Assignment 3: Data Exploration

Jackie Fahrenholz, Section #2

OVERVIEW

This exercise accompanies the lessons in Environmental Data Analytics on Data Exploration.

Directions

1. Change "Student Name, Section #" on line 3 (above) with your name and section number.
2. Work through the steps, **creating code and output** that fulfill each instruction.
3. Be sure to **answer the questions** in this assignment document.
4. When you have completed the assignment, **Knit** the text and code into a single PDF file.
5. After Knitting, submit the completed exercise (PDF file) to the dropbox in Sakai. Add your last name into the file name (e.g., "FirstLast_A03_DataExploration.Rmd") prior to submission.

The completed exercise is due on <>.

Set up your R session

1. Check your working directory, load necessary packages (tidyverse), and upload two datasets: the ECOTOX neonicotinoid dataset (ECOTOX_Neonicotinoids_Insects_raw.csv) and the Niwot Ridge NEON dataset for litter and woody debris (NEON_NIWO_Litter_massdata_2018-08_raw.csv). Name these datasets "Neonics" and "Litter", respectively. **Be sure to add the `stringsAsFactors = TRUE` parameter to the function when reading in the CSV files.**

```
#check working directory
getwd()
```

```
## [1] "C:/Users/Jackie/Desktop/ENV872/Environmental_Data_Analytics_2022/Assignments"
```

```
#have necessary packages available
library(tidyverse)
#load the datasets
Neonics <- read.csv("../Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv" ,stringsAsFactors = TRUE)
Litter <- read.csv("../Data/Raw/NEON_NIWO_Litter_massdata_2018-08_raw.csv"  ,stringsAsFactors = TRUE)
```

Learn about your system

2. The neonicotinoid dataset was collected from the Environmental Protection Agency's ECOTOX Knowledgebase, a database for ecotoxicology research. Neonicotinoids are a class of insecticides used widely in agriculture. The dataset that has been pulled includes all studies published on insects. Why might we be interested in the ecotoxicologoy of neonicotinoids on insects? Feel free to do a brief internet search if you feel you need more background information.

   Answer: Pesticides are targeted at insects so their effectiveness in controlling pests is important as we wish to measure this when dealing with crop management. Though, this may impact species of insect like pollinaters (bees) unintentionally, or be harmful to other closely related organisms above them on the food chain that may cause a negative food chain reaction.

3. The Niwot Ridge litter and woody debris dataset was collected from the National Ecological Observatory Network, which collectively includes 81 aquatic and terrestrial sites across 20 ecoclimatic domains. 32 of these sites sample forest litter and woody debris, and we will focus on the Niwot Ridge long-term ecological research (LTER) station in Colorado. Why might we be interested in studying litter and woody debris that falls to the ground in forests? Feel free to do a brief internet search if you feel you need more background information.

   Answer: Measuring litter fall and woody debris is a measure of forest productivity. Collecting this data is useful in monitoring forest health from a tree growth and leaf area. It also measures decaying matter that will return the nutrients back to the soil after decomposition occurs.

4. How is litter and woody debris sampled as part of the NEON network? Read the NEON_Litterfall_UserGuide.pdf document to learn more. List three pieces of salient information about the sampling methods here:

   Answer: There are ground traps and elevated traps, which are sampled at different intervals throughout the year. Plots are nested within each other, and are given IDs. There are 7 functional groups (type of matter collected) each with a measurement taken upon sampling. *

Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

```
print(dim(Neonics))
```

```
## [1] 4623   30
```

6. Using the `summary` function on the "Effect" column, determine the most common effects that are studied. Why might these effects specifically be of interest?

```
summary(Neonics$Effect)
```

```
##     Accumulation        Avoidance         Behavior     Biochemistry
##               12              102              360               11
##          Cell(s)      Development        Enzyme(s) Feeding behavior
##                9              136               62              255
##         Genetics           Growth        Histology       Hormone(s)
##               82               38                5                1
##    Immunological     Intoxication       Morphology        Mortality
##               16               12               22             1493
##       Physiology       Population     Reproduction
##                7             1803              197
```

   Answer: Mortality and Population are the two columns with the most information. The effect of the chemical on the insects is important as is the abundance and or species of the insects that the information is being tested on. Density of a pest will change management practices.

