ECE 3400: Intelligent Physical Systems

Assistant Professor
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Intelligent Physical Systems

IPS can perceive, reason about, and act upon their environment

- Sensors
- Controllers
- Actuators

Quadrotor

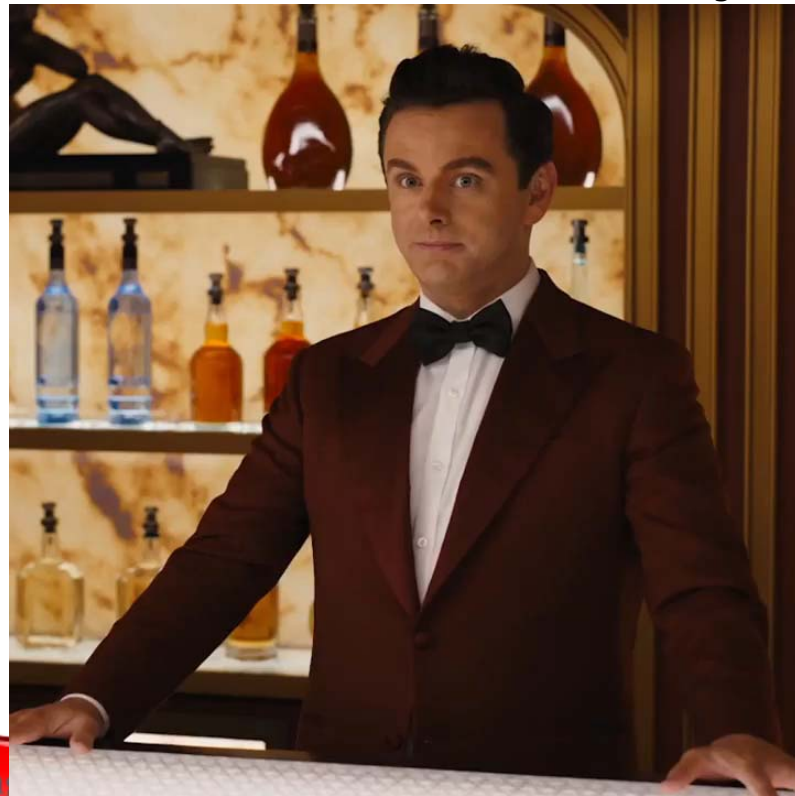KUKA industrial arm

Google humanoid

Dishwasher

Intelligent Physical Systems

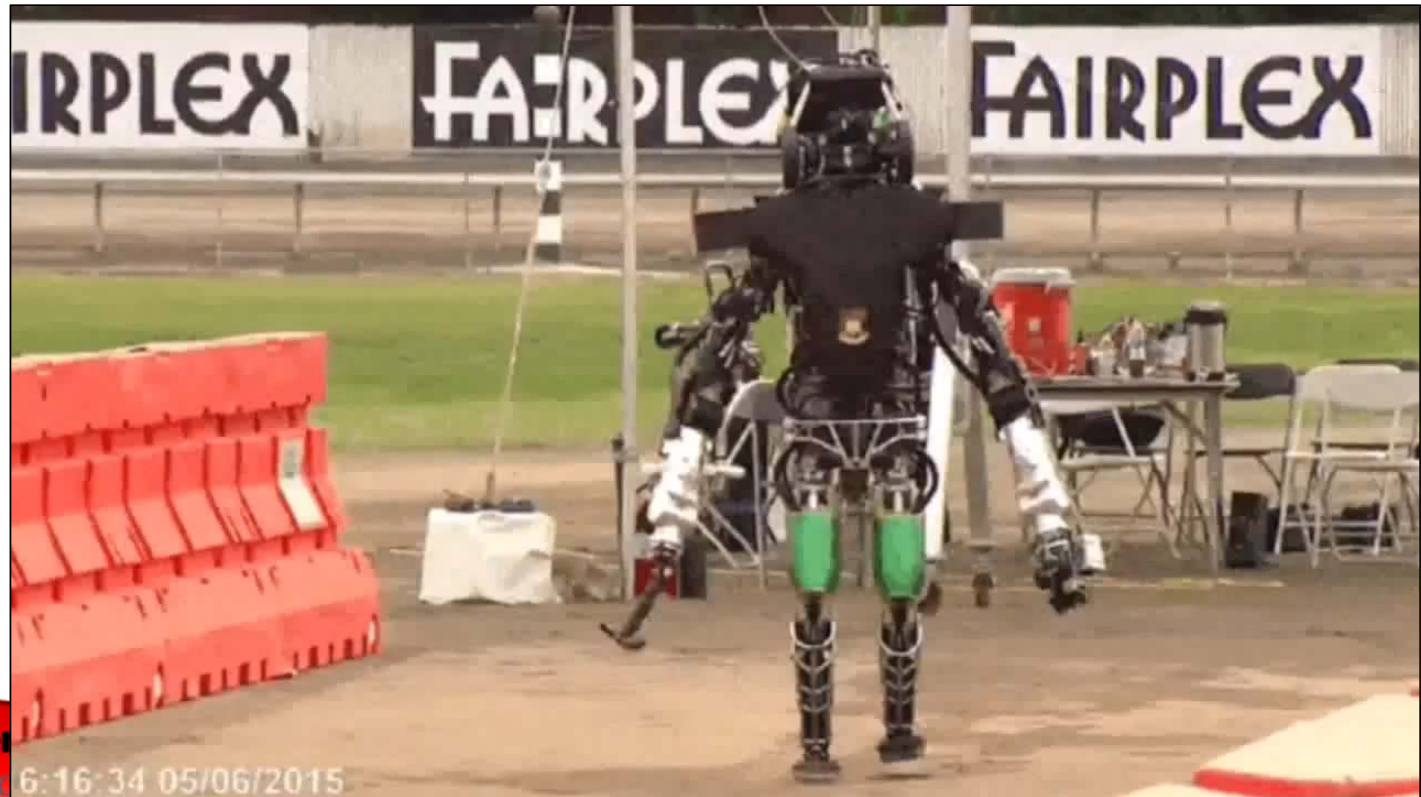*IPS can perceive, reason about, and act upon their environment*

