

CS 378: Autonomous Intelligent Robotics

Instructor: Jivko Sinapov

<http://www.cs.utexas.edu/~jsinapov/teaching/cs378/>

Announcements

FRI Summer Research Fellowships:

<https://cns.utexas.edu/fri/beyond-the-freshman-lab/fellowships>

Applications are due March 1st but apply now!

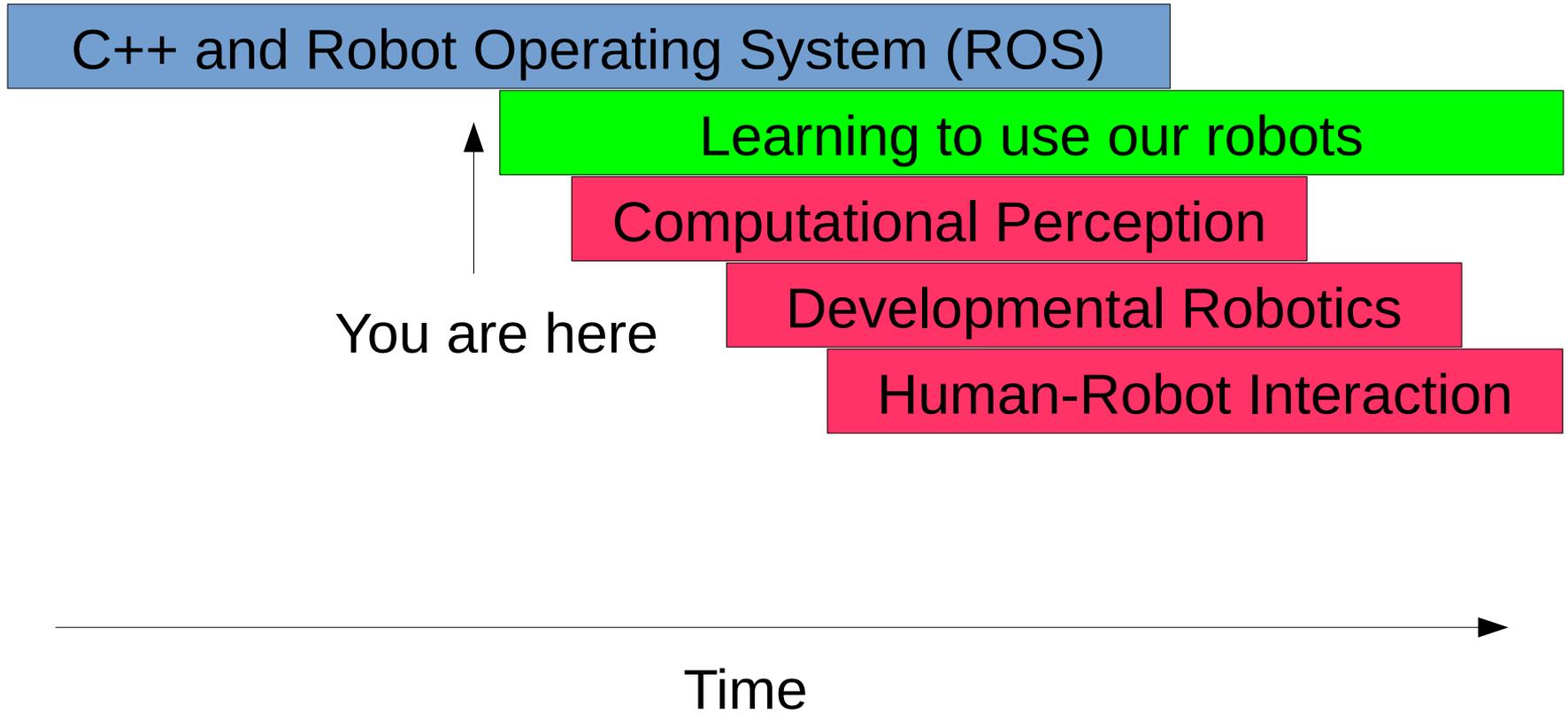
Funding is available for 4-5 students per FRI stream

Announcements

A few volunteers needed for explore UT

- Help setup and run the mobile robots during the open house
- Help run a drone robot demo
- Saturday at 10 am (event starts at 11 am)
- Email me if interesting in helping out
- Everyone is welcome to the event

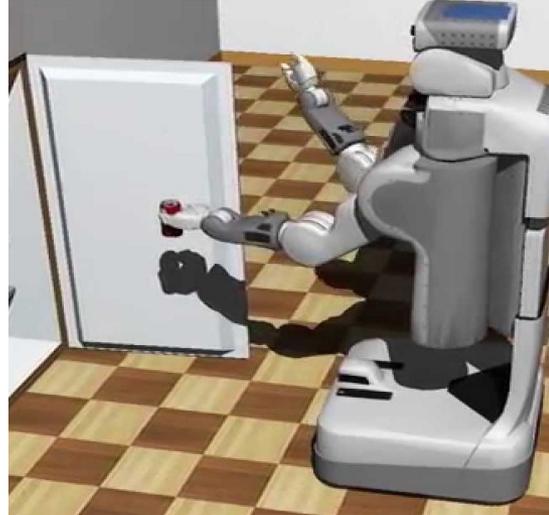
Semester Schedule



Progression



2D simulation



3D simulation



Real World

The Gazebo 3D simulator

- Install gazebo_ros package:
sudo apt-get install ros-indigo-gazebo-ros
- Run the simulator:
roslaunch gazebo_ros rubble_world.launch
- Guide for installing the gazebo simulator on Mac OS:
[http://gazebo-sim.org/tutorials?tut=install_from_source
&cat=install](http://gazebo-sim.org/tutorials?tut=install_from_source&cat=install)

Reading Discussion

D. McDermott (1981). "Artificial intelligence meets natural stupidity". Ch. 5 in *Mind Design: Philosophy, Psychology, Artificial Intelligence*, pp. 143-160, MIT Press.

Rich Sutton (2001). "Verification, The Key to AI".

Rich Sutton (2001). "Verification".

Reading Discussion

“What is Doug Lenat's CYC?”

