GENERAL ASSEMBLY

STATISTICS FUNDAMENTALS

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STATISTICS FUNDAMENTALS

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

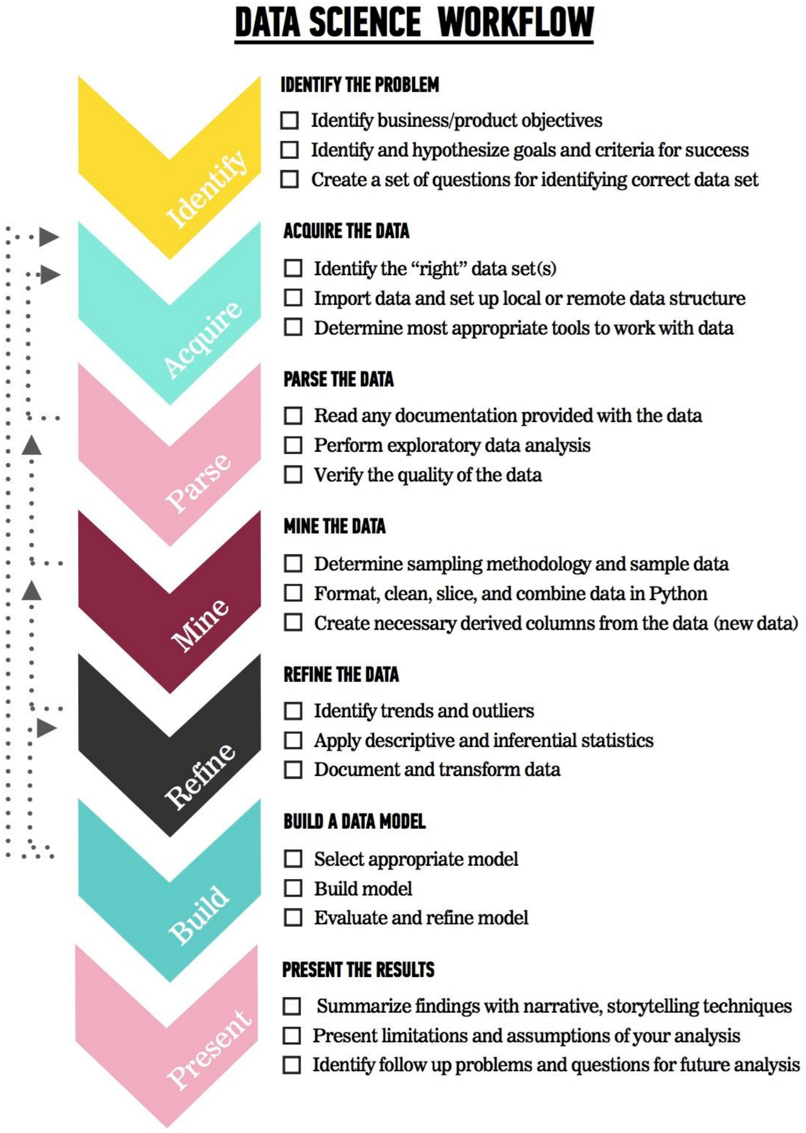
OPENING

STATISTICS FUNDAMENTALS

LET'S REVIEW 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

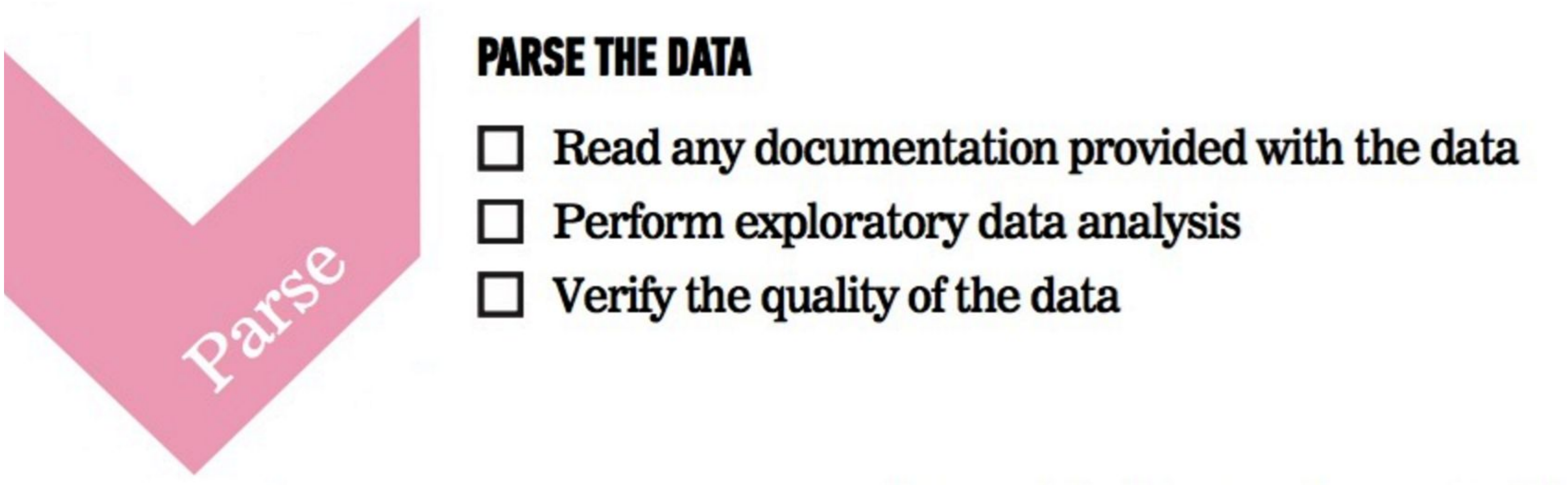
PRESENT THE RESULTS

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

TODAY

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

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



PARSE THE DATA

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

PARSE THE DATA

- Secondary data = we didn’t directly collect it ourselves
- Example data dictionary

Variable	Description	Type of Variable
Profession	Title of the account owner	Categorical
Company Size	1- small, 2- medium, 3- large	Categorical
Location	Planet of the company	Categorical
Days Since Last Delivery	Integer	Continuous
Number of Deliveries	Integer	Continuous

PARSE THE DATA

- Questions to ask while parsing
  - Is there documentation for the data? Is there a data dictionary?
  - What kind of filtering, sorting, or simple visualizations can help understand the data?
  - What information is contained in the data?
  - What data types are the variables?
  - Are there outliers? Are there trends?

