Phototaxis in Pillbugs: Working with Circular Data

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Goals for today

By the end of today you will:

1. Be able to identify circular data and articulate why it must be treated differently than linear data

2. Implement your own experiment and test a hypothesis

3. Analyze and plot your own circular data

Photokinesis and Phototaxis

- Photokinesis: a change in the velocity of an organism in response to a change in light levels

- Phototaxis: orientation or movement towards or away from a light source
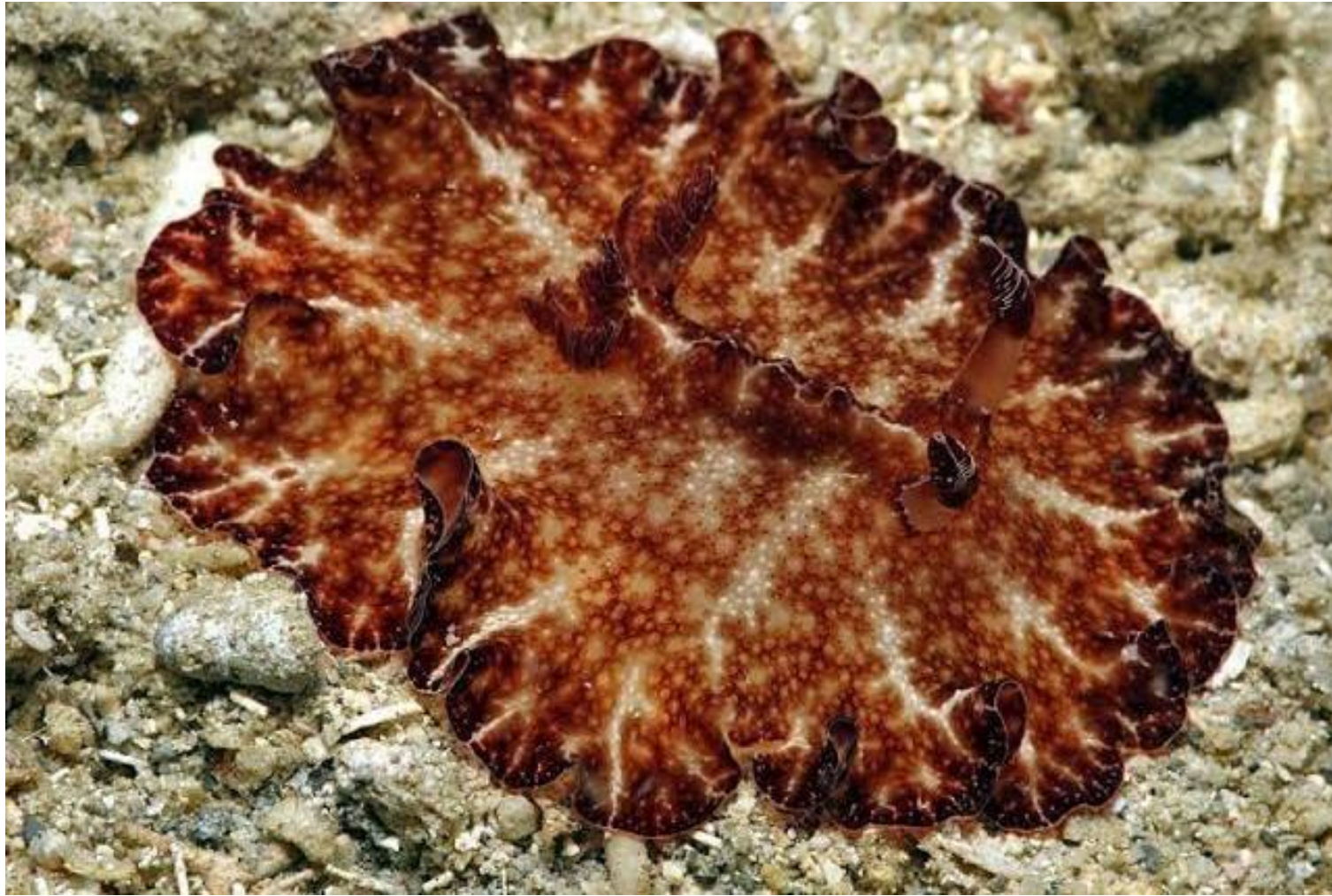
Photokinesis

