# ENVX2001 - Model selection

## Learning Outcomes

In this lab, you will work towards achieving learning outcomes

## Lab Objectives

In this lab, we will:

- []
- []

> 💡 Tip
>
> Please work on this exercise by creating your own R Markdown file.

# Exercise 1: Model quality - multiple vs adjusted $r^2$

Data: *California_streamflow* spreadsheet

Import the "California_streamflow" sheet into R.

```
CODE
# Load library if needed
library(readxl)
# Load data
stream_data ← read_xlsx("data/california_streamflow.xlsx", "streamflow")
```

in this exercise we will use the same data as last week. To jog your memory, the dataset contains 43 years of annual precipitation measurements (in mm) taken at (originally) 6 sites in the Owens Valley in California. Through model selection via partial F-test we have the final model as below:

```
CODE
fit ← lm(runoff_volume ~ rock_creek + pine_creek, data = stream_data)
```

We will now add a totally useless variable to the dataset. This variable is a random number generated from a normal distribution with mean 3 and standard deviation 2. We use the `set.seed()` function to make sure that everybody gets the same random values.

```
CODE
set.seed(100) # to make sure everybody gets the same results

# this generates the random number into the dataset
stream_data$random_no ← rnorm(n = nrow(stream_data), mean = 3, sd = 2)
```

We will see the impact of including a totally useless variable, such as this random variable, has on measures of model quality, $r^2$ and adjusted $r^2$ values.

**Task: create two regression models:**

1. `runoff_volume ~ rock_creek + pine_creek`
2. `runoff_volume ~ rock_creek + pine_creek + random_no`

## Question 2

Compare each in terms of their multiple $r^2$ and adjusted $r^2$ values. Which performance measure (multiple $r^2$ or adj $r^2$) would you use to identify which predictors to use in your model?

### Answer

There is only a small difference in the multiple $r^2$ and adj $r^2$ between the models, but one goes up and the other goes down. Since the random number is a totally useless value, this demonstrates that the adjusted $r^2$ is the better performance measure to use.

```
CODE
mod_rand1 ← lm(runoff_volume ~ rock_creek + pine_creek,data = stream_data)
summary(mod_rand1)
```

```
OUTPUT

Call:
lm(formula = runoff_volume ~ rock_creek + pine_creek, data = stream_data)

Residuals:
     Min       1Q   Median       3Q      Max
-0.09832 -0.02350  0.01076  0.03291  0.08568

Coefficients:
```

```
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 3.35762    0.10547  31.835  < 2e-16 ***
rock_creek  0.44437    0.08925   4.979 1.26e-05 ***
pine_creek  0.21051    0.06861   3.068  0.00385 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04937 on 40 degrees of freedom
Multiple R-squared:  0.8749,    Adjusted R-squared:  0.8686
F-statistic: 139.8 on 2 and 40 DF,  p-value: < 2.2e-16
```

CODE

```r
mod_rand2 ← lm(runoff_volume ~ rock_creek + pine_creek + random_no ,data = stream_data)
summary(mod_rand2)
```

OUTPUT

```
Call:
lm(formula = runoff_volume ~ rock_creek + pine_creek + random_no,
    data = stream_data)

Residuals:
     Min      1Q  Median      3Q     Max
-0.10327 -0.02401  0.01220  0.03179  0.08056

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 3.359356   0.106303  31.602  < 2e-16 ***
rock_creek  0.442795   0.089956   4.922  1.6e-05 ***
pine_creek  0.207234   0.069324   2.989  0.00482 **
random_no   0.003213   0.005077   0.633  0.53055
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04974 on 39 degrees of freedom
Multiple R-squared:  0.8761,    Adjusted R-squared:  0.8666
F-statistic: 91.96 on 3 and 39 DF,  p-value: < 2.2e-16
```

# Exercise 2: Fish productivity

Fish communities were surveyed in lakes across a eutrophication gradient to investigate the relatioship between productivity and fish diversity.

