



Telling a robot how to behave

Adam Finkelstein
COS 116: Spring 2010



Today: Understanding a simple robot

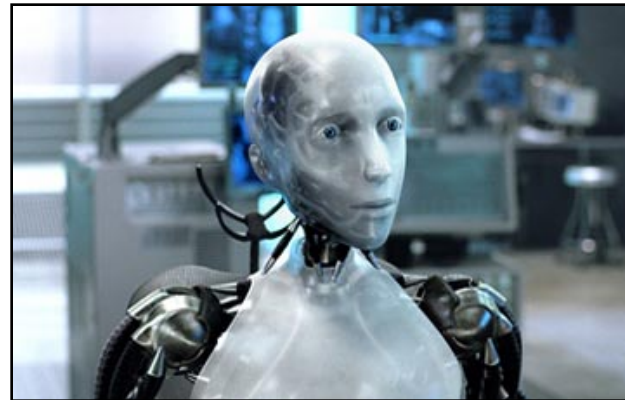
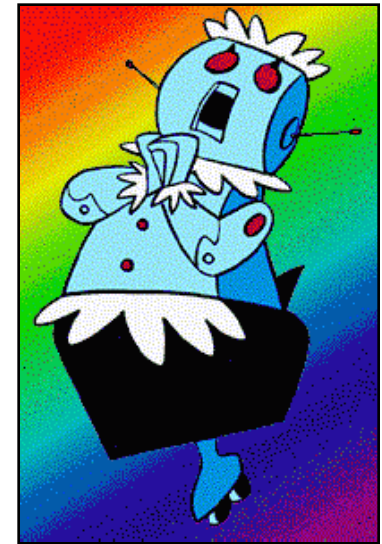
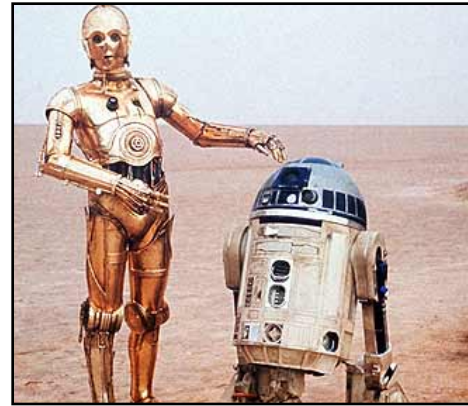
Why?

- Larger goal: seek an answer to

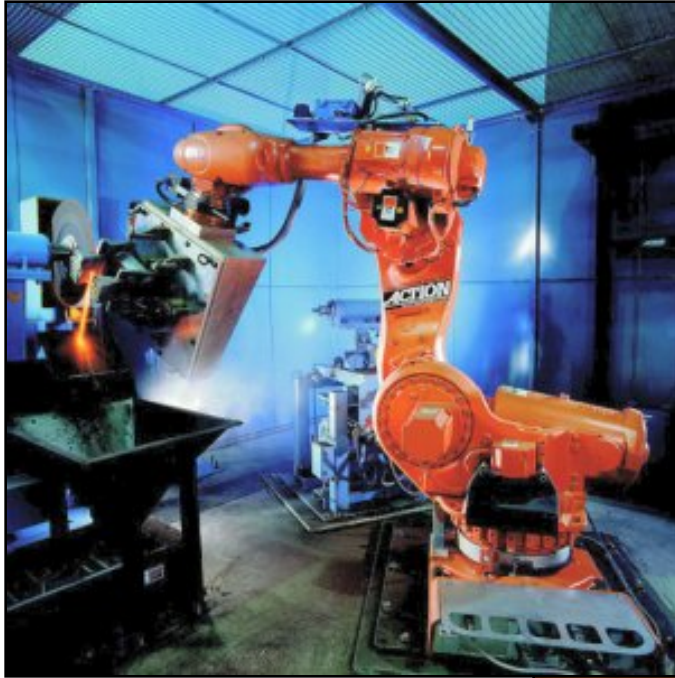
“What is Computation?”

