5: Part 1 - Data Visualization Basics

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Objectives

1. Perform simple data visualizations in the R package `ggplot`
2. Develop skills to adjust aesthetics and layers in graphs
3. Apply a decision tree framework for appropriate graphing methods

Opening discussion

Effective data visualization depends on purposeful choices about graph types. The ideal graph type depends on the type of data and the message the visualizer desires to communicate. The best visualizations are clear and simple. A good resource for data visualization is Data to Viz, which includes both a decision tree for visualization types and explanation pages for each type of data, including links to R resources to create them. Take a few minutes to explore this website.

Set Up

```
library(tidyverse);library(lubridate);library(here)
library(ggridges)

here()
```

```
## [1] "/home/guest/EDA/EDA-Spring2023"
```

```
PeterPaul.chem.nutrients <-
  read.csv(here("Data/Processed_KEY/NTL-LTER_Lake_Chemistry_Nutrients_PeterPaul_Processed.csv"), string
PeterPaul.chem.nutrients.gathered <-
  read.csv(here("Data/Processed_KEY/NTL-LTER_Lake_Nutrients_PeterPaulGathered_Processed.csv"), stringsA
EPAair <- read.csv(here("Data/Processed_KEY/EPAair_O3_PM25_NC1819_Processed.csv"), stringsAsFactors = T

EPAair$Date <- ymd(EPAair$Date)
PeterPaul.chem.nutrients$sampledate <- ymd(PeterPaul.chem.nutrients$sampledate)
PeterPaul.chem.nutrients.gathered$sampledate <- ymd(PeterPaul.chem.nutrients.gathered$sampledate)
```

ggplot

ggplot, called from the package `ggplot2`, is a graphing and image generation tool in R. This package is part of tidyverse. While base R has graphing capabilities, ggplot has the capacity for a wider range and more sophisticated options for graphing. ggplot has only a few rules:

- The first line of ggplot code always starts with `ggplot()` #what will go inside will always be a data frame
- A data frame must be specified within the `ggplot()` function. Additional datasets can be specified in subsequent layers.
- Aesthetics must be specified, most commonly x and y variables but including others. Aesthetics can be specified in the `ggplot()` function or in subsequent layers.
- Additional layers must be specified to fill the plot.

Geoms

Here are some commonly used layers for plotting in ggplot: this will be the second lines

- geom_bar
- geom_histogram
- geom_freqpoly
- geom_boxplot
- geom_violin
- geom_dotplot
- geom_density_ridges
- geom_point
- geom_errorbar
- geom_smooth
- geom_line
- geom_area
- geom_abline (plus geom_hline and geom_vline)
- geom_text

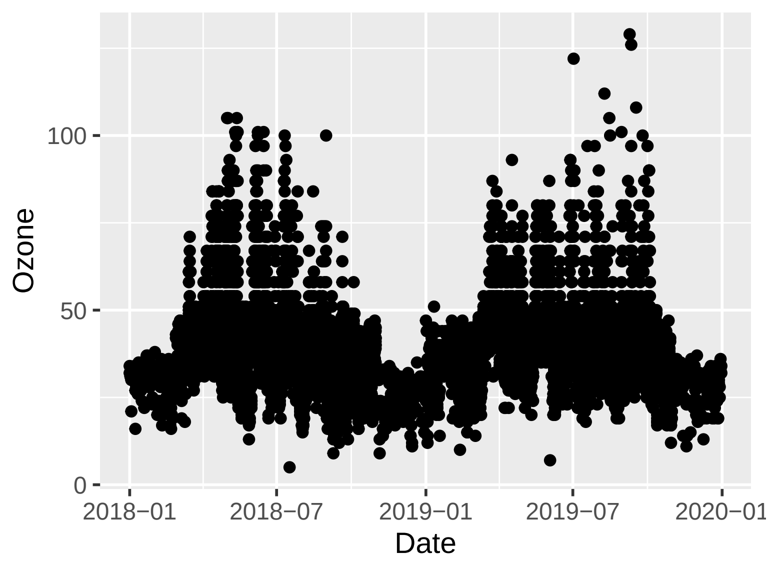
Aesthetics

Here are some commonly used aesthetic types that can be manipulated in ggplot:

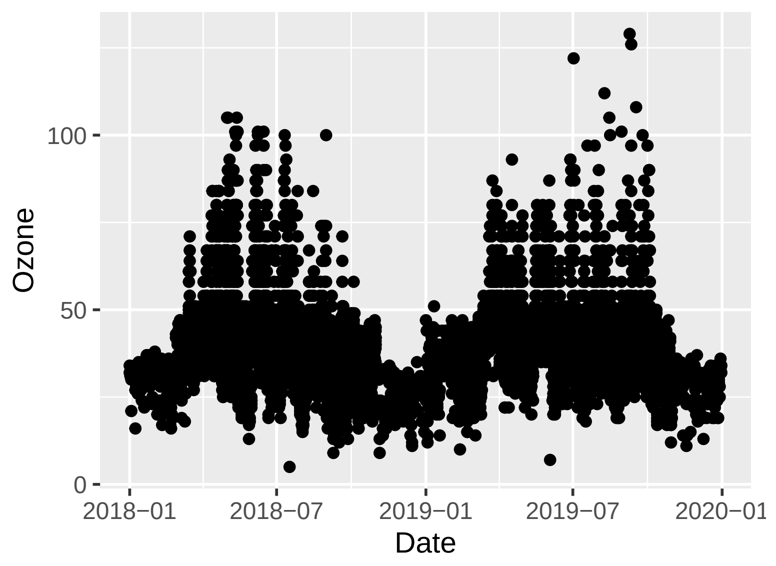
- color
- fill
- shape
- size
- transparency

Plotting continuous variables over time: Scatterplot and Line Plot

```
# Scatterplot
ggplot(EPAair, aes(x = Date, y = Ozone)) +
  geom_point()
```

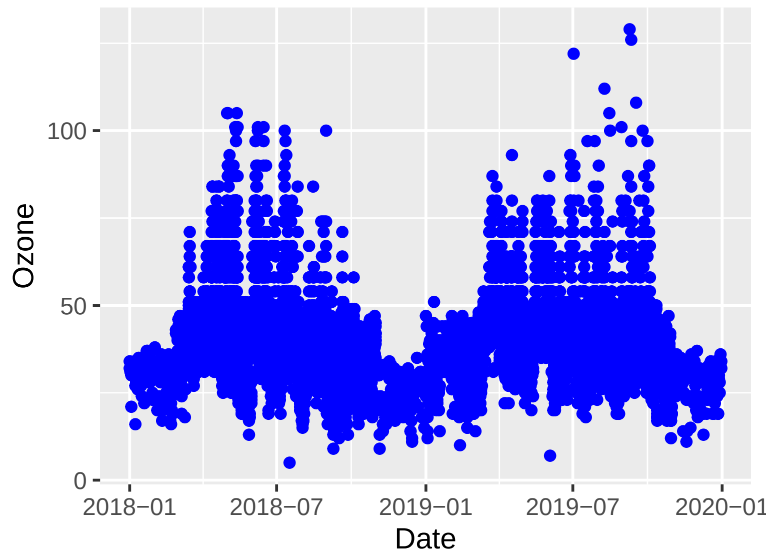


```
O3plot <- ggplot(EPAair) +
  geom_point(aes(x = Date, y = Ozone))
print(O3plot)
```



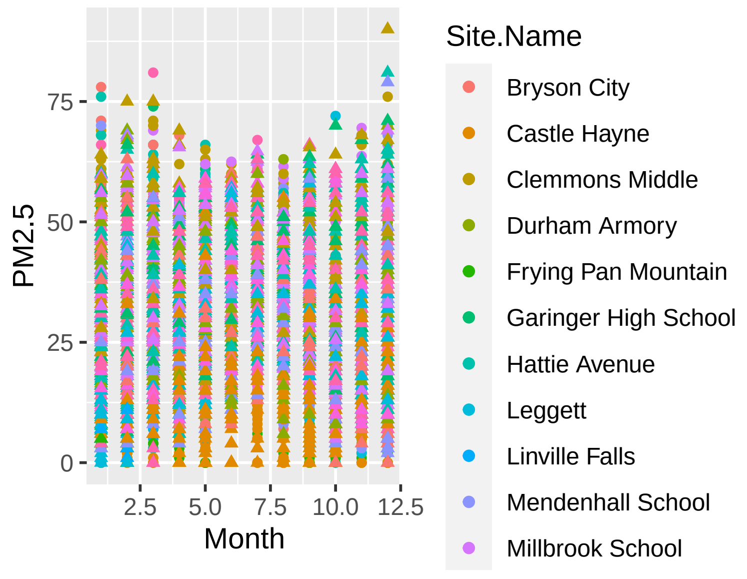
```
#the ggplot specified more than one line, two plots on the same window. this is how you store the plot.

# Fix this code
O3plot2 <- ggplot(EPAair) +
  geom_point(aes(x = Date, y = Ozone), color = "blue")
print(O3plot2)
```



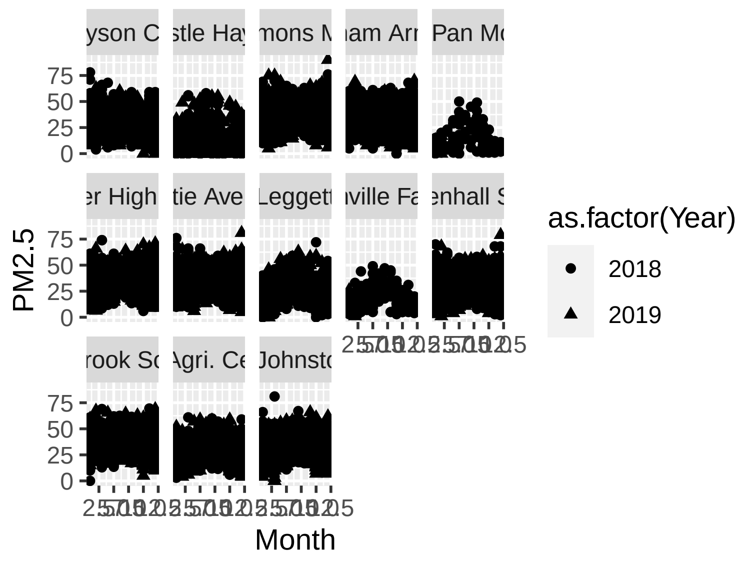
```
#you want to change the color, when you specify the color inside the aesthetics, you are adding a new l

# Add additional variables
# How could you automatically assign a marker color to a variable? you keep the color function inside t
PMplot <-
  ggplot(EPAair, aes(x = Month, y = PM2.5, shape = as.factor(Year), color = Site.Name)) +
  geom_point()
print(PMplot)
```

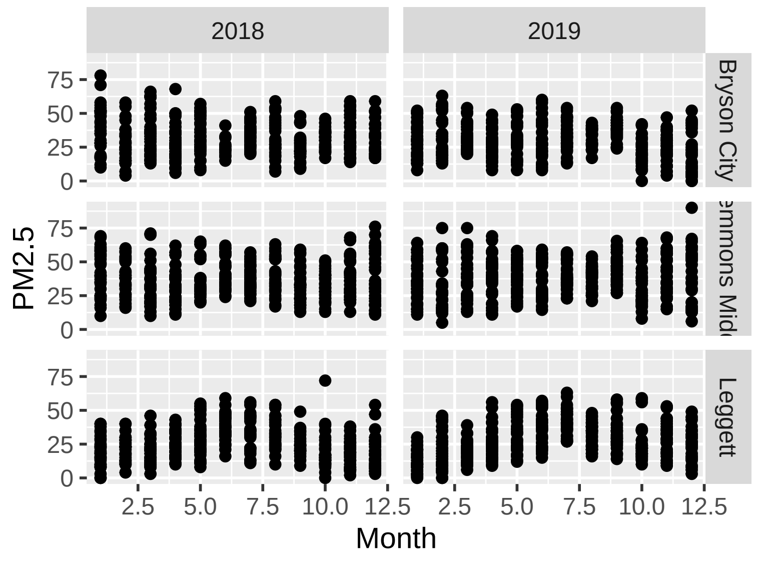


```
#the as.factor(year) will automatically assign them.

# Separate plot with facets to get better visualization.
PMplot.faceted <-
  ggplot(EPAair, aes(x = Month, y = PM2.5, shape = as.factor(Year))) +
  geom_point() +
  facet_wrap(vars(Site.Name), nrow = 3) #instead coloring the sites of different colors, you are creati
print(PMplot.faceted)
```

