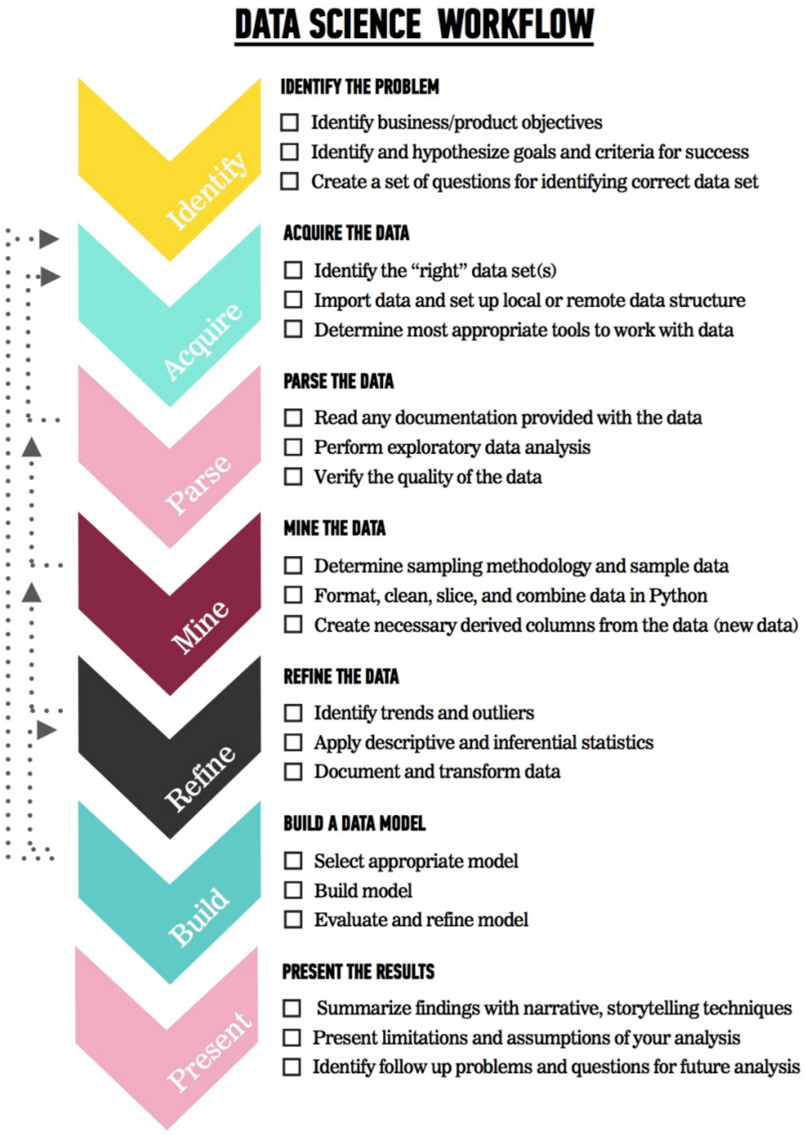
EXIT TICKETS

- better explanation needed on each syntax / function
- I am still unclear of how pandas work , in terms of the importing of database
- I would like to know how to work with unstructured data, esp with images or sound
- Why these particular formats are being used. csv, numpy etc.
- Will we need to be really proficient in Python for this course?
- Need more clarity on Git workflow
- why do programmers love mac???
- how can we go about doing "self-practice" before the next lesson? any resources to use?
- Quite unsure about the syntax on numpy and pandas. Worried I won't be up to speed enough.
- I wonder if the coding part could be done differently - slide and code on 2 different screens? cos difficult to follow where the course instructor is at.

THE DATA SCIENCE WORKFLOW

The steps:

1. Identify the problem
2. Acquire the data
3. Parse the data
4. Mine the data
5. Refine the data
6. Build a data model
7. Present the results



DATA SCIENCE WORKFLOW

IDENTIFY THE PROBLEM

☐ Identify business/product objectives
☐ Identify and hypothesize goals and criteria for success
☐ Create a set of questions for identifying correct data set

ACQUIRE THE DATA

☐ Identify the "right" data set(s)
☐ Import data and set up local or remote data structure
☐ Determine most appropriate tools to work with data

PARSE THE DATA

☐ Read any documentation provided with the data
☐ Perform exploratory data analysis
☐ Verify the quality of the data

MINE THE DATA

☐ Determine sampling methodology and sample data
☐ Format, clean, slice, and combine data in Python
☐ Create necessary derived columns from the data (new data)

REFINE THE DATA

☐ Identify trends and outliers
☐ Apply descriptive and inferential statistics
☐ Document and transform data

BUILD A DATA MODEL

☐ Select appropriate model
☐ Build model
☐ Evaluate and refine model

PRESENT THE RESULTS

☐ Summarize findings with narrative, storytelling techniques
☐ Present limitations and assumptions of your analysis
☐ Identify follow up problems and questions for future analysis

WHAT IS A GOOD QUESTION?

- Specific: The dataset and key variables are clearly defined.

- Measurable: The type of analysis and major assumptions are articulated.

- Attainable: The question you are asking is feasible for your dataset and is not likely to be biased.

- Reproducible: Another person (or future you) can read and understand exactly how your analysis is performed.

- Time-bound: You clearly state the time period and population for which this analysis will pertain.

LAB

PANDAS LAB

GENERAL ASSEMBLY

STATISTICS FUNDAMENTALS

Tan Kwan Chong

Chief Data Scientist, Booz Allen Hamilton

LEARNING OBJECTIVES

- Use NumPy and Pandas libraries to analyze datasets using basic summary statistics: mean, median, mode, max, min, quartile, inter-quartile range, variance, standard deviation, and correlation
- Create data visualizations - including: line graphs, box plots, and histograms- to discern characteristics and trends in a dataset
- Identify a normal distribution within a dataset using summary statistics and visualization
- ID variable types and complete dummy coding by hand

