

Center, Spread and Data Displays Compared

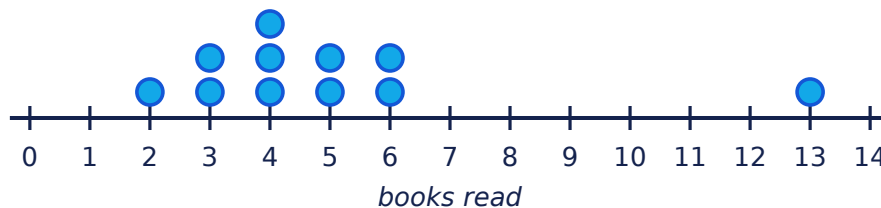
Grade 9 – Algebra 1 math · Lesson · Standards: S-ID.A.1, S-ID.A.2, S-ID.A.3

Quick answer: Dot plots, histograms and box plots show the shape of a data set. The mean and median measure center, while the interquartile range and standard deviation measure spread. Outliers pull the mean and standard deviation but barely move the median and IQR, so skewed data are best described with the median and IQR.

Standards: S-ID.A.1, S-ID.A.2, S-ID.A.3 · **Level:** Grade 9 Algebra 1

How do dot plots, histograms and box plots display data?

A dot plot stacks one dot per value above a number line, which suits small data sets. A histogram groups values into equal-width bins and shows counts as bars. A box plot shows five numbers: minimum, first quartile (Q1), median, third quartile (Q3) and maximum.



Books read by 11 students. The dot at 13 is far from the rest.

Center and spread

- **Mean:** the sum divided by the number of values.
- **Median:** the middle value of the sorted data.
- **Interquartile range (IQR):** $Q3 - Q1$, the width of the middle half of the data.
- **Standard deviation:** a typical distance of the values from the mean. A larger value means more spread.

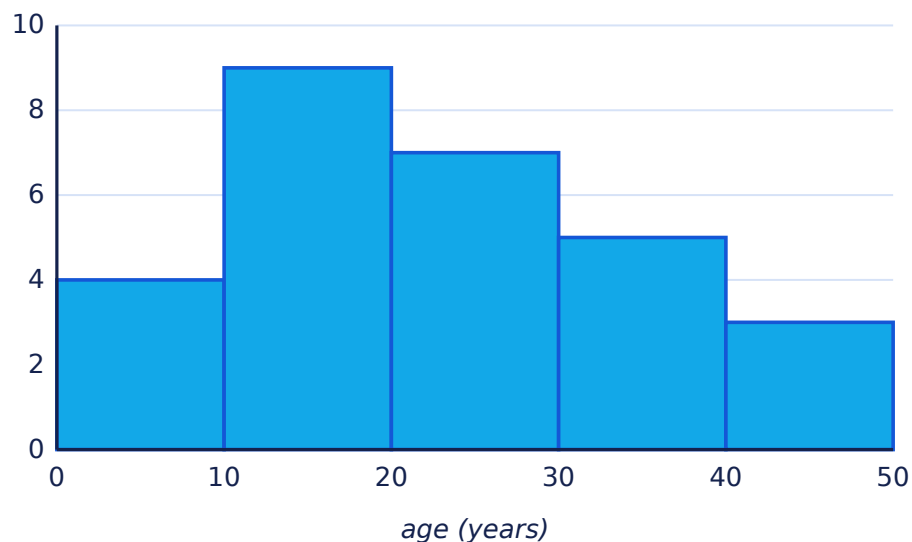
How do you find the five-number summary?

Method

1. Sort the data from least to greatest.
2. Find the median. It splits the data into a lower and an upper half (leave the median out of both halves when there is an odd number of values).
3. Q1 is the median of the lower half and Q3 is the median of the upper half.
4. Report the minimum, Q1, median, Q3 and maximum.

Worked example

The data 2, 3, 3, 4, 4, 4, 5, 5, 6, 6, 13 have median 4, $Q1 = 3$ and $Q3 = 6$. So $IQR = 6 - 3 = 3$.



Ages of 28 fair visitors. The tallest bar is 10 to 20.

What do outliers do to the center and the spread?

A common rule calls a value an outlier if it is more than $1.5 \times IQR$ below $Q1$ or above $Q3$. Here $Q3 + 1.5 \times 3 = 10.5$, so 13 is an outlier. With 13 the mean is 5; without it the mean drops to 4.2, but the median stays 4.

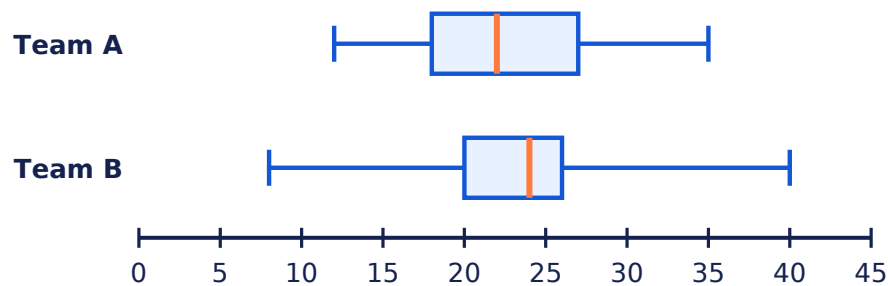
Choosing a summary

Roughly symmetric data: use the mean and the standard deviation.

Skewed data or data with outliers: use the median and the IQR, because they resist extreme values.

How do you compare two distributions?

Compare the centers (medians or means), then the spreads (IQR or standard deviation), then the shape and any outliers. Always answer in context, such as "Team B scores more points in a typical game and is more consistent."



Team B has the higher median and the narrower box.

Common mistake

Reading the length of a box plot as the number of data values. Each quarter of the data lies in each part, whatever its length.

Mathbot's tip

If the mean is far from the median, look for a skew or an outlier before trusting the mean.

Key points to remember

- Five-number summary: minimum, Q1, median, Q3, maximum.
- $IQR = Q3 - Q1$, and an outlier lies more than $1.5 \times IQR$ beyond a quartile.
- A larger standard deviation means the values are more spread out.
- Outliers change the mean far more than the median.
- Compare distributions by center, spread, shape and outliers, in context.

Center, Spread and Data Displays Compared: frequently asked questions

What is the difference between the mean and the median?

The mean is the sum divided by the count, so every value affects it. The median is the middle value of the sorted list, so extreme values barely affect it.

How do you find the interquartile range?

Find Q1, the median of the lower half, and Q3, the median of the upper half. Subtract: $IQR = Q3 - Q1$. It measures the spread of the middle half of the data.

What does standard deviation tell you?

It describes how far values typically lie from the mean. A small standard deviation means the values cluster near the mean, and a large one means they are spread out.

How do you decide if a value is an outlier?

Compute $1.5 \times \text{IQR}$. A value below $Q1$ minus that amount or above $Q3$ plus that amount is an outlier. It is far enough from the rest to deserve a closer look.

Which measures should you use for skewed data?

Use the median and the IQR, because a long tail or an outlier drags the mean and standard deviation toward the extreme values.