Discodoris boholiensis

Moves fast in daylight, slow in darkness

Phototaxis

Positive

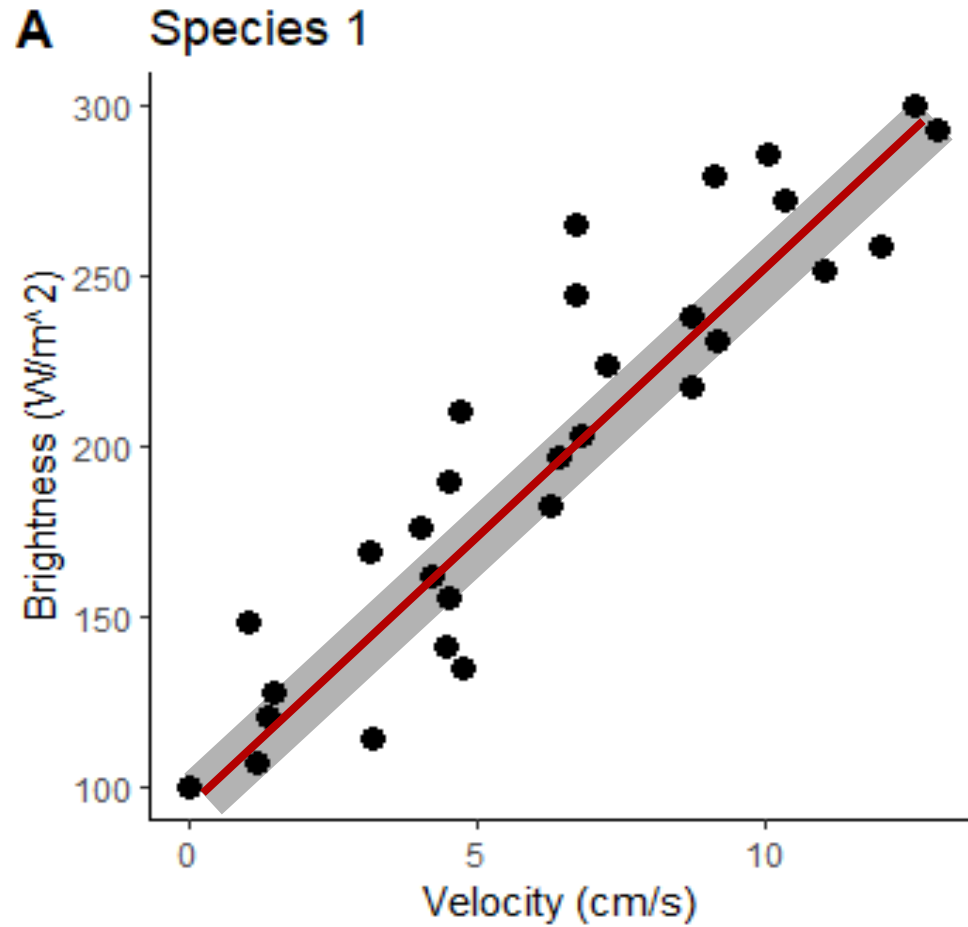roaches wen u turn on the lights

I'm out

Negative

Experiment from the Pre-Class Reading

- Focusing on Photokinesis: a change in the velocity of an organism in response to a change in light levels

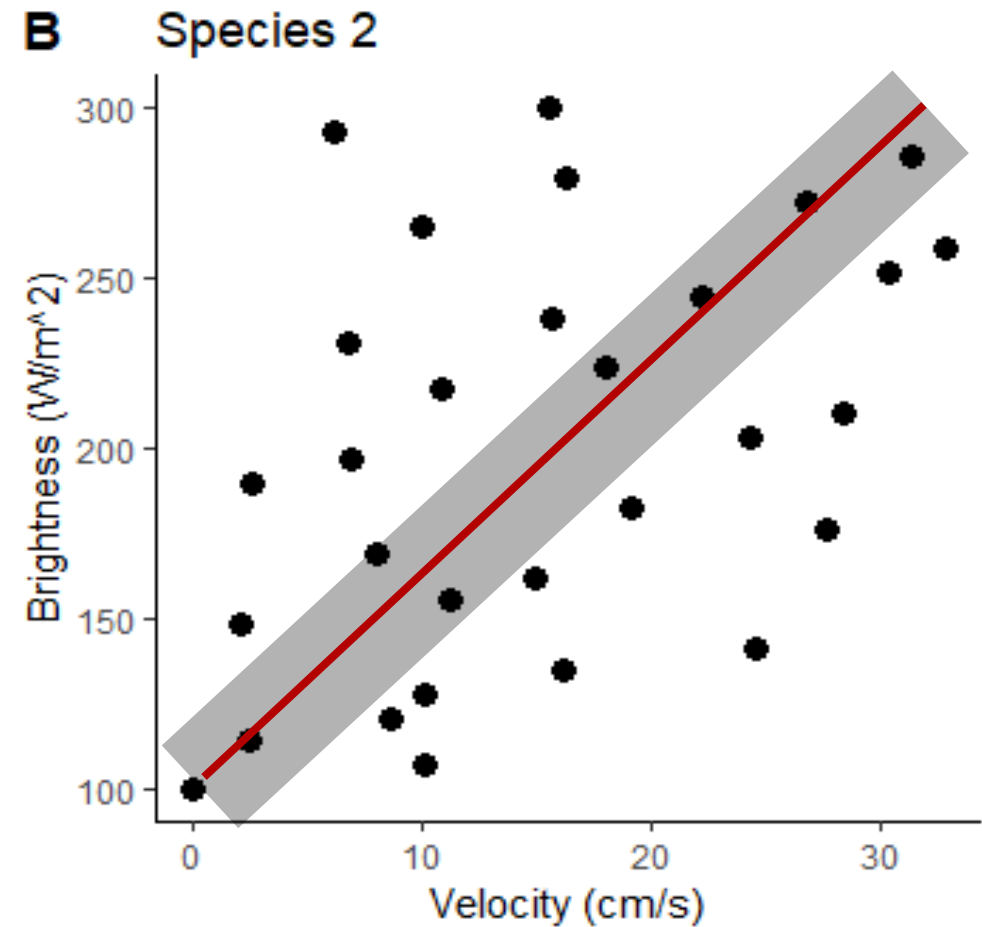- Looking at velocity of roly polys as room brightness increased
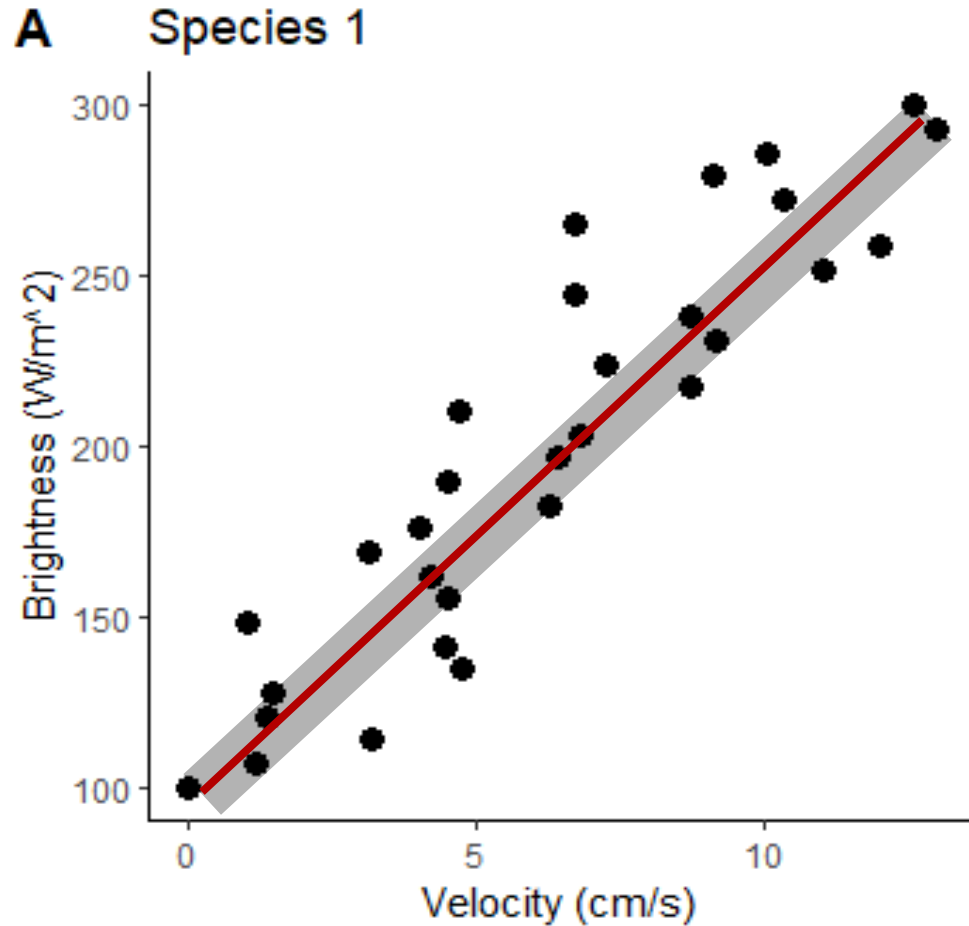
Linear Regression

