Telling a robot how to behave

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COS 116: 2/7/2008

Survey results

- Class break-down
  - Freshmen: 10
  - Sophomore: 10
  - Juniors: 10
  - Seniors: 4
- Majors
  - 6 ECO
  - 6 POL
  - 3 ENG
  - 3 East Asian St.
  - 2 MAT
  - 2 Classics
  - 1 WWS
  - 1 SOC
  - 1 Comp. Litt.
  - 1 HIST
  - 1 ORFE
  - 1 ELE
  - 6 Undecided
- Own a:
  - PC: 25
  - Mac: 11
  - Game console: 17
  - Palm: 1
  - iPod: 27
- Have a web page:Yes:4 No: 30
- Ever posted on blog: Yes: 15; No: 19
- Programming: Yes:8 ; No: 26
- College:
  - 9 Forbes
  - 4 Mathey
  - 2 Butler
  - 7 Wilson
  - 5 Rocky
  - 7 Whitman

Today: Understanding a simple robot

Why?

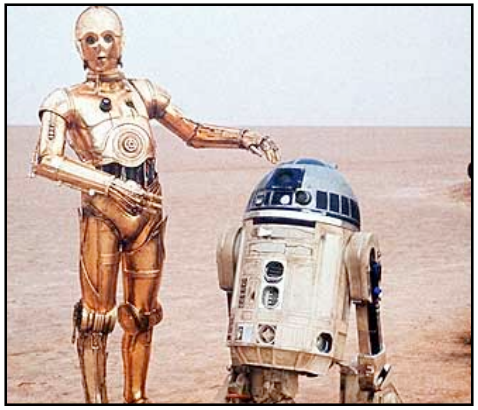
- Larger goal: work towards an answer to

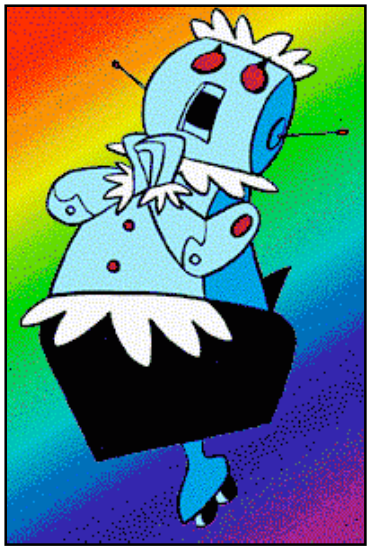
  "What is Computation?"

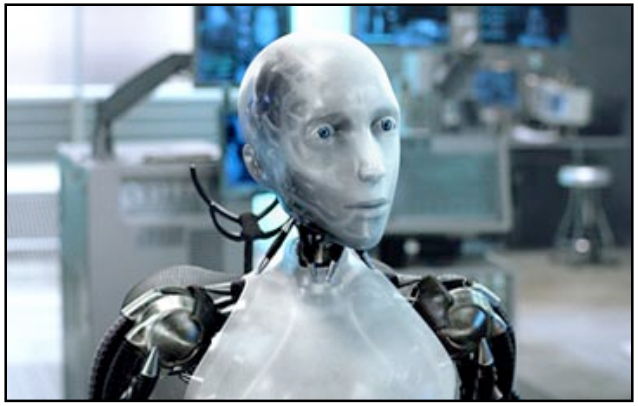
- Acquire insight into technology that will become pervasive within the next decade.

