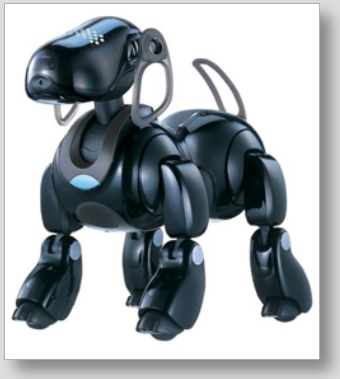
Finding Red Pixels – Part 2



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Administrivia

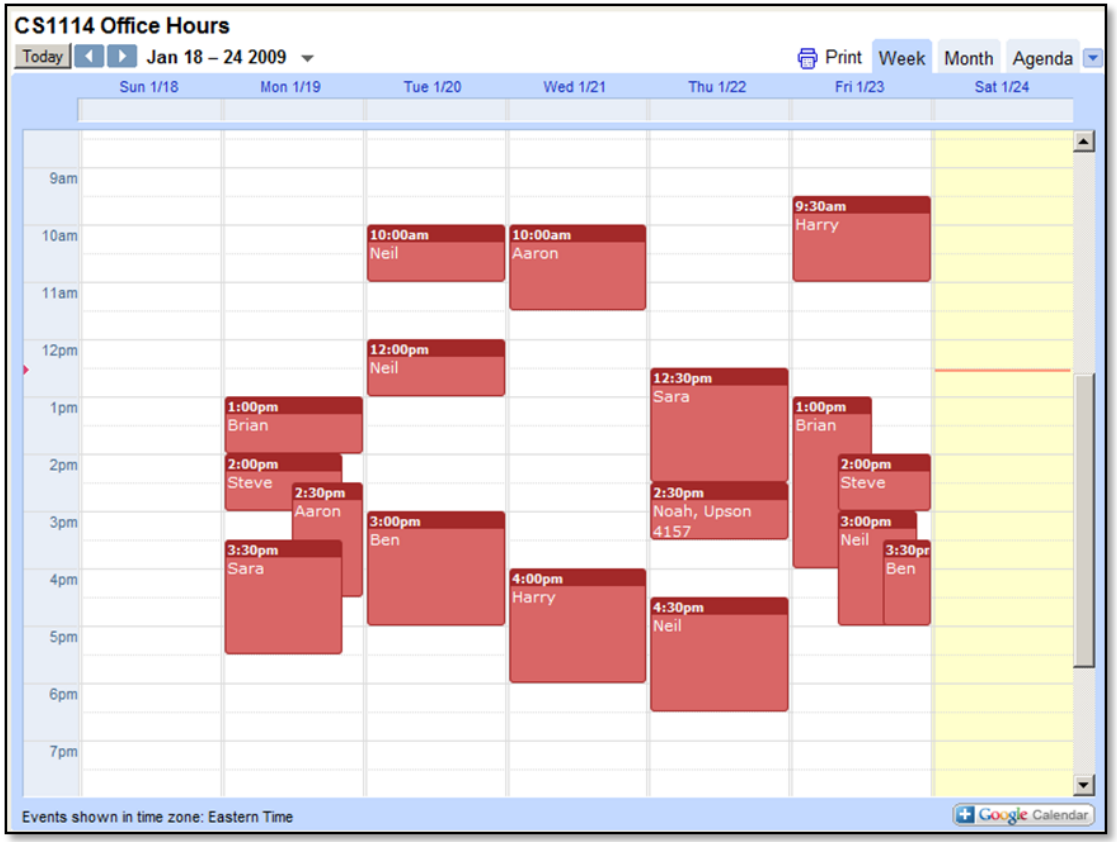
- You should all have access to the Upson 317 lab, CSUG accounts
  - If not, please let me know
- Your card should now unlock Upson 319

Administrivia

- Assignment 1 posted, due next Friday by 5pm
  - You should have all gotten email from me announcing the assignment
- Quiz 1 on Thursday
- No evening lecture tonight

Administrivia

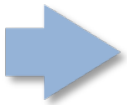
- Office hours are posted on the website



