Telling a robot how to behave

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COS 116: Spring 2011

Today: Understanding a simple robot

Why?

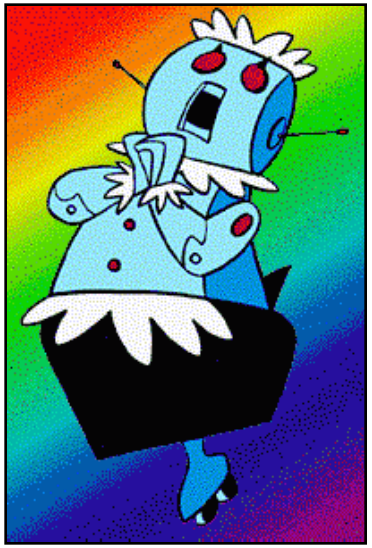
- Larger goal: seek an answer to

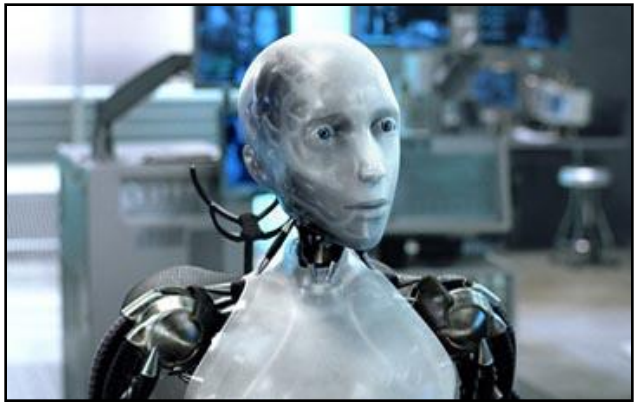
  "What is Computation?"

- Acquire insight into technology that will become pervasive within the next decade. Tangible example of "Breathing life into matter."

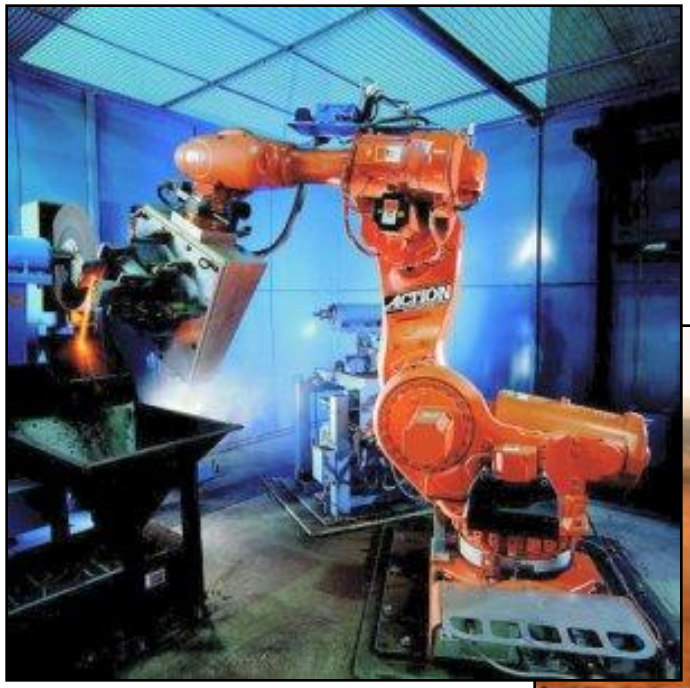
- First encounter with many themes of the course.

