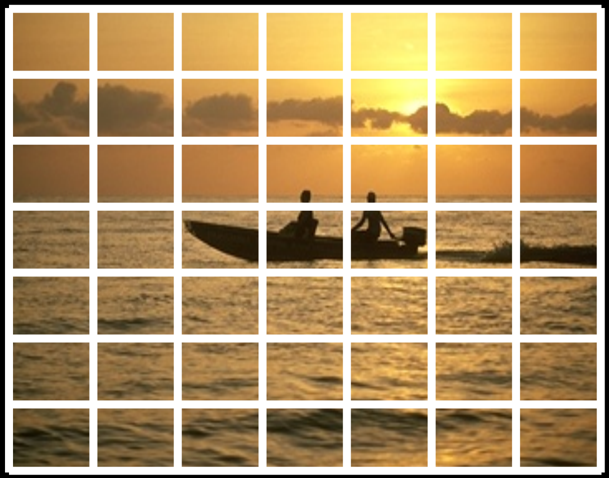
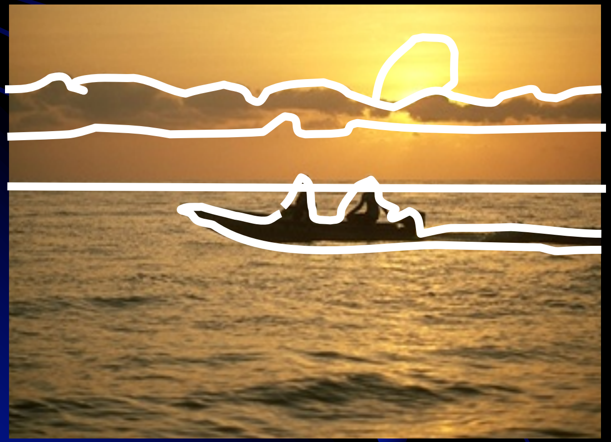
CSSE463: Image Recognition Day 3

- Announcements/reminders:
  - Lab 1 should have been turned in yesterday (due now if use a late day). 2 early, 2 late, all others on time. ☺
  - Tomorrow: Lab 2 on color images. **Bring laptop again and sit next to your partner**.
  - If you see examples of Img Rec in life, please send to me!
- Last class?
- Today:
  - Introduce **Fruit Finder**, due **next Friday**.
  - Lots of helpful hints in Matlab.
  - Connected components and morphology
- Next week: Edge features
- Questions?

