VISUAL FORM AND PATTERN RECOGNITION

- We have focused on the detection of features (points of light, edges, lines, colors)
- Now consider some slightly more sophisticated shapes
- What aspects of the visual system allow us to extract shapes?
- The key to recognizing objects is to see the foreground from the background, and a big clue is contrast differences

1. **Contours via contrast**
   a) Areas of center-surround fields
      i. Enhance contrast
   b) Lateral inhibition
      i. Fields beside one another inhibit each other
      ii. Sharpens the differences between them (increases contrast)
      iii. Mach bands
         1. Example of edges being sharpened
   iv. Hermann grid
      1. 2D set of edges
      2. competition of large peripheral black fields and smaller, central white fields
   v. Lightness contrast
      1. inhibition across an area causes a region’s lightness to be perceived as different
2. Stimulus change
   a) Movement of the image is important for edge detection

3. Spatial frequency
   a) Visual system has spatial frequency detectors
   b) Fourier analysis occurs on visual scene
   c) Contrast sensitivity function
      i. Our ability to detect a given spatial frequency depends on contrast between backgrounds and foreground
      ii. Optimal spatial frequency
          1. Higher or lower sp. freq. requires more contrast
          2. Implications?

4. Perceptual processing
   a) Bottom-up vs./and top-down processes
   b) Attention
      i. Focus processing detail in an “area”
      ii. Can be disk-shaped (a region) or even ring-shaped
      iii. Allows detailed extraction of features in a smaller region
      iv. Attention both selects and suppresses environmental stimulation
c) Feature Integration Theory (FIT)

i. Describes processing of light (visual stimuli) into information

ii. Preattentive stage (before attending)
   1. Bottom-up, automatic
   2. Extracts perceptual primitives
   3. Parallel processing of all elements of a display
   4. Leads to detection of textures, shapes, and objects
      - Textons
        a) Specific 2D characteristics of a texture

      - Geons
        a) 2D or 3D primitives that combine to make up object shapes
        b) combination of geons leads to recognition/distinction of objects
        c) more geons leads to…

iii. Focused attention stage
    1. Not instantaneous
    2. Requires effort and conscious scrutiny
    3. Often requires serial search to examine all elements of a display
    4. Allows you to group (and separate) the immediate results of the preattentive stage
    5. Use expectancies and knowledge to put the primitives together
5. Processing “Philosophies”

a) Computation (e.g., Marr)

i. Serial process

ii. Data driven computation

iii. Primal sketch

iv. 2.5D sketch

v. 3D model representation

vi. stages seen as “computer routines”

vii. active problem solving routine at each stage

b) Connectionist model

i. aka parallel distributed processing (PDP) or neural networks

ii. large but finite set of neurons (“nodes”) in a network

iii. accept inputs and “settle” into a pattern of activation

iv. biologically plausible

v. feasible