INTRODUCTION

SUMMARY STATISTICS

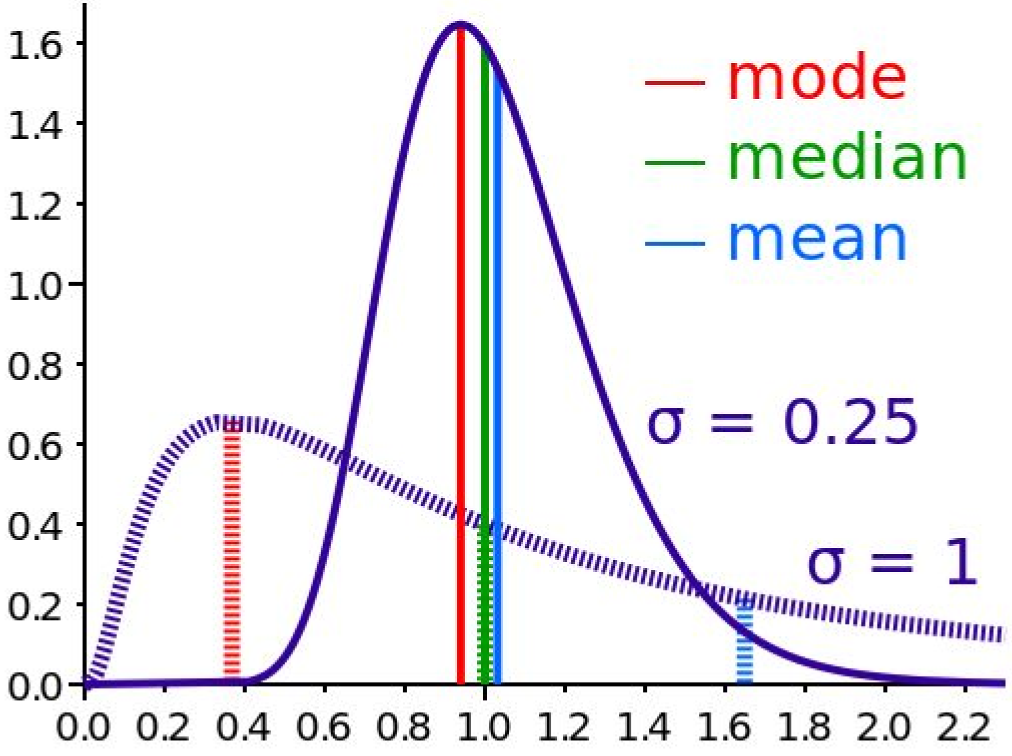
WE’RE GOING TO COVER SEVERAL TOPICS

- 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.

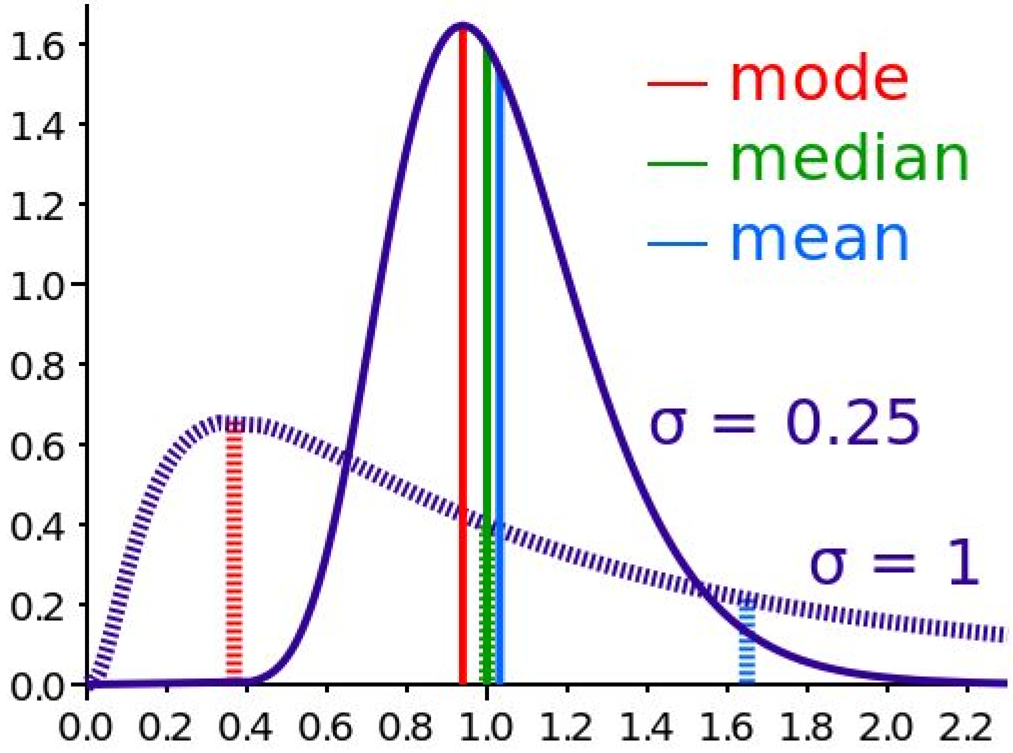
MEAN EXAMPLE

- 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.