Movie: Passengers

Intelligent Physical Systems

IPS can perceive, reason about, and act upon their environment
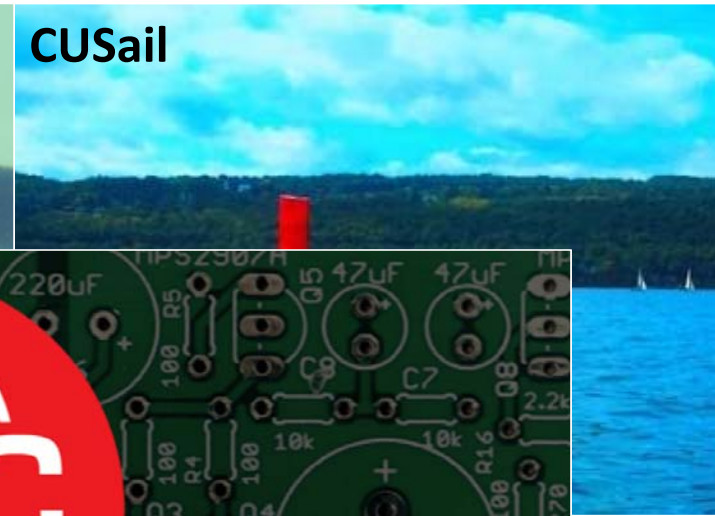
DARPA Grand Challenges Compilation

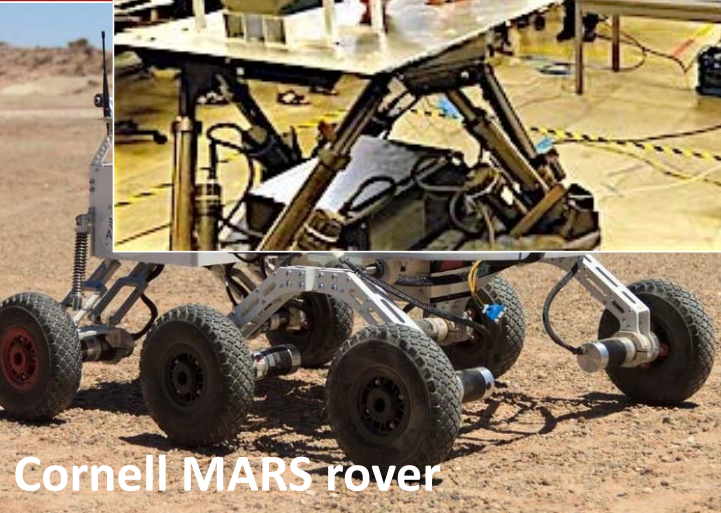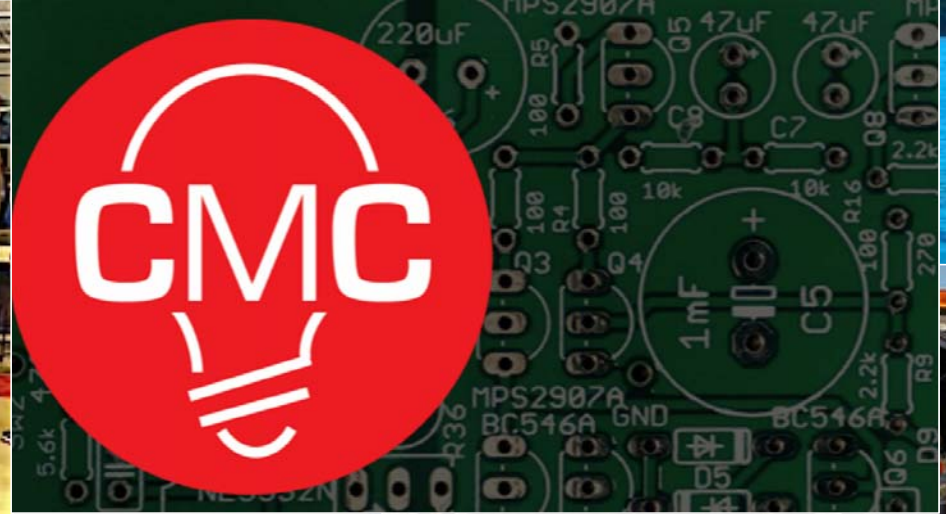# Intelligent Physical Systems *@Cornell*