OPENING

STATISTICS FUNDAMENTALS

TODAY

- We’re going to begin to talk about step 3: Parsing the Data

- We’ll begin to talk about the fundamentals of Statistics

INTRODUCTION

LAYING THE GROUND WORK

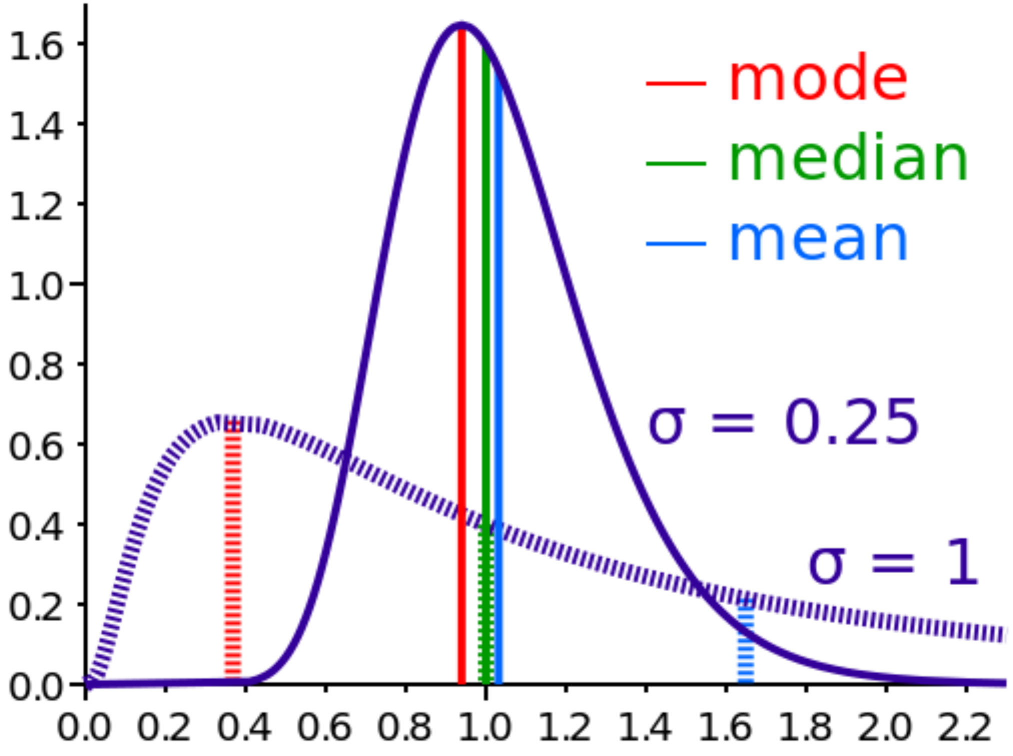
WE’RE GOING TO COVER SEVERAL TOPICS

- Mean
- Median
- Mode
- Max
- Min
- Quartile
- Interquartile Range
- Variance
- Standard Deviation
- Correlation

MEAN

- The mean of a set of values is the sum of the values divided by the number of values. It is also called the average.

$$\overline{X} = \frac{\sum X}{N}$$



MEAN EXAMPLE

- Find the mean of 19, 13, 15, 25, and 18.

MEAN EXAMPLE

- Find the mean of 19, 13, 15, 25, and 18.

$$\frac{19 + 13 + 15 + 25 + 18}{5} = \frac{90}{5} = 18$$

MEDIAN

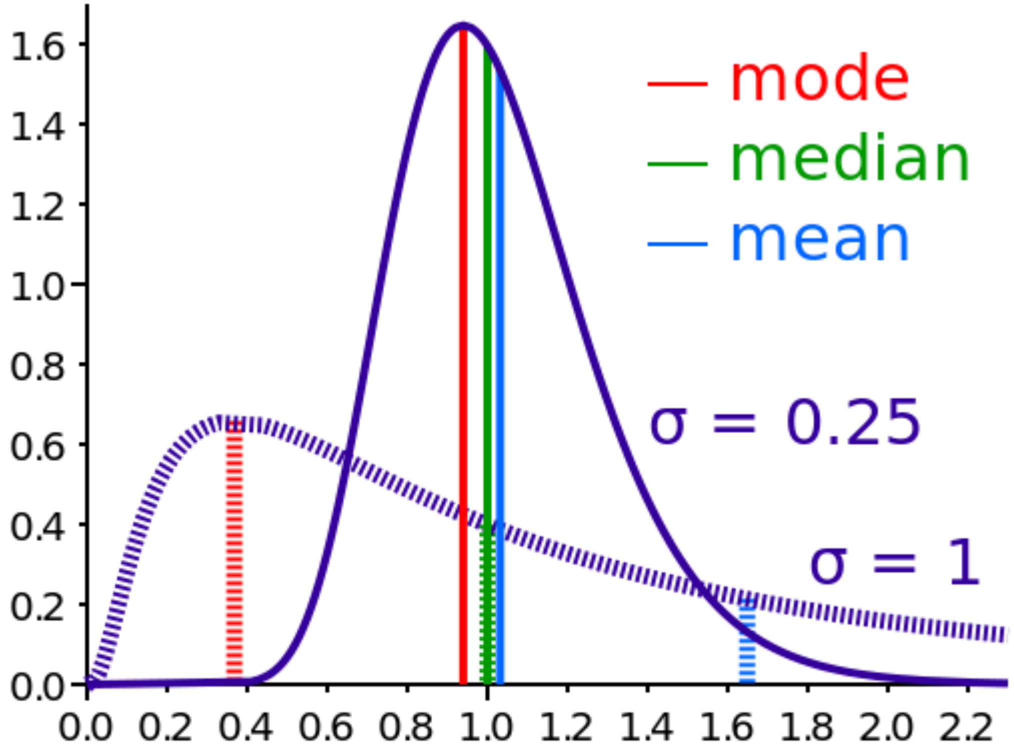
- The median refers to the midpoint in a series of numbers.

- To find the median

  - Arrange the numbers in order smallest to largest.

  - If there is an odd number of values, the middle value is the median.

  - If there is an even number of values, the average of the middle two values is the median.



MEDIAN EXAMPLE

- Find the median of 19, 29, 36, 15, and 20.

MEDIAN EXAMPLE

- Find the median of 19, 29, 36, 15, and 20.

Ordered Values:

15, 19, 20, 29, 36

20 is the median

MEDIAN EXAMPLE

- Find the median of 67, 28, 92, 37, 81, 75.

MEDIAN EXAMPLE

- Find the median of 67, 28, 92, 37, 81, 75.

Ordered Values:

28, 37, 67, 75, 81, 92

67 and 75 are the middle values.

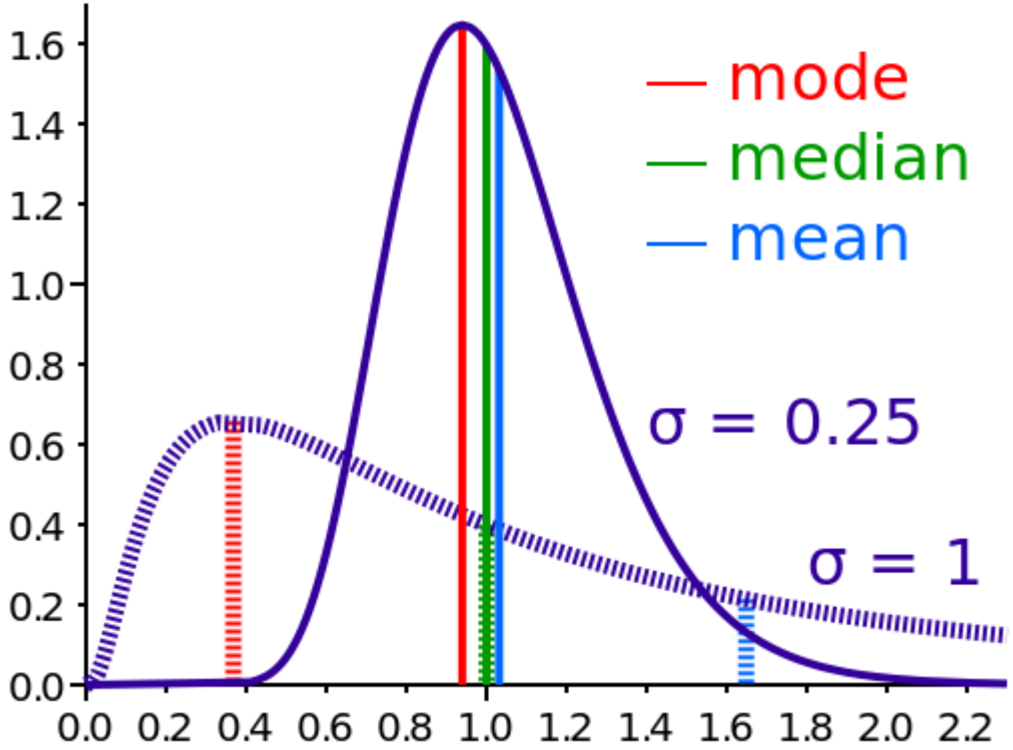
$$\frac{67 + 75}{2} = \frac{142}{2} = 71$$

71 is the median.

