# Descriptive and Exploratory Analysis

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Lectures : https://github.com/COGS108/Lectures-Wi23

**Descriptive**: The goal of descriptive analysis is to understand the components of a data set, describe what they are, and explain that description to others who might want to understand the data.

- Problem: Understanding whether users are nice or mean on Youtube
- Data science question: Are the words that people use in their comments more frequently positive words (great, awesome, nice, useful) or negative words (bad, stupid, lame, awful)?
- Type of analysis: Descriptive analysis

To answer this you would calculate statistics about YouTube comments

Statistics

*“the science that deals with the **collection, classification, analysis, and interpretation of numerical facts or data**”*

Source: dictionary.com

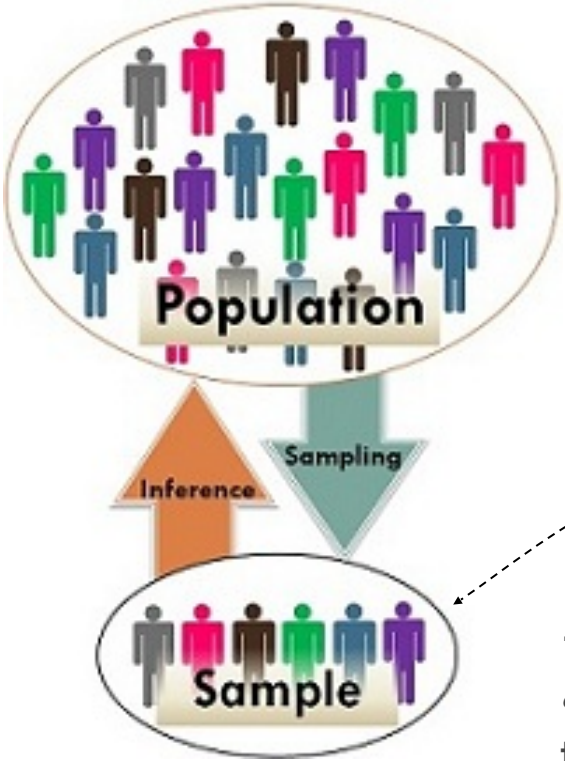
# statistic

“*A quantity computed from a sample*”

Source: dictionary.com

# Populations & Samples

We want to learn something about this..




Our <u>population</u>: *all* YouTube comments

Our <u>sample</u>: 100,000 comments

....but we can only *actually* collect data from this

Image source: keydifferences.com

# statistic

"*A quantity computed from a sample*"

For our YouTube analysis, we could take a random sample of comments from YouTube and calculate the following statistic: *the number of positive and the number of negative words in each review*.

Source: dictionary.com

# Best sampling practices:

- Always think about what your population is
- Collect data from a sample that is representative of your population
- If you have no choice but to work with a dataset that is not collected randomly and is biased, be careful not to generalize your results to the entire population

You'd want to be sure you sample randomly across *all* YouTube comments, making sure not to get more comments from one genre over another, or one location over another, etc.

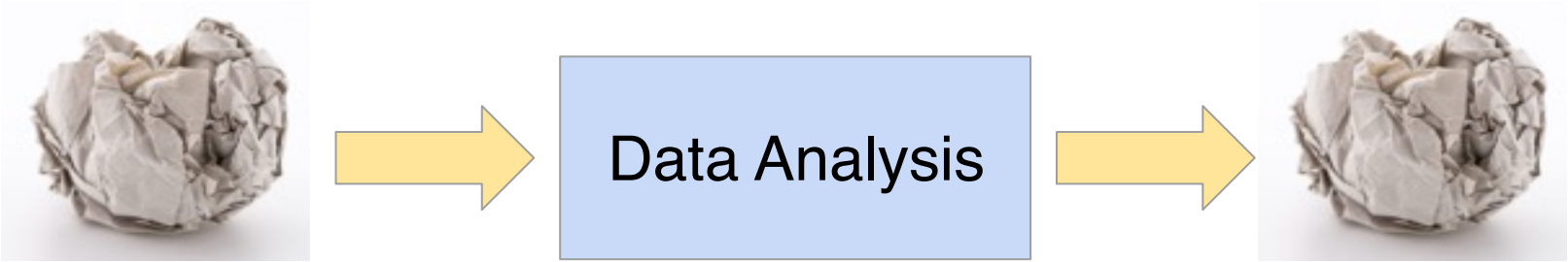
# Examples of bad sampling:

- Surveying subscribers of a Marvel movie magazine for research on Americans' attitudes toward DC movies
- Randomly sampling Facebook users for what TV shows people like

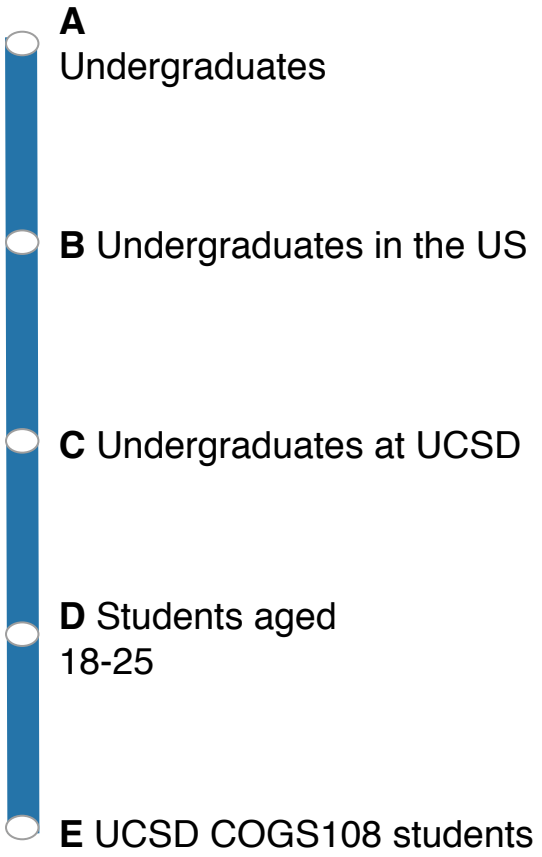
To understand *all* YouTube comments, you wouldn't just want to sample from one YouTube channel, or videos in a single language.

It's *always* worth spending time at the beginning of a project to determine whether or not the data you have are garbage. Be certain they are actually able to help you answer the question you're interested in.

# **GIGO** : Garbage In. Garbage Out.



For the survey data I collected from you all, which of the following best describes the population I could generalize findings back to.



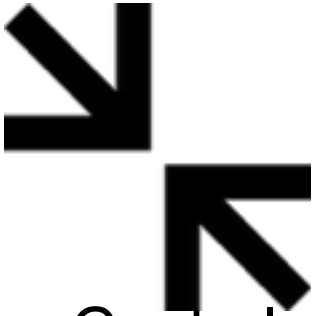
Descriptive

# Descriptive Analysis

Size

Missingness

Shape



Central Tendency

Variability

Descriptive

## Size

How many observations (rows) and variables (columns) you have is an important first step. You should always be aware of the size of your dataset .

Descriptive

# Missingness

It's critical to know how many observations have missing data for variables of interest in your data. Knowing *why* their missing is also important.

Descriptive

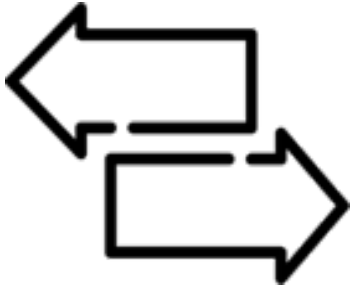
## Shape

It's critical to know the distribution of the variables in your dataset. Certain statistical approaches can only be used with certain distributions.

Descriptive

# Central Tendency

Knowing the mean, median, and/or mode can help you get an idea of what a typical value is for your variable(s) of interest



# Variability

The central tendency tells you part of the story. The variability in the values in your observation helps fill in the rest.

Which of the following is NOT something accomplished by a descriptive analysis?

**A** Describes typical values in your dataset

**B** Determines the size of your dataset

**C** Establishes causal relationships between variables

**D** Identifies missing data

**E** Determines how variable values in your dataset are

## Descriptive Statistics & Summary

"*We must suppress some of the truth to communicate the truth... In short, the techniques of descriptive statistics are designed to match the salient features of the data set to human cognitive abilities.*"

-I.J. Good (1983)

Descriptive

Descriptive Analyses are often included as “Table 1” in academic publications

Table 1. Baseline Characteristics of the Patients.*

| Characteristic | Ranibizumab Monthly (N = 301) | Bevacizumab Monthly (N = 286) | Ranibizumab as Needed (N = 298) | Bevacizumab as Needed (N = 300) |
|---|---|---|---|---|
| Age — no. (%) | | | | |
| 50–59 yr | 2 (0.7) | 1 (0.3) | 6 (2.0) | 2 (0.7) |
| 60–69 yr | 33 (11.0) | 28 (9.8) | 31 (10.4) | 34 (11.3) |
| 70–79 yr | 102 (33.9) | 84 (29.4) | 115 (38.6) | 103 (34.3) |
| 80–89 yr | 142 (47.2) | 150 (52.4) | 126 (42.3) | 142 (47.3) |
| ≥90 yr | 22 (7.3) | 23 (8.0) | 20 (6.7) | 19 (6.3) |
| Mean — yr | 79.2±7.4 | 80.1±7.3 | 78.4±7.8 | 79.3±7.6 |
| Sex — no. (%) | | | | |
| Female | 183 (60.8) | 180 (62.9) | 185 (62.1) | 184 (61.3) |
| Male | 118 (39.2) | 106 (37.1) | 113 (37.9) | 116 (38.7) |
| Race — no. (%)† | | | | |
| White | 297 (98.7) | 281 (98.3) | 296 (99.3) | 294 (98.0) |
| Other | 4 (1.3) | 5 (1.7) | 2 (0.7) | 6 (2.0) |
| History of myocardial infarction — no. (%) | 34 (11.3) | 40 (14.0) | 30 (10.1) | 36 (12.0) |
| History of stroke — no. (%) | 14 (4.7) | 18 (6.3) | 22 (7.4) | 16 (5.3) |
| History of transient ischemic attack — no. (%) | 12 (4.0) | 25 (8.7) | 12 (4.0) | 19 (6.3) |
| Blood pressure — mm Hg | | | | |
| Systolic | 134±18 | 135±19 | 136±17 | 135±17 |
| Diastolic | 75±10 | 75±10 | 76±9 | 75±10 |
| Visual-acuity score and Snellen equivalent | | | | |
| 68–82 letters, 20/25–40 — no. (%) | 111 (36.9) | 94 (32.9) | 116 (38.9) | 103 (34.3) |
| 53–67 letters, 20/50–80 — no. (%) | 98 (32.6) | 118 (41.3) | 108 (36.2) | 119 (39.7) |
| 38–52 letters, 20/100–160 — no. (%) | 67 (22.3) | 53 (18.5) | 58 (19.5) | 58 (19.3) |
| 23–37 letters, 20/200–320 — no. (%) | 25 (8.3) | 21 (7.3) | 16 (5.4) | 20 (6.7) |
| Mean score | 60.1±14.3 | 60.2±13.1 | 61.5±13.2 | 60.4±13.4 |
| Total thickness at fovea — μm‡ | 458±184 | 463±196 | 458±193 | 461±175 |
| Retinal thickness plus subfoveal-fluid thickness at fovea — μm | 251±122 | 254±121 | 247±122 | 252±115 |
| Foveal center involvement — no. (%) | | | | |
| Choroidal neovascularization | 176 (58.5) | 153 (53.5) | 176 (59.1) | 183 (61.0) |
| Fluid | 81 (28.2) | 81 (28.3) | 77 (25.8) | 72 (24.0) |
| Hemorrhage | 20 (6.6) | 24 (8.4) | 24 (8.1) | 25 (8.3) |
| Other | 18 (6.0) | 20 (7.0) | 15 (5.0) | 18 (6.0) |
| No choroidal neovascularization or not possible to grade | 2 (0.7) | 8 (2.8) | 6 (2.0) | 2 (0.7) |

* Plus–minus values are means ±SD.
† Race was self-reported.
‡ Total thickness at the fovea includes the retina, subretinal fluid, choroidal neovascularization, and retinal pigment epithelial elevation.

