**Please sit close to the central "pit"; many demos**

# Telling a robot how to behave

COS 116: 2/9/2006

Sanjeev Arora

# Survey results

- Class break-down
  - Freshmen: 10
  - Sophomore: 18
  - Juniors: 8
  - Seniors: 8
- Majors
  - Economics: 9
  - Sociology: 3
  - English: 3
  - Philosophy: 2
  - Math: 2
  - History: 2
  - 1 each of Religion, Psychology, Classics, Geosciences, Politics
  - 8 Undecided or unlisted

- Own a:
  - PC: 25
  - Mac: 13
  - Game console: 15
  - Palm: 5
  - iPod: 23
- Have a web page:Yes:7  No: 26
- Ever posted on blog: Yes: 10; No: 22
- Programming: None: 27 ; Some: 6
- Highest math course:
  - None or pre-calc: 16
  - Calculus: 5
  - Multivariable / linear algebra: 7
  - Higher math: 7 (214 or higher)

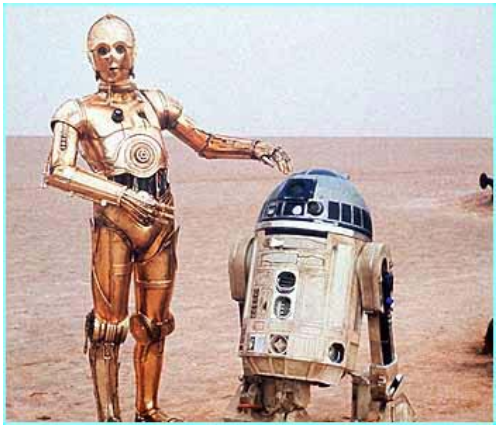
# Today: Understanding a simple robot

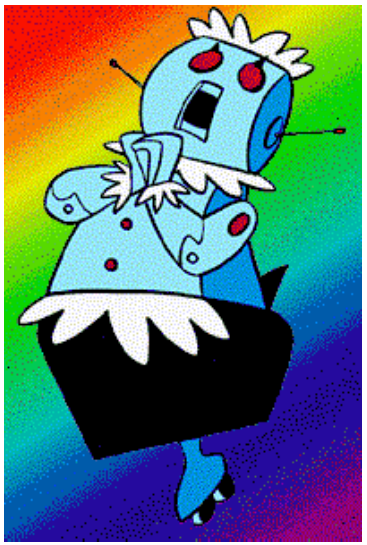
Why?

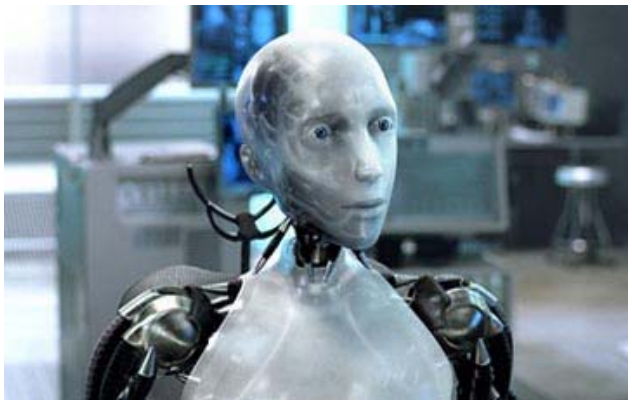
- Bigger goal: trying to work towards an answer to "What is Computation?"

- Acquire insight into  a technology that will become pervasive within the next decade.