There is a search for an ultimate "ontology", or codification of all objects and their possible relationships,” -- is this the goal of/relate to the study some of us participated at the beginning of the semester?”

- Kathryn

Reading Discussion

“For some of the “IS-A” relationships, I understood why the application was not accurate. However, given that most of these relationships seemed vague and unclear, what would be an entirely accurate “IS-A” relationship? If there are none, then how exactly can natural language interfaces be manufactured given how complex the simplest of English language constructs are? “

- Anrav

Reading Discussion

“What is his deal with the naming of these programs? I feel as though naming these programs something that normal people will understand might help the normalization of these programs to the general public. How would the naming scheme affect anything significantly?”

- Jonathan

The Verification Principle

The Verification Principle: *An AI system can create and maintain knowledge only to the extent that it can verify that knowledge itself [8].*

The Verification Principle

- The key to AI is a system that can tell whether or not it is working correctly
- An AI system must be in charge of its own learning
- Eventually, it will be widely adopted

The Verification Principle

“A proposition is said to be verifiable, in the strong sense of the term, if and only if, its truth could be conclusively established in experience. But it is verifiable, in the weak sense, if it is possible for experience to render it probable.”



A. J. Ayer (1910 - 1989)

Reading Discussion

“How do humans verify things? How does this affect how robots would verify? What would a robot need to do to make up for things that humans can do but robots cannot?”

- Kiana

Reading Discussion

“I would like to know how close we are today to having a fully autonomous verification system in robots. How much progress has been made in the last 15 years? How exactly would the robot verify the knowledge it's given?”

- Ruchira

Reading Discussion

“Was there any purpose of releasing two separate articles a single day apart instead of publishing them together?”

- Nathan

Readings for this week

Hoffmann, Matej, and Rolf Pfeifer. "The implications of embodiment for behavior and cognition: animal and robotic case studies." arXiv preprint arXiv:1202.0440 (2012).

Hoffman, Guy. "Embodied cognition for autonomous interactive robots." Topics in cognitive science 4.4 (2012): 759-772.

Michel, Philipp, Kevin Gold, and Brian Scassellati. "Motion-based robotic self-recognition." Intelligent Robots and Systems, 2004.(IROS 2004). Proceedings. 2004 IEEE/RSJ International Conference on. Vol. 3. IEEE, 2004.

Today

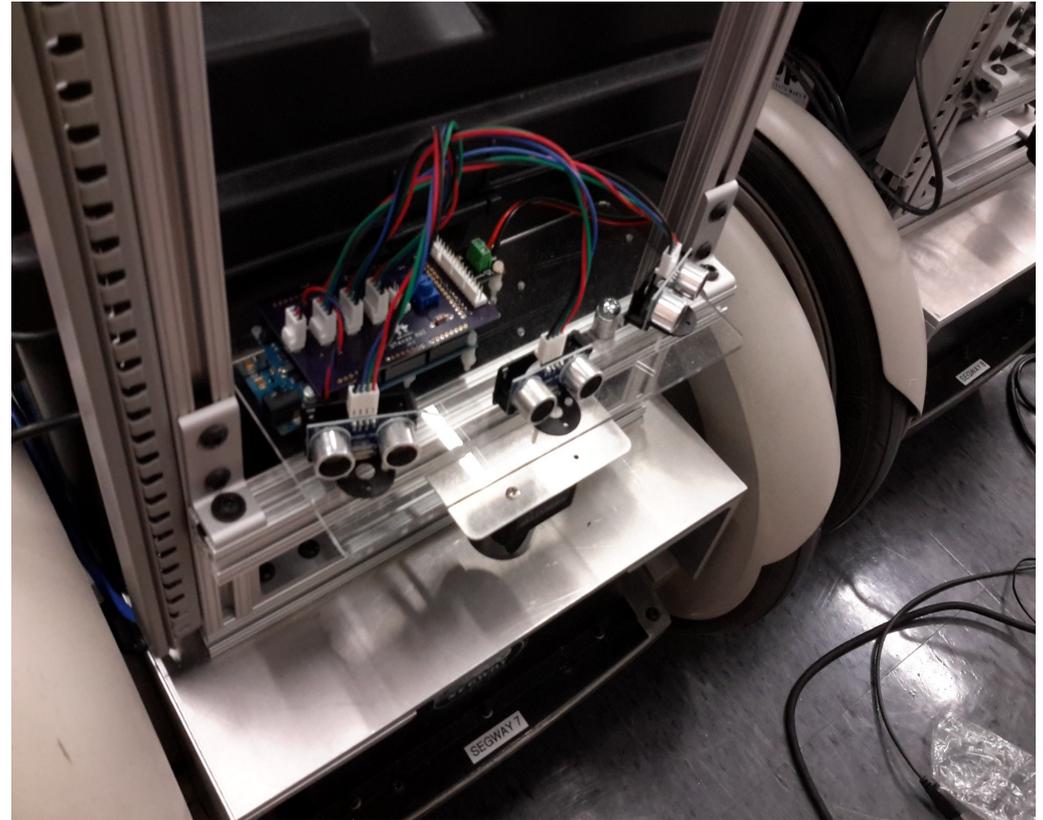
- Final Project Ideas
- Embodiment
- Homework 4 Q & A / Help