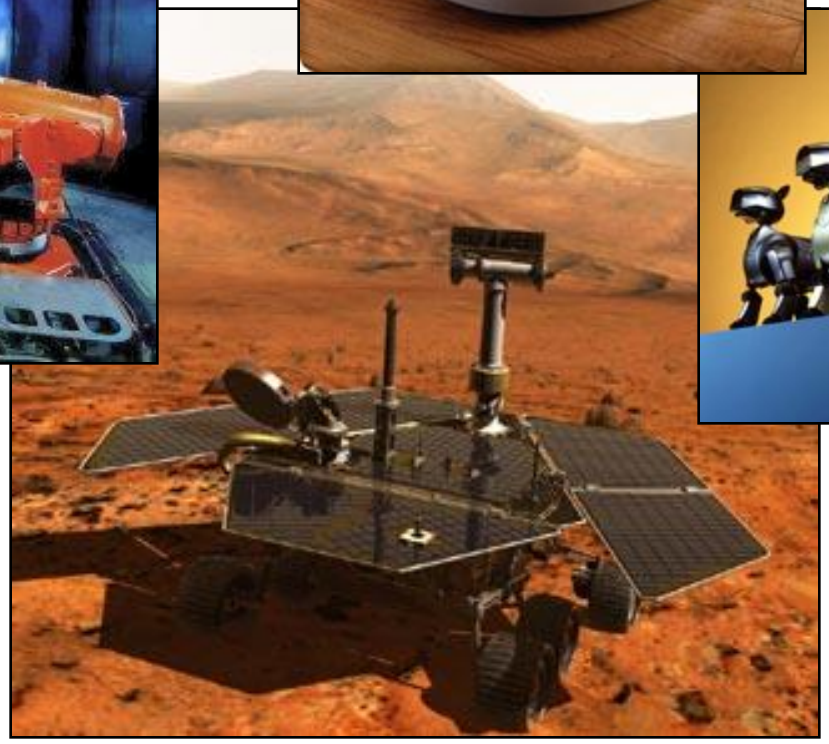
Robots in culture





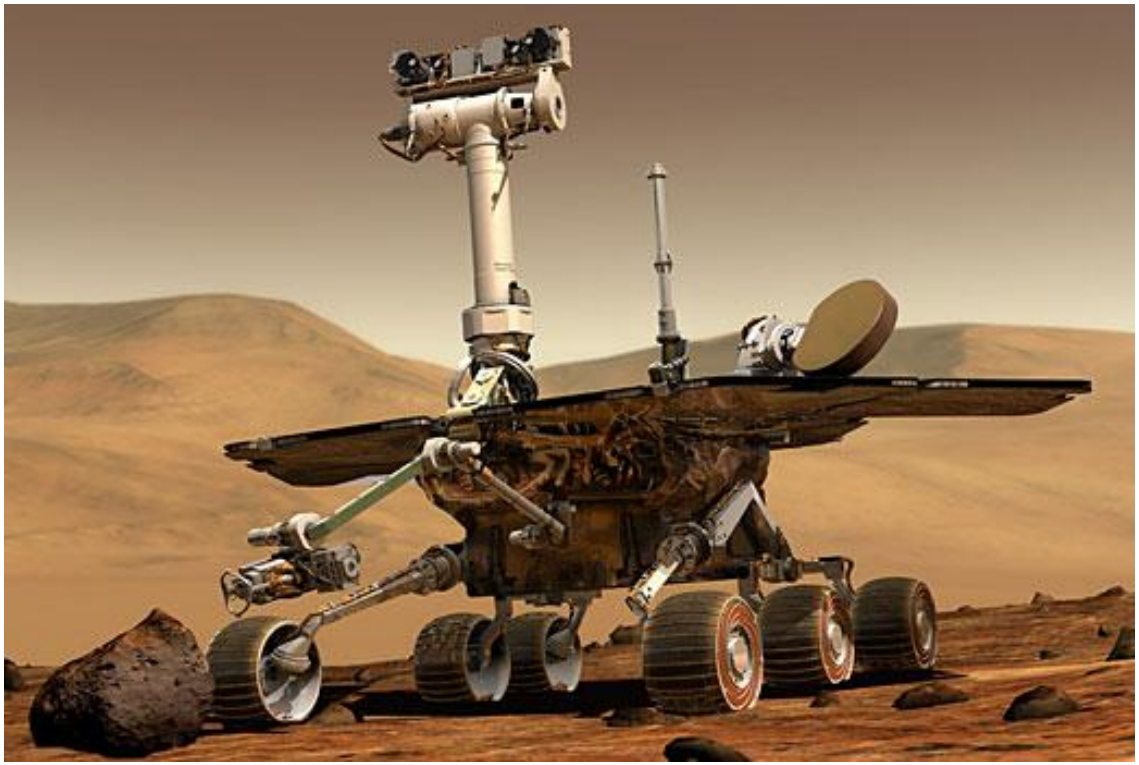
Real robots





Discussion…

- Mars rover: what are the design principles?