- First encounter with many themes of this course

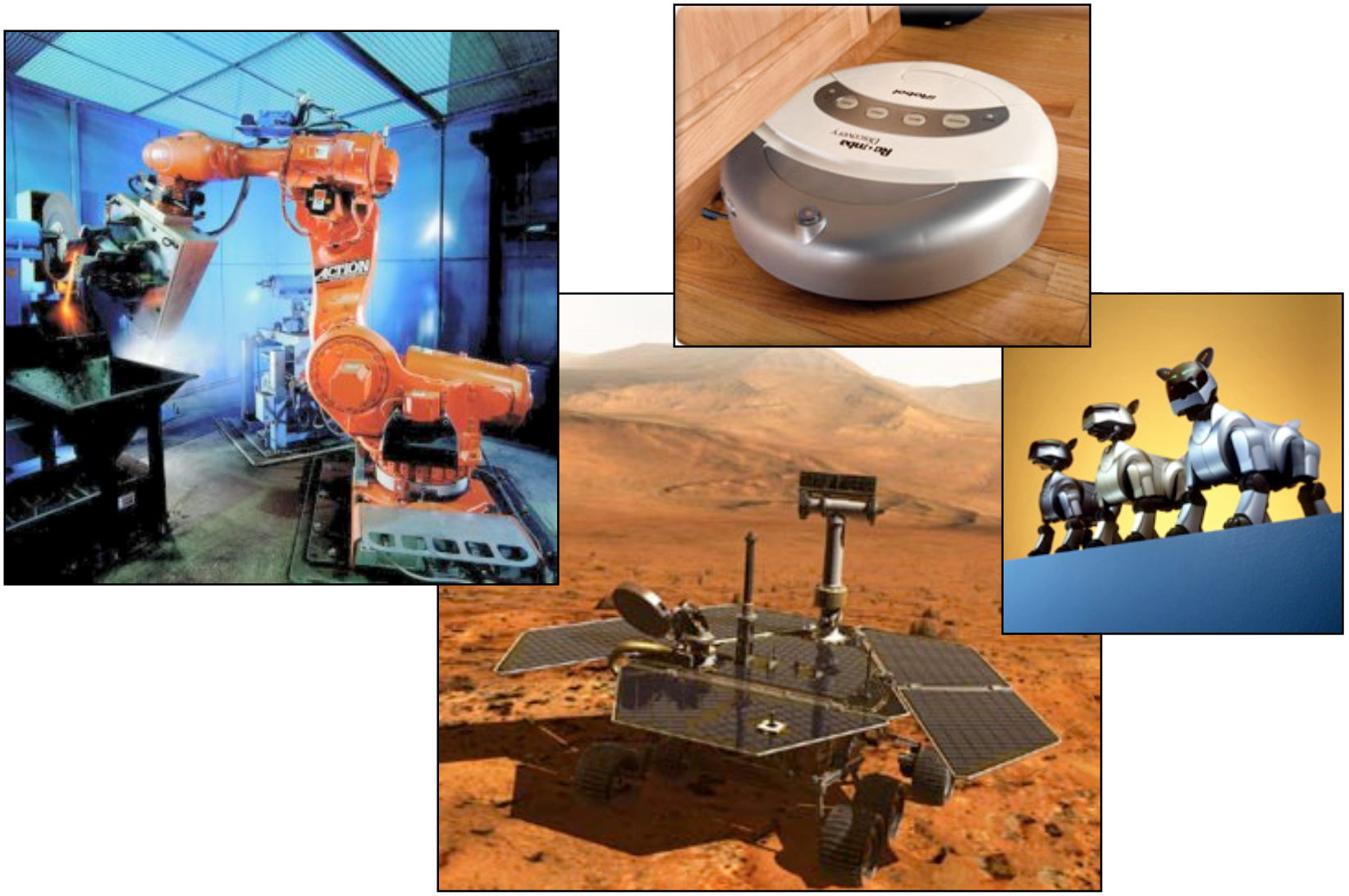
Robots in culture



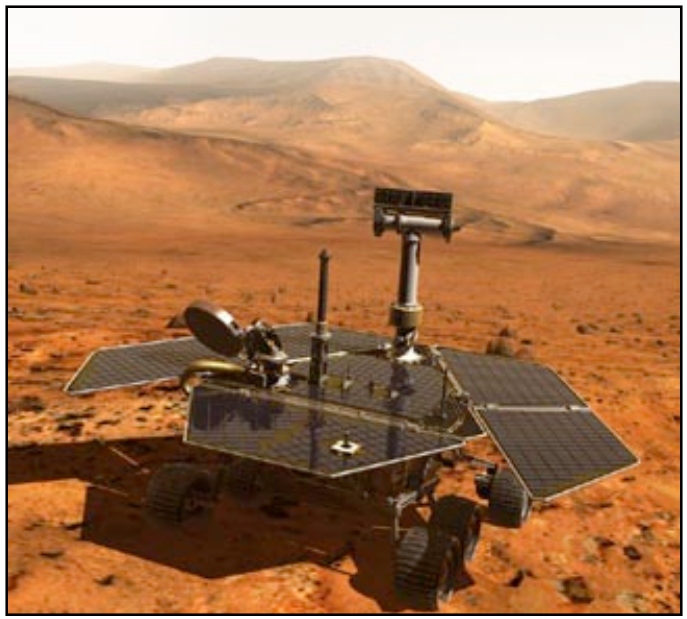




Real robots



Discussion Time



How do you think the Mars Rover works?

