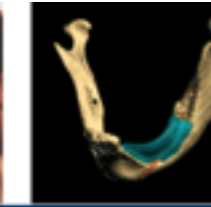
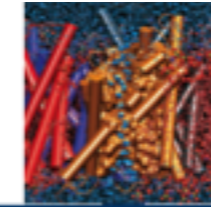
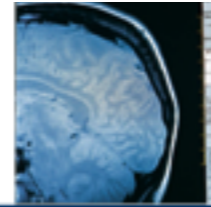
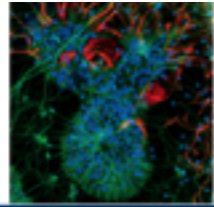


# The Roles of Reductionism, Emergence, and Functional Equivalence in Speech Comprehension

*Stephen E. Levinson*

*Department of Electrical and Computer Engineering  
(email at: [selevins@illinois.edu](mailto:selevins@illinois.edu))*

*June 16<sup>th</sup>, 2014*



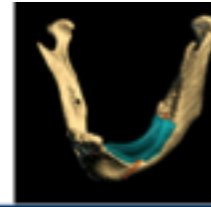
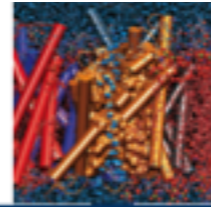
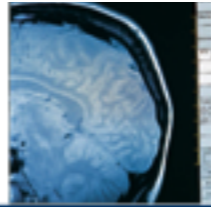
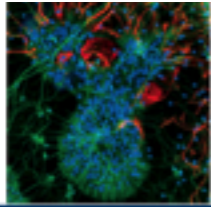
# Language Acquisition and Robotics Group

## Current Students:

- Logan Niehaus
- Alex Duda
- Luke Wendt
- Felix Wang
- Onyeama Osuagwu
- Jacob Bryan
- Yuchen He
- Chun Yang

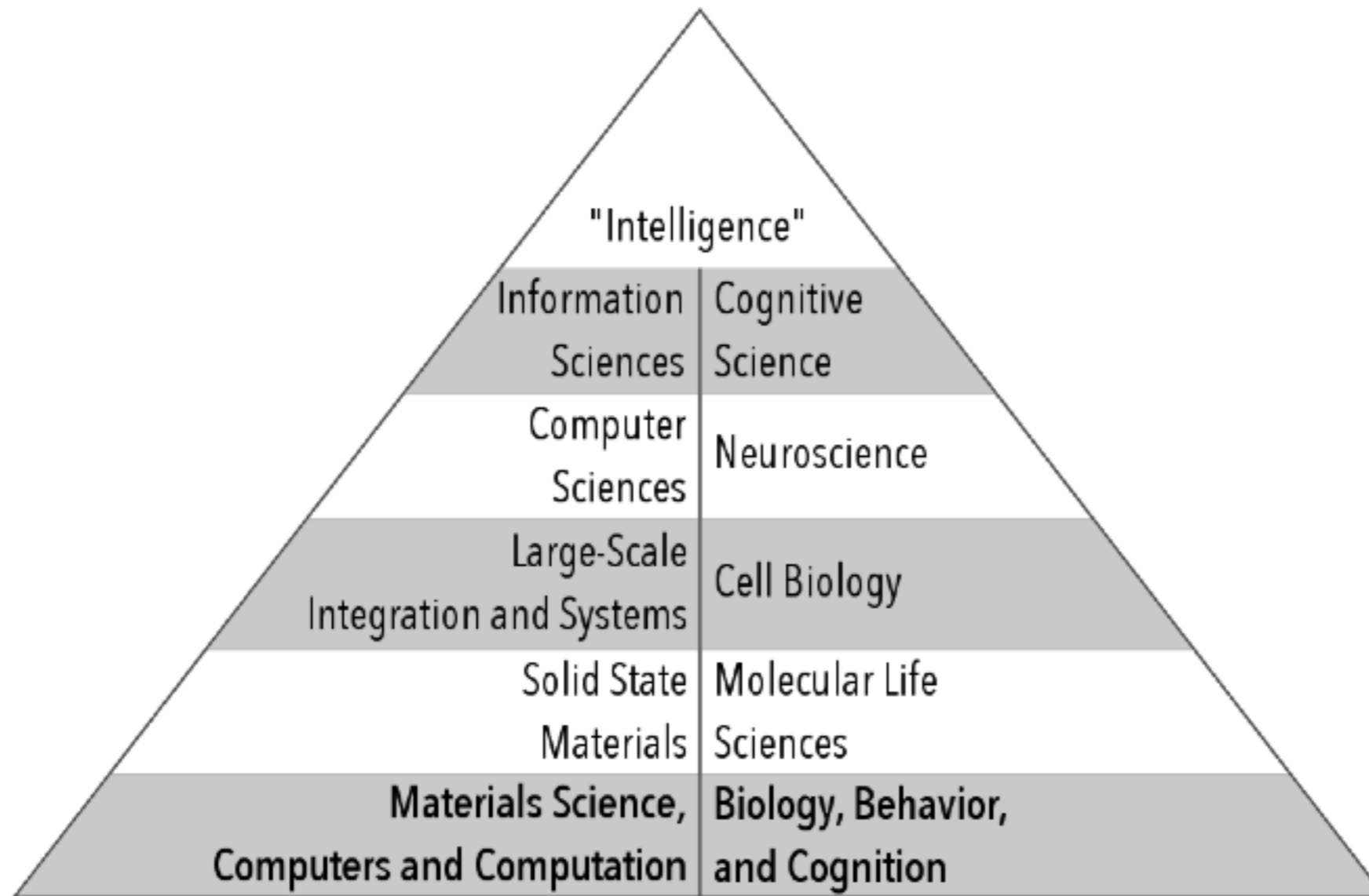
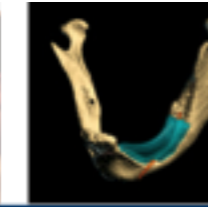
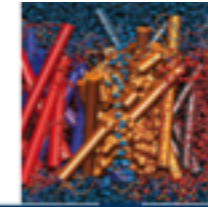
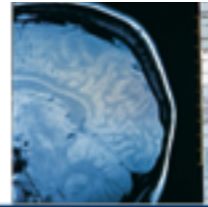
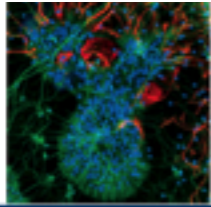
## Past Students:

