



# CS 248 Assignment 1

## Paint Program

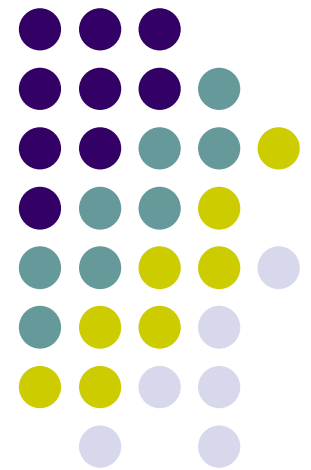
**CS248 Help Session #1**

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**Modified by: Sean Walker, Rene Patnode**

**Stanford University**

**October 6, 2004**





# Session Overview

- Getting Started
- Assignment Discussion
  - Overpainting Brush
  - Tinting Brush
  - Brush Visualization
- Grading Details
- Extra Credit
- Questions

# Getting Started



1. Read assignment carefully and pay attention to the details.
2. Go to help session
3. Familiarize yourself with Raptor/Firebird Lab Located in the Basement of Sweet Hall



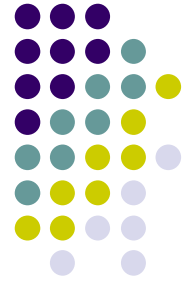
# Development Environment

- Ways to work with TA Support
  - Go to Sweet Hall (Best Way – 5 Minutes)
  - Work Remotely (Good Way – 5 Minutes)
- Ways to work without TA support
  - Reproduce Sweet Hall Lab development environment on you own Machine (1 Hour)
  - Your code still has to work on the Sweet Hall machines (more risk for you)



# Sweet Hall

1. Pick a free computer, Log on
2. Copy assignment from  
`/usr/class/cs248/assignments/assignment1/`  
to local directory
3. Run `make`
4. Run `./paint.i386-linux`



# Working Remotely

1. ssh to firebird, raptor or Ieland (make sure X-tunneling is enabled)
2. Export the display (using e.g. Exceed3D)
3. Follow instructions on previous slide