CU Air

CUAUV

CUSail

Cornell Cup

Cornell MARS rover

Cornell Blimp

Team Cornell,
DARPA Grand Challenge 2005

Intelligent Physical Systems *@Cornell*

- Robotics mailing list: ROBOTICS-L@list.cornell.edu
- Robotics Seminar (1 credit): Wednesday 2-3pm, Upson 531

Semester Project

Build a maze-mapping robot that can...

...start on a 660Hz tone
...navigate the black grid
...detect walls/perform obstacle avoidance
...sense and distinguish treasures (IR beacons) in the maze
...display progress on a screen (wireless comm., FPGA VGA driver)
...recognize unreachable places
...signal that it is done visually and audibly
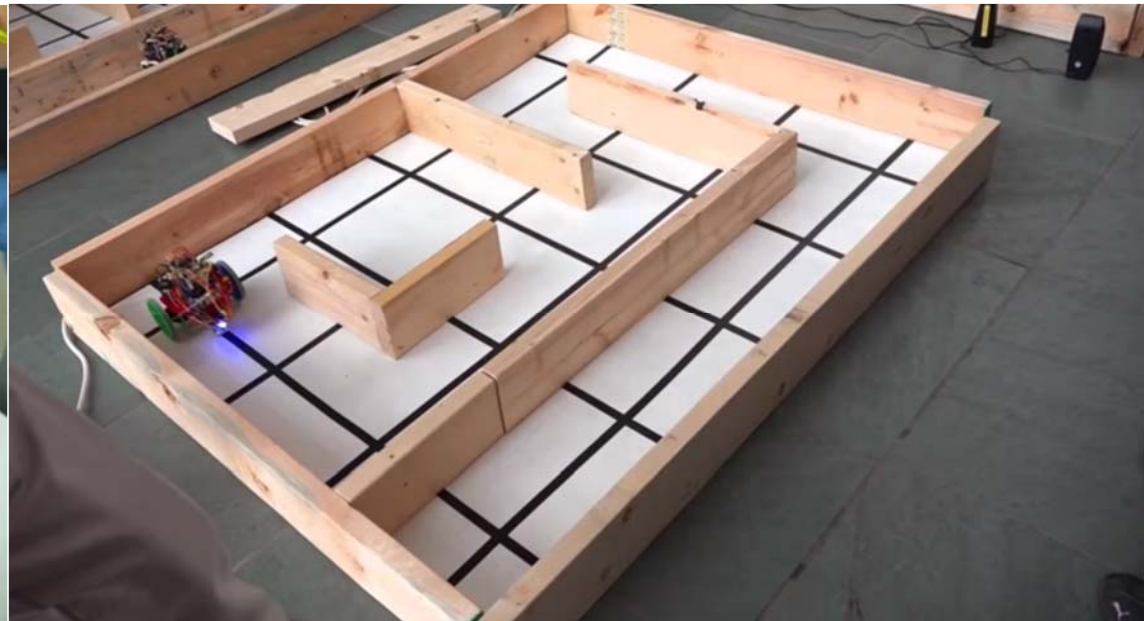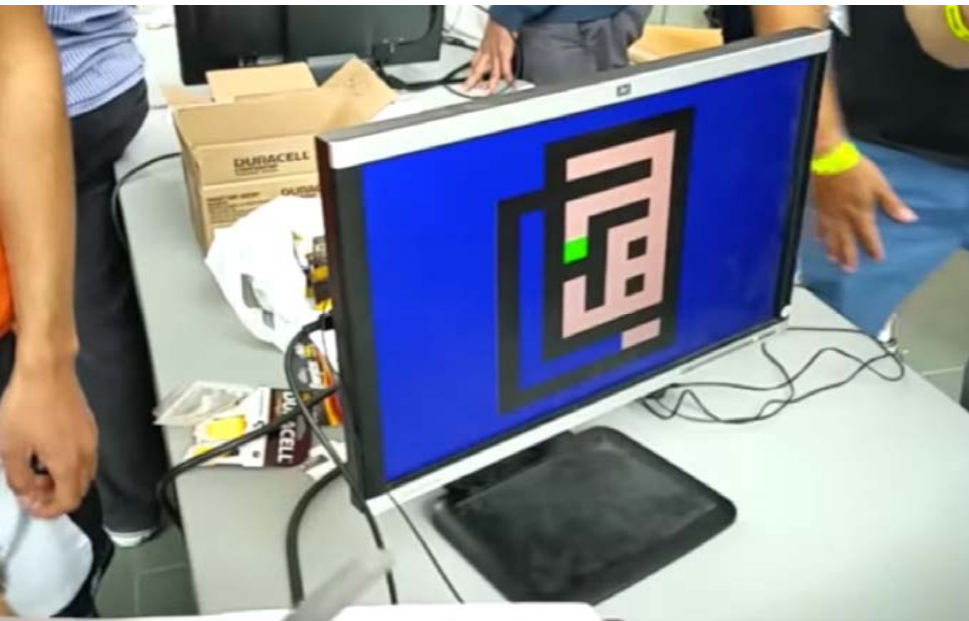
Semester Project

