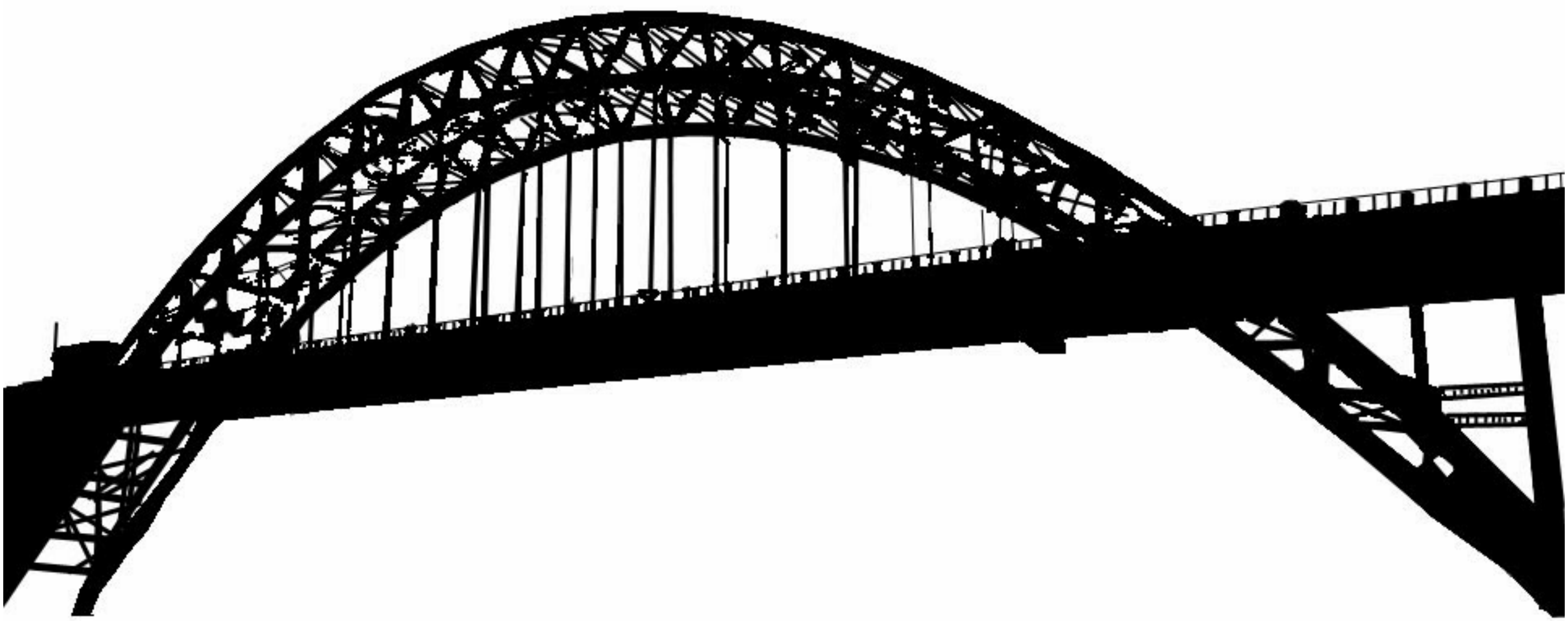
Appendix 1 – Building Bridges Introductory Presentation

Building Bridges:

An active learning lesson in evolution and collaboration



Learning Goals

Collaborate with people from **different backgrounds and abilities** to reach a common goal.

- Work with someone you don't know
- If you are experienced in R, work with someone who has less experience

Make an evidence-based claim

Learning Goals

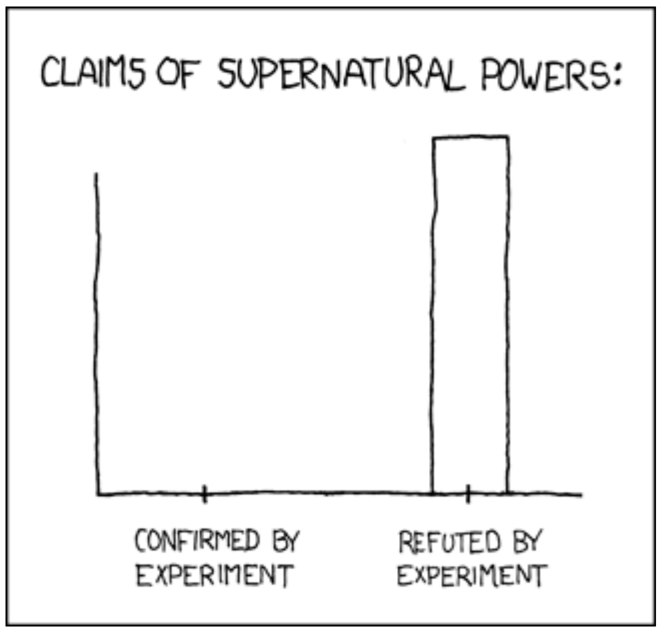
Collect data (by building and competing bridges)