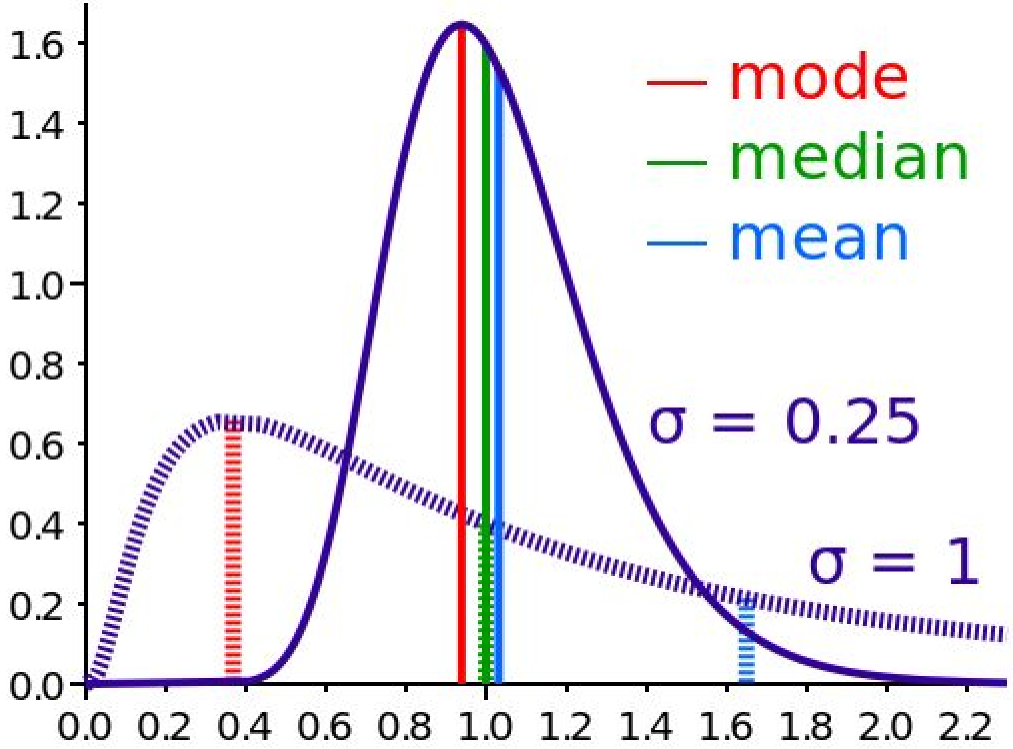
$$\frac{67 + 75}{2} = \frac{142}{2} = 71$$

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.

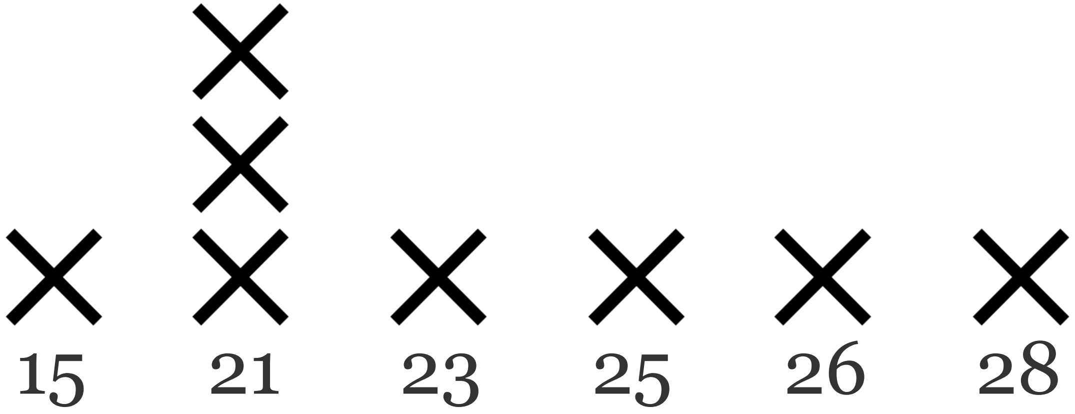


MODE EXAMPLE

- 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.



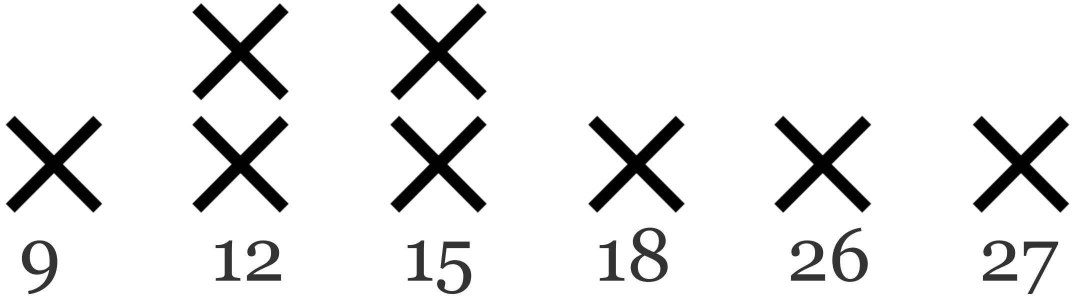
21 is the mode because it occurs most frequently

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.



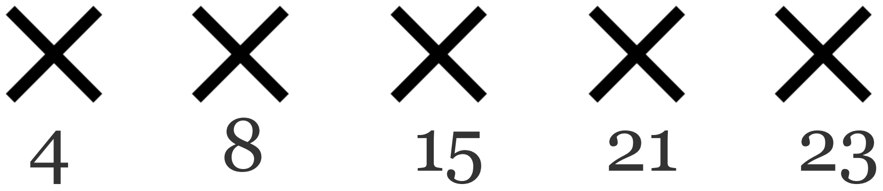
12 and 15 are the modes since the both occur twice.

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/starter-code of the class repo.

