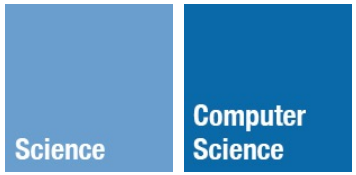
Solving Problems in CS



CS 100: Introduction to the Profession

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Day 1 takeaway: CS is about *solving problems*

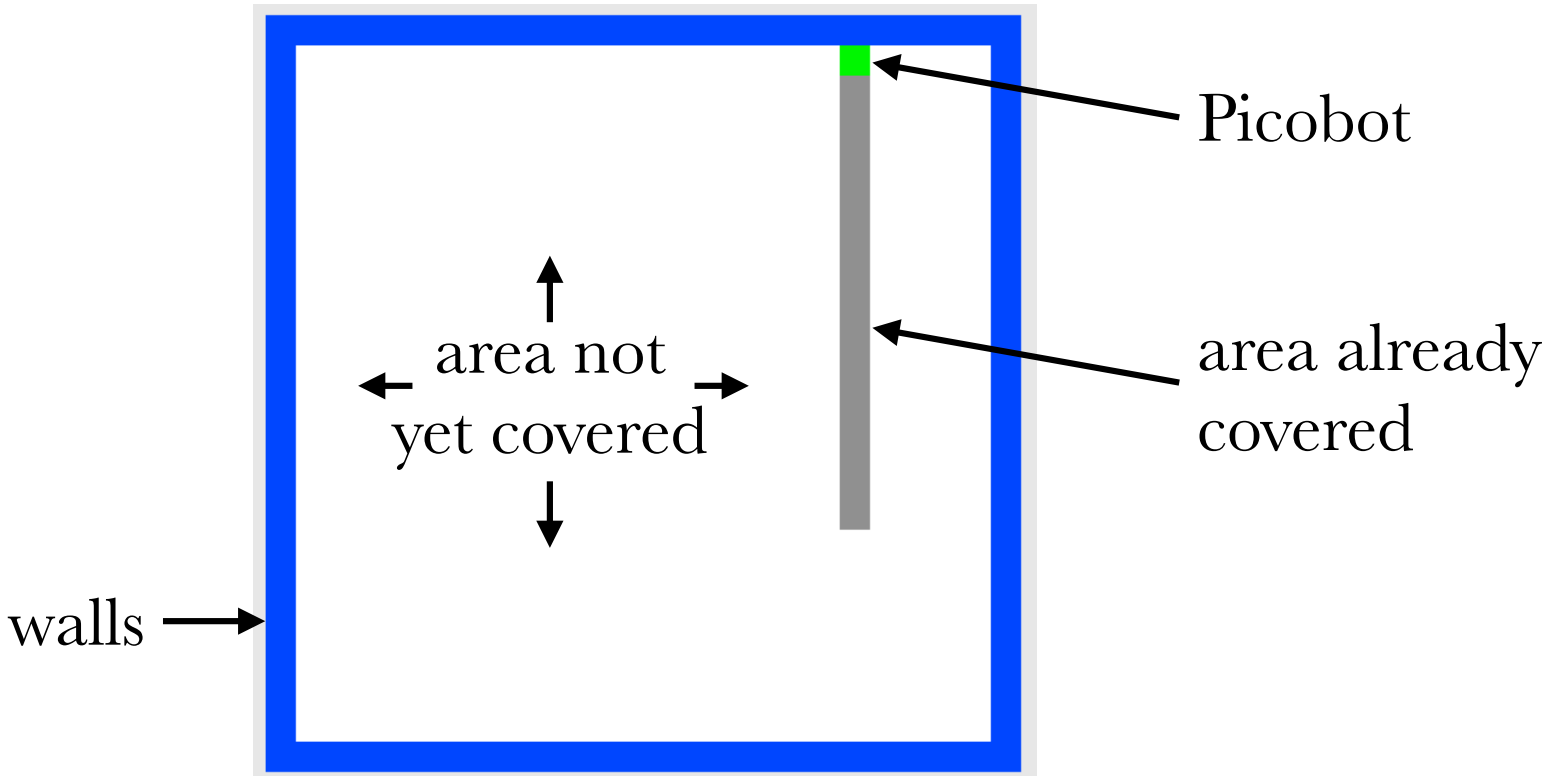
- *What* problems?
- How to *represent* these problems?
- How *efficiently* can we solve them?
- Is it *possible* to solve them?

What problems?

