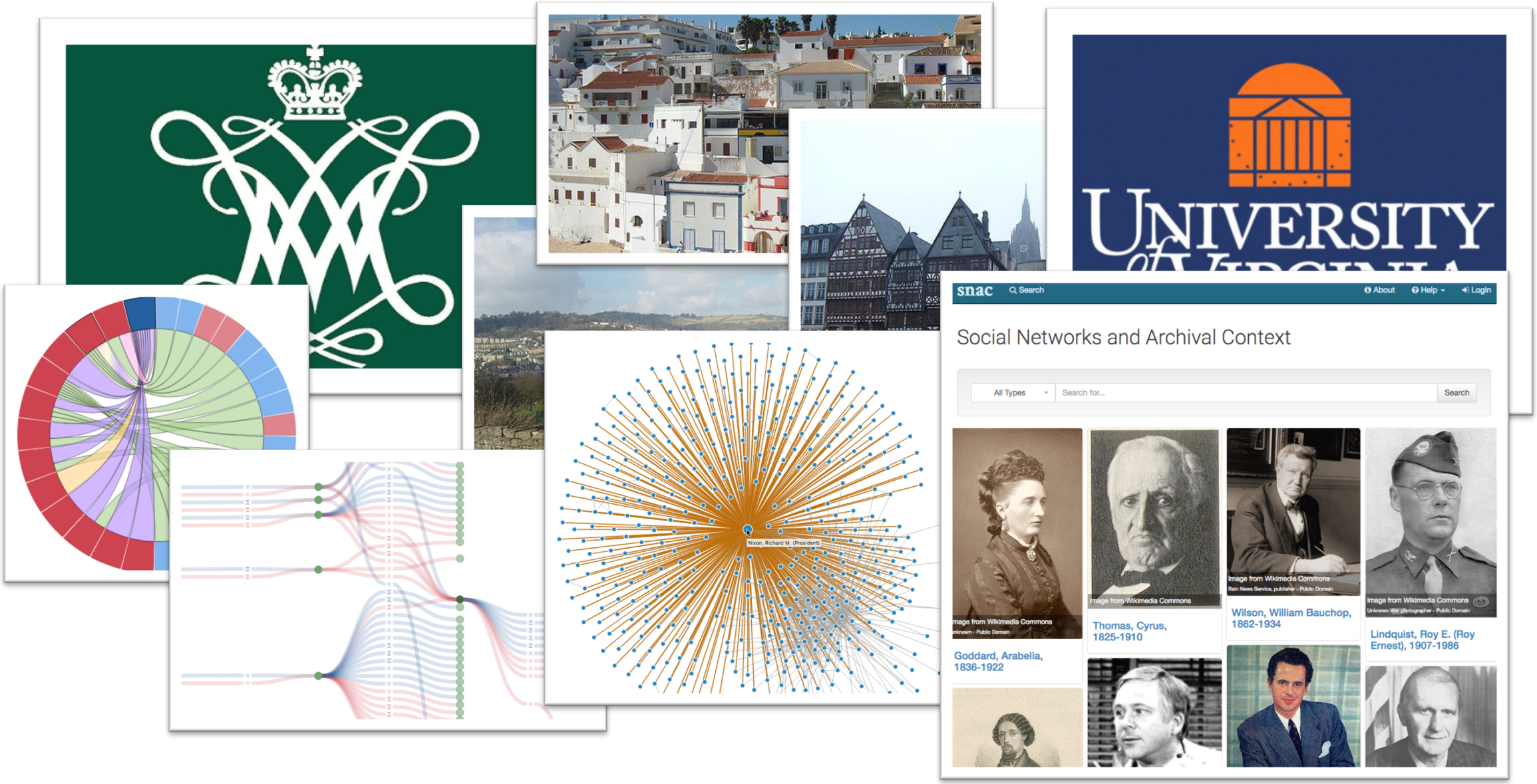
- This will be a very difficult class
  - Hard material
  - “Holy Grail” of computer science
  - Useful in practice
  - Job Interviews
- Lots of opportunities to succeed!

Hopefully not you…

While difficult, students have done well…



Who Am I?