- Qiong Liu
- Weiyu Zhu
- Kevin Squire
- Matt McClain
- Lydia Majure



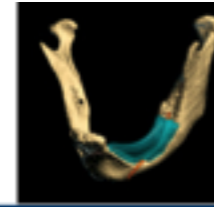
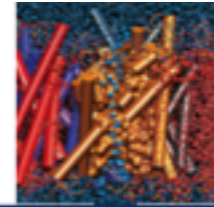
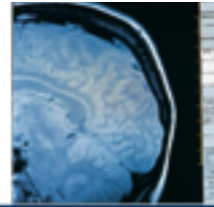
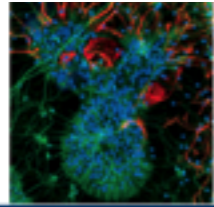
# Methodologies

- Reductionist (Einstein)
- Functionally Equivalent (Turing, Wiener, von Neumann)
- Emergent (Gibbs, Shannon)
- Beckman Charter



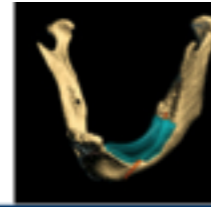
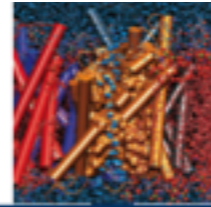
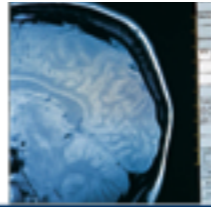
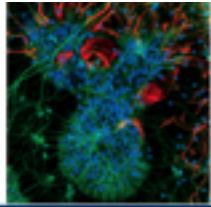
The Beckman Institute for Advanced Science and Technology