A   Species 1

Brightness (W/m^2) vs Velocity (cm/s)
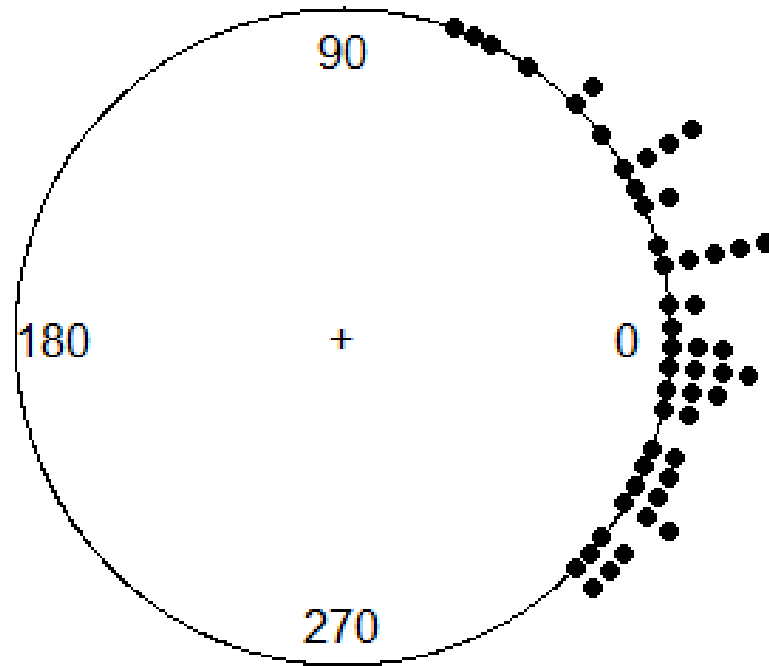
Slope

Spread (R^2)