Correction from last time

```
D = [ 10 30 40 106 123 8 49 58 112 145 16 53 ]
```

```
D(1)  = D(1) + 20;
D(2)  = D(2) + 20;
D(3)  = D(3) + 20;
D(4)  = D(4) + 20;
D(5)  = D(5) + 20;
D(6)  = D(6) + 20;
D(7)  = D(7) + 20;
D(8)  = D(8) + 20;
D(9)  = D(9) + 20;
D(10) = D(10) + 20;
D(11) = D(11) + 20;
D(12) = D(12) + 20;
```



```
for i = 1:12
    D(i) = D(i) + 20;
end
```

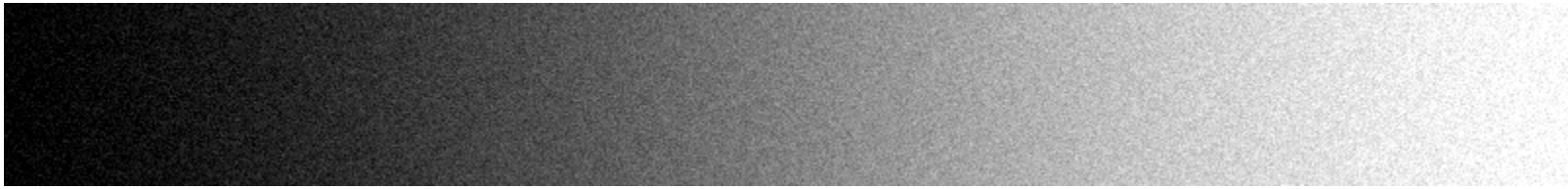
```
D = D + 20;
```

- "Vectorized" code
- Usually much faster than loops
- **But please use for loops for assignment 1**

Why 256 intensity values?

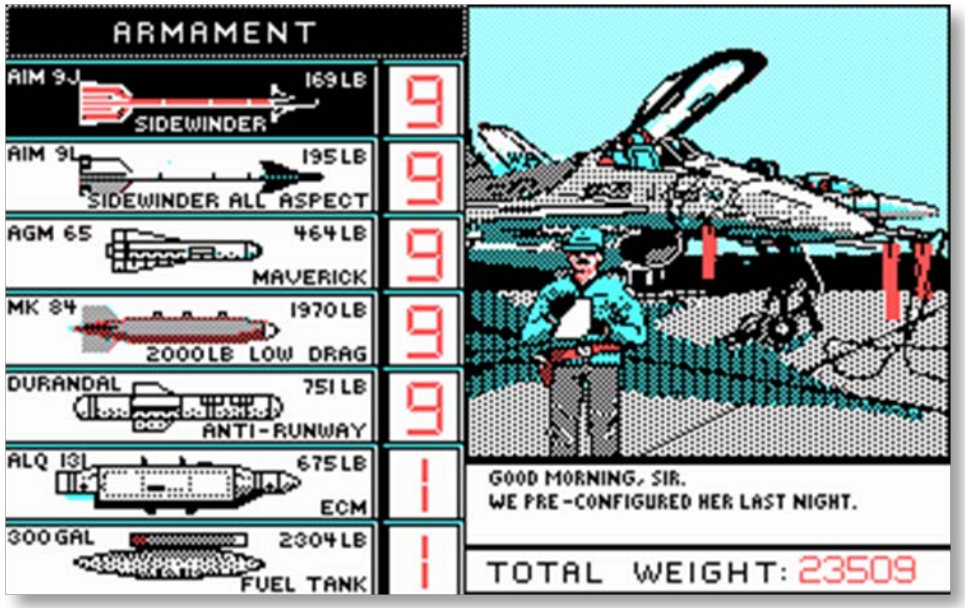
8-bit intensity (2^8 = 256)

5-bit intensity (2^5 = 32)



5-bit intensity with noise

Why 256 intensity values?



4-color CGA display

Today's (typical) displays:

256 * 256 * 256 = 16,777,216 colors

How many black pixels?

```
nzeros = 0;
[nrows,ncols] = size(D);
for row = 1:nrows
    for col = 1:ncols
        if D(row,col) == 0
            nzeros = nzeros + 1;
        end
    end
end
```

What if we need to execute this code many times?

