Descriptive Statistics

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Why describe data?

- Determine if our sample reflects the population of interest.
- Identify outliers.
- Obtain metrics necessary for inferential tests.
- Understand the distribution of our data values – test for normality.
- Identify the type of statistical test to run.

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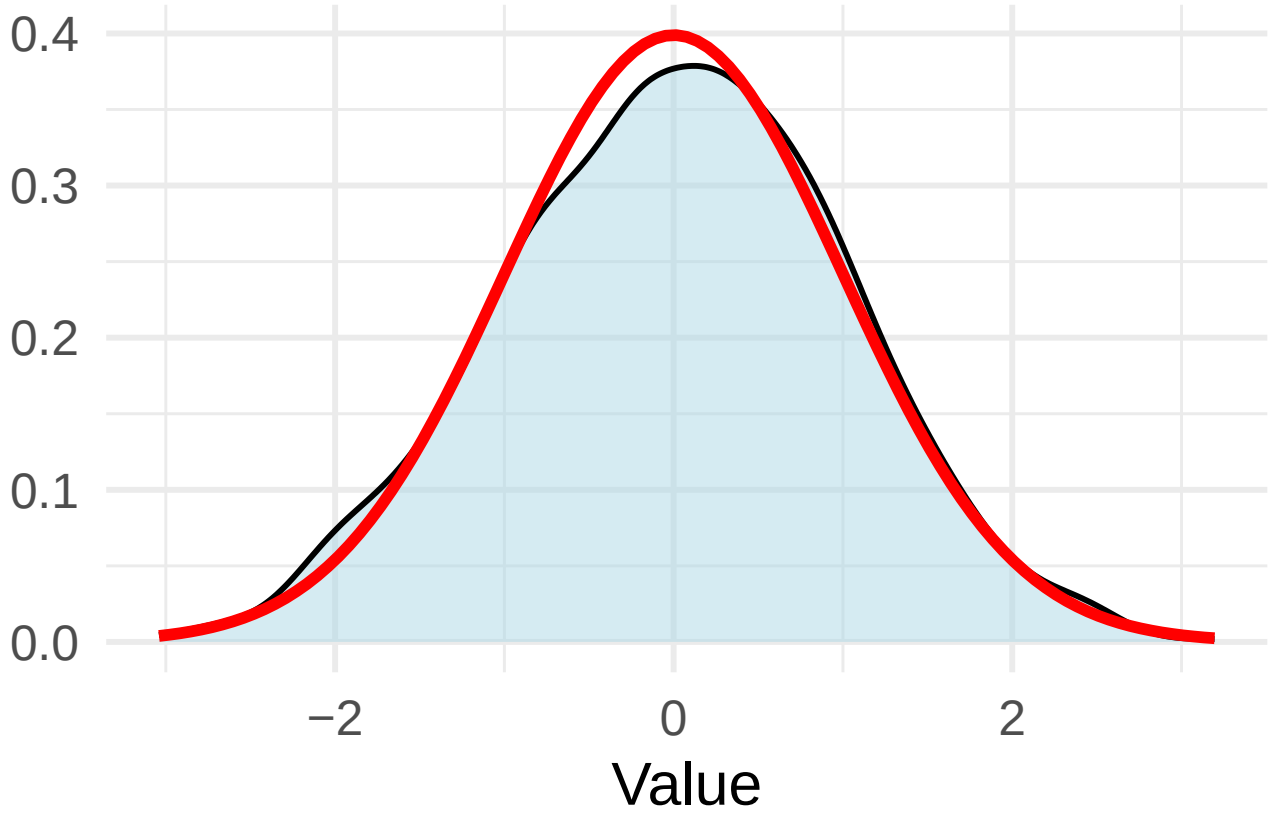
Data description and visualization

- We can examine our data and run statistical tests to see if the distribution approximates a normal curve.
- Typically, we start by visualizing our data.



