

Phototaxis in Pillbugs: Working with Circular Data

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Goals for today

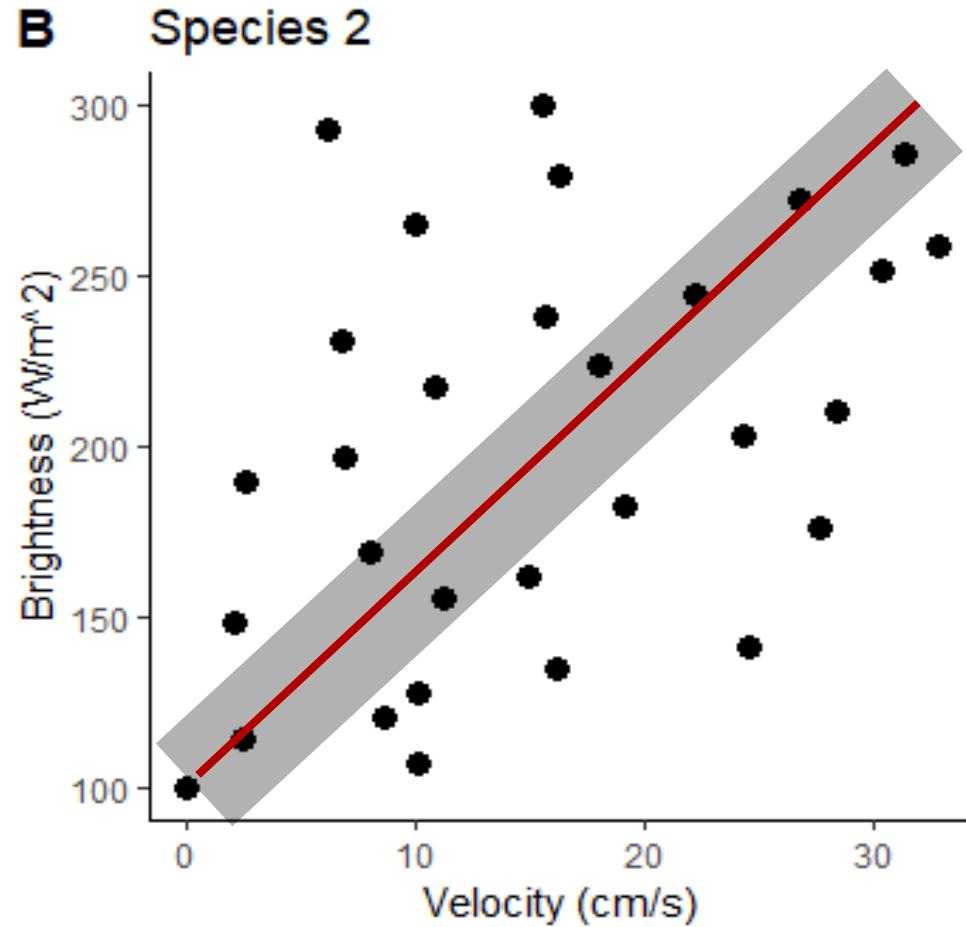
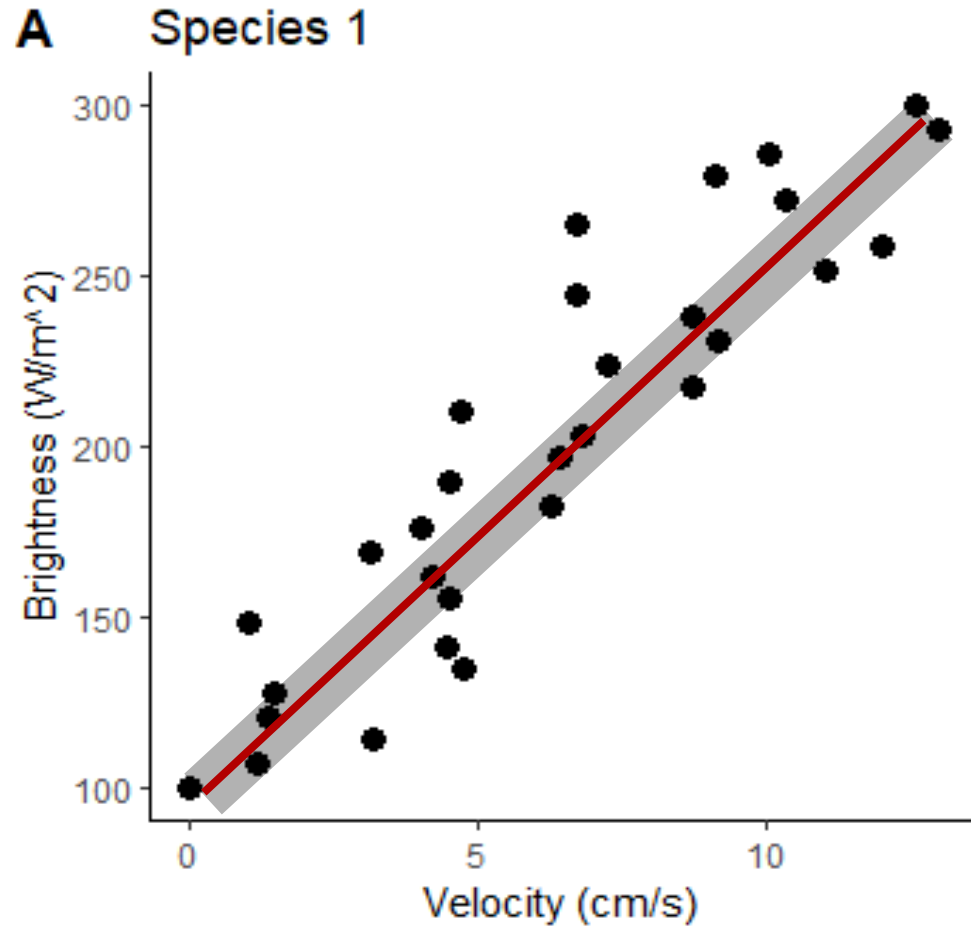
By the end of today you will:

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: changing your behavior in response to a change in light levels
 - Examples?
- Phototaxis: orientation or movement towards or away from a light source
 - Examples?

From the Readings—Linear Regression

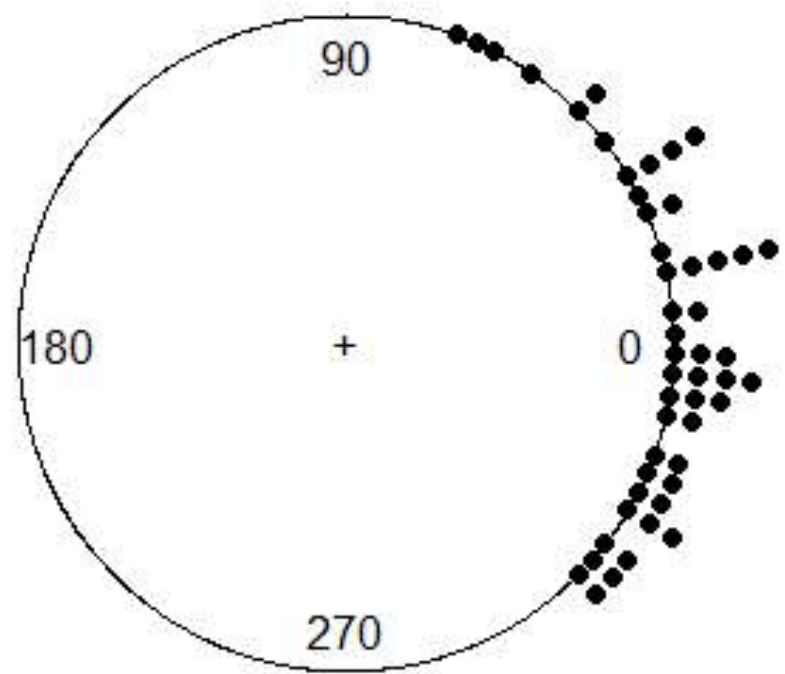


Slope
Spread (R^2)

