Color Charts

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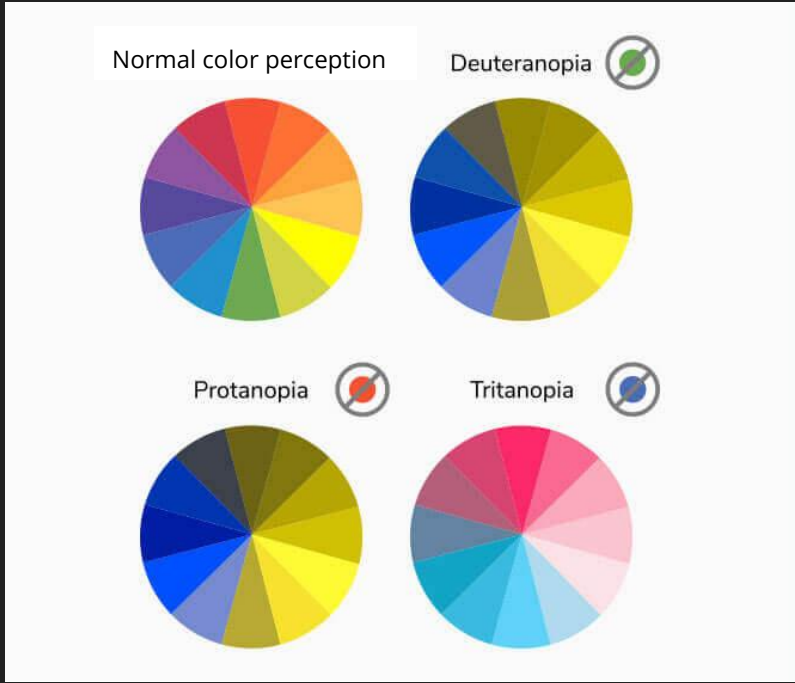
COS IW Spring 2020
Random Apps of Kindness
Advisor: Prof. A. Kaplan

Motivation

- Common color blindness types:
  - Red-green
  - Blue-yellow
  - Complete
- More common in males [1]:
  - 1 in 12 males
  - 1 in 200 females
- Affects approximately 13 million Americans [1]



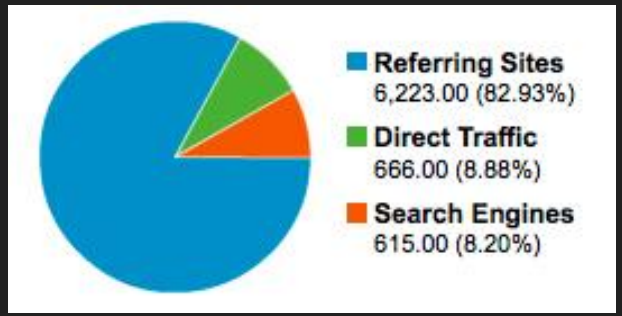
[1] https://ghr.nlm.nih.gov/condition/color-vision-deficiency

Motivation (cont.)

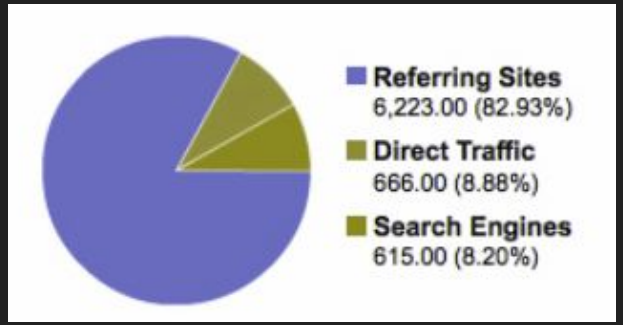
- Many visuals such as charts, graphs, and diagrams rely on the use of color to convey information
- What about color blind users?

Motivation (cont.)

