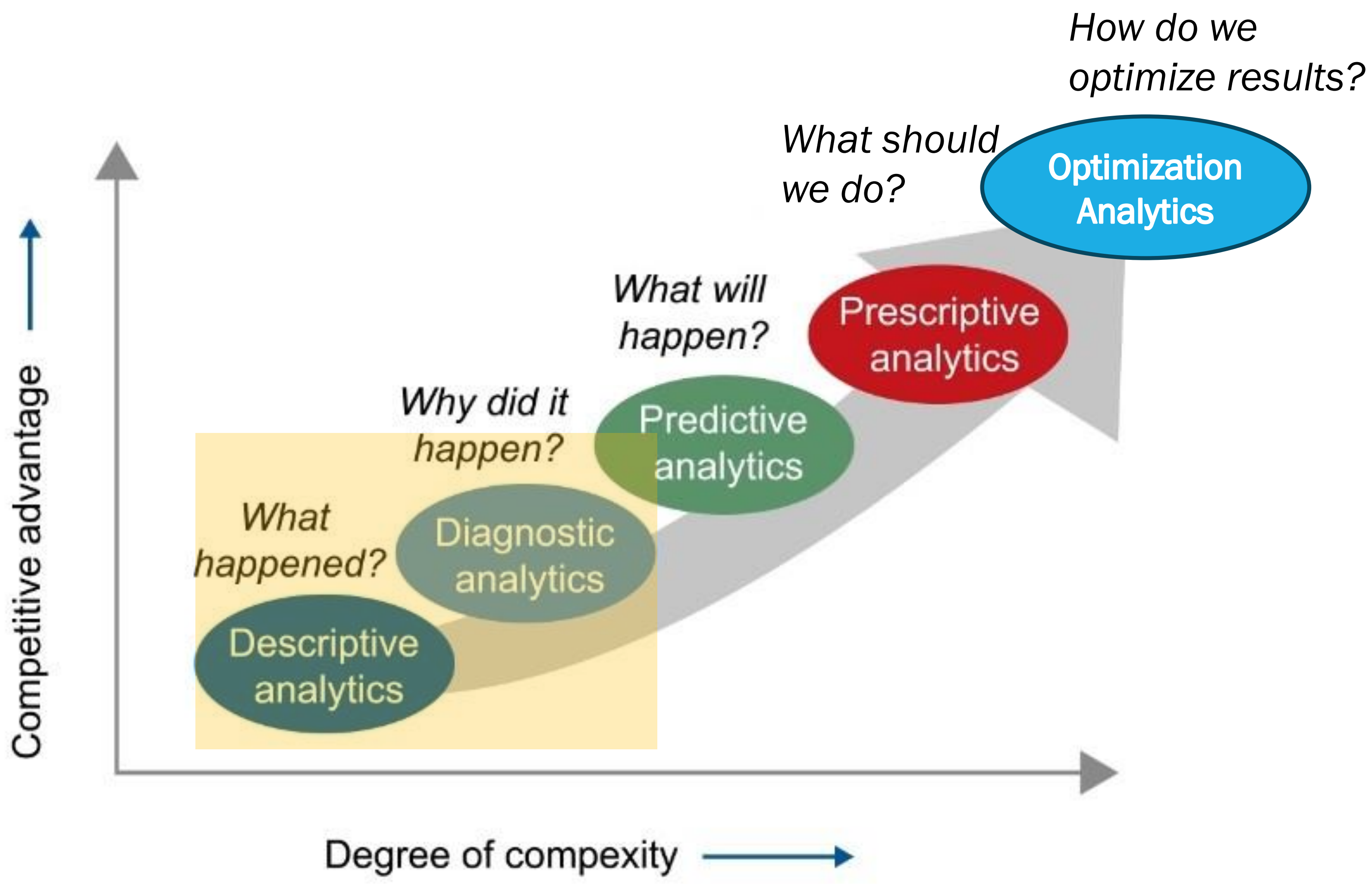
# DATA SAMPLING

# HIERARCHY OF DATA ANALYSIS TYPES

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# POPULATION VS SAMPLE

- Ideally, analyze all data for insights.
- Examples:
  - A mobile company wants to assess all potential customers.
  - A government must consider all citizens' needs for a new service.
- Full data collection is often impractical due to:
  - High costs of data acquisition
  - Time constraints
  - Computational and storage limitations
  - Increased complexity in processing large datasets
- Solution: Select a representative, make inference

# DATA SAMPLING

A ***Sampling Method*** is a process to select a subset of observations from the entire population. Ideally, the observations in the sample are representative of the population. Common methods include:

- Random Sampling: Each subset of n units is equally likely to be chosen.
- Stratified Sampling: The population is divided into meaningful groups (strata), and samples are drawn from each.
- Cluster Sampling: The population is divided into clusters (unrelated to key study features), and some clusters are randomly selected.
- Systematic Sampling: Every kth observation is selected from a random starting point, where k ≈ (population size) / n.
- Convenience Sampling: Easily accessible observations are selected (non-random).