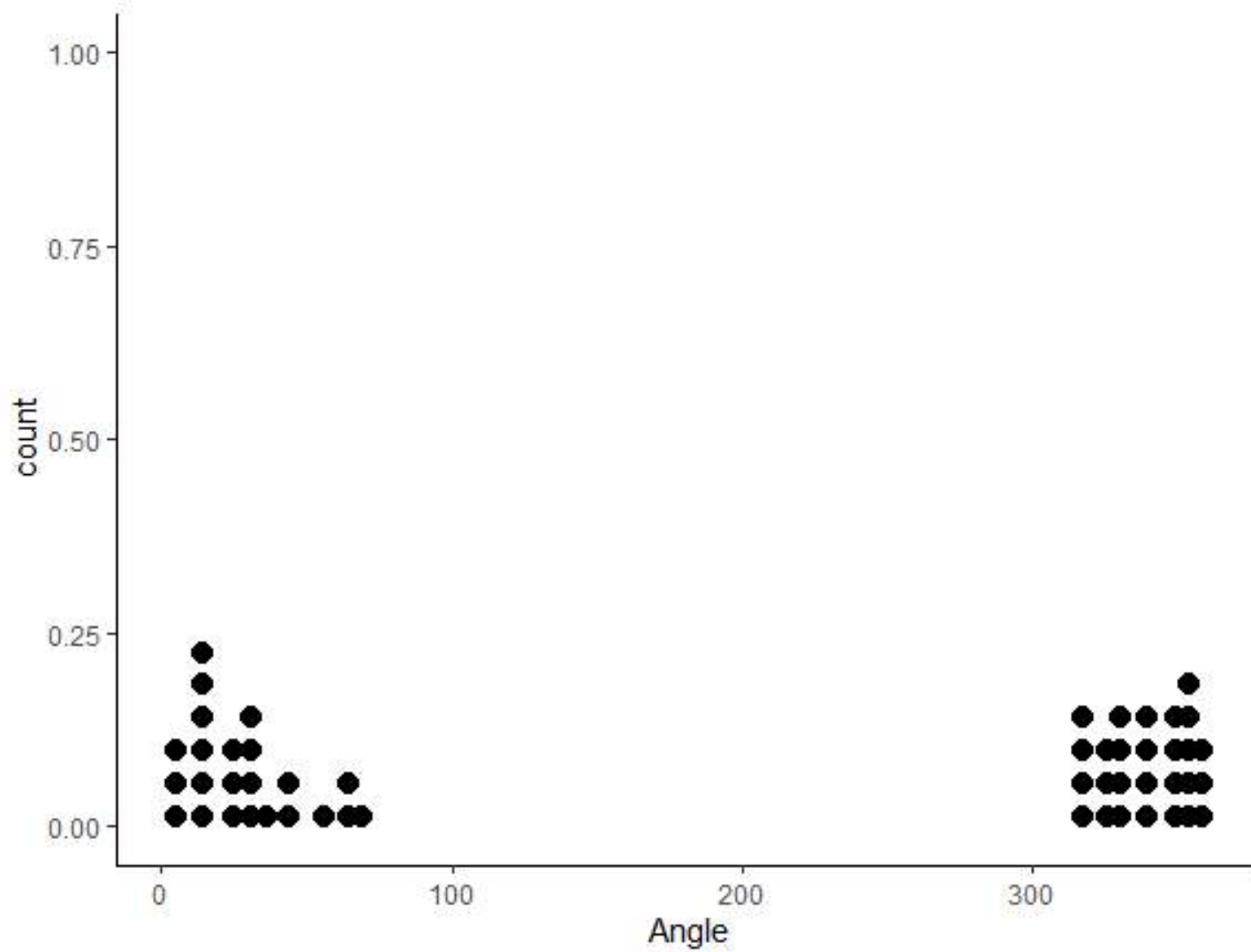
Photokinesis & Phototaxis

How would you design an experiment to test for phototaxis?

