The CS5 Times

Eager Penguins Invade Computer Lab

Claremont (AP): The first-day offering of Harvey Mudd’s popular CS5 laboratory was disrupted when a large flock of penguins took every seat in the room. “They’re cute,” complained a distraught student, “but they smell like fish and there’s no room for us.”

Professors attempted to drive the penguins away by repeatedly shouting “Shark!”, but the penguins were unmoved.

Handouts (read them all!):
- Today’s lecture notes
- A preprinted blank "worksheet"

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Overview

Weeks 1-3: Thinking functionally
Weeks 4-6: Computer organization
Weeks 7-10: Oops! (Object oriented programs)
Weeks 11-14: Theoretical foundations

Capstone Project!

14 weeks of action-packed excitement!
Python

• Relatively “nice” syntax
• Emerging as language of choice in many fields
• Packages for graphics, audio, scientific computing, …
Some Things You’ll Do This Semester…

**Sequence alignment**

**ATTATCG**
**ACATTC**

Distance is 4
**ATTAT-CG**
**A-CATTC-C**

**ATTATCG** $\rightarrow$ Delete T
**A TATCG** $\rightarrow$ Change T to C
**A CAT_CG** $\rightarrow$ Insert T here
**A CATTCG** $\rightarrow$ Delete G
**A CATTC**
Spel Cheking...
Connect 4 AI
**Picobot!**

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

This language is not Turing-Complete. I guess that makes it “unreasonable”!

**Reading:** Chapter 1 in the book [http://www.cs.hmc.edu/csforall/](http://www.cs.hmc.edu/csforall/)
Environment in the NEWS!

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

For example, here its surroundings are

\[
\begin{array}{ccc}
N & x & W \\
W & E & X \\
S & & \\
\end{array}
\]

Surroundings are always in NEWS order.
Surroundings

How many distinct surroundings are there?

W E
N S
State

Picobot's memory is a single number, called its state. State is the *internal context* of computation.

Picobot always starts in state 0.

*State* and *surroundings* represent everything the robot knows about the world.
Picobot moves according to a set of rules:

<table>
<thead>
<tr>
<th>state</th>
<th>surroundings</th>
<th>direction</th>
<th>new state</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>xxWS</td>
<td>N</td>
<td>0</td>
</tr>
</tbody>
</table>

If I'm in state 0 seeing xxWS,

Then I move North, and change to state 0.
Wildcards

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

I am in state 0. My surroundings are xxWS.

Aha! This matches x***

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

<table>
<thead>
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<th>direction</th>
<th>new state</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>x***</td>
<td>N</td>
<td>0</td>
</tr>
</tbody>
</table>

and EWS may be wall or empty space

N must be empty
What Will This Set of Rules Do to Picobot?

<table>
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<tr>
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<th>surroundings</th>
<th>direction</th>
<th>new state</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>x***</td>
<td>-&gt;</td>
<td>N</td>
</tr>
<tr>
<td>0</td>
<td>N***</td>
<td>-&gt;</td>
<td>X</td>
</tr>
</tbody>
</table>

Add some code here to make Picobot go up and down in the same column forever!

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.
This Week!

Write rules that will always cover these two rooms. *(separate* sets of rules are encouraged…*)

**Lab Problem**

Your “program” can be slow but it should work for any starting location and for any wall-connected maze!

**Problem 2**

*DEMO!*

*our best:* 3 states, 7 rules (but Cam Zhou had 6)  
*our best:* 4 states, 8 rules
What’s the Point?

• **Simple syntax can support “powerful” computation:** The picobot language syntax is very simple, yet it can control a robot in a complex environment.

• **Computer scientists examine limitations of languages:**
  - Are there environments that the picobot language cannot navigate?
  - If so, what features could be added to give the language more “power”?
How About “General” Rooms?

Picobot has 100 states, but the “room” could be arbitrarily big and weird!
Python and the Command Line

```python
bow:2:1169> python3
Python 3.4.5 (default, Jul 03 2016, 13:32:18) [GCC] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> "Hello, world"
'Hello, world'
>>> 7*6
42
>>> import math
>>> math.pi
3.141592653589793
>>> equator = 40000 / 1.609
>>> equator / pi / 2
Traceback (most recent call last):
  File "<stdin>" , line 1, in <module>
NameError: name 'pi' is not defined
>>> equator / math.pi / 2
3956.6176032789394
>>> from math import pi
>>> equator / pi
7913.235206557879
>>> quit()
bow:2:1170
```

Python makes it easy to experiment!
Defining Your Own Functions!

```python
def dbl(x):
    return 2 * x
```

Notice the indentation. This is done using "tab" and it's absolutely necessary!

Sublime often indents for you!

"Outdent" with shift-tab!
def dbl(x):
    """This function takes a number x and returns 2 * x"""
    return 2 * x
Composition of Functions

def quad(x):
    return 4 * x

Doubly cool!

def quad(x):
    return dbl(dbl(x))
# myFunc
# Author: Ran Libeskind-Hadas
# Date: August 27, 2011

def myFunc(x, y):
    """returns x + 42 * y""
    return x + 42 * y
CS5 Black Worksheet

Name: ____________________________________________

Date: ____________________________________________

• Your name (that you prefer to use in class)

• Your pronouns:

• What do you like to do for fun?

• Something you want me to know about you: