Color Deficiency in Data Visualization

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Color Vision Deficiency and Data Visualization

As mentioned in class, color vision deficiency is an important issue to be aware of when creating data visualizations. While red-green confusion is the most well known there are several types, all of which should be considered when creating accessible visualizations.

Types of color vision deficiencies:

Red-green color blindness The most common type of color blindness makes it hard to tell the difference between red and green.

There are 4 types of red-green color blindness:

Deuteranomaly is the most common type of red-green color blindness. It makes green look more red. This type is mild and doesn't usually get in the way of normal activities.

Protanomaly- makes red look more green and less bright. This type is mild and usually doesn't get in the way of normal activities.

Protanopia and **deuteranopia** both make you unable to tell the difference between red and green at all.

Blue-yellow color blindness This less-common type of color blindness makes it hard to tell the difference between blue and green, and between yellow and red.

There are 2 types of blue-yellow color blindness:

Tritanomaly- makes it hard to tell the difference between blue and green, and between yellow and red.

Tritanopia- makes you unable to tell the difference between blue and green, purple and red, and yellow and pink. It also makes colors look less bright.

Complete color blindness If you have complete color blindness, you can't see colors at all. This is also called **monochromacy**, and it's quite uncommon. Depending on the type, you may also have trouble seeing clearly and you may be more sensitive to light.

Source: https://www.nei.nih.gov/learn-about-eye-health/eye-conditions-and-diseases/color-blindness/types-color-blindness

