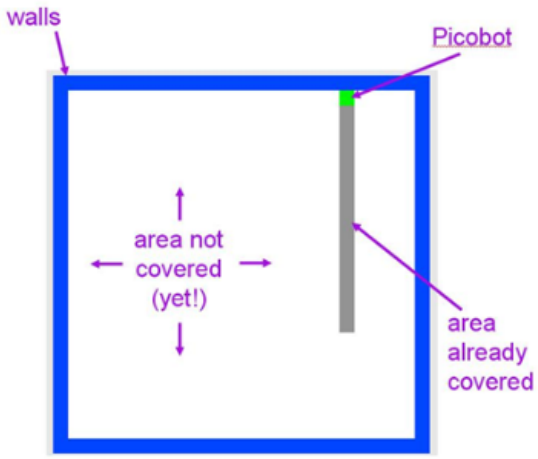
Picobot starts at a *random* location in a room — you don't have control over Picobot's initial location. The walls of the room are blue; picobot is green, and the empty area is white. Each time picobot takes a step, it leaves a grey trail behind it. When Picobot has completely explored its environment, it stops automatically.

- picobot overview:



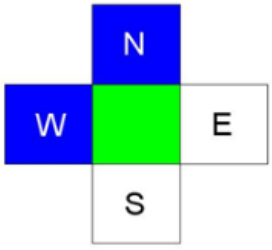
Goal: whole-environment coverage with only *local sensing…*

Apr 24-8:28 AM

Surroundings

Not surprisingly, picobot has limited sensing power. It can only sense its surroundings immediately to the north, east, west, and south of it. For example,

- example picobot surroundings:



Here, picobot's surroundings are

NxWx

N E W S

Surroundings are always in NEWS order.

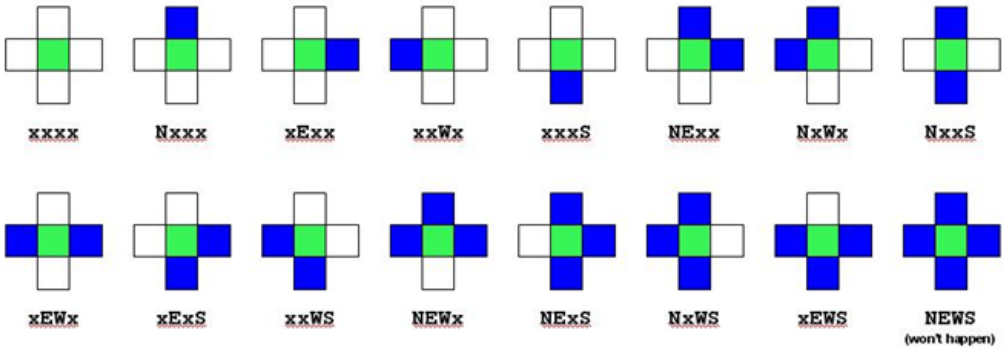
In the above image, Picobot sees a wall to the north and west and it sees nothing to the east or south. This set of surroundings would be represented as follows:

```
NxWx
```

The four squares surrounding picobot are always considered in NEWS order: an `x` represents empty space, the appropriate direction letter (`N`, `E`, `W`, and `S`) represents a wall blocking that direction. Here are all of the possible picobot surroundings:

Apr 24-8:29 AM

- all possible picobot surroundings:



Apr 24-8:29 AM

State

Picobot's memory is also limited. In fact, it has only a single value from 0 to 99 available to it. This number is called picobot's ***state***. In general, "state" refers to the relevant context in which computation takes place. Here, you might think of each "state" as one piece — or behavior — that the robot uses to achieve its overall goal. Picobot always begins in state 0. The state and the surroundings are all the information that picobot has available to make its decisions!

Rules

Picobot moves according to a set of rules of the form

```
StateNow   Surroundings   ->   MoveDirection   NewState
```

For example,

```
  0   xxxS   ->   N   0
```

is a rule that says "if picobot starts in state `0` and sees the surroundings `xxxS`, it should move `N`orth and stay in state `0`." The `MoveDirection` can be `N`, `E`, `W`, `S`, or `X`, representing the direction to move or, in the case of `X`, the choice not to move at all. If this were picobot's only rule and if picobot began (in state `0`) at the bottom of an empty room, it would move up (north) one square and stay in state `0`. However, **picobot would not move any further**, because its surroundings would have changed to `xxxx`, which does not match the rule above.

