Before we start

If you or someone you know is suffering from **food and/or housing insecurities** the Triton Food Pantry (in the old Student Center),

https://www.facebook.com/tritonfoodpantry/

is free and anonymous, and includes produce.

If you find yourself in an uncomfortable situation, ask for help. We are committed to upholding University policies regarding nondiscrimination, sexual violence and sexual harassment.

OPHD at (858) 534-8298, ophd@ucsd.edu , http://ophd.ucsd.edu.

CARE at Sexual Assault Resource Center at 858 5345793 sarc@ucsd.edu http://care.ucsd.edu

Counseling and Psychological Services (**CAPS**) at 858 5343755 or http://caps.ucsd.edu

Financial aid resources, the possibility of emergency grant funding, and off-campus housing referral resources are available. See CAPS and your college dean.

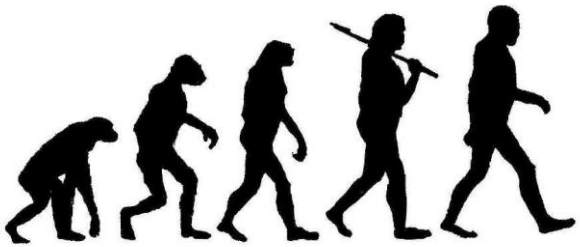
CSE 105
THEORY OF COMPUTATION

"Winter" 2018

http://cseweb.ucsd.edu/classes/wi18/cse105-ab/

Theory of computability

KNOW
LIMITS



Introductions

Clickers

Frequency: 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

When did you take CSE 21?

A. Winter 2017
B. Fall 2016
C. ~~Spring 2016~~ Spring 2017
D. ~~Winter 2016~~ Fall 2017
E. Didn't take it (ever / @ UCSD)

Why use clickers?

About the team

Instructors: Miles Jones and Mia Minnes

CSE 4208: office hours Wed. 10 – 12.

Best way to get in touch is via Piazza

- Public post: question about class policy, notes, etc.
- Private post: question about your HW submission, grading, special circumstances.
- Emails:
  - mej016@eng.ucsd.edu
  - minnes@eng.ucsd.edu

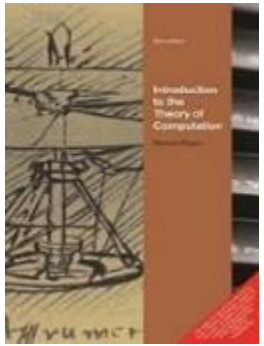
Logistics

Weekly activities:
Pre-class reading + Class + Review Quiz + Individual HW + Discussion section + Group HW

Individual HW: no collaboration; graded mostly for **completion** (one Q for correctness)
Group HW: graded for **correctness**, work with up to two others, builds on Individual HW

Discussion sections: Tuesday "Depth" ; Thursday "Breadth"
one hour 3 hours.

Exams: **Wednesday** February 7, in class
Friday March 2, in class
Final Exam **Saturday** March 17 11:30am-2:29pm
No makeup exams



Gradescope: Homework submission, exam return, interim reports
Piazza: announcements and Q&A, homework solutions
Office hours: drop-in (on Google calendar) + one-on-one

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

Frequency: AB

To change your remote frequency
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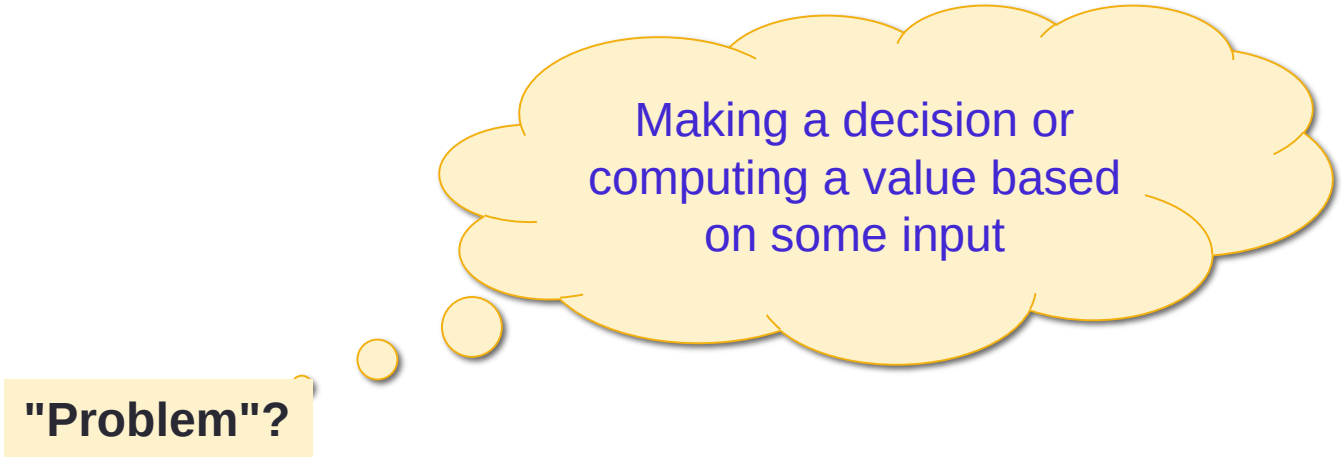
CSE 105's big questions