Definition of “Robot”:

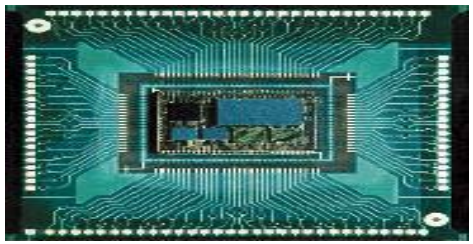
- A machine that can be programmed to interact with the physical environment in a desired way

- Key word: *programmed*
  - As opposed to cars, televisions, which are operated by people

Components of a robot

Three stages:

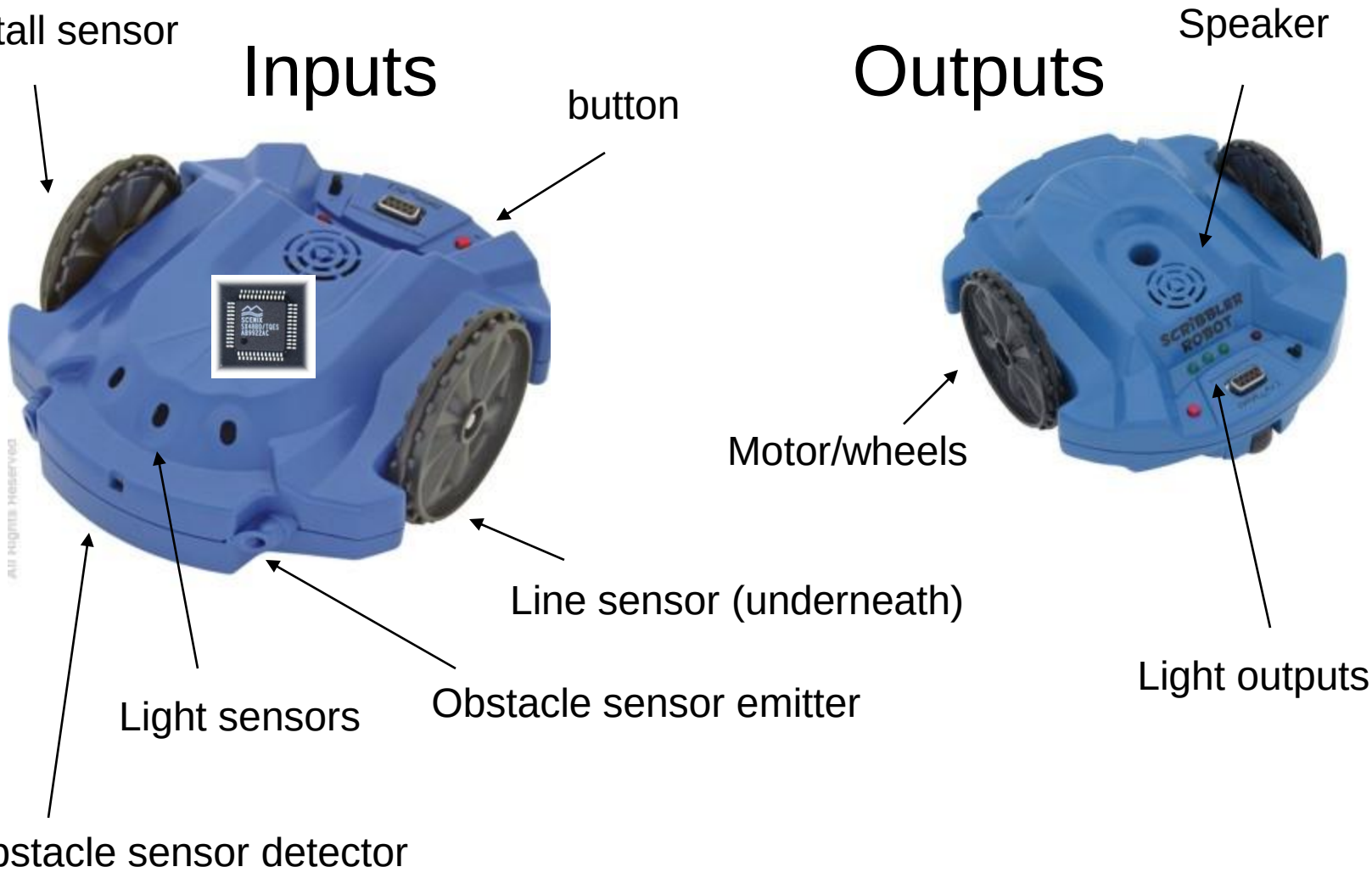
1. Sensors/Inputs: light, sound, motion...