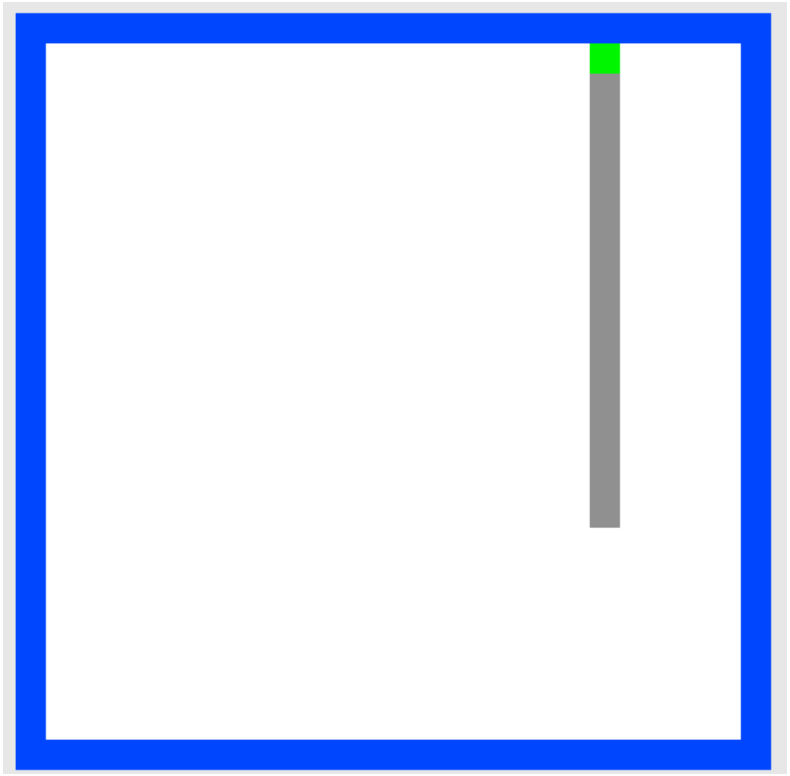
- *theoretical* CS: mathematical/abstract
  - e.g., if we can verify the solution to a given problem quickly, can we also solve it quickly? (aka P=NP?)
- *applied* CS: real-world problems
  - e.g., can we get a robot to reliably explore every corner of a room?

How to *represent* these problems?

- i.e., so that a computer can be used to can automate their solutions
- typically many possible representations
  - choice may be limited by real-world constraints!



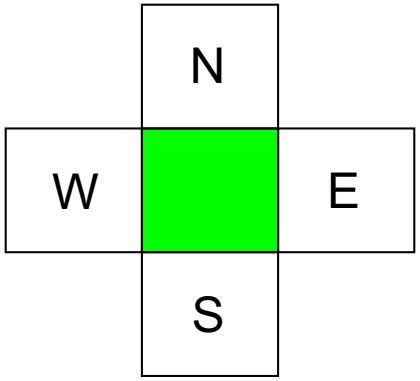
Picobot implementation by, and figures adapted from
Zach Dodds and Wynn Vonnegut, Harvey Mudd College



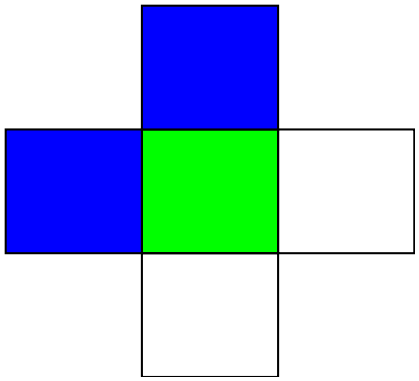
What does the bot need to sense/remember in order to fully explore the room?

So many options!

- our goal: only *local sensing*
  - i.e., immediate surroundings only
  - minimizes hardware cost