Restrictions

…must use Arduino Unos

…must use an FPGA DE0 nano

…must use Nordic wireless radios

…the total robot must cost less than $100:

- Suggested components include IR line sensors, IR distance sensors, electret microphones, continuous rotation servos
- Mechanical additions may include chassis, wheels, etc.
- Alternative components

Rumors!

Class website: https://cei-lab.github.io/ece3400/
Piazza: https://piazza.com/cornell/fall2017/ece3400/home
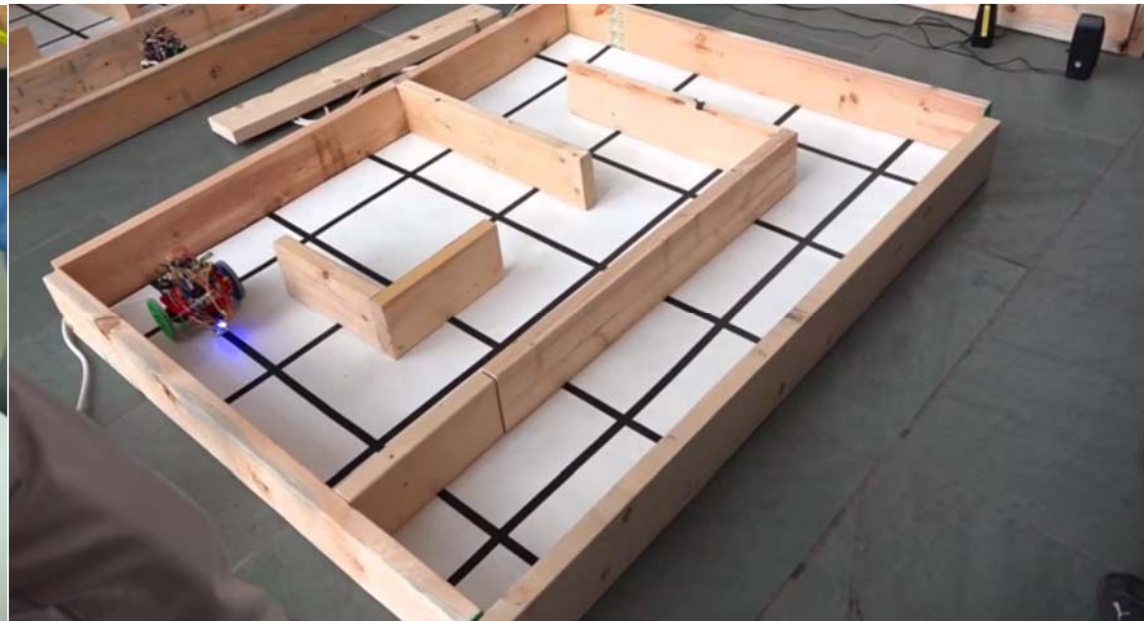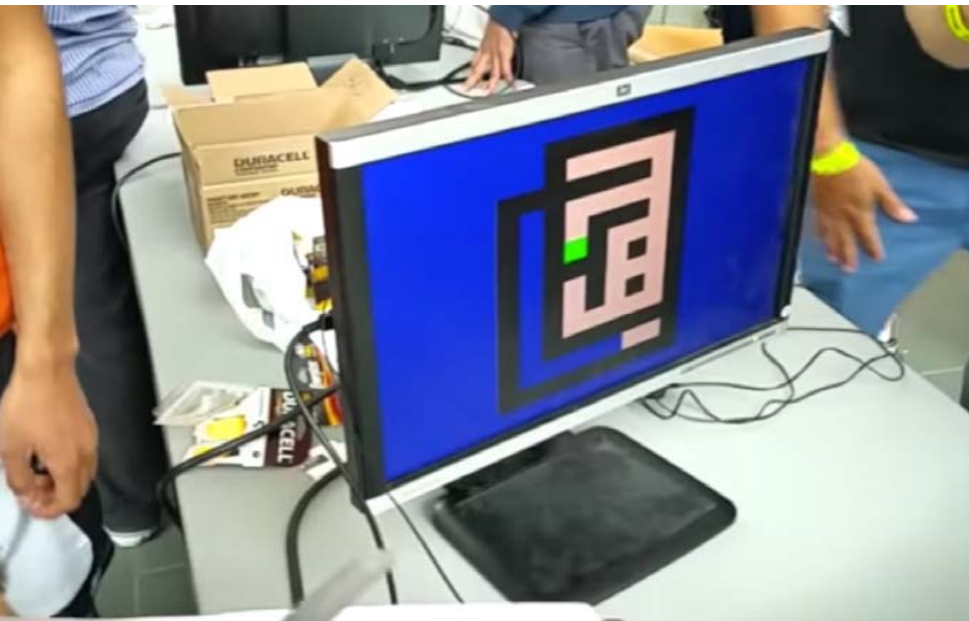
- Same challenge as the past two years