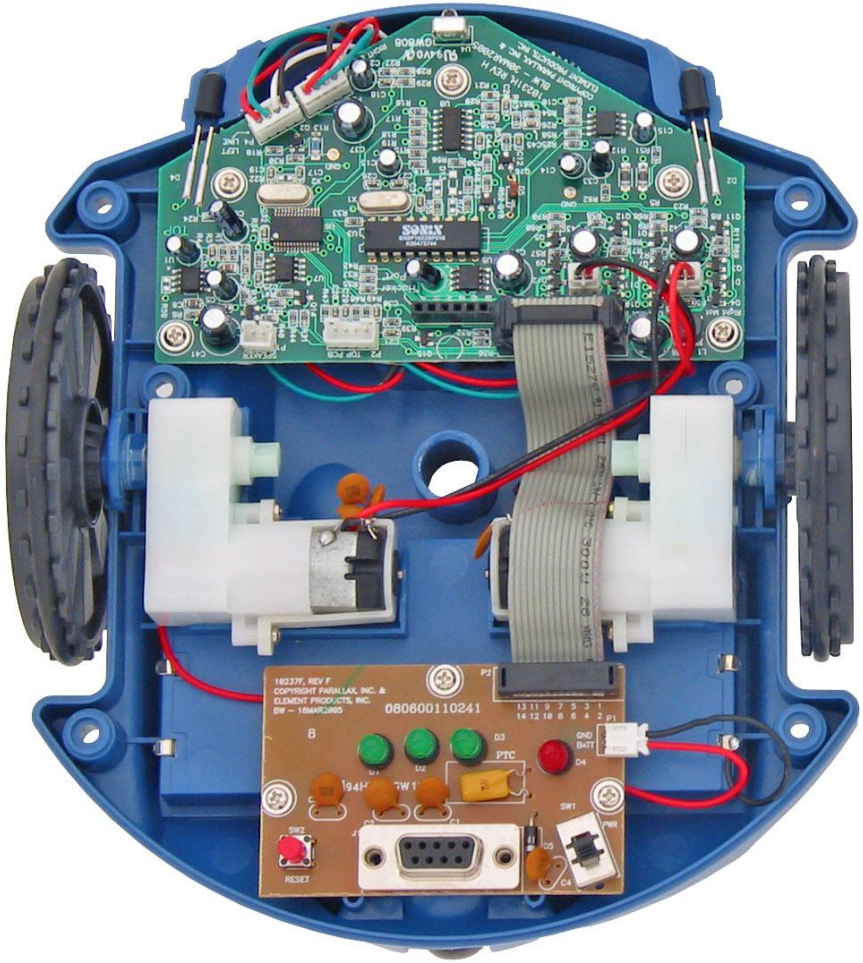
2. Computing Hardware

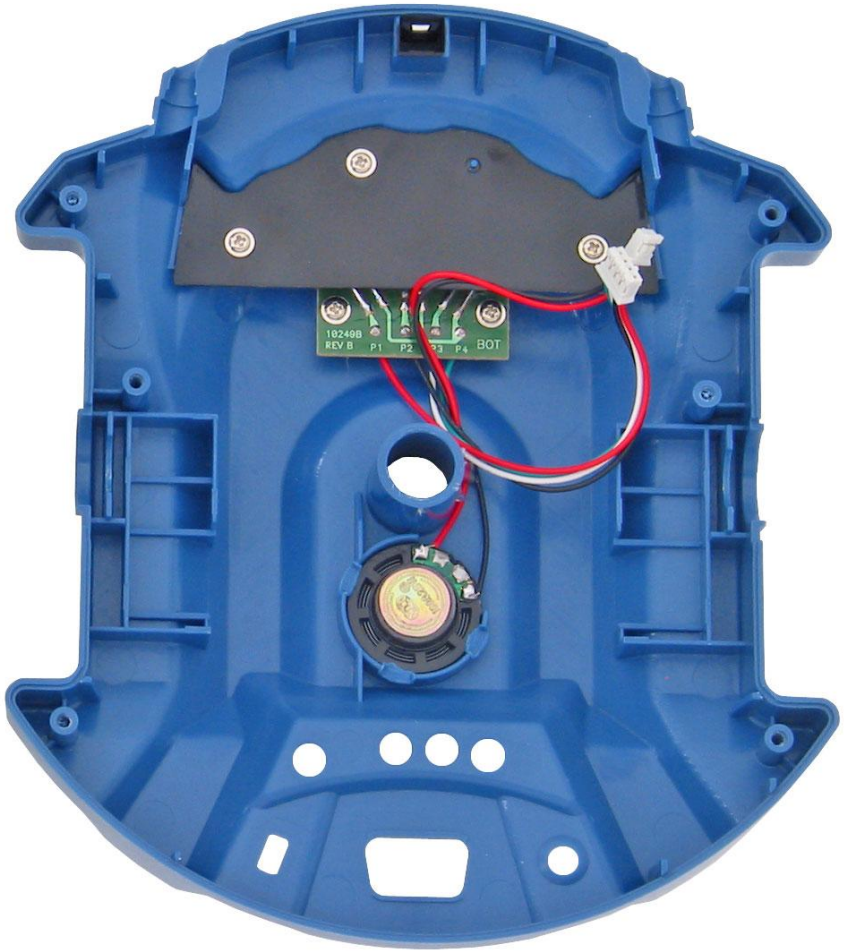
3. Outputs/Actions: motors, lights, speakers…