Types of Projects

Project Ideas



Vending Machine



Sonar Sensor

Project Ideas

Write ROS code to allow the robot to use an LED light strip



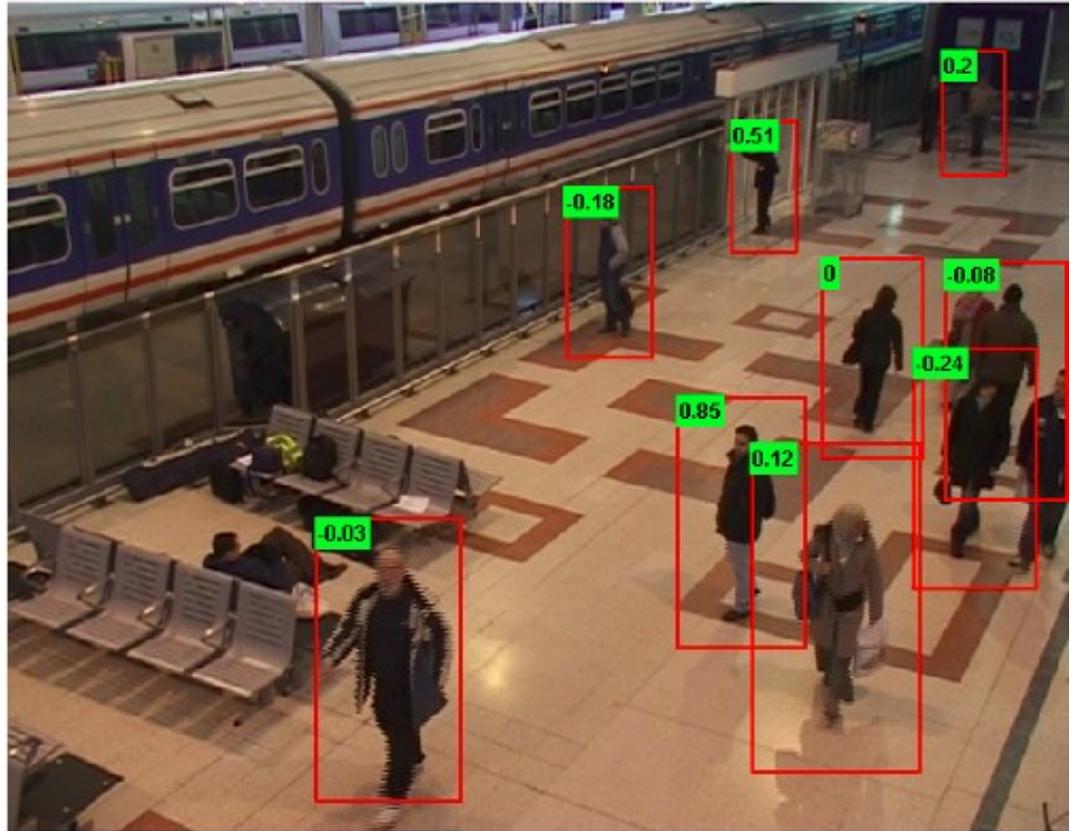
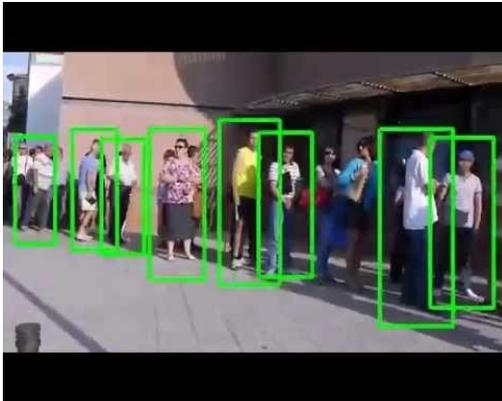
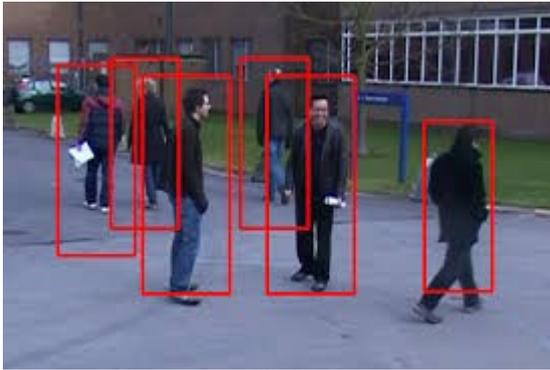
Project Ideas