CODEALONG PART 1: BASIC STATS

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

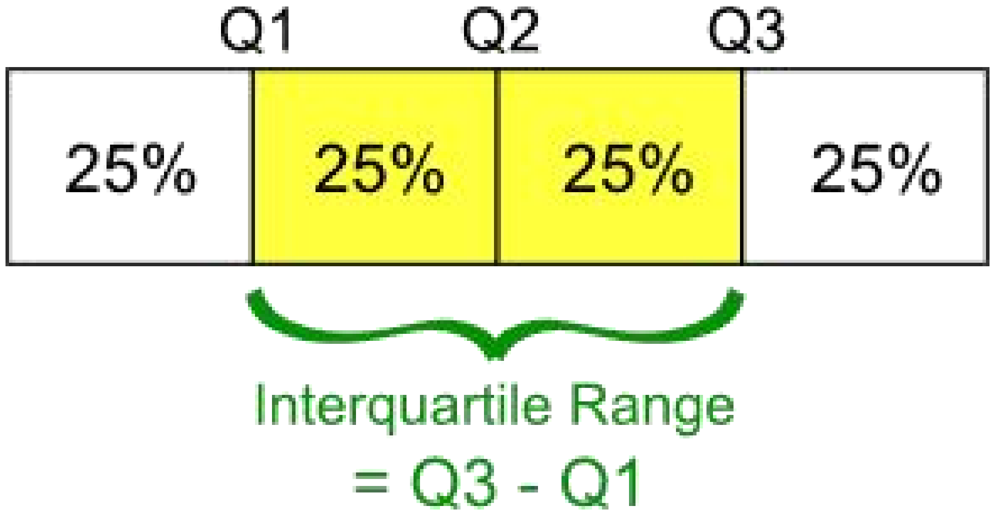
```
Methods available include:
.min() - Compute minimum value
.max() - Compute maximum value
.mean() - Compute mean value
.median() - Compute median value
.mode() - Compute mode value
.count() - Count the number of observations
```

QUARTILES AND INTERQUARTILE RANGE

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

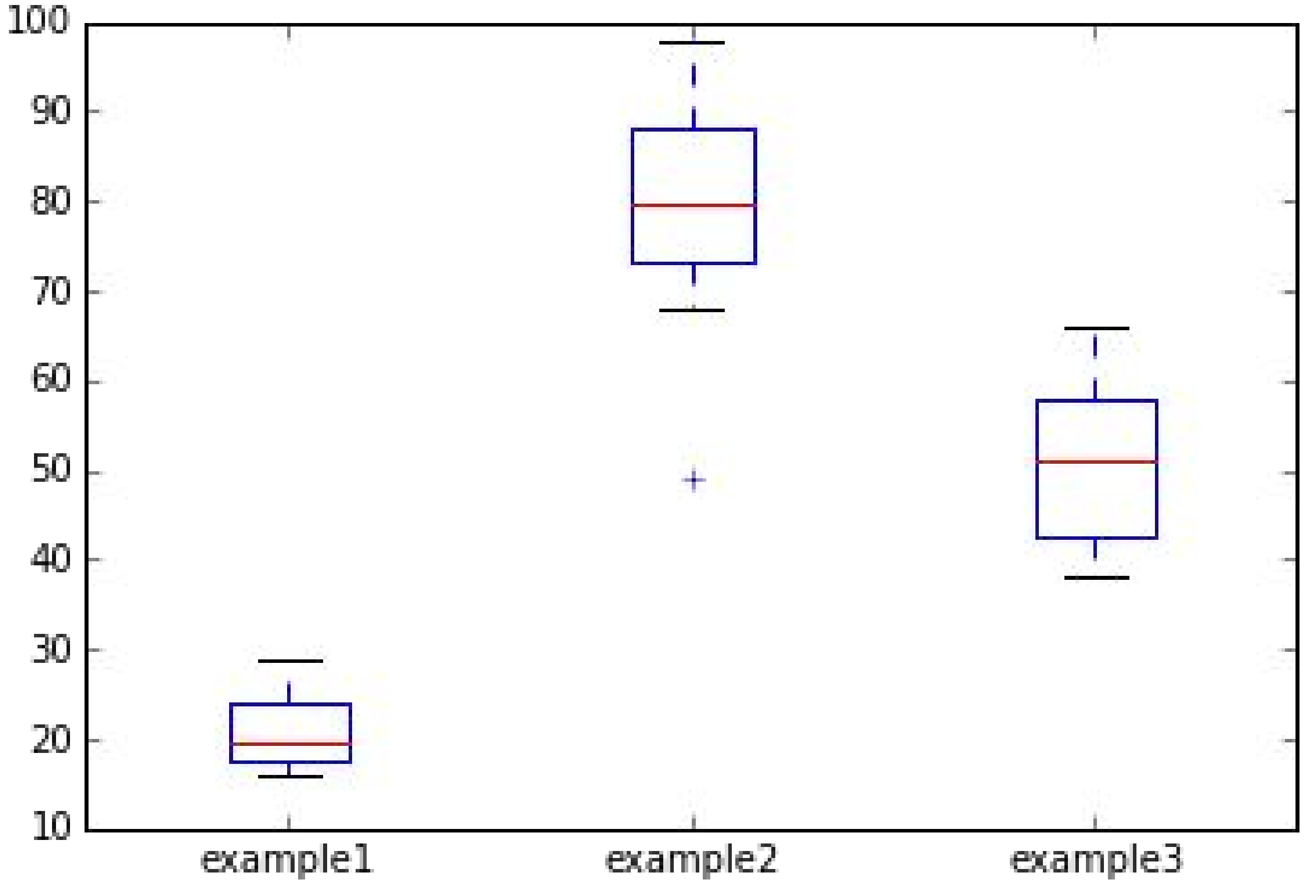
- The values that divide each part are called first, second, and third quartiles, denoted Q1, Q2, and Q3, respectively.

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



CODEALONG PART 2: BOX PLOT

- Box plots give a nice visual of min, max, mean, median, and the quartile and interquartile range.