https://www.nejm.org/doi/full/10.1056/nejmoa1102673

**Descriptive**

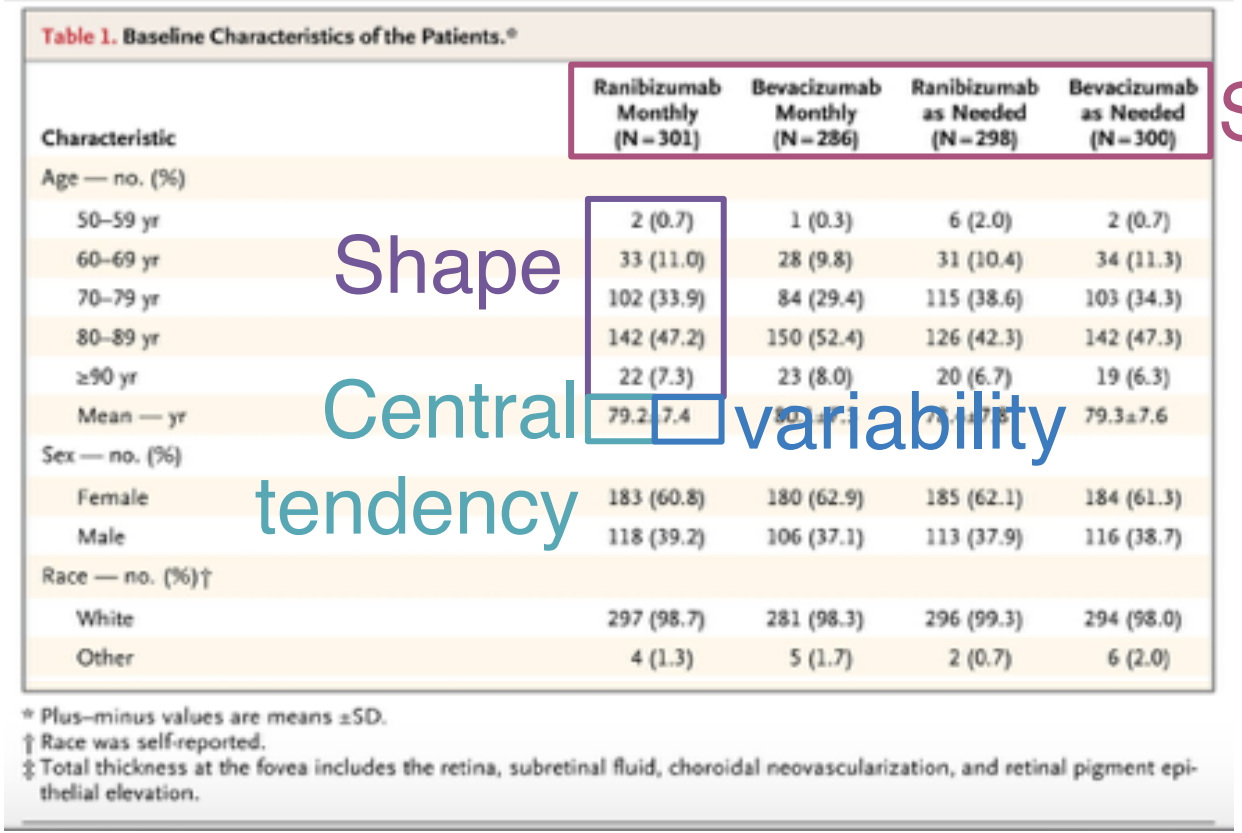


Table 1. Baseline Characteristics of the Patients.*

| Characteristic | Ranibizumab Monthly (N=301) | Bevacizumab Monthly (N=286) | Ranibizumab as Needed (N=298) | Bevacizumab as Needed (N=300) |
|---|---|---|---|---|
| Age — no. (%) | | | | |
| 50–59 yr | 2 (0.7) | 1 (0.3) | 6 (2.0) | 2 (0.7) |
| 60–69 yr | 33 (11.0) | 28 (9.8) | 31 (10.4) | 34 (11.3) |
| 70–79 yr | 102 (33.9) | 84 (29.4) | 115 (38.6) | 103 (34.3) |
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| ≥90 yr | 22 (7.3) | 23 (8.0) | 20 (6.7) | 19 (6.3) |
| Mean — yr | 79.2±7.4 | [illegible] | [illegible] | 79.3±7.6 |
| Sex — no. (%) | | | | |
| Female | 183 (60.8) | 180 (62.9) | 185 (62.1) | 184 (61.3) |
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* Plus–minus values are means ±SD.
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Size

Shape

Central tendency

variability

Zooming in on this we see variables stratified by Age, Sex, and Race

Descriptive

# Descriptive Statistics & Summary

Calculating descriptive statistics, understanding what they tell you about your data, and reporting them are critical steps in every analysis.