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

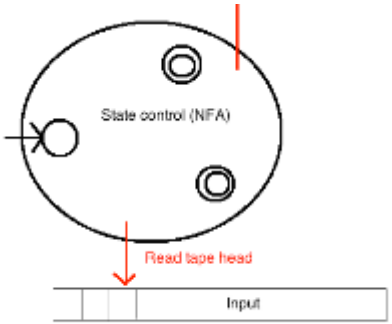


Computational problems

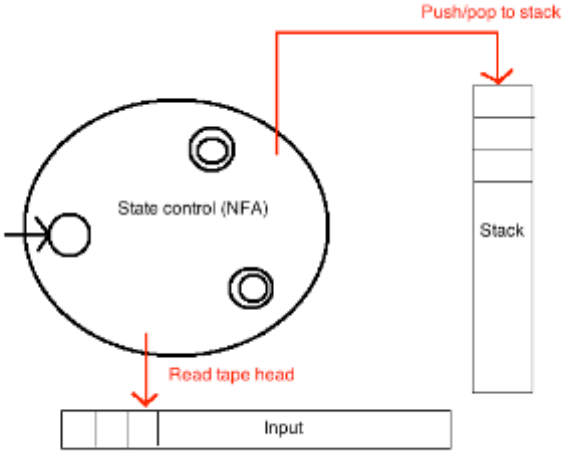
- Find a file on your computer
- Determine if your code will compile
- Find a run-time error in your code
- Certify that your system is un-hackable

Which of these is hardest?

