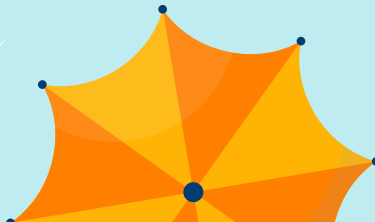




# **It's Raining Stats: Activities for Simulation and Inference**

<https://z.umn.edu/MCTM26>



# Who are we?

Regina



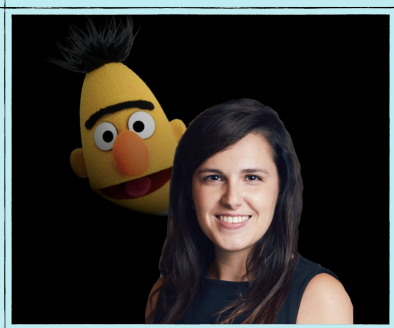
Vee



Pablo



Chelsey



Andy





**Today we will...**

# MN Mathematics Benchmark

## Data Analysis

### 9.1.1.8

Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples or simulated samples of the same size to gauge the variation in estimates or predictions.

(MP1, MP4)



<https://z.umn.edu/MCTM26>



The Western Regional Climate Center reports precipitation at the start of each hour.

On average, Seattle is reported to have measurable rain in 9% of recorded hours





Suppose Albert Hoffman were to visit Seattle, WA for one week (168 hours).

How many hours is it likely to rain in the week that he is in Seattle?



## Your Task:

Create a model that you could use to simulate the number of hours it rains in the week that he is in Seattle.

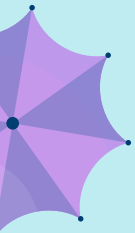
Relevant Information:

- Seattle is reported to have measurable rain in 9% of recorded hours
- One week is equal to 168 hours



# Open CODAP:

**<https://codap.concord.org/>**





CODAP

[Get Started](#)

[Educators](#)

[Developers](#)

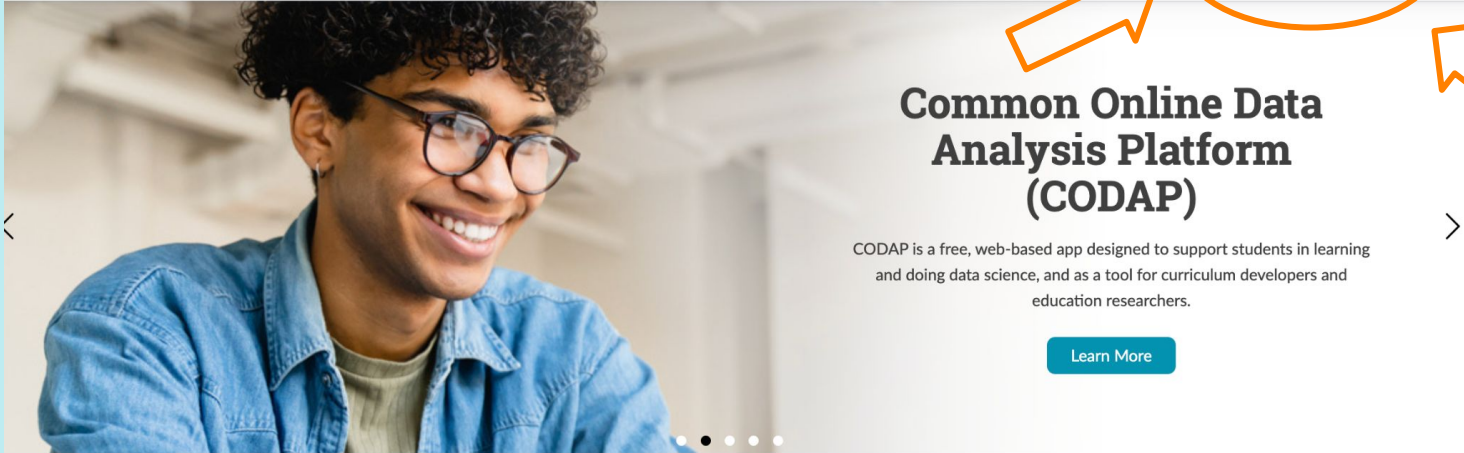
[Researchers](#)

[Community](#)

[Help](#)

[About](#)

[Launch CODAP](#)



