BIOL 220 Problem Set 11: Correlation

Answer Key

Due Friday, April 19, 2024 by end of day

Submit your answers via Google Classroom

Benefits of biodiversity

Figure 1: Ho'omaluhia Botanical Garden, an urban green space on O'ahu. Photo credit: Daniel Ramirez / Flickr

Fuller *et al.* (2007) measured the diversity of plant, bird, and butterfly species in 15 urban green spaces of varying size. They also asked 312 green-space users about their emotional "attachment" to green spaces to see if more biodiverse green space lead to greater emotional attachment from users.

Attachment	Area (ha)	Number of butterfly species	Number of bird species	ln(Number of plant species)
4.4	23.8	6	12	5.1
4.5	16.0	14	18	5.5

Attachment	Area (ha)	Number of butterfly species	Number of bird species	ln(Number of plant species)
4.7	6.9	8	8	6.4
4.5	2.3	10	17	4.7
4.3	5.7	6	7	5.3
3.8	1.2	5	4	4.6
4.4	1.4	5	8	4.5
4.6	15.0	7	22	5.5
4.1	3.1	9	7	5.2
4.2	3.8	5	4	4.6
4.6	7.6	10	11	4.5
4.2	12.9	9	11	5.0
4.3	4.0	12	13	5.0
4.4	5.6	11	16	5.6
4.2	4.9	7	7	5.4

Questions 1–5 refer to the prompt and data above

To get these data into *R* you can copy-paste and run this code:

```
fuller_etal_2017 <- data.frame(
    attachment = c(4.4, 4.5, 4.7, 4.5, 4.3, 3.8, 4.4, 4.6, 4.1,
                   4.2, 4.6, 4.2, 4.3, 4.4, 4.2),
    area_ha = c(23.8, 16.0, 6.9, 2.3, 5.7, 1.2, 1.4, 15.0, 3.1,
                3.8, 7.6, 12.9, 4.0, 5.6, 4.9),
    butterfly = c(6, 14, 8, 10, 6, 5, 5, 7, 9, 5, 10, 9, 12, 11, 7),
    bird = c(12, 18, 8, 17, 7, 4, 8, 22, 7, 4, 11, 11, 13, 16, 7),
    ln_plant = c(5.1, 5.5, 6.4, 4.7, 5.3, 4.6, 4.5, 5.5, 5.2,
                 4.6, 4.5, 5.0, 5.0, 5.6, 5.4)
)
```

1. Calculate the product-moment correlation coefficient for each of the following pairs of numerical variables:
    a. Attachment and Number of butterfly species [1 point]
    b. Attachment and Number of bird species [1 point]
    c. Attachment and ln(Number of plant species) [1 point]

Answers

a. *Attachment and Number of butterfly species*

```
cor(fuller_etal_2017$butterfly, fuller_etal_2017$attachment)
```

```
[1] 0.3506204
```

b. *Attachment and Number of bird species*

```
cor(fuller_etal_2017$bird, fuller_etal_2017$attachment)
```

```
[1] 0.6055798
```

c. *Attachment and ln(Number of plant species)*

```
cor(fuller_etal_2017$ln_plant, fuller_etal_2017$attachment)
```

```
[1] 0.4135939
```

2. Which measure of biodiversity is most strongly correlated with attachment? [1 point]

Answer

Number of bird species has the highest correlation with Attachment

3. Larger green spaces (greater area) might have more species and cause greater emotional attachment. Calculate the correlation between Area (ha) and Attachment. Round your answer to the nearest 0.01. [1 point]

Answer

```
cor(fuller_etal_2017$area_ha, fuller_etal_2017$attachment)
```

```
[1] 0.3640941
```

4. This question refers to Question 3. Using `cor.test`, what is the P-value and 95% CI of the correlation between green space area and attachment? [1 point]

Answer

```r
cor.test(fuller_etal_2017$area_ha, fuller_etal_2017$attachment)
```

```

	Pearson's product-moment correlation

data:  fuller_etal_2017$area_ha and fuller_etal_2017$attachment
t = 1.4095, df = 13, p-value = 0.1822
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.1821401  0.7385994
sample estimates:
      cor 
0.3640941 
```

5. This question refers to Questions 3 and 4. Calculate the P-value for the correlation test "by hand" using the t distribution. To answer this question, paste your code into the google form. [2 point, partial credit will be given]

   Your code should show (at a minimum):

   - how you calculate the degrees of freedom
   - how you use one of the t distribution functions (either `dt`, `pt`, `qt`, or `rt`) to calculate the P-value

Answers

```
# calculate correlation coeff
cor_area_ha <- cor(fuller_etal_2017$attachment,
                   fuller_etal_2017$area_ha)

# could have alternatively just copied the cor coef
# from question 3, either approach is fine
cor_area_ha <- 0.3640941

# calculate df
df <- nrow(fuller_etal_2017) - 2

# calculate test stat from cor coeff and SE
SE_r <- sqrt((1 - cor_area_ha ^ 2) / df)
test_stat <- cor_area_ha / SE_r

# calculate P-val
P_value <- 2 * pt(test_stat, df = df, lower.tail = FALSE)
P_value
```

```
[1] 0.1821575
```

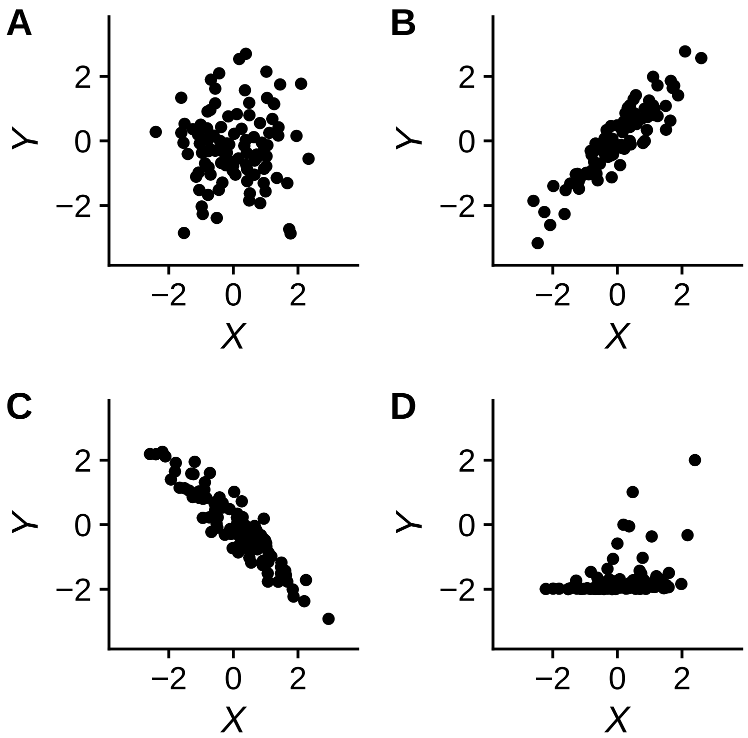
Visualizing correlation

Suppose that you measure two numerical variables X and Y. The figure below depicts four possible outcomes.

Questions 6–7 refer to the prompt and figure above

6. Which panel depicts the strongest positive association between X and Y? [1 point]

   a.
   b.
   c.
   d.



> **Answer**
>
> B

7. Which panel depicts data that likely violate the assumptions of correlation tests? [1 point]

    a.
    b.
    c.
    d.

> **Answer**
>
> D