Our robot: Scribbler



Scribbler inside

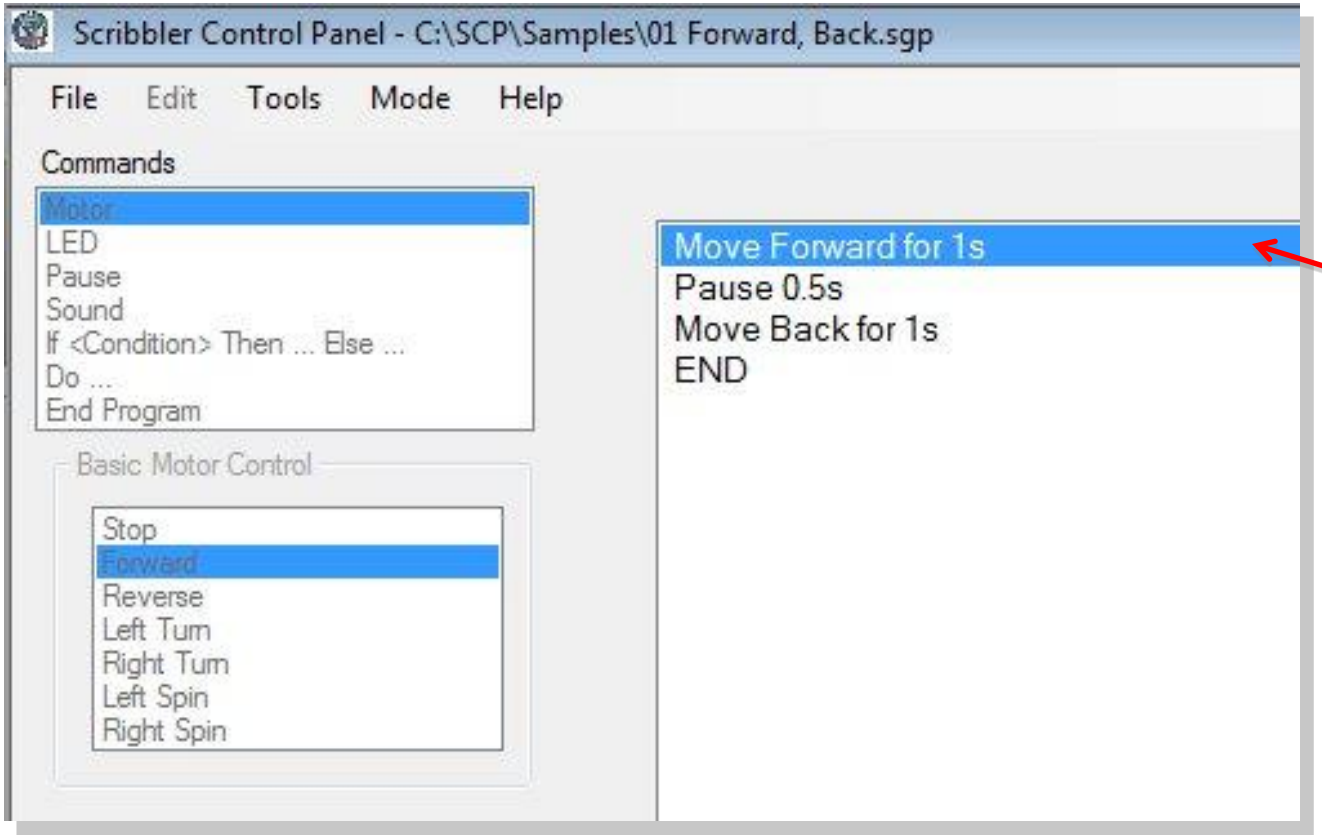




Formal specification of actions

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

Controlling Scribbler: Give it a “Program”



“Simple instruction”

“Compound” instructions

- If <condition> then … else ….
- Do for … times …;
  Do while ….
  Do while not …

Always remember… (esp. for Scribbler labs):

- Microprocessor can do one thing at a time
- Very fast -- 20 million operations per second!
- Complicated idea usually requires compound instruction.