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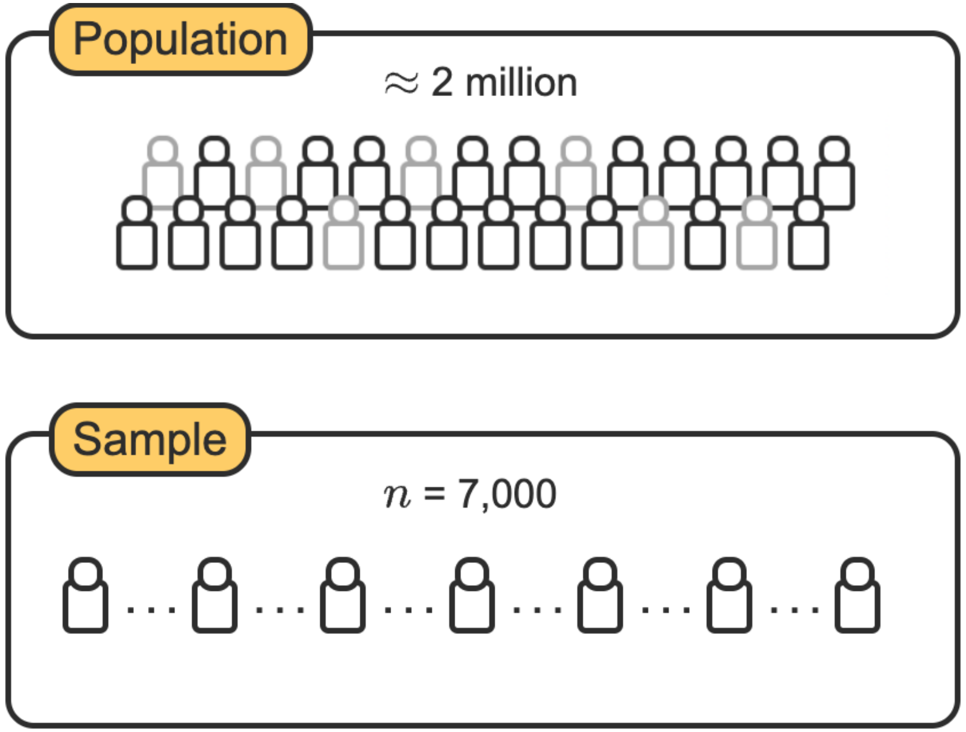
# SAMPLING SCENARIO

- A ***population*** is the entire set of all individuals, items, or events of interest.
- An ***observational unit (aka observation)*** is an individual, item, or event of the population where data is recorded.
- A ***sample*** is a subset of observations from the population used for analysis.
- Example: Transportation satisfaction survey across 5 cities.