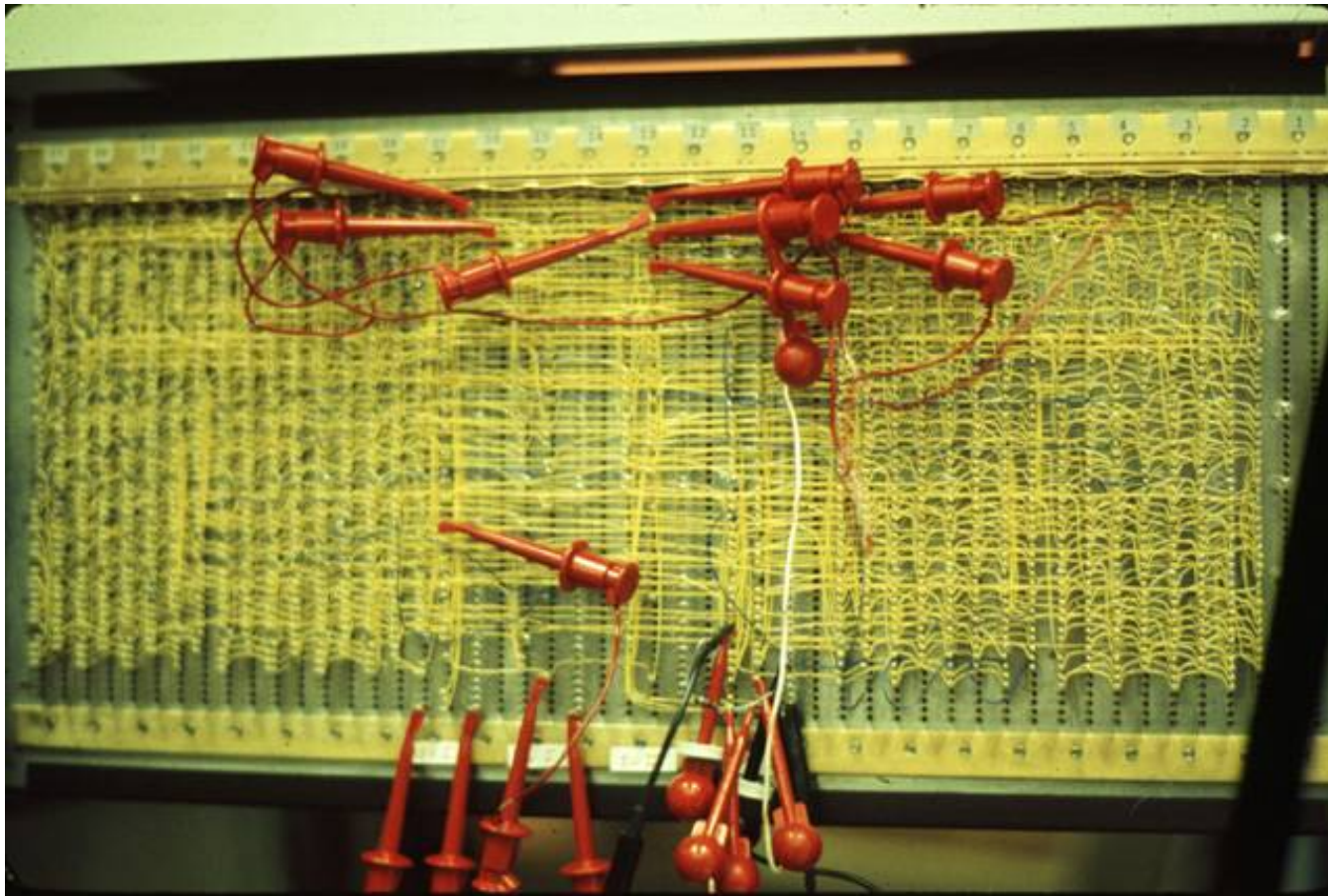
```
>ssh raptor.stanford.edu  
>setenv DISPLAY yourIP:0.0  
>xterm &
```



# Assignment Discussion

- You are going to write a paint program
  - Teaches you 2D Raster Graphics
  - Visualize concepts learned in Class (Brushes, HSV)
  - Be creative with extra credit
- The next slides follow the Assignment (Handout #3) step by step
  - Reminder: Read the assignment

# Paint Program 1973



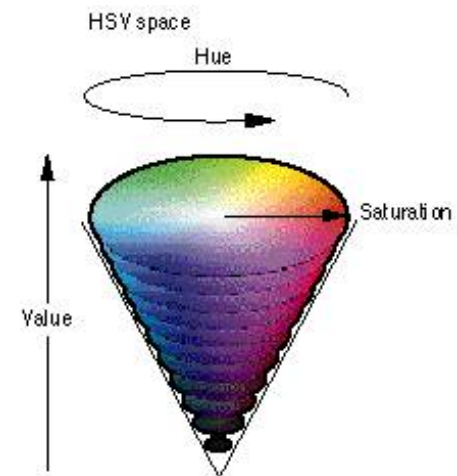
Source: Dick Shoup "SuperPaint: An Early Frame Buffer Graphics System" IEEE Annals of the History of Computing, Vol 23, No 2, Apr-Jun 2001





# Part 1: Over Painting Brush

- Rectangular Overpainting Brush
  - Like Microsoft Paint or “Pencil Tool” in PhotoShop
- Color Picker for RGB, HSV
  - See <http://java.sun.com/docs/books/tutorial/uiswing/components/colorchooser.html> or any commercial paint program
    - Value (1.0 bright, 0.0 black)
    - Saturation (1.0 strong hue, 0.0 faded hue)
- Size Control for Brush