- Explore slightly new labs

- Explore new lectures

- Explore new teaching style

- Feedback is welcome!

Websites

Class website: https://cei-lab.github.io/ece3400/

Team Alpha: https://cei-lab.github.io/ECE3400-2017-teamAlpha/
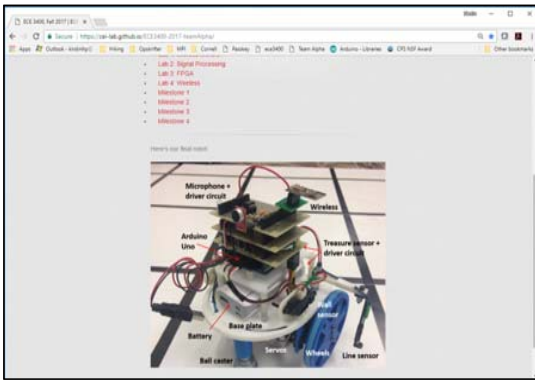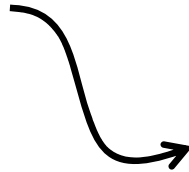
ECE 3400 2017

ECE 3400 2018
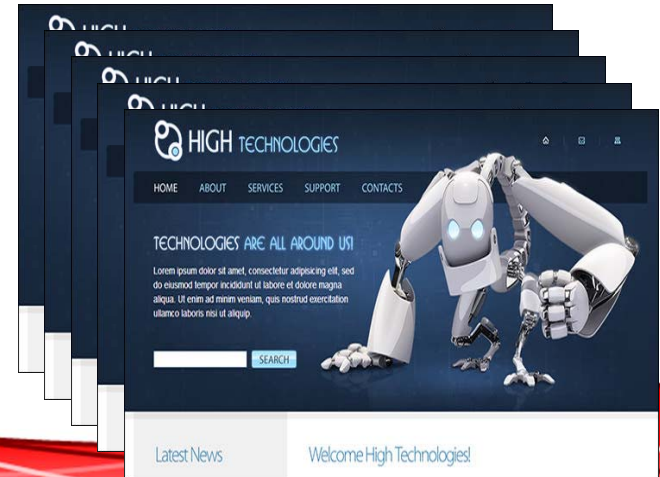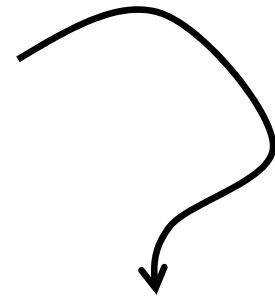
ECE 3400 2019

- Robotics is a field in rapid flux

- Rapid prototyping is a critical skill

- Starting from scratch is not realistic

- Critical reading, inspiration and innovation

- Work distribution within the teams

ECE3400 Cornell **Engineering**
Electrical and Computer Engineering

Semester Schedule

Class website: https://cei-lab.github.io/ece3400/

Week	Topic	Week	Topic
1	Intro, Arduino/website/Github	9	Prototyping EE, *LAB 4*
2	IPS fundamentals, team work/time management, *Website, LAB 1*	10	Algorithms
3	Sensors and filters	11	Algorithms, *Milestone 3*
4	Embedded control, *LAB 2*	12	Evaluating and debugging IPS
5	Actuators and control, *Milestone 1*	13	Power and alternative IPS
6	FPGA, VGA, *Milestone 2*	14	Discussion of websites *Milestone 4*
7	Prototyping ME, *LAB 3*	15	IPS Ethics, Career Center talk
8	Wireless communication	16	Final Competition

Grading

- Each of the 4 labs count up to 20 points

- Each of the 4 milestones count up to 10 points

- The final competition gives up to 20 points

- The final robot design gives up to 25 points

- The final webpage gives up to 20 points

- Team work assessments give up to 15 points

- Make tutorials for extra credits

Score	200-155	154-110	109-65	64-20	19-0
Grade	A	B	C	D	F

Subject to rescaling without warning!

