# Assignment 3: Data Exploration

Taro Katayama, Section #1

### **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.

```
getwd()
```

- ## [1] "/Users/tarokatayama/Desktop/Duke\_Semester\_2/Environmental\_data\_analytics/R\_Projects/Environment
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  getwd()
- ## [1] "/Users/tarokatayama/Desktop/Duke\_Semester\_2/Environmental\_data\_analytics/R\_Projects/Environment

```
library(tidyverse)
library(ggplot2)
Neonics<- read.csv("./Data/Raw/ECOTOX_Neonicotinoids_Insects_raw.csv", stringsAsFactors = TRUE)
view(Neonics)
Litter<- read.csv("./Data/Raw/NEON_NIWO_Litter_massdata_2018-08_raw.csv", stringsAsFactors = TRUE)
View(Litter)</pre>
```

### 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 ecotoxicology of neonicotinoids on insects? Feel free to do a brief internet search if you feel you need more background information.

Answer: We might be interested in the ecotoxicology of neonicotinoids for a variety of reasons.

1) we might be interested in the effects of neonicotinoids on human health. 2) we might be interested in the effects of neonicotinoids on wildlife, specifically non-target animals. 3) we might be concerned with the effectiveness of neonicotinoids on target species.

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: We might be interested in studying litter and woody debris that falls to the ground because they may indicate which species of insect lives within the leaf litter. For example, the spiders may like a certain type of leaf litter, and are found most ofetn there. It will be easier to identify the ideal habitat for these insect species, and apply the insecticide appropriately.

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: Litter and woody debris was sampled at terrestrial NEON sites that contain woody vegetation that is greater than 2m tall. In sites with forested tower airsheds, the samples took place in 20~40 mx 40 m plots. \*In sites with low-saturated vegetation over the tower airshed, the samples take place in 40 mx 40 m tower plots +~26~20 mx 20 m plots.

## Obtain basic summaries of your data (Neonics)

5. What are the dimensions of the dataset?

## dim(Neonics)

### ## [1] 4623 30

Answer: 30 columns and 4623 rows

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: population (1803 cases), followed by Mortality (1493), and Behavior (360) is the most common effects. These effects are of interest because they give you a sense of how effective the insecticide is to an assortment of insects.

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)