7. Using the `summary` function, determine the six most commonly studied species in the dataset (common name). What do these species have in common, and why might they be of interest over other insects? Feel free to do a brief internet search for more information if needed.

```
summary(Neonics$Species.Common.Name)
```

```
##                          Honey Bee                       Parasitic Wasp
##                                667                                  285
##              Buff Tailed Bumblebee                 Carniolan Honey Bee
##                                183                                  152
##                         Bumble Bee                    Italian Honeybee
##                                140                                  113
##                    Japanese Beetle                  Asian Lady Beetle
```

```
##                              94                                  76
##                  Euonymus Scale                      Wireworm
##                              75                                  69
##               European Dark Bee                 Minute Pirate Bug
##                              66                                  62
##             Asian Citrus Psyllid                   Parastic Wasp
##                              60                                  58
##           Colorado Potato Beetle                  Parasitoid Wasp
##                              57                                  51
##             Erythrina Gall Wasp                    Beetle Order
##                              49                                  47
##       Snout Beetle Family, Weevil          Sevenspotted Lady Beetle
##                              47                                  46
##                  True Bug Order              Buff-tailed Bumblebee
##                              45                                  39
##                   Aphid Family                  Cabbage Looper
##                              38                                  38
##             Sweetpotato Whitefly                  Braconid Wasp
##                              37                                  33
##                  Cotton Aphid                  Predatory Mite
##                              33                                  33
##           Ladybird Beetle Family                     Parasitoid
##                              30                                  30
##                  Scarab Beetle                  Spring Tiphia
##                              29                                  29
##                   Thrip Order              Ground Beetle Family
##                              29                                  27
##               Rove Beetle Family                  Tobacco Aphid
##                              27                                  27
##                  Chalcid Wasp             Convergent Lady Beetle
##                              25                                  25
##                  Stingless Bee                 Spider/Mite Class
##                              25                                  24
##             Tobacco Flea Beetle                 Citrus Leafminer
##                              24                                  23
##                 Ladybird Beetle                       Mason Bee
##                              23                                  22
##                        Mosquito                   Argentine Ant
##                              22                                  21
##                         Beetle          Flatheaded Appletree Borer
##                              21                                  20
##             Horned Oak Gall Wasp                 Leaf Beetle Family
##                              20                                  20
##               Potato Leafhopper          Tooth-necked Fungus Beetle
##                              20                                  20
##                  Codling Moth           Black-spotted Lady Beetle
##                              19                                  18
##                  Calico Scale                 Fairyfly Parasitoid
##                              18                                  18
##                   Lady Beetle             Minute Parasitic Wasps
##                              18                                  18
##                    Mirid Bug                  Mulberry Pyralid
##                              18                                  18
##                     Silkworm                    Vedalia Beetle
```

```
##                                 18                                 18
##              Araneoid Spider Order                          Bee Order
##                                 17                                 17
##                     Egg Parasitoid                      Insect Class
##                                 17                                 17
##           Moth And Butterfly Order       Oystershell Scale Parasitoid
##                                 17                                 17
## Hemlock Woolly Adelgid Lady Beetle              Hemlock Wooly Adelgid
##                                 16                                 16
##                               Mite                       Onion Thrip
##                                 16                                 16
##              Western Flower Thrips                      Corn Earworm
##                                 15                                 14
##                 Green Peach Aphid                         House Fly
##                                 14                                 14
##                          Ox Beetle                 Red Scale Parasite
##                                 14                                 14
##                 Spined Soldier Bug              Armoured Scale Family
##                                 14                                 13
##                  Diamondback Moth                     Eulophid Wasp
##                                 13                                 13
##                 Monarch Butterfly                     Predatory Bug
##                                 13                                 13
##              Yellow Fever Mosquito               Braconid Parasitoid
##                                 13                                 12
##                       Common Thrip       Eastern Subterranean Termite
##                                 12                                 12
##                             Jassid                        Mite Order
##                                 12                                 12
##                           Pea Aphid                  Pond Wolf Spider
##                                 12                                 12
##           Spotless Ladybird Beetle             Glasshouse Potato Wasp
##                                 11                                 10
##                           Lacewing           Southern House Mosquito
##                                 10                                 10
##            Two Spotted Lady Beetle                        Ant Family
##                                 10                                  9
##                       Apple Maggot                           (Other)
##                                  9                                670
```

Answer: The six most studied species included in this study are: the honey bee, parasitic wasp, buff tailed bumblebee, carniolan honey bee, bumble bee, italian honeybee. These are all pollinator species, both native and non-native.

8. Concentrations are always a numeric value. What is the class of Conc.1..Author. in the dataset, and why is it not numeric?

```
class(Neonics$Conc.1..Author.)
```

```
## [1] "factor"
```

Answer: We loaded our data in with the condition of `stringAsFactor = TRUE`, causing these values to be loaded as factors. This means that they are
recognized as categorical variables.