Help the robot “see” something it currently cannot

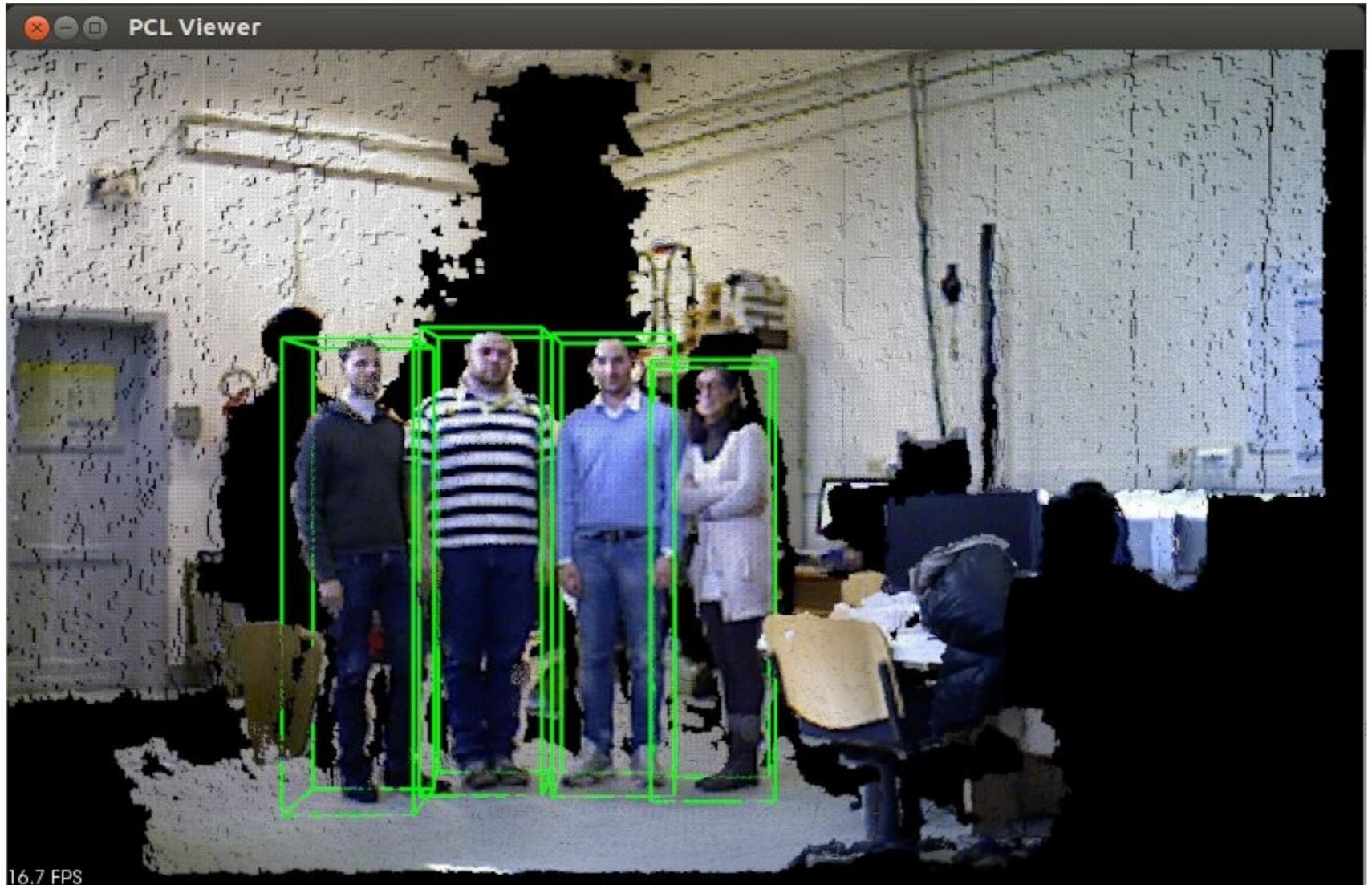
Project Ideas



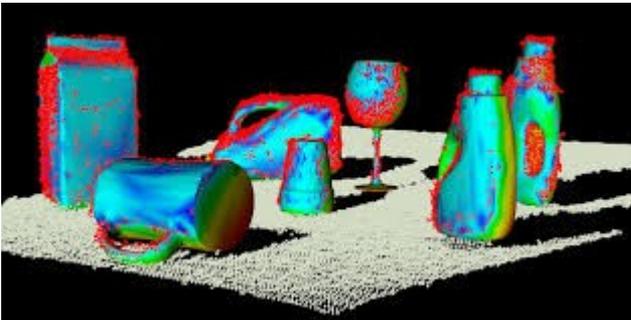
Project Ideas



Project Ideas



Project Ideas



Project Ideas

- ROS Driver / Controller for new devices (vending machine, sonar sensor, LED light strip)
- Help the robot see something new
- Creative ideas: make the robot dance
- Write a high level app that uses the existing code base (e.g., a message delivery task)

Project Ideas (cont'd)

- Find an interesting or useful ROS package and integrate it with our system:
 - <http://www.ros.org/browse/list.php>
- Find an interesting computer vision package or tutorial and implement it as a ROS node
 - <http://pointclouds.org/documentation/tutorials/>
 - <http://docs.opencv.org/2.4/doc/tutorials/tutorials.html>

Final Project Timeline

- Project Proposal due: **March 29th**
- Project Presentations / Demos: **Last Week of Class (May 3rd and 5th)**
- Final Report due: **May 11th**

Embodiment

Embodiment



No body

Body

Traditional View of AI

Mainstream Science on Intelligence December 13, 1994:

An Editorial With 52 Signatories, History, and Bibliography by Linda S. Gottfredson, University of Delaware

*“Intelligence is a very general mental capability that, among other things, involves the ability to **reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience.**”*

Traditional vs Embodied AI

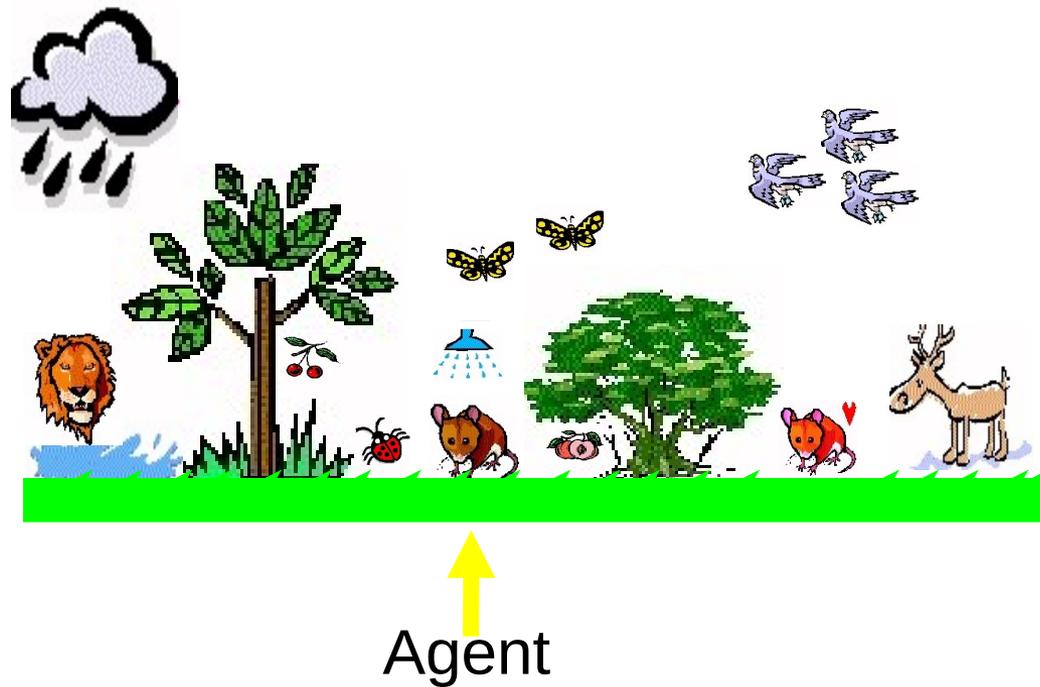
- Abstract intelligence
 - attempt to simulate “highest” human faculties:
 - language, discursive reason, mathematics, abstract problem solving
- Environment model
 - Condition for problem solving in abstract way
 - “brain in a vat”
- Embodiment
 - knowledge is implicit in the fact that we have a body
 - embodiment is a foundation for brain development
- Intelligence develops through interaction with environment
 - Situated in a specific environment
 - Environment is its best model