Get started with CODAP



Explore example documents



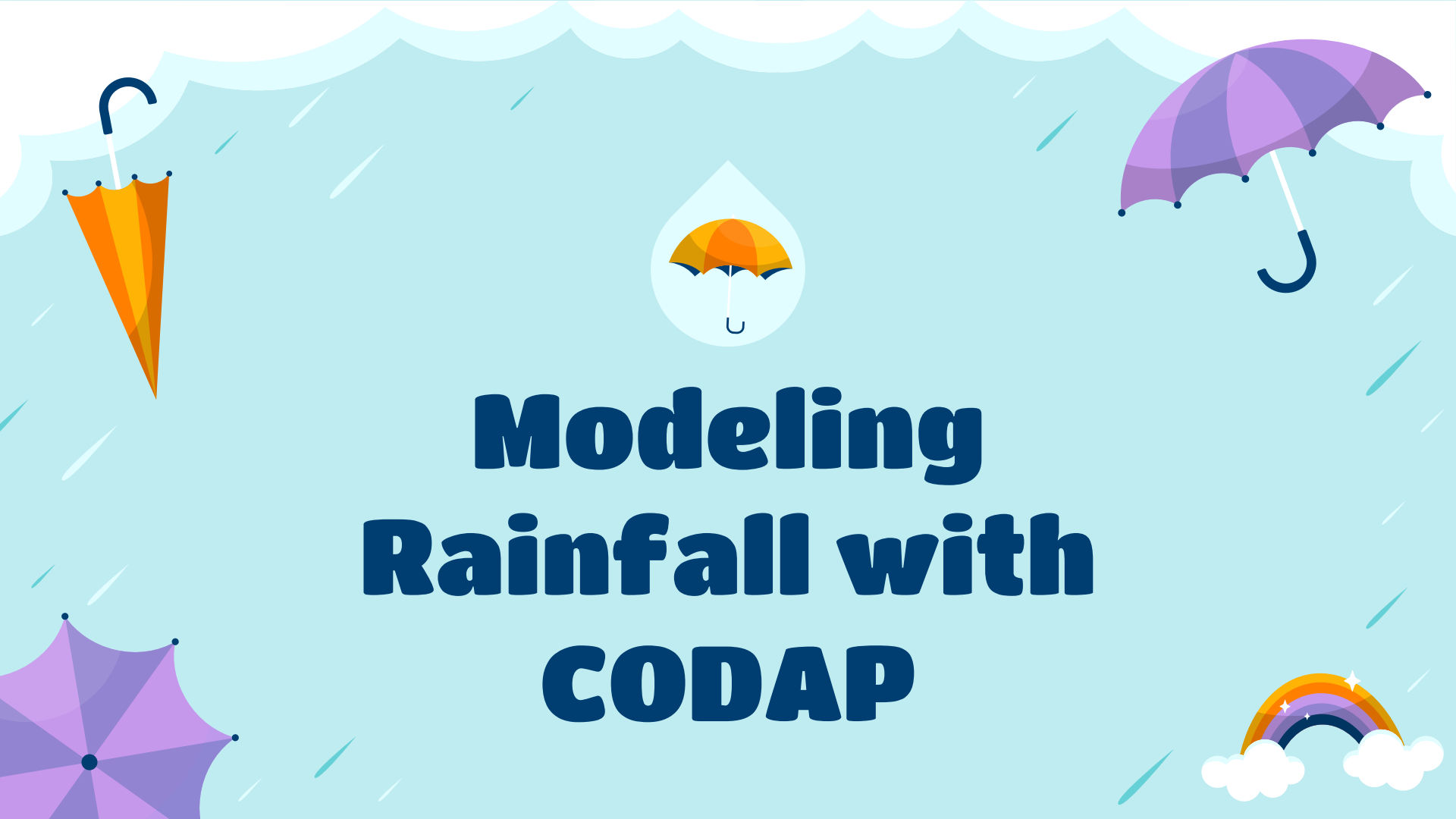
Join the community



WHAT WOULD YOU LIKE TO DO?

OPEN DOCUMENT OR BROWSE EXAMPLES

CREATE NEW DOCUMENT

The background is a light blue sky with white rain streaks falling from the top. At the top, there are stylized white clouds with light blue outlines. Four umbrellas are scattered around: a yellow one on the left, a purple one on the right, a purple one in the bottom left, and a rainbow with white clouds on the bottom right. In the center, a white teardrop shape contains a small yellow umbrella icon.

