National Aeronautics and Space Administration

LAUNCH INTO MATH

Exercise 3: Medians and Interquartile Ranges

Space radiation (energy that is emitted in the form of rays, electromagnetic waves, and/or energetic particles) is a pretty big deal. Overexposure to radiation can increase the risk of diseases like cancer. In order to study radiation levels in deep space, NASA is sending Helga and Zohar, two radiation-detecting phantoms, or stand-ins for humans, on the Artemis I mission. In the exercise below, discover how space radiation relates to solar activity data.

Feel free to use a calculator for these exercises... unless you really, really love long multiplication and division.

The Radiation Situation

Space meteorologists monitor radiation from the Sun to ensure safety on all of NASA's missions. The Sun's activity increases and decreases in an 11-year solar cycle. One way to track this cycle is to count sunspots. Sunspots are areas on the Sun's surface with particularly strong magnetic fields where energy can be stored. When sunspots interact with each other, there can be an explosion of this energy! During these explosions, called solar flares, the Sun emits energetic particles into space.

Solar Cycle 24

As a budding space meteorologist, you are studying the 24th recorded solar cycle, which began in December 2008 and ended in December 2019. The data set below shows the number of sunspots observed during each June in the 11-year cycle.

Problem 1: What is the median (second quartile) of the Solar Cycle 24 data set?

Problem 2: What are the first and third quartiles of the Solar Cycle 24 data set?

Problem 3: What is the interquartile range (IQR) of the data set? (The IQR measures the middle 50% of the data.)

Solar Cycle 24: June data

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
# of sunspots	6.3	18.8	56.1	92.0	76.7	102.9	66.5	20.5	19.2	15.6	1.2

The first quartile (Q_1), is the median of all the numbers to the left of the second quantrile (Q_2). The third quartile (Q_3), is the median of the numbers to the right of Q_2. Subtact Q_1 from Q_3, and you've got the IQR!

Meet the Artemis Team

Kristen Brown is the deputy project manager for HERMES, a collection of instruments designed to monitor solar activity from lunar orbit. Read more about the Kristen's work and the HERMES mission *here*.

Additional Resources

Houston We Have a Podcast episode: Hazard 1: Radiation
Purposeful Passenger: Artemis I Manikin Helps Prepare for Moon Missions with Crew
Hazards to Deep Space Astronauts Lessons

Solutions to Exercise 3: Medians and Interquartile Ranges

Solar Cycle 24

Problem 1: Find the median of the Solar Cycle 24 data set.

Solution: To determine the median, or second quartile, we first sort the data from smallest to largest:

1.2, 6.3, 15.6, 18.8, 19.2, 20.5, 56.1, 66.5, 76.7, 92.0, 102.9

The median is the middle number in the sorted data:

~~1.2~~, ~~6.3~~, ~~15.6~~, ~~18.8~~, ~~19.2~~, **20.5**, ~~56.1~~, ~~66.5~~, ~~76.7~~, ~~92.0~~, ~~102.9~~

Final solution: The median is 20.5.

Problem 2: Find the first and third quartiles of the Solar Cycle 24 data set.

Solution: We already know that the second quartile, or Q_2, of the Solar Cycle 24 data set is 20.5. We determine the first quartile, or Q_1, by finding the median of all the values to the left of Q_2:

~~1.2~~, ~~6.3~~, **15.6**, ~~18.8~~, ~~19.2~~, |**20.5**| 56.1, 66.5, 76.7, 92.0, 102.9

To determine the third quartile, or Q_3, find the median of all the values to the right of Q_2:

1.2, 6.3, 15.6, 18.8, 19.2, |**20.5**| ~~56.1~~, ~~66.5~~, **76.7**, ~~92.0~~, ~~102.9~~

Final solution: The first quartile is 15.6 and the third quartile is 76.7.

Problem 3: Calculate the interquartile range (IQR) of the Solar Cycle 24 data set.

Solution: Now that we have Q_1 and Q_3, we calculate the IQR:

$$IQR = Q_3 - Q_1 = 76.7 - 15.6 = 61.1$$

Final solution: The interquartile range for the Solar Cycle 24 set is 61.1. This means that the amount of spread in the middle half of the data set is 61.1 sunspots.