The datasheet has thefollowing variables:

- lake_id Unique identifier for each lake
- chla Log-transformed Chlorophyll a
- richness Log-transformed species richness
- evenness Log-transformed Pielou's evenness

- abundance Log-transformed abundance per unit effort (NPUE)
- biomass Log-transformed biomass per unit effort (BPUE)
- productivity Log-transformed productivity proxy

```
CODE
#Load library if necessary
library(tidyverse)

#Read in data
fish_data ← read_csv("data/fish_communities.csv")
```

```
OUTPUT
Rows: 39 Columns: 7
── Column specification ──────────────────────────────────
Delimiter: ","
chr (1): lake_id
dbl (6): chla, richness, evenness, abundance, biomass, productivity

ℹ Use `spec()` to retrieve the full column specification for this data.
ℹ Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
CODE
#Have a look at the structure of the data
str(fish_data)
```

```
OUTPUT
spc_tbl_ [39 × 7] (S3: spec_tbl_df/tbl_df/tbl/data.frame)
 $ lake_id     : chr [1:39] "FTH" "XLH" "HGH" "LH" ...
 $ chla        : num [1:39] 4.61 4.53 3.84 3.71 2.43 ...
 $ richness    : num [1:39] 2.64 2.89 1.99 2.94 2.37 ...
 $ evenness    : num [1:39] -0.356 -0.67 -0.423 -0.405 -0.589 ...
 $ abundance   : num [1:39] 2.24 3.34 1.24 2.67 1.12 ...
 $ biomass     : num [1:39] 4.96 6.03 4.67 6.52 5.32 ...
 $ productivity: num [1:39] 3.47 4.47 2.71 4.47 3.24 ...
 - attr(*, "spec")=
  .. cols(
  ..    lake_id = col_character(),
  ..    chla = col_double(),
  ..    richness = col_double(),
  ..    evenness = col_double(),
  ..    abundance = col_double(),
  ..    biomass = col_double(),
  ..    productivity = col_double()
  .. )
 - attr(*, "problems")=<externalptr>
```

Explore the data on your own before making any models. (*Hint:* remember that we are only interested in the numeric variables for our linear models)

## Question 1

Are there any obvious relationships between the response variable (productivity) and the other variables?
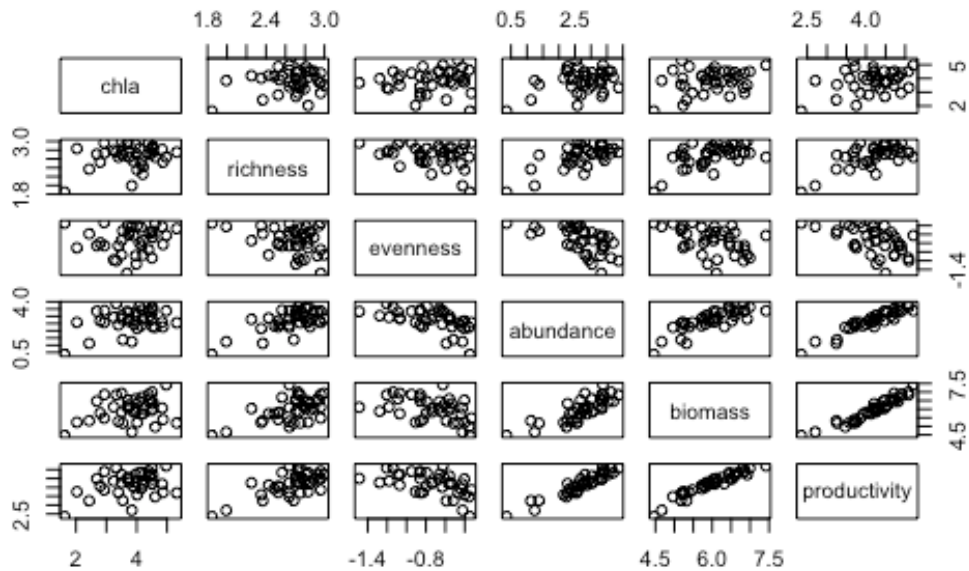
## Answer

```
CODE
#correlation matrix
cor(fish_data[,-1])
```

```
OUTPUT
               chla   richness    evenness   abundance    biomass productivity
chla         1.0000000  0.2388845  0.0872381  0.3449158  0.2809369    0.3406440
richness     0.2388845  1.0000000 -0.3295238  0.6585895  0.5704803    0.6611413
evenness     0.0872381 -0.3295238  1.0000000 -0.5553243 -0.4396433   -0.5162017
abundance    0.3449158  0.6585895 -0.5553243  1.0000000  0.8089680    0.9379798
biomass      0.2809369  0.5704803 -0.4396433  0.8089680  1.0000000    0.9571907
productivity 0.3406440  0.6611413 -0.5162017  0.9379798  0.9571907    1.0000000
```

```
CODE
#Plot the variables

pairs(fish_data[,-1])
```



Productivity has a strong relationship with biomass and abundance

## Question 2

Are there any other patterns or potential issues you can see from the exploratory plots?

# Take home exercise:

# Review

## Attribution