Normal color perception



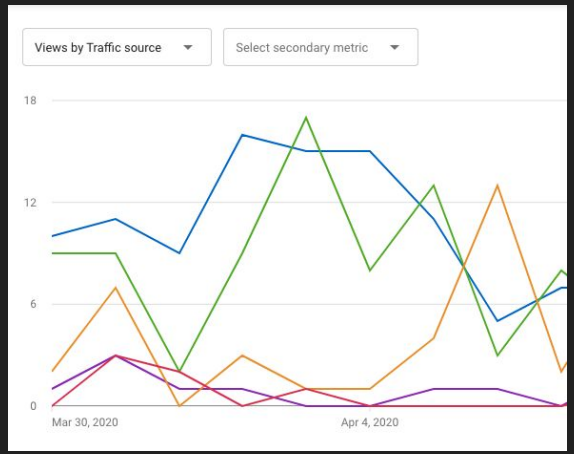
Protanopia



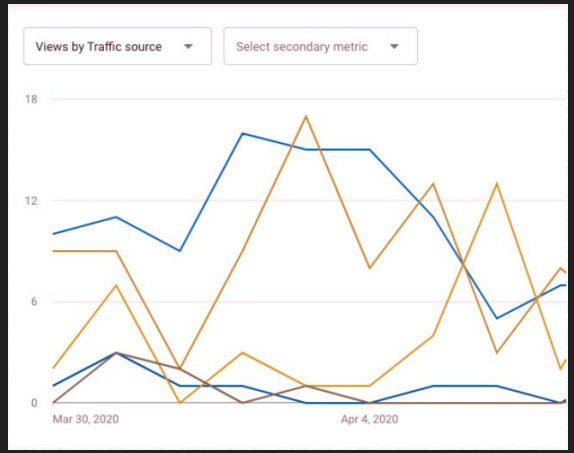
Google Analytics

Motivation (cont.)

Normal color perception



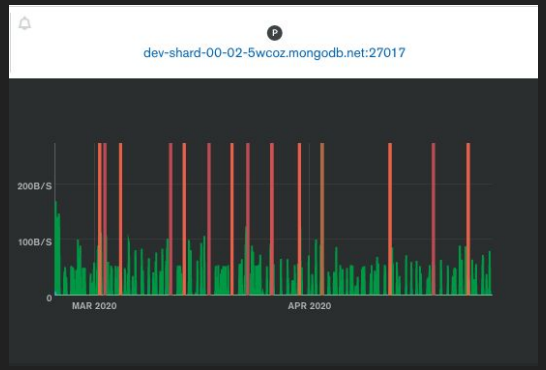
Protanopia



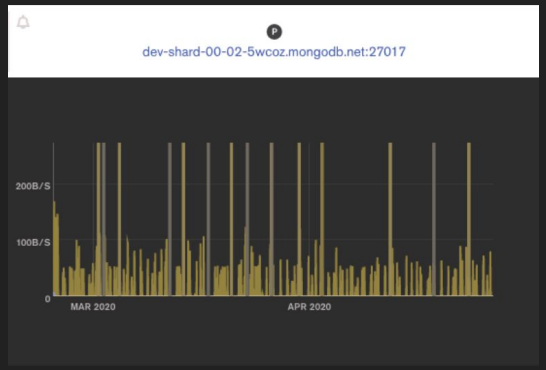
YouTube Analytics

Motivation (cont.)

Normal color perception

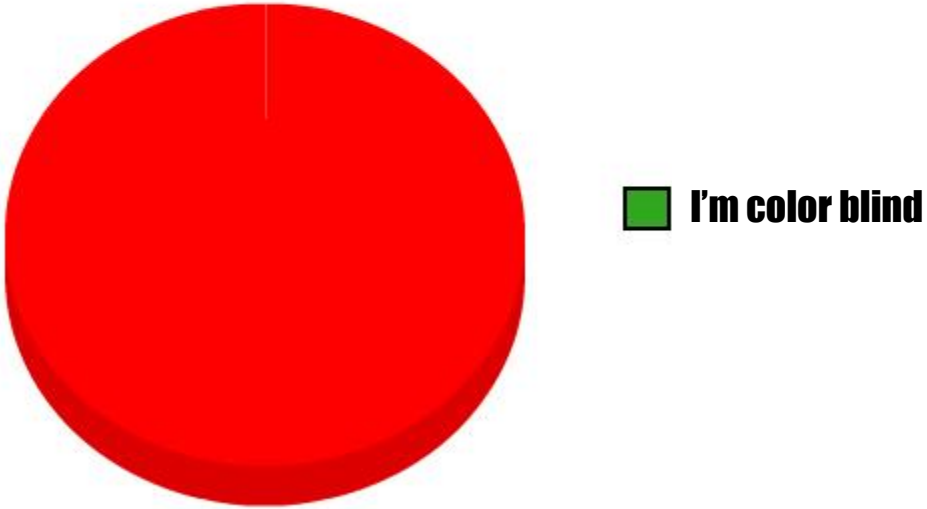


Protanopia



MongoDB Analytics

Why I hate pie charts.



