Is It Rare?

ID: 9095

Time required
45 minutes

Activity Overview

In this activity, students use the Poisson distribution to determine the probabilities for various numbers of hurricanes hitting the United States in a given year. Students will also explore the graph of the Poisson distribution and how it behaves.

Topic: Discrete Random Variables

- *For cases involving n Bernoulli trials, determine when the Poisson distribution function is appropriate and use it to estimate the probability of exactly k successes.*
- *Derive the formula for the Poisson distribution function as the limiting case of the binomial distribution function when the number of trials is large and the mean value of the binomial distribution ≤ 10.*

Teacher Preparation and Notes

- *The Poisson distribution is most commonly used to model the number of random occurrences of some phenomenon in a specified unit of space or time.*
- *The Poisson distribution is defined by the equation* $P(m, x)=\frac{m^x e^{-m}}{x!}$ *where x represents the number of occurrences of the event, m is the average number of occurrences in the specified interval, and e is the base of the natural logarithm (approximately 2.718).*
- *Hurricane data can be found on the National Weather Service website, www.nhc.noaa.gov/pastall.shtml.*
- *Notes for using the TI-Nspire™ Navigator™ System are included throughout the activity. The use of the Navigator System is not necessary for completion of this activity.*
- ***To download the student TI-Nspire document (.tns file) and student worksheet, go to education.ti.com/exchange and enter "9095" in the keyword search box.***

Associated Materials

- *IsItRare_Student.doc*
- *IsItRare.tns*

Suggested Related Activities

To download any activity listed, go to education.ti.com/exchange and enter the number in the keyword search box.

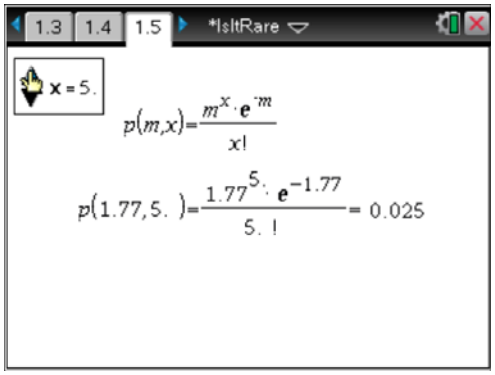
- *Numb3rs – Season 2 – "The O.G." – Is It Really Rare? (TI-84 Plus family) — 6446*
- *How many? (Stats) (TI-Nspire technology) — 8982*
- *How many? (Stats) (TI-84 Plus family) —— 8981*

The 11 hurricanes hitting the United States in 1995 was one for the record books. To compute the probability of this happening, a Poisson Distribution is used because the hurricanes are independent of each other and are historically rare (happen less than two times a year for the United States.)

Poisson distributions are useful for finding the probability that a rare event happens at a constant rate over time – that is, finding the probability of an event that typically has occurred a small number times over a large number of trials (like the number of hurricanes per year.) The distribution is a "reasonable probability distribution" for infrequent events that have occurred in the past an average of *m* times in a given time period.

Problem 1 – Using the Poisson Distribution

Students will click on the arrows to find the probability that *x* number of hurricanes occurred in the United States.

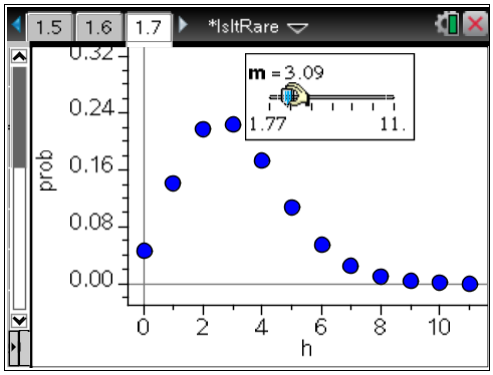


TI-Nspire Navigator Opportunity: *Quick Poll*

See Note 1 at the end of this lesson.

Problem 2 – Exploring the graph of the Poisson Distribution

As the students change the *m*-value (the average number of hurricanes per year) from 1.77 to 11 by dragging the slider. Students should see that the number of hurricanes occurring with the highest probability is approximately the same of the average number of hurricanes.



TI-Nspire Navigator Opportunity: *Quick Poll*

See Note 2 at the end of this lesson.

Solutions – Student Worksheet

1. P(1.77, 0) = 0.1703, P(1.77, 1) = 0.3015
P(1.77, 2) = 0.2668, P(1.77, 3) = 0.1574
P(1.77, 4) = 0.0697, P(1.77, 5) = 0.0247
P(1.77, 6) = 0.0073, P(1.77, 7) = 0.0018
P(1.77, 8) = 0.00041, P(1.77, 9) = 0.00008
P(1.77,10) = 0.000014, P(1.77, 11) = 0.0000023

2. One hurricane per year has the greatest probability of occurring because the average number of hurricanes per year is 1.77.

3 **a.** 0.738

b. 0.261

c. they are complementary

Solutions – Exercises:

1. P(9, 0) = 0.0001, P(9, 1) = 0.001, P(9, 2) = 0.005 , P(9, 3) = 0.015 , P(9, 4) = 0.034 , P(9, 5) = 0.061 , P(9, 6) = 0.091 , P(9, 7) = 0.117 , P(9, 8) = 0.132 , P(9, 9) = 0.132 , P(9, 10) = 0.119

2. 15

3. 0.884

TI-Nspire Navigator Opportunities

Note 1

Problem 1, *Quick Poll*

Consider sending a *Quick Poll* asking students “Which numbers of hurricanes have the highest probability of occurring?” Then use the results to have a class discussion as to why that is.

Note 2

Problem 2, *Quick Poll*

Consider sending a *Quick Poll* asking students “What changes they observe in the graph as the *m*-value is changed.