**Exploratory**: The goal is to find unknown relationships between the variables you have measured in your data set. Exploratory analysis is open ended and designed to verify expected or find unexpected relationships between measurements.

# Exploratory

Exploratory Data Analysis (EDA) detective work answering the question: "*What can the data tell us?*"

Exploratory

# Why EDA?

- Understand data properties
- Discover Patterns
- Generate & Frame Hypothesis
- Suggest modeling strategies
- Check assumptions (sanity checks)
- Communicate results (present the data)

…..and if you don’t, you’ll regret it

Exploratory

The dataset


You

https://en.wikipedia.org/wiki/Blind_men_and_an_elephant#/media/File:Blind_monks_examining_an_elephant.jpg

Exploratory

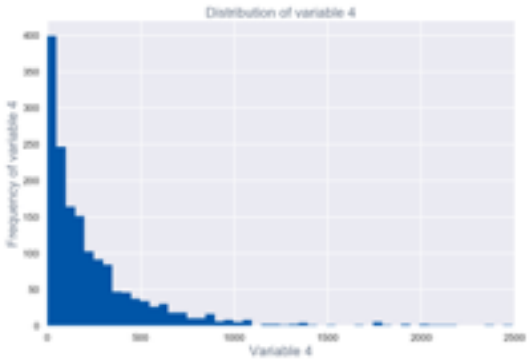
The general principles of exploratory analysis:

- Look for missing values
- Look for outlier values
- Calculate numerical summaries
- Generate plots to explore relationships
- Use tables to explore relationships
- If necessary, transform variables