Embodied AI

Embodied Intelligence (EI) is a mechanism that learns how to survive in a environment (potentially hostile)

- Mechanism: biological, mechanical or virtual agent with embodied sensors and actuators
- EI acts on environment and perceives its actions
- EI learns so it must have associative self-organizing memory
- Knowledge is acquired by EI

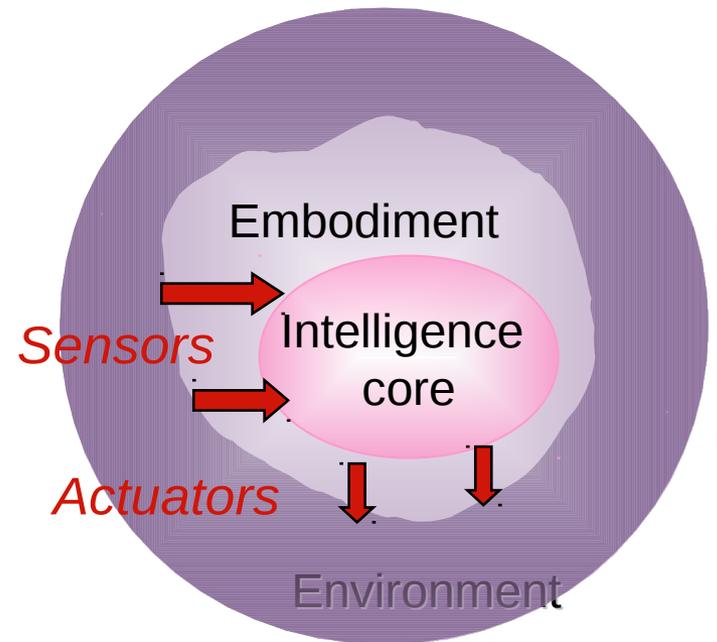
Embodied AI



Drawing by Ciarán O'Leary- Dublin Institute of Technology

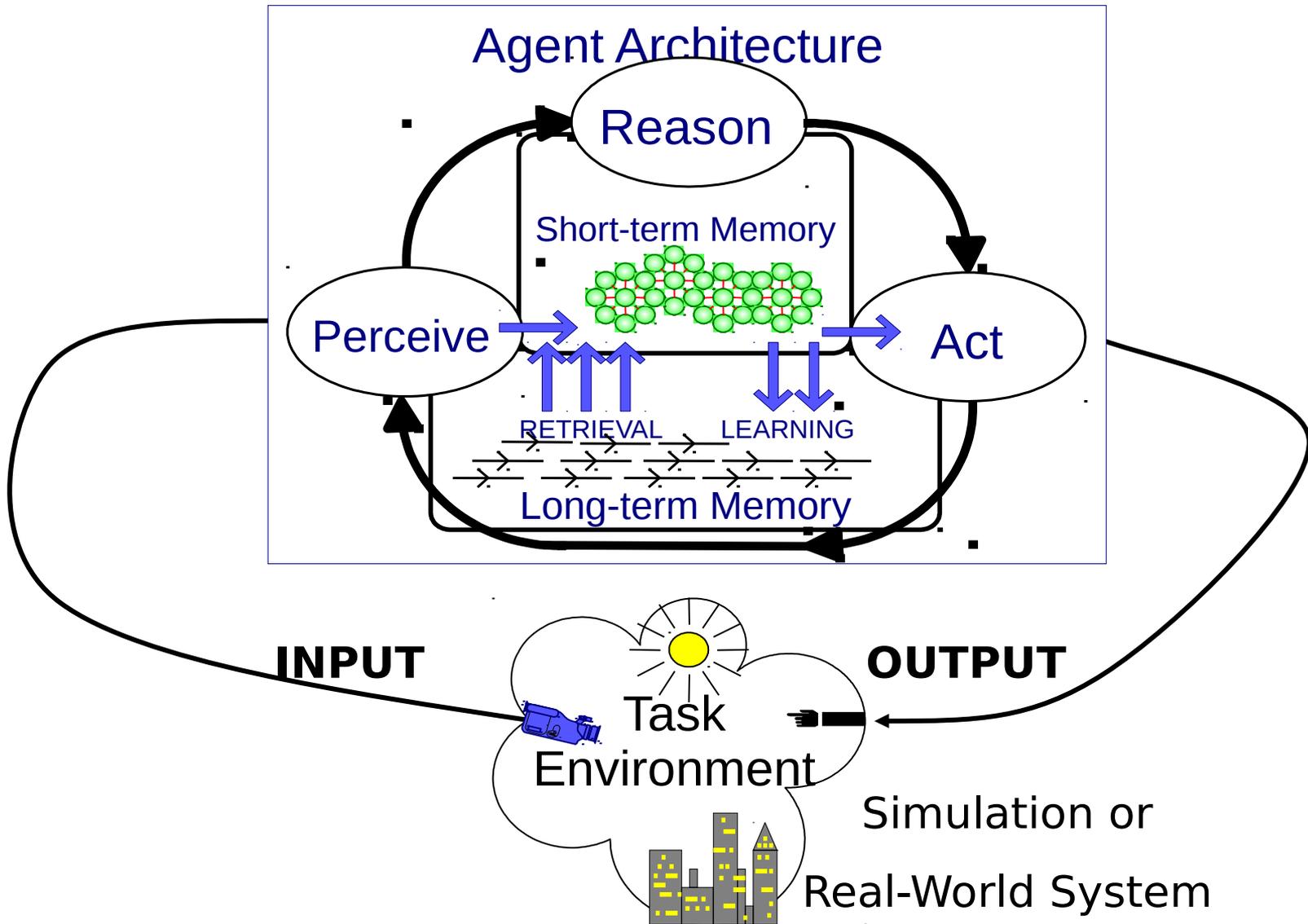
Embodied AI

“Embodiment of a mind is a mechanism under the control of the intelligence core that contains sensors and actuators connected to the core through communication channels.”