P Value

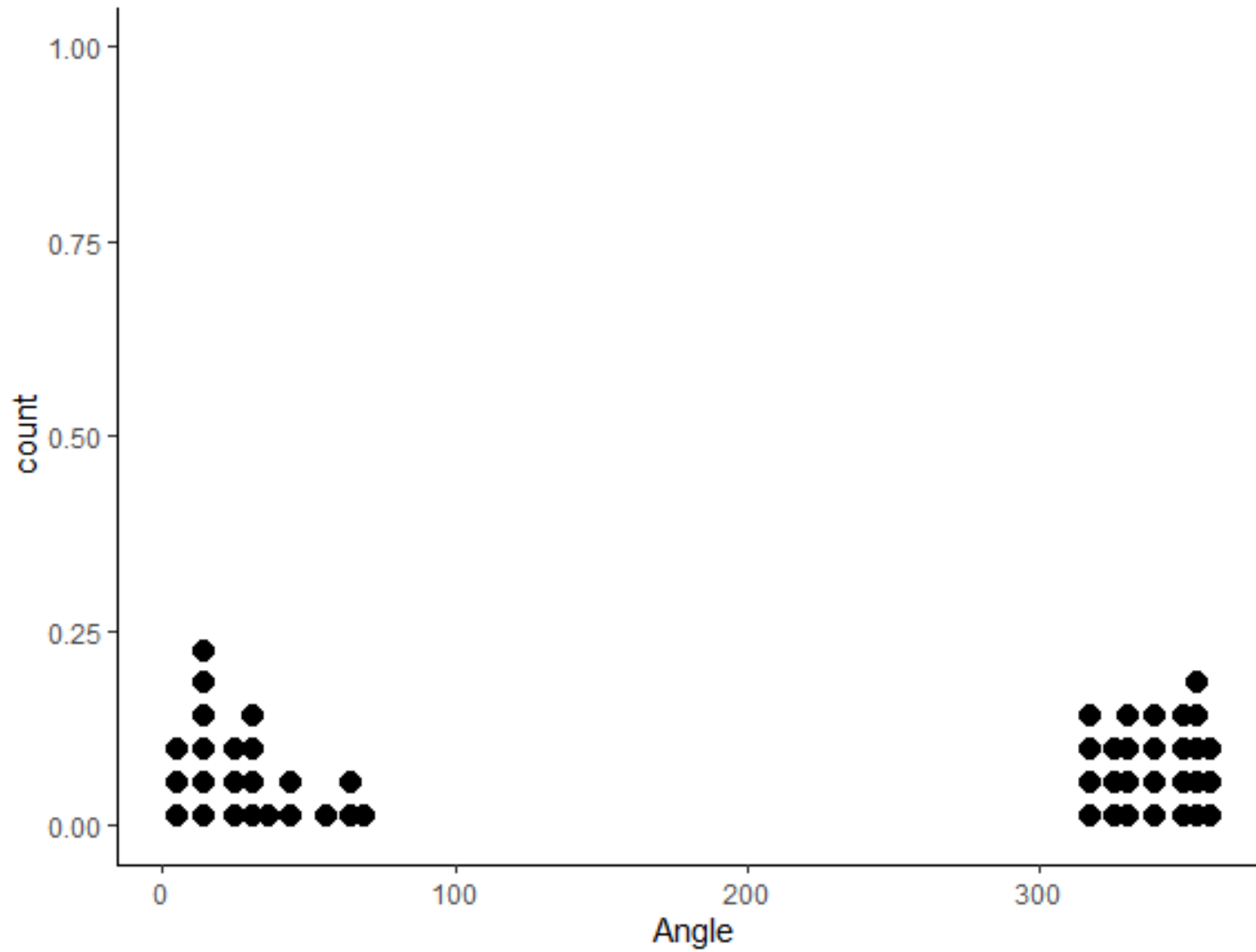# From the Readings—Linear Regression

Thinking about the experiment

- Based on the graphs, were the roly polys exhibiting photokinesis? What are some differences between species 1 and 2?
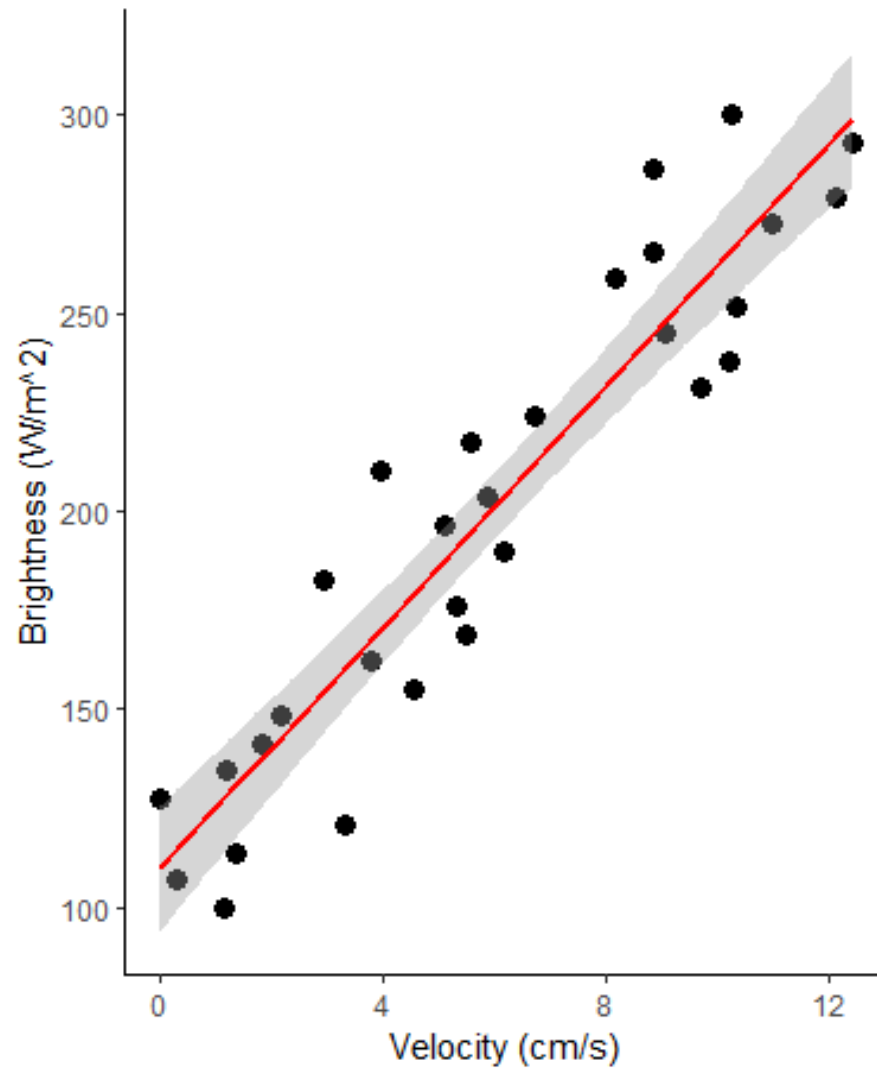
- How would you test for phototaxis?
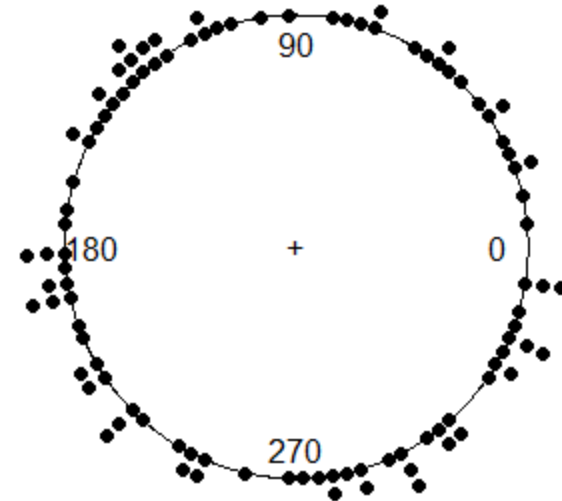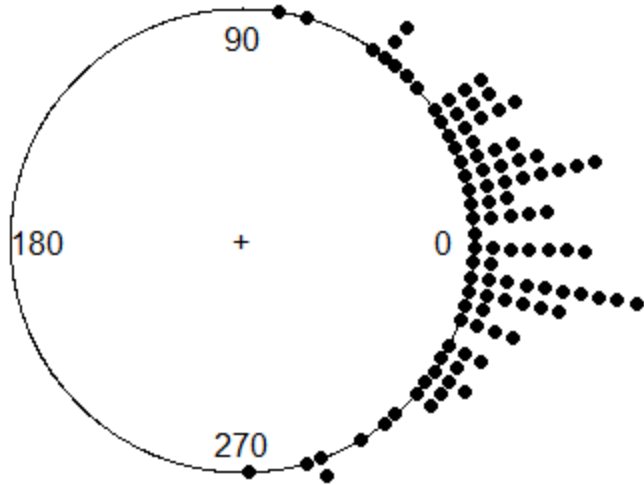
Circular Data