ECE3400

Cornell **Engineering**
Electrical and Computer Engineering

Outcomes

- Skills in IPS design

    - Sensors

    - Mechanics

    - Feedback control

    - Analog/digital circuits

    - Embedded control and algorithms

- Skills in interdisciplinary team work and leadership

- Skills in online communication

Why do you want to take this course?

- *Take responsibility for your own learning!*
  - Try all disciplines
  - Attend lectures
  - Check/answer Piazza
  - Read class websites
  - Make user-friendly websites
  - Make tutorials, add helpful links
- Ask lots of questions
  - Piazza
  - Team and/or TAs
  - Kirstin
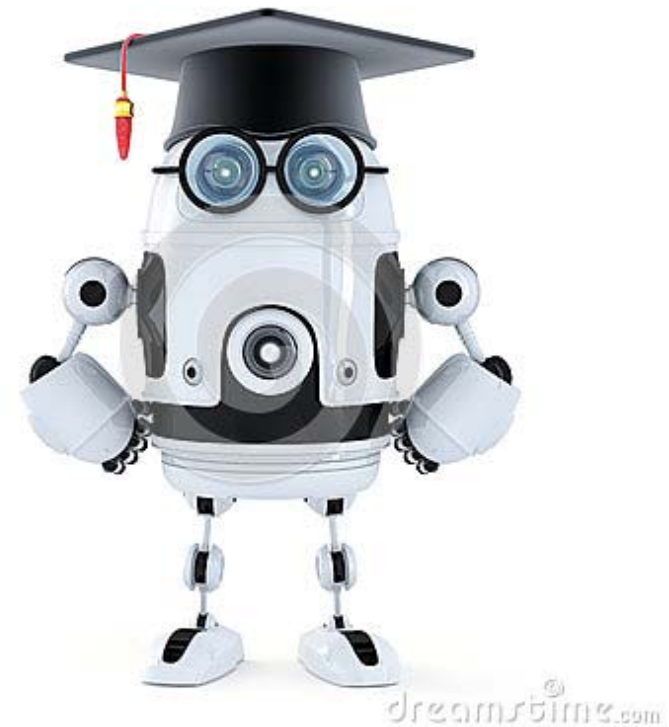
Where?

- Lectures in Kimball B11
  - Monday/Wednesday: Fundamentals
  - Friday: Practical Implementation / mandatory team meetings
  - Come on time!
- Lab work in PH427
  - Only access when TAs are present
  - Shared facility: Keep it orderly!
  - Come on time!
- Skunkworks facility in PH414
  - Currently TA access only

People with computers must sit to the left of the class room

Teaching Assistants

Class website: https://cei-lab.github.io/ece3400/

Mon 1.25-4.25pm

Christopher Fedors

Yangyi Hao

Mon 7.30-10.30pm

Vaidehi Garg

Claire Chen

Wed 7.30-10.30pm

Daniel Kim

Adarsh Jayakumar

Thur 7.30-10.30pm

Vidya Ramesh

Justin Selig

Fri 1.25-4.25pm

Curran Sinha

Leah Forrest
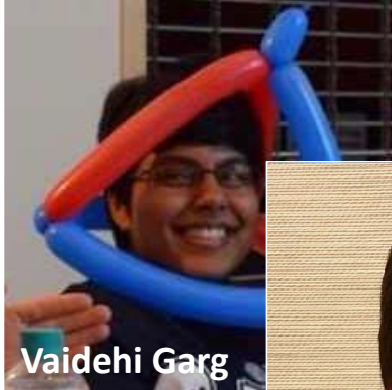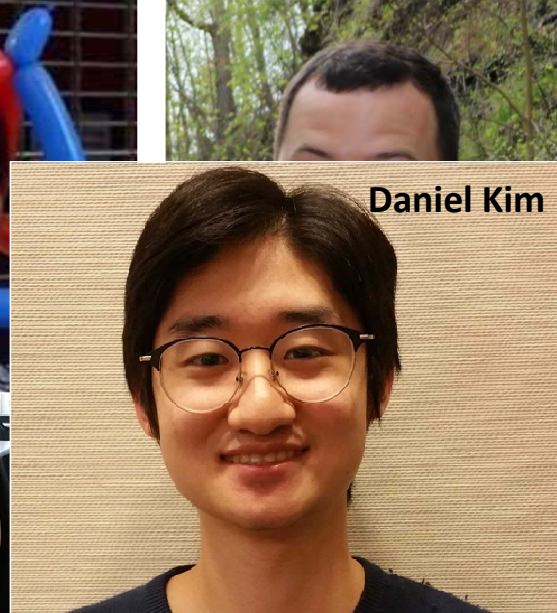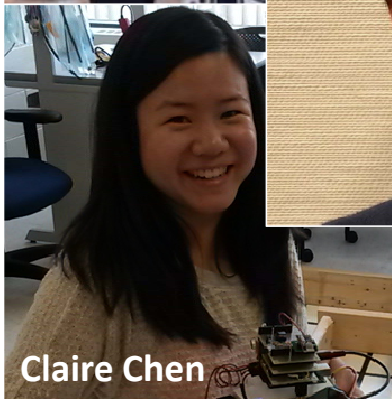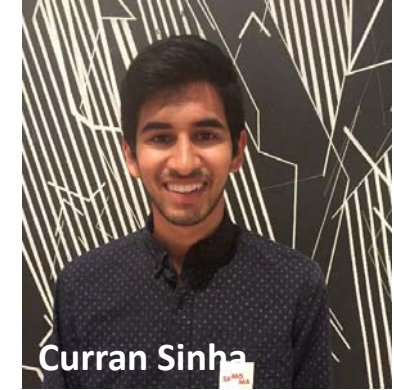
Good Team Work