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, lawnmowers, which are operated by people

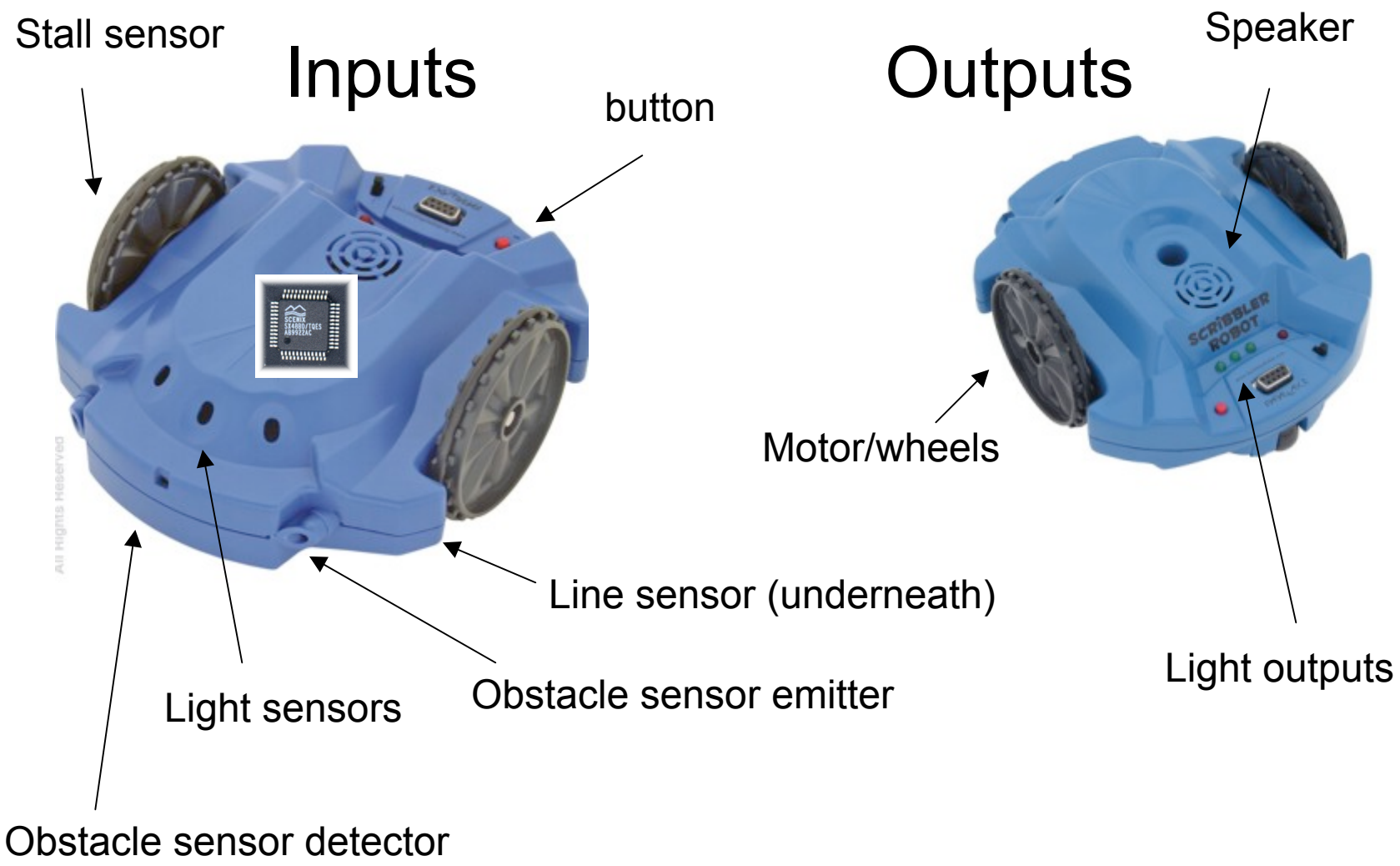
Components of a robot