Apr 24-8:29 AM

Wildcards

The asterisk * can be used inside surroundings to mean "I don't care whether there is a wall or not in that position." For example, xE** means "there is no wall North, there ***is*** a wall to the East, and there may or may not be a wall to the West or South." As an example, the rule

```
0   x***   ->   N   0
```

is a rule that says "if picobot starts in state 0 and sees ***any surroundings without a wall to the North***, it should move North and stay in state 0." If this new version (with wildcard asterisks) were picobot's only rule and if picobot began (in state 0) at the bottom of an empty room, it would first see surroundings xxxS. These match the above rule, so picobot would move North and stay in state 0. Then, its surroundings would be xxxx. These ***also*** match the above rule, so picobot would again move North and stay in state 0. In fact, this process would continue until it hit the "top" of the room, when the surroundings Nxxx no longer match the above rule.

Comments

Anything after the pound sign (#) on a line is a comment (as in python). Comments are human-readable explanations of what is going on, but ignored by picobot. Blank lines are ignored as well.

Apr 24-8:29 AM

An example

Consider the following set of rules:

```
# state 0 goes N as far as possible
0 x*** -> N 0   # if there's nothing to the N, go N
0 N*** -> X 1   # if N is blocked, switch to state 1

# state 1 goes S as far as possible
1 ***x -> S 1   # if there's nothing to the S, go S
1 ***S -> X 0   # otherwise, switch to state 0
```

Recall that picobot always starts in state 0. Picobot now consults the rules and uses the rule that applies to make its move and enter its next state. It then starts all over again, looks at the rules and finds the one that applies. In this case, picobot will follow the first rule up to the "top" of its environment, moving north and staying in state 0 the whole time. Eventually, it encounters a wall to its north. At this point, the topmost rule no longer applies. However, the next rule "0 N*** -> X 1" does apply now! So, picobot uses this rule which causes it to stay put (due to the "X") and ***switch to state 1***. Now that it is in state 1, neither of the first two rules will apply. Picobot follows state 1's rules, which guide it back to the "bottom" of its environment. And so it continues...

Note: if more that one rule applies at any one time, picobot complains and halts.

Apr 24-8:30 AM

The assignment

For this assignment, your task is to design two different sets of picobot rules:

- **hw 0, problem 3**: one set that will allow picobot to completely cover an empty square room

  Remember to click on the "Enter rules for Picobot" before you try to run picobot. Remember also to submit your solution by copying and pasting the Picobot code to a file named hw0pr3.txt and uploading it to Moodle! We recommend that you paste the code into the idle3.1 editor then save the file.

- **hw 0, problem 4**: another set that will allow picobot to completely navigate a connected maze (without loops) with corridors one square wide

  Remember to click on the "Enter rules for Picobot" before you try to run picobot. Remember also to submit your solution by copying and pasting the Picobot code to a file named hw0pr4.txt and uploading it to Moodle! We recommend that you paste the code into the idle3.1 editor then save the file.

Remember that your solutions must work from arbitrary starting positions within the environment.

Apr 24-8:30 AM

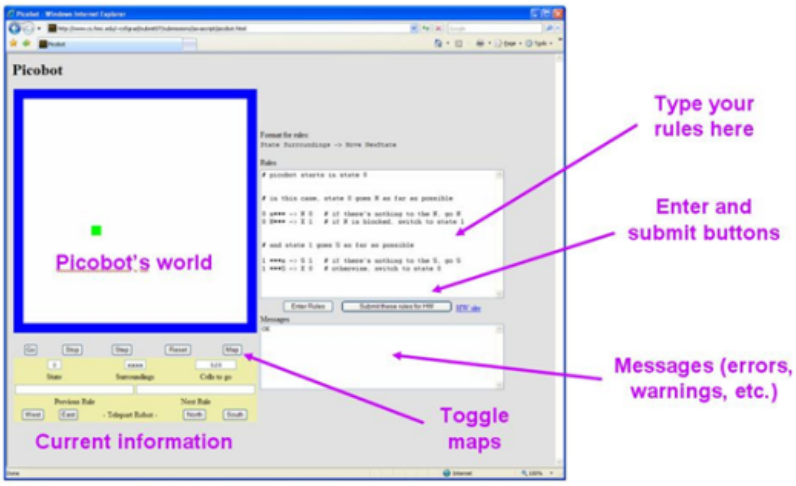
Optional extra credit

At heart, CS fundamentally tries to answer questions of complexity: to show that problems are easier than initially thought — or, sometimes, to prove that they ***can't*** be handled with fewer resources. You might think about how *efficient* your solutions are — both in terms of the number of states used and in terms of the number of rules. There are other ways to measure efficiency as well (e.g., speed). For optional extra credit, try to create as efficient a solution as possible for the maze-solving set of rules. That is,

- for problem 3 (the empty room), see if you can use *only 6 rules* [+3 points]
- for problem 4 (the maze), see if you can use *only 8 rules* [+5 points]
- for problem 5, [+5 points] submit the "stalactite room" in any number of rules:

Apr 24-8:30 AM

The following is an overview of the pieces of the Picobot (Bucknell's version does not have a **Submit** button!):



Apr 24-8:30 AM