UNIVERSITY of VIRGINIA
snac
Search
About
Help
Login
Social Networks and Archival Context
All Types
Search for...
Search
Goddard, Arabella, 1836-1922
Thomas, Cyrus, 1825-1910
Wilson, William Bauchop, 1862-1934
Lindquist, Roy E. (Roy Ernest), 1907-1986
Nixon, Richard M. (President)

Office Hours

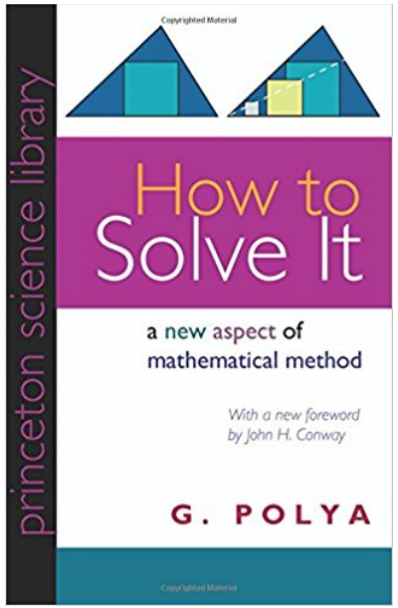
- Rice 210
  - Poll time! www.menti.com code: 28 92
  - By appointment

Requirements

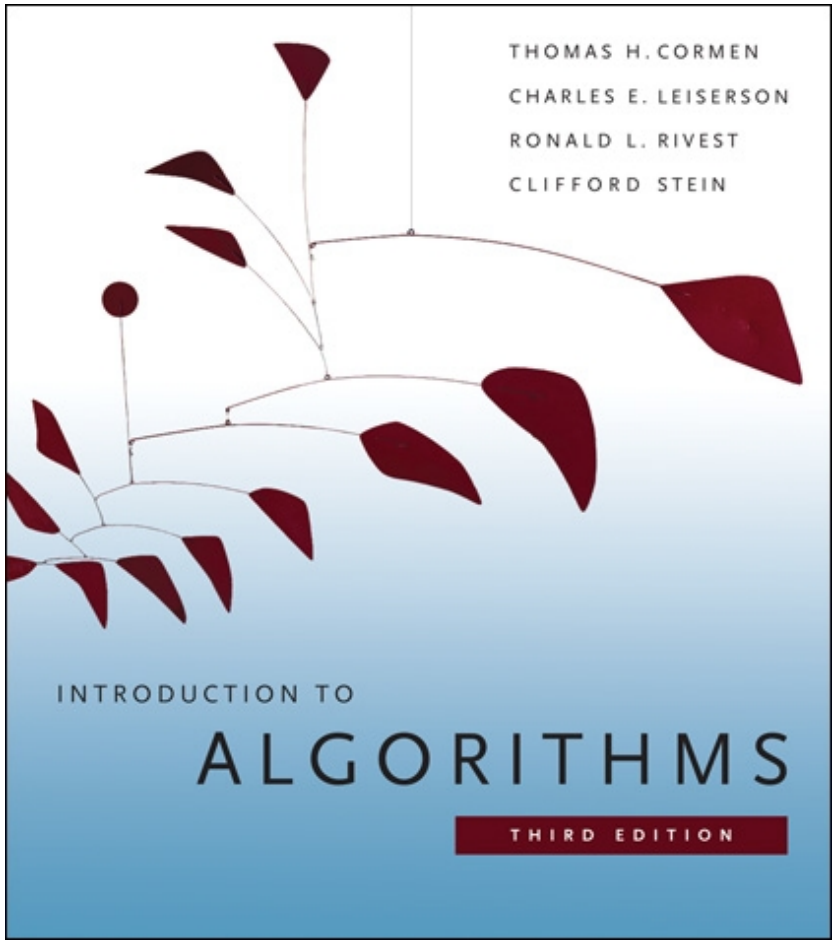
- Discrete Math (CS 2102)
- Data Structures (CS 2150)
- Derivatives, series (Calc I)
- Tenacity
- Inquisitiveness
- Creativity

Textbook

- No textbook required
- Highly recommended:

