Foundations of Computing

Introduction

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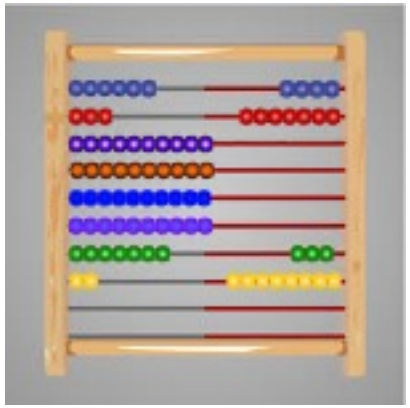
Course Information

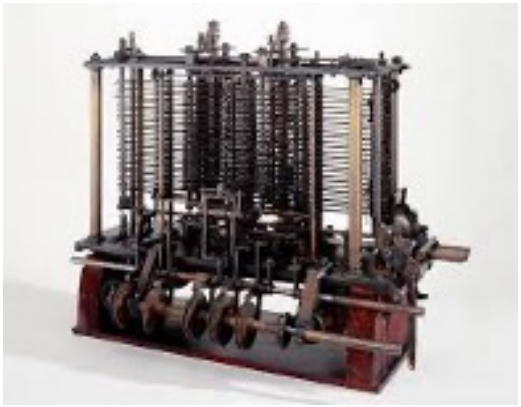
- Course Title: CSCI 3313 – Foundations of Computation
- Professor: Arkady Yerukhimovich
- Lectures: 11:10 - 12:25 on Tuesdays and Thursdays in SEH 1300, 1400, 1450
- Labs: Wednesday 10-11:15 or 11:15-12:30 in SEH 1300, 1400, 1450
- Webpage: `https://gw-cs3313.github.io/`
- We will also use Blackboard and Piazza

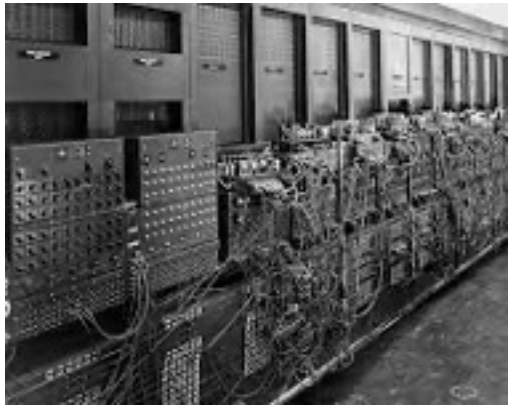
Outline

1. What this course is about
2. Course Logistics
3. Expectations and Grading
4. Important Policies

What is a computer?







What can a computer do?

- Arithmetic
- Basic logical operations
- Play Tron
- Algebra and calculus
- TikTok
- Destroy humanity

Course objective

We will aim to define what a "computer" is and prove what problems it can and cannot solve

Why study this?

- Theory of computation is beautiful!!!
- We will encounter useful tools along the way
  - Regular expressions
  - Context-free grammars
  - Etc.
- Will give you an understanding of WHY some problems are harder than others

But I am not good at math

- This class will involve a good deal of math!
  - Logic, proofs, etc.
  - No linear algebra or calculus!
- My main goal is to help you build intuition
  - It is easy to get lost in notation and details
  - But, if you understand the intuition of why something is true (or false), this gets MUCH easier

CS 3313: What is it about?

- Theoretical foundations of Computer Science
  - What is a "computer"?
  - What can/can't a computer compute?
  - How do we reason about the power of computation?
- Math tools to reason about computation
  - Mathematical models of computation
  - Proofs of properties of these models
  - Build intuition about power of respective models
- Instead of asking HOW to solve a problem, we ask
  - WHAT problems can be solved?
  - WHY are some problems harder than others?
  - Learn "fundamental properties" of computation

Course Learning Objectives

- Understand and design different automata (machine) models
  - Apply mathematical reasoning to assert properties of the machines
  - Determine the limits for each machine model
- Formal models for defining languages and compilers – Grammars
  - Relationship between languages and automata/machines
- Understand foundations behind "solvable" and "unsolvable" problems
  - How to determine if a problem is solvable on a computer
- Understand definition of efficient computation and what can be solved efficiently
  - Reason about basic complexity classes