## Buff Tailed Bumblebee ## 183 152 ## Bumble Bee	## ##	Honey Bee 667	Parasitic Wasp 285
## Bumble Bee			
## Japanese Beetle Asian Lady Beetle ## 94			•
## Japanese Beetle ## 94 76 ## Euonymus Scale Wireworm ## Furopean Dark Bee ## 66 66 ## Asian Citrus Psyllid Parastic Wasp #6 60 ## Colorado Potato Beetle Parasitoid Wasp ## 60 58 ## Colorado Potato Beetle Parasitoid Wasp ## 60 58 ## Erythrina Gall Wasp Beetle Order ## 57 51 ## Erythrina Gall Wasp Beetle Order ## 47 46 ## Snout Beetle Family, Weevil Sevenspotted Lady Beetle ## 47 46 ## True Bug Order Buff-tailed Bumblebee ## 38 38 38 ## Sweetpotato Whitefly Braconid Wasp ## 33 33 ## Cotton Aphid Predatory Mite 33 33 ## Ladybird Beetle Family Parasitoid ## 30 30 ## Scarab Beetle ## 30 30 ## Scarab Beetle Spring Tiphia ## 30 30 ## Rove Beetle Family Tobacco Aphid ## 29 29 ### Thrip Order ## 29 72 ### Rove Beetle Family Tobacco Aphid ## 27 ### Chalcid Wasp Convergent Lady Beetle ## 25 ### Stingless Bee Spider/Mite Class ## 24 ### 1 Tobacco Flea Beetle Citrus Leafminer ## 24 ## 24 23 ### 1 Tobacco Flea Beetle Family Associated Applete Beetle ## 24 ### 24 23 ### 1 Tobacco Flea Beetle Family Tobacco Aphid ## 24 ### 24 23 ### 1 Tobacco Flea Beetle Family Tobacco Aphid ## 25 ### 1 Tobacco Flea Beetle Family Tobacco Aphid ## 24 ### 1 Tobacco Flea Beetle Family Tobacco Aphid ## 25 ### 1 Tobacco Flea Beetle Family Tobacco Aphid ## 25 ### 1 Tobacco Flea Beetle Family Tobacco Aphid ## 24 ### 1 Tobacco Flea Beetle Family Tobacco Aphid ## 24 ### 1 Tobacco Flea Beetle Family Tobacco Aphid ## 24 ### 24 23 ### 25 25 ### 26 26 27 ### 27 27 ### 27 27 ### 32 32 22 ### 33 32 32 22 ### 34 34 35 35 35 35 35 35 35 35 35 35 35 35 35	##	Bumble Bee	Italian Honeybee
## Euonymus Scale ## Euonymus Scale ## Euonymus Scale ## European Dark Bee ## Buropean Dark Bee ## Asian Citrus Psyllid ## Colorado Potato Beetle ## Frythrina Gall Wasp ## Snout Beetle Family, Weevil ## Snout Beetle Family Darber Buff-tailed Bumblebee ## Aphid Family ## Sweetpotato Whitefly ## Sweetpotato Whitefly ## Cotton Aphid ## Cotton Aphid ## Socarab Beetle ## Goround Beetle Family ## Cotton Aphid ## Cotton Aphid ## Cotton Aphid ## Scarab Beetle ## Cotton Aphid ##	##	140	113
## Euonymus Scale ## Feropean Dark Bee ## Beropean Dark Bee ## Asian Citrus Psyllid Parastic Wasp ## Colorado Potato Beetle Parasitoid Wasp ## Colorado Potato Beetle Parasitoid Wasp ## Colorado Potato Beetle Parasitoid Wasp ## Snout Beetle Family, Weevil Sevenspotted Lady Beetle ## True Bug Order Buff-tailed Bumblebee ## Aphid Family Cabbage Looper ## Aphid Family Baraconid Wasp ## Sweetpotato Whitefly Baraconid Wasp ## Cotton Aphid Predatory Mite ## Again Sarado Beetle Family Parasitoid ## Scarab Beetle Family Parasitoid ## Buff-tailed Bumblebee ## Cotton Aphid Predatory Mite ## Sweetpotato Whitefly Baraconid Wasp ## Sound Beetle Family Parasitoid ## Scarab Beetle Family Parasitoid ## Scarab Beetle Spring Tiphia ## 29 29 ## Thrip Order ## Parasitoid Ground Beetle Family ## 29 29 ## Rove Beetle Family Tobacco Aphid ## 25 22 ## Buff-tailed Bumblebee ## 25 25 ## Convergent Lady Beetle ## 25 26 ## Tobacco Flea Beetle ## 25 22 ## Tobacco Flea Beetle ## 25 22 ## Buff-tailed Bumblebee ## 23 22 ## Buff-tailed Bumblebee ## 24 23 ## Buff-tailed Bumblebee ## 25 22 ## Buff-tailed Bumblebee ## 26 22 ## Buff-tailed Bumblebee ## 27 27 ## Buff-tailed Bumblebee ## 28 29 ## Convergent Lady Beetle ## Buff-tailed Bumblebee ## 28 29 ## Buff-tailed Bumblebee ## 29 22 ## Buff-tailed Bumblebee ## 29 22 ## Buff-tailed Bumblebee ## 29 22 ## Buff-tailed Bumblebee ## 20 22 ## Buff-tailed Bumblebee ## 21 20 ## Buff-tailed Bumblebee ## Buff-tailed Bumblebee ## 20 20 ## Buff-tailed Bumblebee ## Buff-tailed Bumble	##	Japanese Beetle	Asian Lady Beetle
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##	Codling Moth	Disable anothed Lady Deatle
##	Codling Moth	Black-spotted Lady Beetle 18
##	Calico Scale	
##	18	Fairyfly Parasitoid
##		Minuta Panasitia Vara
##	Lady Beetle	Minute Parasitic Wasps
##	18	18
##	Mirid Bug	Mulberry Pyralid
##	18 Silkworm	18
##	Silkworm 18	Vedalia Beetle 18
## ##		
##	Araneoid Spider Order 17	Bee Order 17
##		
##	Egg Parasitoid 17	Insect Class 17
##		
##	Moth And Butterfly Order 17	Oystershell Scale Parasitoid 17
##	Hemlock Woolly Adelgid Lady Beetle 16	Hemlock Wooly Adelgid 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: Honey Bee (667), Parasitic Wasp (285), Buff Tailed Bumblebee (183), Carniolan Honey Bee (152), Bumble Bee (140) were the most commonly studied speices in the dataset. They are all bee/wasp species. They might "bee" of interest because bees are very important species that are responsible for a number of ecological services such as pollination and honey production. When developing insecticides, they may want to create one that does not have adverse effects on the

important bee species.

