On your way in...

Drop-off:
1. Homework 8 (2 piles, IDs < 50)

Pick-up
1. Homework 9 (due Wednesday)
2. Lecture 25 notes
Welcome to CS 134!

Introduction to Computer Science
Iris Howley
- HTML -

Spring 2019
COLOR MATHEMATICS

Continuing computational color
RGB Color System

- Red Green Blue
- Each has value 0-255
  - For the Images lab, we used 0→1 to represent 0→255
  - But outside, people generally use 0-255

Reminder!

- \( r,g,b = 255, 0, 0 \)
- \( r,g,b = 0, 32, 96 \)
- \( r,g,b = 216,216,0 \)
RGB Color System

- RGB Color is additive
  - Turn all three colors on, you get white: (255,255,255)
  - Darker colors have lower values. Black is (0,0,0)

- Gray pixels have equivalent values for red, green, blue

\[ r, g, b = 64, 64, 64 \quad \text{and} \quad r, g, b = 128, 128, 128 \]
Optimizing RGB

• $r,g,b = 255, 255, 255$
• This is a lot of bits! 9 characters!

• Historically, computers have used a different specification for colors
Number Systems

• Our number system (1...9) is Base-10

Why do we use Base-10 as our numerical system?

• Greeks and Romans commonly used Base-5 as well!
• Mayans used Base-20 (counting fingers and toes?)
• Indigenous Yuki people used Base-8 (the spaces between fingers?)
Number Systems

• Back to RGB!

• 0-255 → 256 numbers
• $16 \times 16 = 256$

• We’ll need Base-16 to maintain the number of colors
  ▪ Base-16 == “Hexadecimal” == “Hex”
### Base-16

<table>
<thead>
<tr>
<th>Decimal</th>
<th>Hexadecimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>A</td>
</tr>
<tr>
<td>11</td>
<td>B</td>
</tr>
<tr>
<td>12</td>
<td>C</td>
</tr>
<tr>
<td>13</td>
<td>D</td>
</tr>
<tr>
<td>14</td>
<td>E</td>
</tr>
<tr>
<td>15</td>
<td>F</td>
</tr>
<tr>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>17</td>
<td>11</td>
</tr>
</tbody>
</table>

What is going on here?!
Base-16

• 0 1 2 3 4 5 6 7 8 9 A B C D E F 10 11 12 ...

Similar to:
• 10 in decimal is: $1 \times 10 + 0 = 10$
• 11 in decimal is: $1 \times 10 + 1 = 11$

• 10 in hexadecimal is ___ in decimal:
  ▫ $1 \times 16 + 0 = 16$
• 11 in hexadecimal is ___ in decimal:
  ▫ $1 \times 16 + 1 = 17$

The 10’s place in hexadecimal represents 16, not 10!
Base-16

• 0 1 2 3 4 5 6 7 8 9 A B C D E F 10 11 12 ...19 1A 1B
• 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

• 19 in hexadecimal is ___ in decimal:
  ▪ 1 \times 16 + 9 = 25

• 1A in hexadecimal is ___ in decimal:
  ▪ 1 \times 16 + 10 = 26

• FF in hexadecimal is ___ in decimal:
  ▪ 15 \times 16 + 15 = 255
Base-16

• F01 in hexadecimal is ___ in decimal:
  ▪ $15 \times (16 \times 16) + 0 \times 16 + 1 = 3841$

• 101 in decimal is:
  ▪ $1 \times (10 \times 10) + 0 \times 10 + 1 = 101$
Number Systems in Python

Python stores the decimal number

```
>>> mynum = int("1A", 16)
26
```

The number

Its base

Its base

Python stores the decimal number
Number Systems in Python

• >>> hex(26)
  '0x1a'

• >>> int("1a", 16)
  26

• >>> int(hex(26), 16)
  26
RGB → Hexadecimal

#970515

Red | Green | Blue

(means this is hexadecimal)

https://www.smashingmagazine.com/2012/10/the-code-side-of-color/
RGB → Hexadecimal

• If a color’s RGB is #000000 in hexadecimal, what color is it?
  ▪ Black! Same as in the 0-255 values

• If a color’s RGB is #FFFFFF in hexadecimal, what color is it?
  ▪ White

• What about #666666 in hexadecimal?
Try this...

• emacs shared/index.html

```html
<html>
  <head>
    <link rel="stylesheet" href="index.css" type="text/css">
    <title>Computer Science 134C - Introduction to Computer Science</title>
  </head>
  <body>
    <p class="title?">
      <font size="5">CSCI 134C</font>
    </p>
  </body>
</html>
```
Try this...

- emacs shared/index.html
Try this...

- emacs shared/index.html

```html
<html>
  <head>
    <link rel="stylesheet" href="index.css" type="text/css">
    <title>
      Computer Science 134C – Introduction to Computer Science
    </title>
  </head>
  <body>
    <p class="title2">
      <font size="5" color="#0000FF">CSCI 134C</font>
    </p>
  </body>
</html>
```

No change! Why?
Using Hexadecimal on the Web

- 216 “Web Safe Colors”
  - Non-dithered
  - Described in no more than 8 bits (256) for older computers
- Red, Green, Blue values from:
  - 00, 33, 66, 99, CC, FF
    - Multiples of #33
  - 6 possible values for each of RGB = 6*6*6 = 216
Using Hexadecimal on the Web

- There are 140 named colors (supported by all browsers)
- 216 > 140

https://www.w3schools.com/colors/colors_names.asp
THE INTERNET

Python and Markup Languages and Color
(oh my!)
HTML

- **HyperText Markup Language**
- Similar-ish to Markdown, which we saw in lab
- Specifies how to format text
  - Different tags/symbols specify how computer should display text
# Lab 9: Analysis of Sorting Algorithms

CS134C (Spring 2019) - _due Thursday/Friday at noon_**

In this lab we're going to experiment with Jupyter Notebooks. According to the [Jupyter Notebooks website](https://jupyter.org/), "The Jupyter Notebooks website provides a flexible tool for creating and sharing documents that contain live code, equations, visualizations, and narrative text. It integrates a variety of tools including Python, R, and Julia.