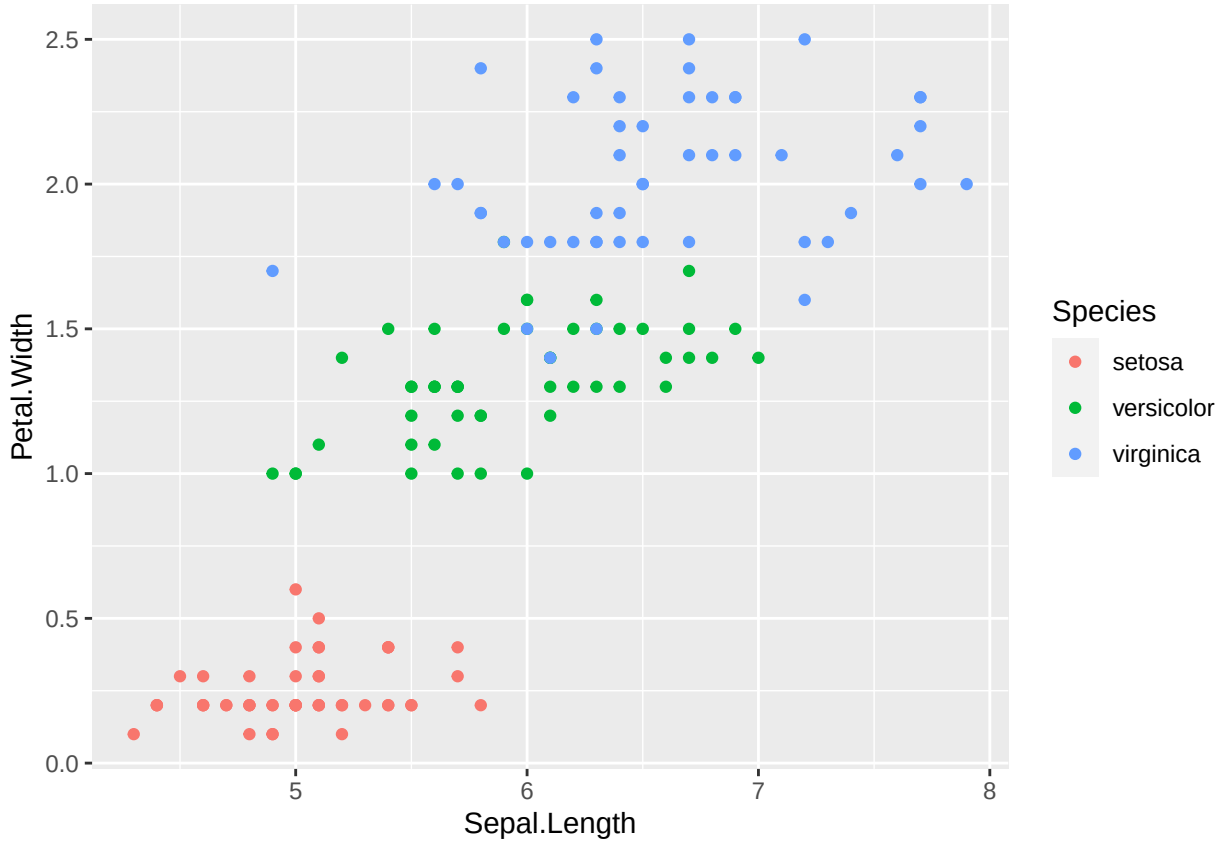
Test your plots

While not an exact science, there are some great tools to test how your visualizations may look to someone with these conditions. The one I like the most is Sim Daltonism. (Download here)

However, this application only works on Macs so if you have a windows or linux machine, I would recommend the program that was suggested in class.

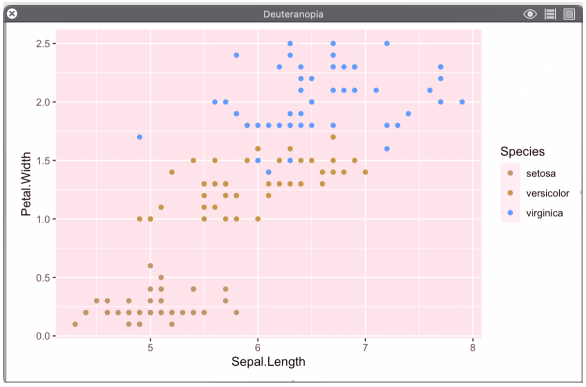
Here is an example of what the standard ggplot color palette looks like with different color vision deficiencies.

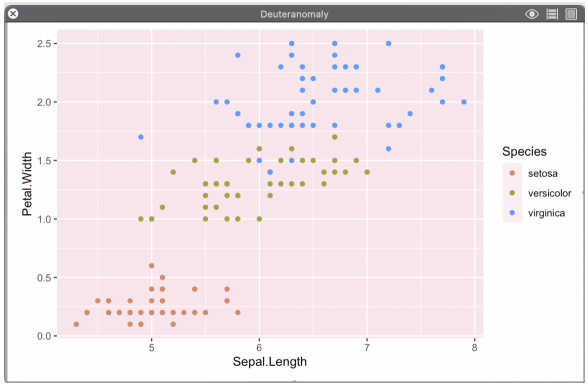
```
iris %>%
  ggplot(
    aes(x = Sepal.Length, y = Petal.Width, color = Species)
  ) +
  geom_point()
```