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"
```

```
help("factor")
class(Neonics$Test.Location)
```

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

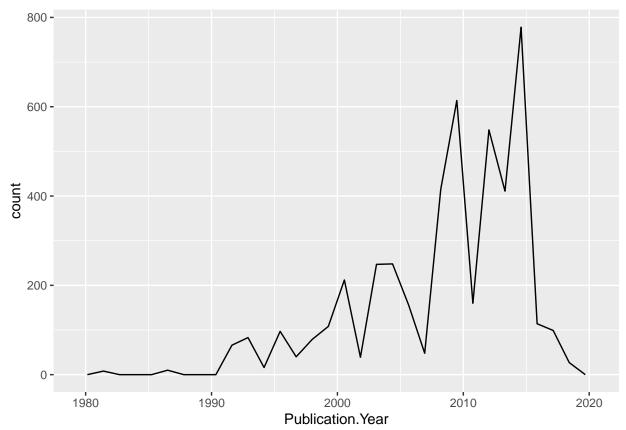
Answer: The class is a factor. It is not numeric because the class Conc.1..Author is categorical data that has a limited number of different values. Categorical data is most appropriately classed as a factor.

# Explore your data graphically (Neonics)

9. Using geom\_freqpoly, generate a plot of the number of studies conducted by publication year.

```
ggplot(Neonics) +
geom_freqpoly(aes(x=Publication.Year))
```

## `stat\_bin()` using `bins = 30`. Pick better value with `binwidth`.

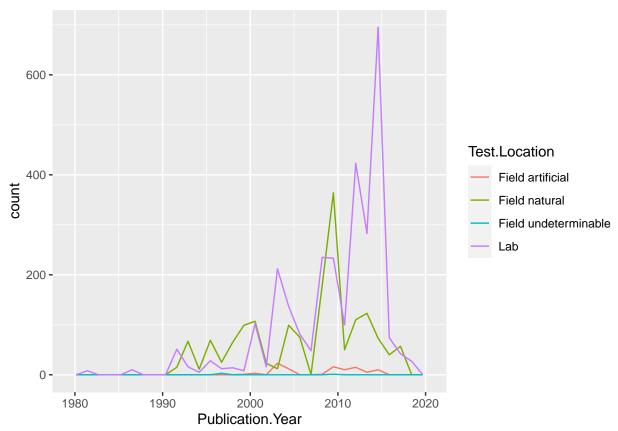


10. Reproduce the same graph but now add a color aesthetic so that different Test.Location are displayed as different colors.

```
ggplot(Neonics) +
geom_freqpoly(aes(x=Publication.Year, color=Test.Location), bin=50)
```

## Warning: Ignoring unknown parameters: bin

## `stat\_bin()` using `bins = 30`. Pick better value with `binwidth`.

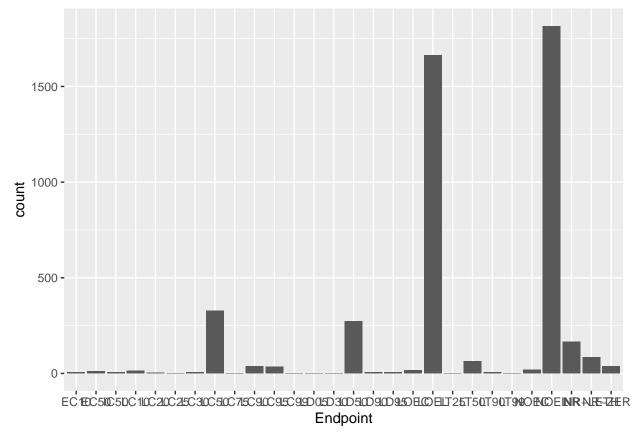


Interpret this graph. What are the most common test locations, and do they differ over time?

Answer: The most common test locations are 'labs', followed by 'field natural', followed by 'field artificial'. The general trend shows that tests increase over time, with lab test locations peaking around 2015. The field natural test location on the other hand peaks around 2009, and then drops off after that.

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: The two most common endpoints are 'NOEL' and 'LOEL'. 'NOEL' stands for 'no observable effect level', which means the highest dose given without producing a significant effect compared to the control. 'LOEL' stands for 'Lowest observable effect level', which means lowest dose producing effects that were significantly different from control.

### 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.

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

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