Circular Data

Circular Data

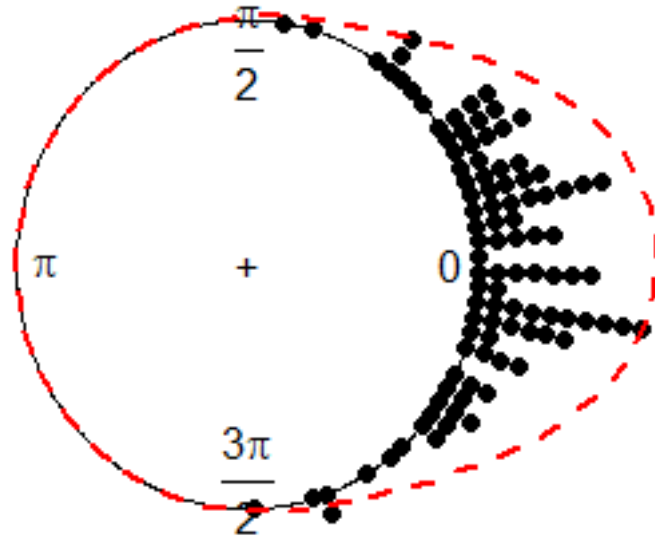| Linear	Circular
Test if slope is = 0	Test if points are oriented uniformly
R^2	Mean resultant vector

Circular Data—Test of Uniformity

Ho: The points are oriented uniformly
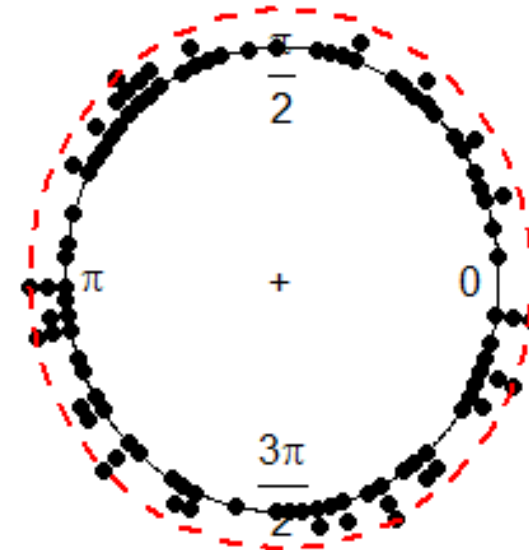around the circle