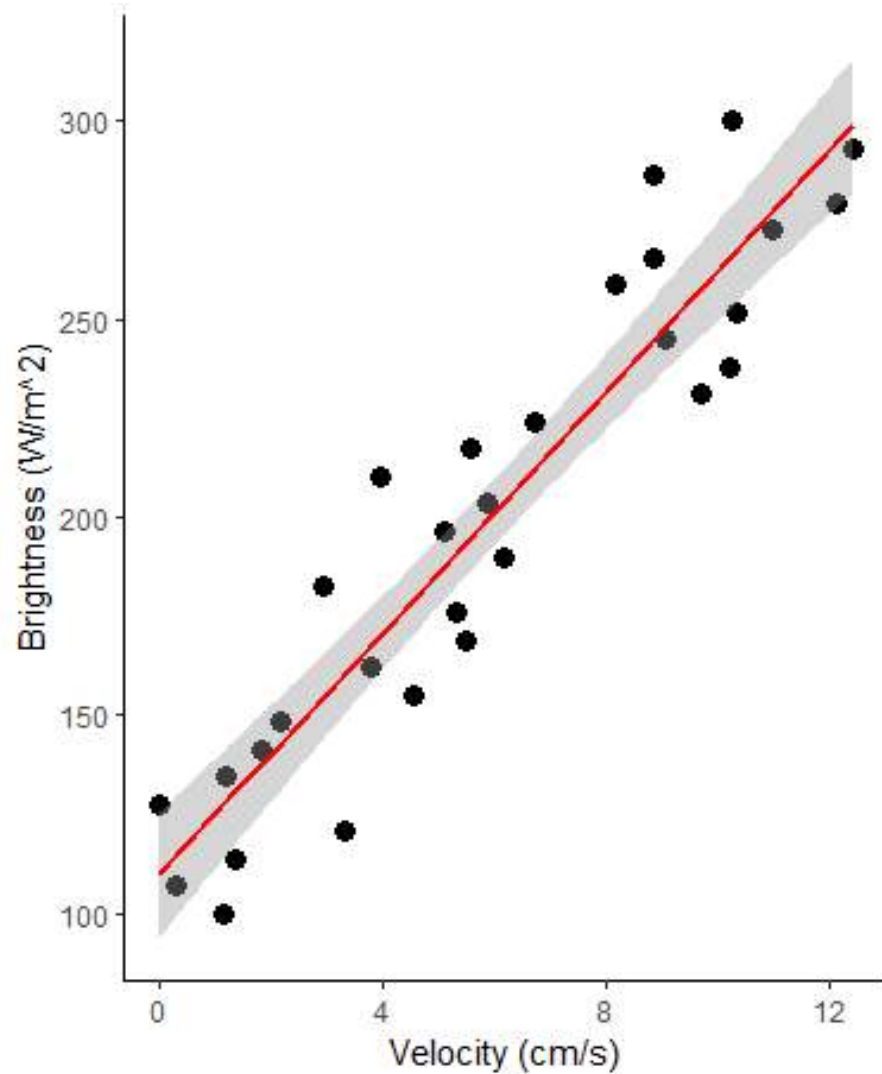
Circular Data



Circular Data

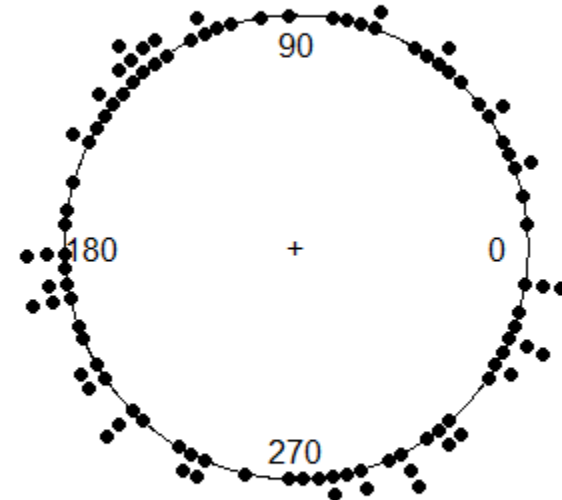
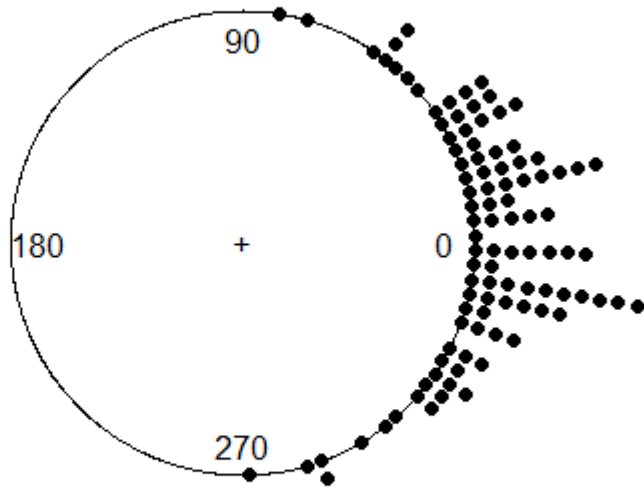


