Perception

• Outline for the next 2 lectures:
  – What is perception for?
  – Aspects of perception
  – Low-level perception
  – Constraints
  – Mid-level vision: Gestalt organization
  – Perception and the brain

What is perception?

• Somehow we must connect to the world
• There are sources of energy around us
  – Some are good (light, sound, heat)
  – Some are bad (sharp objects, intense heat)
• These sources of energy provide information to allow us to satisfy goals.
• Perception allows us to use this energy.

Perceptual modalities

• We perceive many aspects of the world
  – Light in the visible spectrum (vision)
  – Air movement (hearing)
  – Infra-red radiation (heat)
  – Forces approaching dangerous levels (pain)
  – The presence of certain chemicals (taste + odor)
  – The position of our bodies in space (proprioception)
• In this course, we focus primarily on vision
Organization of vision

- Finding edges
- Detecting colors
- Locating objects in space

Low level vision

Organisation of vision

- Determining object features
- Segregating objects from background

Mid level vision

Organization of vision

- Object recognition
- Face recognition
- Scene recognition

High level vision

Mid level vision

Low level vision
The problem of vision

• Visual space is three-dimensional
  – We have two eyes
  – The retina of each eye is two-dimensional
  – Information about the three-dimensions must be extracted from two-dimensions.
• Percepts are ambiguous

Possibilities

• There are far more possibilities than we see
• Vision immediately gives us objects
  – We don’t just see squiggles and textures
• The visual system makes guesses about what is out in the world.
  – We are interested in how it makes those guesses.
Constraints

- Constraints limit the possibilities considered
- What kinds of constraints does the visual system use?
  - Example:
    - How far away is an object? (Depth)
- Cues
  - Monocular cues (only one eye is needed)
    - Stationary cues
    - Kinetic cues
  - Binocular cues (two eyes are needed)
- Many have been incorporated into paintings.

Monocular cues

- Interposition
  - Nearer things block farther things.
- Linear Perspective
  - Things recede into the distance.

Constraints and illusions

- Sometimes the guesses made by the visual system turn out to be wrong.
  - The Muller-Lyer illusion.
  - Why might this happen?
    - Linear perspective.
Relative size

- The same object makes a smaller retinal image when it is far away than when it is close.
Kinetic cues to depth

• Motion parallax
  – Things that are close move more quickly than things that are far away.
  • Animators make use of this cue
  – On the freeway
    • Trees whiz by
    • Mountains do not move as much
    • The sun or moon seems to stay in the same place.

Binocular cues to depth

• Convergence
  – When objects are very close the eyes point inward
  – When objects are at a distance, eyes point in a more parallel direction.
Stereopsis

• Your eyes are a few inches apart
  – They get slightly different views of an object
  • Try it…
• The visual system matches up the images from each eye
  – The amount of disparity between corresponding points is used as a measure of distance.
  – Images do not need to have meaning

Random dot stereograms can give the illusion of depth.

Summary of depth cues

• Monocular
  – Stationary cues
  – Kinetic cues
• Binocular cues
• These cues take some time to develop
What are the objects?

• The visual system must figure out what aspects of the world go together
  – What aspects of a scene are part of the same object?
  – What aspects are a part of different objects?
• Example: Gestalt laws of grouping

Grouping principles

• Proximity
  ![Proximity Diagram]

  vs.

  ![Contrast Diagram]

Similarity

  ![Similarity Diagram]

  vs.

  ![Contrast Diagram]
Good Continuation

Common Region

vs.

Why we have these rules

• Vision must happen quickly
  – We cannot afford to spend much time processing
• There are not a lot of likely possibilities
  – Optics does not change
    • Evolution had a long time to find good methods of perception
  – There are many useful regularities in the visual world
  – Illusions rarely happen in the wild
Low-level vs. High-level perception

- Many regularities in low-level perception
- Fewer regularities in high-level perception
  - Many possible kinds of objects
  - Complex kinds of motion
    - Biological motion
- We explore issues in high-level perception next class.

Biological Motion

Perception and the brain

- Visual information
  - Retina
  - Thalamus (like a relay station)
  - Occipital lobe
  - Information is initially separated by visual field.
    - Left visual field to right hemisphere
    - Right visual field to left.