The goal of this project is help color blind people better read charts, graphs, and diagrams on the web.

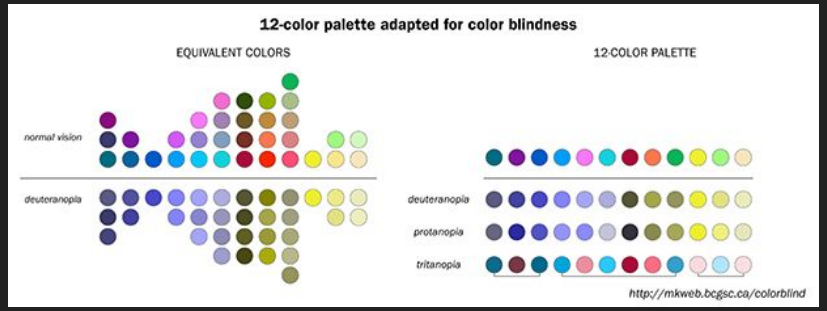
Problem Background and Related Work

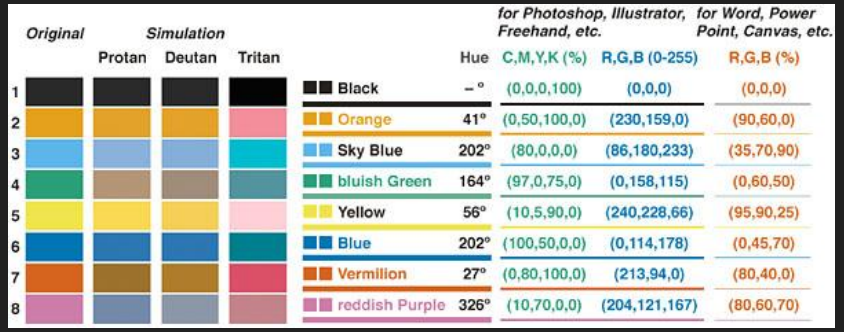
Two relevant areas:

1. Researched color blind friendly palettes
2. Existing color blind accessibility Chrome extensions

Researched Palettes

M. Kyrzywinski (2011) [2]





M. Okabe and K. Ito (2002) [3]

P. Tol [4]

bright:
blue red green yellow cyan purple grey

high-contrast:
blue yellow red

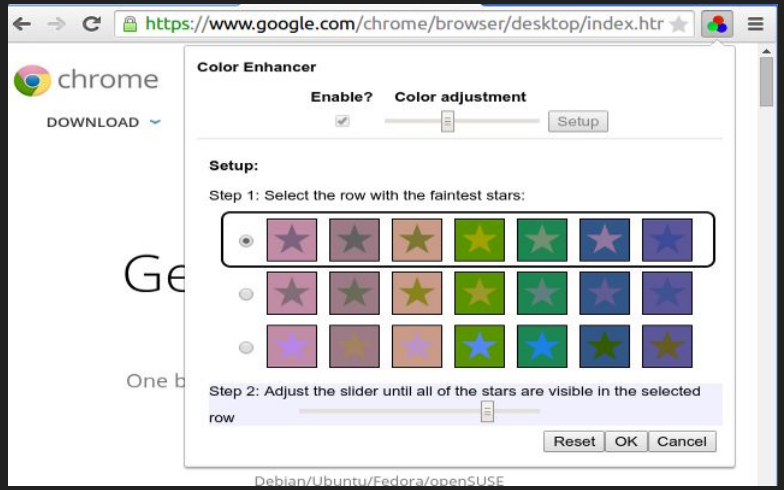
vibrant:
orange blue cyan magenta red teal grey