Circular Data



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

Circular Data—Test of Uniformity

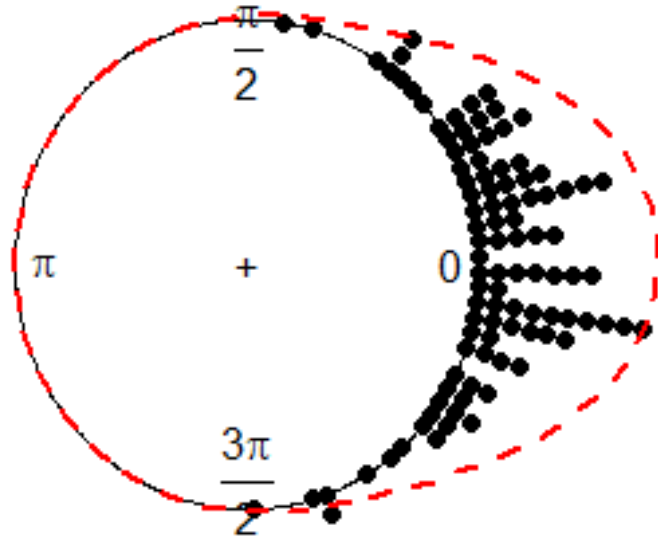


H_0 : The points are oriented uniformly around the circle

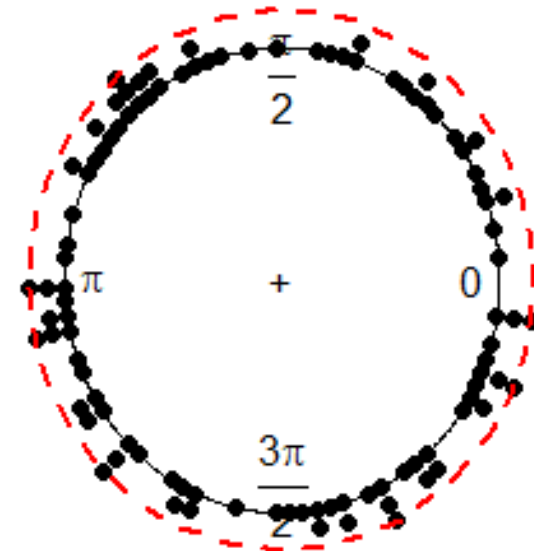
H_a : The points are not oriented uniformly around the circle

Circular Data—Test of Uniformity

Rayleigh Test of Uniformity:
 $P < 0.05$



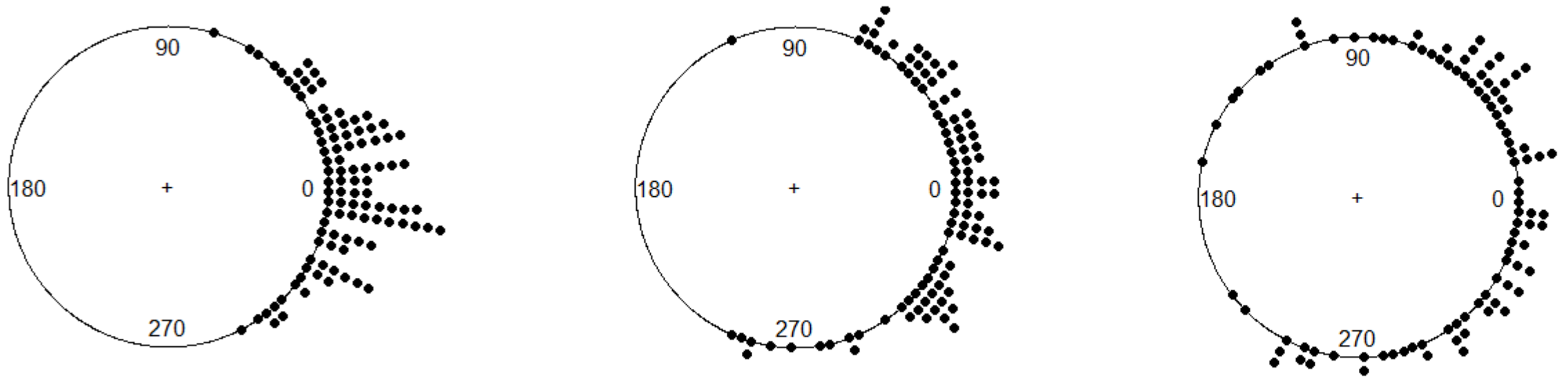
Rayleigh Test of Uniformity:
 $P = 0.73$