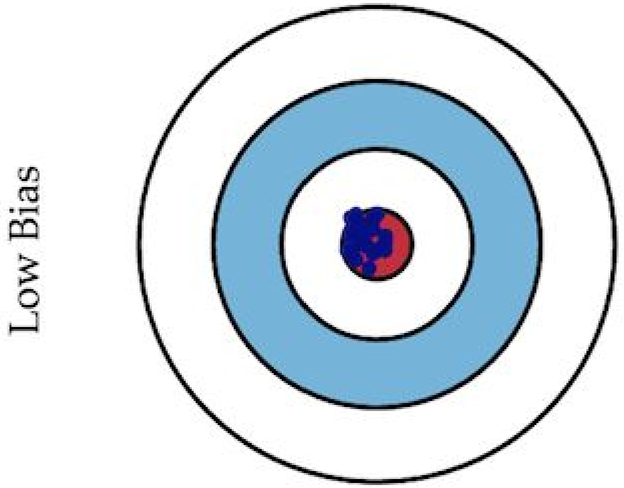
MINI INTRO TO MODELLING

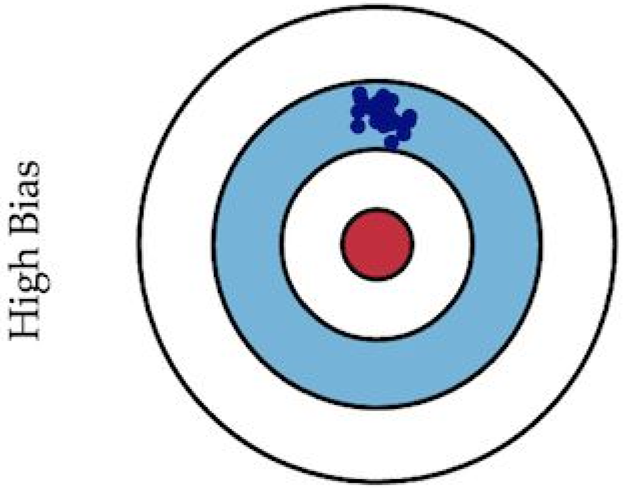
- The purpose of modelling is to create an estimator that will either predict a number or a class. Ex, predict a stock price tomorrow (number) or predict if a photo contains a cat or a dog (a class).
- Even though model performance could be very good (ones hope), in practice it will not be perfect, it will have some errors.
- Though we will study this in a lot more detail, we can start introducing some concepts related to the errors in our models.
- We usually say that error can be due to either Variance or Bias.

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.