Spatial component of color





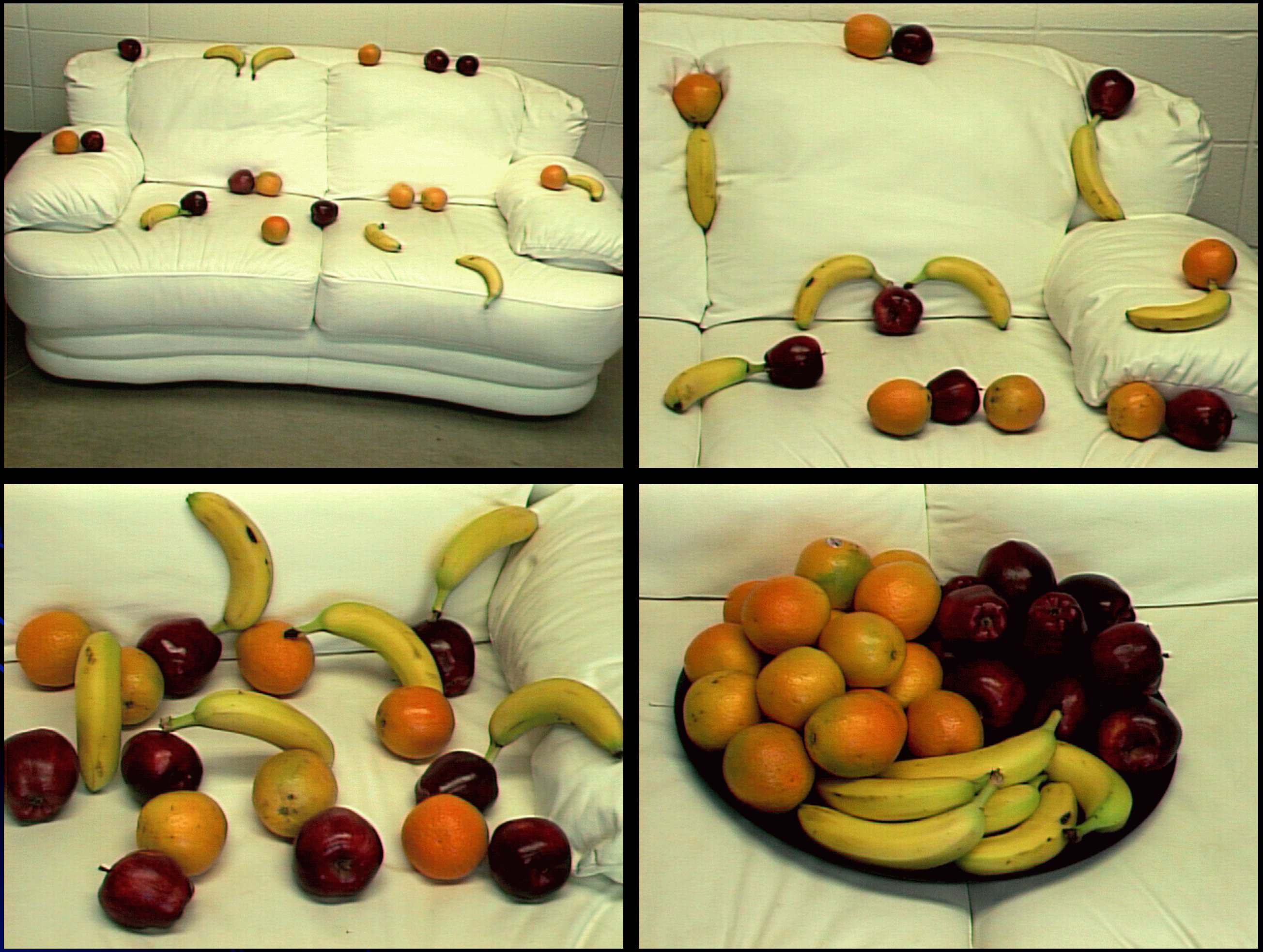
- Break image into parts and describe each one
  - Can describe each part with moments or histograms
- Regular grid
  - Pros?
  - Cons?
- Image regions
  - Pros?
  - Cons?

Additional reading

- Color gamuts
  - http://en.wikipedia.org/wiki/Gamut
- Color coherence vectors
  - Extension of color histograms within local neighborhoods
  - Used in:
    - A. Vailaya, H-J Zhang, and A. Jain. On image classification: City images vs. landscapes. Pattern Recognition 31:1921-1936, Dec 1998.
  - Defined in:
    - G Pass, R Zabih, and J Miller. Comparing images using color coherence vectors. 4th ACM Conf. Multimedia, pp 65-73, Boston, 1996.

Project 1: Counting Fruit

- How many apples? bananas? oranges?



Why the fruit-finder?

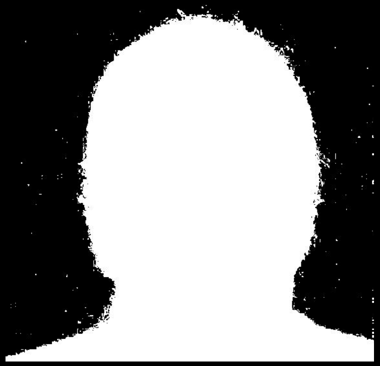
- Crash-course in using and applying Matlab
  - For this reason, I will direct you to some useful functions, but will not give details of all of them
- Practice feature extraction
- Practice writing a conference-paper style report
  - Formal and professional!
  - Use style similar to ICME sunset paper (Abstract, Introduction, Process, Results, …)
  - Lots of details in specification and rubric.
- Warning: The project grade is determined by the paper quality: even a finder that gets 100% accuracy can earn a low grade.