Ha: The points are not oriented
uniformly around the circle

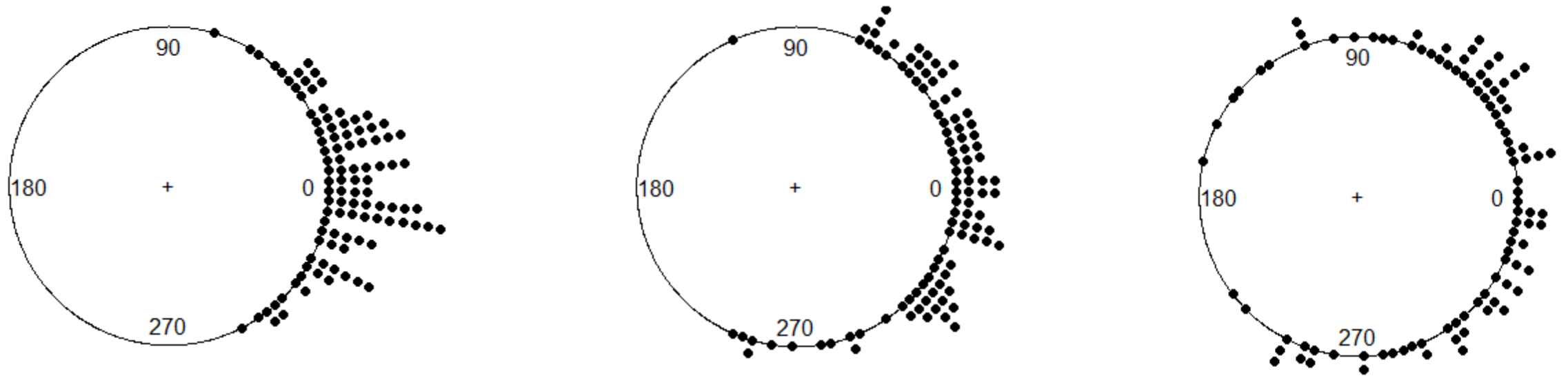# Circular Data—Test of Uniformity

Rayleigh Test of Uniformity:
P<0.05

Rayleigh Test of Uniformity:
P=0.73

Ho: The points are oriented uniformly
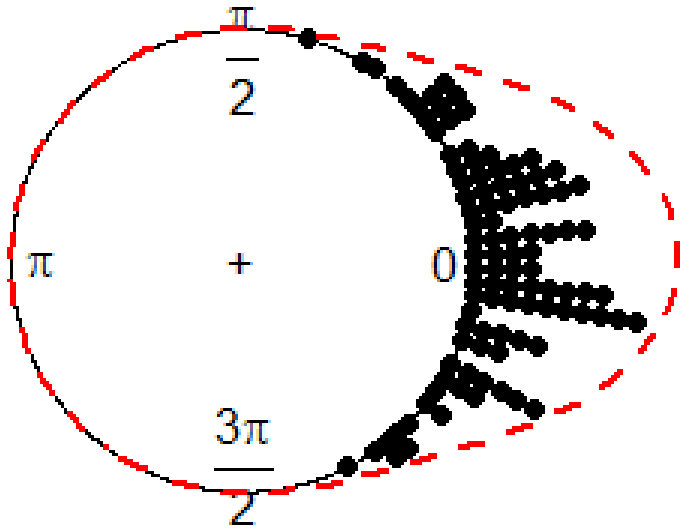around the circle

Ha: The points are not oriented
uniformly around the circle
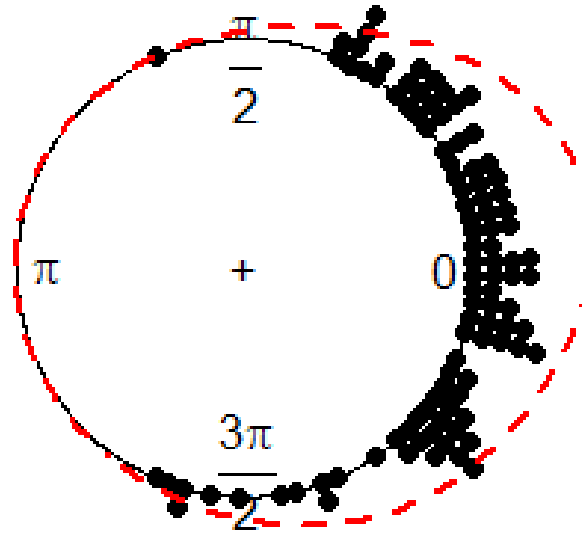
Circular Data—Mean Resultant Vector

Circular Data—Mean Resultant Vector

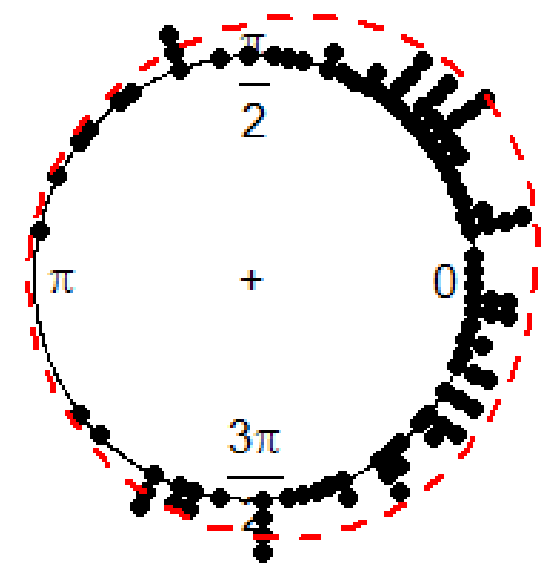Rayleigh Test of Uniformity:
P<0.05

Rayleigh Test of Uniformity:
P<0.05

Rayleigh Test of Uniformity:
P<0.05

Mean Angle: ~0

Mean Angle: ~0

Mean Angle: ~0

Circular Data—Mean Resultant Vector
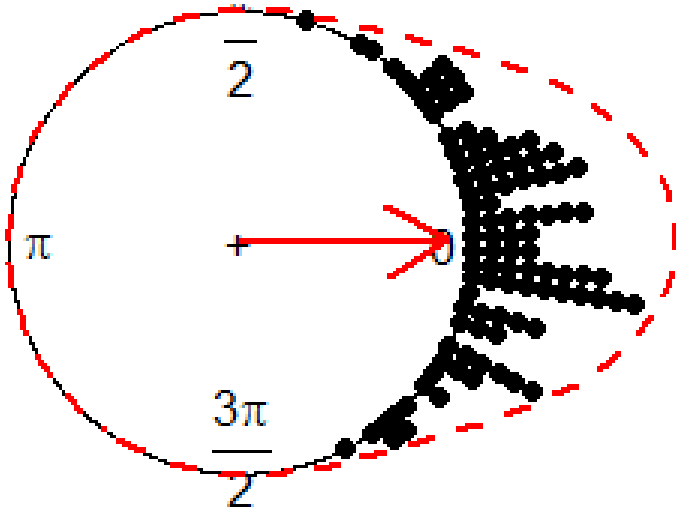
Rayleigh Test of Uniformity:
P<0.05