MODE

- The mode of a set of values is the value that occurs most often.

- A set of values may have more than one mode or no mode.

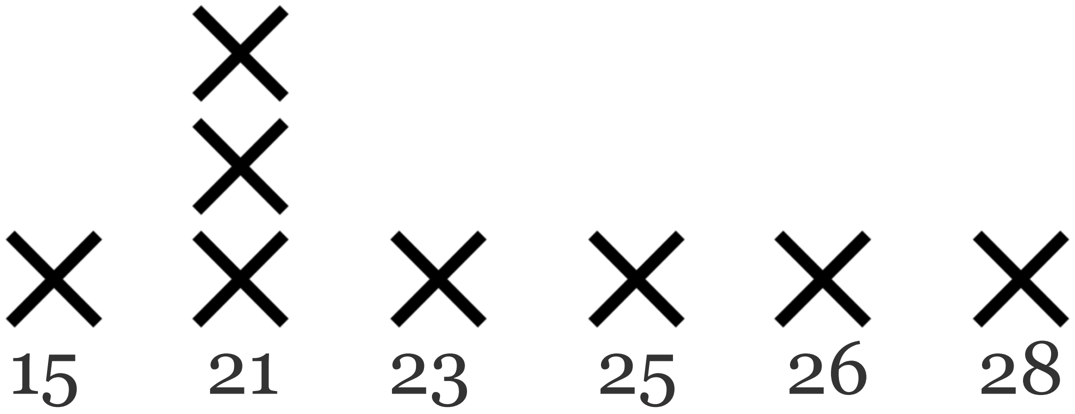


MODE EXAMPLE

- Find the mode of 15, 21, 26, 25, 21, 23, 28, and 21.

MODE EXAMPLE

- Find the mode of 15, 21, 26, 25, 21, 23, 28, and 21.



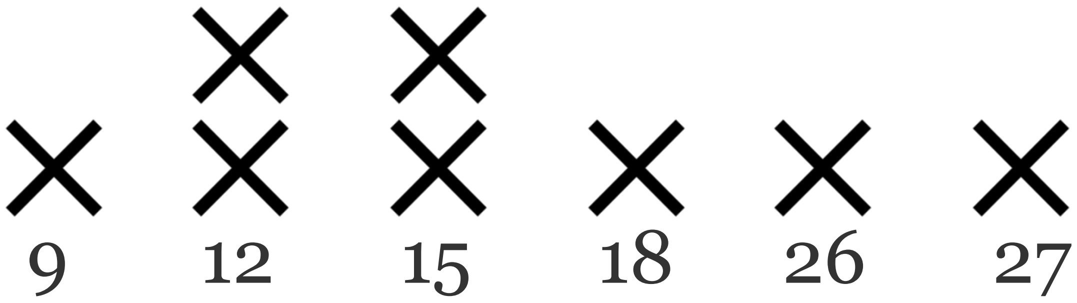
21 is the mode because it occurs most frequently

MODE EXAMPLE

- Find the mode of 12, 15, 18, 26, 15, 9, 12, and 27.

MODE EXAMPLE

- Find the mode of 12, 15, 18, 26, 15, 9, 12, and 27.



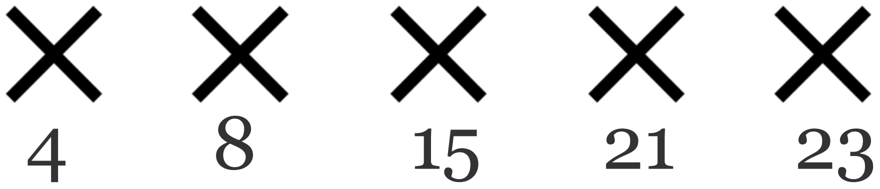
12 and 15 are the modes since the both occur twice.

MODE EXAMPLE

- Find the mode of 4, 8, 15, 21, and 23.

MODE EXAMPLE

- Find the mode of 4, 8, 15, 21, and 23.



There is no mode since all values occur the same number of times.

ACTIVITY: KNOWLEDGE CHECK

EXERCISE

ANSWER THE FOLLOWING QUESTIONS (5 minutes)

1. For the following groups of numbers, calculate the mean, median and mode by hand. Also determine the min and max.

   a. 18, 24, 17, 21, 24, 16, 29, 18

   b. 75, 87, 49, 68, 75, 84, 98, 92

   c. 55, 47, 38, 66, 56, 64, 44, 39

DELIVERABLE

Answers to the above questions

CODEALONG

SUMMARY STATISTICS IN PANDAS

CODEALONG: SUMMARY STATISTICS IN PANDAS

- Open the starter-code notebook located in lessons/lesson-03/code/ of the class repo.

CODEALONG PART 1: BASIC STATS

- We can use Pandas to calculate the mean, median, mode, min, and max.

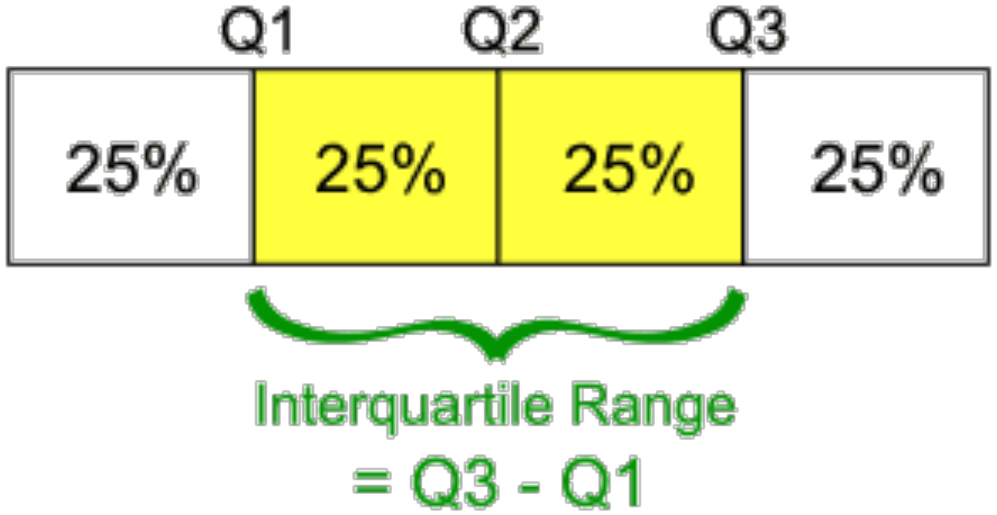
```
Methods available include:
.min() - Compute minimum value
.max() - Compute maximum value
.mean() - Compute mean value
.median() - Compute median value
.mode() - Compute mode value
.count() - Count the number of observations
```

QUARTILES AND INTERQUARTILE RANGE

- Quartiles divide a rank-ordered data set into four equal parts.