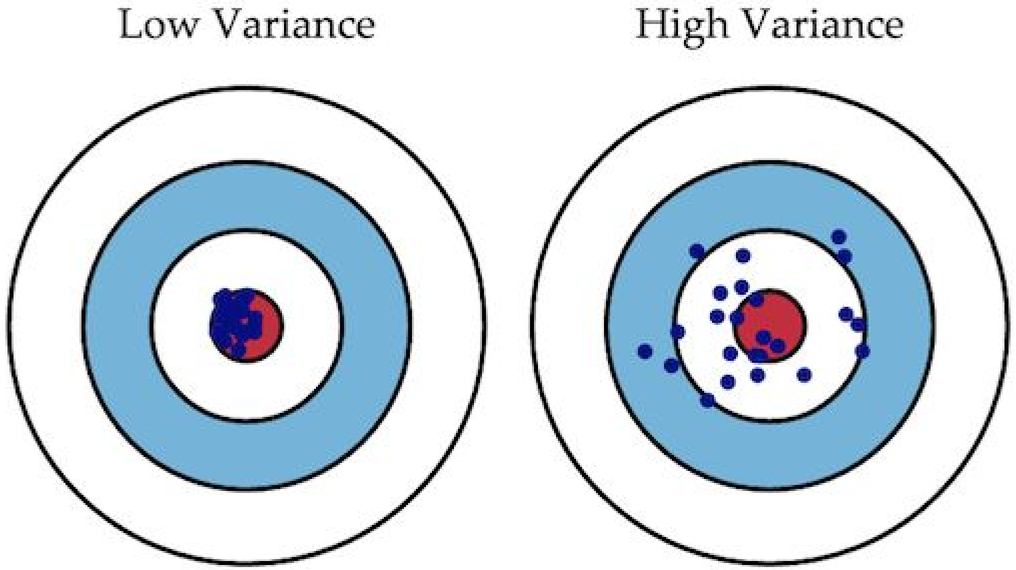




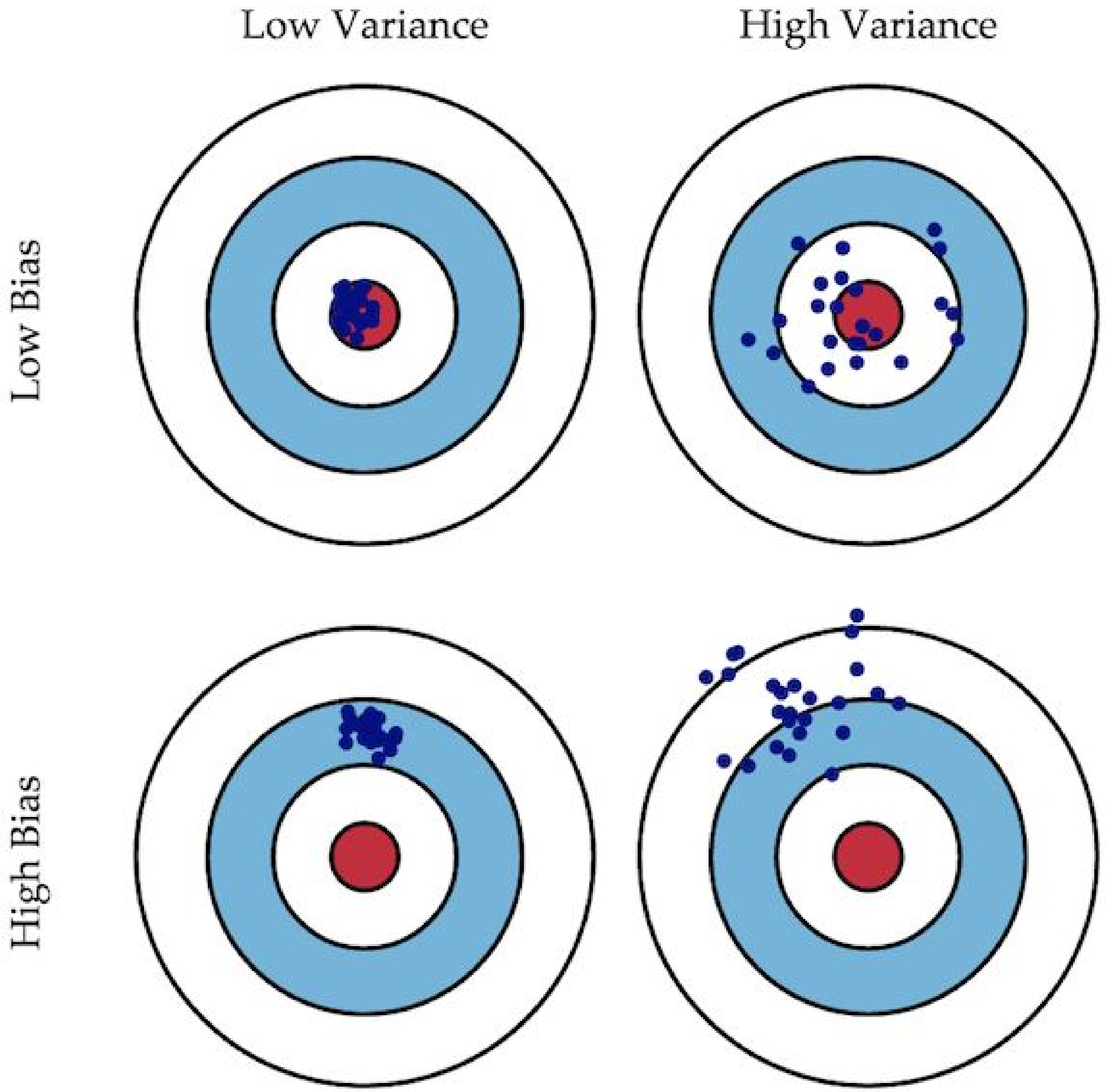
BIAS VS. VARIANCE

- 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.