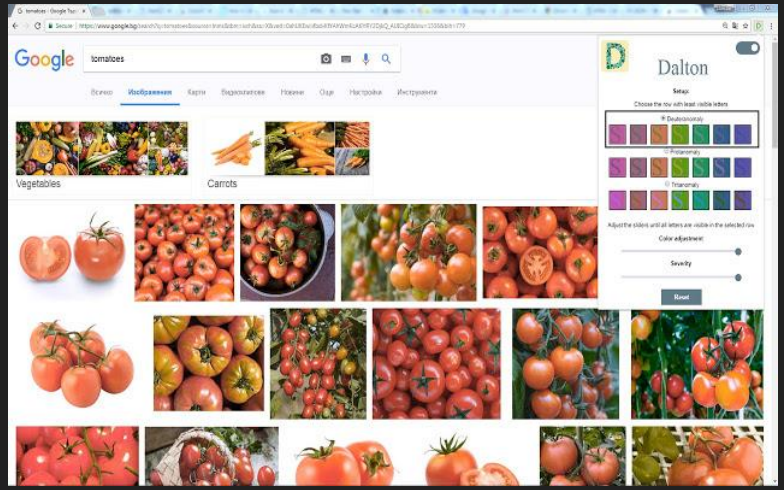
muted:
rose indigo sand green cyan wine teal olive purple pale grey

light:
light blue orange light yellow pink light cyan mint pear olive pale grey

[2] http://mkweb.bcgsc.ca/colorblind/
[3] https://jfly.uni-koeln.de/color/
[4] https://personal.sron.nl/~pault/#sec:qualitative

Existing Chrome Extensions





Color Enhancer — suggested by Chrome under their accessibility settings (188,934 users)

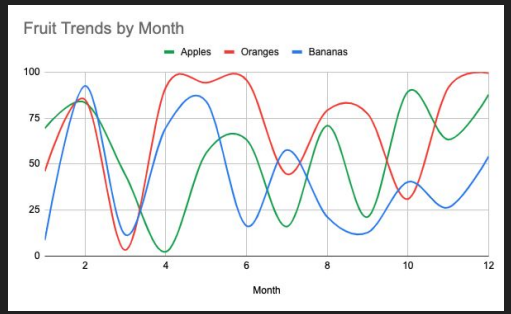
Dalton — alternative 3rd party extension (3,634 users)

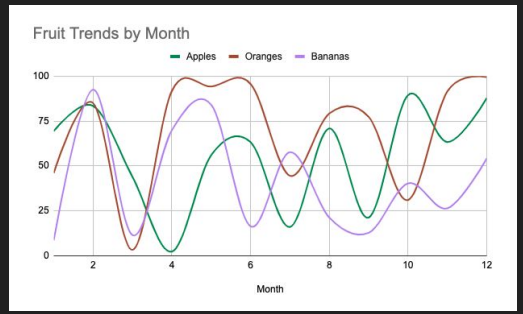
Existing Chrome Extensions (cont.)

