
Welcome
to CS 3630

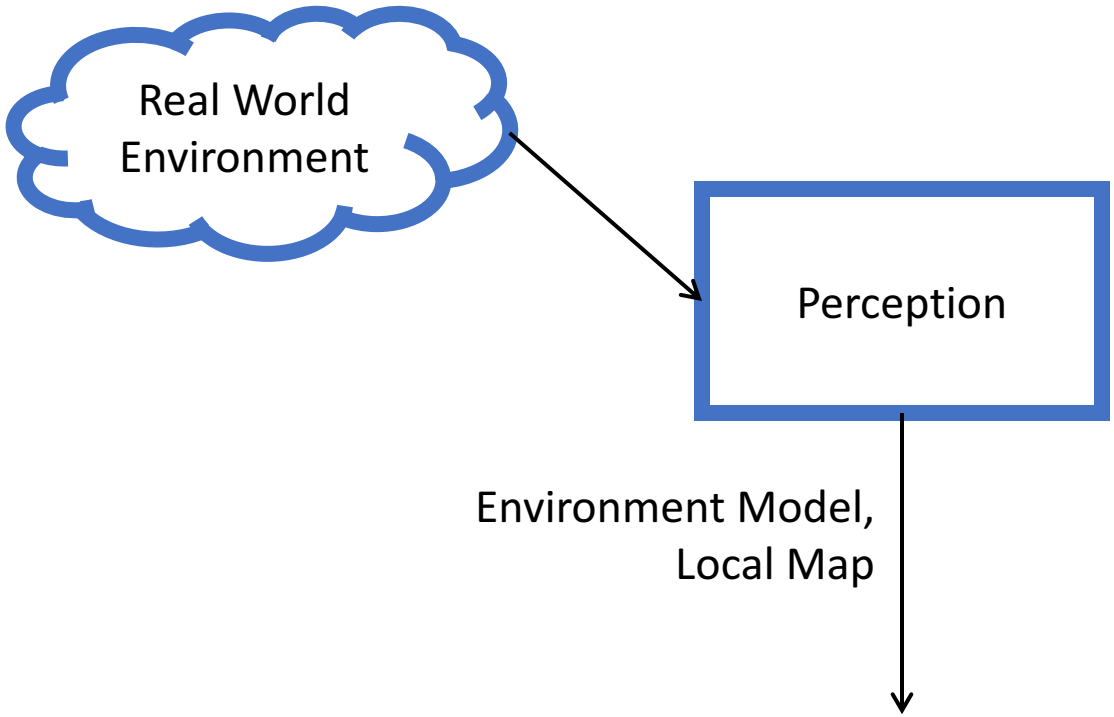
What this class is about

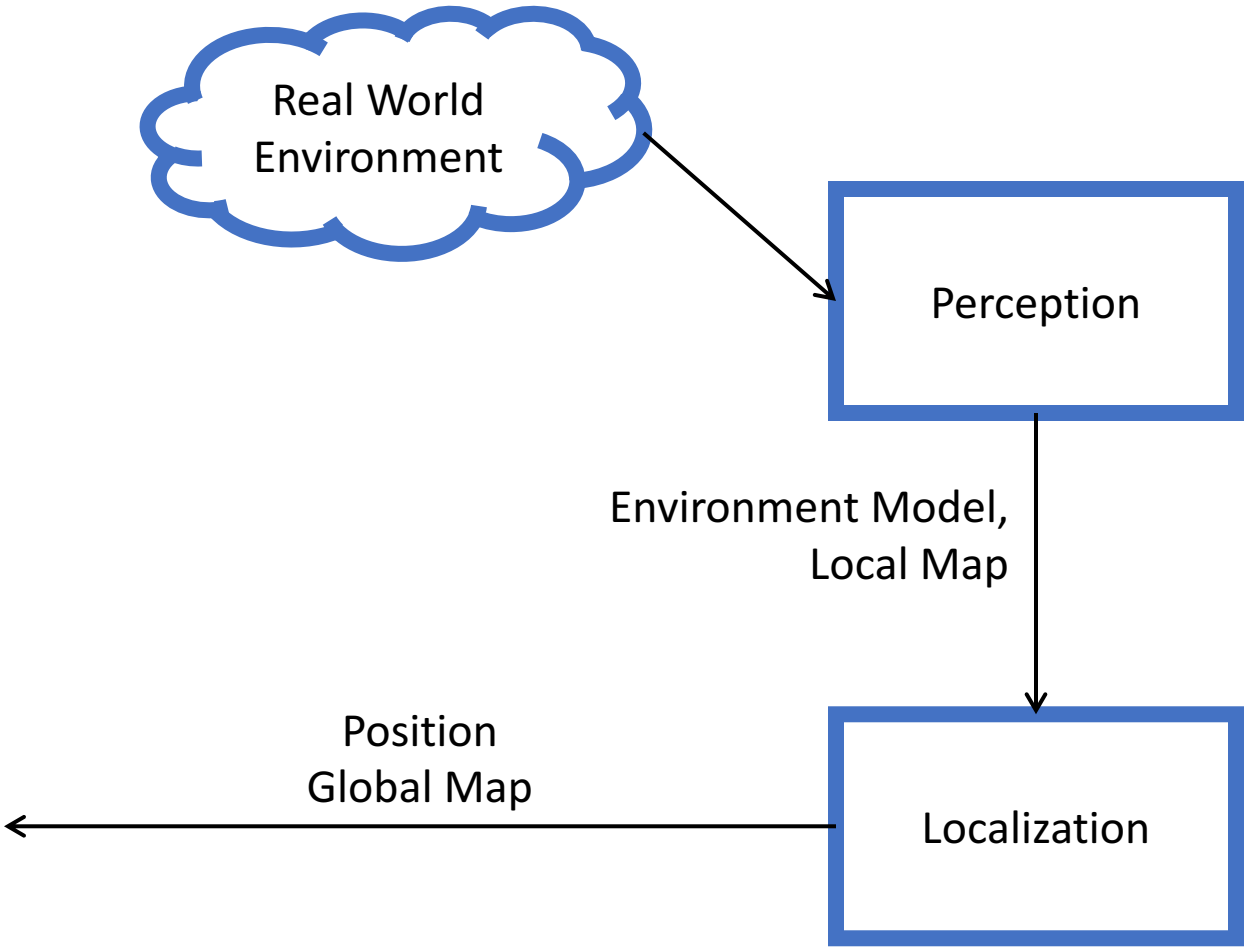