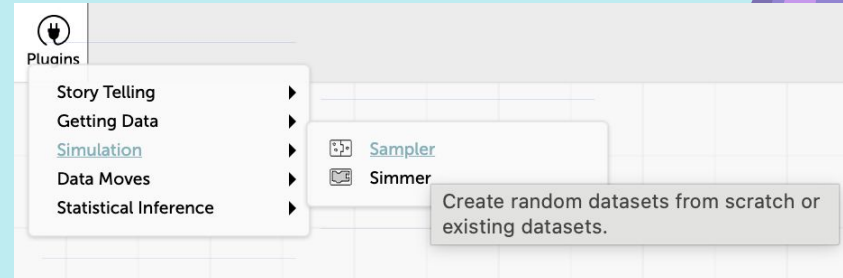
# Modeling Rainfall with CODAP

# Next, we'll add a sampler:

**1** Click "Plugins" and then **Simulation › Sampler**

**2** Change the sampler to a spinner

**3** Update your model with labels and percentages

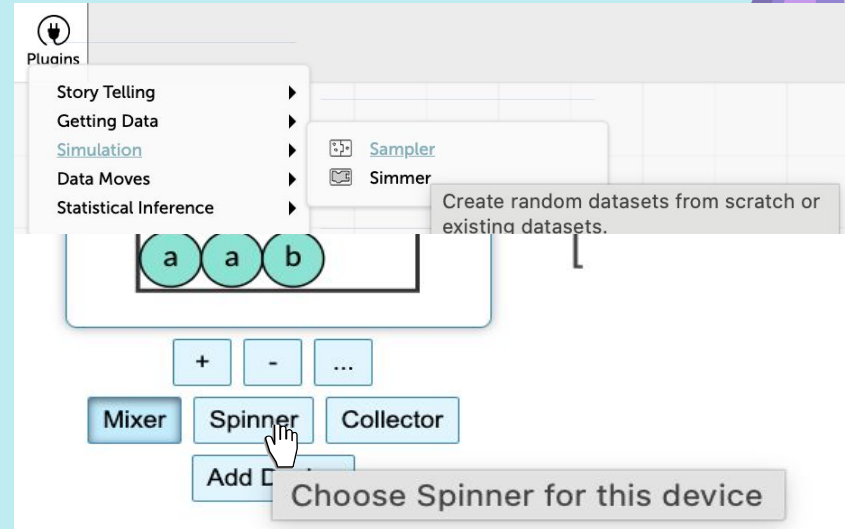


# Next, we'll add a sampler:

**1** Click "Plugins" and then Simulation › Sampler

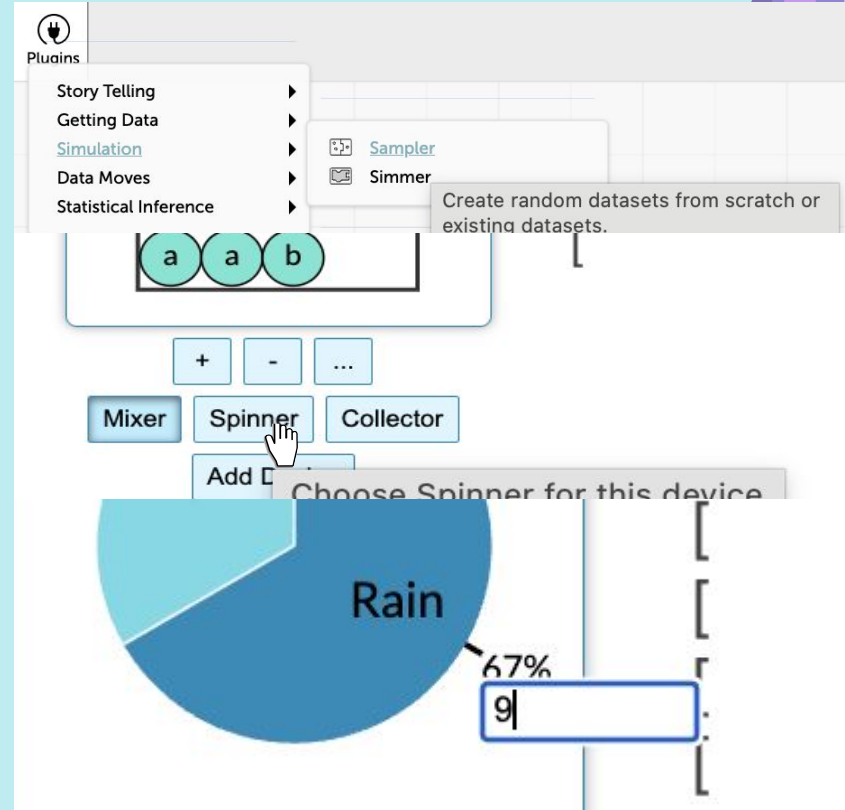
**2** Change the sampler to a spinner

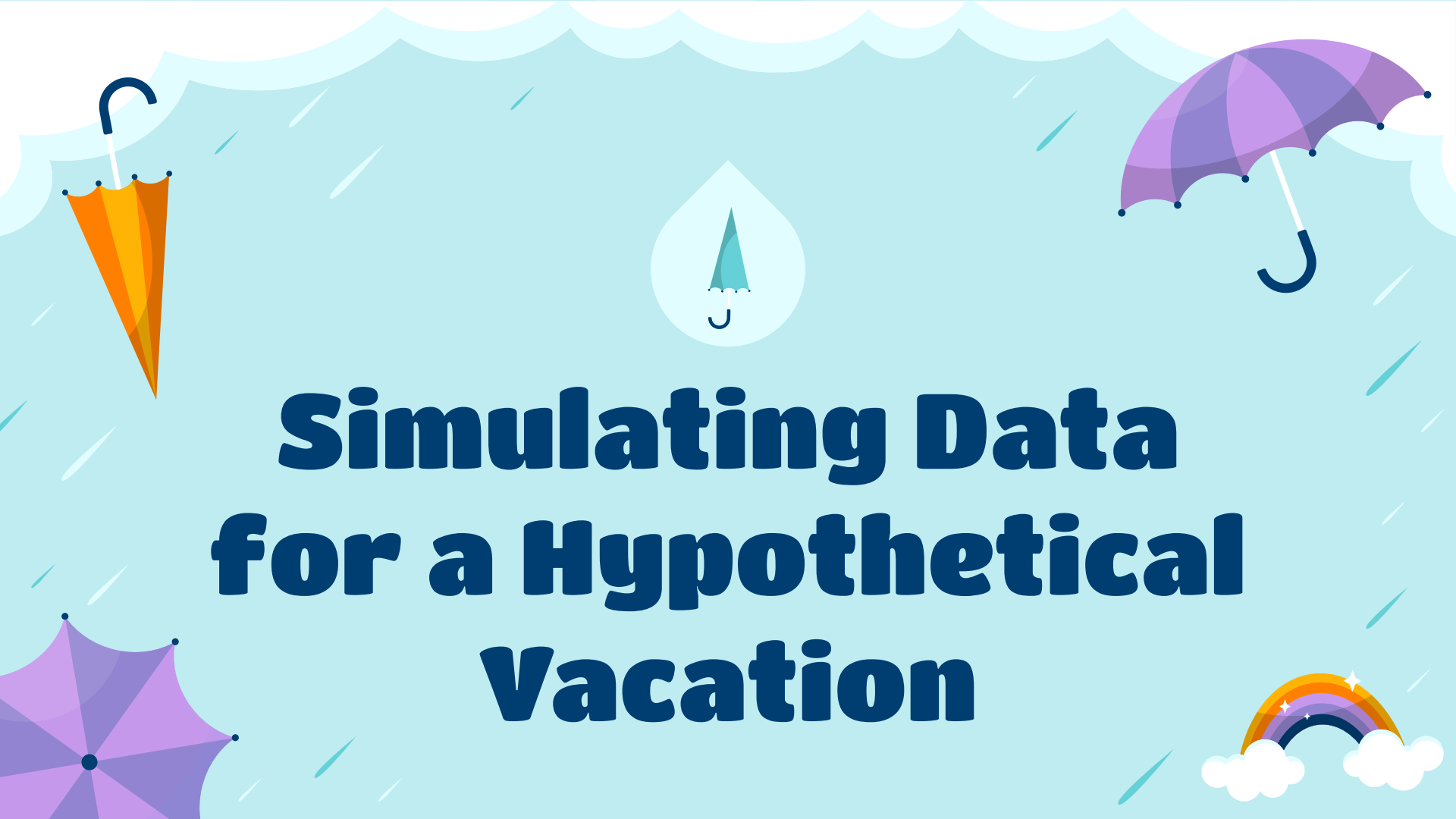
**3** Update your model with labels and percentages



# Next, we'll add a sampler:

- 1 **Click "Plugins" and then Simulation › Sampler**
- 2 **Change the sampler to a spinner**
- 3 **Update your model with labels and percentages**







The background is a light blue sky with white rain streaks falling diagonally. There are four umbrellas: a yellow one on the left, a purple one on the right, a purple one in the bottom left, and a rainbow with white clouds on the bottom right. In the center, there is a white teardrop shape containing a small teal umbrella icon.