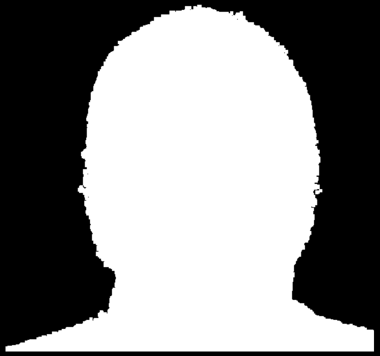
Fruit-finding technique

- Observe
  - What numbers define a banana’s “yellow”? (using imtool pixel zoom)
- Model
  - Can you differentiate between yellow and orange? Orange and red? (Decisions)
  - Note: this isn’t using a classifier yet; just our best guess at hand-tuned *boundaries*
- Classify pixels using your model (today’s how-to)
- “Clean up” the results
  - Mathematical morphology: today’s discussion!
- Write up your results in a professional report (as you go)

Region processing

- Binary image analysis
  - Today, we'll only consider binary images composed of *foreground* and *background* regions
    - Example: apple and non-apple
    - Use **`find`** to create a mask of which pixels belong to each





Q1

Matlab How-to create a mask

- Lots of “Random” tidbits that I used in my solution:
  - zeros
  - size
  - find

Modifying the mask requires us to define which pixels are neighbors

Neighborhoods

- Do we consider diagonals or not?
- 4-neighborhood of pixel p:
  - Consists of pixels in the 4 primary compass directions from p.
- 8-neighborhood of pixel p:
  - Adds 4 pixels in the 4 secondary compass directions from p.

Morphological operations (Sonka, ch 13)

- Morphology = form and structure (shape)
- For binary images
  - Done via a structuring element (usually a rectangle or circle)
- Basic operations:
  - Dilation, erosion, closing, opening

Dilation

- Given a structuring element, adds points in the union of the structuring element and the mask

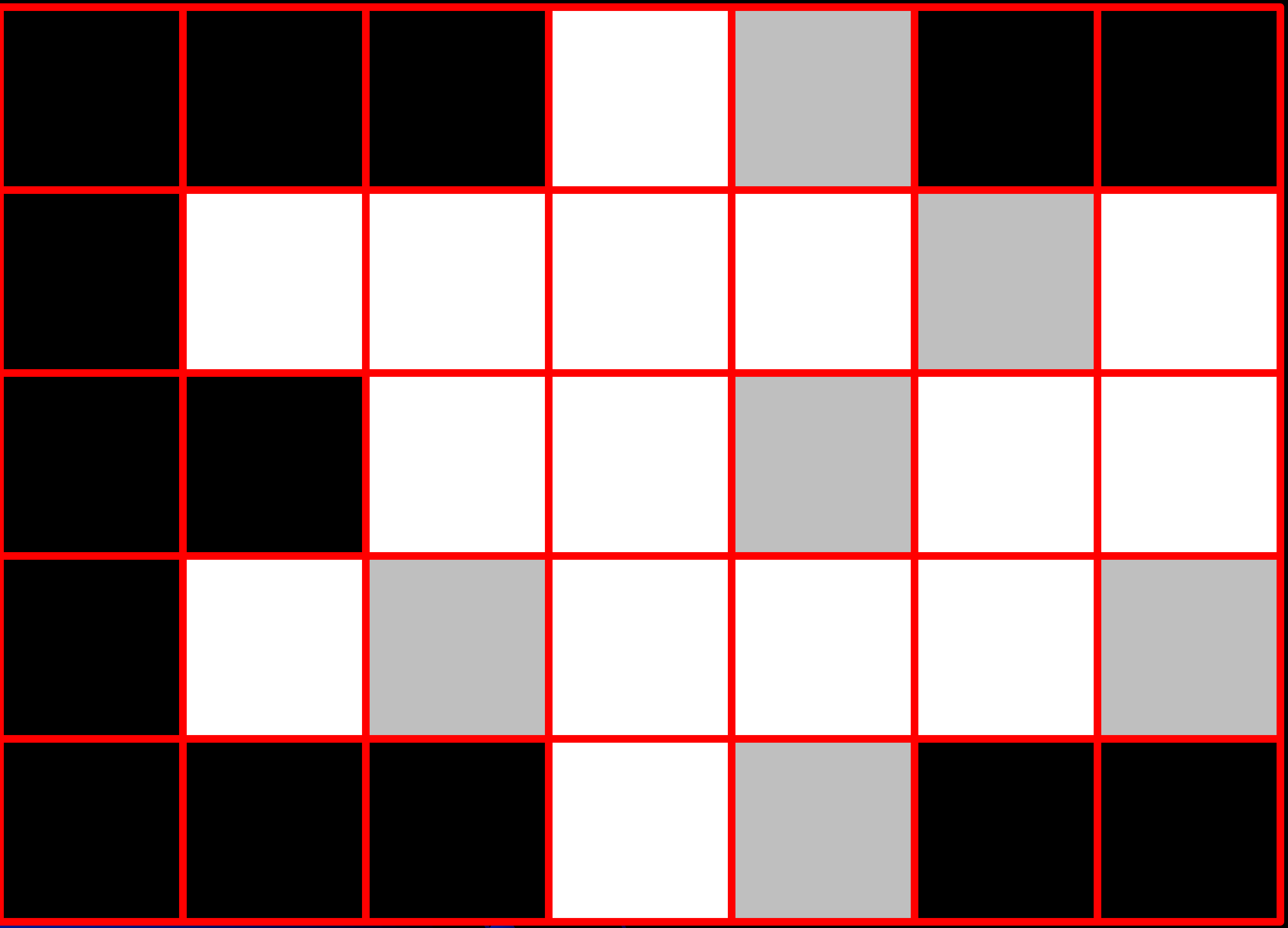
- Intuition: Adds background pixels adjacent to the boundary of the foreground region to the foreground.