robotics, AI and perception

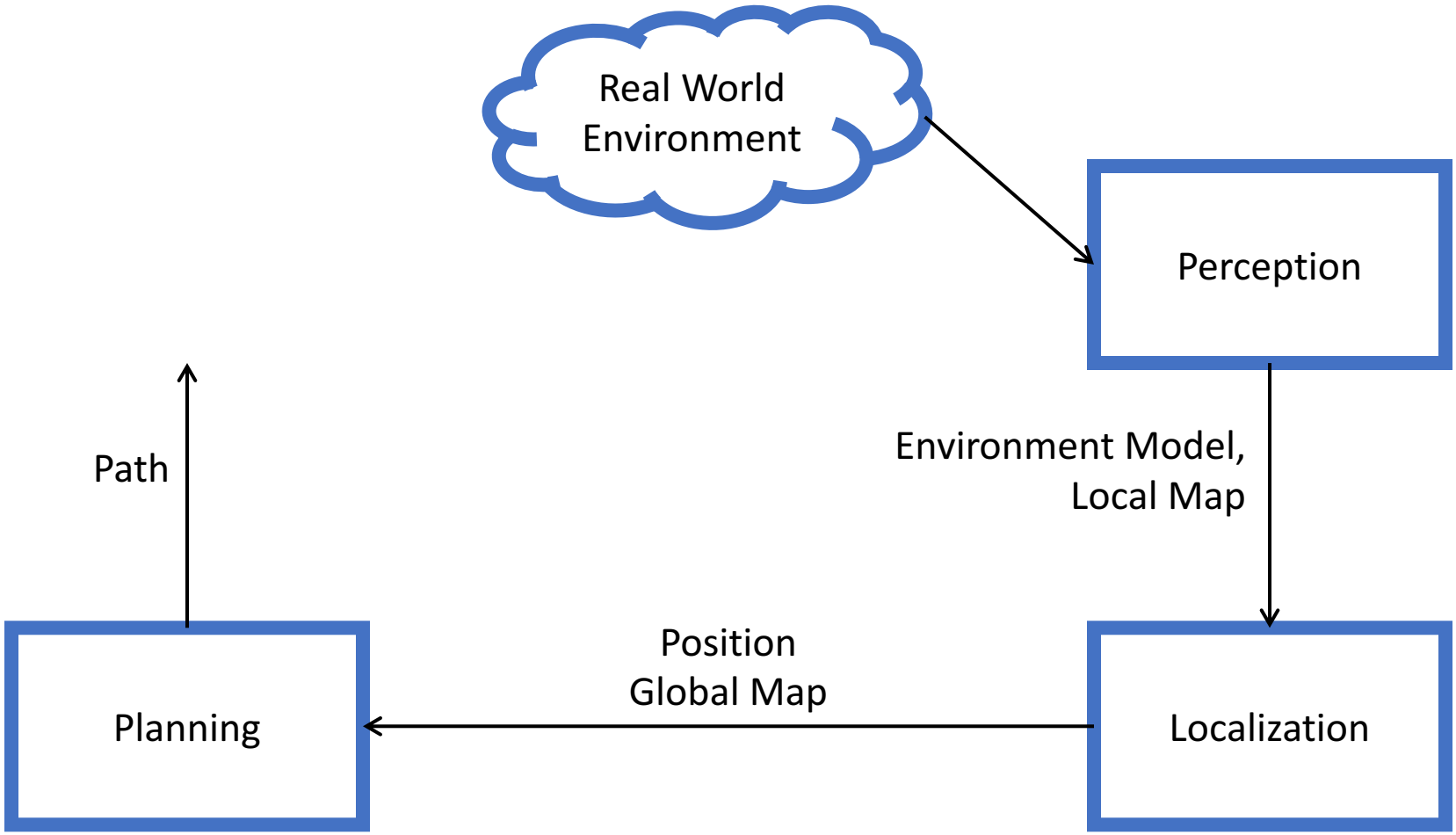
making a robot be (somewhat) intelligent