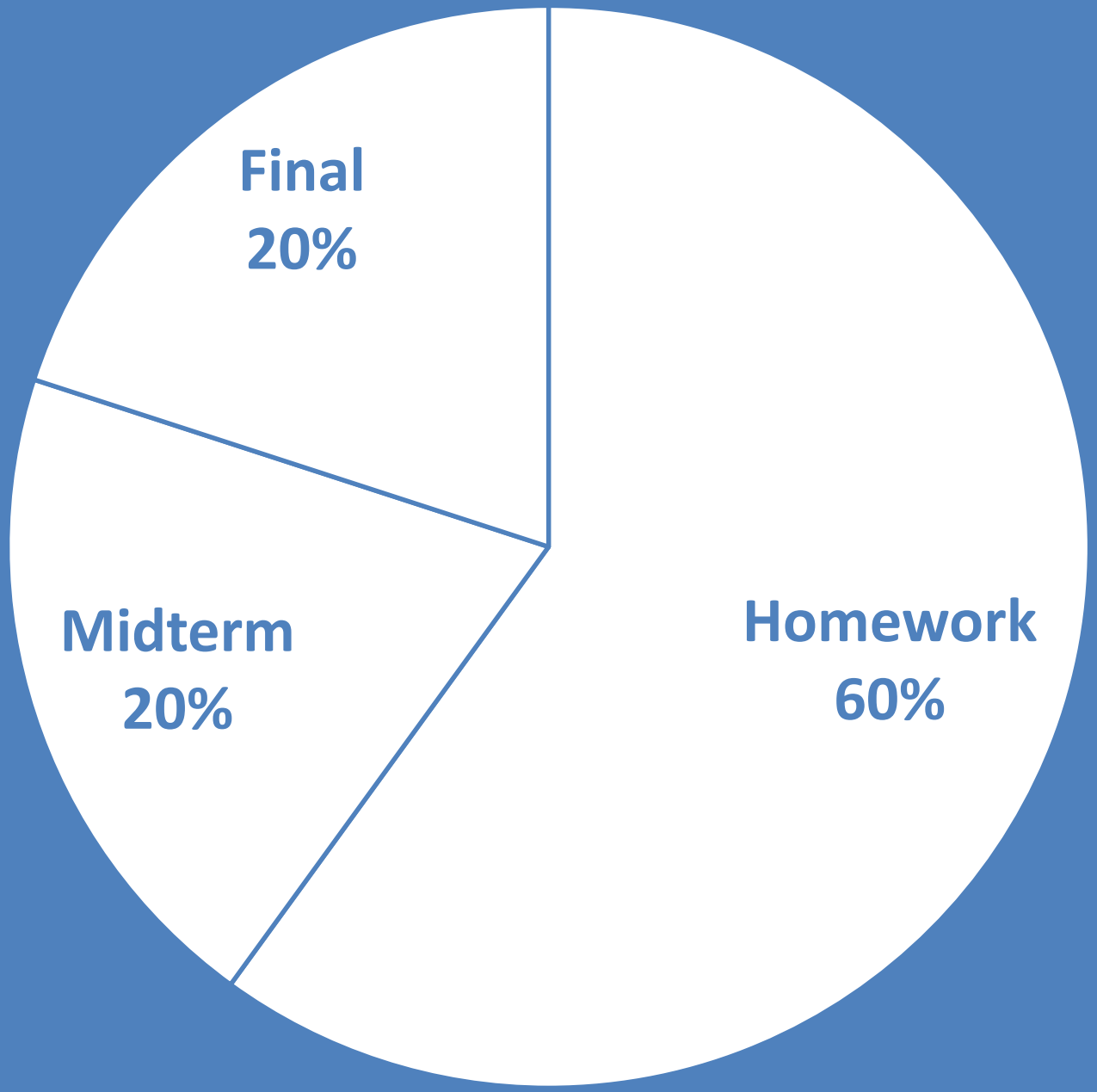


Polya. *How to Solve It.*



Cormen et al. (CLRS) *Introduction to Algorithms*. Third Edition.