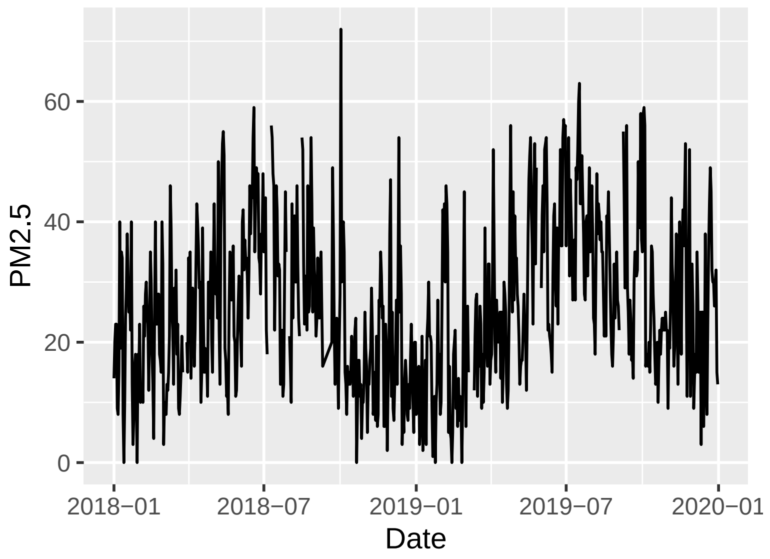


```
# Filter dataset within plot building and facet by multiple variables; you're not interested in all the
PMplot.faceted2 <-
  ggplot(subset(EPAair, Site.Name == "Clemmons Middle" | Site.Name == "Leggett" |
                Site.Name == "Bryson City"),
         aes(x = Month, y = PM2.5)) +
  geom_point() +
  facet_grid(Site.Name ~ Year) #the columns are going to represent the year
print(PMplot.faceted2)
```



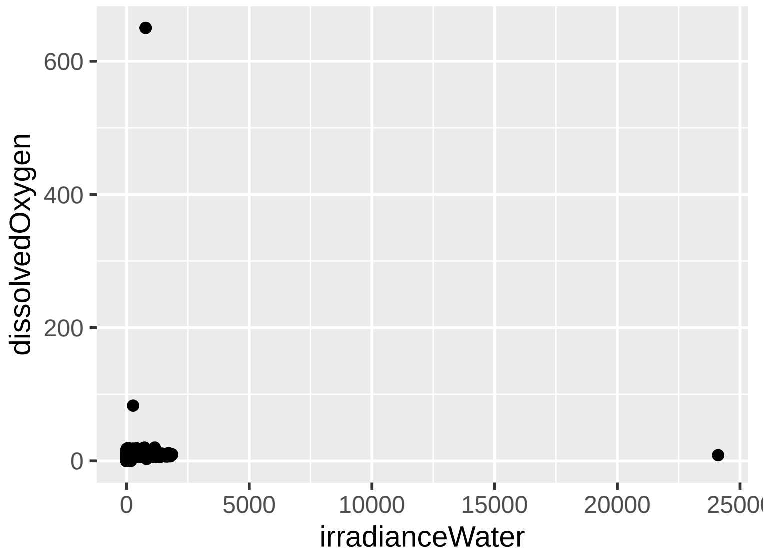
```
# Plot true time series with geom_line
PMplot.line <-
```

```
  ggplot(subset(EPAair, Site.Name == "Leggett"),
         aes(x = Date, y = PM2.5)) +
  geom_line()
print(PMplot.line)
```