Without Color Enhancer

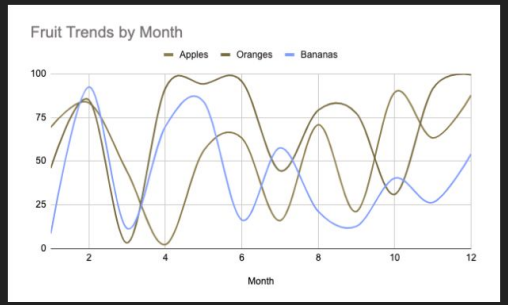
With Color Enhancer

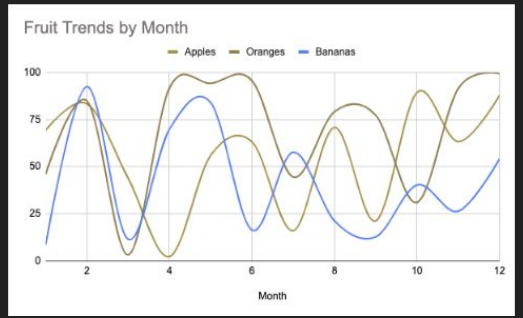
Normal color perception





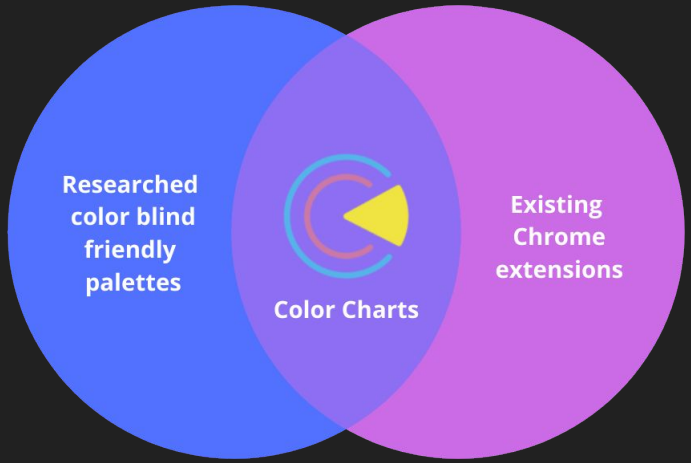
Protanopia



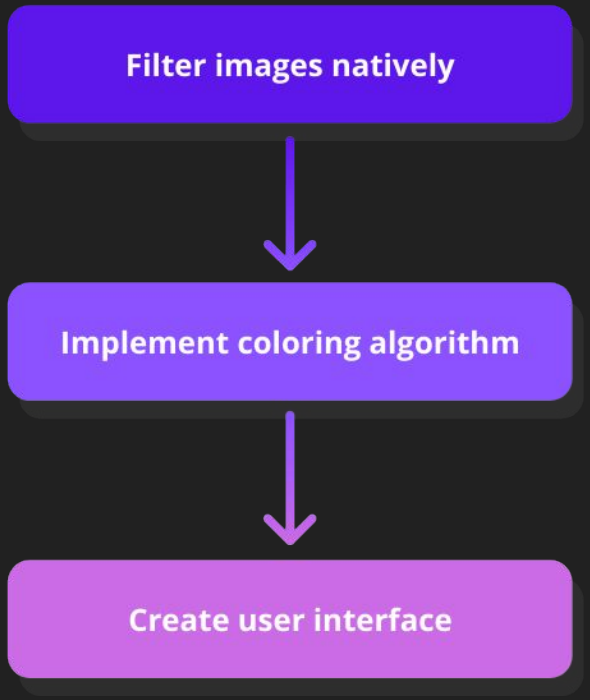


Approach

- Combine both areas of related work
- Create a Chrome extension that recolors images (specifically visuals such as charts, graphs, and diagrams) with researched color blind friendly palettes
- Output colors are not dependent on input colors



Implementation



1. Filtering images in line and preserving the structural integrity of the page
2. Implementing recoloring algorithm, mapping original colors to color blind friendly colors
3. Creating user interface where users can selectively filter and select palettes

Filtering Images Natively

- For each image:
  - Use HTML Canvas to “draw” image and access pixels
  - Export filtered image into base64 encoded data URI format
  - Set original src attribute to data URI
- Preserves page’s structural integrity by replacing <img> with <img>

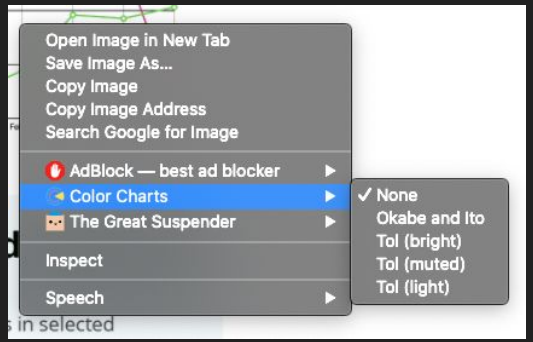
Implementing Coloring Algorithm

- Uses two pass recoloring process
- Maps original → 12 main colors of color wheel → color blind friendly colors
- Ignores grayscale colors
- Uses RGB and CIE L*a*b* colorspaces