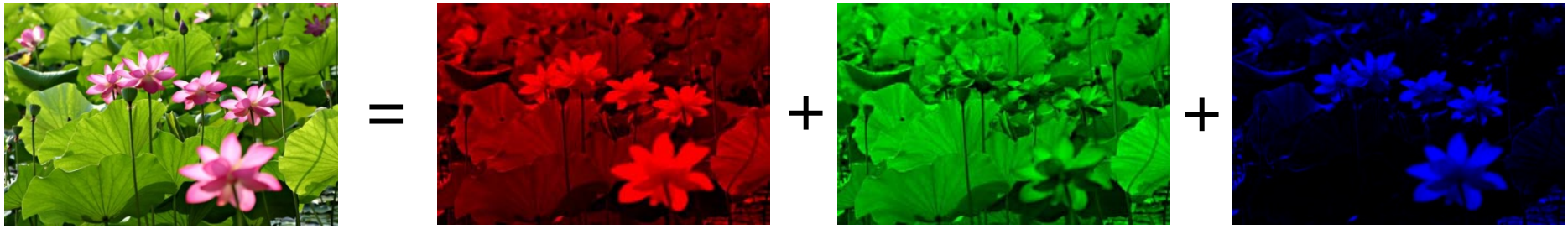
Turning this into a function

```
function [ nzeros ] = count_zeros(D)
% Counts the number of zeros in a matrix
nzeros = 0;
[nrows,ncols] = size(D);
for row = 1:nrows
    for col = 1:ncols
        if D(row,col) == 0
            nzeros = nzeros + 1;
        end
    end
end
```

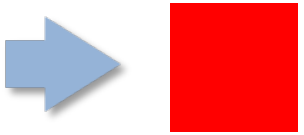
Save in a file named **count_zeros.m**

```
count_zeros([1 3 4 0 2 0])
```

What about red pixels?



red(1,1) == 255, green(1,1) == blue(1,1) == 0



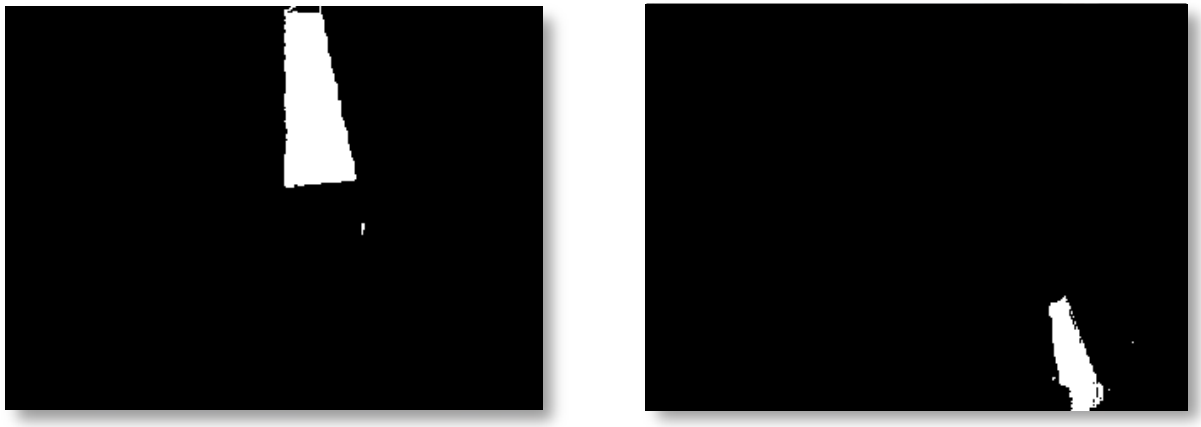
How many red pixels?

```
img = imread('wand1.bmp');
[red, green, blue] = image_rgb(img);
nreds = 0;
[nrows,ncols] = image_size(img);
for row = 1:nrows
    for col = 1:ncols
        if red(row,col) == 255
            nreds = nreds + 1;
        end
    end
end
```

```
for row = 1:nrows
    for col = 1:ncols
        if red(row,col) == 255
            nreds = nreds + 1;
        end
    end
end
```

- We've counted the red pixels in Matlab
  - Can anything go wrong?

Are we done?



- Assignment 1: come up with a *thresholding* function

Finding the lightstick

- We've answered the question: is there a red light stick?

- But the robot needs to know **where** it is!