Course Schedule – Topics

- Part 1: Automata and Languages (weeks 1-6)
  - Finite Automata – same as Finite State Machines in Hardware!
  - Pushdown Automata – adding simple "memory" to finite state machines
  - Languages recognized by these machines
- Part 2: Turing Machines and Computability (weeks 7-10)
  - Turing machines
  - What is computable? What is not computable?
  - Reductions between problems
- Part 3: Complexity Theory (weeks 11-14)
  - Time complexity and P vs. NP
  - Poly-time reductions and NP-completeness
  - Space complexity
  - Interactive proofs

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Instruction team

- Instructor: Arkady Yerukhimovich
- Grad TAs:
  - Suvasree Biswas
  - Oliver Broadrick
- Undergrad TAs and LAs:
  - Ryah Carpenter – UTA
  - Kyle Vitale – UTA
  - Clare Jenney – LA
  - Pravin Khanal – LA
  - Karl Simon – LA

Course Materials

- Lectures: Tuesday/Thursday – 11:10-12:25
- Labs: Wednesday – 10-11:15 or 11:10-12:25

- Course webpage
  - will have links to syllabus, lecture notes, online resources (and tutorial videos when applicable)
  - `http://gw-cs3313.github.io`

- Blackboard will be used for:
  - Synchronous online lectures (including recordings)
  - Homework and solutions
  - Reporting grades

- Piazza – for discussions: you've used this before...

Lectures

Accessing Lectures:

- In person
- Zoom: Zoom information on Blackboard

Important:

- Zoom option is ONLY for students who have a legitimate reason not to attend class in person.

Textbooks / Software

- Textbook:
  - "Introduction to the Theory of Computation" 3rd edition (earlier versions will work too) by Michael Sipser, CEngage publishers
- Alternate textbooks:
  - "Introduction to Formal Languages and Automata", 6th edition by Peter Linz (earlier editions will work too), JB Learning
  - "Introduction to Theoretical Computer Science" by Boaz Barak
- Online notes and resources
- JFLAP – simulator for automata
  - You can install it locally on your laptop
  - Check the tutorial video on the course webpage
  - This will be optional, but useful

Piazza

- The purpose of this:
  - to encourage you to ask and answer questions
  - Be very careful not to border on plagiarism!
  - Don't post your HW solution to the world!!
- Signup instructions posted on Blackboard
- Do not expect instant response or substitute Piazza for office hours!
  - Piazza is not manned 24 hours/7 days a week
  - Sometimes an answer may take more than 24 hours!
- Posting on piazza, not the same as telling instructor things
  - E.g. : I'm going to miss the exam! I need to attend class virtually!
  - Use email for this
- Do NOT wait until the last minute to ask for clarifications...
  - The instructors and TAs do NOT plan on spending their weekend checking Piazza!

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Grading

- Exam(s): 50%
  - 3 exams
  - Approximately weeks 6, 10, and Finals week
  - Lowest score exam will count for 10%, others for 20% each
- Homework - 30% – lowest score will be dropped
- Participation, quizzes, and in-class (lab) exercises - 20%
- Grades curved (and scaled as percentage of highest score in class)

Homework

- Homework will come out (approximately) every week
- Homework is due (on Blackboard) by 5:00PM on Friday
- NO LATE HOMEWORK ACCEPTED
  - In VERY special cases, this may be allowed – email the professor
- For all grading inquiries on homework contact Grad TAs and instructor via email
  - Do not post to piazza

In-class Quizzes, Exercises, and Participation

In Class Exercises:

- You will learn through in-class activities and exercises in many classes (lecture+lab)
  - Make sure you attend lecture and lab
  - Let instruction team know if you need to miss for some reason
- In-class exercises are due by end of class/day

Quizzes:

- Lectures will sometimes include short quizzes to test your grasp of the material

Discussion:

- We STRONGLY encourage questions during lecture, labs, and on Piazza
- Participating in discussion is part of your grade

Excused Absences

If you are sick or cannot participate in a given lecture, please email me.

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Sharing Online Course Content

- Recordings of lectures MUST NOT be shared outside of class. These are only for students registered in the class.
- Slides and recordings made by the professor may be downloaded and shared.

In Class Behavior

- Treat others with respect. We have students coming from diverse backgrounds, and I want everyone to feel welcome.
- Encourage others by asking questions and helping each other
- Do not disparage anybody

Important

Everyone will enjoy the class more if we treat each other with respect.

Enjoy the Class