H_0 : The points are oriented uniformly
around the circle

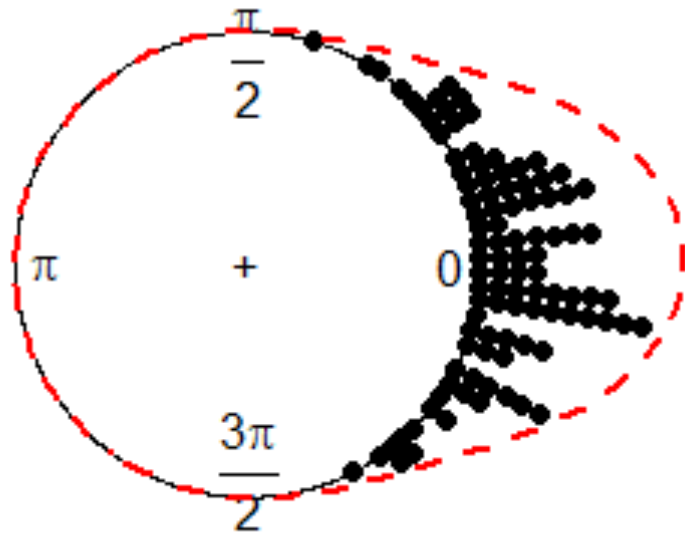
H_a : The points are not oriented
uniformly around the circle

Circular Data—Mean Resultant Vector



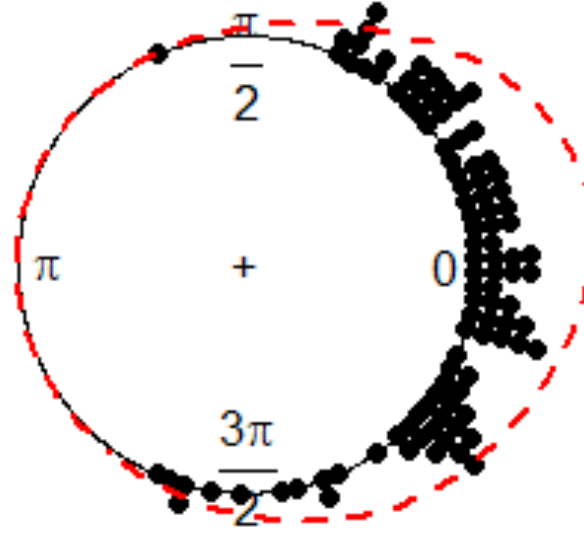
Circular Data—Mean Resultant Vector

Rayleigh Test of Uniformity:
 $P < 0.05$



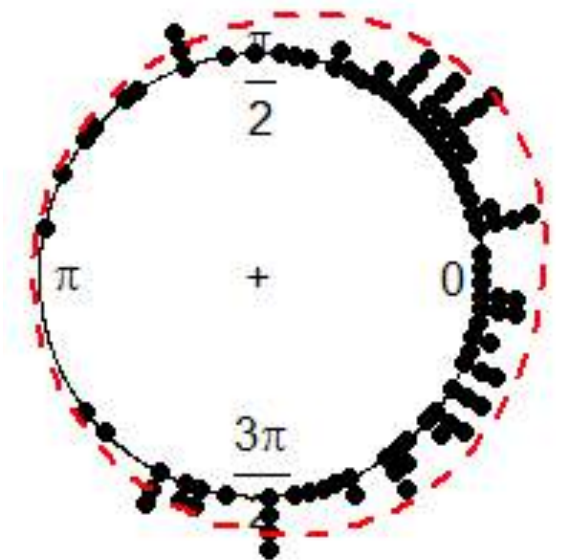
Mean Angle: ~ 0

Rayleigh Test of Uniformity:
 $P < 0.05$



Mean Angle: ~ 0

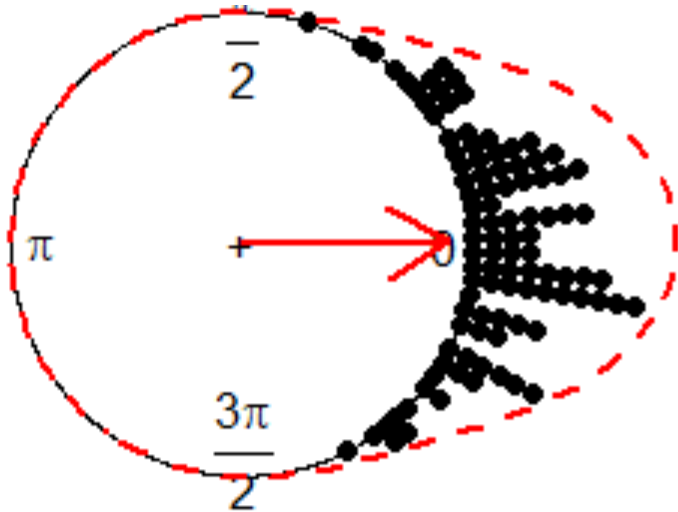
Rayleigh Test of Uniformity:
 $P < 0.05$