Picobot can only sense things directly to the N, E, W, and S

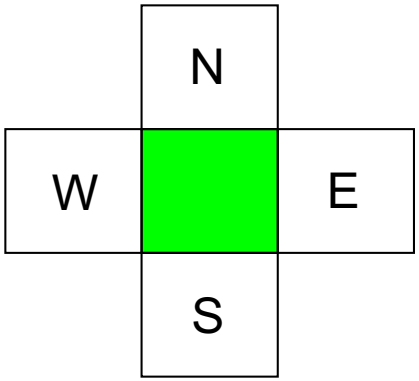


E.g., N and W are obstructed, while E and S are clear

Nx**W**x

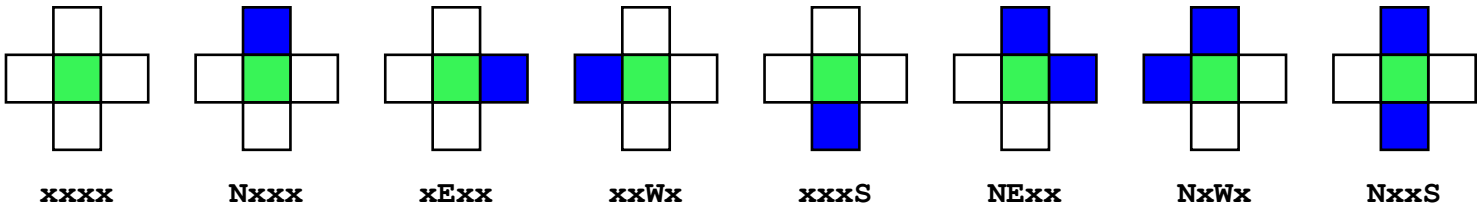
N E W S

Surroundings are always in NEWS order.



How many possible surroundings?

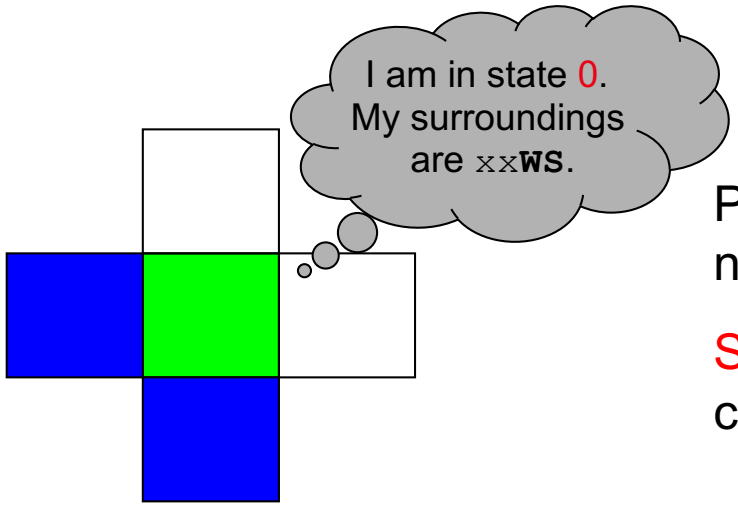
Answer: $2^4 = 16$



In addition to its sensors, Picobot also has:

1. knowledge of its *current state*
2. a *list of rules* (its program) dictating movement and state transitions based on its current state and surroundings

State

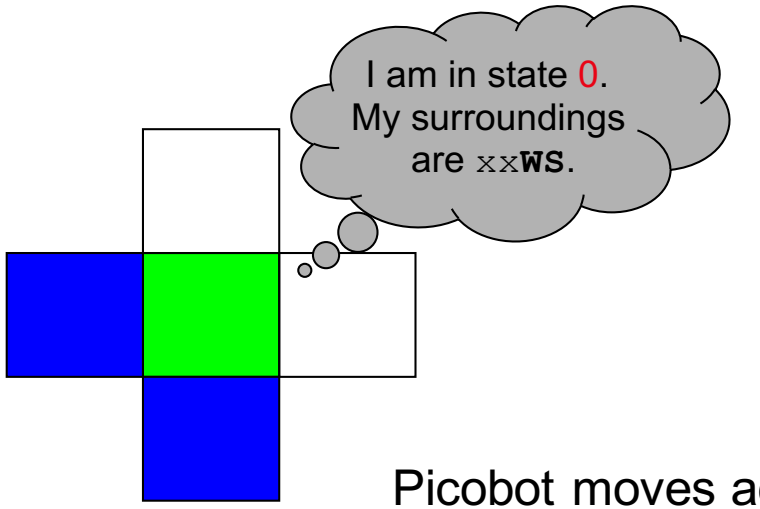


Picobot's memory is a single number, called its state.

State is the *internal context* of computation.

Picobot always starts in state 0.

Rules



Aha!
I should move N.
I should enter state 0.

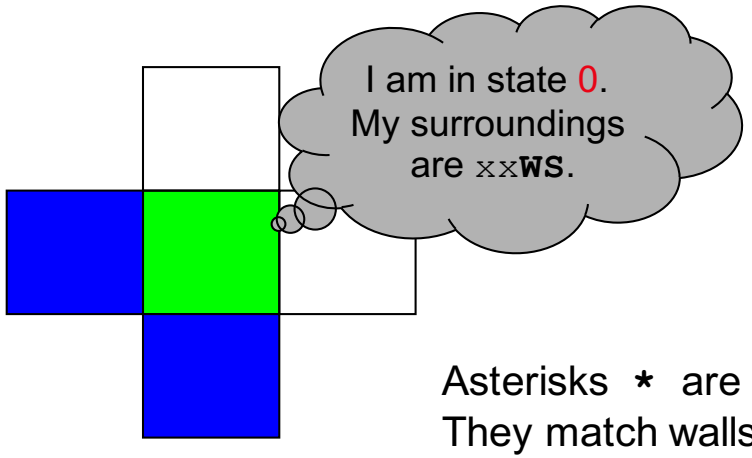
Picobot moves according to a set of rules:

state	surroundings		direction	new state
0	xx**WS**	→	N	0

If I'm in state 0
seeing xx**WS**,

Then I move **N***orth, and*
change to state 0.