Rayleigh Test of Uniformity:
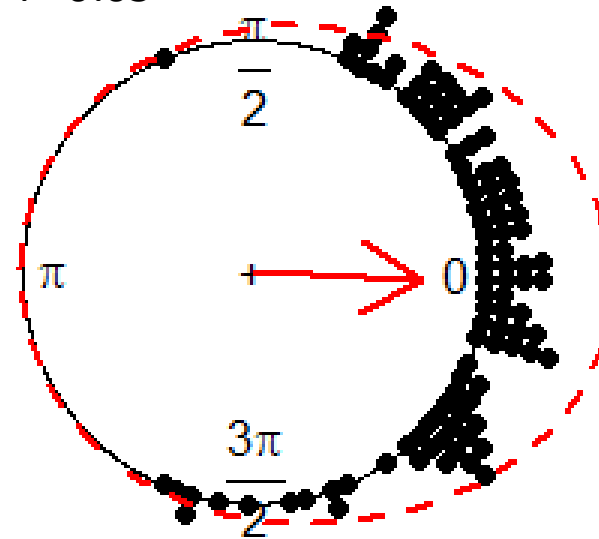P<0.05

Rayleigh Test of Uniformity:
P<0.05

Mean Angle: ~0
Resultant Vector Length: 0.89

Mean Angle: ~0
Resultant Vector Length: 0.72
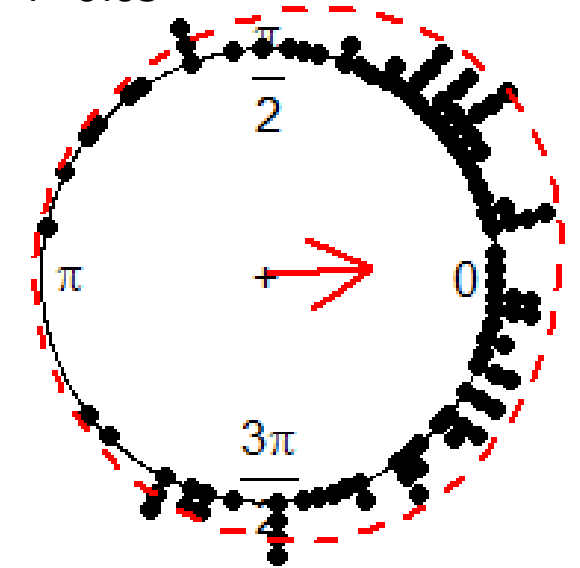
Mean Angle: ~0
Resultant Vector Length: 0.44

Comparing two distributions
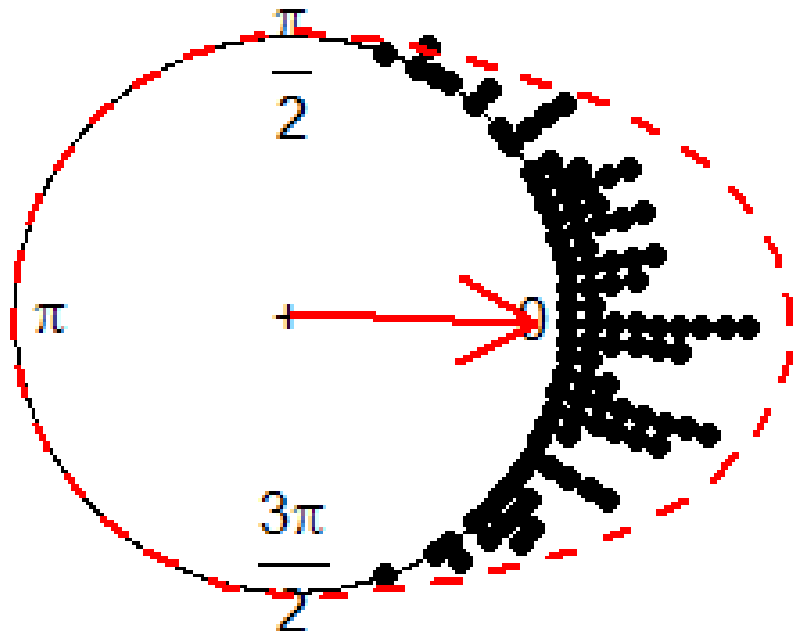
Test of Uniformity: p<0.05
Mean Angle: ~0
Resultant Vector Length: 0.89
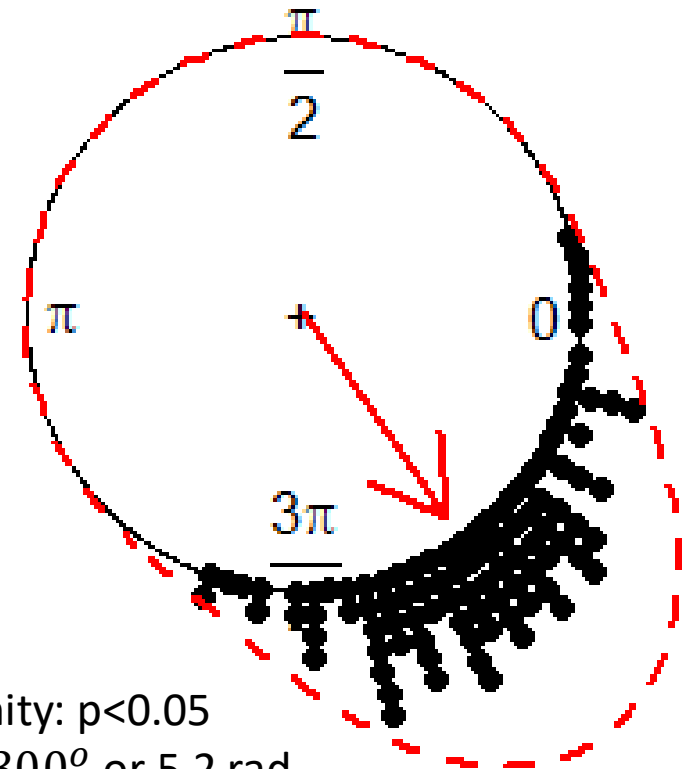
Test of Uniformity: p<0.05
Mean Angle: ~300° or 5.2 rad
Resultant Vector Length: 0.89