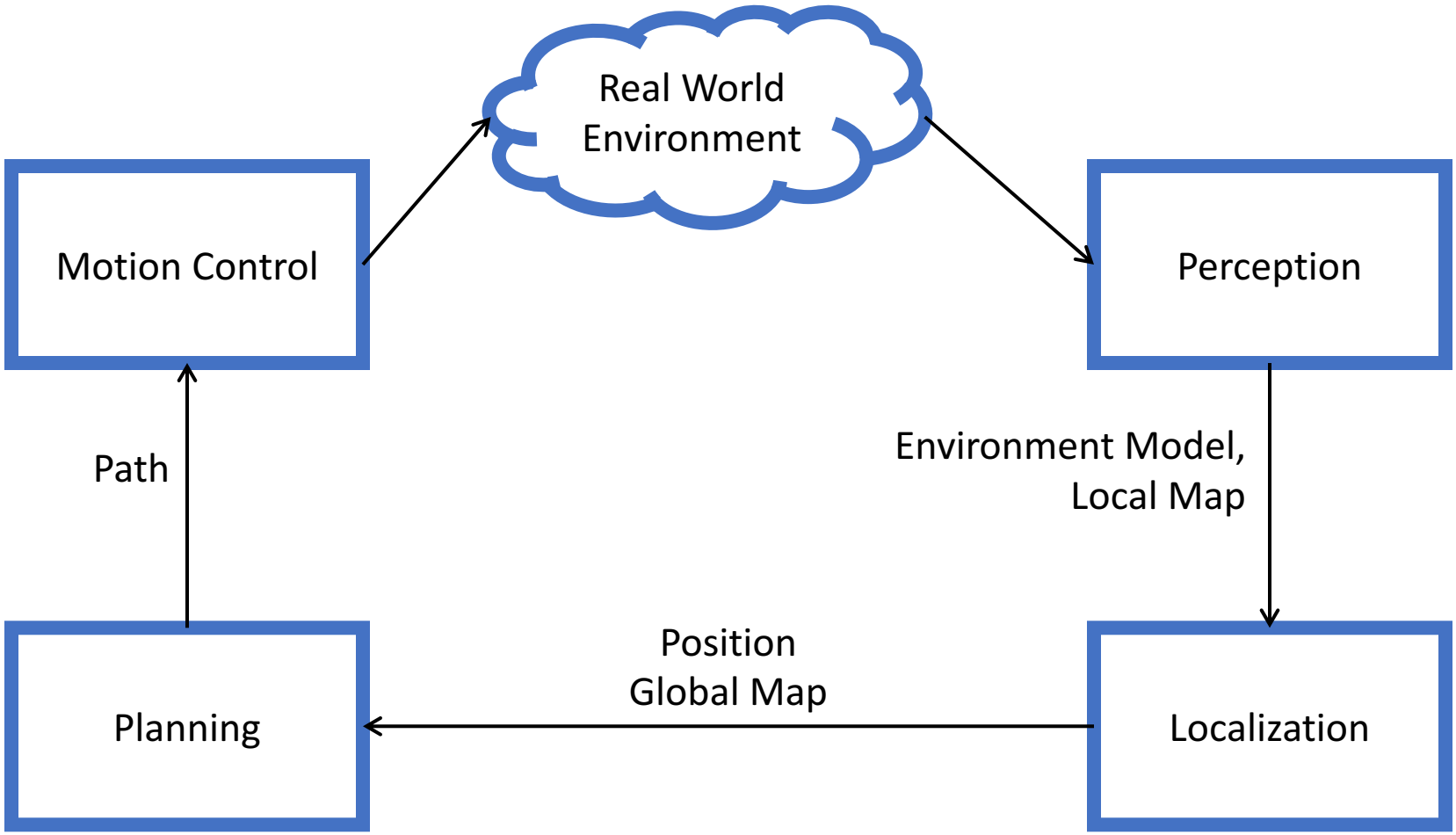
robot navigation


Real World
Environment


Real World
Environment
Perception
Environment Model,
Local Map


Real World
Environment
Perception
Environment Model,
Local Map
Position
Global Map
Localization


Real World
Environment
Perception
Environment Model,
Local Map
Localization
Position
Global Map
Planning
Path


Real World
Environment
Motion Control
Perception
Path
Environment Model,
Local Map
Position
Global Map
Planning
Localization

Meet the team!

Vivian Chu
Nick Ryan
Jing Dong
Sajid Anwar
Srujana Buddi
Abhishek Tondehal
Hanbeen Kim
Yang Tian

Tell us about you…

What is a robot?

- derived from the Czech work robota - forced labor.

- Isaac Asimov popularized robots and robotics (the study of robotics) over the next 40 years.

- Many definition of what a robot is today:
  - Reprogrammable machine with at least 3 DOF (IFR/RIA)
  - Intelligent connection between perception and action (M. Brady)

October 31, 2016

A Roadmap for US Robotics

From Internet to Robotics

2016 Edition

http://cra.org/ccc/wp-content/uploads/sites/2/2016/11/roadmap3-final-rs-1.pdf

Major application areas

- Manufacturing
- Consumer and professional services
- Health, independence and quality of life
- Public safety
- Field Robotics