Mean Angle: ~ 0

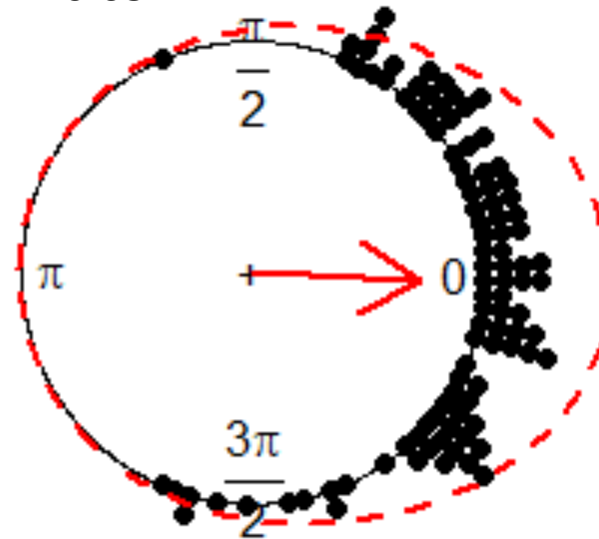
Circular Data—Mean Resultant Vector

Rayleigh Test of Uniformity:
 $P < 0.05$



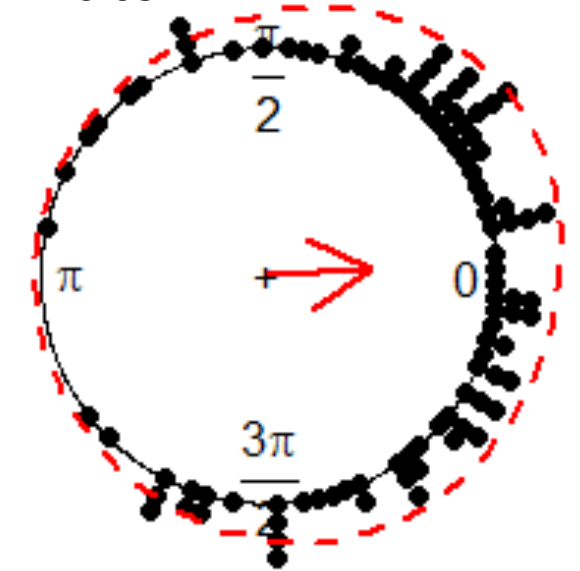
Mean Angle: ~ 0
Resultant Vector Length: 0.89

Rayleigh Test of Uniformity:
 $P < 0.05$



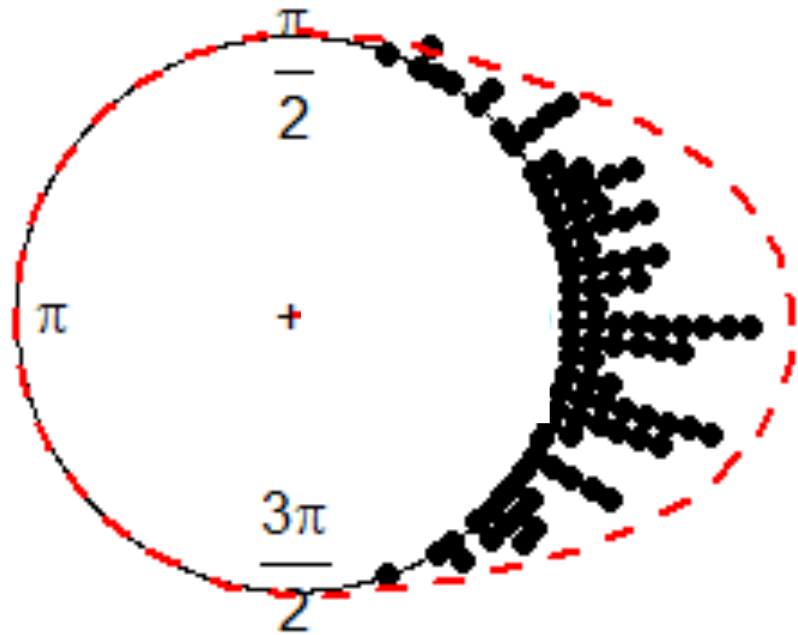
Mean Angle: ~ 0
Resultant Vector Length: 0.72