Drawing and quote by Janusz Starzyk
EECS, Ohio University

Embodied AI



Embodiment in Humans

Embodiment in Humans

Fetal Growth From 8 to 40 Weeks



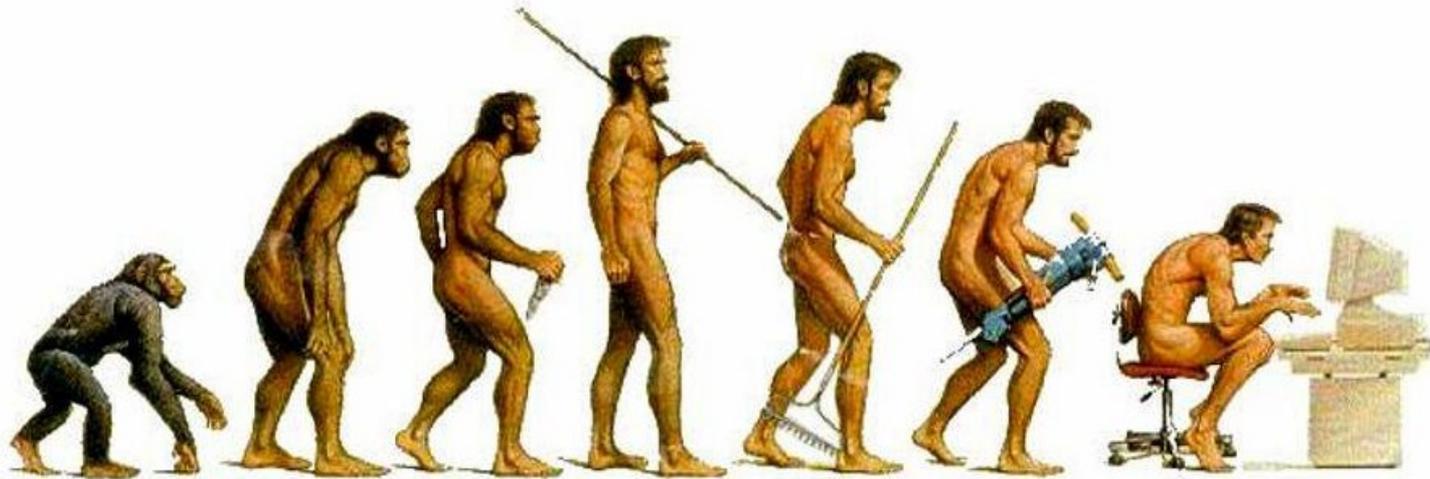
<https://anagnk.files.wordpress.com/2013/03/fetal-growth.jpg>