# **Simulating Data for a Hypothetical Vacation**

# Simulate Data for Trial #1

Model | Measures | About

START STOP  Medium CLEAR DATA

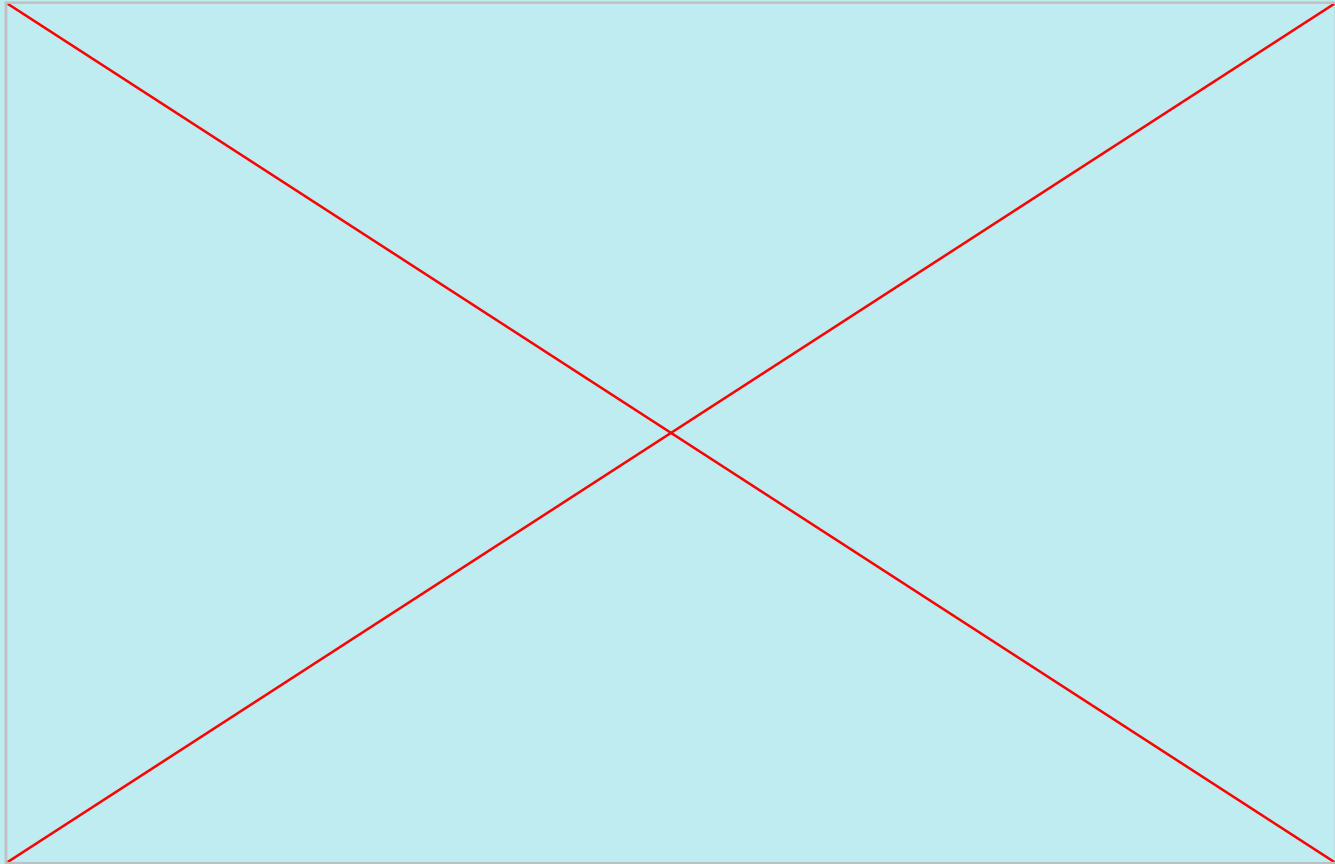
Select ▼ 168   items  with replacement ▼

Collect 1   samples

The background is a light blue sky with white rain streaks. At the top, there are stylized white clouds. Four umbrellas are scattered around: an orange one on the left, a purple one on the right, a purple one in the bottom left, and a rainbow with white clouds in the bottom right. In the center, a white teardrop shape contains a pair of purple rain boots.

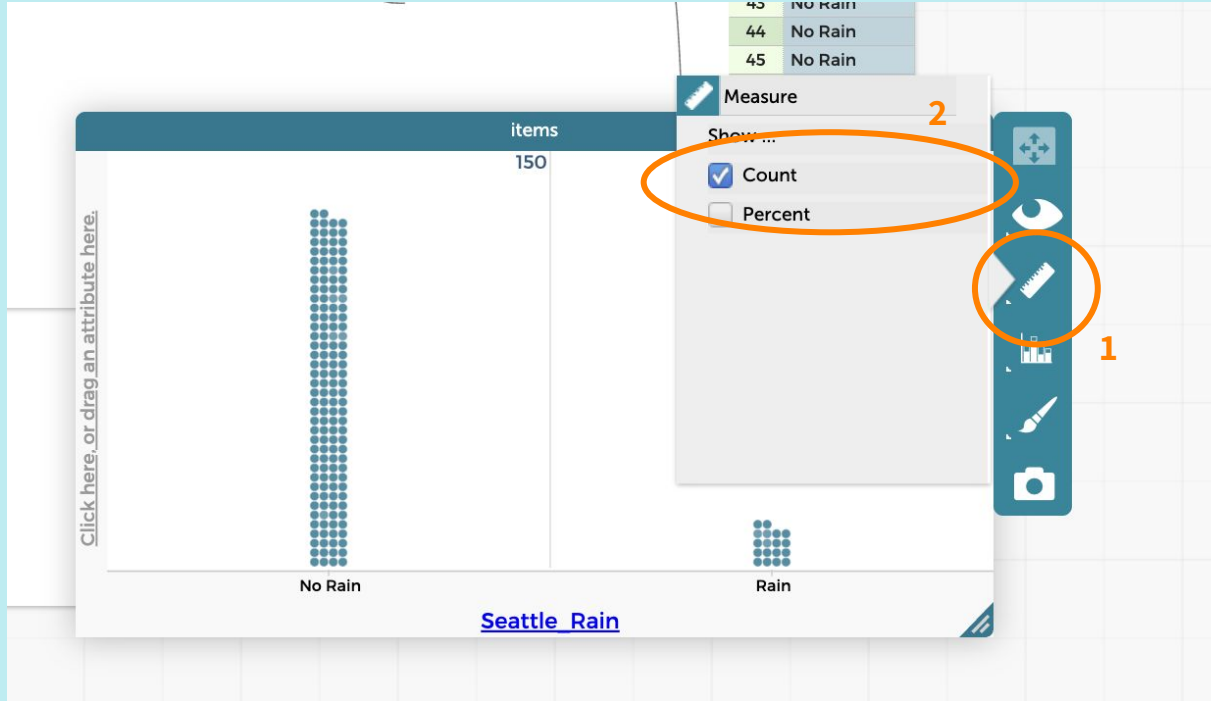
# Plotting the Results of the Trial

# Plot Trial #1



The background is a light blue sky with stylized white clouds at the top and bottom. Rain is falling, represented by white diagonal lines. There are four umbrellas: a yellow one on the left, a purple one on the right, a purple one in the bottom left, and a purple one inside a white raindrop in the center. A rainbow with white clouds is in the bottom right.