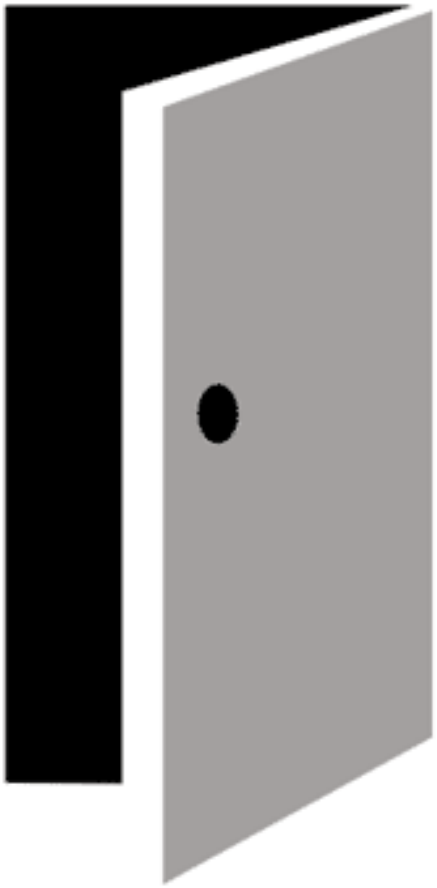
Semantics of “Do While..”; a discussion

Why programmable?

- Benefits of a programmable device:
  - Flexible
  - Multi-use
  - Universal

vs

Example 1: As a burglar alarm



If beam interrupted…

Beep!

Example 2: As an artiste

Interesting note:
Scribbler is even 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

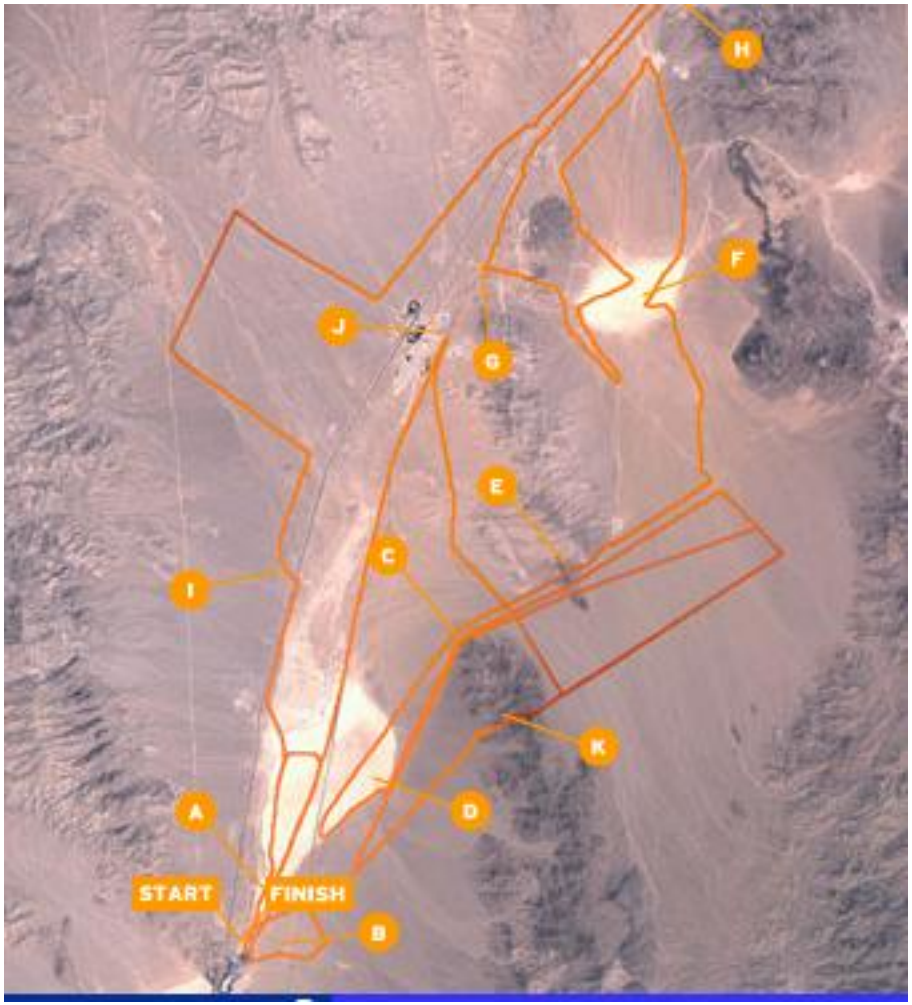
Where are things going?