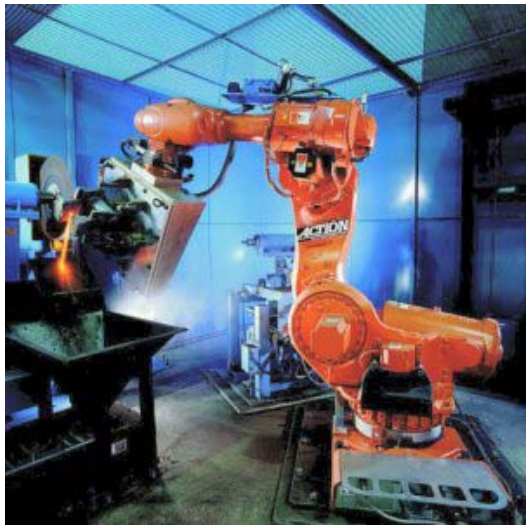
# Robots in culture







# Real robots



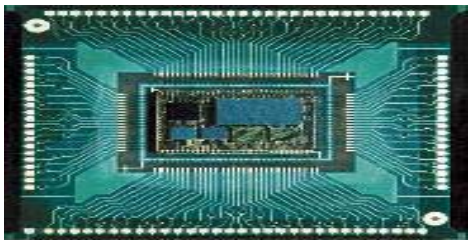
# Definition of “Robot”:

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

# Components of a robot

- Conceptually, each robot has 3 groups of components:

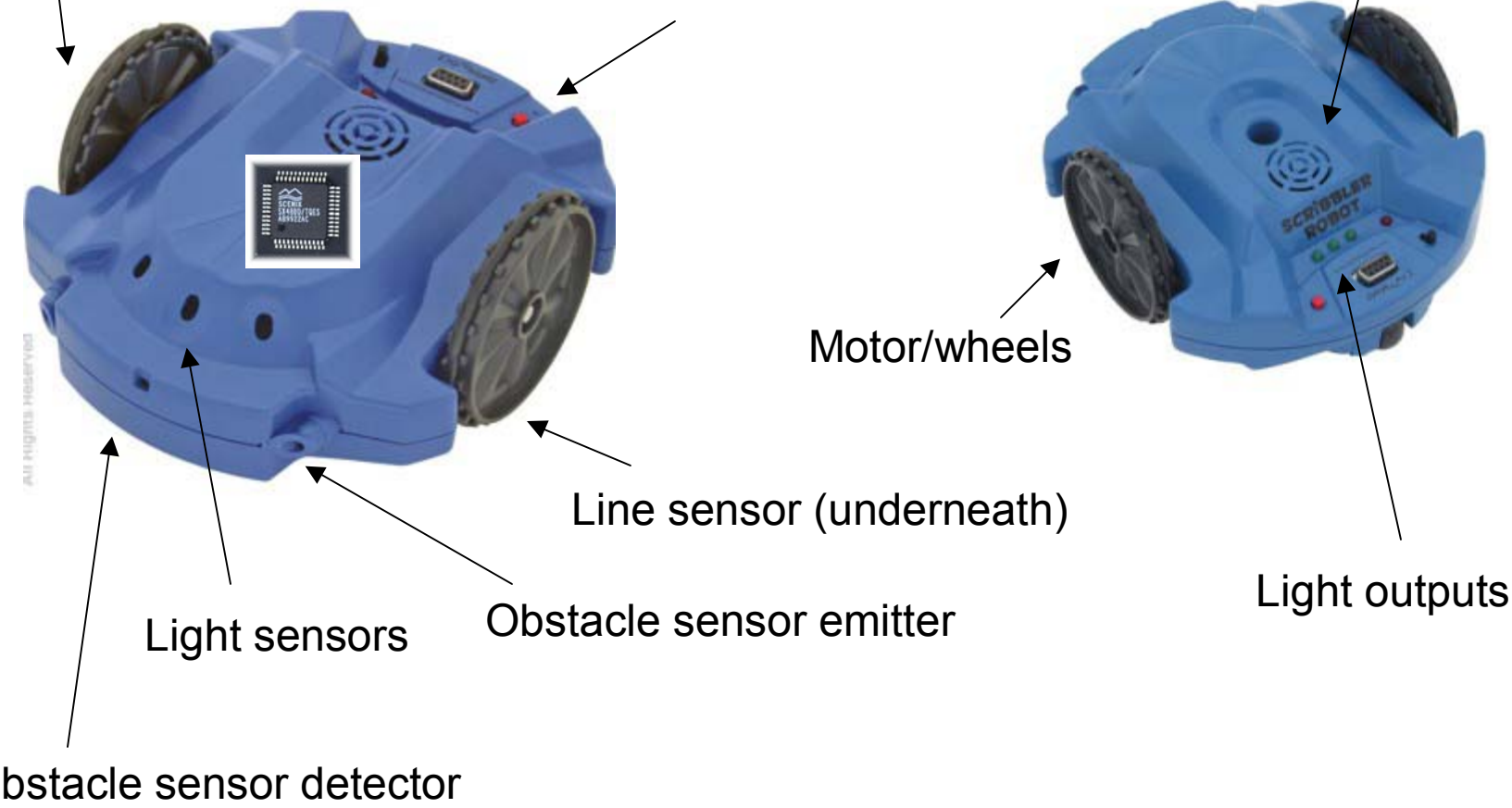
Sensors/Inputs: light, sound, motion, etc.