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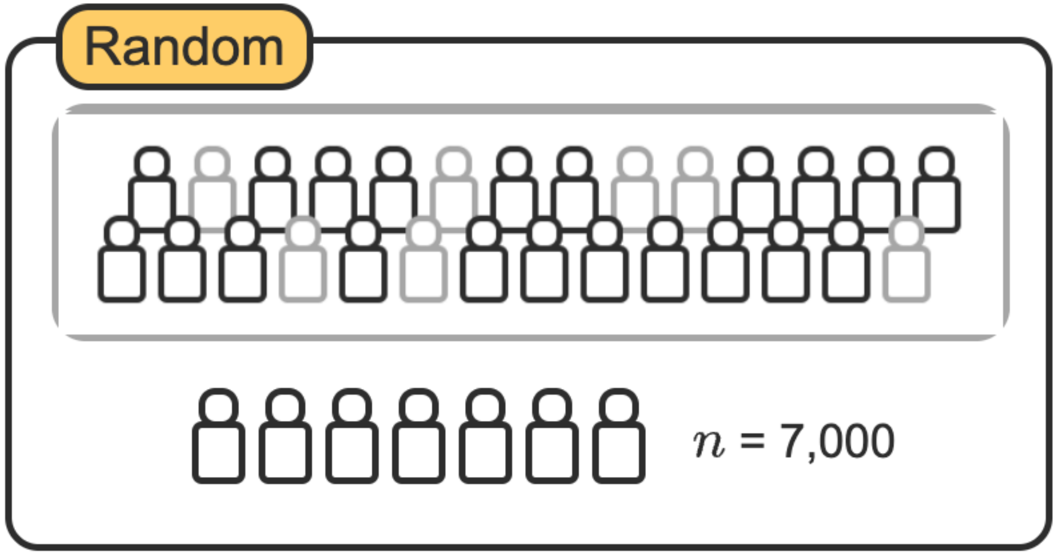
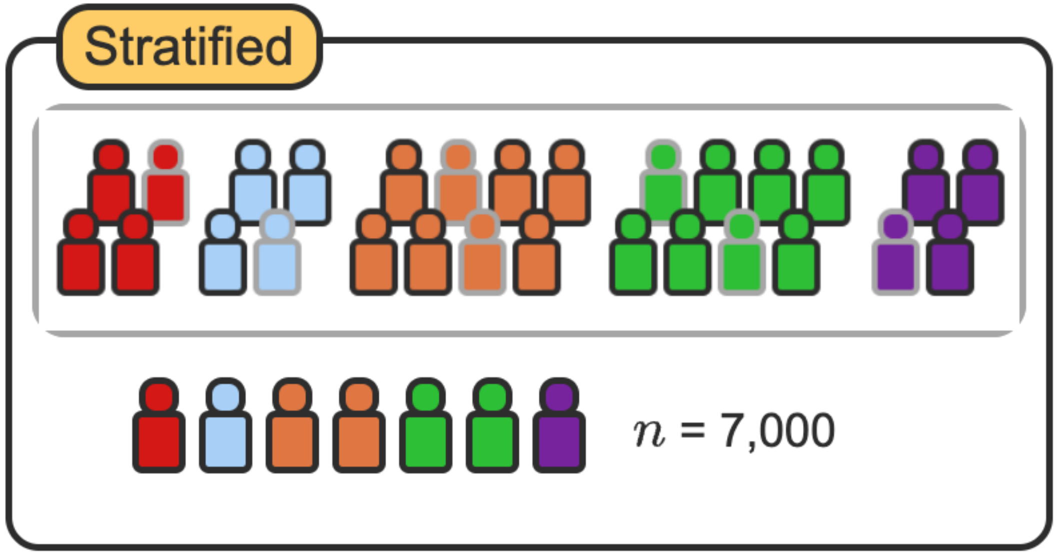
# RANDOM SAMPLING

- In random sampling, passengers are selected at random from a list of all passengers in the five cities.
- Random sampling reduces the potential for sampling bias.
- But this could result in missing important events that occur less frequently.



# STRATIFIED SAMPLING

- Passengers are first divided into groups based on city.
- Then from each group, passengers are selected at random.
- Unlike pure random sampling, stratified sampling ensures adequate representation from each city.
- This is especially important when working with data that includes events that are relatively rare (e.g., customer churn, network intrusion, cancer cell detection, etc.)

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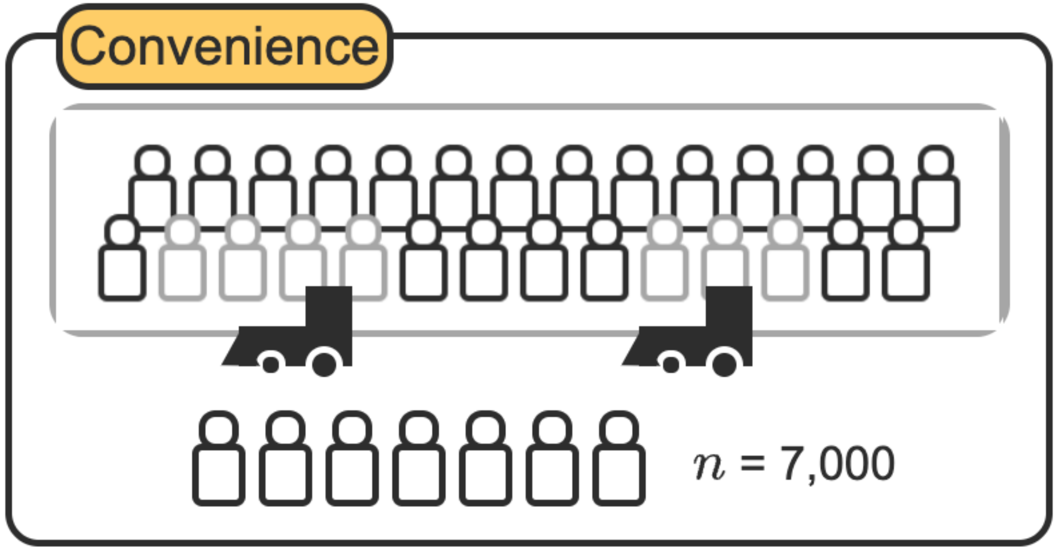
# CONVENIENCE SAMPLING

- Select passengers waiting in the train stations uses convenience sampling.
- This method is easy and quick, but the sample is not likely representative of all train passengers.