Demo: Painting, Picking Colors in PaintShop Pro 7

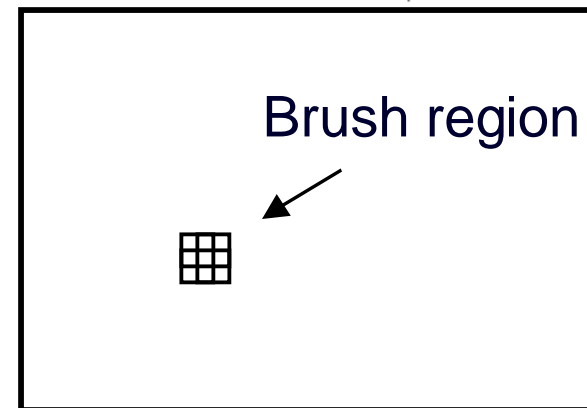


# Part 1: Basic Painting Loop

Basic painting loop:

```
do Forever
  readmouse (x, y, buttondown)
  if buttondown then
    do i = -brushwidth/2 to brushwidth/2
      do j = -brushwidth/2 to brushwidth/2
        modifypixel (x, y, i, j)
```

```
      enddo
    enddo
  endif
enddo
```





# Part 1: Over Painting Brush

- Once you are done with Part 1 you should be able to draw some basic images



- Notice the hard edges and jaggies around the stroke... this is what Part 2 will fix



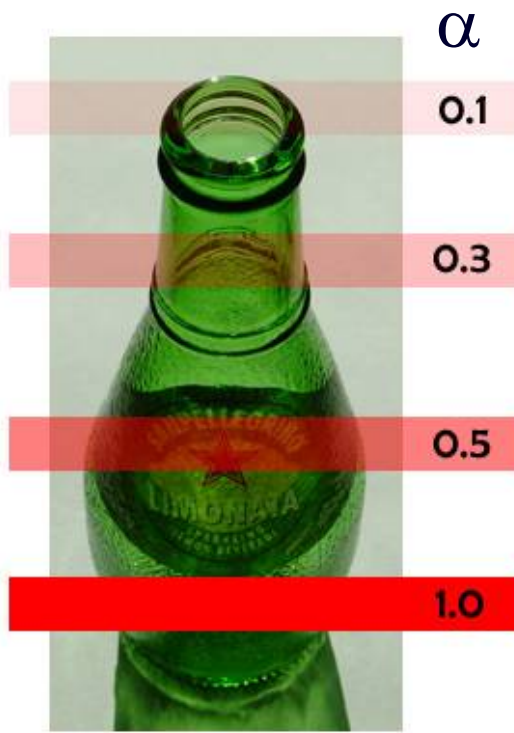
## Part 2: Tinting Brush

- Implement Weighted Mask Driven Brush as described in Handout #4
  - Instead of a rectangular brush, have it gently “blend” to its surroundings. Use HSV interpolation
- Checkboxes for interpolating along H,S,V axis
  - Allow all permutations HSV, HS, HV, SV, H, S, V
- Choose a mask function and give user control over it
  - Make sure it gradually falls off to zero at edges!

# Part 2: Weighted Blending



Like painting with partially transparent paint.  
Commonly referred to as “alpha” blending.



## Compositing equation

$$C_{\text{new}} = (1-\alpha) C_{\text{old}} + \alpha C_{\text{paint}}$$

# Part 2: Mask driven painting



Lookup array determines how each pixel in the brush

Paint every pixel in the brush region

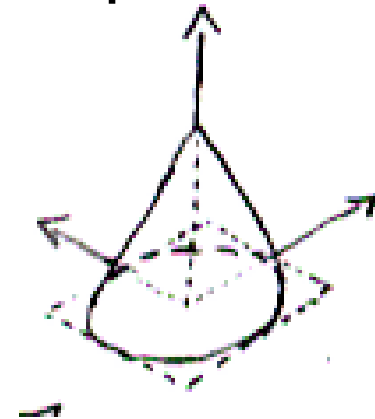
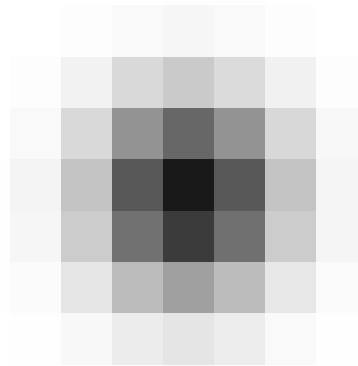
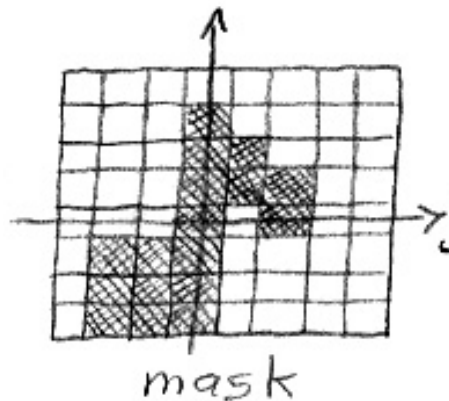
Paint only some of the pixels