# Counting the Hours of Rain



The background is a light blue sky with stylized white clouds at the top and bottom. Rain is falling, represented by white diagonal lines. There are four umbrellas: an orange one on the left, a purple one on the right, a purple one in the bottom left, and a rainbow with white clouds at the bottom right. In the center, there is a large white raindrop containing a white cloud.

**Run Additional  
Trials**

# Trial #2 (and so on...)

v1.0.4 Sampler 2

Model Measures About

START STOP Fastest **CLEAR DATA**

experiments (1 cases) samples (1 case)

Select 168 items with replac Delete all the sampled items from the dataset

Collect 1 samples

Seattle\_Rain

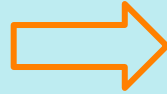
Rain

No Rain

sample 1

items 150

here\_or\_drag\_an\_attribute\_here.

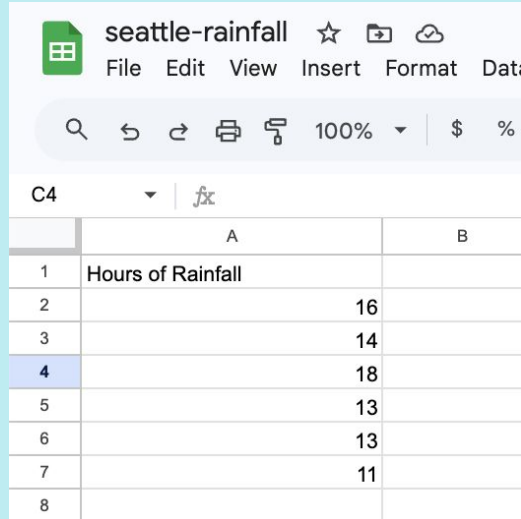


START STOP

Select 168 items

Collect 1 samples

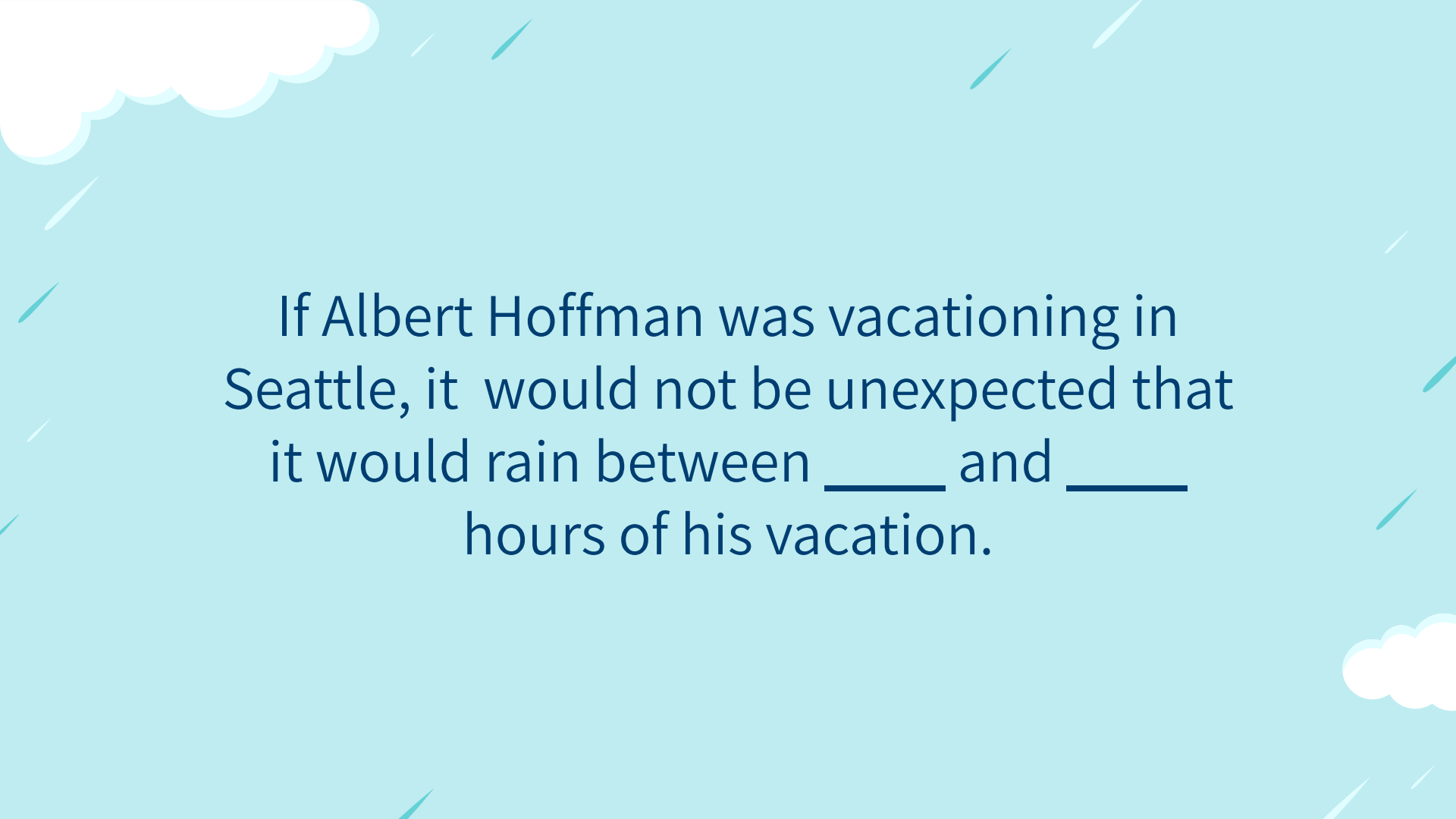
# Enter your data:



The screenshot shows a Google Sheets spreadsheet titled "seattle-rainfall". The spreadsheet has a menu bar with "File", "Edit", "View", "Insert", "Format", and "Data". Below the menu bar is a toolbar with search, undo, redo, print, and zoom (100%) icons. The active cell is C4, and the formula bar shows a function icon. The spreadsheet contains a table with the following data:

	A	B
1	Hours of Rainfall	
2		16
3		14
4		18
5		13
6		13
7		11
8		

<https://z.umn.edu/rainfall-data>



If Albert Hoffman was vacationing in Seattle, it would not be unexpected that it would rain between \_\_\_\_\_ and \_\_\_\_\_ hours of his vacation.