Manipulate and visualize data in R

Evaluate predictions from evolutionary theory (make evidence-based claims)

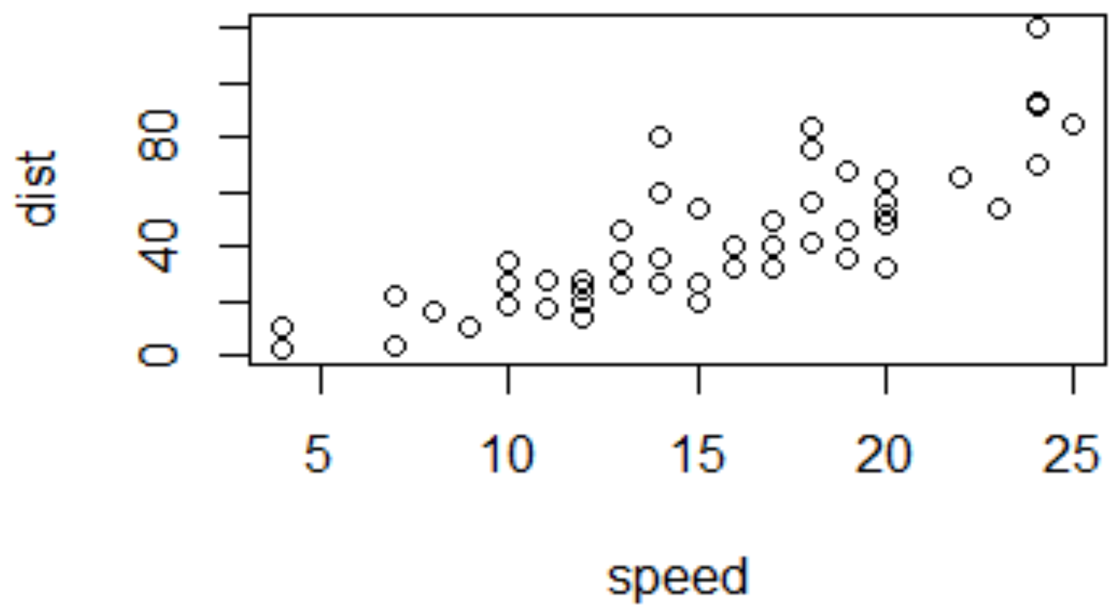
What is an evidence-based claim?

A statement that addresses the original question or hypothesis and is **supported by data or evidence**



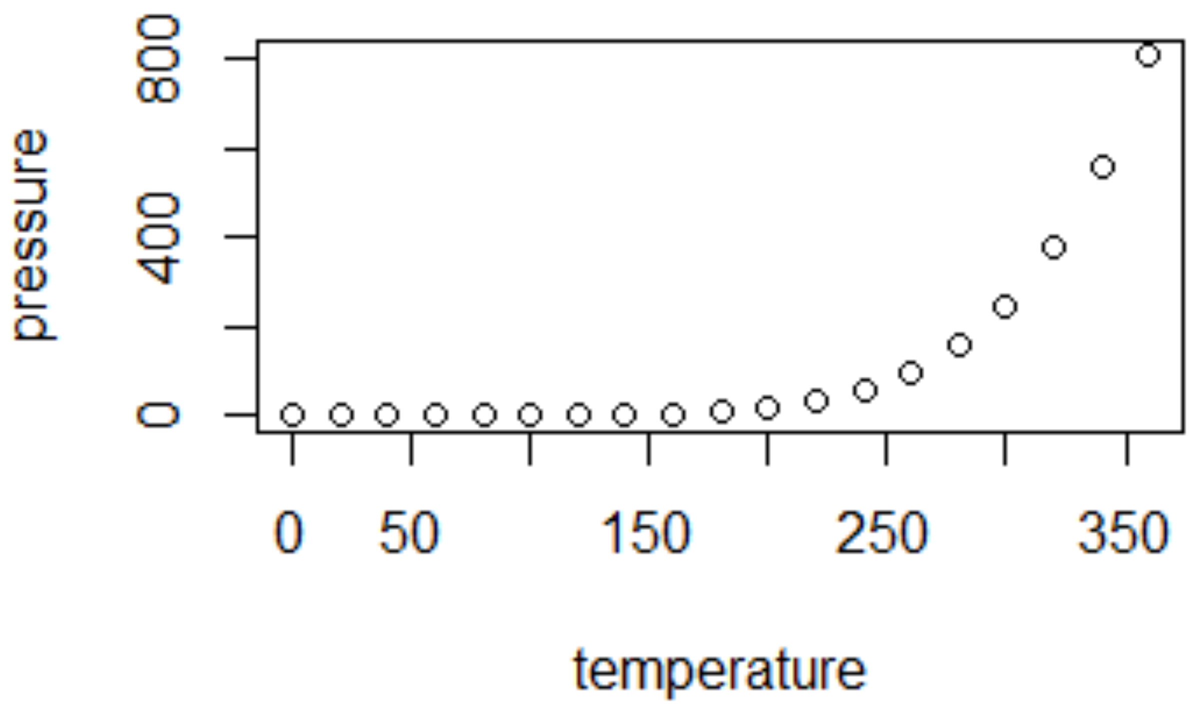
…but this person might be for real! (Randall Munroe/xkcd)