Finding the rightmost red pixel

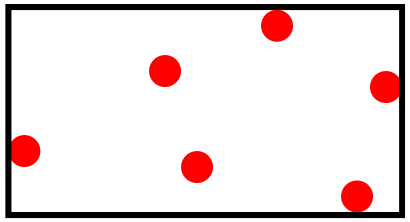
- We can always process the red pixels as we find them:

```
right = 0;
for row = 1:nrows
    for col = 1:ncols
        if red(row,col) == 255
            right = max(right,col);
        end
    end
end
```

Finding the lightstick – Take 1

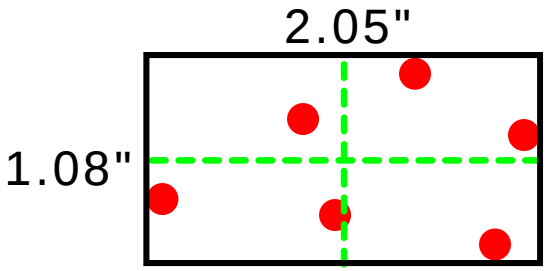
- Compute the bounding box of the red points
- The bounding box of a set of points is the smallest rectangle containing all the points
  - By “rectangle”, I really mean “rectangle aligned with the X,Y axes”

Finding the bounding box



- Each red pixel we find is basically a point
  - It has an X and Y coordinate
  - Column and row
    - Note that Matlab reverses the order

What does this tell us?



Aspect ratio: 2.05/1.08 = 1.9

- Bounding box gives us some information about the lightstick
  - Midpoint → rough location
  - Aspect ratio → rough orientation
    - (aspect ratio = ratio of width to height)

Computing a bounding box

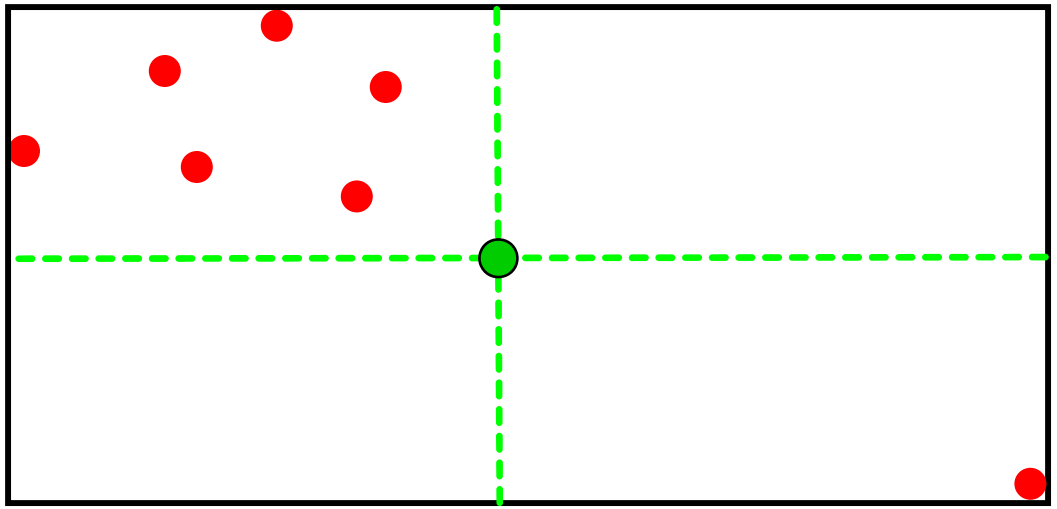
- Two related questions:
  - Is this a good idea? Will it tell us **reliably** where the light stick is located?
  - Can we compute it quickly?

Computing a bounding box

- Lots of CS involves trying to find something that is both useful and efficient
  - To do this well, you need a lot of clever ways to efficiently compute things (i.e., algorithms)
  - We're going to learn a lot of these in CS1114

Beyond the bounding box

- Computing a bounding box isn't hard
  - Hint: the right edge is computed by the code we showed a few slides ago
  - You'll write this and play with it in A2
- Does it work?



Finding the lightstick – Take 2

- How can we make the algorithm more robust?
  - New idea: compute the centroid
- Centroid:

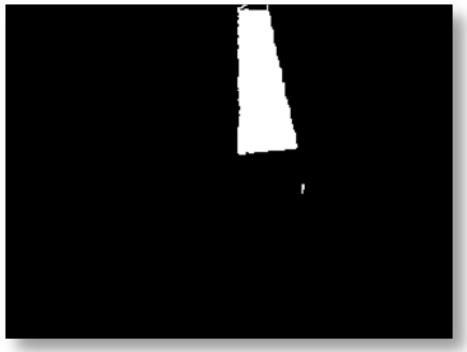
  (average x-coordinate, average y-coordinate)
  - If the points are scattered uniformly, this is the same as the midpoint of the bounding box
  - Average is sometimes called the mean
  - Centroid = center of mass

Computing the centroid?