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

2. Computing Hardware (programmable)

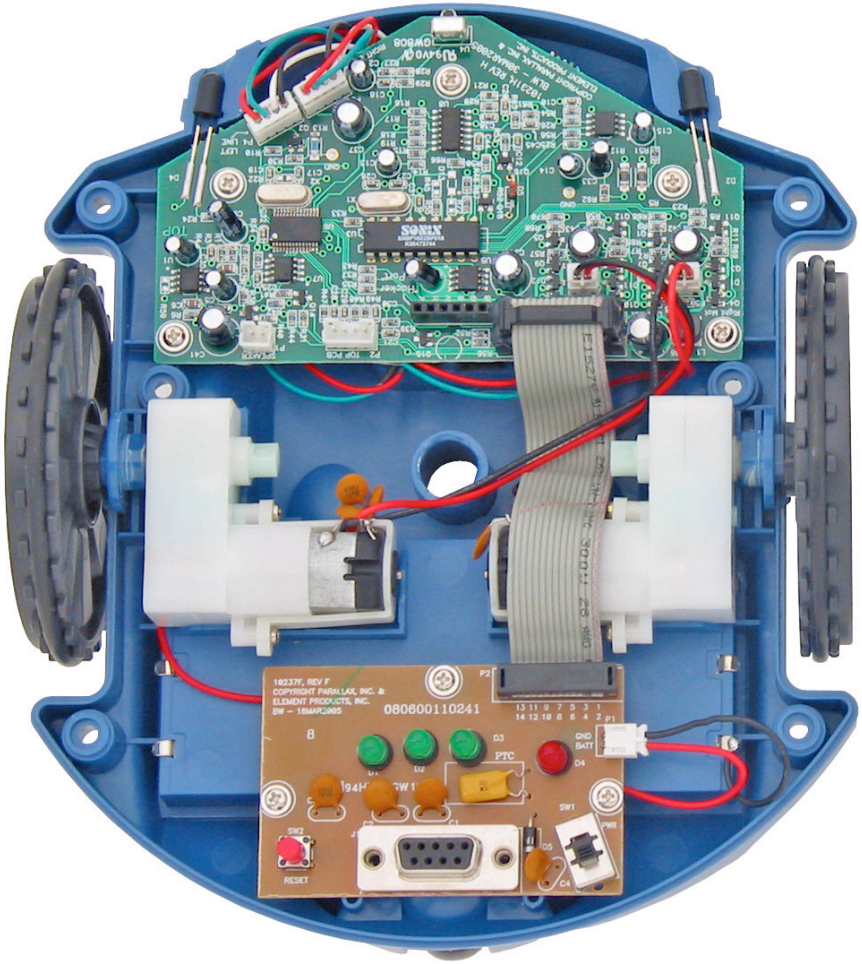
3. Outputs/Actions: motors, lights, speakers…