Wildcards



Aha! This matches x***

Asterisks * are wild cards.
They match walls ***or*** empty space:

state	surroundings		direction	new state
0	x***	→	N	0

here, EWS may be wall or empty space

What will this set of rules do to Picobot?

state	surroundings		direction	new state
0	`x***`	->	N	0
0	`N***`	->	X	1
1	`***x`	->	S	1
1	`***S`	->	X	0

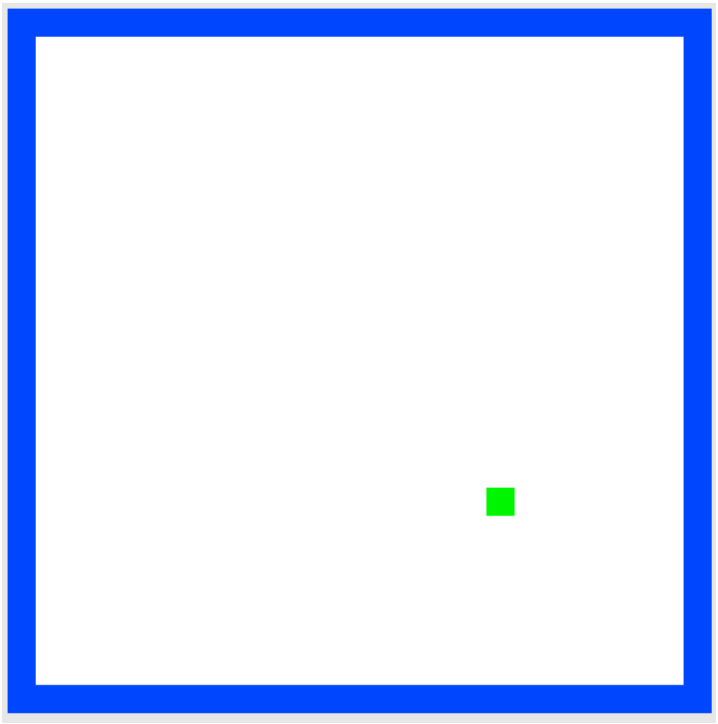
Picobot checks its rules from the top each time.

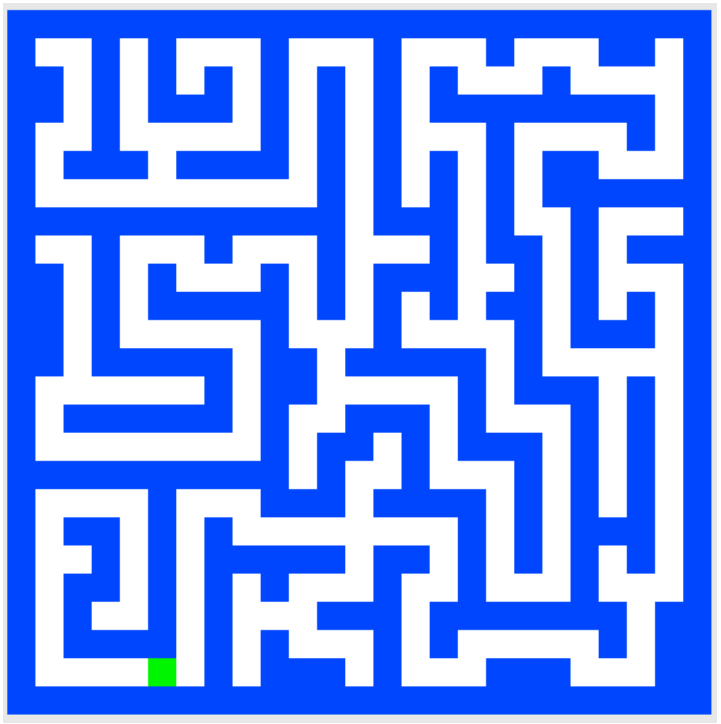
When it finds a matching rule, that rule runs.

