Welcome back to CS 42!

Grab a yellow piece of paper.
Write your name, the date, and an answer to the question:

How can you tell whether a binary number is odd?

Come up with the clearest, briefest description you can.

Bonus question: what makes for a “good” Picobot program?
Quick binary refresher

A **bit** is a binary digit: 0 or 1.

A **bitstring** is a sequence of zero or more bits.

We can assign a **numeric value** to non-empty bit strings.

\[
\begin{array}{cccccccc}
0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\
2^7 & 2^6 & 2^5 & 2^4 & 2^3 & 2^2 & 2^1 & 2^0 \\
128 & 64 & 32 & 16 & 8 & 4 & 2 & 1 \\
32 & + & 8 & + & 2 & = & 42 \\
\end{array}
\]
Where are we?

We want to come up with a precise definition for the word *computer*. 
What is Computer Science?

Not a definitive definition!

Computer Science is the study of how we can automate our ability to generate, transform, store, and retrieve information.
What does Computer Science study?

Given a problem

Is there a solution?

What is it?

How good is it?
What does Computer Science study?

Given a problem

Is there a solution?

What is it?

How good is it?

What do we mean by “problem”?

Theory of computation
What do we mean by “problem”?

A problem is a question that we can write down and give to a computer, which can give us an answer.
What is a computer?
write down a definition that’s free of jargon
What is a computer?

Not a definitive definition! But it is up-goer-five-approved!

It is a computer if:

1. I can ask it a question, by using words or numbers (or so on).
2. It then acts all on its own to come up with an answer to my question.
3. It can tell me the answer.

Key features: data + automatic behavior
Is Picobot a computer?
Unifying idea: States & Transitions

**state**: all the internal information needed to take the next step

**transition**: change state (based on input)
State machines

think of each state as a subtask

\[
\begin{align*}
0 \text{x***} & \rightarrow N 0 \\
0 \text{N***} & \rightarrow X 1 \\
1 \text{***x} & \rightarrow S 1 \\
1 \text{***S} & \rightarrow X 0
\end{align*}
\]
Common vocabulary for state machines

computer scientists say

Deterministic Finite Automaton (DFA)

deterministic: each state has one (and only one) transition for each possible input character.

finite: there are a finite number of states.

automaton: it operates under its own power.

engineers say

Finite State Machine (FSM)

"accepting" state (double circle)

We’ll use both “DFA” and “FSM”, interchangeably.
DFAs are a model of computation

A model of computation is:
a precise definition of how automated behavior (i.e., computation) acts on data.
DFAs are a model of computation

For DFAs:

The data are bitstrings.

The computation proceeds as follows:

A state machine starts in an initial state.

It consumes the input one bit at a time, taking transitions as required.

The machine stops when the input is empty.

The machine then accepts or rejects, based on its final state.
DFAs describe a language, i.e., a set of (bit) strings

it’s all the inputs accepted by the DFA

What language is described by this DFA?

$L = \{\lambda, 0, 00, 000, \ldots\}$

$L = \{w | w \text{ has no 1s}\}$
Draw these DFAs

It's okay if you don't finish all of them.

(1) \( L = \{ w | \text{the third bit in } w \text{ is a } 1 \} \)

(2) \( L = \{ w | \text{the number of } 0 \text{s in } w \text{ is a multiple of 3} \} \)

Write test cases first!!!!
At least three strings accepted by the DFA.
At least three strings rejected by the DFA.
Write test cases first!!!!
At least three strings accepted by the DFA.
At least three strings rejected by the DFA.
(2) $L = \{ w \mid$ the number of 0s in $w$ is a multiple of 3$\}$

Write test cases first!!!!
At least three strings **accepted** by the DFA.
At least three strings **rejected** by the DFA.
What does Computer Science study?

Given a problem
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What does Computer Science study?

CS 42 in one slide

Given a problem

Is there a solution?

What is it?

How good is it?
What makes for a “good” FSM?
Volkswagen Emissions Cheat Exploited 'Test Mode'

One key part of the unfolding Volkswagen emissions cheating was in two different modes: "On Road" and "Test Mode".

The 482,000 Volkswagen and Audi cars are equipped with software that can switch between five and 20 miles per hour between five and 20 miles per hour, according to U.S. authorities.

Volkswagen's emissions cheating likely caused dozens of deaths in the US

By Seth Borenstein, Associated Press

WASHINGTON (AP) — Volkswagen's pollution-cheating software has killed hundreds of innocent Americans, the president of the country's largest environmental group said Monday, adding to the international scandal over the German automaker's emissions.

Volkswagen HQ raided by German police

By Irene Chapple and Mark Thompson @CNNMoney

Rupert Murdoch: Ben Carson would be a 'real black president'
HW 0

Due next Tuesday at 11:59pm

- Create some FSMs in JFLAP
- Use the Distinguishability Theorem
- Turn things in using the submission system.
  - username:
  - default password:

be sure to change your password!