Image courtesy of InTouch Health


JOHN DEERE

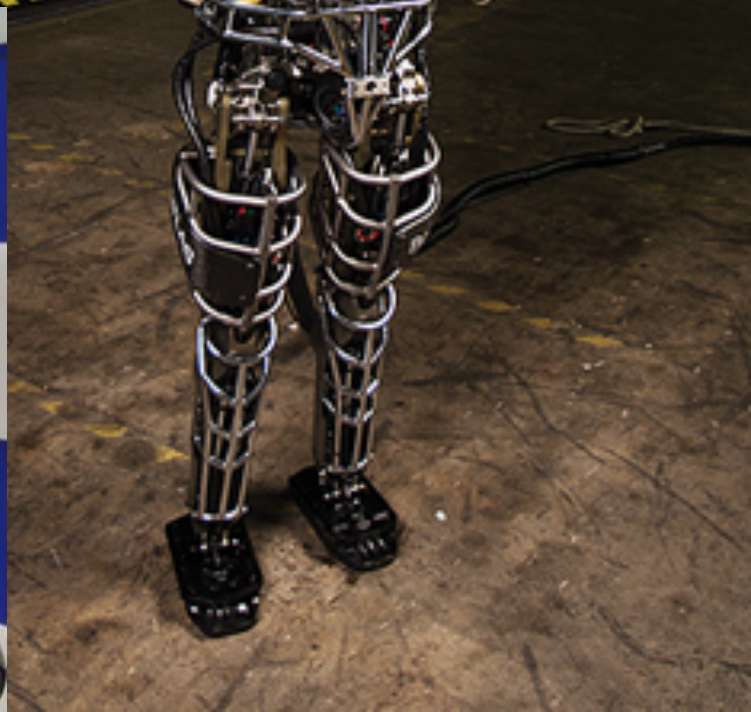

ROBOTICS
ROBOTICS


da Vinci S
2
1


ASIMO
HONDA


Boston Dynamics


産総研
AIST
KAWADA



Rethink
Manufacturing

Aethon and Savioke
Building Deliveries

DJI
Agriculture

Bossa Nova
Store Inventory

Fetch
Warehouse Logistics

[Every Car Company]
Self-Driving Cars

State of the art

- Single-arm manipulation works well in known/constrained environments
- Navigation is mostly solved on flat(ish) terrain
- Aerial vehicles work well in open spaces but with significant power and computing constraints

- Challenges:
  - Combining navigation and manipulation (mobile manipulation)