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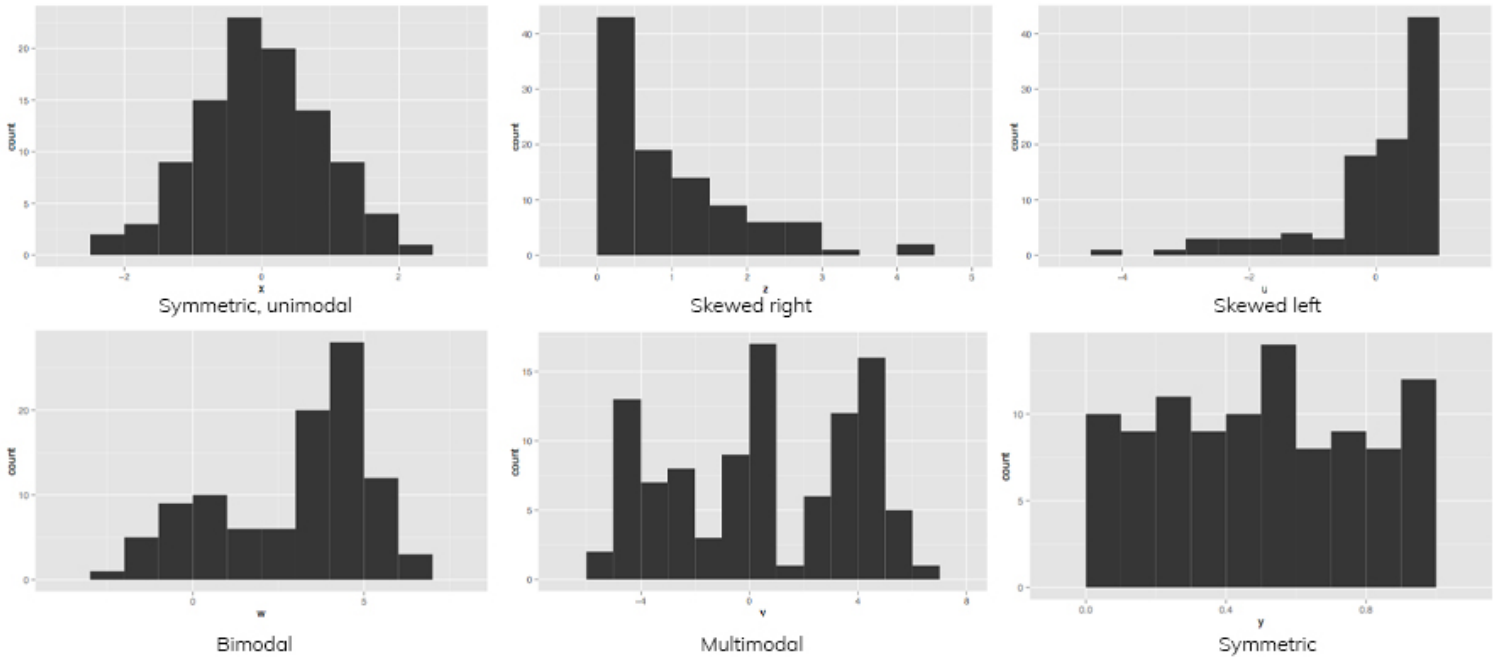
Histogram basic

- Continuous data are most commonly visualized using Histograms.



