Learning goals

KNOW LIMITS

PROOF
Introductions
Clickers

When did you take CSE 21?
A. Winter 2017
B. Fall 2016
C. Spring 2016
D. Winter 2016

PCYNH 109: AB

To change your remote frequency
1. Press and hold power button until flashing
2. Enter two-letter code
3. Checkmark / green light indicates success

Why use clickers?
Logistics

Homework: ~1 / week; 7 over the quarter (drop lowest score) can work in groups!

In-class: Group discussion + iClicker; Skim book first
Discussion section Fridays: homework warmup

Weekly review quiz: 5 Qs each Friday; can make up missed points through participation

Exams: Tuesday April 25, in class
       Tuesday May 23, in class
       Final Exam Saturday June 10, 8:00am-11:00am

Gradescope: Homework submission, exam return, interim reports
Piazza: announcements and Q&A.
One-on-one office hours: with your personal CSE 105 tutor! Find yours on Piazza.
How to excel

• Prepare ahead of class
  • Read assigned sections, read homework questions

• Engage in class
  • Discuss questions with your neighbors, look for (counter)examples
  • Go over wrong choices too!

• Reinforce after class
  • Briefly summarize what you learned

• Start homework early and work in a group
  • Tackle problems together: brainstorm, plan, and solve together

• Seek help and seek to help others, with integrity
How to excel with integrity

It's an integrity violation to…

• Click in for someone who is absent
• Sign discussion attendance sheet for someone who is absent
• Ask others to give you specific HW or review quiz or test answers
• Share your answers on HW or review quiz or test
• Work on HW with anyone other than your HW partners
• Search the internet or other resources not provided for the class for HW solutions
• Share answers or notes while taking an exam

This not a complete list … you are responsible for knowing and following the guidelines Academic integrity violations will be taken seriously and reported immediately
About this class: Academic integrity

You are working on a homework question with your group members and are stuck on a question. You run into a friend who solved the problem already and shows you her solution. You look at it, but put it away before continuing the group conversation. Is this acceptable?

A. Yes
B. No

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About this class: Academic integrity

You're not sure if you are interpreting a homework problem correctly. You write a post on Piazza explaining your approach to answering it, and asking if this is the correct way to interpret the question. Is this acceptable?

A. Yes
B. No
CSE 105's big questions

• What problems are computers capable of solving?
• What resources are needed to solve a problem?
• Are some problems harder than others?

Making a decision or computing a value based on some input
Questions about algorithms

Are they correct (for given specification)?

Is there a better approach to solving the same problem?

Does each problem have a solution?

If so, can that solution be found by an algorithm?
Questions about algorithms

Are they correct (for given specification)?

\[ \text{CSE 20, 21, 101} \]

Is there a better approach to solving the same problem?

\[ \text{CSE 100, 101, CSE 105: complexity theory} \]

Does each problem have a solution?

\[ \text{CSE 105: computability theory} \]

If so, can that solution be found by an algorithm?

\[ \text{CSE 105: computability theory} \]
Group activity

Goal: find treasure hidden somewhere in grid. Describe an algorithm for each robot.

Do you need to assume anything?
Do you need to keep track of any information?

Robot 1: can move North, East, West, South.
Robot 2: can move in four diagonal directions.
Computer = algorithm?

- Your experience: Java, python, C, etc.
- Other computer models:
  - Quantum computers
  - DNA computation
  - Supercomputers / Datacenters with parallelized and distributed computation
  - Power-sensitive computation for mobile
  - Embedded circuits

Different contexts call for different algorithms + different performance constraints
Bird's eye view of CSE 105

• Pick a model of computation

• Study what problems it can solve

• Prove its limits
Bird's eye view

- Pick a model of computation
- Study what problems it can solve
- Prove its limits

**Classification**: is input of type A or not?
  e.g. is n prime? is list sorted?

**Computation**: for specific input, what value should I output?
  e.g. what's min cost of Hamiltonian tour?
Bird's eye view

• Pick a model of computation
• Study what problems it can solve
• Prove its limits

Classification: is input of type A or not?
Decision problem

Computation: for specific input, what value should I output?
Function problem
Bird's eye view

- Pick a model of computation
- Study what problems it can solve
- Prove its limits

**Classification**: is input of type A or not?
**Decision problem**

**Computation**: for specific input, what value should I output?
**Function problem**
Bird's eye view

- Pick a model of computation
- Study what problems it can solve
- Prove its limits

**Classification**: is input of type A or not? 

**Decision problem**

\[ \{ w \mid w \text{ is of type A}\} \]

PRIME = \{ 2, 3, 5, 7, \ldots \}  
SORTED = \{ <1,3>, <-1, 8, 17> \ldots \}  

Decision problems are coded by sets of strings
Models of computation

- Finite automata
- Context-free grammars
- Turing machines
Models of computation

- Finite automata
- Context-free grammars
- Turing machines
So let's get going 😊

- **Textbook** reference: Chapter 0, Section 1.1
- **Friday**: Discussion section
- **Friday**: Review quiz 1 due; see link on website
- **Monday**: HW1 due 11pm via Gradescope.
Automata

- Text processing
grep, regexp

- Natural language processing

- Hardware design
  Moore machines, Mealy machines: CSE 140

- Controllers / Robots
  SPIS!