- Acquire insight into technology that will become pervasive within the next decade.
- First encounter with many themes of the course.

Robots in culture

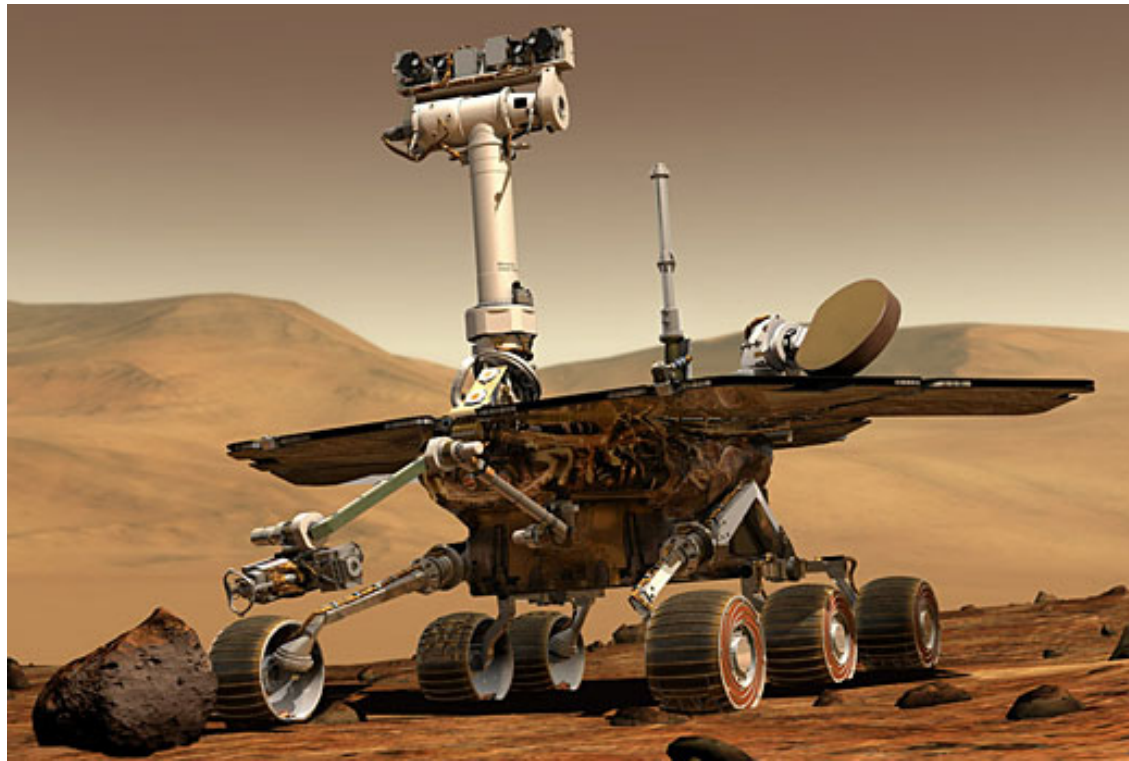


Real robots



Discussion...

- Mars rover: what are the design principles?





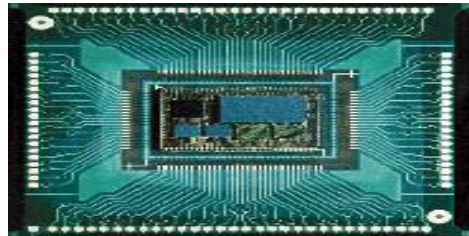
Definition of “Robot”:

- A machine that can be programmed to interact with the physical environment in a desired way
- Key word: *programmed*
 - As opposed to cars, televisions, which are operated by people

Components of a robot

Three stages:

1. Sensors/Inputs: light, sound, motion...



Computing Hardware



3. Outputs/Actions: motors, lights, speakers...

Our robot: Scribbler

Stall sensor

Inputs

button

Outputs

Speaker



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Light sensors

Obstacle sensor emitter

Line sensor (underneath)