## Part 2: Weighted mask driven painting



Mask contains alpha/weight for each pixel in brush



- $0 \leq \alpha \leq 1$  everywhere
- $\alpha$  is highest in the middle of the mask,  $\leq 1$
- $\alpha$  is smooth ( $\geq C^0$ ) except (optionally) at the center
- $\alpha$  Falls off to zero at the edges of the mask

# Part 2: RGB vs. HSV interpolation



## RGB interpolation

$$\text{NewR} = (1-\alpha) \text{CanvasR} + \alpha \text{PaintR}$$

$$\text{NewG} = (1-\alpha) \text{CanvasG} + \alpha \text{PaintG}$$

$$\text{NewB} = (1-\alpha) \text{CanvasB} + \alpha \text{PaintB}$$

---

## HSV interpolation

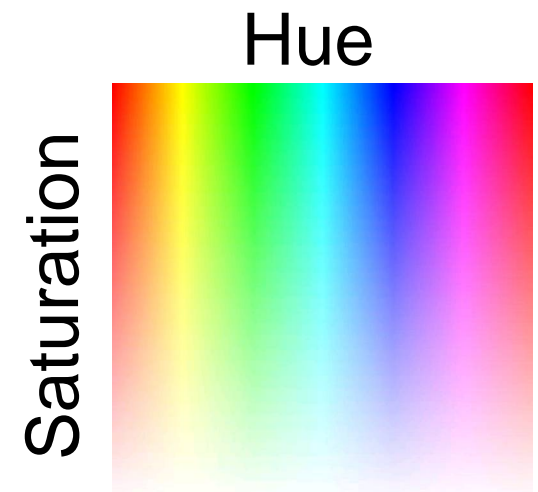
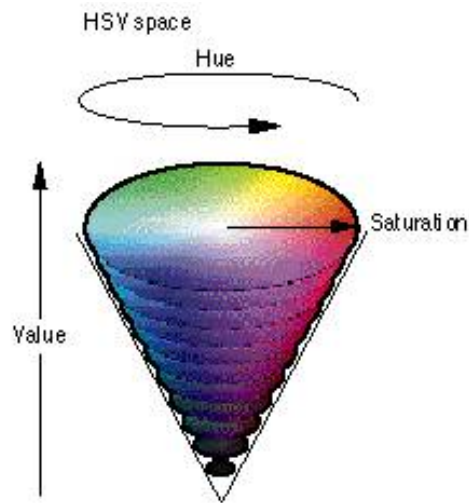
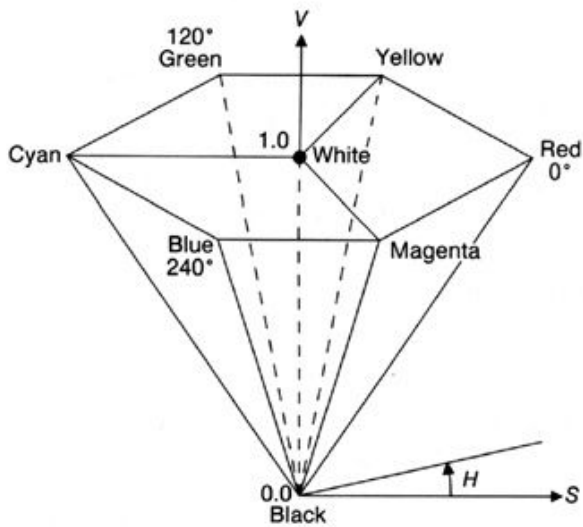
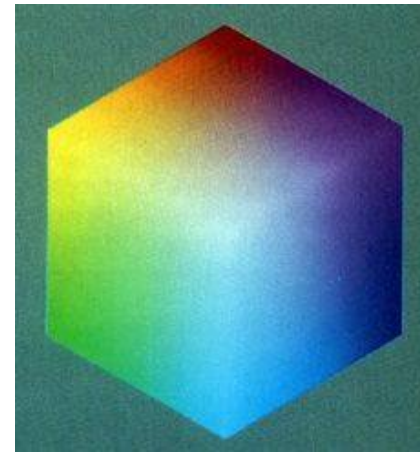
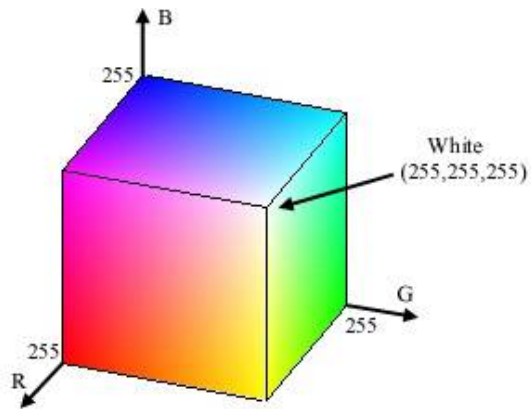
$$\text{NewH} = (1-\alpha) \text{CanvasH} + \alpha \text{PaintH}$$