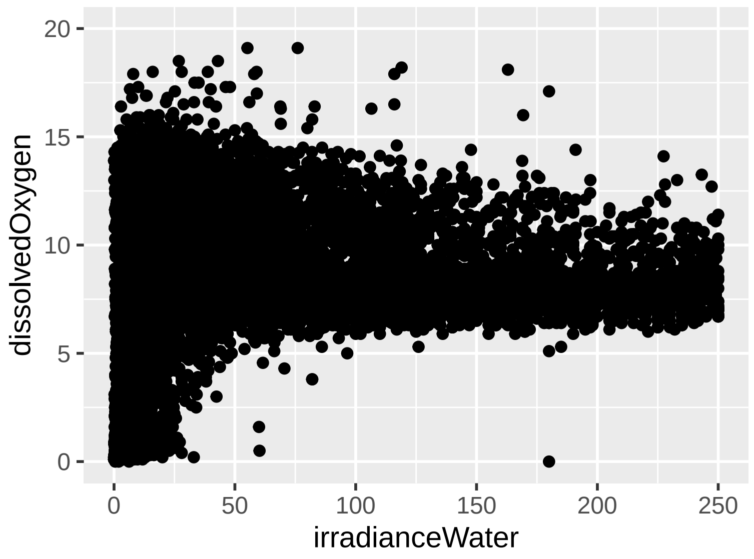
Plotting the relationship between two continuous variables: Scatterplot

```
# Scatterplot
lightvsDO <-
  ggplot(PeterPaul.chem.nutrients, aes(x = irradianceWater, y = dissolvedOxygen)) +
  geom_point()
print(lightvsDO)
```

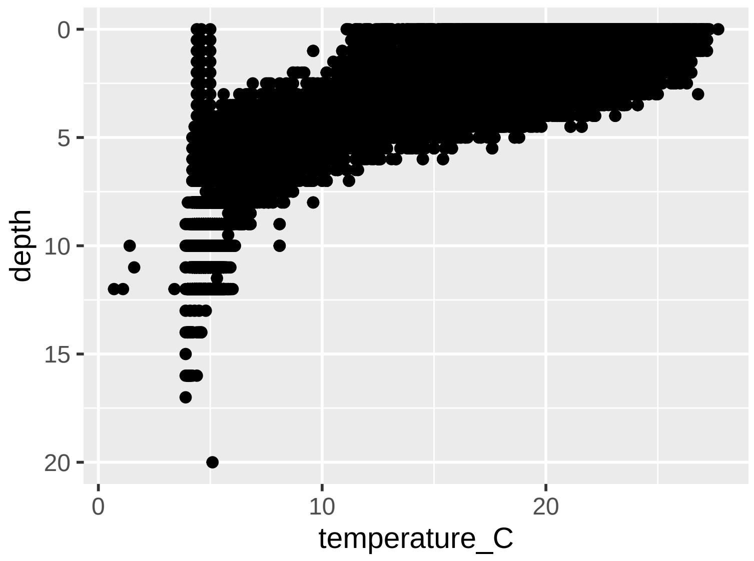


```
#this is not a good visualization because the two points are so far from the others, that the majority

# Adjust axes
lightvsDOfixed <-
  ggplot(PeterPaul.chem.nutrients, aes(x = irradianceWater, y = dissolvedOxygen)) +
  geom_point() +
  xlim(0, 250) +
  ylim(0, 20)
print(lightvsDOfixed)
```

