LEC 01

Perception informs an organism what is in its environment, and where it is. Evolutionarily significant actions: hunting/gathering food; fleeing from predators, finding mates, navigating the environment.

Relationship between the physical world and the perceptual world

1. Naive realism -- The world is simply as it appears. Hence no real mystery about perception.
   Problems:  
   - Sensitivity to a small fraction of physical energy
   - Different animals perceive the world in very different ways
   - Multistability

2. Subjective idealism -- The world exists only as a result of perception (George Berkeley). Philosophers' brain-in-a-vat problem.
   Problems:  
   - Generally leads to solipsism
   - Not scientifically useful

John Locke's observation with lukewarm water; Distinction between primary and secondary qualities

3. Perception is a function of:  
   - available physical energy
   - sensitivities of our sense organs
   - processing of sensory information by the brain

LEC 02

Perception appears easy and immediate
("How do you see?" vs. how do you make a cup of coffee?)

Vision is a hard problem:
  1. Artificial intelligence: chess vs. visual object recognition
  2. Over half of the primate cortex is involved in visual perception

What's the problem that vision must solve:
  Inputs: arrays of light intensities (2D and unstructured)
  Outputs: A representation of the 3D environment, 3D shapes of object, relative locations, material properties, identity.
The difference between input and output in human vision:
- Image angle vs. perceived 3D angle
- Image shape vs. perceived 3D shape
- Image size vs. perceived size
- Image color vs. perceived color

Distal stimulus / Scene ---> Proximal stimulus / Retinal image ---> Visual percept

*Fundamental problem of perception:* Every proximal stimulus is consistent with many different distal stimuli

Vision is an inverse problem:
- **Optics:** mapping from 3D scene to projected image
- **Inverse optics:** mapping from projected image to 3D scene

*Problem:* Each projected image is consistent with many different scene interpretations.

Perception involves construction by the mind/brain (governed by strict "rules")
Understanding perception involves understanding the "rules of construction."

- Adleson's checkerboard illusion
- Neon color spreading
- McGurk effect

LEC 03

How to approach the study of any complex system?
Approaching a black box:
- detailed internal circuitry vs. input-output relationships

Study a complex system at multiple levels of analysis:
1. Computational analysis (What problem is it solving?)
2. Representation and algorithm (What strategy is it using?)
3. Hardware implementation (electronic circuitry / mechanical parts)

The three levels in the example of a cash register

Multiple approaches to the study of perception
1. Theoretical / Computational
2. Psychological / Behavioral
3. Biological / Neuroscience
Theoretical approaches:
   Every visual input is consistent with many different interpretations.
   So, how does the brain "choose"?

   Different theoretical answers:
   - Built-in "hard-wired" knowledge (over evolution)
   - Principle of simplicity
   - The likelihood principle
   - The "no-coincidence" principle

Psychological approaches (behavioral reactions to stimuli)

1. Phenomenal / Naturalistic
   Problems with "phenomenal":
   - preverbal infants; animals
   - inconsistent usage of words
   - response bias
   - misreporting
   - unconscious prior expectations / motivations

   Problems with "naturalistic"
   - limited by environment
   - lack of control / systematic manipulation
   - repeatability

2. Experimental (design stimuli to systematically study specific factors)
   Matching experiments
   Detection experiments
      weakest detectable stimulus
      smallest detectable change
   Magnitude estimation
   Response time