  - Operation in dynamic, unconstrained environments
  - Humans
  - …

Hottest Markets


BostonDynamics
Boston
Dynamics

Admin

tion: Fridge

everages

Guinness

Guinness

Widmer

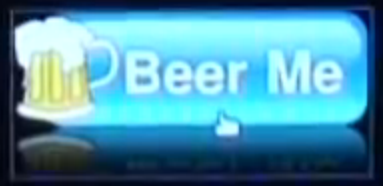
Widmer

Beer Bucket

Robot Status

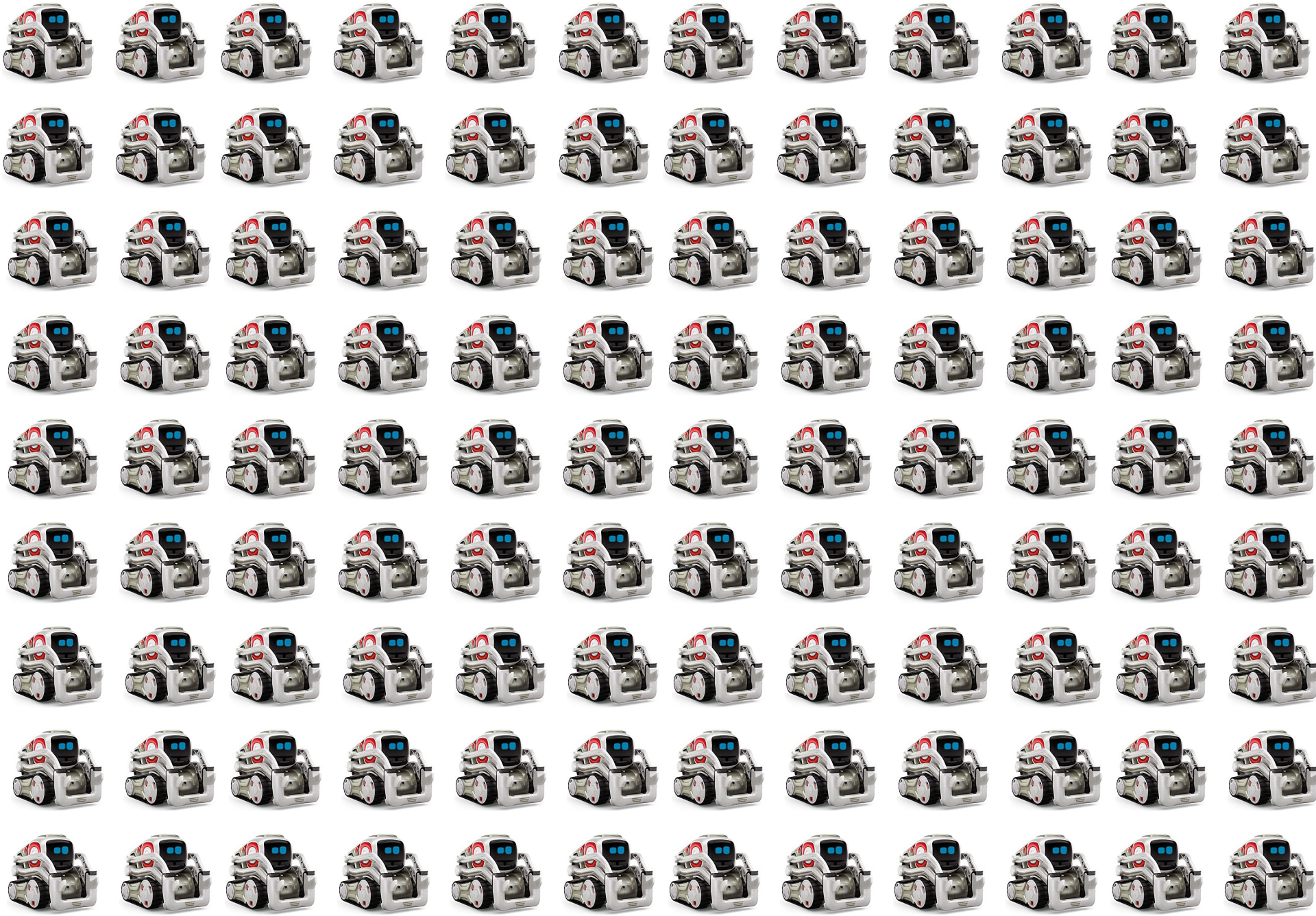
Request State:
The robot is ready to serve liquid refreshment. Please select a delivery location, pick up to 3 beers from the menu on the left, drag them into the beer bucket, and click the "Beer Me" button. If your desired delivery location is not in the list, the beer sprint team accepts bribes in most forms to add a pose of your choice.