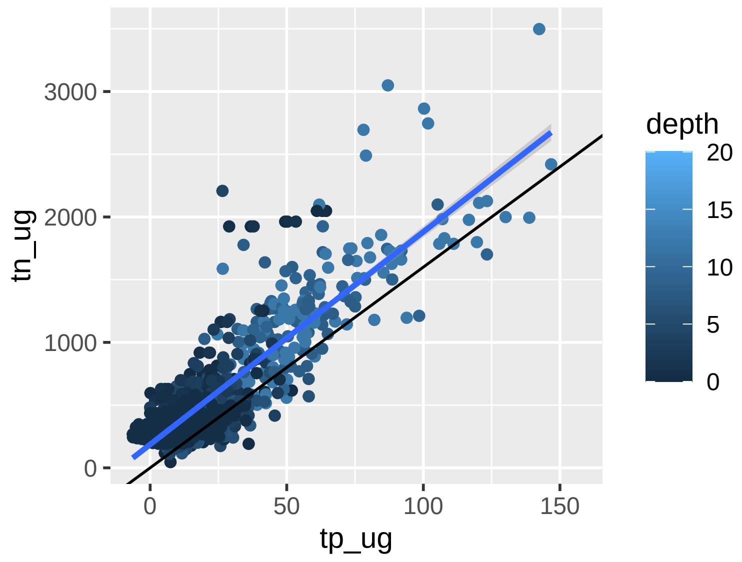


```
# Depth in the fields of limnology and oceanography is on a reverse scale
tempvsdepth <-
  ggplot(PeterPaul.chem.nutrients, aes(x = temperature_C, y = depth)) +
  #ggplot(PeterPaul.chem.nutrients, aes(x = temperature_C, y = depth, color = daynum)) +
  geom_point() +
  scale_y_reverse() #if we dont specify this, then the values are going to be plotted to the maximum va
print(tempvsdepth)
```



```r
NvsP <-
  ggplot(PeterPaul.chem.nutrients, aes(x = tp_ug, y = tn_ug, color = depth)) +
  geom_point() +
  geom_smooth(method = lm) + #ask ggplot to add a trend line
  geom_abline(aes(slope = 16, intercept = 0))
print(NvsP)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

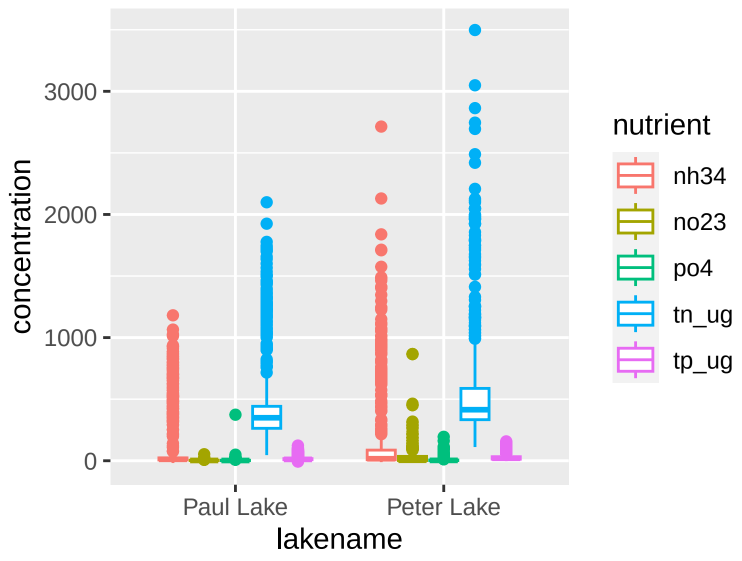


Plotting continuous vs. categorical variables