# Split Up!

**Modeling  
Rainfall in  
Olympia**

**Modeling  
Rainfall in  
Astoria**

## Split Up!

### Modeling Rainfall in Olympia

On average, Olympia is reported to have measurable rain in 13% of recorded hours

### Modeling Rainfall in Astoria

On average, Astoria is reported to have measurable rain in 16% of recorded hours

The background is a light blue sky with white raindrops falling diagonally. There are four umbrellas: one orange on the top left, one purple on the top right, one purple on the bottom left, and one rainbow on the bottom right. In the center, there is a white teardrop shape containing a small rainbow with two white clouds. The main text is in a bold, dark blue font.

# Automating the Number of Hours of Rain

START STOP Medium CLEAR DATA

Select 168 items with replacement

Collect 5 samples

# Sampler Data

experiments (1 cases)				samples (5 cases)			items (840 cases)		
in-index	experiment	description	sample size	in-index	sample	in-index	output	Olympia	
1	1	Spinner ...	168	1	1	152		no_rain	
				2	2	153		no_rain	
				3	3	154		no_rain	
				4	4	155		no_rain	
				5	5	156		no_rain	
						157		no_rain	
						158		no_rain	
						159		rain	
						160		no_rain	
						161		no_rain	
						162		no_rain	
						163		no_rain	
						164		no_rain	
						165		no_rain	
						166		no_rain	
						167		no_rain	
						168		no_rain	
						1		no_rain	
						2		no_rain	
						3		no_rain	
						4		rain	
						5		no_rain	
						6		no_rain	



### Sampler Data

<i>experiments (1 cases)</i>				<i>samples (5 cases)</i>		<i>items (840 cases)</i>		
in- dex	experi- ment	descrip- tion	sample size	in- dex	sample	in-	output	Olympia
1	1	Spinner ...	168	1		153		no_rain
				2		154		no_rain
				3		155		no_rain
				4		156		no_rain
				5		157		no_rain
						158		no_rain
						159		rain



Add a new attribute to this table



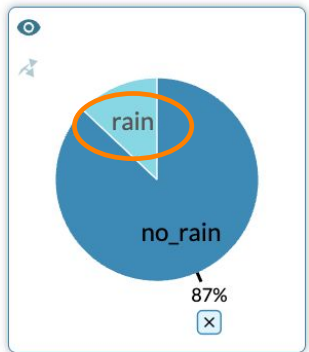


START STOP Fastest CLEAR DATA

Select 168 items with replacement

Collect 5 samples

Olympia



Mixer Spinner Collector Add Device

experiments (1 cases)

in-index	experiment	description	sample size
1	1	Spinner ...	168

samples (5 cases)

in-index	sample	CountRain
1	1	
2	2	
3	3	
4	4	
5	5	

items (840 cases)

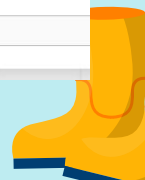
in-index	output	Olympia
1		no_rain
2		no_rain
3		no_rain
4		no_rain
5		rain
6		no_rain
7		no_rain
8		no_rain
9		rain
10		no_rain
11		no_rain
12		no_rain
13		rain
14		rain
15		no_rain
16		no_rain
17		no_rain
18		no_rain
19		no_rain
20		no_rain
21		no_rain
22		no_rain
23		no_rain
24		no_rain
25		no_rain

Attribute Name: CountRain

Formula: `count(Olympia = "rain")`

--- Insert Value --- --- Insert Function ---

Cancel Apply





v1.0.4 Sampler

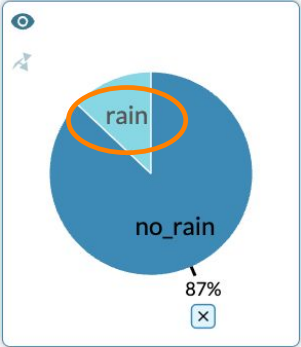
Model Measures About

START STOP Fastest CLEAR DATA

Select 168 items with replacement

Collect 5 samples

Olympia



sample 1

Mixer Spinner Collector

Add Device

Sampler Data

experiments (1 cases)				samples (5 cases)			items (840 cases)		
in-index	experiment	description	sample size	in-index	sample	CountRain	in-index	output	Olympia
1		1 Spinner ...	168	1	1		1		no_rain
				2	2		2		no_rain
				3	3		3		no_rain
				4	4		4		no_rain
				5	5		5		rain
							6		no_rain
							7		no_rain
							8		no_rain
							9		rain
							10		no_rain
							11		no_rain
							12		no_rain
							13		rain
							14		rain
							15		no_rain
							16		no_rain
							17		no_rain
							18		no_rain
							19		no_rain
							20		no_rain
							21		no_rain
							22		no_rain
							23		no_rain
							24		no_rain
							25		no_rain

Attribute Name: CountRain

Formula: `count(Olympia = "rain")`

Cancel Apply

samples

Click here, or drag an attribute here.