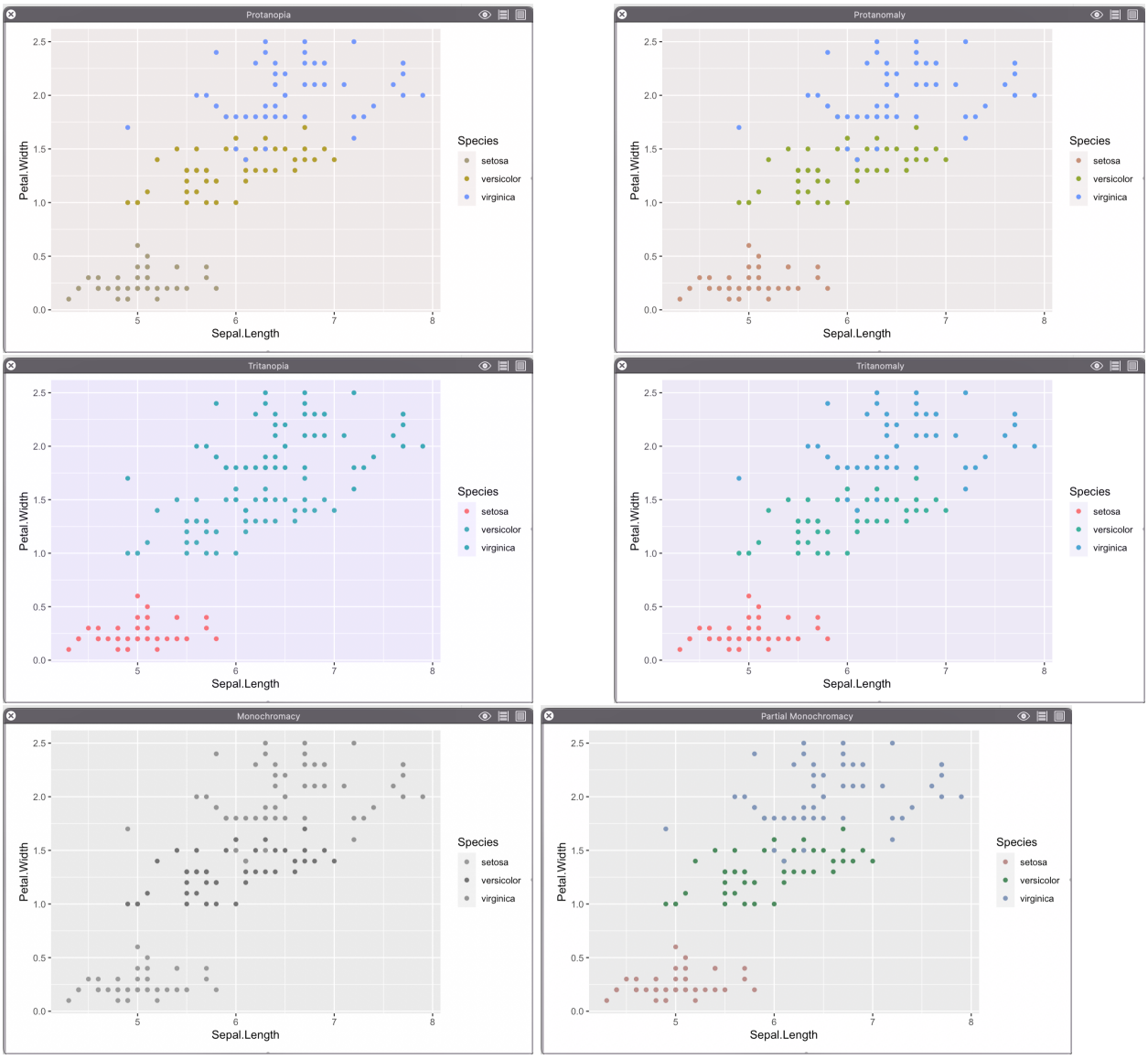


Original:

Here is how this might plot look like with the above conditions:



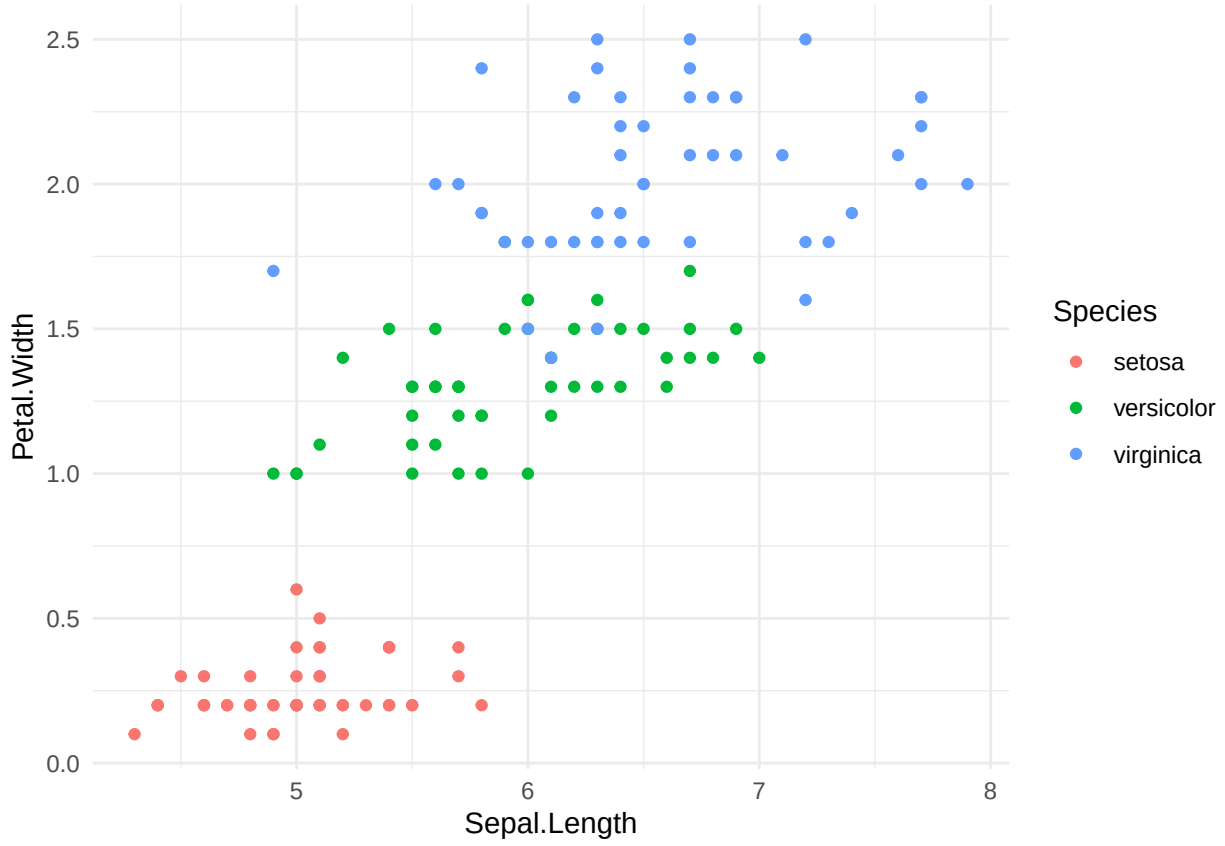




Ways to improve without changing color:

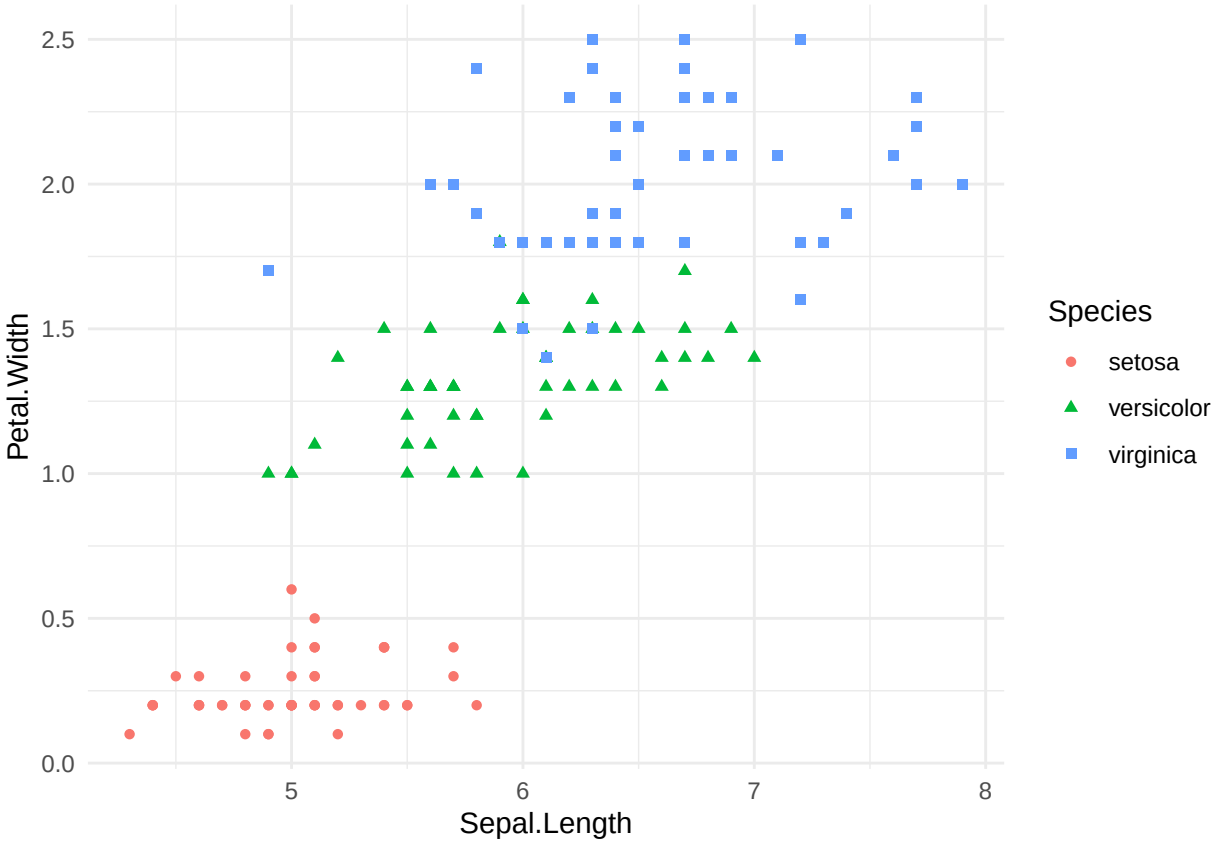
Increase Contrast:

```
iris %>%
  ggplot(
    aes(x = Sepal.Length, y = Petal.Width, color = Species)
  ) +
  geom_point() +
  theme_minimal()
```