# EDA Approaches to “Get a Feel for the Data”

Understanding the relationship between variables in your dataset

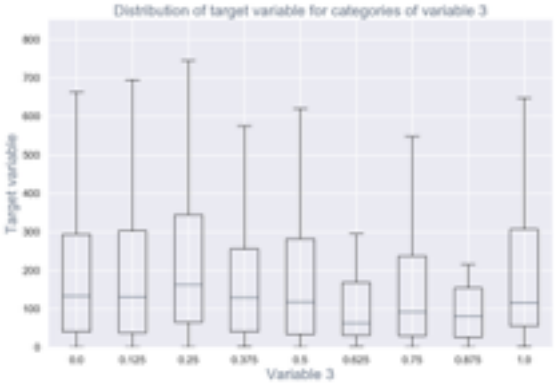
**Exploratory**




## Univariate

understanding a single variable

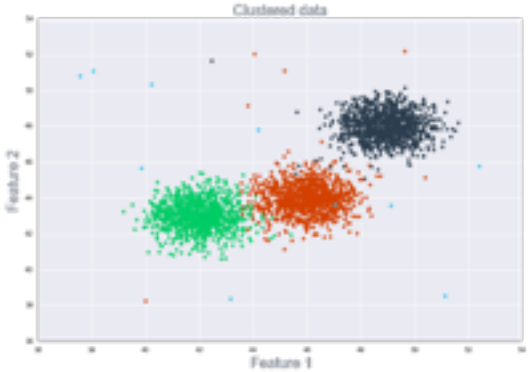
i.e.: histogram, densityplot, barplot




## Bivariate

understanding relationship between 2 variables

i.e.: boxplot, scatterplot, grouped barplot, boxplot

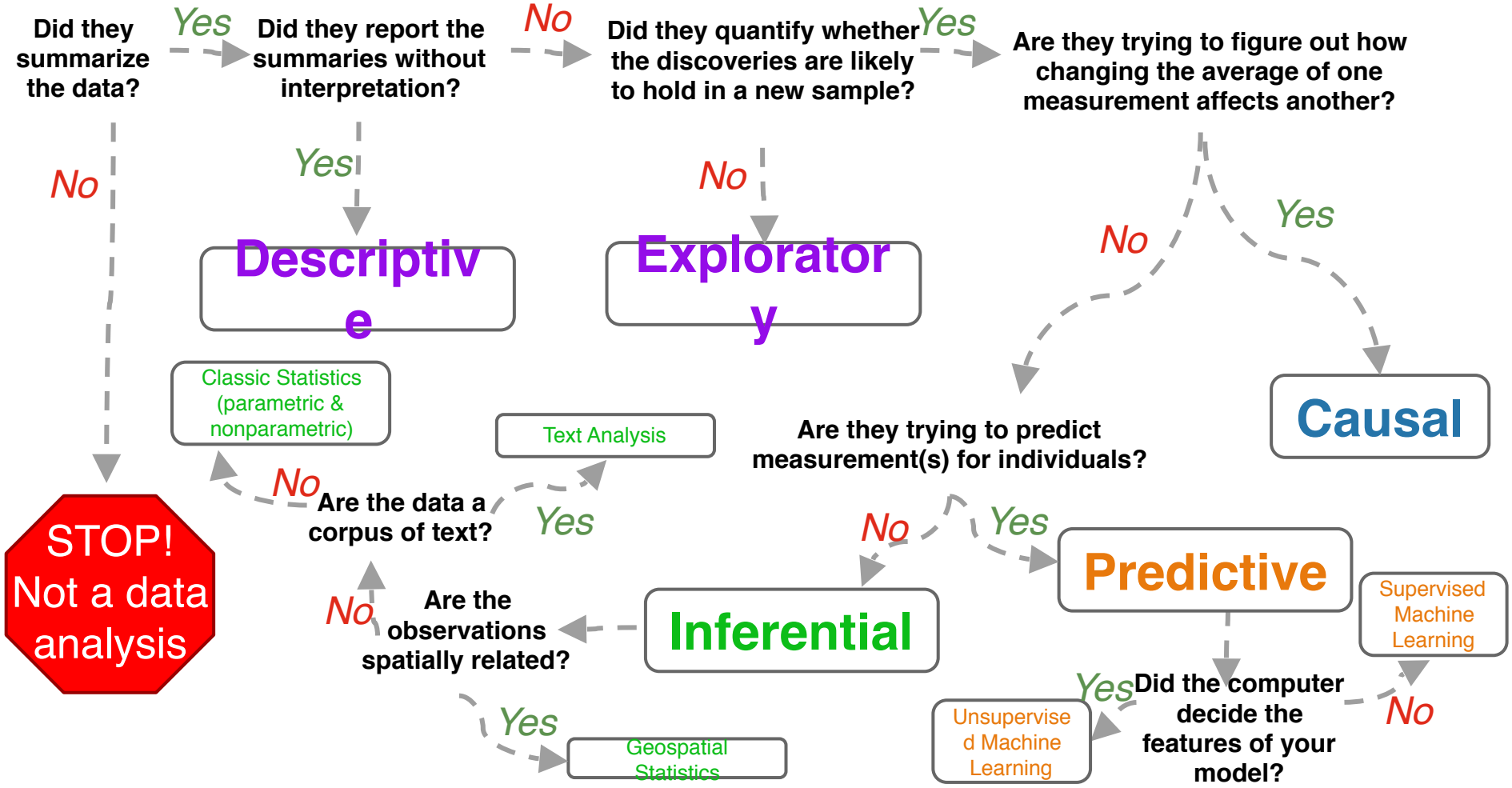



## Dimensionality Reduction

projecting high-D data into a lower-D space

i.e.: PCA, ICA, Clustering

Image source: https://www.svds.com/value-exploratory-data-analysis/


Did they summarize the data?
Yes
Did they report the summaries without interpretation?
No
Did they quantify whether the discoveries are likely to hold in a new sample?
Yes
Are they trying to figure out how changing the average of one measurement affects another?
No
Yes
Causal
No
Yes
Descriptive
No
Exploratory
Classic Statistics (parametric & nonparametric)
No
Are the data a corpus of text?
Yes
Text Analysis
Are they trying to predict measurement(s) for individuals?
No
Yes
Predictive
STOP! Not a data analysis
No
Are the observations spatially related?
Inferential
Yes
Geospatial Statistics
Supervised Machine Learning
Yes
Did the computer decide the features of your model?
No
Unsupervised Machine Learning