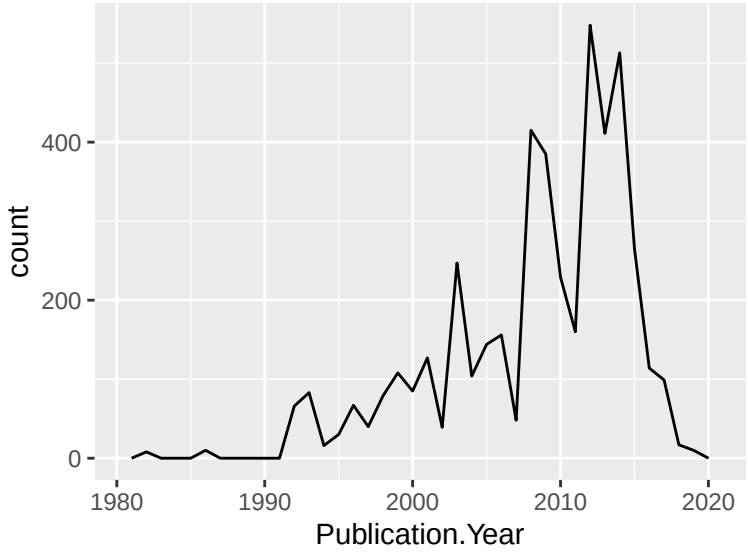
Explore your data graphically (Neonics)

9. Using `geom_freqpoly`, generate a plot of the number of studies conducted by publication year.

```
#how many years do we have
summary(Neonics$Publication.Year)
```

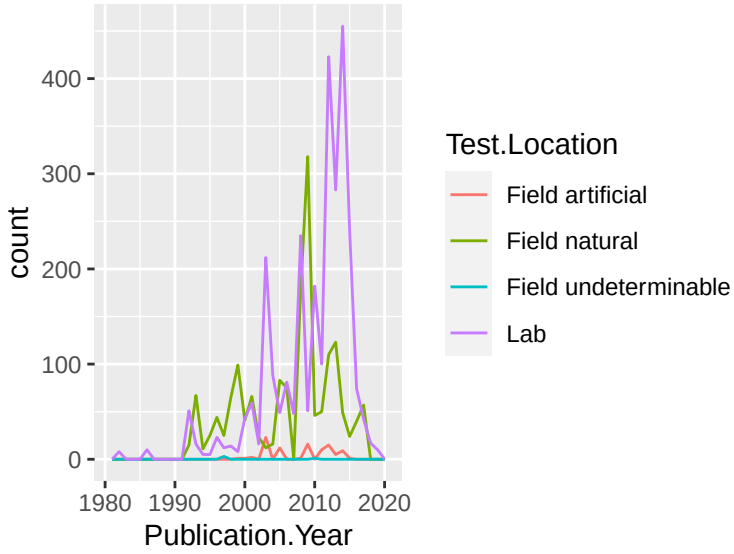
```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1982    2005    2010    2008    2013    2019
```

```
#plot the graph
ggplot(Neonics) +
  geom_freqpoly(aes(x = Publication.Year), bins = 38)
```



10. Reproduce the same graph but now add a color aesthetic so that different Test.Location are displayed as different colors.

```
#change the color!
ggplot(Neonics) +
  geom_freqpoly(aes(x = Publication.Year, color = Test.Location), bins = 38)
```