$$\text{NewS} = (1-\alpha) \text{CanvasS} + \alpha \text{PaintS}$$

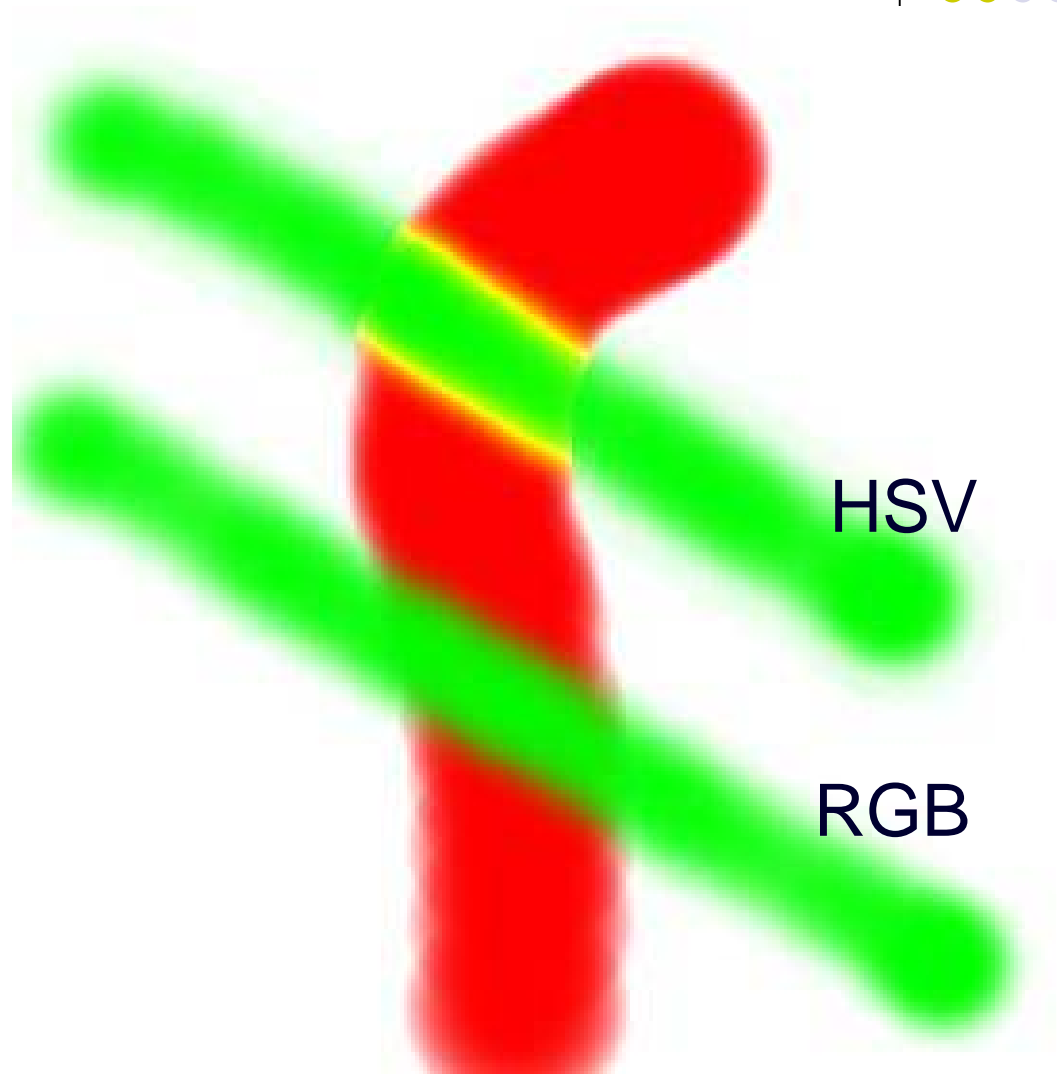
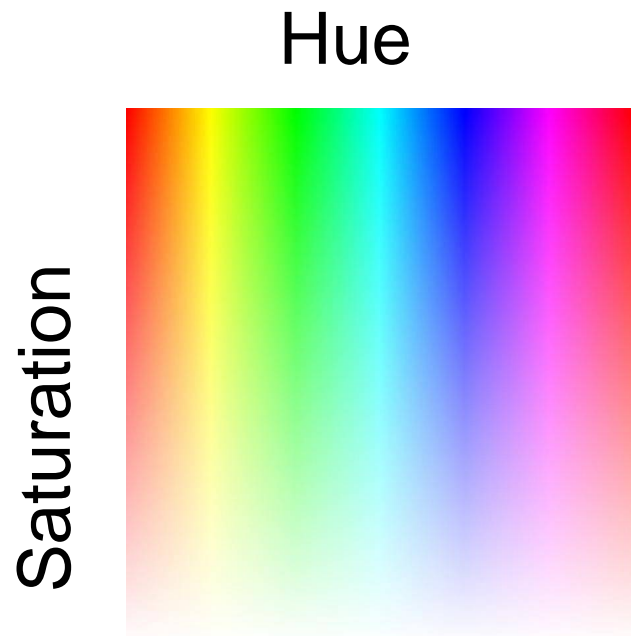
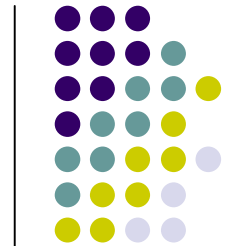
$$\text{NewV} = (1-\alpha) \text{CanvasV} + \alpha \text{PaintV}$$



# Part 2: RGB vs. HSV



# Part 2: RGB vs. HSV interpolation





## Part 2: Math Example

- Interpolating half way between Red and Cyan ( $\alpha = 0.5$ )
- $\text{NewColor} = 0.5 \text{ Cyan} + 0.5 \text{ Red}$

	<b>R</b>	<b>G</b>	<b>B</b>	<b>H</b>	<b>S</b>	<b>V</b>
<b>Cyan</b>	0.0	1.0	1.0	180	1.0	1.0
<b>Red</b>	1.0	0.0	0.0	0	1.0	1.0
<b>Interpolation</b>	0.5	0.5	0.5	90	1.0	1.0
	50% Gray			Greenish		



## Part 2: HSV Checkboxes

- Choose which HSV components to affect.
- Allow for any combination.