- “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



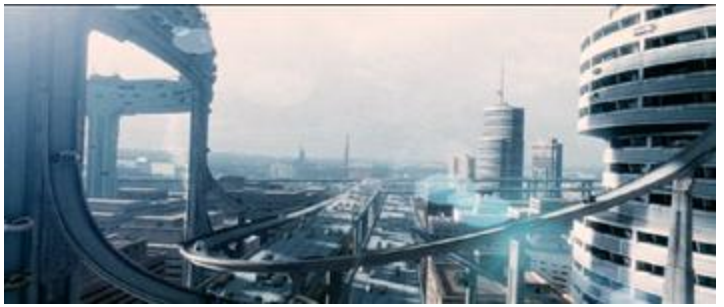
The Princeton Entry

Undergraduate Project; reached the finals

Where are we going?

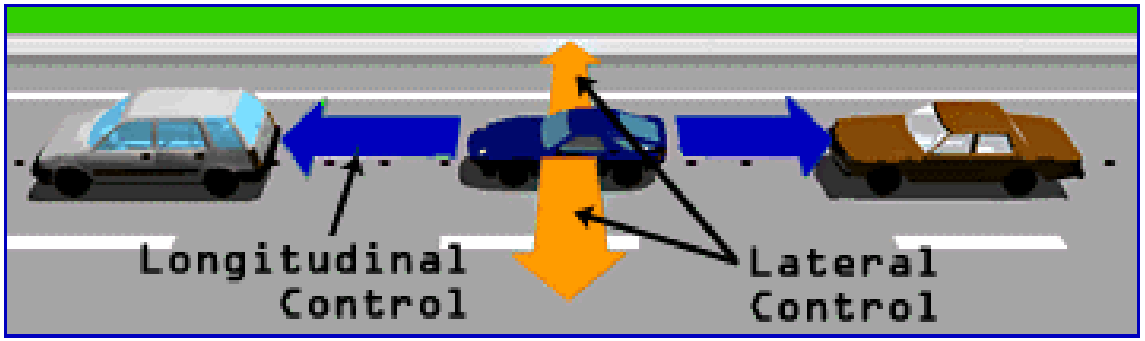
Where are things going?

- Automated highways



(From Minority Report)

- Being actively researched



What is going inside us?

- “Da Vinci” Robotic surgery system

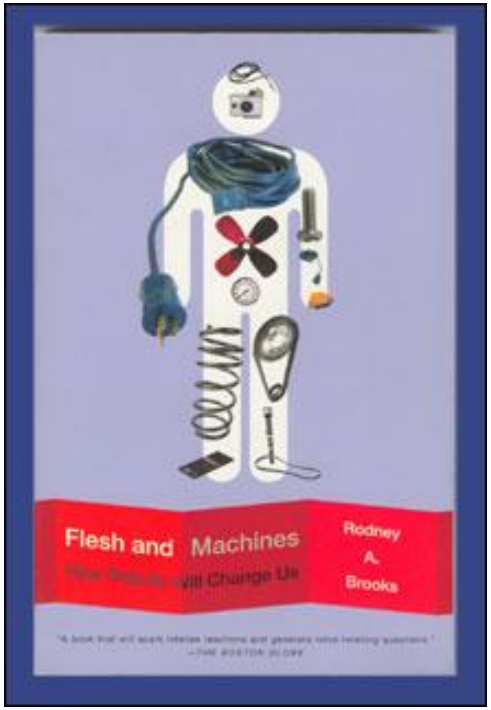
- More precise, though often still controlled by human

Why are multi-purpose robots so hard to build?

- Need precise instruments that act like: eyes, ears, hands, fingers, …
- Need smart ways (“algorithms”) 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.)