Double Encoding:

```
iris %>%
  ggplot(
    aes(x = Sepal.Length, y = Petal.Width, color = Species, shape = Species)
  ) +
  geom_point() +
  theme_minimal()
```



A Better Palette:

I really like the Okabe-Ito pallete designed by Masataka Okabe and Kei Ito

(learn more read here:)

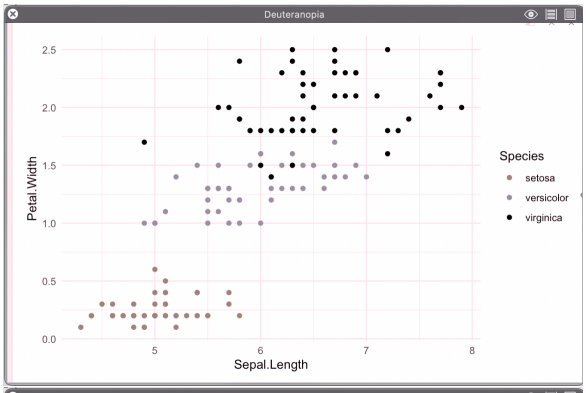
Here is a good visual guide.

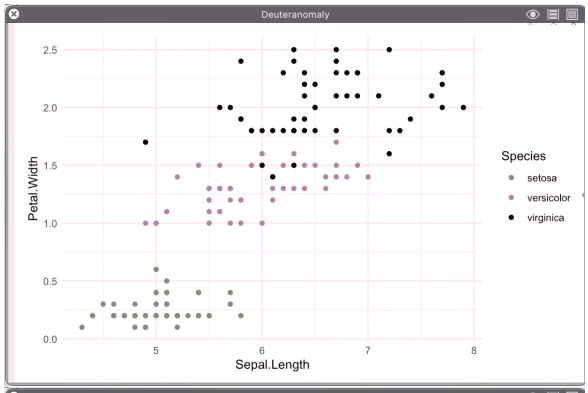
To easily use this palette in R, I like the `ggokabeito` package, which can be downloaded from CRAN.

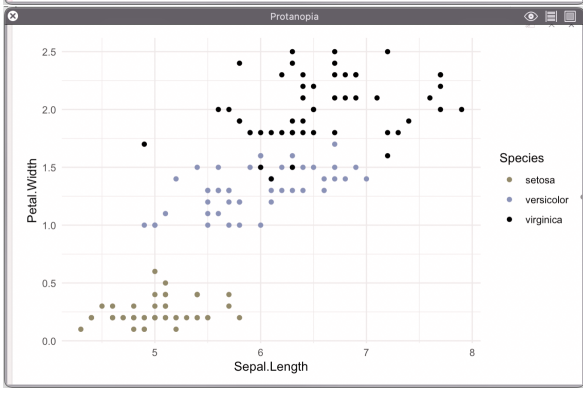
Example with new color palette:

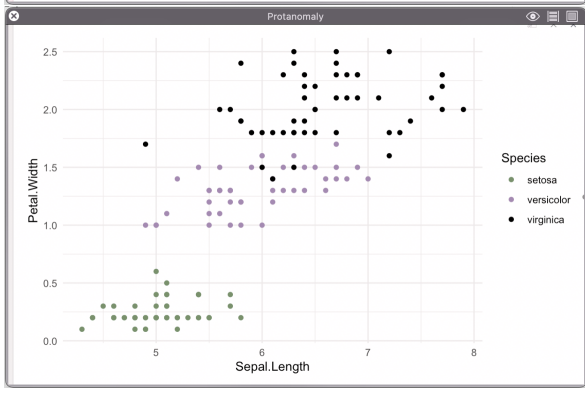
```
iris %>%
  ggplot(
    aes(x = Sepal.Length, y = Petal.Width, color = Species)
  ) +
  geom_point() +
  scale_color_okabe_ito(order = c(3,7,9)) +
  theme_minimal()
```