Rayleigh Test of Uniformity:
 $P < 0.05$

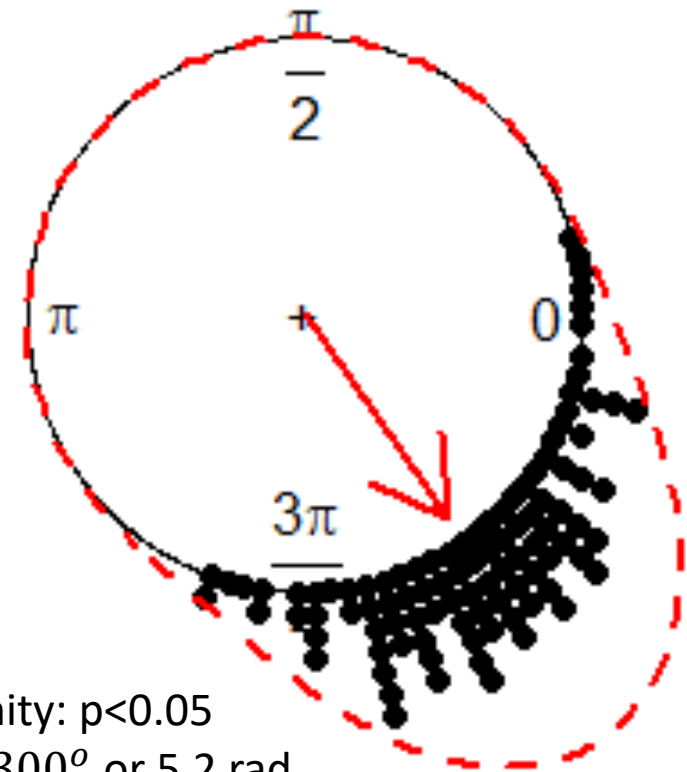


Mean Angle: ~ 0
Resultant Vector Length: 0.44

Comparing two distributions

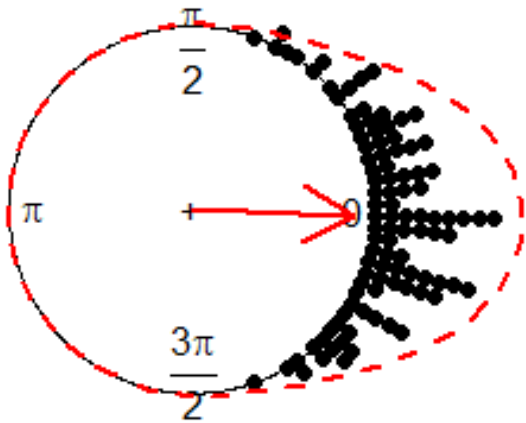


Test of Uniformity: $p < 0.05$
Mean Angle: ~ 0
Resultant Vector Length: 0.89

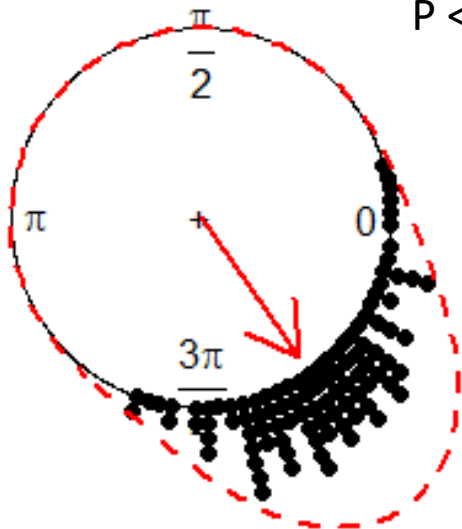


Test of Uniformity: $p < 0.05$
Mean Angle: $\sim 300^\circ$ or 5.2 rad
Resultant Vector Length: 0.89

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

- Follow the instructions on the handout to complete your experiment!
- Relative Angle = Crossing Angle – Lamp Position

R-Shiny

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

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.