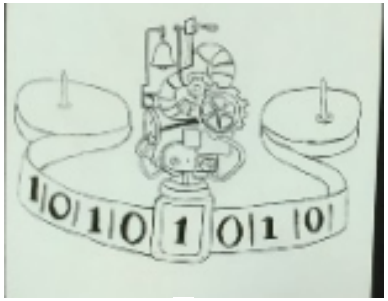
Hardest = uses more resources



Finite automata



Pushdown automata



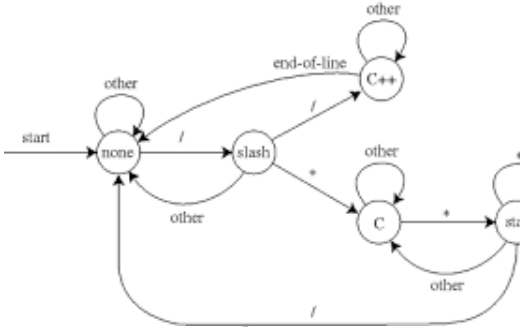
Turing machine

Simplest computations

- Text processing

  grep, regexp

- Tokenizing



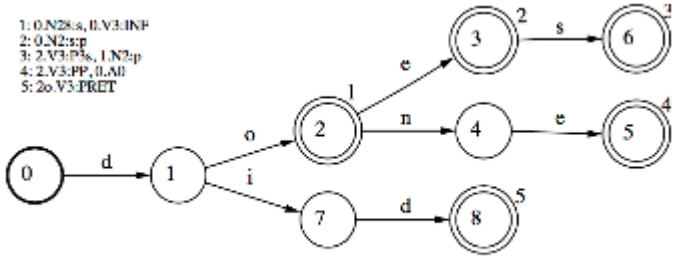


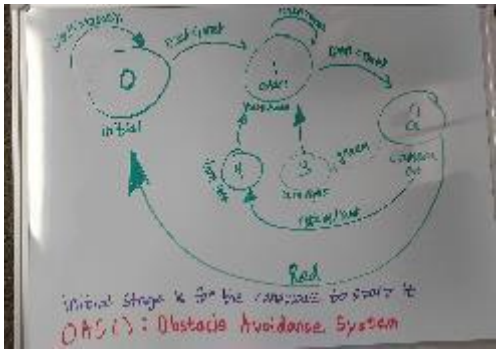
Fig. 1. Representation of dictionaries by automata.

- Natural language processing
- Hardware design

  Moore machines, Mealy machines: CSE 140

- Controllers / Robots

  SPIS!



Model

- Input: string
- Output: yes/no

does this string belong to a certain set of strings L

language.

When do we output yes?

For input strings that match a specific pattern.

Vocabulary review

From CSE20, etc. Sipser p. 14

- { 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 ε
  - 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 Σ) is a set of strings (over Σ)

{ab, cc}* = { ε, ab, cc, abab, ccab, cccc, ... }

Build up from simplest patterns

Alphabet here is {0,1}

- ∅
- {ε}
- { 001, 110 }

- { 0,1 }*

Regular expressions give us syntax to describe languages.

Regular expression

Sipser 1.52 p. 64

R is a **regular expression** over the alphabet Σ if

1. $R = a$, where $a \in \Sigma$
2. $R = \varepsilon$
3. $R = \emptyset$
4. $R = (R_1 \cup R_2)$, where R_1, R_2 are themselves regular expressions
5. $R = (R_1 \circ R_2)$, where R_1, R_2 are themselves regular expressions
6. (R_1^*), where R_1 is a regular expression.

$R_1 R_2$

Σ is shorthand for (0 U 1) if Σ = {0,1}, Parentheses may be omitted, R^+ means RR^*, R^k means R concatenated with itself k times

Regular expression

Sipser 1.52 p. 64

Which languages are described by each of these regular expressions?

1. $R = a$, where $a \in \Sigma$
2. $R = \varepsilon$
3. $R = \emptyset$
4. $R = (R_1 \cup R_2)$
5. $R = (R_1 \circ R_2)$
6. (R_1^*)

Examples

$\Sigma = \{0, 1\}$

1. $R = a$, where $a \in \Sigma$
2. $R = \varepsilon$
3. $R = \emptyset$
4. $R = (R_1 \cup R_2)$
5. $R = (R_1 \circ R_2)$
6. (R_1^*)

- L ($(0 \cup 1) \cup 1$) = { $= \{0,1\} \cup \{1\}$ $0, 1$ }
- L ($(\Sigma\Sigma\Sigma\Sigma)^*$) = { $w \in \{0,1\}^* \mid |w| = 4k$ for $k \in \mathbb{N}$ }
- L ($1^*\emptyset 0$) = { }

A more complicated example

Which of the following strings is **not** in the language described by

$$(\quad (\,(00)^*(11)\,)\;\; U \;\; 01 \quad)^*$$

A. 00
B. 01
C. 1101
D. ε
E. I don't know

And another …

Let L be the language over {a,b} described by the regular expression

$$((a \cup \emptyset)\, b^*)^*$$

Which of the following is **not** true about L?

A. Some strings in L have equal numbers of a's and b's
B. L contains the string aaaaaa
C. a's never follow b's in any string in L
D. L can also be represented by the regular expression $(ab^*)^*$
E. More than one of the above.

Regular expressions in practice

- **Compilers**: first phase of compiling transforms Strings to Tokens keywords, operators, identifiers, literals
  - One regular expression for each token type

- **Other software tools**: grep, Perl, Python, Java, Ruby, …

For next time

- Start Individual Homework 0 **due Saturday**
  - Set up course tools: *Gradescope*, Piazza
  - Read all the questions + relevant examples in the book
  - Start working ☺
  - *Review CSE 20 / Math 109 / CSE 21 / Sipser Ch 0 as needed.*
- Discussion section Tuesday **"Depth"**
  - Review lecture material and Chapter 0.

Pre class-reading for Friday: Figure 1.4, Definition 1.5