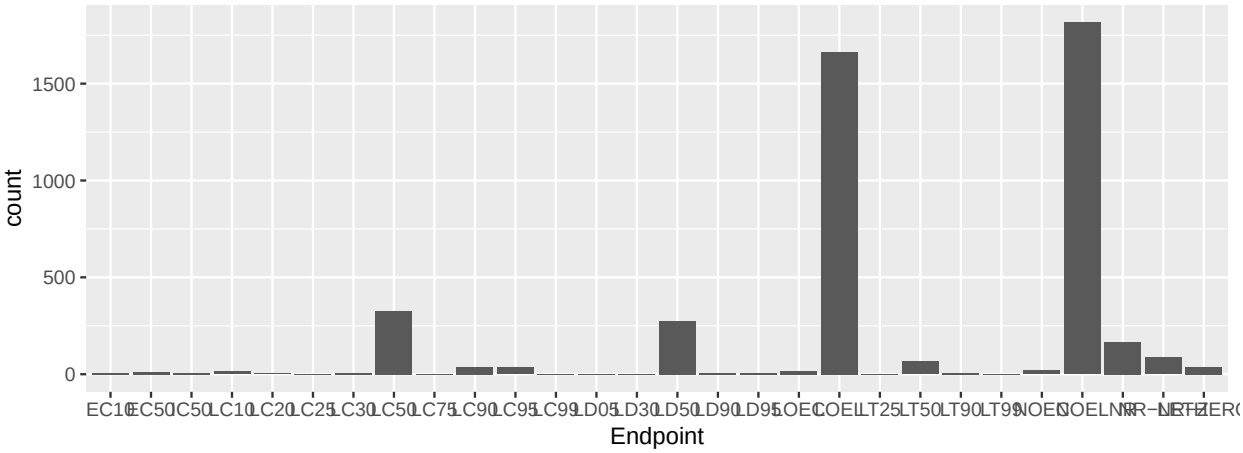


Interpret this graph. What are the most common test locations, and do they differ over time?

Answer: The lab is the most common test location and increased in use overtime. Natural field experiments were also common and fluxated overtime.

11. Create a bar graph of Endpoint counts. What are the two most common end points, and how are they defined? Consult the ECOTOX_CodeAppendix for more information.

```
ggplot(Neonics, aes(x = Endpoint)) +
  geom_bar()
```



Answer: NOEL and LOEL are the two most common endpoints. According to the appendix these are 'non-observable-effect-level' and 'lowest-observable-effect- level' respectively.

Explore your data (Litter)

12. Determine the class of collectDate. Is it a date? If not, change to a date and confirm the new class of the variable. Using the `unique` function, determine which dates litter was sampled in August 2018.

```
print(class(Litter$collectDate))
```

```
## [1] "factor"
```

```
Litter$collectDate <- as.Date(Litter$collectDate, format = "%Y-%m-%d")
#check this to make sure it worked
print(class(Litter$collectDate))
```

```
## [1] "Date"
```

```
#samples in Aug 2018?
unique(Litter$collectDate)
```

```
## [1] "2018-08-02" "2018-08-30"
```

13. Using the `unique` function, determine how many plots were sampled at Niwot Ridge. How is the information obtained from `unique` different from that obtained from `summary`?

```
#show all the unique values
unique(Litter$plotID)
```

```
##  [1] NIWO_061 NIWO_064 NIWO_067 NIWO_040 NIWO_041 NIWO_063 NIWO_047 NIWO_051
##  [9] NIWO_058 NIWO_046 NIWO_062 NIWO_057
## 12 Levels: NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 NIWO_057 ... NIWO_067
```

```
#this counts them for you "# of distinct"
n_distinct(Litter$plotID)
```

```
## [1] 12
```

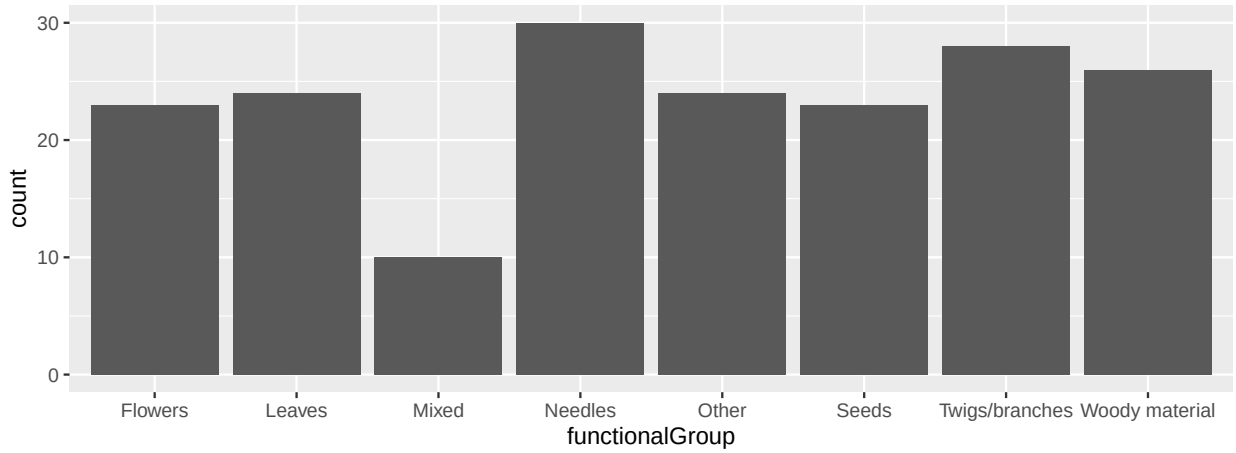
```
#summarize those values
summary(Litter$plotID)
```

```
## NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 NIWO_057 NIWO_058 NIWO_061
##       20       19       18       15       14        8       16       17
## NIWO_062 NIWO_063 NIWO_064 NIWO_067
##       14       14       16       17
```

Answer: Unique function allows us to see what the actually unique name of each plot is whereas the summary function tells you the name and the count of each of the unique plot names.