```
Litter$collectDate<- as.Date(Litter$collectDate, format= "%Y-%m-%d")
class(Litter$collectDate)
```

## [1] "Date"

View(Litter)

unique(Litter\$collectDate)

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

Answer: Using the 'unique' function, I found out that litter was sampled on 08/02/2018, and 08/30/2018

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?

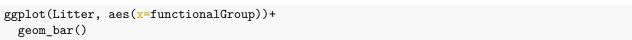
### unique(Litter\$plotID)

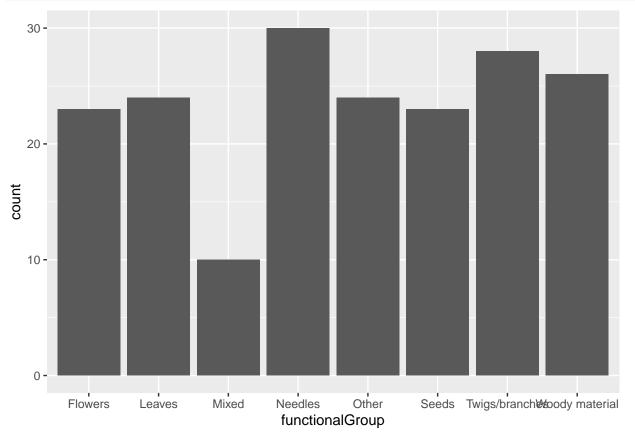
```
## [1] NIWO_061 NIWO_064 NIWO_067 NIWO_040 NIWO_041 NIWO_063 NIWO_047 NIWO_051
## [9] NIWO_058 NIWO_046 NIWO_062 NIWO_057
## 12 Levels: NIWO_040 NIWO_041 NIWO_046 NIWO_047 NIWO_051 NIWO_057 ... NIWO_067
summary(Litter$plotID)
```

```
## 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: There are 12 unique plots. Unique is different from summary because unique only gives you unique plots at Niwot Ridge. Summary gives you unique plots but also gives you the number of samples from each plot.

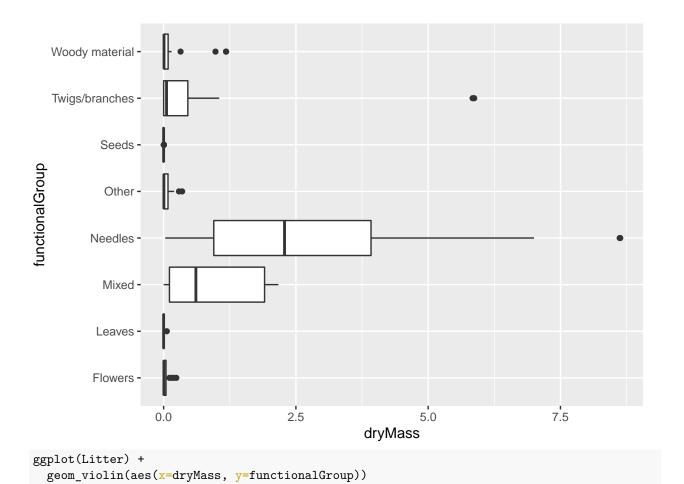
14. Create a bar graph of functionalGroup counts. This shows you what type of litter is collected at the Niwot Ridge sites. Notice that litter types are fairly equally distributed across the Niwot Ridge sites.

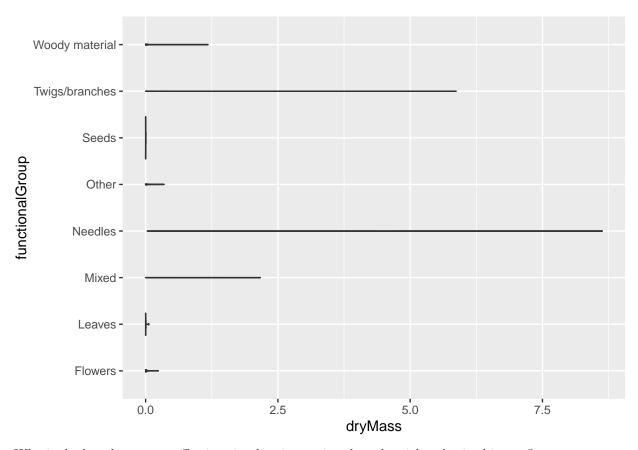




15. Using geom\_boxplot and geom\_violin, create a boxplot and a violin plot of dryMass by functional-Group.

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





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

Answer: Boxplot is more effective because in this case, the median for the data is very close to zero for most functional groups, and is not represented well in violin plots.

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

Answer: Needles has the highest biomass, followed by mixed.