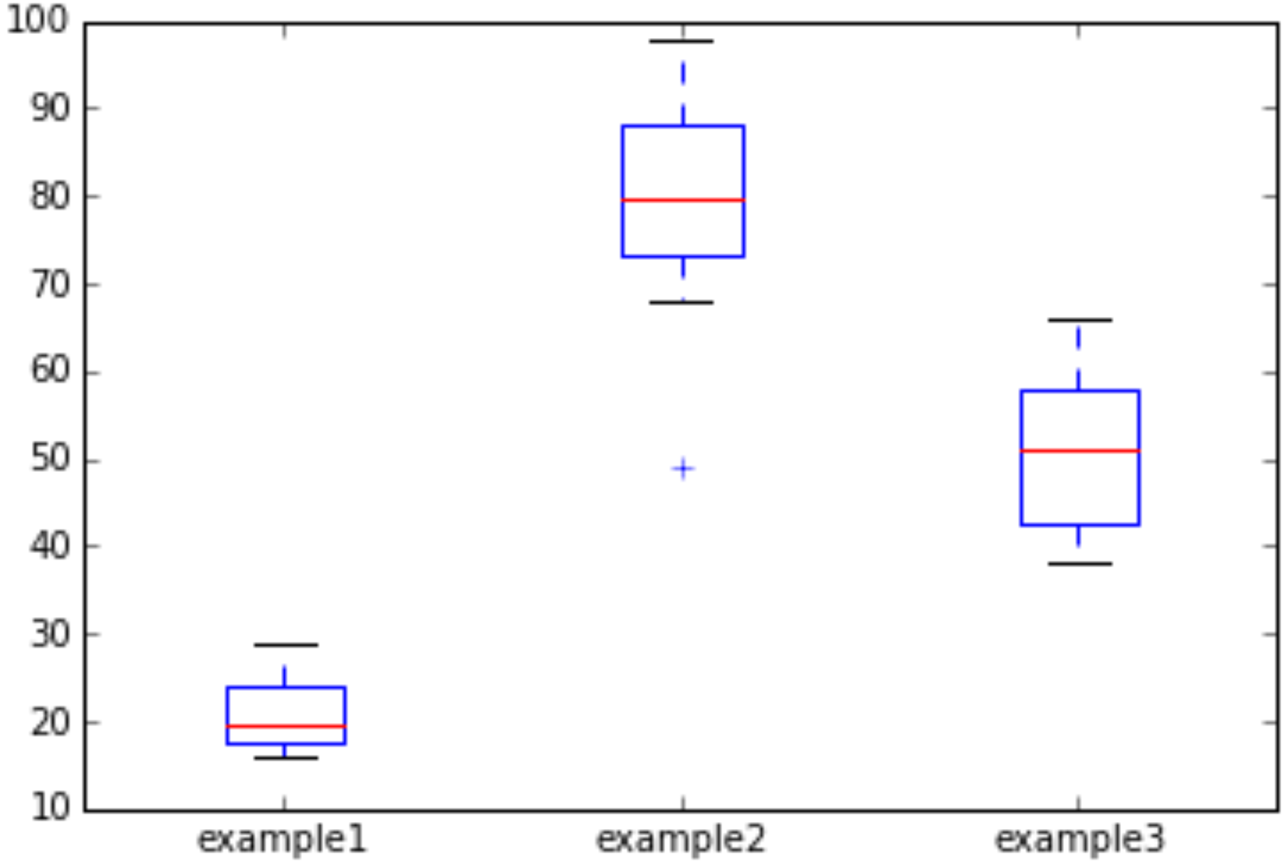
- The values that divide each part are called first, second, and third quartiles, denoted Q1, Q2, and Q3, respectively.

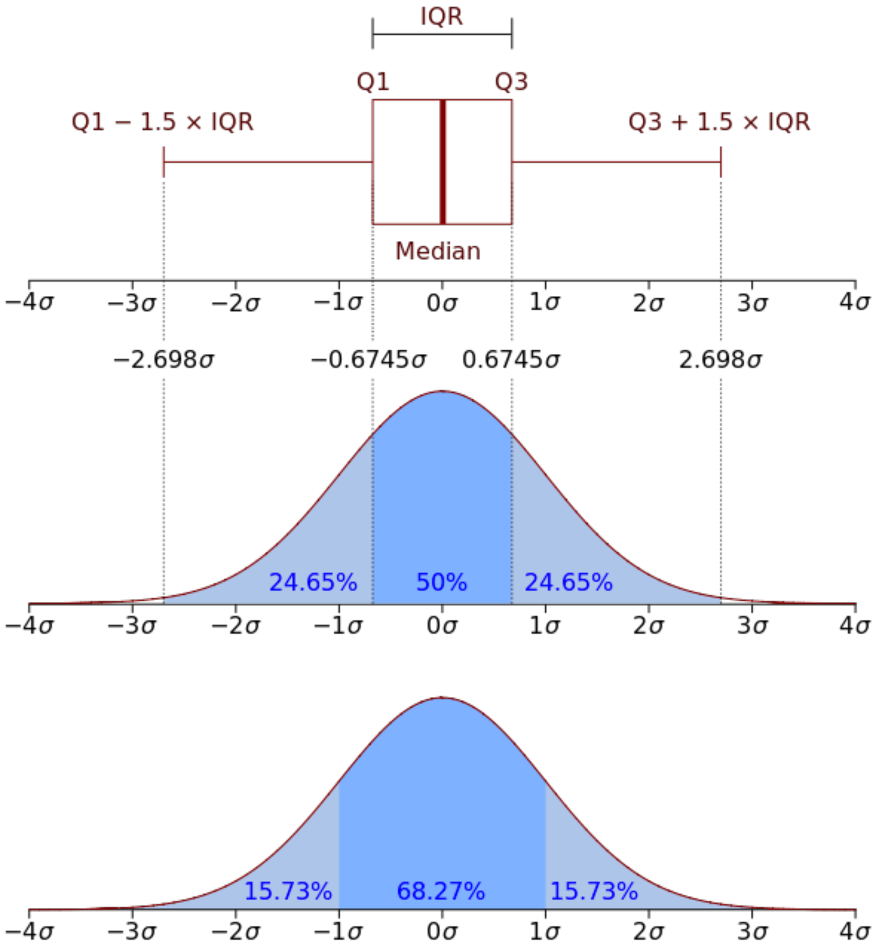
- The interquartile range (IQR) is Q3 - Q1, a measure of variability.