- We could do everything we want by simply iterating over the image as before
  - Testing each pixel to see if it is red, then doing something to it
- It's often easier to iterate over *just* the red pixels
- To do this, we will use the Matlab function called **`find`**

The find function

img



thresh

X = % x-coords of nonzero points

Y = % y-coords of nonzero points

Your thresholding function

```
[X,Y] = find(thresh);
```

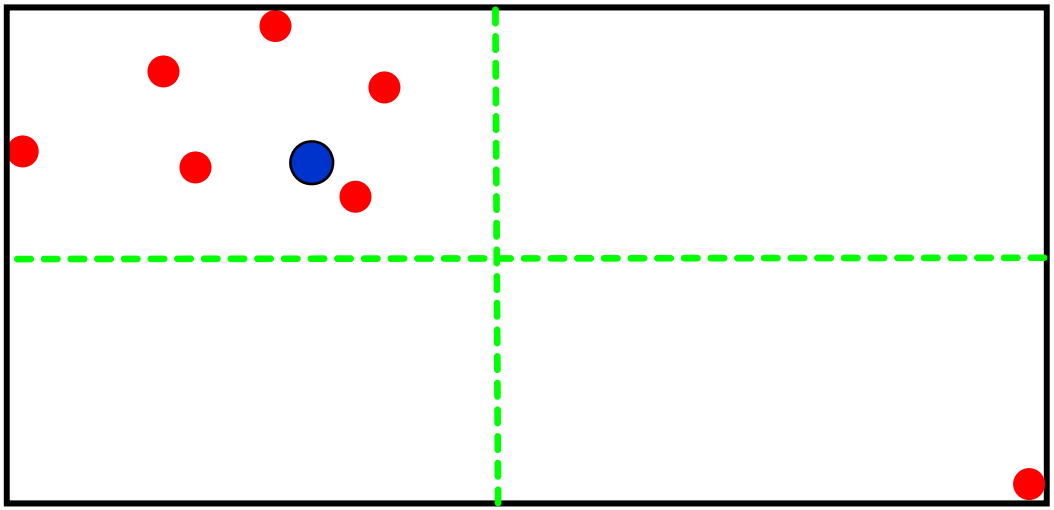
Using find on images

- We can get the x- and y- coordinates of every red pixel using **`find`**
  - Now all we need to do is to compute the average of these numbers
  - We will leave this as a homework exercise
    - You might have done this in high school

Q: How well does this work?

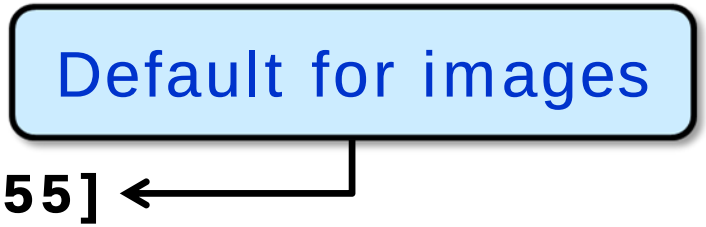
- A: Still not that well
  - One “bad” red point can mess up the mean
- This is a well-known problem
  - What is the average weight of the people in this kindergarten class photo?

How well does this work?



Types in Matlab

- Different types of numbers:
  - Integer (int) { 17, 42, -144, … }
    - Signed
    - Unsigned
      - **8-bit (uint8) [0 : 255]**
      - 16-bit (uint16) [0 : 65,535]



  - Floating point (double) { 3.14, 0.01, -20.5, … }

Converting between types

- Most numbers in Matlab are **double** by default (images are an exception)
- Various functions for converting numbers:

```
double  uint8  uint16
```

- What happens when we do this:

```
uint8(200) + uint8(200) % Result = ?
```

Images in different formats

- **uint8** : intensities in range [0-255]
- **uint16** : intensities in range [0-65535]
- **double** : intensities in range [0.0-1.0]

- **imdouble(img)** converts an image to double format
- **double(img)** almost converts an image to double format

For next time

- Attend section tomorrow in the lab
- Reminder: Quiz on Thursday, beginning of class