**HTML:**

<h1>Lab 9: Analysis of Sorting Algorithms</h1>  
<b>CS134C (Spring 2019) - <i>due Thursday/Friday at noon</i></b>

In this lab we're going to experiment with Jupyter Notebooks. According to the [Jupyter Notebooks website](https://jupyter.org/), "The Jupyter
HTML

- `<h1>`Text goes here`<h1>` → Makes a level 1 heading
  - Guess – there’s also an `<h2>`</h2>, and `<h3>`</h3>, and ...
- `<b>`Text goes here`</b>` → Makes the text bold
- `<i>`Text goes here`</i>` → Makes the text italic
- `<a href="http://url-here.com">Link Text Here</a>` → Makes a hyperlink
- `<font face="courier">Text goes here</font>` → Changes the font
  - `<font size="+2">Text goes here</font>` → Increases font size
  - `<font color="#666666">Text goes here</font>` → Changes font color
- `<p>`Text goes here`</p>` → Paragraph definition (~2 newlines)
- `<br>` → Line break (~1 newline)
1. `<ol>`
2. `<li>` This is a bullet in an ordered list, so it’s a numbered list</li>
3. `<li>` Another numbered item.</li>
4. `</ol>`
   • `<ul>`
   • `<li>` This is a bullet in an un-ordered list, so it’s a bulleted list</li>
   • `<li>` Another bulleted item.</li>
   • `</ul>`
HTML Header

• `<html>` → Defines what language being used
• `<head>` Text & Tags in here are part of the header</head>
• `<title>` This title appears in the web browser</title>
• `<body>` Text & Tags in here are part of the body text</body>

```html
<html>
<head>
  <link rel="stylesheet" href="index.css" type="text/css">
  <title>Computer Science 134C – Introduction to Computer Science</title>
</head>
<body>
  <p class="title2">
    <font size="5" color="#0000FF">CSCI 134C</font>
  </p>
</body>
</html>
```
Pulling Source Code from Web Pages

- `pip install requests`
- `import requests`
- `r = requests.get('http://www.cs.williams.edu/~cs134/')`
- `r.text`
Processing Source Code from Web Pages

• If you want to parse the HTML text from a string, the Beautiful Soup module is recommended:
  ▪  https://www.crummy.com/software/BeautifulSoup/bs4/doc/

• > pip install beautifulsoup4
Pretty-Printing Source Code from Web Pages

• >>> from bs4 import BeautifulSoup
• >>> soup = BeautifulSoup(r.text, 'html.parser')

• >>> print(soup.prettify())
Processing Source Code from Web Pages

- >>> soup.title
  - <title>
    - Computer Science 134C - Introduction to Computer Science
  - </title>
- >>> soup.title.name
  - 'title'
- >>> soup.title.string
  - '\n      Computer Science 134C - Introduction to Computer Science\n      '
- >>> soup.title.parent.name
  - 'head'
- >>> soup.p
  - <p class="title2">
    - <font size="5">CSCI 134C</font>
  - </p>
Processing Source Code from Web Pages

• >>> soup.a
• <a href="#lectures">Lectures</a>
• >>> soup.find_all('a')
• [<a href="#lectures">Lectures</a>, <a href="#labs">Labs</a>, <a href="#homeworks">Homeworks</a>, <a href="#resources">Resources</a>, <a href="http://www.cs.williams.edu/~iris">Iris Howley</a>, <a href="http://www.cs.williams.edu/~bailey">Duane A. Bailey</a>, <a href="http://greenteapress.com/wp/think-python-2e/" target="_blank">greentreepress.com</a>, <a href="thinkpython2.pdf" target="_blank">here</a>, <a href="syllabus.pdf" target="_blank">Course Syllabus</a>, <a href="http://csci.williams.edu/the-cs-honor-code-and-computer-usage-policy/" target="_blank">Department Honor Code and Computer Usage Policy</a>, <a href="#top">Description</a>, …]
Extracting All URLs

• for link in soup.find_all('a'):
  ▪ print(link.get('href'))

Extracting All Text

• for link in soup.find_all('a'):
  ▪ print(soup.get_text())
QUESTIONS?
Leftover Slides
Markup Languages

- LaTeX for formatting documents
  - Lecture notes, exams, etc.
  - Great for math formulas

- Like a computer language for Microsoft Word
Binary RGB

- Usually, RGB color is stored as three bytes
  - (depending on OS / programming language)
  - One byte for R, one for G and one for B.
  - One byte == 8 bits
    - (a single yes/no or on/off value)

- 00000000 - 00000000 - 00000000
  - Black

- 11111111 - 11111111 – 11111111
  - White

8 bits to represent each color
2 choices for each bit (0,1)

$2^8 = 256$ colors