CODEALONG PART 2: BOX PLOT

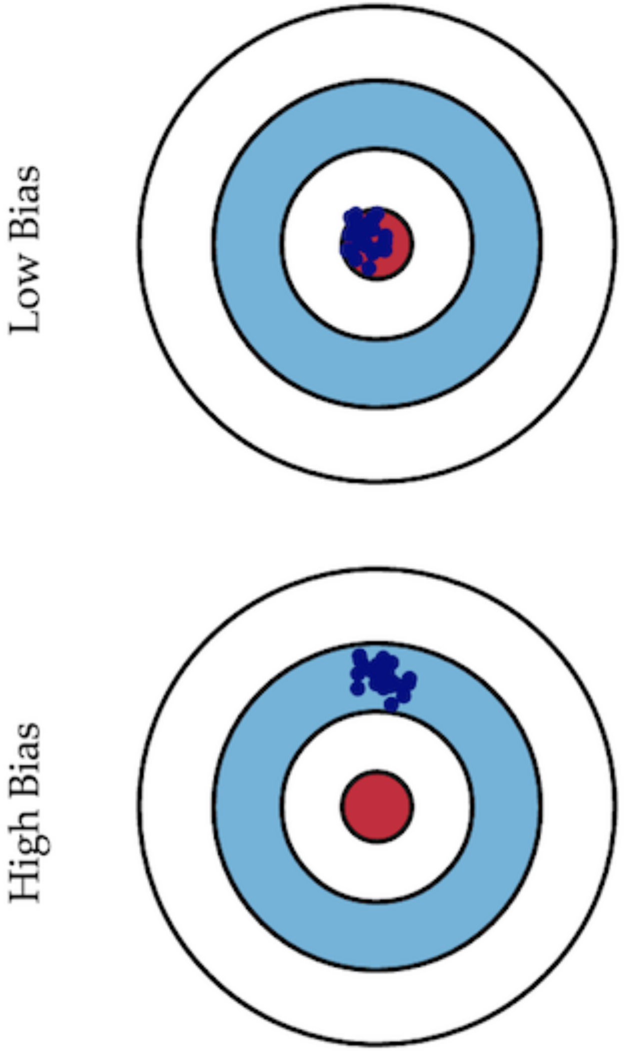
- Box plots give a nice visual of the distribution of data through their quartiles and outliers





BIAS VS. VARIANCE

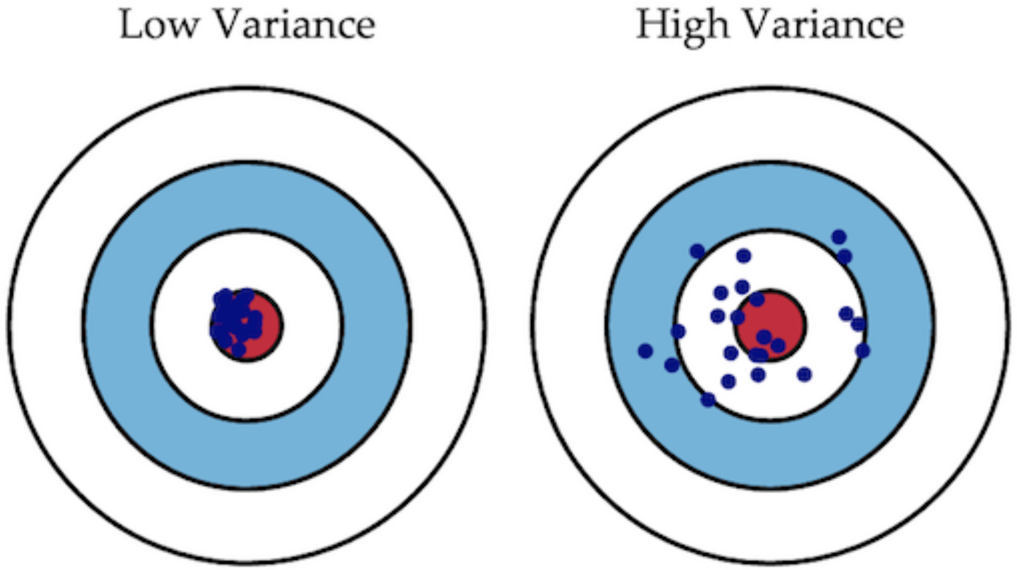
- Error due to **bias** is calculated at the difference between the *expected prediction* of our model and the *correct value* we are trying to predict.
- Imagine creating multiple models on various datasets. **Bias** measures *how far off in general* models' predictions are from the correct value.



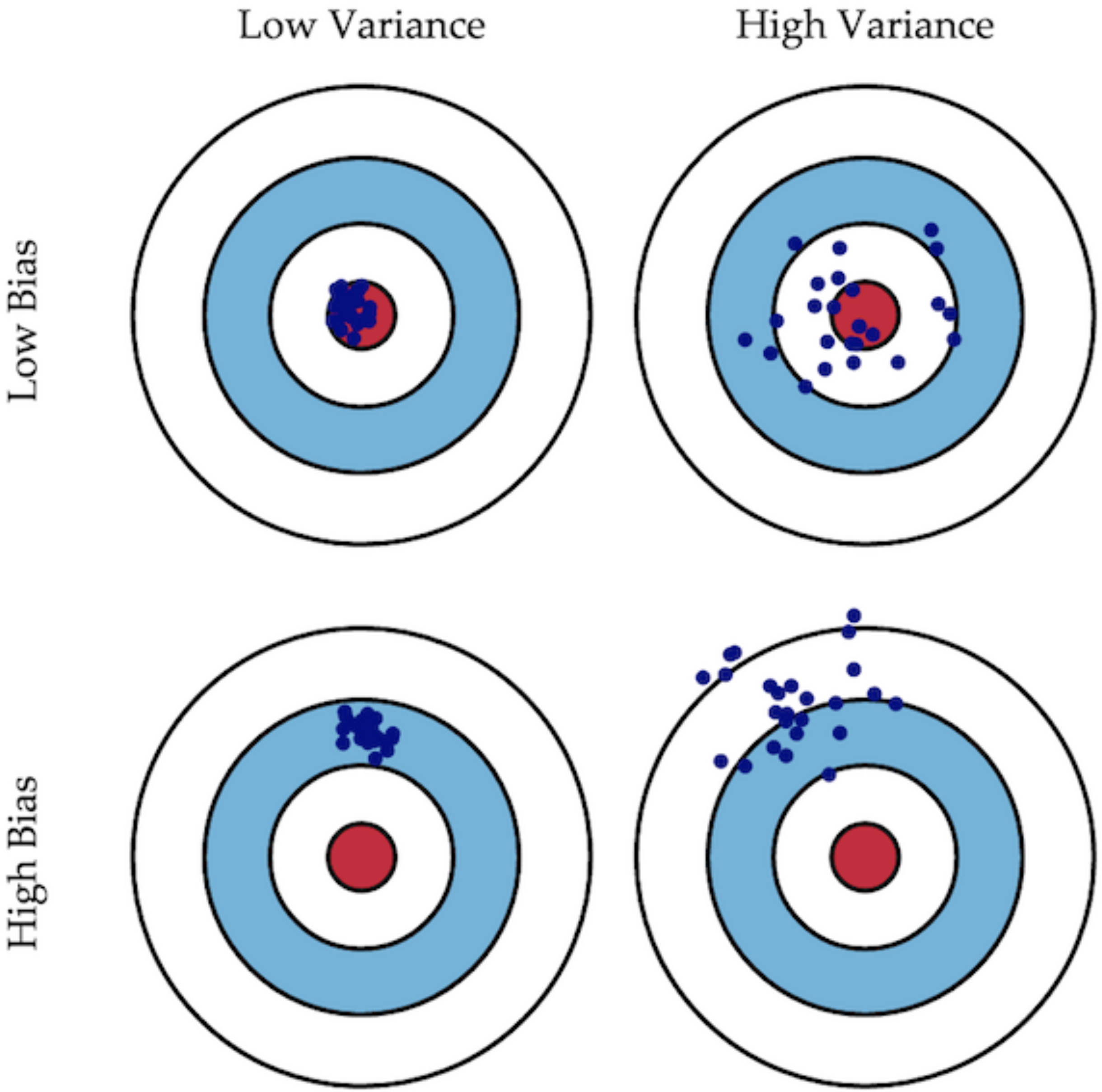
BIAS VS. VARIANCE

- Error due to **variance** is taken as the variability of a model prediction for a given point.