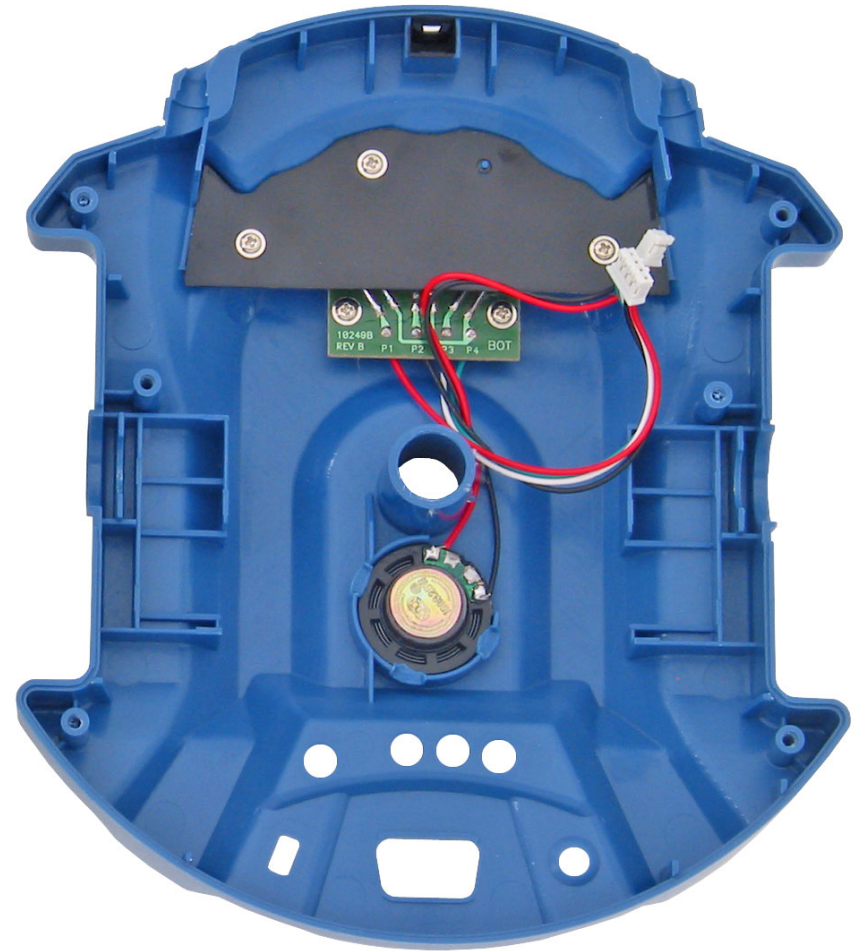
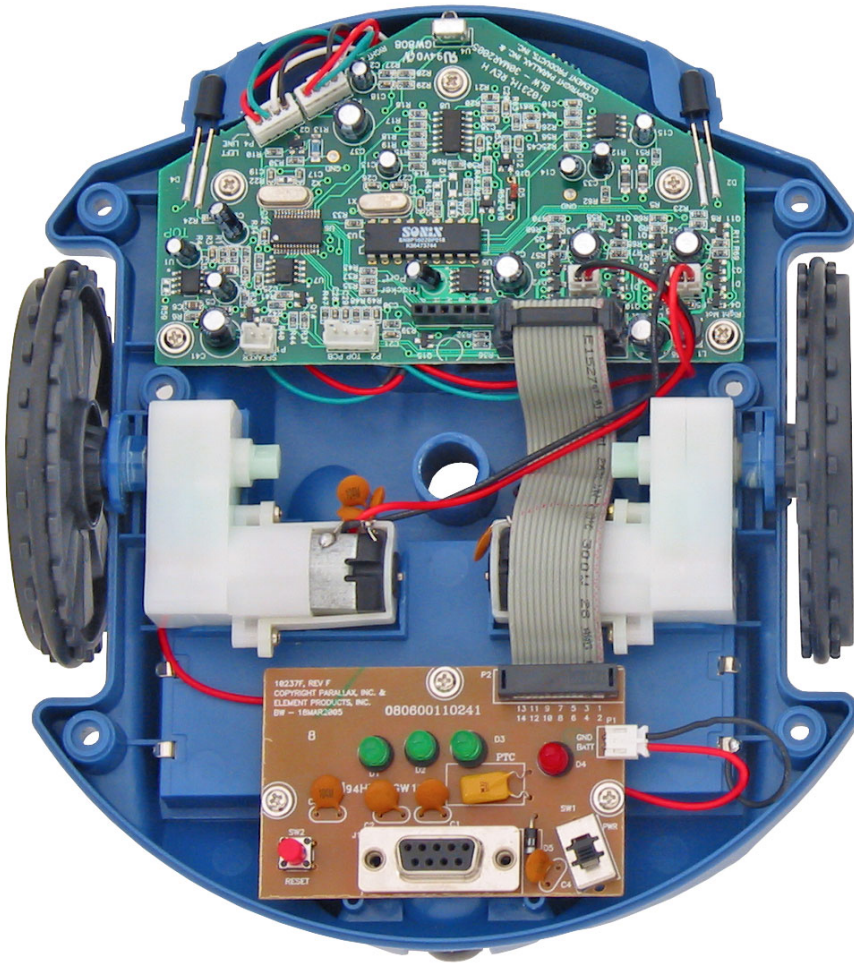
Obstacle sensor detector