Computing Hardware

Outputs/Actions: motor control, lights, speakers, etc.

# Our robot: Scribbler



# Formal specification of actions

- Fact of life in computing: hardware is “dumb”
- Forces us to make nebulous concepts precise
  - What is language? Music? Intelligence?

- Is it possible to have more “intelligent” hardware? A radically different computer?

# Always remember (esp. for Scribbler labs):

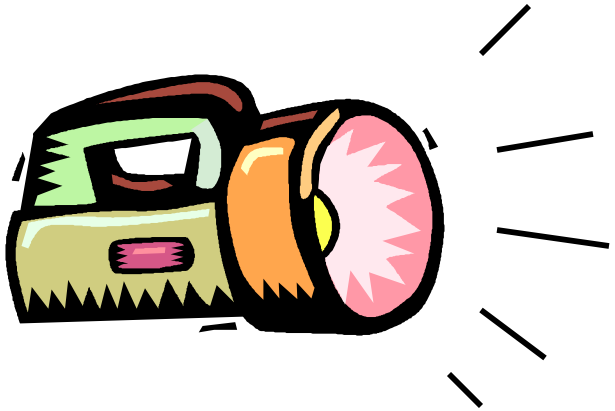
- Microprocessor can do only one thing at a time
- It is very fast--20 million operations per second!
- Sequence of instructions within { … } form a "compound instruction"

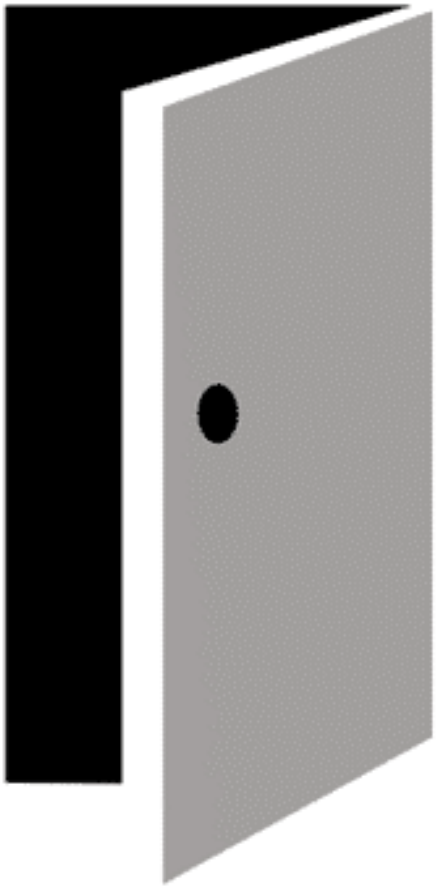
# Why programmable?

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

  - Universal
- Main difference between computers and other technologies

# Example 1: As a burglar alarm





Beep!