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

CODEALONG PART 3: STANDARD DEVIATION & VARIANCE

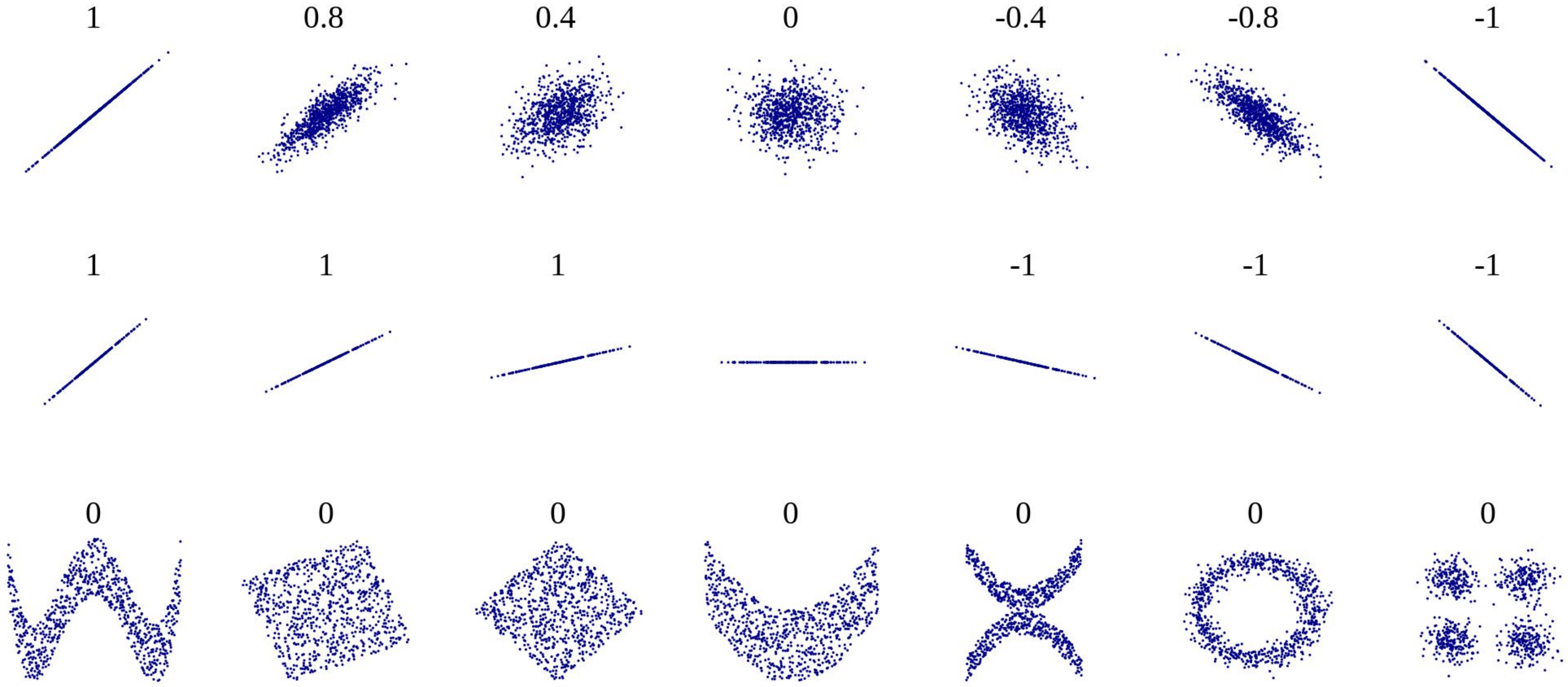
- You can calculate variance and standard deviation easily in Pandas.

```
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.

- 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

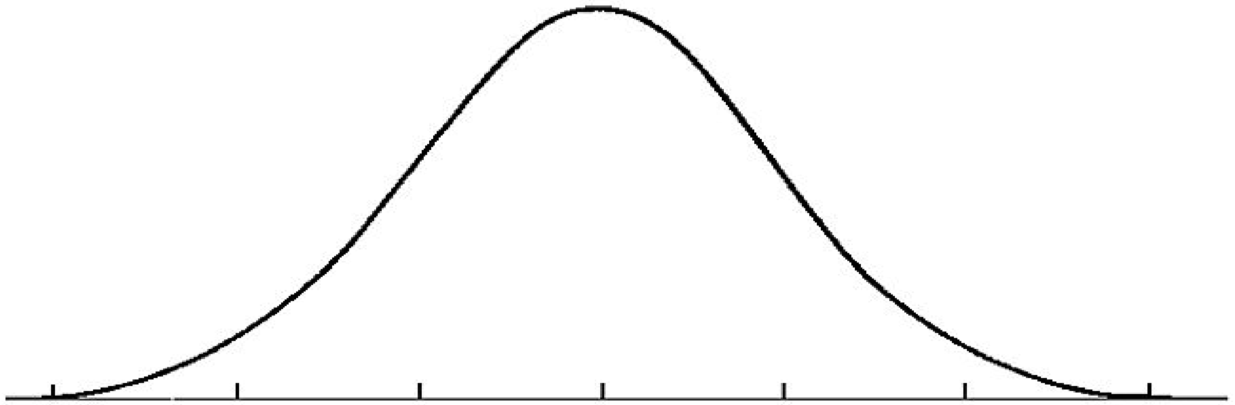
IS THIS NORMAL?

THE NORMAL DISTRIBUTION

- A normal distribution is often a key assumption to many models (usually we want the errors from our models to be normally distributed).

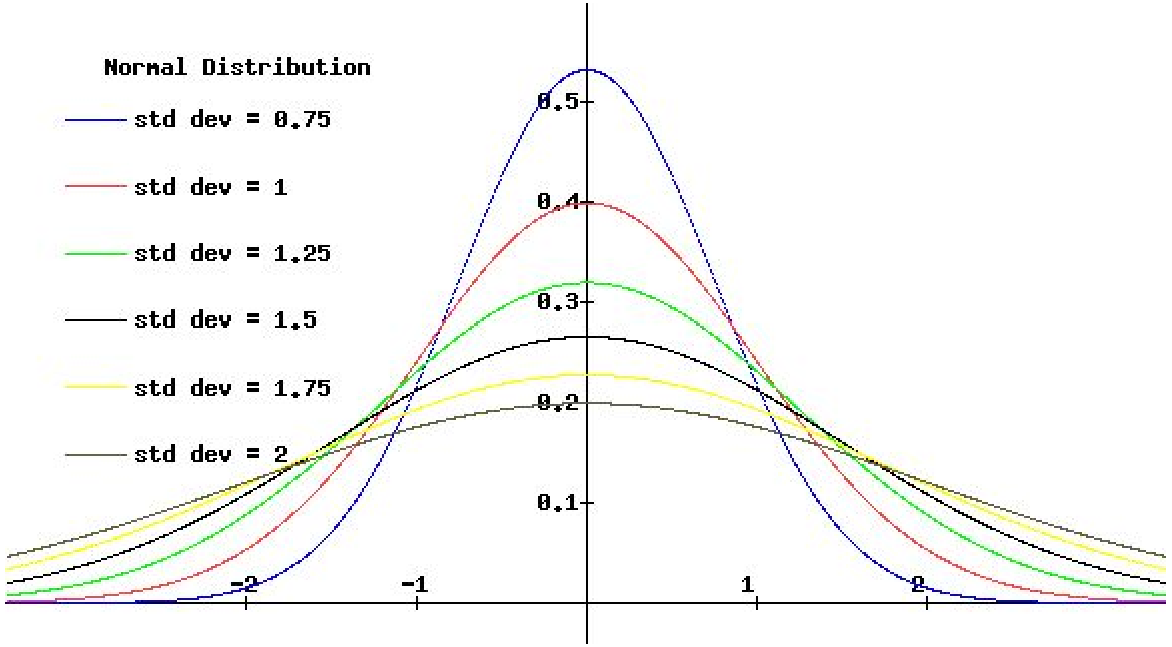
- The normal distribution depends upon the *mean* and the *standard deviation*.

- The *mean* determines the center of the distribution. The *standard deviation* determines the height and width of the distribution.



THE NORMAL DISTRIBUTION

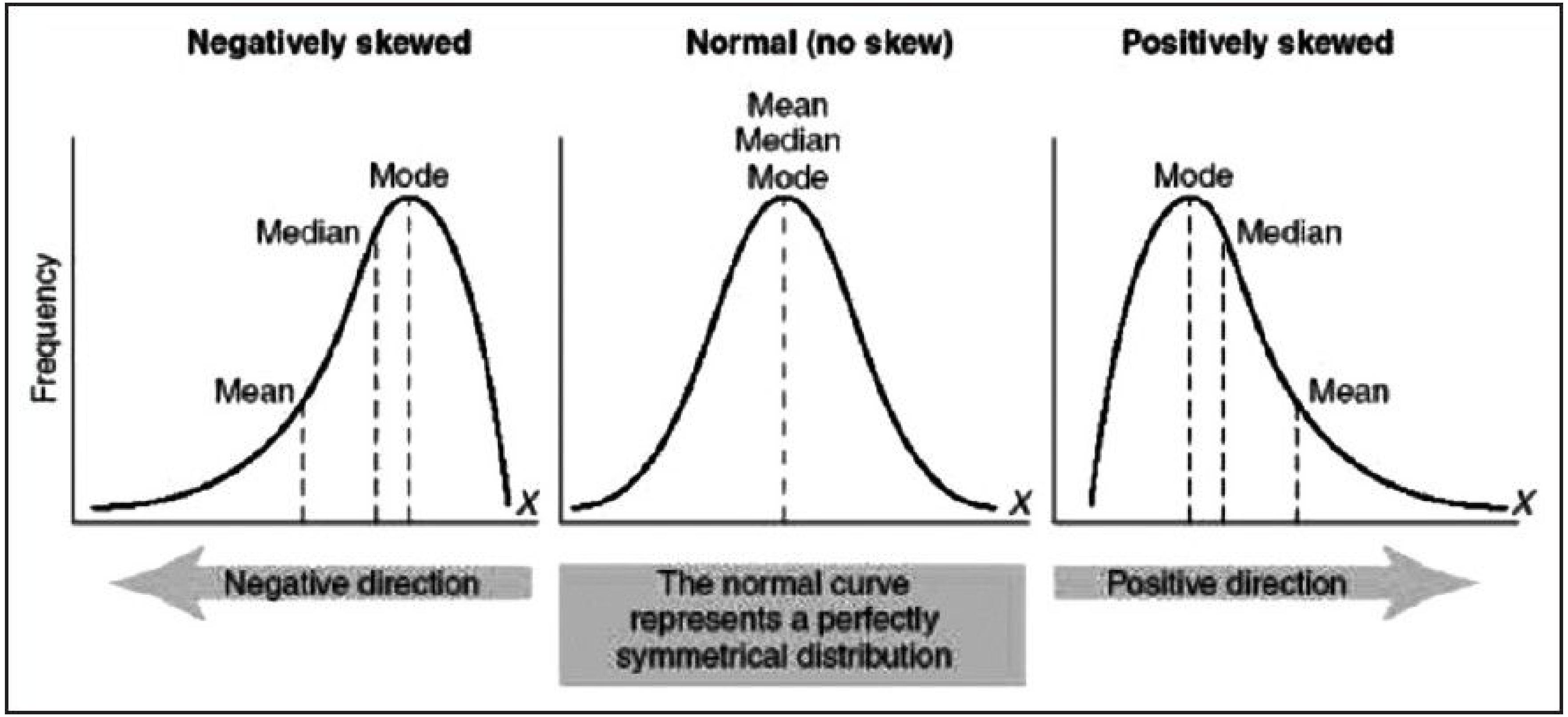
- Normal distributions are symmetric, bell-shaped curves.
- When the standard deviation is large, the curve is short and wide.
- When the standard deviation is small, the curve it tall and narrow.