Embodiment in Humans



Source: Getty Images

Embodiment in Humans



Embodiment in Humans



*Human Brain
at Birth*

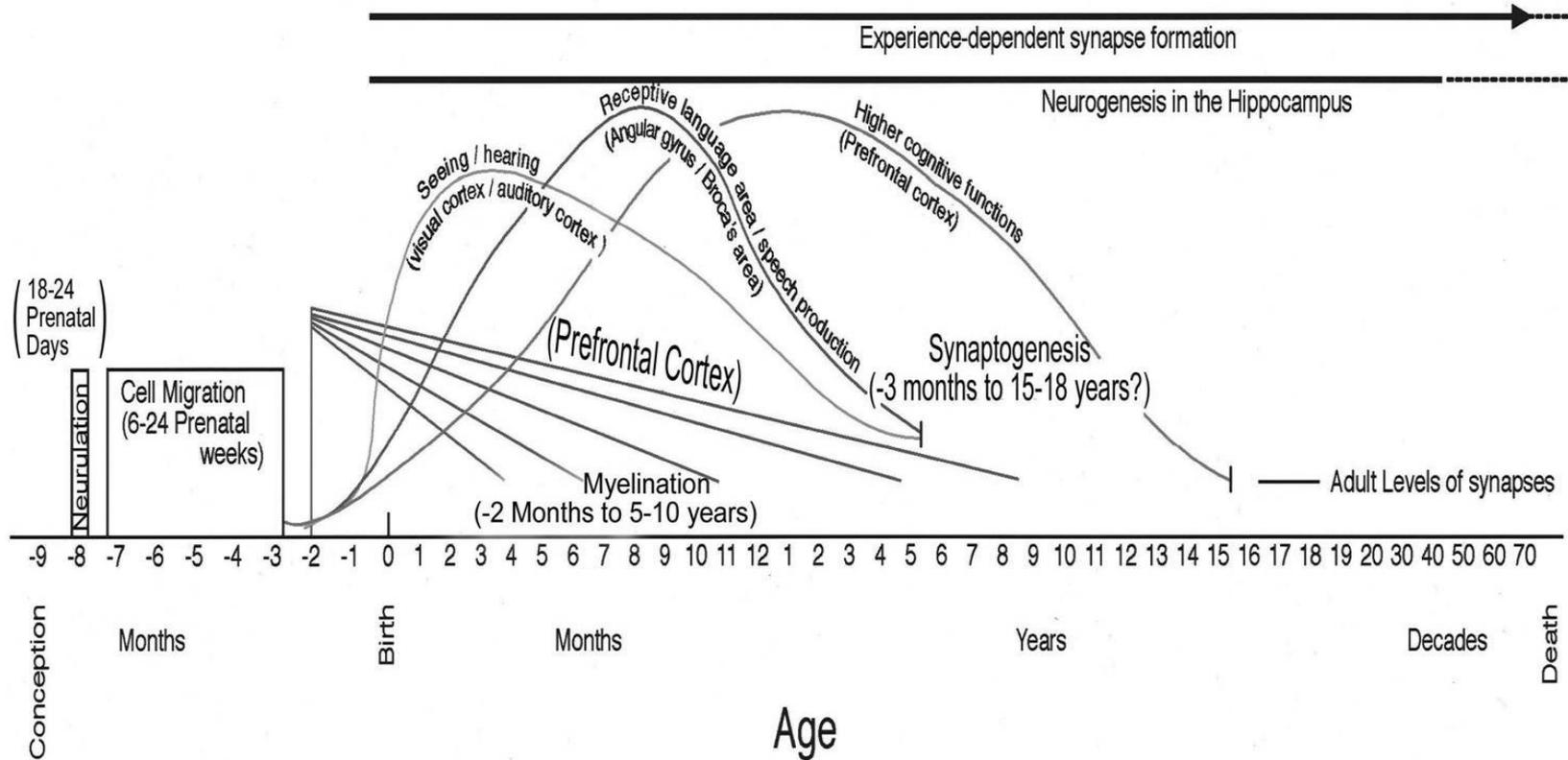


6 Years Old



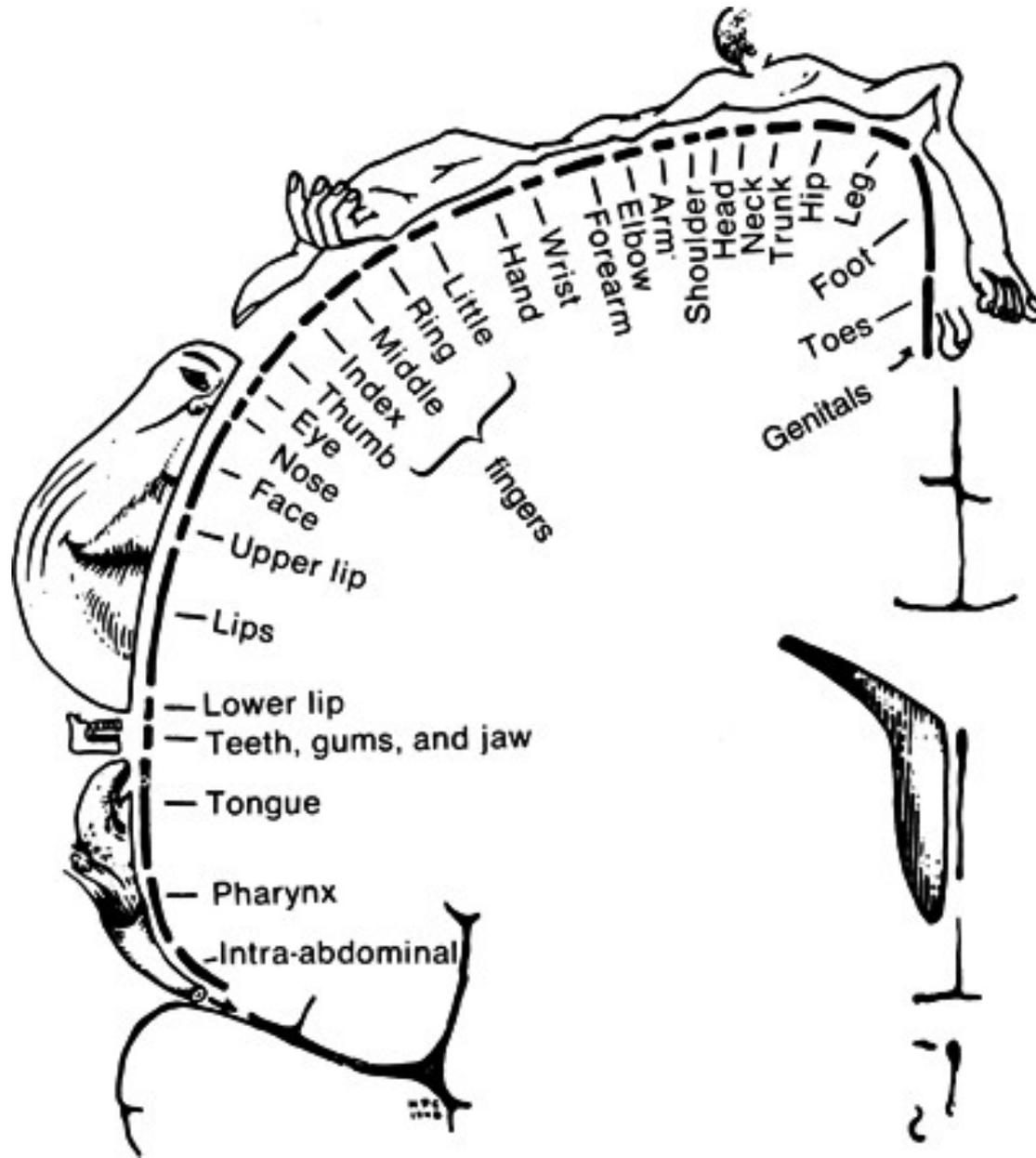
14 Years Old

Synaptic Density over Time



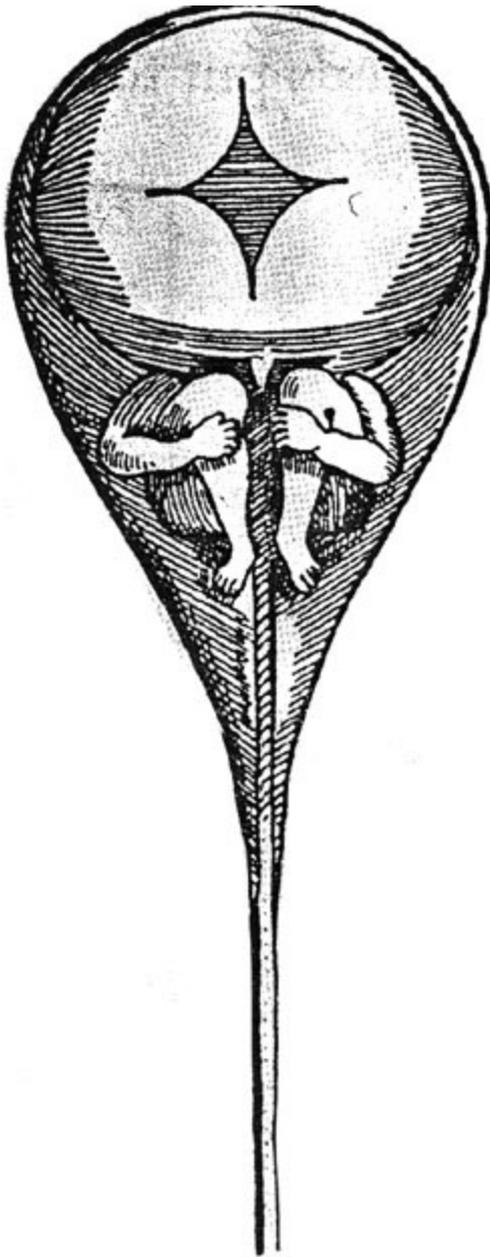
Thompson, R. A., & Nelson, C. A. (2001). Developmental science and the media: Early brain development. *American Psychologist*, 56(1), 5-15.