Example of an evidence based claim



"As predicted by theory, when the speed of a vehicle increases, so does the distance traveled"

Practice making evidence based claims!



Talk to your neighbor. Come up with a statement that is supported by this graph.

Manipulating and Visualizing Data in R

Why use R?

- Science demands transparency (R code is a recipe to reproduce our work)

- R allows us to easily share our complete work with others − including code, results, explanations (in R Markdown)

- Many packages (groups of functions) being constantly developed and updated

Let’s practice R skills

Open up a script and name it something meaningful like: "Evo_Lab_2_YourName.R"

Assignment with <-

#remember to document your code like this:
#assign the value of 2 to a variable called "a"
a <- 2

#view contents of variable
a

> [1] 2

Practice

Assign a number to a variable with the name of your choosing.

Vectors

#Make a vector
b <- **c**(1,2, 10, 11.2, 14)

#add scalar to vector
a + b

> [1] 3.0 4.0 12.0 13.2 16.0

Practice

Make a new vector with five values, multiply it by 2.

Boxplots – data setup

#create two vectors
group_a <- **c**(1:10) *#creates vector of integers 1 - 10*
group_a

> [1] 1 2 3 4 5 6 7 8 9 10

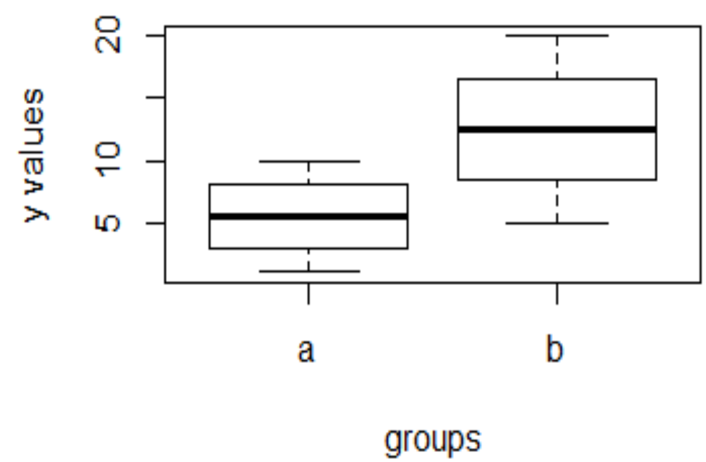
group_b <- **c**(5:20)
group_b

> [1] 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Boxplots

#create and box and whisker set for each group
#notice the line breaks to keep the line short

boxplot(group_a, group_b,
xlab = "groups", ylab =
names = **c**("a", "b"))



Practice

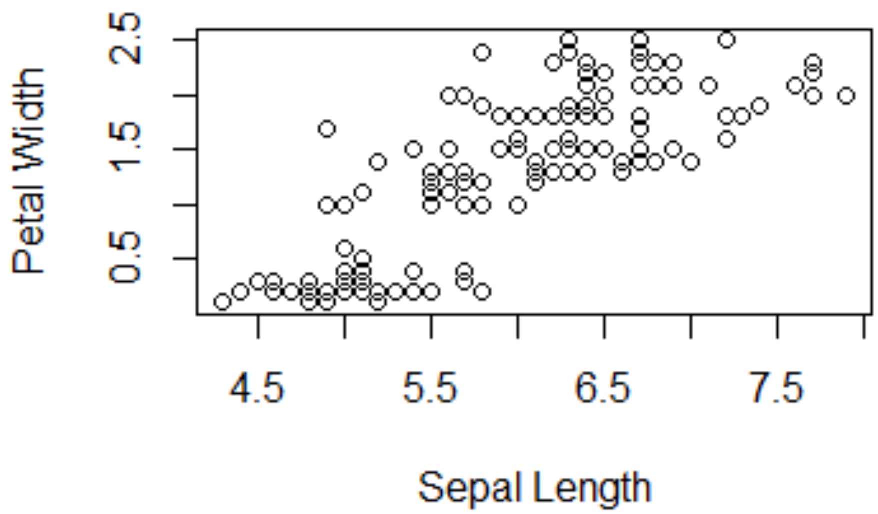
Make 2 new vectors with 5 values each.