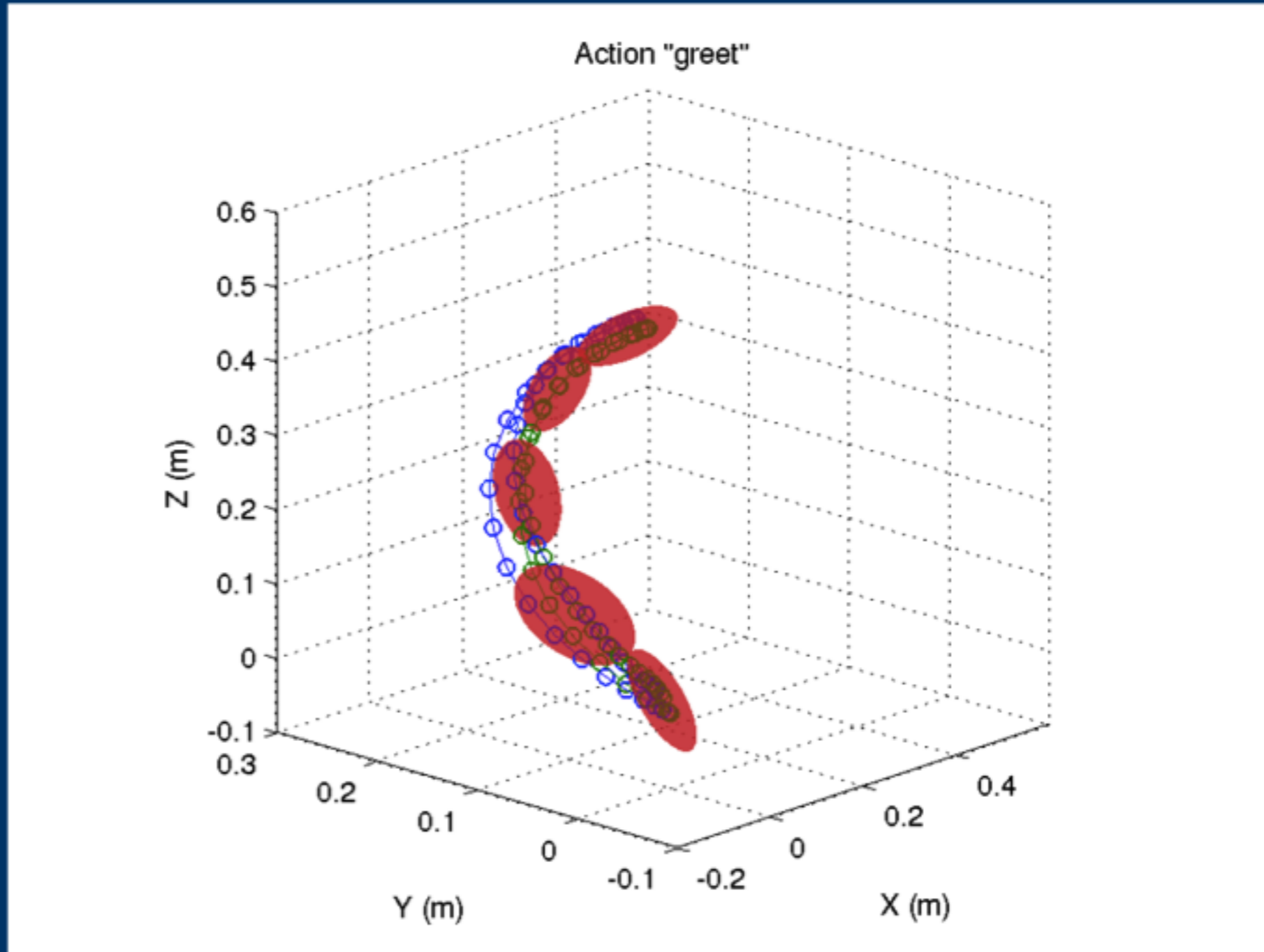
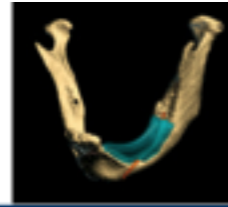
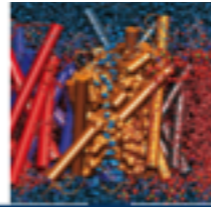
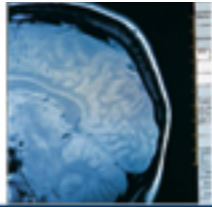
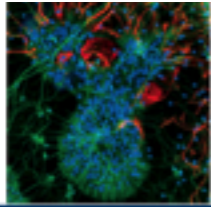
# Functional Equivalence – Abstractions

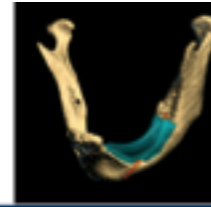
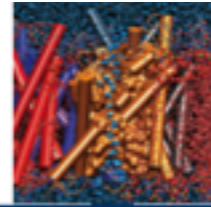
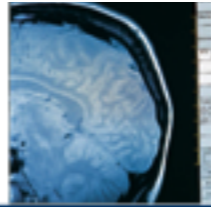
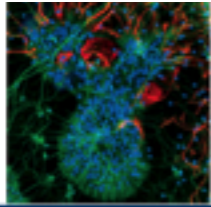
- Computational Model of Turing
- Homeostasis / Adaptation from Wiener
- Utilitarian Model from von Neumann
  
- Videos:
  - Choreography
  - Motor Babbling
  - Reaching and Grasping
  - Maze Navigation
  - Gesture Learning



# Mental Models of Reality

- Perception
- Language
- Signals / Symbols
- Agency

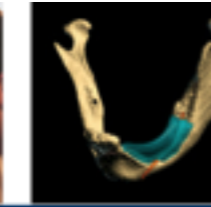
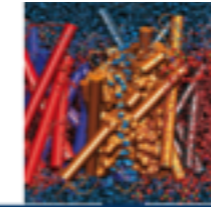
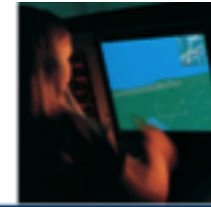
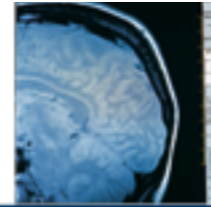
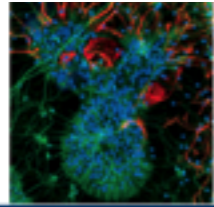




# Emergent Brains and Minds

- Reliable function from unreliable components
- Information processing vs. regulation
- Representations
- Sensorimotor integration (spatial reasoning)
- Artificial neural networks (perceptron, spin glass, SOM)





# Working Hypotheses

- Not universal computation
- Heuristic approximation – table lookup from associative memory
- Distinguish information bearing signals from regulatory
- Brain states to mental states from non-linear dynamics for reliability (equilibria of  $\dot{x} = f(x, t)$ )
- Reinforcement learning