16

18

20

22

24

26

28

30

32

34

CountRain





v1.0.4 Sampler

Model Measures About

START STOP  Fastest CLEAR DATA

Select 168 items with replacement

Collect 5 samples

in- dex exper- ment

Delete all the sampled items from the dataset





v1.0.4 Sampler

Model Measures About

START STOP  Fastest CLEAR DATA

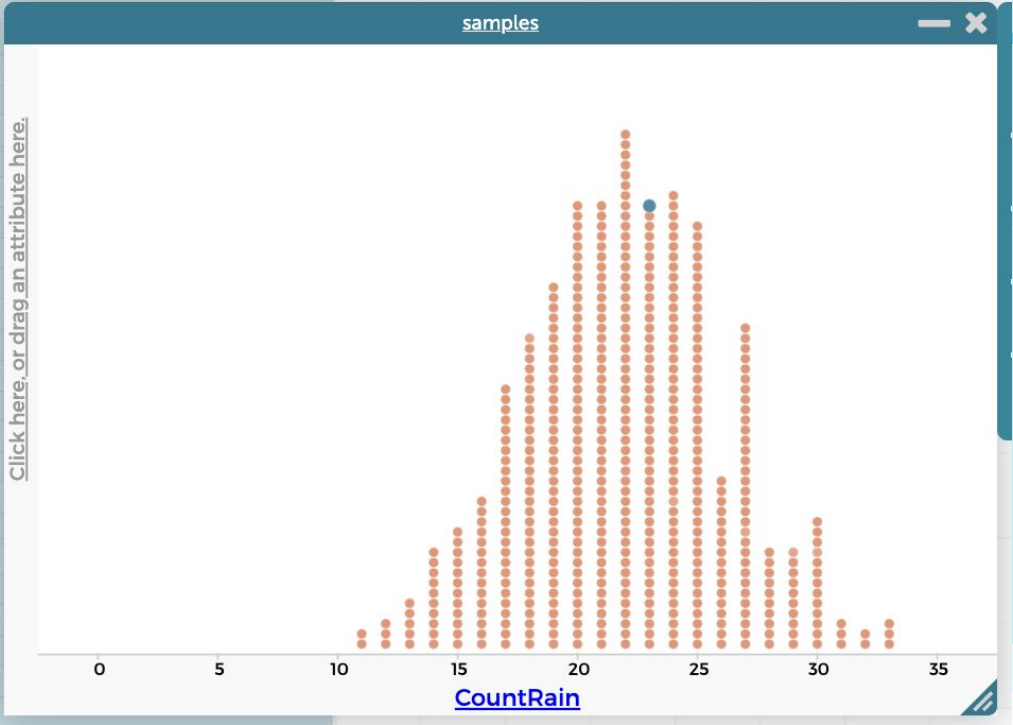
Select ▼ 168 items with replacement ▼

Collect 500 samples





samples (500 cases)			items (84000 cases)	
in-index	sample	CountRain	in-index	Olympia
477	477	26	145	no_rain
478	478	29	146	no_rain
479	479	15	147	no_rain
480	480	16	148	no_rain
481	481	17	149	no_rain
482	482	23	150	no_rain
483	483	27	151	no_rain
484	484	18	152	rain
485	485	25	153	rain
486	486	16	154	no_rain
487	487	22	155	no_rain
488	488	24	156	rain
489	489	18	157	no_rain
490	490	17	158	no_rain
491	491	19	159	no_rain
492	492	16	160	no_rain
493	493	18	161	no_rain
494	494	30	162	no_rain
495	495	25	163	no_rain
496	496	17	164	no_rain
497	497	19	165	no_rain
498	498	19	166	no_rain
499	499	29	167	no_rain
500	500	23	168	no_rain



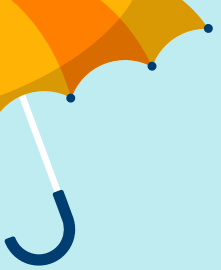
The background is a light blue color with white rain streaks falling diagonally. At the top, there are stylized white clouds. Four umbrellas are scattered around: a yellow one on the left, a purple one on the right, a purple one in the bottom left, and a rainbow one in the bottom right. In the center, there is a white water drop icon containing a yellow umbrella.

# **Evaluating Where Albert Hoffman Vacationed**

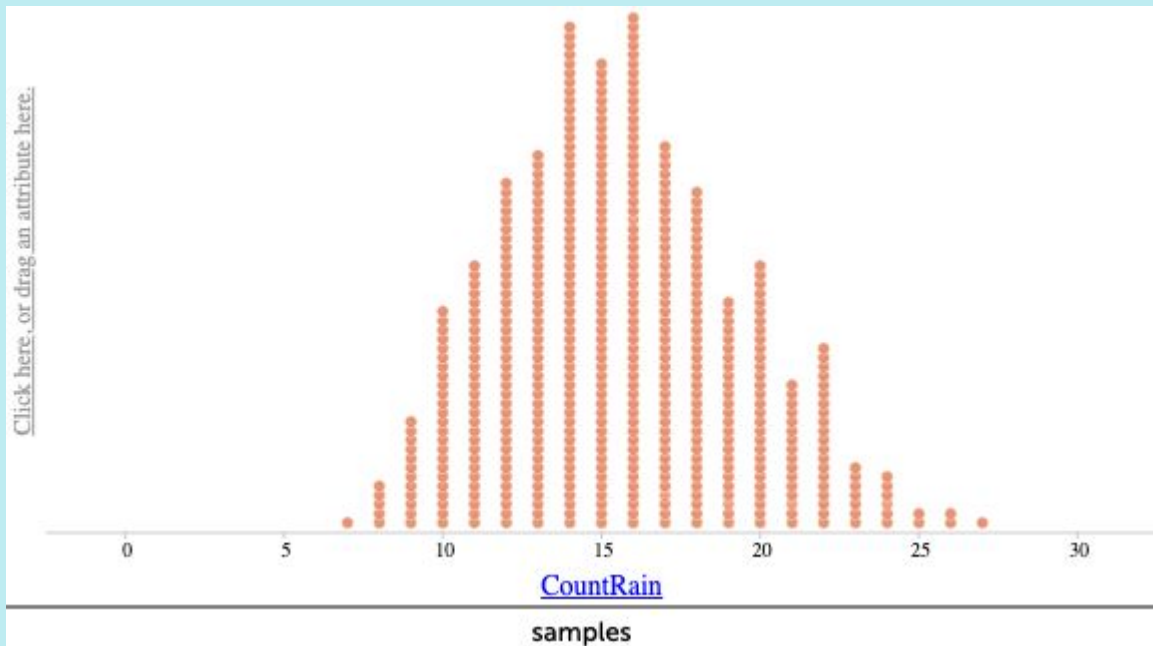


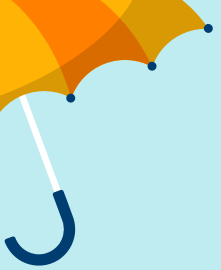
Suppose Albert Hoffman used the methodology that the Western Regional Climate Center uses to collect hourly data from his vacation. Based on this, on his vacation it rained only **15 out of the 168 hours**.