Executive Status:
The executive is not currently active.



COZMO

anki



Course logistics…

Website

Piazza:
https://piazza.com/gatech/spring2017/cs3630/home

Office Hours

Will be posted on *Piazza*.

Prerequisites

- The only formal prerequisite is CS1332 Data Structures & Algorithms.
- Prior knowledge of fundamentals of linear algebra and probability is also assumed.
- This course requires that you have a laptop and a cell phone compatible with the Cozmo app (any recent version of Android or iOS)

Textbook

No assigned textbook for this course, but material covered in lectures has significant overlap with the following:

- *Introduction to Autonomous Mobile Robots*, by R. Siegwart, I. Nourbakhsh, MIT Press, 2011.
- *Robotics, Vision and Control*, by Peter Corke, Springer, 2011.
- *Mobile Robots: Navigation, Control and Remote Sensing*, by G. Cook, Wiley-IEEE Press, 2011.

All three books are available in digital form through online access at the Georgia Tech library.

Assignments and Grading

Labs:

- 7 labs, each worth 8% of final grade
- Lab 1 completed individually, Labs 2-7 in pairs
- All programming will be in Python 3

Assignments and Grading

Quizzes:

- 10 quizzes throughout the semester
- Two lowest quiz grades will be dropped
- Remaining 8 quizzes each worth 5.5% of final grade

Late submissions

- Quizzes – no late quizzes or rescheduling for missed quizzes except for extenuating circumstances

- Labs – up to two late days allowed, but a grade penalty of 50% and 75% will be applied at the first and second day, respectively. Since almost all labs require a live demo for grading (usually done in class), please contact a TA well ahead of time to schedule a time to demo your solution if you are missing class or are making a late submission.

Final Exam

- There is no final exam (or midterm, or any other exam) in this course. Demos for Lab 7 will take place on the final day of the course.

Homeworks

- There are no homeworks, but we will make practice problems and solutions available that will be similar in content to the quiz questions

Extra Credit

You can earn extra credit throughout the semester through the following:

- Make a particularly helpful Piazza post, which is endorsed by at least 3 course staff. [0.2% of final grade]
- Contribute example code that does something new, interesting and/or useful, which is endorsed by at least 3 course staff. The code must be related to Cozmo or provide a tool usable in the course. It may be related to an assignment, but does not have to be. It must not provide a solution to an assignment. [0.5% of final grade]
- Complete the CIOS survey at the end of class. Extra credit of 0.3% of total grade if at least 85% of the class completes the survey.

Collaboration Policy

Rule of thumb: Don’t copy any one else’s work. If you’re leveraging information heavily from any external source, note that in your submission.

Partners

- When you receive your robot on January 24th, you already need to have a partner.
- Partner arrangements are not fixed and can change throughout the semester. In fact, we encourage anyone not satisfied with their partner to find a new partner to work with. In rare cases, we can facilitate partnering arrangements

Cozmo Robots

You and your partner will receive a Cozmo robot to use for the semester that you will return, with all accessories, at the end of the course. Each Cozmo will be numbered and we will keep track of who has which robot using this spreadsheet. At the end of the semester, you are responsible for returning the robot for which your name is listed. If you switch partners and start using a new robot, please email one of the TAs and they will update the spreadsheet.