Motor/wheels



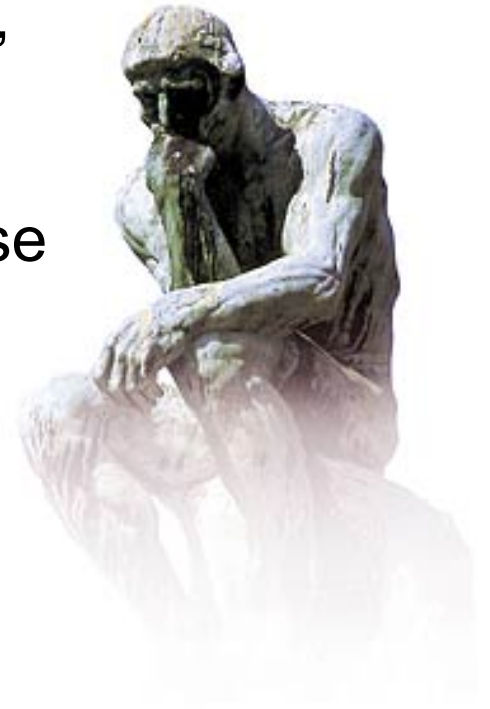
Light outputs

Scribbler inside

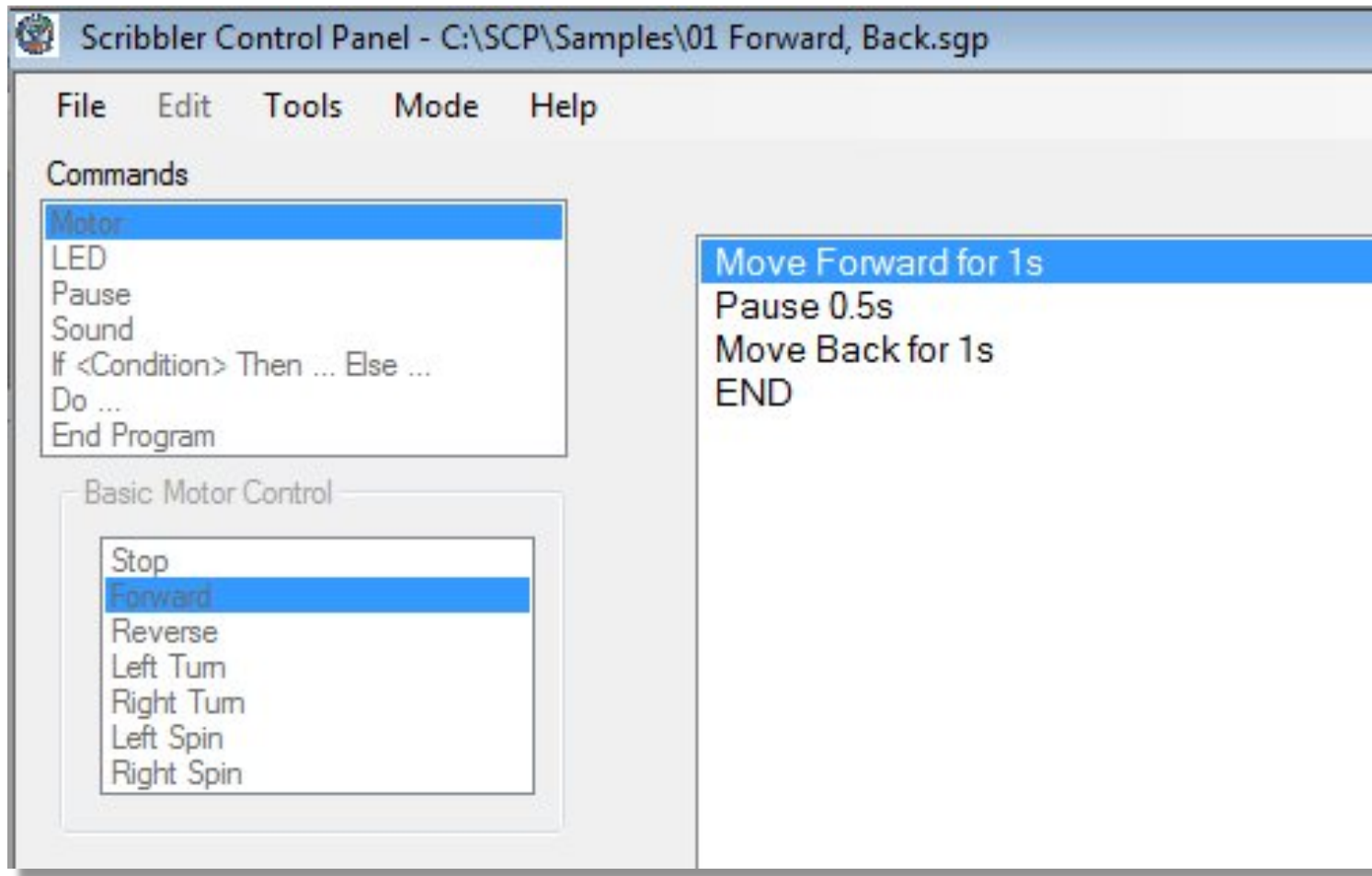


Formal specification of actions

- Fact of life in computing: hardware is “dumb”
- Forces us to make nebulous concepts precise
 - What is language? Music? Intelligence?
- Running themes:
 - What is machine “intelligence”?
 - Are there limits?



Controlling Scribbler





Always remember...

(esp. for Scribbler labs):

- Microprocessor can do one thing at a time
- Very fast -- 20 million operations per second!
- Compound instructions: sequence within {...}

Why programmable?