Penfield (a.k.a. Sensory) Homunculus



And its 3D analog





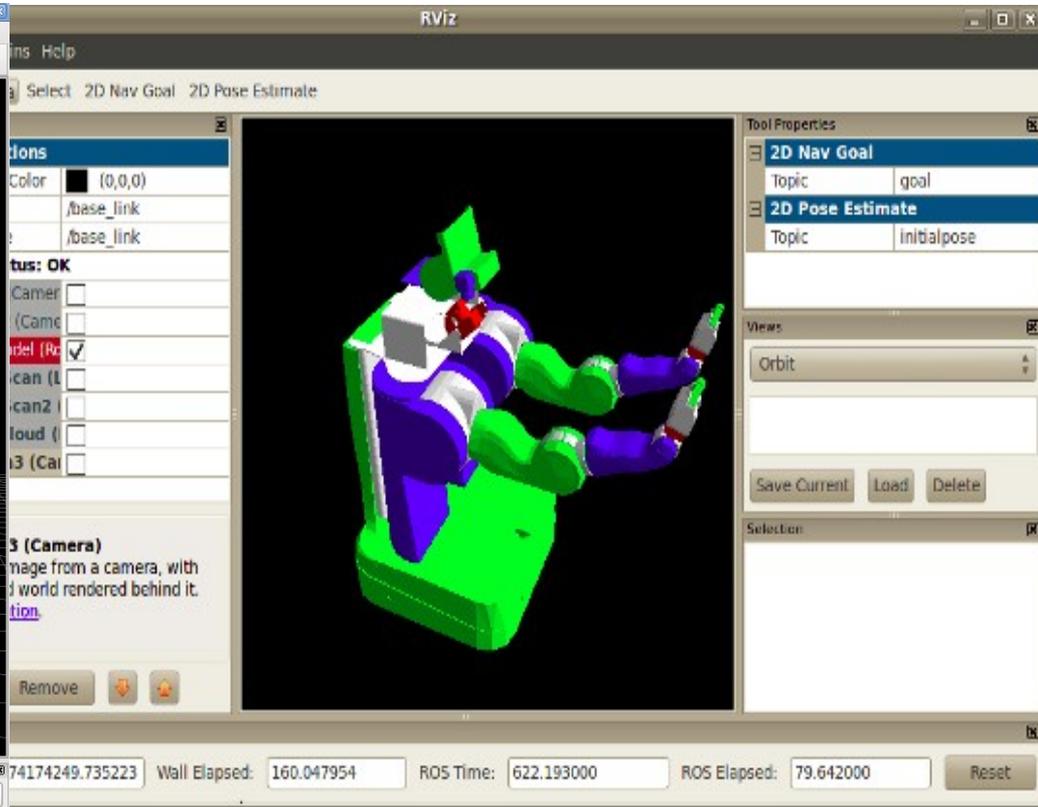
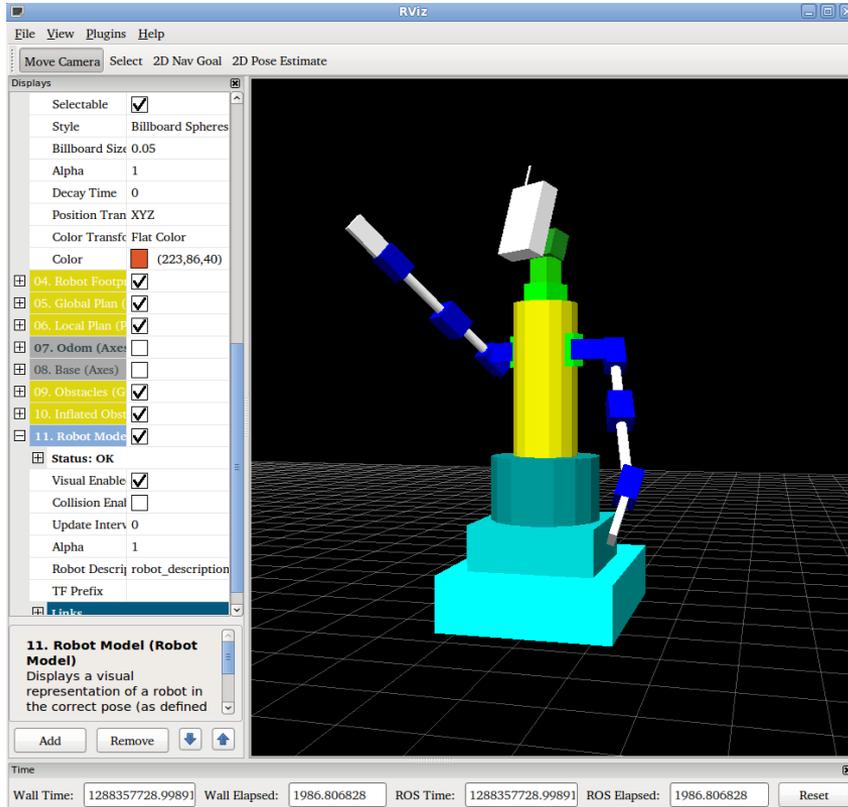
Origins of the word Homunculus:

A miniature, fully formed individual believed by adherents of the early biological theory of preformation to be present in the sperm cell.

Discussion

- Would a robot's body ever need to change over time?
- Do human bodies change in addition to just growing up?

Next Time: Robot Bodies in ROS



Homework 4: Q&A / Help

THE END