SKEWNESS

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

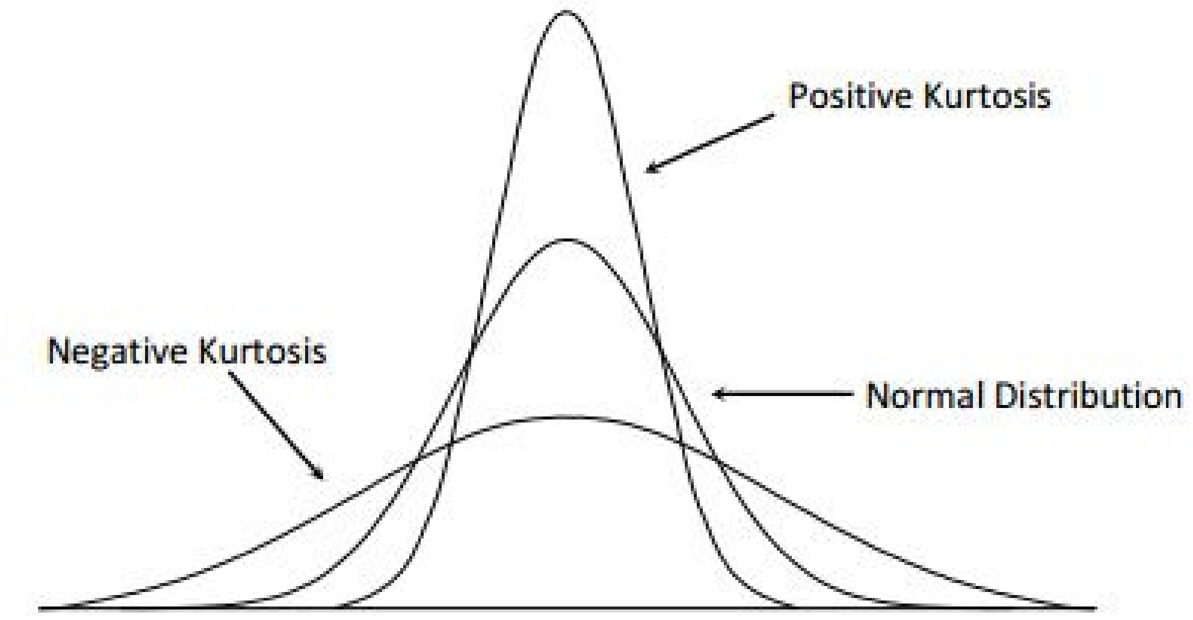
- Skewness can be positive or negative, or even undefined.



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 a distinct peak near the mean, decline rather rapidly, and have heavy tails.



DEMO

DETERMINING THE DISTRIBUTION OF YOUR DATA

DETERMINING THE DISTRIBUTION OF YOUR DATA

- Follow along as we walk through this in an iPython Notebook.

INTRODUCTION

VARIABLE TYPES

VARIABLE TYPES

- Numeric variables can take on a large range of non-predetermined, quantitative values. These are things such as height, income, etc.

- Categorical variables can take on a specific set of variables. These are things such as race, gender, paint colors, movie titles, etc.

- In the next couple of lessons we will learn how to build models to predict both numeric and categorical variables.

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 `urban`, `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.

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?