LEARNING COMPUTING WITH ROBOTS

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Bryn Mawr College

- Founded in 1885
- 1300 Undergraduate women and 300 Graduate students
- 695 miles from here
- New Computer Science program (since 2001)

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Interest in CS has sharply declined
Gender gap has grown
The context of computing has changed
Focus on CS1 as an entry ramp into CS
The IPRE initiative
Mission
Explore making CS education more fun and effective through the context of a personal robot

Target
All levels, from middle school to graduate school

Hosted By
Georgia Tech with Bryn Mawr College and Microsoft Research

Funded By
3 year seed funding provided by Microsoft Research (MSR), Georgia Tech, and Bryn Mawr College
The context of CS1

- Introductory computing courses serve as a gateway into the CS curriculum.

- Should provide interesting and diverse range of examples and exercises.
Alignment of course content to student interests to increase engagement can have a positive impact on students choosing to enter computing as a major in college.


Most tasks should be attainable and provide a basis for supportive and positive feedback to students.

IPRE Ideals

- Use a personal robot
- Let the needs of the curriculum drive the design of the robot, software, and text
- Use tools that are easy to use, scale with experience
- Create an accessible, engaging environment for new, diverse population of students
Additional Motivations

- Computer Science ≠ programming
- Make computing a social activity
- Make computing a medium for creativity
- Performances vs. competitions
IPRE Hypothesis
A Personal robot for every student
Cost same as a typical CS1 text
Design driven by curricular needs

- Run pilot courses with available robots
- Poll students about desired features
- Experiment with software API
- Develop CS1 materials based on the above
- Goal is to teach *computing*, not *robotics*
A Personal Robot Kit

- The robot
- 6 Light sensors
- 7 IR sensors
- Stall sensor
- 2-Tone speaker
- 5 LEDs
- 2 Motors
- Bluetooth wireless
- Camera
- Gamepad
- Myro Python API
- Vision & Image Processing
Exploring a Pyramid
But, I am not a robotics person

- No prior experience necessary!
- Field tested with CS instructors
- Training Workshops
- Extensive Instructor’s materials
- Support available
Light Following
Imagine a corral (an enclosed area with maze like partitions and an entrance) with a light source at the entrance (as shown in the figure to the right). Given the robot's position, can we design a behavior that will enable the robot to exit the corral?
Learning Computing With Robots

- Chapter 1 The World Of Robots
- Chapter 2 Personal Robots
- Chapter 3 Building Brains
- Chapter 4 Sensing From Within
- Chapter 5 Sensing The World
- Chapter 6 Insect-Like Behaviors
- Chapter 7 Control Paradigms
- Chapter 8 Sights & Sounds
- Chapter 9 Image Processing & Perception
- Chapter 10 Artificial Intelligence
- Chapter 11 Computing & Computation
- Chapter 12 Fast, Cheap & Out of Control
Image Processing

```python
pic = takePicture()
show(pic)  # top picture

for pixel in getPixels(pic):
    r, g, b = getRGB(pixel)
    if r > 250 and b < 100 and g > 130:
        setColor(pixel, white)
    else:
        setColor(pixel, black)

show(pic)  # bottom picture
```
Vision: Tracking a ball
Is this CS1?

- Fundamentals of computing
- Program development process
- Basic robotics
- Media computation
- Social implications of computing & robotics.
- Principles of computation
Some Results

- Learned CS concepts through robots
- Robots made learning experience more hands-on, tangible, and exciting
- Most frustrating parts were dealing with robot hardware inconsistencies
- Viewed CS as a type of logic and problem solving; requiring patience & thought
- Discovered that CS and robots are applicable to the real world
Results... CS1/CS2 Enrollments
Desiderata for a CS1 Personal Robot

- Ability to draw
- Ability to take pictures
- Ability to listen
- Ability to make music/tones
- Ability to play sounds and talk
- Ability to express
- Ability for robot interaction
- Ability to have a web presence
Towards a new personal robot...

- 2 motors
- Ability to draw
- Wheel encoders
- Pen Port
- IR range Sensors
- Light/Photo sensors
- Color Camera
- 16x16 LED matrix
- Sound (speech/music)
- Programmable LED’s
- Microphone
- Rechargeable batteries
- Bluetooth Wireless
- Battery-level sensing
- Stall sensing
Abstract Art
Comments?

- For more information, visit:
  www.roboteducation.org

- Credits:

  Ben Axelrod, Tucker Balch, Doug Blank, Natasha Eilbert, Ashley Gavin, Gaurav Gupta, Mansi Gupta, Mark Guzdial, Jared Jackson, Deepak Kumar, Marwa Nur Muhammad, Keith O’Hara, Shikha Prashad, Richard Roberts, Jay Summet, Monica Sweat, Stewart Tansley, Daniel walker