M9 Problem Set: One Way ANOVA for TAs

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Consider an example in which a researcher is investigating the **impact of metal contamination on the diversity of species found in sessile marine invertebrates such as sponges, bryozoans, and sea squirts**. The researcher aims to determine whether **copper reduces species richness**, while **also considering the potential influence of substrate orientation, whether vertical or horizontal**, on invertebrate richness.

To address this, they conducted an experiment where species richness was assessed in replicate samples under each of the six combinations of copper enrichment levels (**"None," "Low," "High"**) and substrate orientations (**"Vertical," "Horizontal"**). This experimental design is referred to as factorial, as it encompasses all levels of one treatment within all levels of the other treatment, also known as orthogonal.

The factorial ANOVA will test the following hypotheses:
1. Whether there are differences in richness among the three levels of copper enrichment.
2. Whether there are differences in richness among the two levels of substrate orientation.
3. Whether there is an interaction effect between copper enrichment and substrate orientation, indicating whether the effect of copper on richness depends on the orientation of the substrate.

Summarize: Write a concise one paragraph summary of this analysis. Remember that any summary should include the following:
1. Statement of the research hypothesis or study objectives.
2. Brief summary of methods (one sentence or less).
3. Statement of the statistical results (including type of test and shorthand: F(df)= obtained value, p = 0.xxx). Include results of the possible interaction between copper enrichment and substrate orientation.
4. Description of any differences, if meaningful, along with an interpretation of why these results make sense (or don't make sense).

#1. Import libraries and load packages

```r
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 4.3.2

## Warning: package 'ggplot2' was built under R version 4.3.2

## Warning: package 'tibble' was built under R version 4.3.1

## Warning: package 'tidyr' was built under R version 4.3.2

## Warning: package 'readr' was built under R version 4.3.2

## Warning: package 'purrr' was built under R version 4.3.1
```

```
## Warning: package 'dplyr' was built under R version 4.3.2

## Warning: package 'stringr' was built under R version 4.3.2

## Warning: package 'forcats' was built under R version 4.3.2

## Warning: package 'lubridate' was built under R version 4.3.2
```

```r
library(lessR)
```

```
## Warning: package 'lessR' was built under R version 4.3.2
```

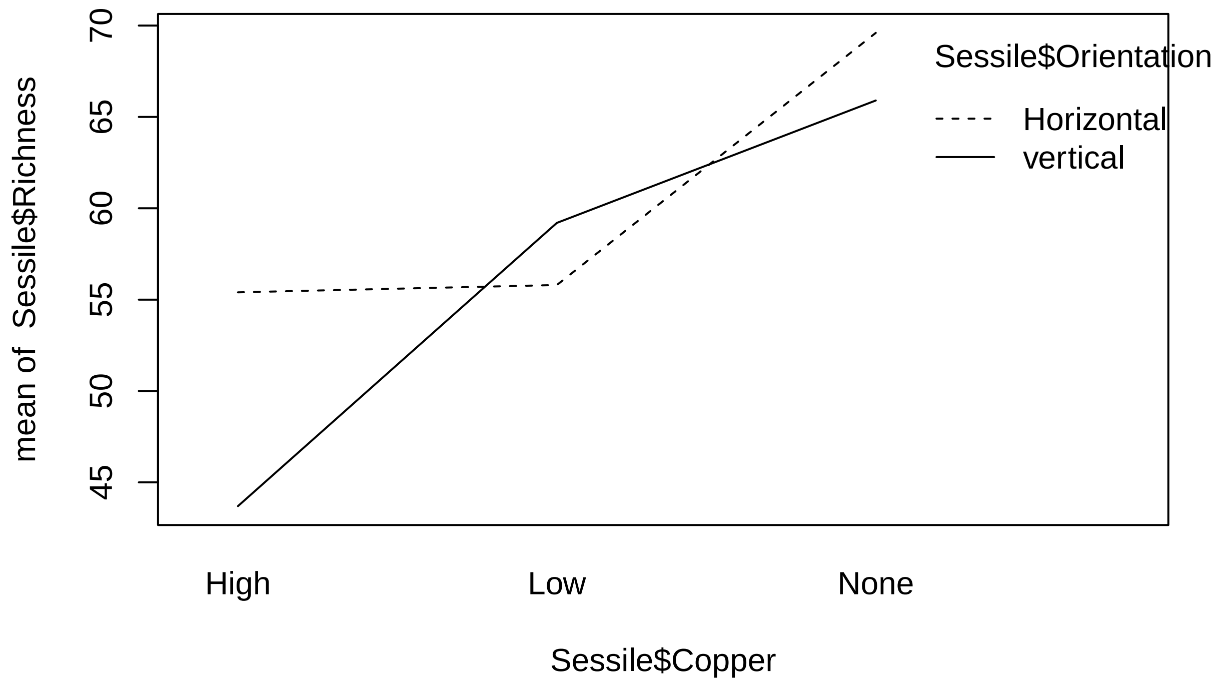
```r
library(readxl)
library(dplyr)
```

```r
Sessile <- read.csv(file = "Sessile.csv", header = TRUE)
```

```r
Sessile.aov <- aov(Richness ~ Copper + Orientation + Copper:Orientation, data = Sessile)
summary(Sessile.aov)
```

```
##                    Df Sum Sq Mean Sq F value               Pr(>F)
## Copper              2   3330  1665.0  192.53 < 0.0000000000000002 ***
## Orientation         1    240   240.0   27.75       0.000002463599 ***
## Copper:Orientation  2    571   285.3   33.00       0.000000000434 ***
## Residuals          54    467     8.6
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
interaction.plot(Sessile$Copper, Sessile$Orientation, Sessile$Richness)
```



References: https://environmentalcomputing.net/statistics/linear-models/anova/anova-factorial/