COMP 150: Developmental Robotics

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This Week

- Embodiment
- Team-up Activity
- Literature Surveys
Announcement

• Readings for Week 4 are out

• Homework 2 will go out on Thursday
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.”
Origin of Intelligence in Humans
Leonardo da Vinci
Rene Descartes

[http://psych.hanover.edu/classes/neuropsychology/webnotes/Class2.html]
Rene Descartes
Homunculus

“A miniature, fully formed individual believed by adherents of the early biological theory of preformation to be present in the sperm cell.”
Grown-up Homunculus
Apps for the brain?
“An important implication of the verification principle is that the robot must have the ability to verify everything that it learns. Because verification cannot be performed in the absence of actions the robot must have some means of affecting the world, i.e., it must have a body.”
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 an 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
“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

Agent Architecture

Reason

Short-term Memory

Perceive

Act

Long-term Memory

RETRIEVAL

LEARNING

INPUT

OUTPUT

Task

Environment

Simulation or Real-World System

From Randolph M. Jones, P: www.soartech.com
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

Rethinking the Brain, Families and Work Institute, Rima Shore, 1997.
Synaptic Density over Time

Penfield (a.k.a. Sensory) Homunculus
And its 3D analog
Sensory and Motor Homunculus
Discussion

- Do we really need a body to study AI?
- What are some of the differences in practice between embodied AI and disembodied AI?
- Which one is "harder" to do?
How do robots currently represent their own bodies?
What kind of data structure would you define to represent this:
What about this?
Types of Robot Joints

(a) Linear Joint
(b) Orthogonal Joint
(c) Rotational Joint
(d) Twisting Joint
(e) Revolving Joint
Robot Bodies in ROS
ROS Tutorial on URDF

http://wiki.ros.org/urdf/Tutorials
What are some limitations of this approach to represent bodies?
Team-up Activity