- Right mix and number of members

- Optimally designed tasks and processes

- Norms

  - Discourage destructive behavior

  - Promote positive dynamics

- High-performing teams include members with a balance of skills.
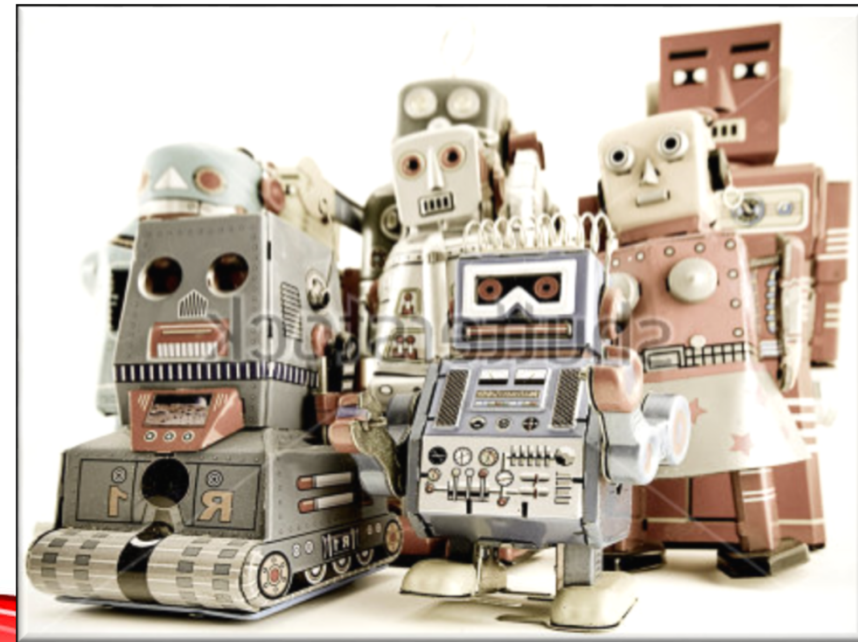
Good Team Work

Raymond Meredith Belbin (born 1927): **Belbin Team Inventory**

maximillion.co.uk

Teams

- Plant
- Monitor-Evaluator
- Specialist

- Coordinator
- Team Worker
- Resource Investigator

- Shaper
- Implementer
- Completer/Finisher

Plant

- Creative, unorthodox and generators of ideas.

- If an innovative solution to a problem is needed, a Plant is a good person to ask.

- Plants can tend to ignore incidentals, and often has a hard time communicating ideas to others.

- Multiple Plants in a team can lead to misunderstandings, as many ideas are generated without sufficient discernment or follow-through.

- The Plant may continue to come up with new solutions and disrupting the implementation process.

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Monitor Evaluator

- ME are fair and logical observers and judges of what is going on in the team.
- Since they are good at detaching themselves from bias, they are often the ones to see all available options with the greatest clarity and impartiality.
- They take a broad view when problem-solving, and by moving slowly and analytically, will almost always come to the right decision.
- However, they can become very critical, damping enthusiasm for anything without logical grounds, and they have a hard time inspiring themselves or others to be passionate about their work.

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Specialist

- Specialists are passionate about learning in their own particular field.
- As a result, they are likely to be a fountain of knowledge and will enjoy sharing this knowledge.
- They also strive to improve and build upon their expertise.
- Specialists bring a high level of concentration, ability, and skill in their discipline to the team, but can only contribute on that specialism and will tend to be uninterested in anything which lies outside its narrow confines

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Coordinator

- A Coordinator is a likely candidate for the chairperson of a team, since they have a talent for stepping back to see the big picture.

- Coordinators are confident, stable and mature and because they recognize abilities in others, they are very good at delegating tasks to the right person for the job.

- The Coordinator clarifies decisions, helping everyone else focus on their tasks.

- Coordinators are sometimes perceived to be manipulative and will tend to delegate all work, leaving nothing but the delegating for them to do.

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Team Worker

- A Team worker keeps the team running smoothly.