- Imagine creating multiple models on various datasets. The **variance** is *how much the predictions for a given point vary* between different realizations of the model.



BIAS VS. VARIANCE



STANDARD DEVIATION

- Standard deviation (SD, σ for population, s for sample) is a measure that is used to quantify the amount of variation or dispersion of a set of data values.

- Standard deviation is the square root of variance.

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

STANDARD ERROR

- The standard error of the mean (SEM) quantifies the precision of the mean.
- It is a measure of how far your sample mean is likely to be from the true population mean.
- It generally increases with the size of an estimate, meaning a large standard error may not indicate the estimate of the mean is unreliable.
- It's often better to compare the error in relation to the size of the estimate.

$$SE_{\bar{x}} = \frac{s}{\sqrt{n}}$$

DEMO

CENTRAL LIMIT THEOREM

CODEALONG PART 3: STANDARD DEVIATION & VARIANCE

- You can calculate variance and standard deviation easily in Pandas.

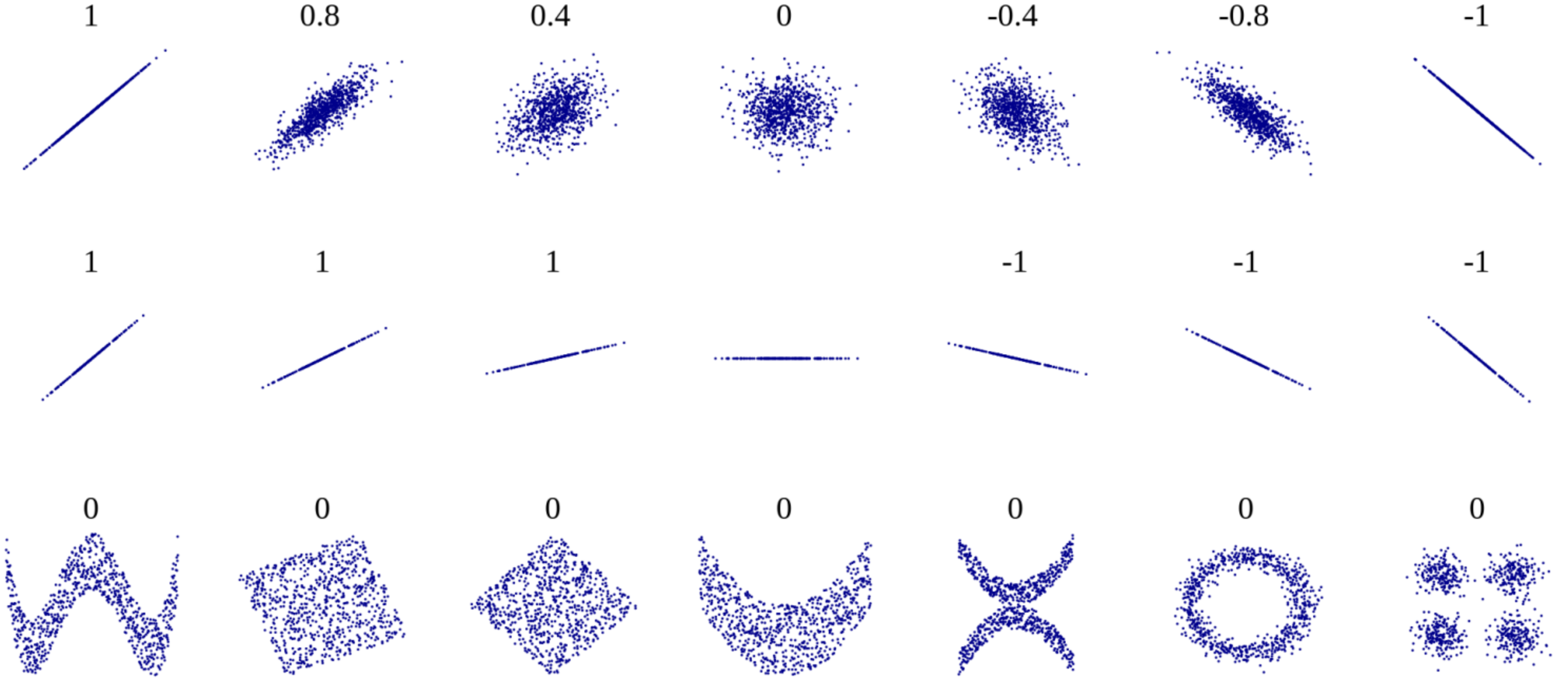
```
Methods include:
.std() - Compute Standard Deviation
.var() - Compute variance
.describe() - short cut that prints out count, mean, std, min, quartiles, max
```

CORRELATION

- The correlation measures the extent of interdependence of variable quantities.

$$r = \frac{1}{n-1}\sum_{i=1}^{n}\frac{\left(x_i - \bar{x}\right)}{s_x}\frac{\left(y_i - \bar{y}\right)}{s_y}$$

- Example correlation values



CONTEXT

- For most projects, descriptive stats will come first. These help you get to know your dataset better.

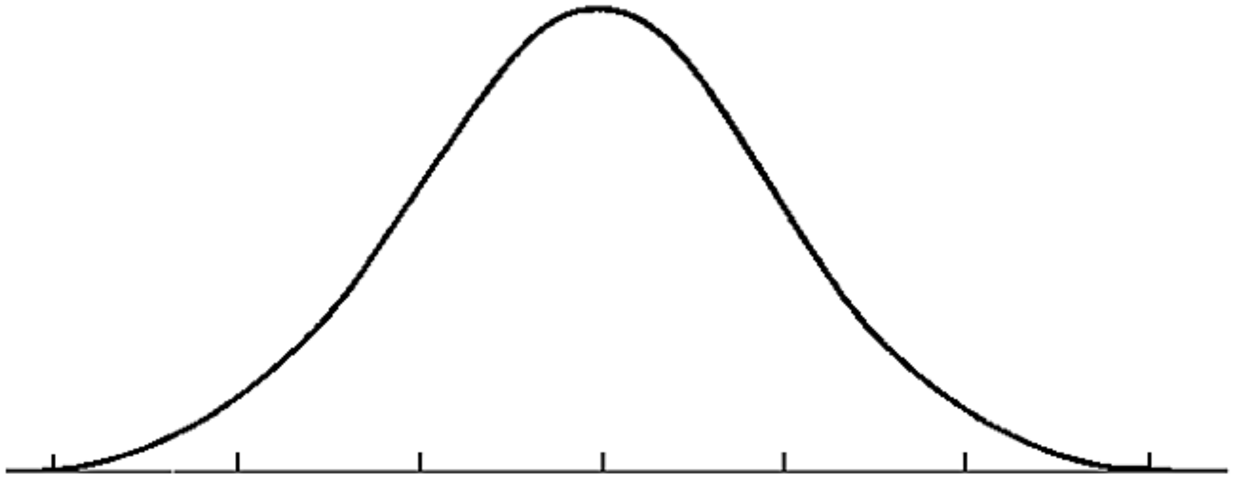
- Sometimes, descriptive stats may be all you need to answer your question.