Comparing two distributions: Watson two-sample test
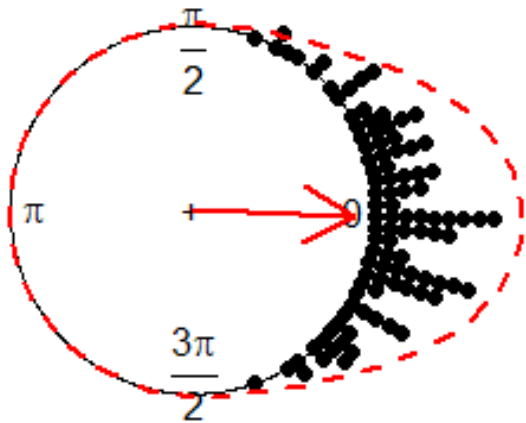
P <0.001
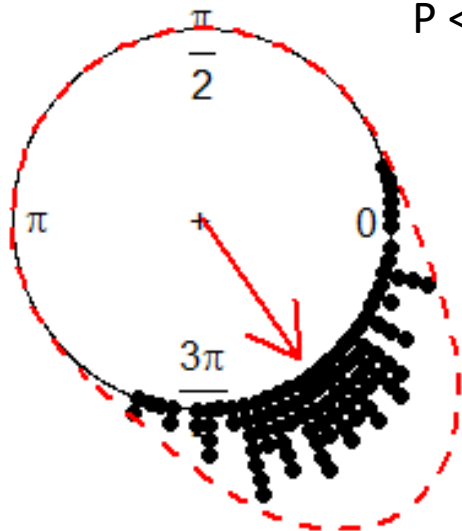
Watson Two-Sample Test
Ho: The mean of the two distributions are the same
Ha: the means of the two distributions are different

Experiment Time

Experimental Subjects

- Pillbugs are terrestrial crustaceans

- They live in dark, cool places like under stones and leaf litter.

- They are best-known for their defensive behavior of rolling into a ball (aka roly poly)

- Why would a pillbug be sensitive to light?

- Would you hypothesize positive or negative phototaxis?

Experiment Details

- Items needed: Box, lamp, paper cup, orientation arena, 6 roly polys

- 3 Experimental Trials (light on), 3 control trials (light off)

- For each trial, place 1 roly poly in the center of the arena under a paper cup, allow the roly poly 30 seconds to adjust, then remove the cup

- Allow the roly poly to reach the edge of the arena and mark with pencil where it exited the arena

- Repeat (more detailed instructions in your handout!)

- Add your group's results to the class data on the board!

R-Shiny

- https://rfitak.shinyapps.io/circbio/

Group 1: Enter a set of angles in degrees, one per line

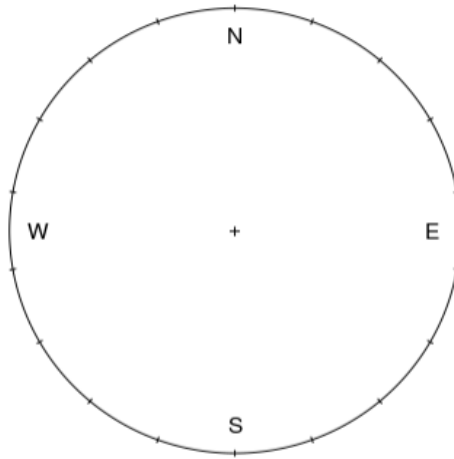**Group 2: Enter a set of angles in degrees, one per line**

Save plot as file type
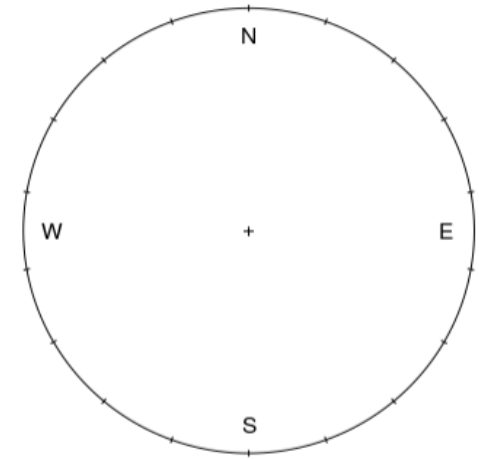
- ● png
- ○ pdf

⬇ Download the plots

Plots

(data points shown in black, mean vector in red)

Group 1

Group 2

Let's think back

- **What is a p-value?**
- What does the mean vector length r mean?
- What does the mean angle tell us?

Results:

Group 1

```
Mean angle:   NA
Mean vector length (r):   NaN
Rayleigh test p-value:
```

Group 2

```
Mean angle:   NA
Mean vector length (r):   NaN
Rayleigh test p-value:
```

Watson's test to compare two groups

```
NULL
```

Exit Ticket

Email danae.diaz@duke.edu, emily.brady@duke.edu, and snowicki@duke.edu the following:

- Of your group's data:
  - A picture of the circular plot of both the light on and light off group.
  - The mean angle, Rayleigh test p-value, and mean resultant vector for both the light on and light off group

In total: 2 plots, 2 Rayleigh tests, 2 mean angles, 2 mean resultant vectors.