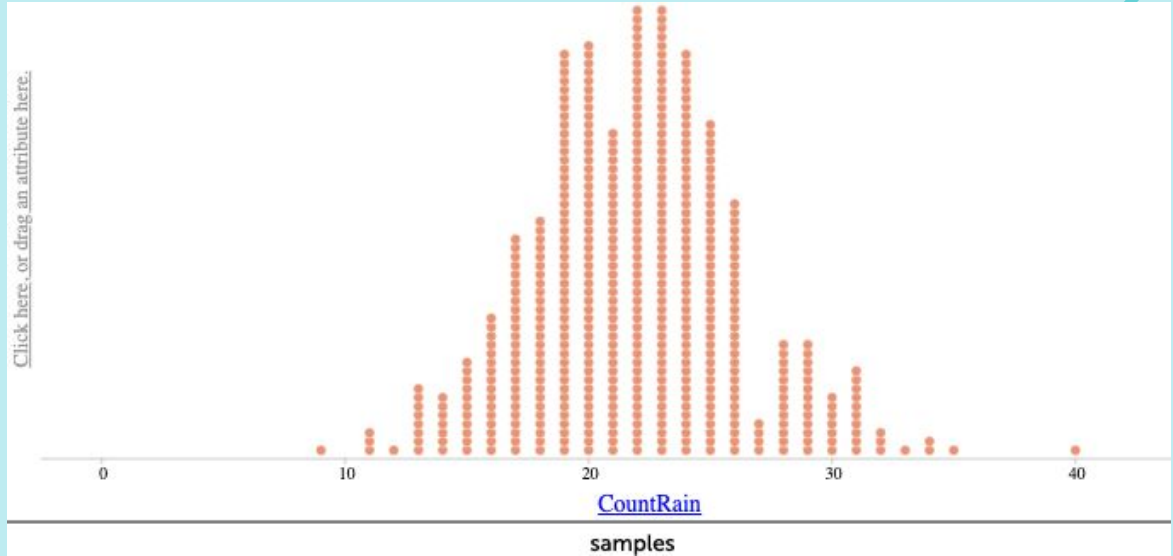


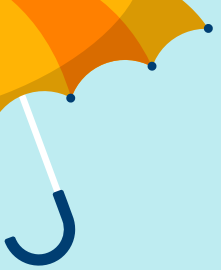
# Was Albert Hoffman vacationing in Seattle?



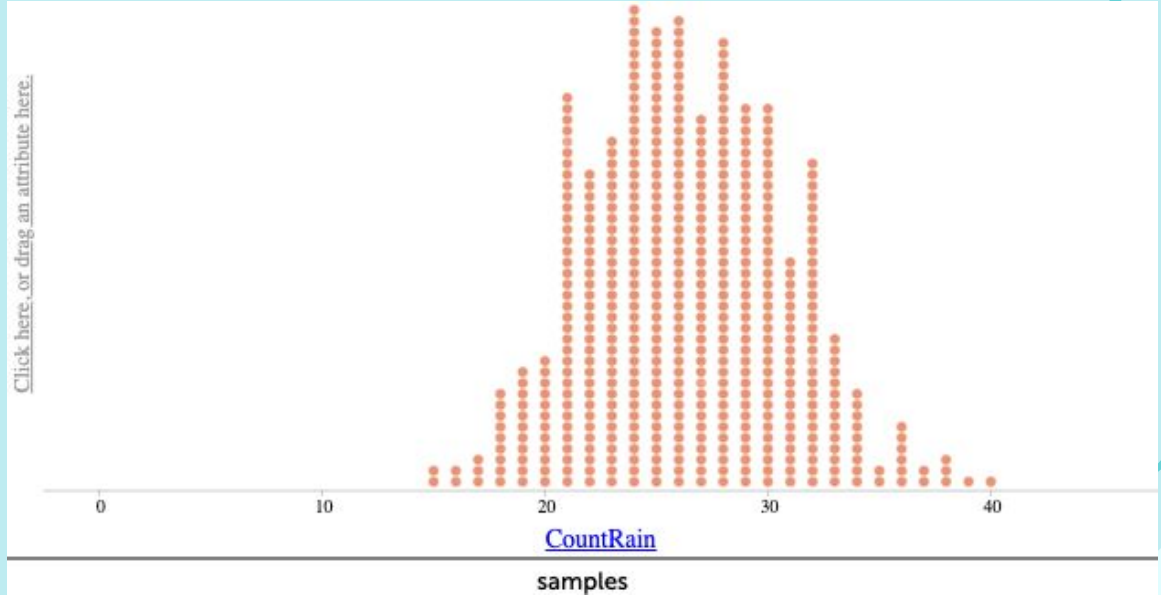


# Was Albert Hoffman vacationing in Olympia?

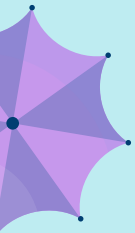




# Was Albert Hoffman vacationing in Astoria?



# Prior Knowledge?



# Prior Knowledge

Become familiar with randomness in a sampling process;

Data Analysis Strand Description: “They will learn how to organize randomness to understand important relationships and use the concept of variability to make sense of the world.”

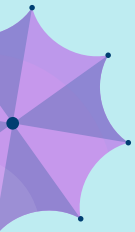
Understand the process of model-simulate-evaluate;

Informal ideas of likely values expected in simulation;

2.1.2.1: Describe the difference between possible and likely. (MP1, MP6)

Differentiate between outcomes from a single trial and results (e.g., summaries) collected from multiple trials

**Extensions?**



# Extensions

Describing distributions (shape, center, variation in context);

9.1.1.9 Use statistics appropriate to the shape of the data distribution to compare the center and spread of two or more data sets

Mean/SD  $\rightarrow$  Expected Value/SE;

9.1.2.4: Calculate experimental probabilities by repeatedly performing simulations or experiments involving a probability model and by using relative frequencies of outcomes. Recognize that as the number of trials increases, the closer the experimental probability approaches the theoretical probability.

Empirical rule (68%–95%–99%);

2 x SE to determine range of likely values;

Transition to  $p$ -value as an evaluation tool

# Thank You!



If you're interested in keeping up with our work, check out  
our website: <https://laser-umn.github.io/>