INTRODUCTION

IS THIS NORMAL?

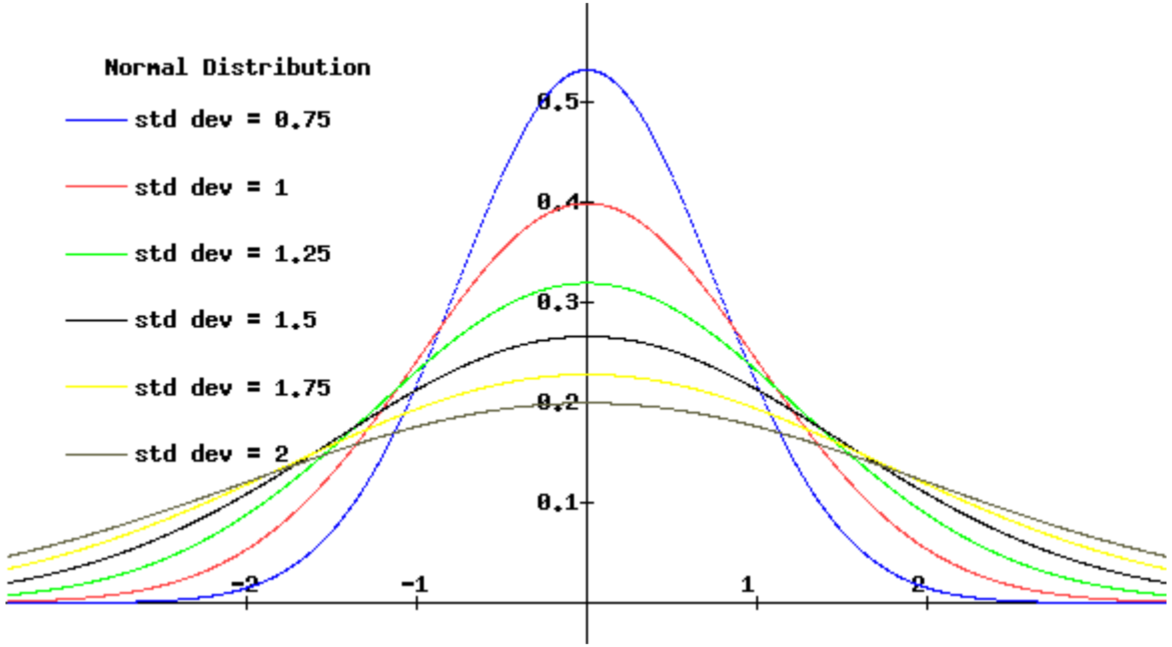
THE NORMAL DISTRIBUTION

- A normal distribution is often a key assumption to many models.
- The normal distribution depends upon the *mean* and the *standard deviation*.
- The *mean* determines the center of the distribution. The *standard deviation* determines the height and width of the distribution.



THE NORMAL DISTRIBUTION

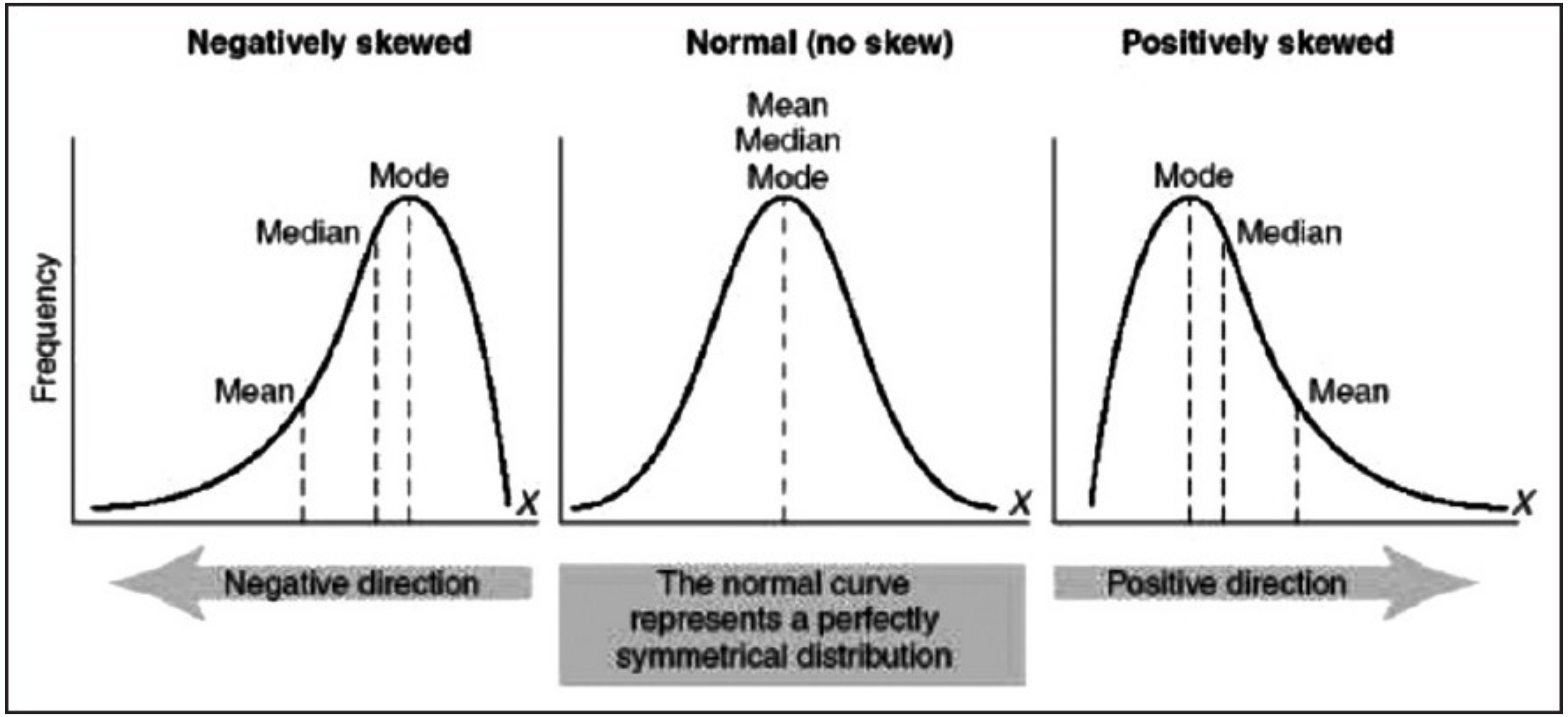
- Normal distributions are symmetric, bell-shaped curves.
- When the standard deviation is large, the curve is short and wide.
- When the standard deviation is small, the curve it tall and narrow.



SKEWNESS

- Skewness is a measure of the asymmetry of the distribution of a random variable about its mean.