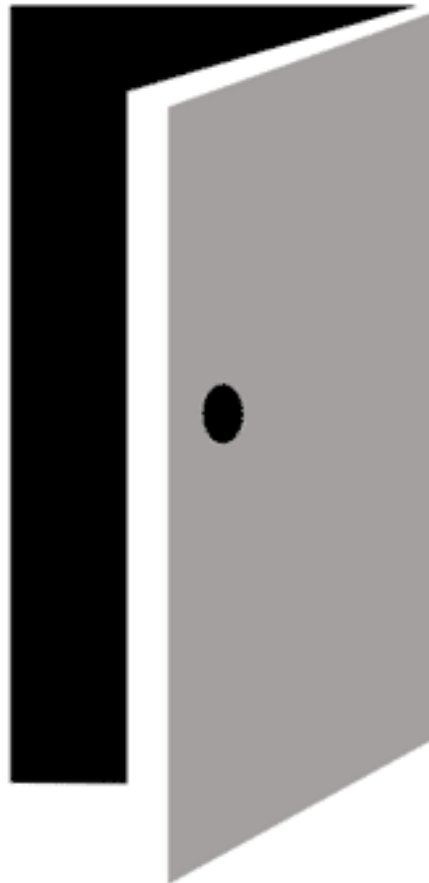
- Benefits of a programmable device:

- Flexible
- Multi-use
- Universal



- Main difference between computers and other technologies

Example 1: As a burglar alarm



If beam interrupted...

Beep!



Example 2: As an artiste





Interesting note: Scribbler is more stupid than you think

Do forever

```
{  
  Move Forward for 1s  
  Move back for 1s  
}  
END
```

=

3 pages of stuff like

GOTO Main

SenseObs:

```
  FREQOUT ObsTxLeft, 1, 38500  
  IF (ObsRx = 0) THEN object_left = 1 ELSE  
  object_left = 0  
  LOW ObsTxLeft  
  FREQOUT ObsTxRight, 1, 38500  
  IF (ObsRx = 0) THEN object_right = 1 ELSE  
  object_right = 0  
  LOW ObsTxRight  
  RETURN
```

SenseLine:

```
  HIGH LineEnable  
  line_right = LineRight  
  line_left = LineLeft  
  LOW LineEnable
```

“Translator” written by
Rajesh Poddar ‘08

Where are things going?

- “Small cleaning agents” – Brooks



Where are things going?

DARPA Grand Challenge (\$2 M prize):

- 132 mile race in the desert
- No human control!
- 5 teams, Stanford won in ~7 hours



The Princeton Entry



Undergraduate Project; reached the finals

Where are we going?



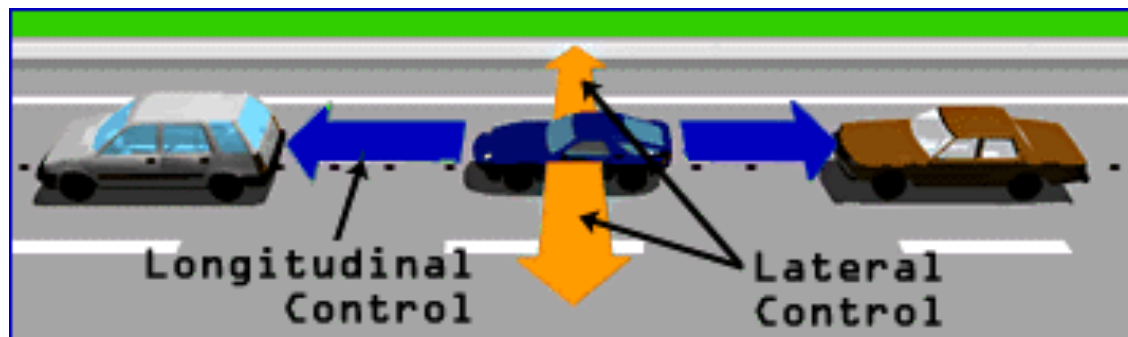
Where are things going?

- Automated highways



(From Minority Report)


- Being actively researched



What is going inside us?

- “Da Vinci” Robotic surgery system
- More precise, though often still controlled by human





Why are multi-purpose robots so hard to build?

- Need precise instruments that act like: eyes, ears, hands, fingers, ...
- Need smart ways to use sensor data (ex: human eyesight vs. high-res camera)

REMINDERS

This week's reading:
Brooks
pp 12-21, pp 32-51.



This week's lab: Web 2.0

(Take-home lab – posted on course web page.)