Code input as strings
Model memory using states

Fig. 1. Representation of dictionaries by automata.
Example: subway turnstile

• A subway turnstile is locked until a token is entered, at which point it unlocks in response to a single push, after which it locks again.

When you approach the turnstile, will it open?

How can we model this problem as a classification question?
Example: subway turnstile

• A subway turnstile is locked until a token is entered, at which point it unlocks in response to a single push, after which it locks again.

When you approach the turnstile, will it open?

How can we model this problem?

Alphabet: \{token entered, push\}  Input: sequence of moves
Language: \{sequences of moves giving unlocked gate\}
Example: subway turnstile

- A subway turnstile is locked until a token is entered, at which point it unlocks in response to a single push, after which it locks again.
Example: subway turnstile

- A subway turnstile is locked until a token is entered, at which point it unlocks in response, after which it locks again.

What happens if the turnstile is pushed while locked?

A. Transition to unlocked  
B. Stay locked  
C. Send error message  
D. None of the above
Example: subway turnstile

• A subway turnstile is locked until a token is entered, at which point it unlocks in response to a single push, after which it locks again.
Example: subway turnstile

- A subway turnstile is locked until a token is entered, at which point it unlocks in response, after which it locks again.

What's the initial state of the turnstile?

A. Locked
B. Unlocked
Example: subway turnstile

- A subway turnstile is locked until a token is entered, at which point it unlocks in response to a single push, after which it locks again.
Finite automata and decision problems

- Decision problem "is w of type A?" coded by the set
  \[ \{ w \mid w \text{ is of type A} \} \]

A problem is **solved** by a finite automaton if the machine **accepts** all w for which the answer is yes and **rejects** all w for which the answer is no.

Those inputs for which the answer is "yes"
Example: subway turnstile

Problem: Which sequences of moves will unlock turnstile?

Alphabet: \{t, p\}

Language: \{sequences of moves giving unlocked gate\} = \{ t, ppt, \ldots \}
= \{strings over alphabet that, when input to this automaton, end in Unlocked state\}
Vocabulary review

- \{ a,b,c,d,e \}  
  The set whose elements are a, b, c, d, e

- \{ a,b \}  
  The set of finite strings over a, b
  - Includes empty string $\varepsilon$
  - Includes a, aa, aaa
  - Includes b, bb, bbb
  - Includes ab, ababab, aaaaaaabbb
  - Does not include infinite sequences of a's and b's
  - Has infinitely many different elements

- $| ababab | = 6$  
  The length of the string ababab is 6

- $| \{ a,b,c,d,e \} | = 5$  
  The size of the set \{a, b, c, d, e\} is 5

- A **language** (over alphabet $\Sigma$) is a set of strings (over $\Sigma$)
Deterministic Finite automaton

- Input: finite string over a fixed alphabet
- Output: "accept" or "reject"

The language recognized by the machine is the set of strings it accepts.
Deterministic Finite automaton

- **Computation** of the machine on an input string
  Sequence of states in the machine, starting with the initial state, determined by transitions of the machine as it reads additional input symbols.

How does the computation of the machine on a string related to whether the string is accepted by the machine?

A. If the **first state** in the computation is an accept state, the string is accepted.
B. If **any state** in the computation is an accept state, the string is accepted.
C. If the **last state** in the computation is an accept state, the string is accepted.
D. If **all of the states** in the computation are accept states, the string is accepted.
E. None of the above
Finite automaton

- Input: finite string over a fixed alphabet
- Output: "accept" or "reject"

Example input: 0001
Finite automaton

- Input: finite string over a fixed alphabet
- Output: "accept" or "reject"

What is the computation of this machine on input 110?

A. q1, q1, q0
B. q1, q1, q2
C. q0, q1, q2, q3
D. q0, q1, q1, q2
E. None of the above
Finite automaton

- Input: finite string over a fixed alphabet
- Output: "accept" or "reject"

Is the empty string accepted?
Is the string 001 accepted?
Is the string 0011010101010 accepted?

What is the language recognized by this machine?
For next time

• Start Homework 1 **due Monday**
  • Set up course tools: Gradescope, Piazza, JFLAP, haskell
  • Find group members
  • Read all the questions + relevant examples in the book
  • Start working 😊
• Review CSE 20 / Math 109 / CSE 21 / Sipser Ch 0 as needed.