Petal.Width
Sepal.Length
Species
setosa
versicolor
virginica


Deuteranopia
Petal.Width
Sepal.Length
Species
setosa
versicolor
virginica


Deuteranomaly
Petal.Width
Sepal.Length
Species
setosa
versicolor
virginica


Protanopia
Petal.Width
Sepal.Length
Species
setosa
versicolor
virginica


Protanomaly
Petal.Width
Sepal.Length
Species
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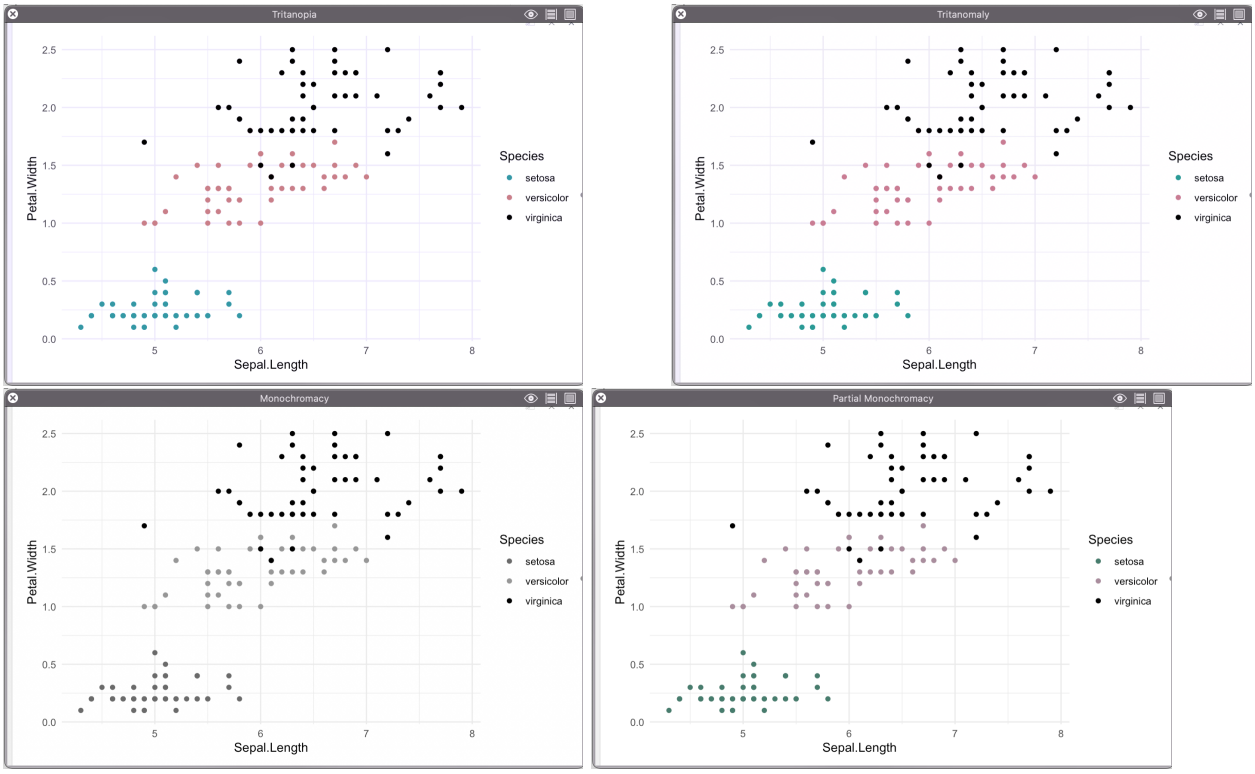
virginica



Other considerations

While it is very important to make sure that data science and visualizations are accessible to as many people as possible, these considerations for color extend further than those with color vision deficiencies. Often times the medium in which we present our visualizations can considerably impact how the color distinctions come across. Not every visualization is viewed on a large projector, some are dispersed for individual viewing, while others may even be printed in black and white. Therefore is it very important to consider double encoding and high contrast colors when creating visualizations.