Use them to make a boxplot including labels.

Bivariate (x,y) or scatter plots

#use some data that comes installed with R

attach(iris) *#attach data*
plot(x = Sepal.Length, y = Petal.Width,
xlab = "Sepal Length", ylab = "Petal Width")



Linear regression

Format: linear model for y (dependent variable) explained by x (independent variable)

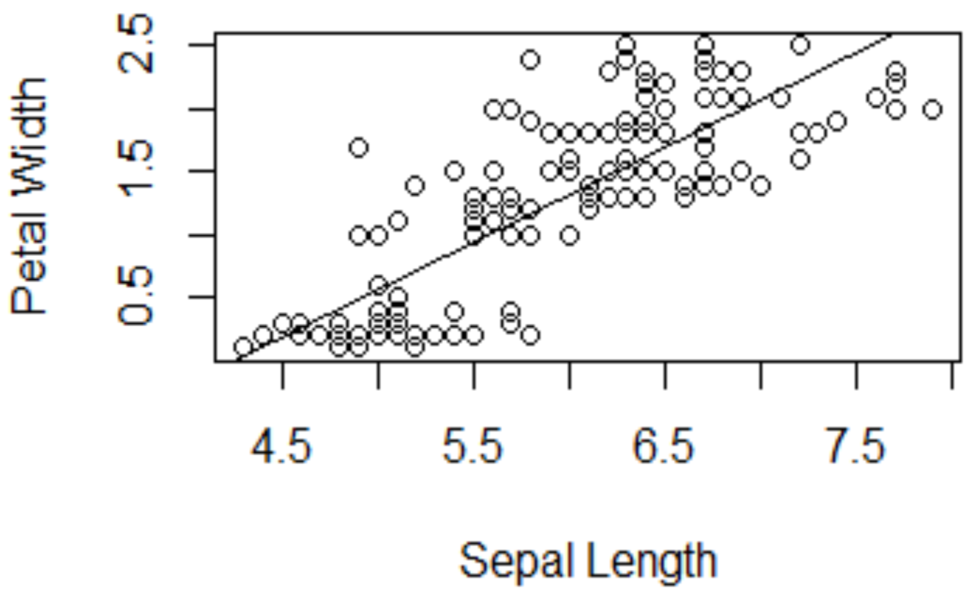
mod <- **lm**(formula = Petal.Width ~ Sepal.Length)
coefficients(mod)

```
> (Intercept) Sepal.Length
> -3.2002150    0.7529176
```

Adding regression trend line

#plot again
plot(x = Sepal.Length, y = Petal.Width,
xlab = "Sepal Length", ylab = "Petal Width")

#add trend line
abline(mod)



Practice

Discuss with your neighbors the meaning of:

- an intercept equal to 3
- a slope equal to -4.5

Practice

Make 2 new vectors with 5 values each.

Create a bivariate plot that includes the trend line from a linear regression.

Evaluating Evolutionary Predictions

Today's lab – predictions:

- Fitness varies among individuals
- Fitness increases over generations (adaptation)
- Traits trade-off
- Complexity increases over generations

Calculating complexity: Shannon's Diversity

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

s is the number of different items

p_i is the frequency of item *i*

Calculating complexity: Shannon's Diversity

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

s is the number of different items

p_i is the frequency of item i

Calculate H for the following (ignore punctuation):

"word word word word new word"

And for:

"Extremely responsible, secretly longed for spontaneity."

(6 word memoir by Sabra Jennings)

Calculating complexity: Shannon's Diversity

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

s is the number of different items

p_i is the frequency of item *i*

- Quantifies information richness
- Might be easier to think of as amount of surprise/ predictability
- Notice the first example was quite predictable ("word word word...")

Lets collect some data!

- Form groups of 4
- Use ONLY materials provided (see hand-out)
- Each group has 8 minutes to make a bridge
- Each group has 1 minute to set up the bridge so that it spans an abyss

Lets collect some data!

- **Length Score**: measure bridge length (cm)
- **Load Score**: I will roll 4 different balls over the bridge. ping-pong = 1, tennis = 2, baseball = 3, billiard = 4
- **Fitness** = load score * length
- Assign 1 group member to data entry
  - Enter data on laptop in front of class
  - Link to Google Sheet is in R markdown file on Canvas

Lets collect some data!

After generation 1, the group with the highest fitness is displayed.

Start generation 2 by using the winning design to inspire construction of new bridge.