Grade Breakdown



10% Extra Credit

Homework

- 11 assignments total
- Mix of written and programming assignments
- Written:
  - 2/3 of all assignments
  - Must be typeset in LaTeX (tutorial is HW0)
  - Submit as a **pdf** and a **zip** folder containing tex file and any supplements
    - Submissions without both attachments (pdf, zip) will **not** be graded
- Programming:
  - 1/3 of all assignments
  - Must implement in Python or Java

Homework 0

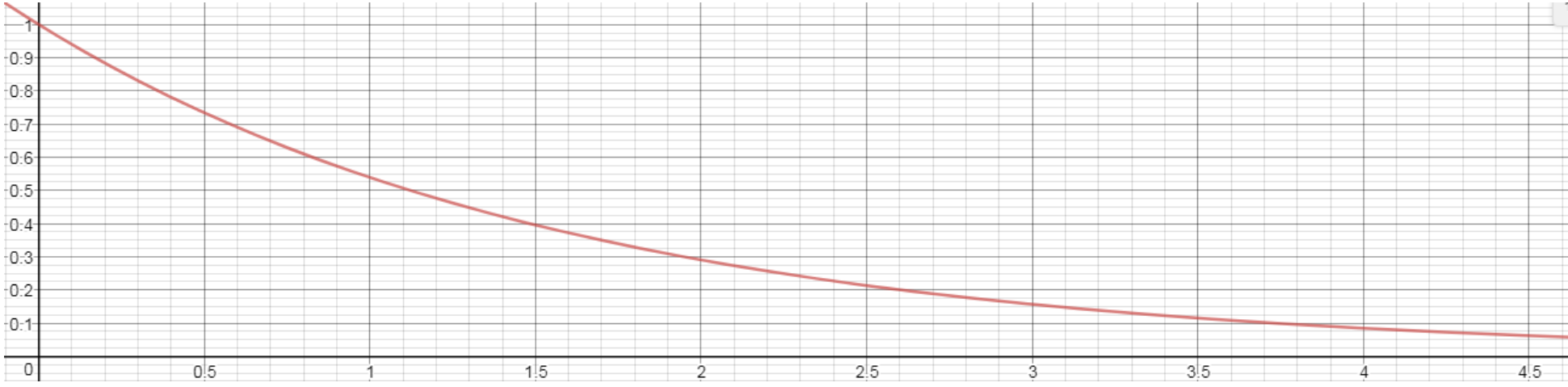
- Homework 0 is out!
  - Learning LaTeX
  - You MUST submit both:
    - A zip with your tex and image
    - A PDF of the final document
  - Due next Monday (but don’t wait that long!)

Academic Integrity

- Collaboration Encouraged!
  - Groups of up to 5 per assignment
  - List your collaborators
- Write-ups/code written independently
- Be able to explain any solution you submit!
- DO NOT seek published solutions online

Late Policy

- $grade = grade_{earned}\, e^{-\frac{1}{\phi} days}$
- Exponential decay
- Accepted until solutions posted
- Extra credit for the radioactive isotope with half-life closest to your homework's



Exams

- Midterm
  - March 6
  - In-class / take-home hybrid
- Final
  - Registrar's official date/time
  - Saturday, May 4, 2-5pm

Regrades

- Initially conducted in person w/ me
  - Thursday TBD
  - By appointment

Extra credit

- Given for extraordinary acts of engagement
  - Good questions/comments
  - Quality discussions
  - Analysis of current events
  - References to arts and music
  - Extra credit projects
  - Slide corrections
  - Etc. Just ask!
- Email: **extra.credit.cs4102@gmail.com**

Feedback

- I am not a course dictator, I am a civil servant
- I’m open to any suggestion to help you learn
- Let me know!
  - In person
  - Email
  - Piazza

Attendance

- How many people are here today?
- Naïve algorithm
  - Everyone stand
  - Professor walks around counting people
  - When counted, sit down
- Run time?
  - Class of n students
  - *O(n)*
- Other suggestions?

Better Attendance

1. Everyone Stand
2. Initialize your “count” to 1
3. Greet a neighbor who is standing: share your name, full date of birth (pause if odd one out)
4. If you are older: give “count” to younger and sit.
   Else if you are younger: add your “count” with older’s
5. If you are standing and have a standing neighbor, go to 3