If beam interrupted…

# Example 2: As an artiste

# Interesting fact: Scribbler is even more "dumb" than you might 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
```

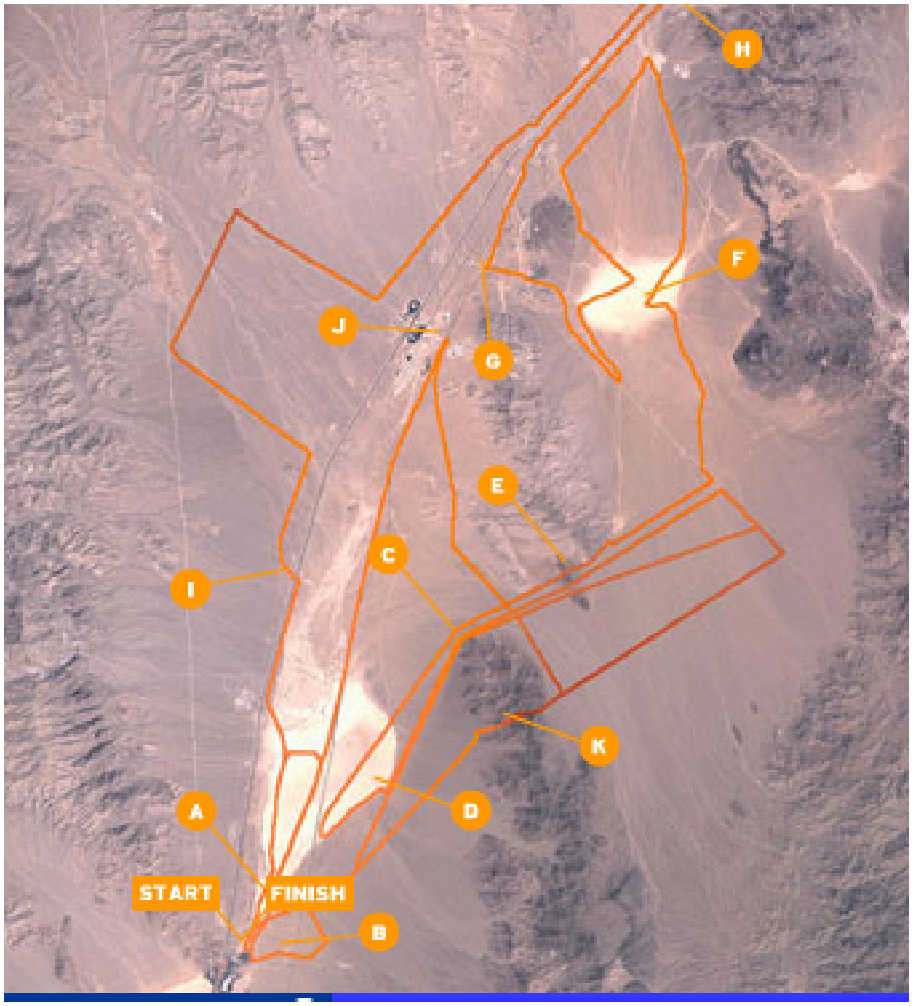
"Translator" written by Rajesh Poddar '08

# Where are things going?

- “Small cleaning agents” – Brooks

# Where are things going?

- 2005 DARPA Challenge ($2 M prize):
  - 132 mile race in the desert
  - No human control!
  - 5 teams, Stanford won in ~7 hours



# The Princeton Entry

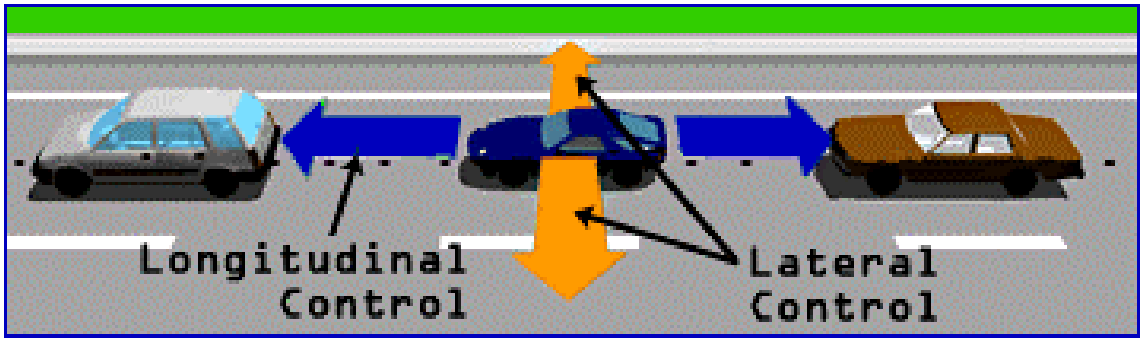

Undergraduate Project; reached the finals

# Where are we going?

- Automated highways

(From Minority Report)

- Being actively researched



# What is going inside us?

- Robot surgery:
  "Da Vinci" Robotic surgery system

- More precise, though often still controlled by human