Interpolate:  H  S  V

```
if (H_check) NewH = (1- $\alpha$ ) CH +  $\alpha$  PaintH
else NewH = CH;
if (S_check) NewS = (1- $\alpha$ ) CS +  $\alpha$  PaintS
else NewS = CS;
if (V_check) NewV = (1- $\alpha$ ) CV +  $\alpha$  PaintV
else NewV = CV;
```



# Part 2: Sample Images



**Overpainting #1 vs.  
Weighted Mask  
driven painting #2**



**Image showing H, S, and V Tinting**

# Part 3: Brush Visualization

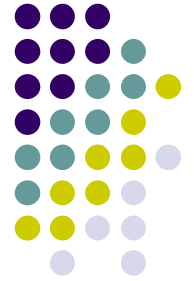


- Brush Visualization should tell user what its color, falloff and size is
  - Brush should always be visible regardless of color
  - Draw 1x (actual size) and 4x (four times larger in x and y) versions of the brush
  - Make the larger version discretized – that is it should be a choppy/chunky/pixel replicated version of the actual brush (think xmag, snoop)
  - Make sure this visualization will help you explain to user, TAs, Professor and yourself how the brush weights affect drawing

# Requirements

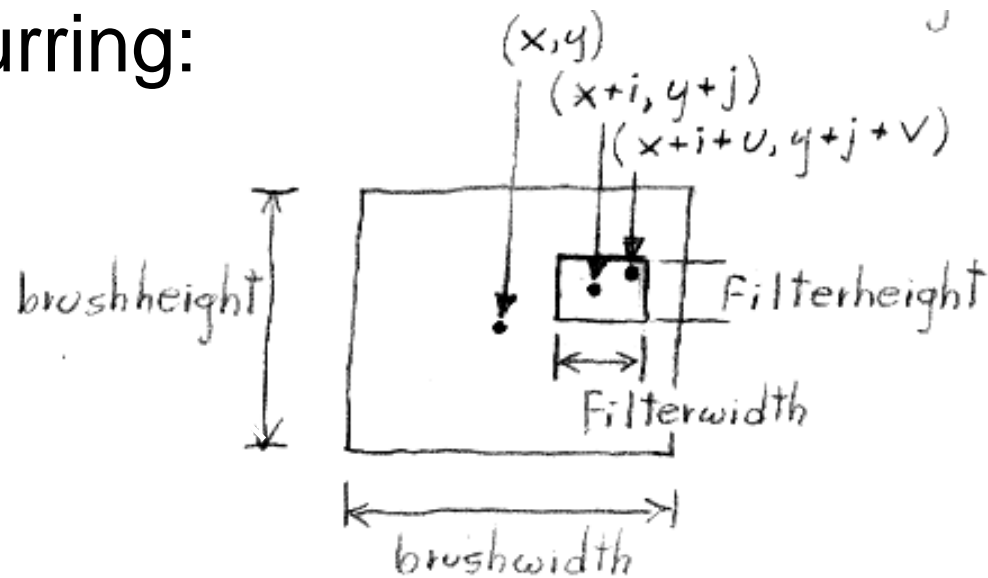


- Correctness (40%)
  - Don't crash
  - Implement all required features
    - (Read the directions like a lawyer)
- Efficiency (20 %)
  - No noticeable lag while using your application
- User Interface (20%)
- Programming Style (20%)
  - Copying code (Don't do it)
- Submitting with `‘/usr/class/cs248/bin/submit’`



# Extra credit example

Blurring:



and  $\sum \omega = \sum_{u,v \in \text{Filter}} \omega(u,v)$

Typical Filters are:

1	1	1
1	1	1
1	1	1

or

0	-1	0
-1	4	-1
0	-1	0



# Questions?



- Ask now
- Come to Office Hours
- Email: [cs248-aut0405-tas@lists.stanford.edu](mailto:cs248-aut0405-tas@lists.stanford.edu)
  
- Remember: Computer Graphics is fun - if you are not having fun ask TAs for help