Tentative Schedule…

DATE	TOPIC	NOTES
Tue Jan 10	Course Introduction	-
Thu Jan 12	Image Processing and Object Recognition	**Bring laptop to class**
Tue Jan 17	Image Processing and Object Recognition	-
Thu Jan 19	Visual Servoing	Quiz
Tue Jan 24	*Go to CCB 345 to pick up Cozmo robots*	**Lab 1 due**
Thu Jan 26	Behavior Control (short lecture, then lab)	**Lab 2 checkpoint**
Tue Jan 31	Coordinate Transforms	Quiz
Thu Feb 2	*In-class demos*	**Lab 2 due**
Tue Feb 7	Mobile Robot Kinematics and Odometry	-
Thu Feb 9	Path Planning: Representations and Fundamentals	Quiz
Tue Feb 14	Path Planning as Search	Quiz
Thu Feb 16	*In-class demos*	**Lab 3 due**
Tue Feb 21	Path Planning: Potential Fields and Probabilistic Methods	-
Thu Feb 23	Representing Uncertainty, Foundations of Localization	Quiz
Tue Feb 28	Histogram Filter, Particle Filter	-
Thu Mar 2	Particle Filter, Kalman Filter Foundations	Quiz

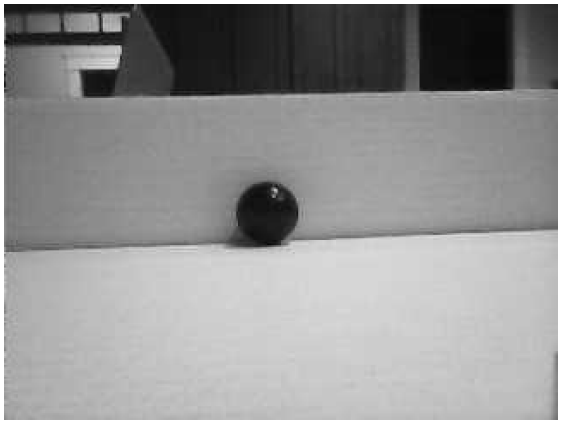
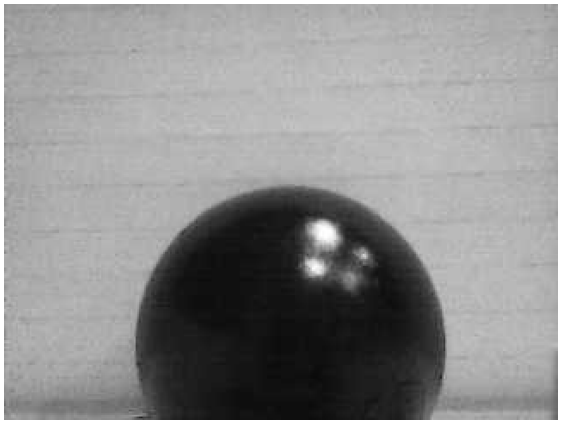
Tentative Schedule…

Tue Mar 7	*In-class demos*	**Lab 4 due**
Thu Mar 9	Guest lecture	-
Tue Mar 14	Kalman Filter	Quiz
Thu Mar 16	*In-class demos*	**Lab 5 due**
Spring Break		
Tue Mar 28	SLAM	-
Thu Mar 30	Mapping and Exploration	Quiz
Tue Apr 4	Visual Odometry	-
Thu Apr 6	*In-class demos*	**Lab 6 due**
Tue Apr 11	Multi-Robot Systems	Quiz
Thu Apr 13	TBD	-
Tue Apr 18	*In-class demos*	**Lab 7 checkpoint**
Thu Apr 20	TBD	Quiz
Tue Apr 25	*Final Competition*	**Lab 7 due; return robots**

in-class lab/demo session, bring robot/laptop to class

Lab 1

- Will be posted tonight and is due January 24th at 3pm
- Objective: detect a ball in the robot's camera image using OpenCV
- This is an individual assignment

OpenCV

- Open source computer vision and machine learning library widely used in robotics

- Since OpenCV can occasionally be challenging to configure, Lab 1 will have a checkpoint to make sure everyone has a working installation
- On **Thursday**, please bring your laptop with a completed install or we will help you with the installation
  - (more details in the lab document)