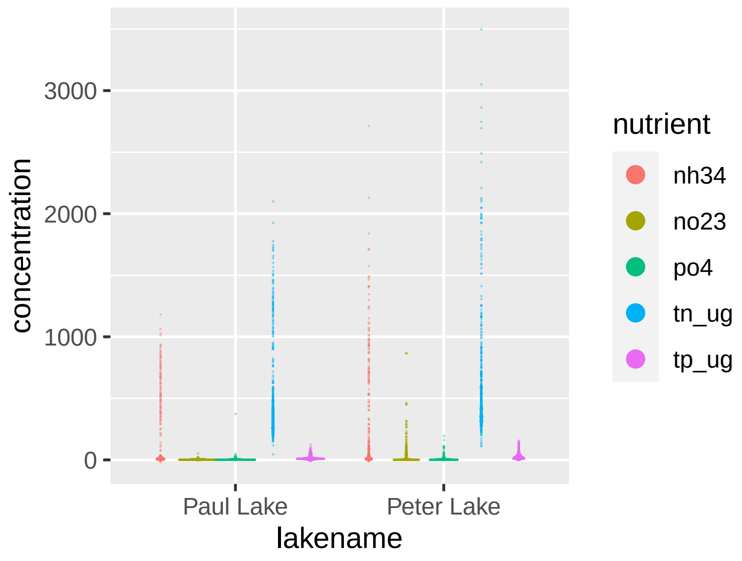
A traditional way to display summary statistics of continuous variables is a bar plot with error bars. Let's explore why this might not be the most effective way to display this type of data. Navigate to the Caveats page on Data to Viz (https://www.data-to-viz.com/caveats.html) and find the page that explores barplots and error bars.

What might be more effective ways to display the information? Navigate to the boxplots page in the Caveats section to explore further.

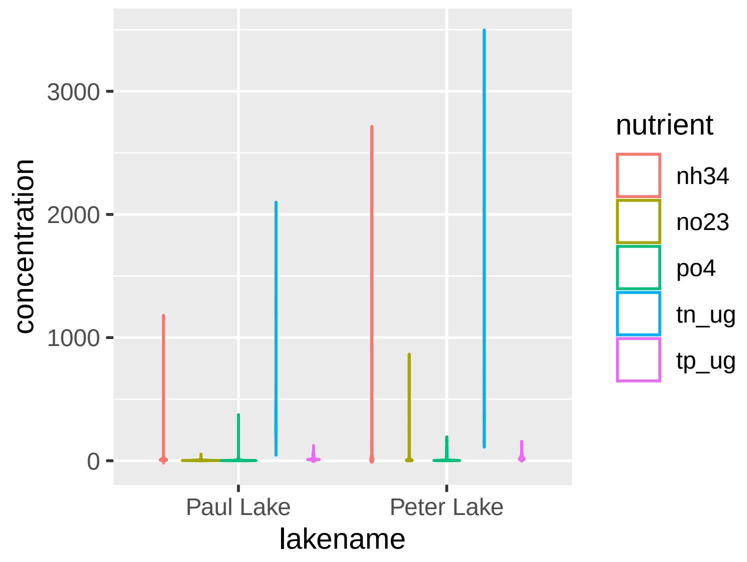
```
# Box and whiskers plot
Nutrientplot3 <-
  ggplot(PeterPaul.chem.nutrients.gathered, aes(x = lakename, y = concentration)) +
  geom_boxplot(aes(color = nutrient)) # Why didn't we use "fill"? the color is the points, the fill wil
print(Nutrientplot3)
```