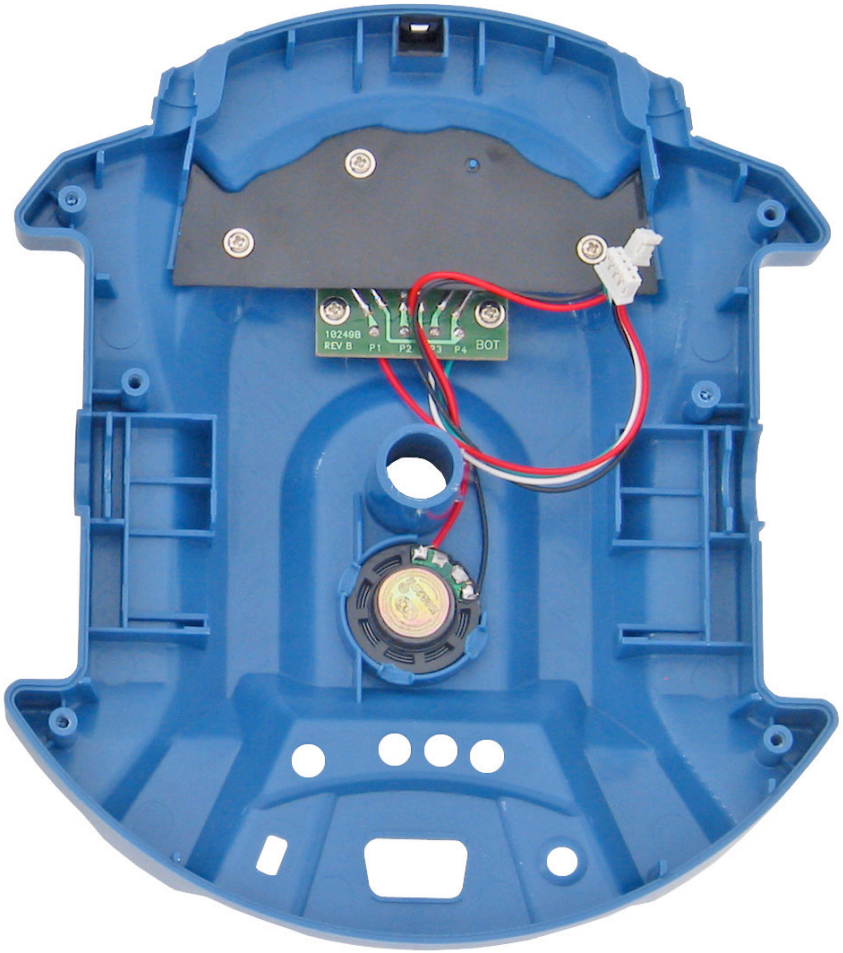
Our robot: Scribbler



Scribbler inside

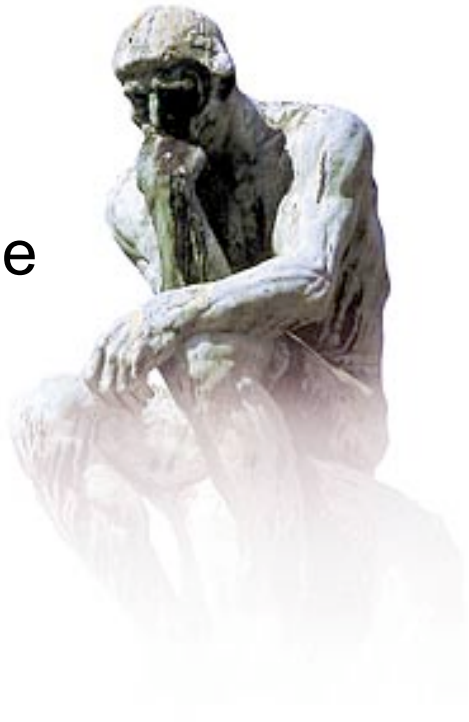
*(In a few weeks:
How Silicon chips and
microprocessors work)*





How to control a machine's behavior

- Fact of life in computing: hardware is "dumb"
- Forces us to make nebulous concepts precise
  - What is an obstacle? Music?

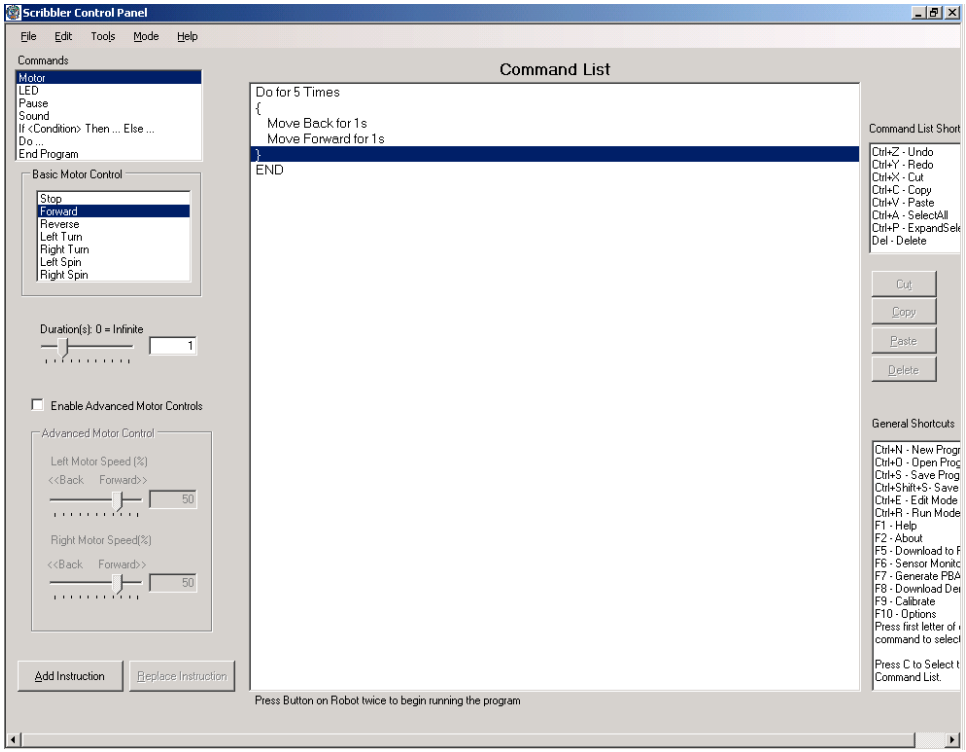


Running theme in this course

Another running theme:

What is machine "intelligence"?
Are there any limits on machine intelligence?