Only one rule is allowed per state and surroundings.

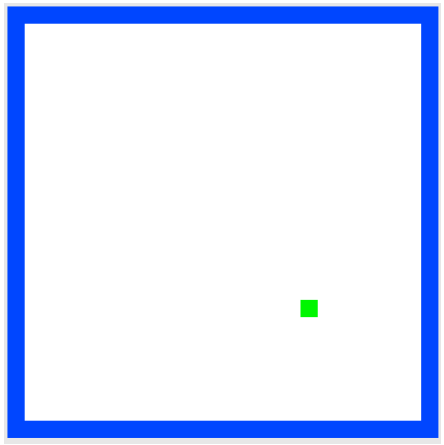
How *efficiently* can we solve them?

- how long does it take a computer to solve increasingly harder versions of the same problem?

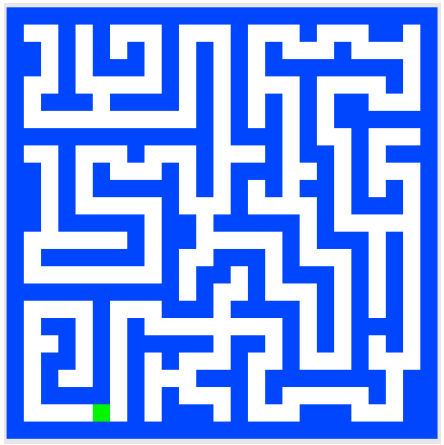




- What is the *minimum number* of states and rules to traverse each room?



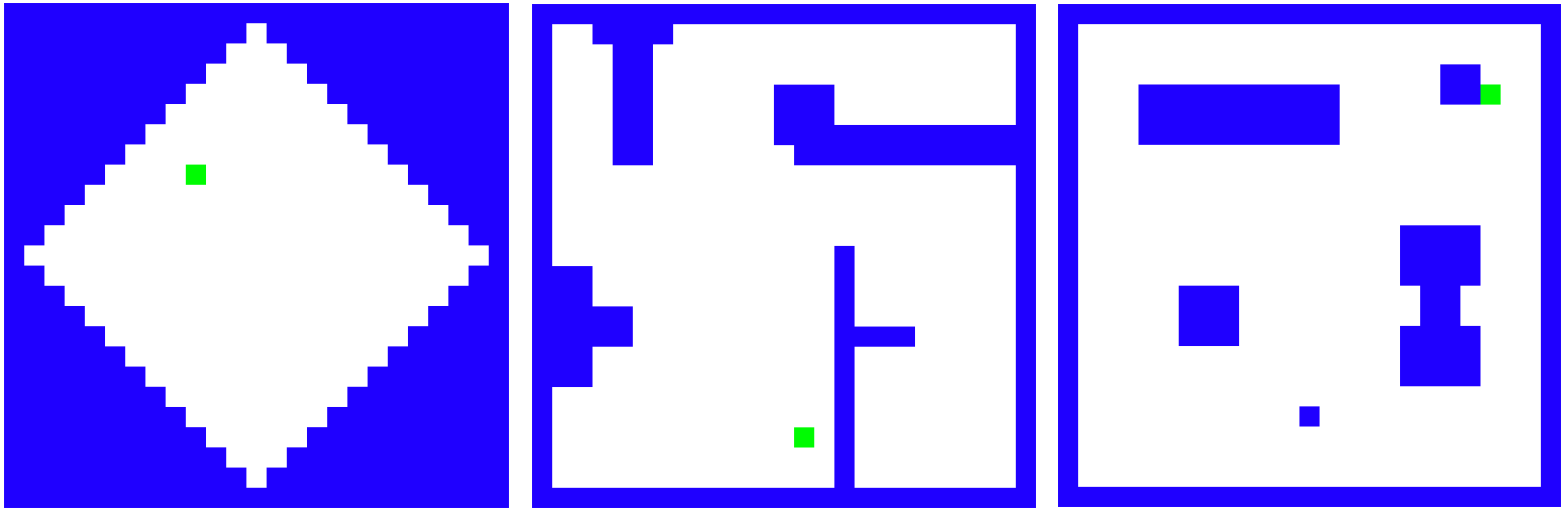
our best: 3 states, 7 rules



our best: 4 states, 8 rules

Is it *possible* to solve them?

- given a problem and its chosen representation, can we automatically solve *every instance of it in finite time*?



- Can you write a set of rules to traverse every possible room?
- How would you measure the complexity of a given room?

Have fun!

When you've solved the first two rooms, create a "secret gist" containing your rules and submit it via the form on the website.

Try solving the harder rooms, if you want!