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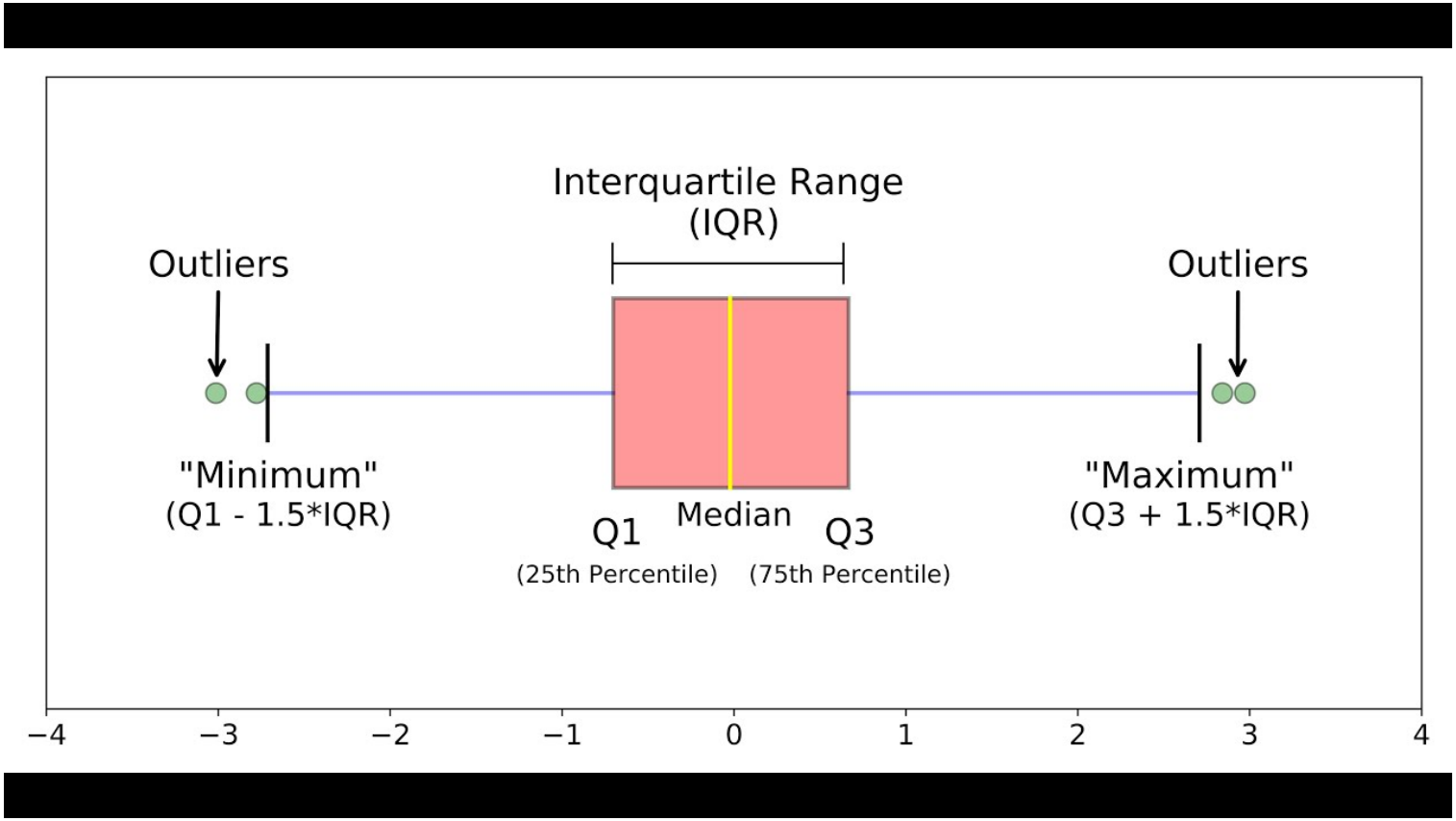
Box and Whisker Basics



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Metrics to Describe data distribution.

- Data and their associated distributions can be described in four primary way:
  - Central Tendency (mean, median, mode)
  - Variability (standard deviation, variance, quantiles)
  - Skew
  - Kurtosis (Peakedness)

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Central tendency

- Mean (Sum of scores/N)
  - Most often used measure of central tendency.
  - Works well with normal and relatively normal curves.
- Median (50th Percentile)
  - No formula. Rank order observations then find the middle.
  - The second most used measure of central tendency.
  - Works best with highly skewed populations.
- Mode (Most Frequent Score)
  - Least used measure of central tendency.
  - Works best for highly irregular and multimodal distributions.

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Central tendency: Mean

- Sample mean is the measure of central tendency that best represents the population mean.
- Mean is **very** sensitive to extreme scores that can "skew" or distort findings.

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Central tendency: Meadian

- Percentiles are used to define the percent of cases equal to and below a certain point on a distribution.
  - The median **is the 50th percentile** half of all observations fall at or below this value.
- But lots of other percentiles are also important.