Controlling Scribbler's behavior



Scribbler Control Panel

(uses "pseudocode")

Let's play with it

Always remember… (esp. for Scribbler labs):

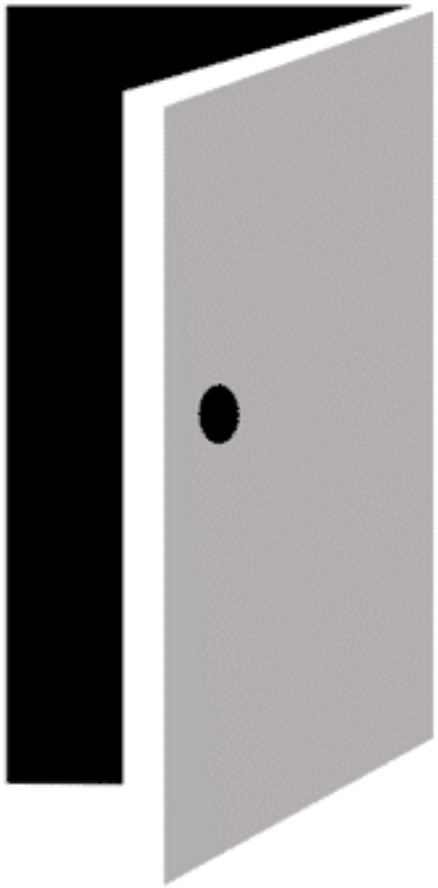
- Microprocessor can do one thing at a time
- Very fast -- 20 million operations per second! (desktop PCs do a few billion ops)
- Sequence of instructions within { … } form a "compound instruction"

Why programmable?

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

- Main difference between computers and other technologies

Example 1: As a burglar alarm



If beam interrupted…

Beep!

Example 2: As an artiste

Interesting note: Scribbler is less smart than is apparent from Control Panel

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

=

3 pages of instructions for microprocessor

```
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

Roomba, the first fully-programmable consumer device

Example: Roomba + bluetooth adapter + software download = a vacuum cleaner controlled by your Wii remote (or iPhone)

Where are things going?

Boss; winner of $2M DARPA Urban Challenge 2007. Completed urban driving course in 4 hours with no accidents at avg speed of 14mph

Princeton entry; semifinalist

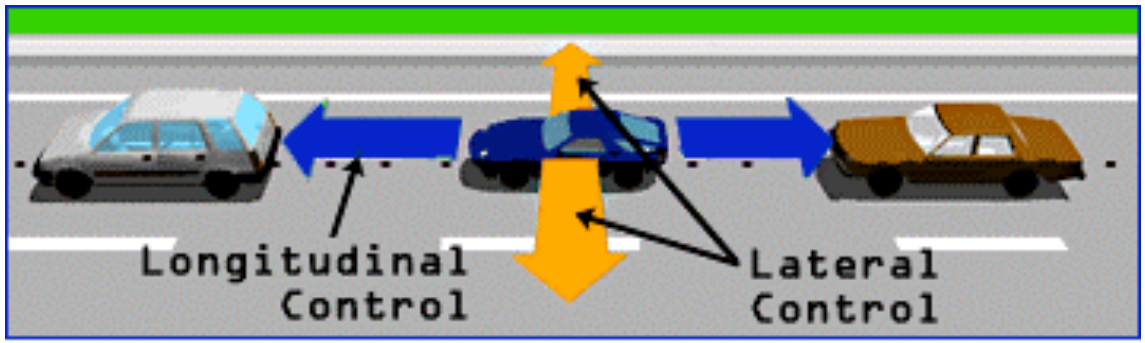
Which of you will be willing to ride in a robocar?

The Future?

- Automated highways

(From Minority Report)

Being actively researched



Why multi-purpose robots have proved so hard to build

•*Need precise instruments akin to human (even animal) eyes, ears, limbs, hands/fingers. Formidable engineering problem!*

• *Need smart ways of using these information from sensors*

(Example: Human vision versus high-resolution video camera)

Another running theme in this course: "Algorithms"

Reminder: Reading for this week; p 3-31 from Brooks.

What is going inside us?

- “Da Vinci” Robotic surgery system

- More precise, though often still controlled by human