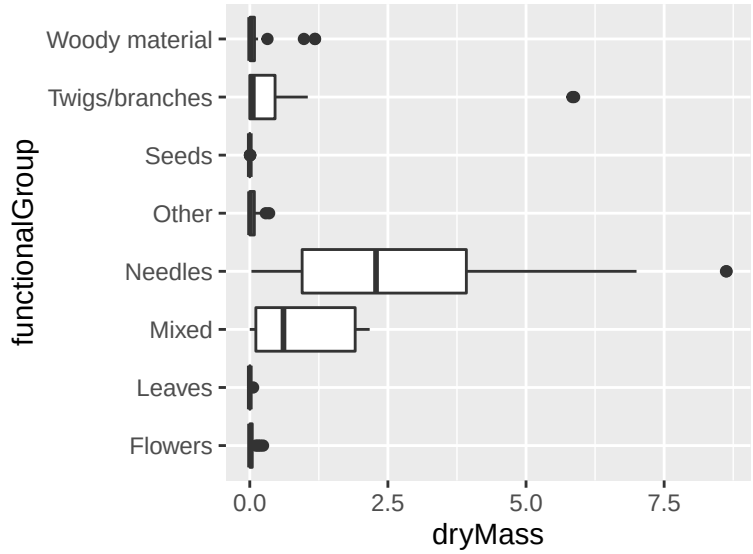
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

```
ggplot(Litter, aes(x = functionalGroup)) +
  geom_bar()
```



15. Using `geom_boxplot` and `geom_violin`, create a boxplot and a violin plot of dryMass by functionalGroup.

```
#box plot
ggplot(Litter) +
  geom_boxplot(aes(x = dryMass, y = functionalGroup))
```

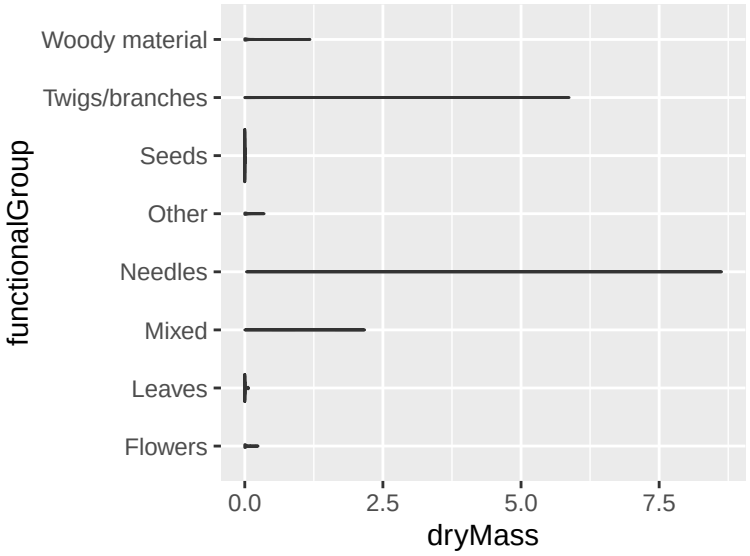



```
#violin plot
ggplot(Litter) +
  geom_violin(aes(x = dryMass, y = functionalGroup),
              draw_quantiles = c(0.25, 0.5, 0.75))
```

```
## Warning in regularize.values(x, y, ties, missing(ties), na.rm = na.rm):
## collapsing to unique 'x' values

## Warning in regularize.values(x, y, ties, missing(ties), na.rm = na.rm):
## collapsing to unique 'x' values

## Warning in regularize.values(x, y, ties, missing(ties), na.rm = na.rm):
## collapsing to unique 'x' values
```



Why is the boxplot a more effective visualization option than the violin plot in this case?

> Answer: In this case, you can see how the data distributed better in the case of the box plot compared to the violin plot. Violin plots are better for data that interacts with each other or to compare variable distribution across various categories

What type(s) of litter tend to have the highest biomass at these sites?

> Answer: Needles, mixed, and twigs/branches