Creating User Interface

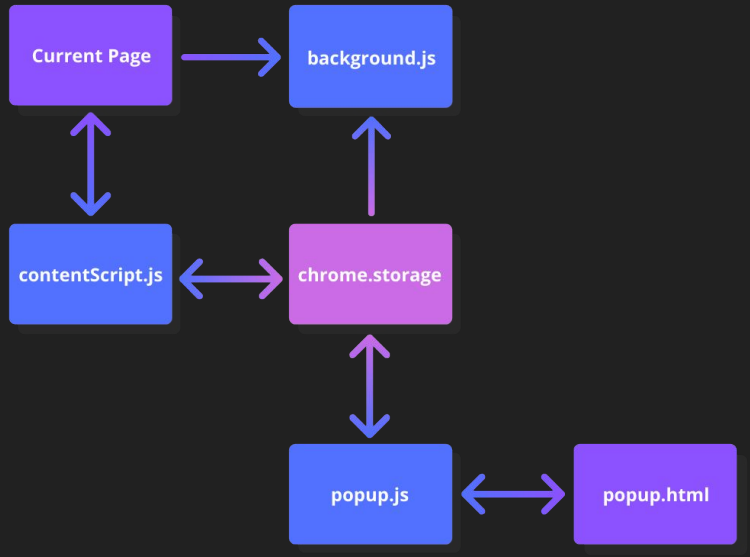
- Popup menu
  - Choose palette
  - Turn selective filtering on/off

- Right click menu
  - If selective filtering is on, right click on image and select palette



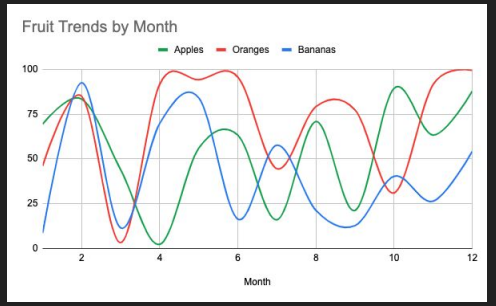
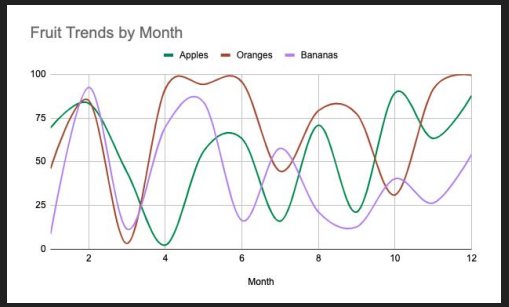
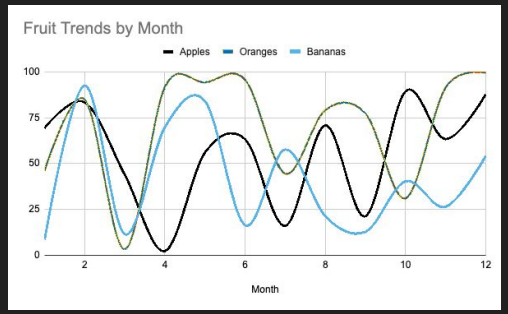
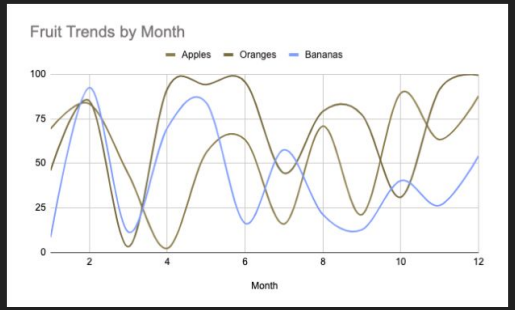
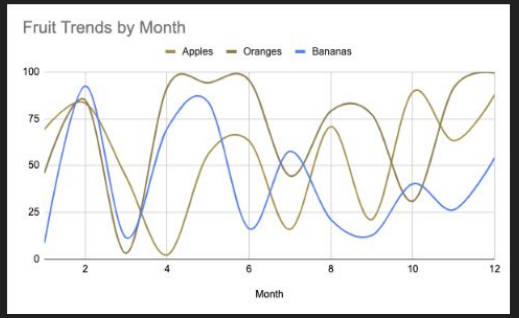
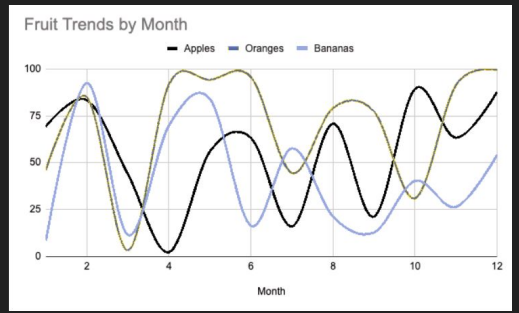
Creating User Interface (cont.)