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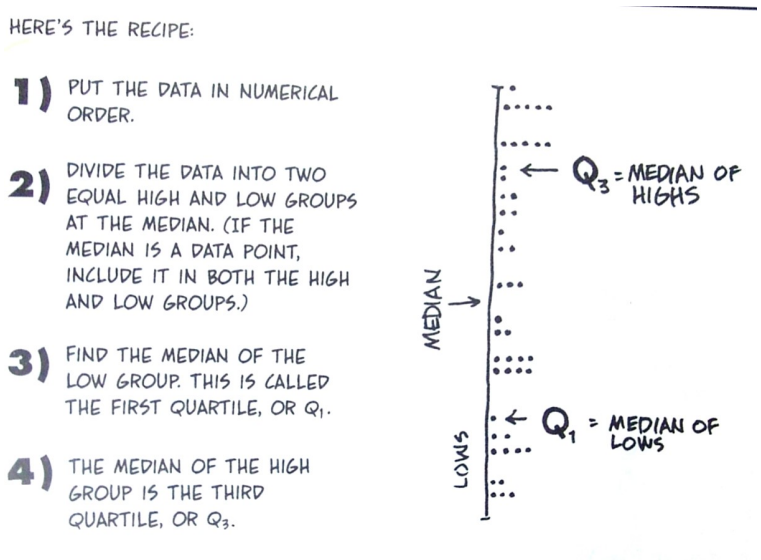
A little about Percentiles

- Quartiles are a common percentile used to represent the value below which.
  - 25% (Q1 or first quartile)
  - 75% (Q3 or third quartile)



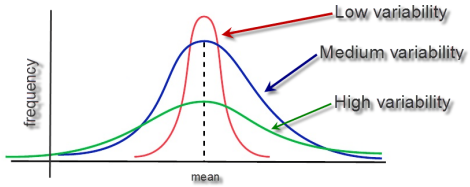
When to use What

- Use the **Mode** when the data are categorical:
  - **Mode**: is the value that occurs most frequently in your data.
  - This is because having the same value occur for measurements with many significant digits is highly unlikely.

- Use the **Median** when you have extreme scores:
  - **Median**: is simply the value that falls in the middle of all your data.

- Use the **Mean** the rest of the time.

Variability



Variability: Standard Deviation

- Standard Deviation measures how spread out the numbers in a dataset are around the mean.
- The sample standard deviation s is calculated as:

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

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Variability

- **Variance** measures the average of the squared differences from the mean, indicating how spread out the data points are.
- The variance σ^2 is calculated as:

$$s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$$

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Variability: Range

- **Range** is the difference between the largest and smallest values in a dataset, providing a measure of the spread or dispersion of the data.
- The range is calculated as:

$$\text{Range} = \max(x) - \min(x)$$

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Percentiles are useful for spread too

- You can use percentiles to get a feel for how spread out the data is and where most of your observations are contained:
  - Inter-quartile range (IQR) = Q3 – Q1

Identifying outliers

- An outlier is an observation that lies outside the overall pattern of a distribution (Moore and McCabe 1999).
- Usually, the presence of an outlier indicates some sort of problem. (e.g. an error in measurement or sample selection).
- But they may also be an indicator of novel data or identification of unique and exciting observations.

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Identifying outliers

- The first and third quantiles (Q1 and Q3) are often calculated to identify outliers.
- One method for systematically identifying outliers uses:
  - Q1 - (1.5 * the inter-quartile range)
  - Q3 + (1.5 * the inter-quartile range)
- Others identify outliers as any values below the 0.5th or above the 99.5th percentile.

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When to use What

- Use the **Standard deviation (SD)** in most cases.
  - SD quantifies how far, on average, each observation is from the mean.
  - The larger the SD, the more highly variable your data.
- Use **range (R)** when describing predictive models.
  - R is simply the maximum minus the minimum value in your data set
  - R is important when modeling or making predictions, since your algorithms are valid only over the range of values used to calibrate your predictive model
- Use the **IQR** to identify and test potential outliers in your data.

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Skewness

- Skewness: This metric quantifies how balanced (symmetrical) your distribution curve is.

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