```
# Dot plot
Nutrientplot4 <-
  ggplot(PeterPaul.chem.nutrients.gathered, aes(x = lakename, y = concentration)) +
  geom_dotplot(aes(color = nutrient, fill = nutrient), binaxis = "y", binwidth = 1,
               stackdir = "center", position = "dodge", dotsize = 2) #binaxis means that you are stacki
print(Nutrientplot4)
```



```r
# Violin plot. this also shows you the density plot. you can see the different of the density for the o
Nutrientplot5 <-
  ggplot(PeterPaul.chem.nutrients.gathered, aes(x = lakename, y = concentration)) +
  geom_violin(aes(color = nutrient)) #
print(Nutrientplot5)
```



```r
# Frequency polygons
# Using a tidy dataset
Nutrientplot6 <-
  ggplot(PeterPaul.chem.nutrients) +
  geom_freqpoly(aes(x = tn_ug), color = "darkred") +
  geom_freqpoly(aes(x = tp_ug), color = "darkblue") +
  geom_freqpoly(aes(x = nh34), color = "blue") +
  geom_freqpoly(aes(x = no23), color = "royalblue") +
  geom_freqpoly(aes(x = po4), color = "red")
print(Nutrientplot6)
```

```
## ‘stat_bin()‘ using ‘bins = 30‘. Pick better value with ‘binwidth‘.
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```
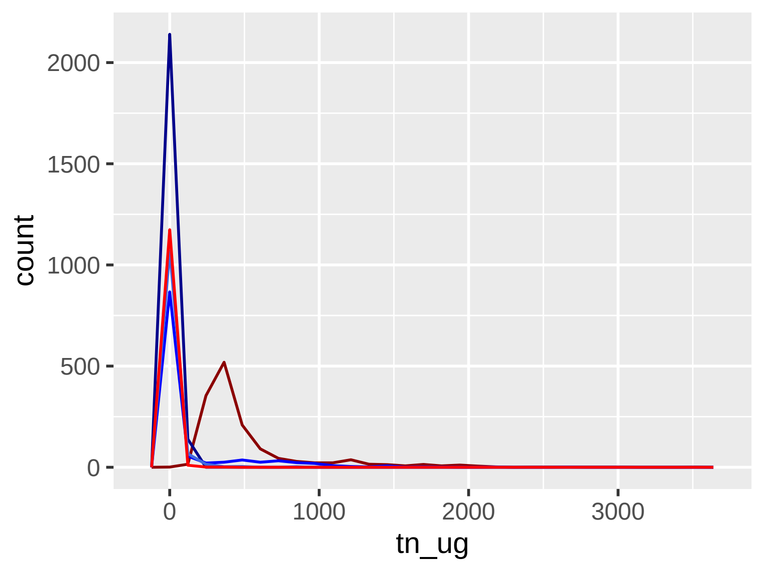
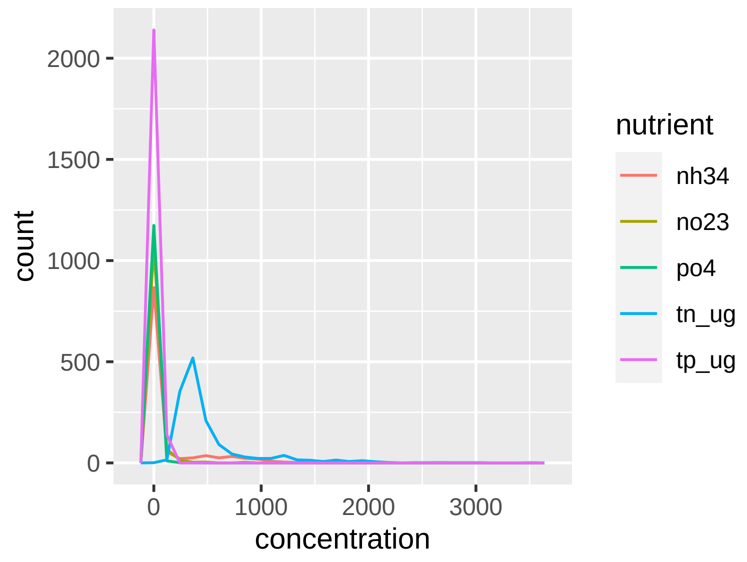



```
#there is a lot of problems because they do not show you any legends. Not all the plots values are tn_u

# Using a gathered dataset
Nutrientplot7 <-
  ggplot(PeterPaul.chem.nutrients.gathered) +
  geom_freqpoly(aes(x = concentration, color = nutrient))
print(Nutrientplot7)
```

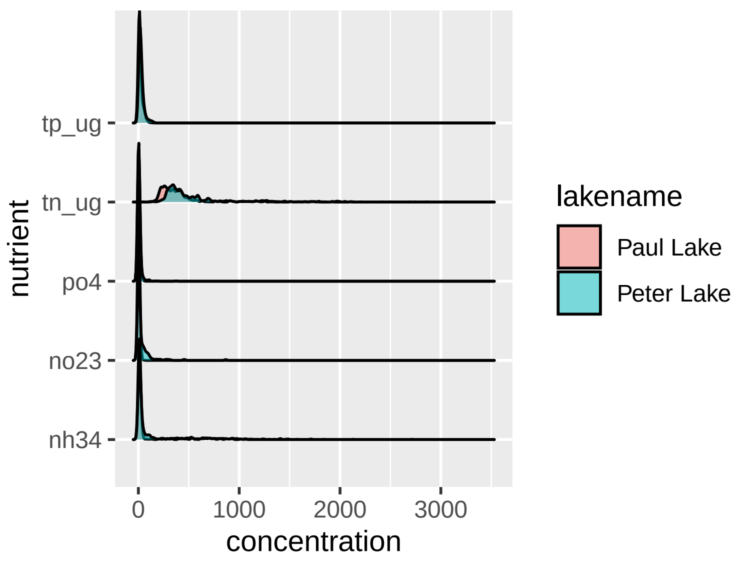
```
## ‘stat_bin()‘ using ‘bins = 30‘. Pick better value with ‘binwidth‘.
```



```
# Frequency polygons have the risk of becoming spaghetti plots.
# See <https://www.data-to-viz.com/caveat/spaghetti.html> for more info.

# Ridgeline plot, this shows the density of the plot over time.
Nutrientplot6 <-
```

```
  ggplot(PeterPaul.chem.nutrients.gathered, aes(y = nutrient, x = concentration)) +
  geom_density_ridges(aes(fill = lakename), alpha = 0.5) #
print(Nutrientplot6)
```

```
## Picking joint bandwidth of 10.9
```


tp_ug
tn_ug
po4
no23
nh34
nutrient
concentration
lakename
Paul Lake
Peter Lake