- Uses Chrome local storage to save user preferences
- Scripts read and write to local storage
- To switch between palettes,
  - Revert images back to original by reading from cache
  - Apply new palette

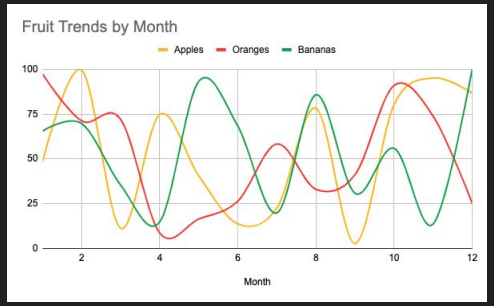
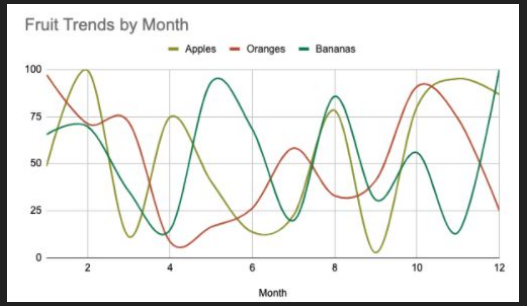
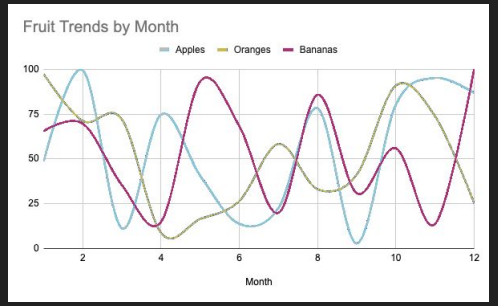
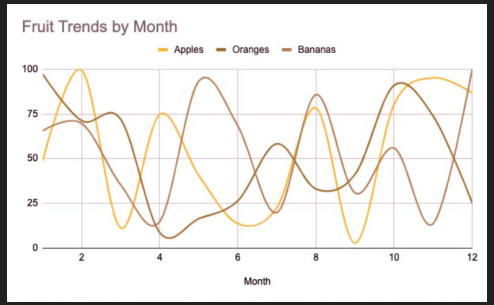
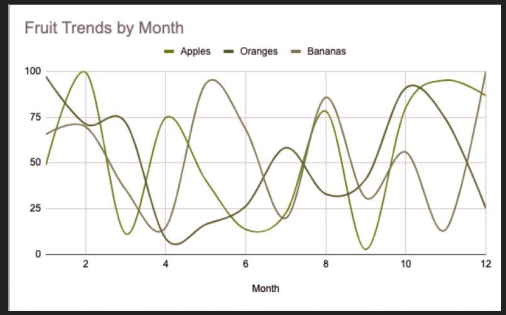
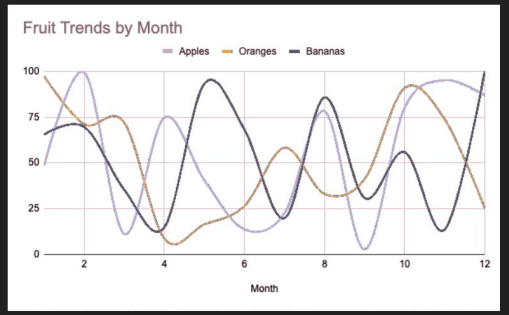


Arrow pointing from A → B:
A writes to B, and B reads from A

Results

	No extension	With Color Enhancer	With Color Charts
Normal color perception			
Protanopia			

Results (cont.)

	No extension	With Color Enhancer	With Color Charts
Normal color perception			
Deuteranopia			

Conclusion

- Color blind friendly palettes are guidelines for ideal colors of visuals
- Badly colored diagrams might not be improved with the use of existing Chrome extensions
- Solution: complete remapping of colors to color blind friendly colors
- Color Charts achieves this with a three step process:
  - Filtering images natively
  - Implementing coloring algorithm
  - Creating user interface
- Remember the color blind friendly palettes and use them!!!!

Thank you to
Professor Kaplan, Carlo, and everyone in this seminar!

Q&A