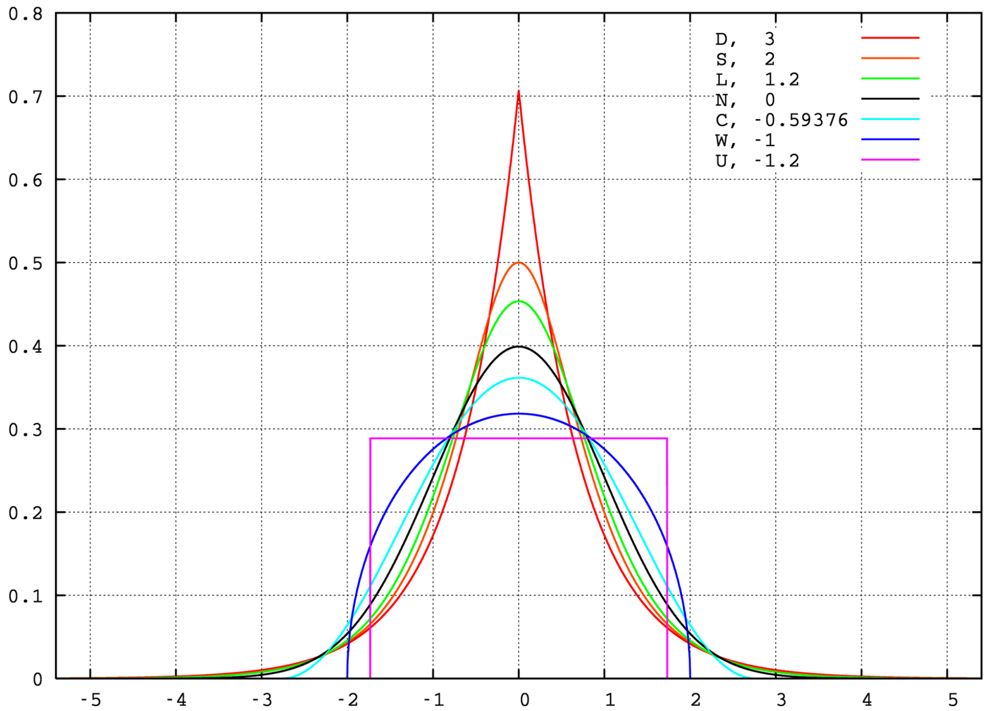
- Skewness can be positive or negative, or even undefined.



KURTOSIS

- Kurtosis is a measure of whether the data are peaked or flat relative to a normal distribution.

- Datasets with high kurtosis tend to have heavier tails and higher peaks compared to the normal distribution



DEMO

DETERMINING THE DISTRIBUTION OF YOUR DATA

DETERMINING THE DISTRIBUTION OF YOUR DATA

- Follow along as we walk through this in a Jupyter Notebook.

GUIDED PRACTICE

IS THIS SKEWED?

ACTIVITY: IS THIS SKEWED?

EXERCISE

DIRECTIONS (10 minutes)

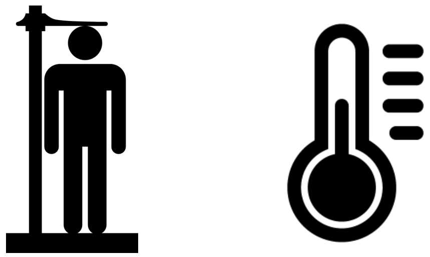
1. We’re going to walk through several images of datasets.
2. For each image, vote on whether the image is:
   a. Normal
   b. Positively, negatively, or not skewed
   c. Has positive, negative, or zero kurtosis
3. Determine how you would correct the issue with each dataset to return it to the normal distribution.

INTRODUCTION

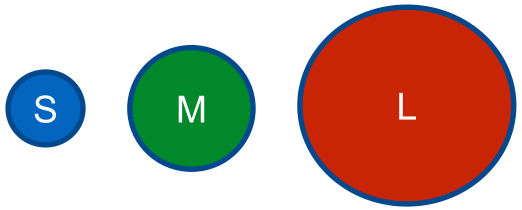
VARIABLE TYPES

VARIABLE TYPES

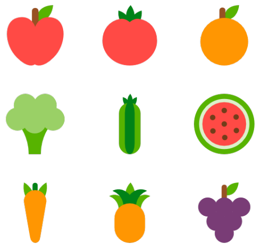
Numeric / Quantitative – values measured on a numerical scale e.g. height, income, temperature



Ordinal – values can be compared and ordered e.g. size (small, medium, large), attitudes (disagree, neutral, agree)



Categorical / Nominal – labels are not ordered e.g. nationality, occupation, movie genres



DEMO

CLASSES

CLASS/DUMMY VARIABLES

- Let’s say we have the categorical variable `area`, which takes on one of the following values: `rural`, `suburban`, and `urban`.

- We need to represent these numerically for a model. So how do we code them?

CLASS/DUMMY VARIABLES

- How about `0=rural`, `1=suburban`, and `2=urban`?

CLASS/DUMMY VARIABLES

- But this implies an ordered relationship - is `urban` twice `suburban`? That doesn’t make sense.

- However, we can represent this information by converting the one `area` variable into two new variables:

  `area_urban` and `area_suburban`.

CLASS/DUMMY VARIABLES

- We'll draw out how categorical variables can be represented without implying order.

- First, let's choose a reference category. This will be our "base" category.

- It's often good to choose the category with the largest sample size and a criteria that will help model interpretation. If we are testing for a disease, the reference category would be people without the disease.

CLASS/DUMMY VARIABLES

- Step 1: Select a reference category. We'll choose `rural` as our reference category.

- Step 2: Convert the values `rural`, `suburban`, and `urban` into a numeric representation that does not imply order.

- Step 3: Create two new variables: `area_urban` and `area_suburban`.

CLASS/DUMMY VARIABLES

- Why do we need only two dummy variables?

`rural`	`urban`	`suburban`

- We can derive all of the possible values from these two. If an `area` isn’t `urban` or `suburban`, we know it must be `rural`.

- In general, if you have a categorical feature with k categories, you need to create k-1 dummy variable to represent all of the information.

CLASS/DUMMY VARIABLES

- Let’s see our dummy variables.

	area_urban	**area_suburban**
rural	0	0
suburban	0	1
urban	1	0

- As mentioned before, if we know `area_urban=0` and `area_suburban=0`, then the area must be `rural`.

CLASS/DUMMY VARIABLES

- We can do this for a `gender` variable with two categories: `male` and female.

- How many dummy variables need to be created?

CLASS/DUMMY VARIABLES

- # of categories - 1 = 2 -1 = 1

CLASS/DUMMY VARIABLES

- We will make `female` our reference category. Thus, `female=0` and `male=1`.

	gender_male
female	0
male	1

- This can be done in Pandas with the `get_dummies` method.

INDEPENDENT PRACTICE

DUMMY COLORS

ACTIVITY: DUMMY COLORS

EXERCISE

DIRECTIONS (15 minutes)

It’s important to understand the concept before we use the Pandas function `get_dummies` to create dummy variables. So today, we’ll create our dummy variables by hand.

1. Draw a table like the one on the white board.
2. Create dummy variables for the variable “colors” that has 6 categories: blue, red, green, purple, grey, and brown. Use grey as the reference.

DELIVERABLE

Dummy variables table for colors

CONCLUSION

TOPIC REVIEW

REVIEW

- Let’s go through the process for creating dummy variables for “colors”.
    - We talked about several different types of summary statistics, what are they?
    - We covered several different types of visualizations; which ones?
    - We talked about the normal distribution; how do we determine your data’s distribution?
- Any other questions?

LESSON

Q & A