- They are good listeners and diplomats, talented at smoothing over conflicts and helping parties understand one another.

- Since the role can be a low-profile one, the benefit of a Teamworker can go unnoticed until they are absent, when the team begins to argue, and small but important things cease to happen.

- Because of an unwillingness to take sides, a Teamworker may not be able to take decisive action when it's needed.

Teams

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Resource Investigator

- The RI gives a team a rush of enthusiasm at the start of the project by vigorously pursuing contacts and opportunities.

- He or she is focused outside the team, and has a finger firmly on the pulse of the outside world.

- Where a Plant creates new ideas, a Resource Investigator will quite happily appropriate them from other companies or people.

- A good RI makes possibilities and an excellent network, but has a tendency to lose momentum towards the end of a project and to forget to follow things up.

Teams

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Shaper

- The Shaper is a task-focused individual who is driven by lots of energy and the need to achieve.
- Shapers are people who challenge the team to improve. They are dynamic and usually extraverted people who enjoy stimulating others, questioning norms, and finding the best solutions
- The Shaper is the one who shakes things up to make sure that all possibilities are considered and that the team does not become complacent.
- Shapers could risk becoming aggressive and bad-humored in their attempts to get things done.

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Implementer

- The Implementer takes their colleagues' suggestions and ideas and turns them into positive action.
- They are efficient and self-disciplined, and can always be relied on to deliver on time.
- They are motivated by their loyalty to the team or company, which means that they will often take on jobs everyone else avoids or dislikes.
- However, they may be seen as closed-minded and inflexible since they will often have difficulty deviating from their own well-thought-out plans, especially if such a deviation compromises efficiency or threatens well-established practices.

Teams

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- Implementer
- Completer/Finisher

Completer/Finisher

- The CF is a perfectionist and will often go the extra mile to make sure everything is "just right," and the things he or she delivers can be trusted to have been double-checked and then checked again.

- The CF has a strong inward sense of the need for accuracy, and sets his or her own high standards rather than working on the encouragement of others.

- They may frustrate their teammates by worrying excessively about minor details and by refusing to delegate tasks that they do not trust anyone else to perform.

Good Team Work

- Plant
- Monitor-Evaluator
- Specialist

- Coordinator
- Team Worker
- Resource Investigator

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- Implementer
- Completer/Finisher

"Nobody's perfect, but a team can be!"

- Mixed teams perform better
- Work on your own weaknesses
- Know the weaknesses of your team
- Use your strengths
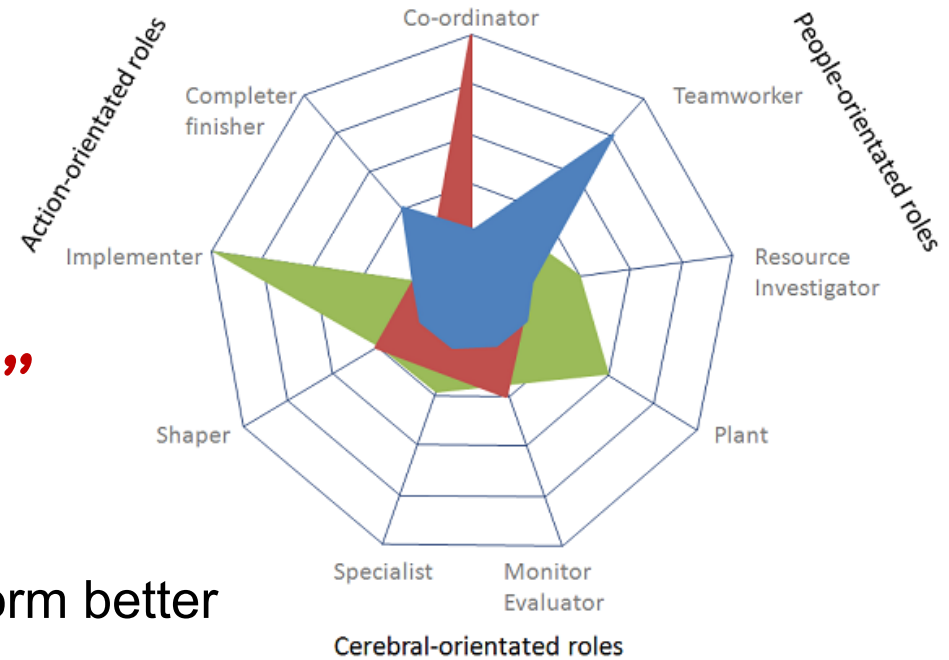
Practical Information

- Fill out the Google form by midnight tonight!
- Join Piazza and check out the class Github/website
- Friday
  - Practical info on working with Arduinos
- Teams ready by Monday
- Next week
  - Lab 1 (PH427)
  - Write up a team contract
- Demo!

Go Build Robots!

Class website: https://cei-lab.github.io/ece3400/
Piazza: https://piazza.com/cornell/fall2017/ece3400/home