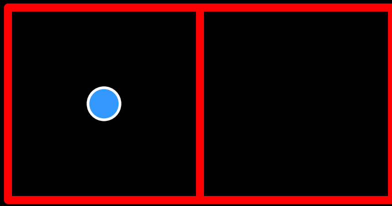
- Def, for image X and structuring element B:

$$X \oplus B = \left\{ p \in \varepsilon^2 : p = x + b, x \in X \text{ and } b \in B \right\}$$

Q7a

Dilation in action





Strel = 2x1,
centered on dot

Dilation

- Matlab: **`imdilate(bw, structureElt)`**
  - Typically want symmetric structuring elements
  - structureElt (for 8 neighborhood) found by:
    - **`structureElt = strel(‘square’, 3);`** % for erosion using 3x3 neighborhood
  - structureElt (for 4 neighborhood) found by:
    - **`structureElt = strel([0 1 0; 1 1 1; 0 1 0]);`**
  - `help strel` lists 11 others
- Demo for intuition: Enlarges a region
- Def:

$$X \oplus B = \left\{ p \in \varepsilon^2 : p = x + b, x \in X \text{ and } b \in B \right\}$$

Q7a

Erosion

- Removes all pixels on the boundary
- Matlab: imerode(bw, structureElt)

$$X \Theta B = \left\{ p \in \varepsilon^{2} : p = x + b \in X \ \forall b \in B \right\}$$

Q7b

Closing and Opening

- Closing (imclose)
  - Dilate, then erode
  - Fills internal holes in a region, while maintaining approximate pixel count
  - Eliminates inlets on the boundary
- Opening (imopen)
  - erode, then dilate
  - Removes small regions
  - Eliminates peninsulas on the boundary

- To make dilation more aggressive,
  - Dilate n times, then erode n times.
  - Or, use a larger structuring element
  - Example: compare *dilating twice using a 3x3 square* with dilating *once using a 5x5 square*.

Connected Components

- Goal: to label groups of connected pixels.
  - Assign each block of foreground pixels a unique integer
  - 4-connectivity vs. 8-connectivity matters
- Matlab help: search for *connected components*, and use *bwlabel* function
- Demo
- I may have you devise an algorithm to do this as part of week 3 take-home test.

Lab 2

- What format? See nice lab 1
- You will work with a partner for each lab
  - Can stay same or change
- I have posted a simpler 10-point grading rubric at the top of each lab
- Please ask questions and complete as much as you can in class
- Each lab is due the following Weds at the same time as the start of class
- Start now!