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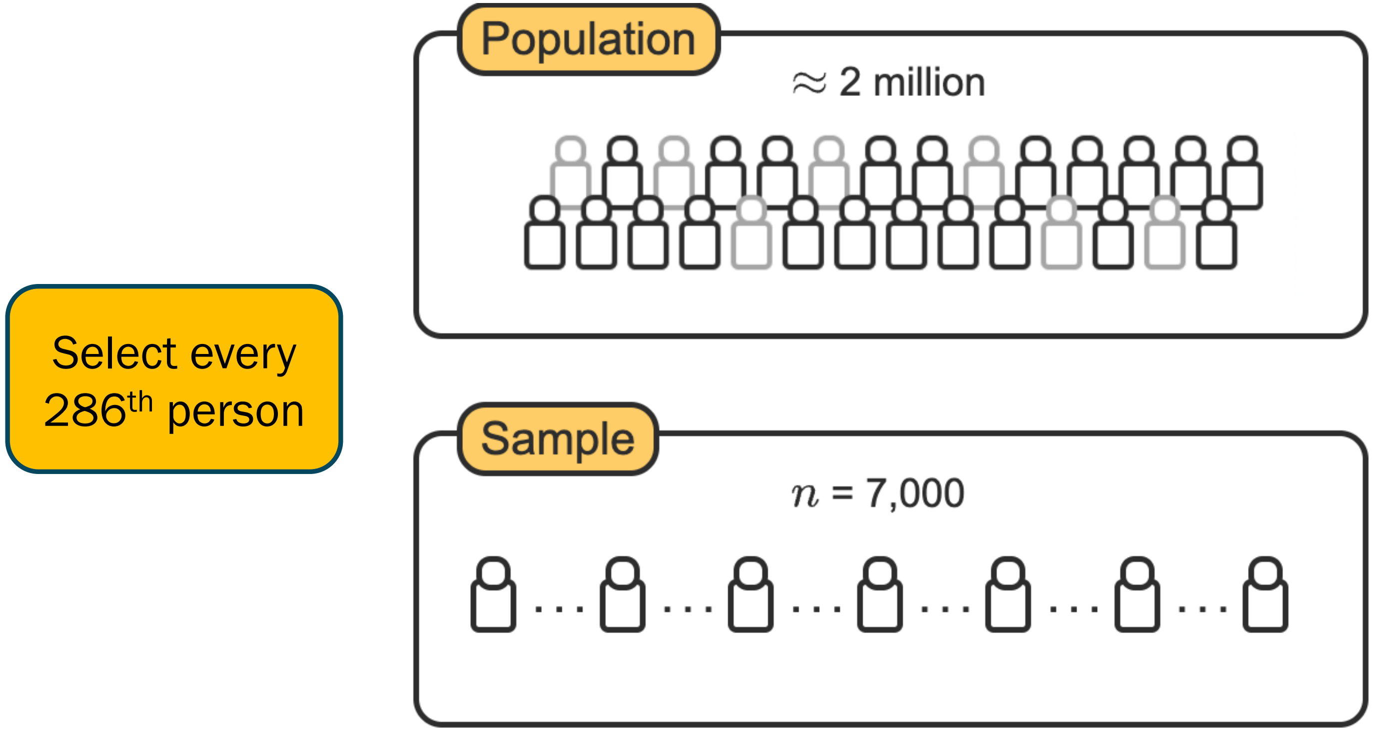
# SYSTEMATIC SAMPLING

- Every 286th passenger from a list of all 2 million potential passengers is selected for the sample.
- Population / sample size = selection criteria
- Depending on ordering of the list, this could be close to random, or highly biased.

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# SAMPLING IN PYTHON

- The pandas method **DataFrame.sample(n=None, frac=None, replace=False, random_state=None)** returns a random sample of items from a dataframe.
- **n** or **frac** specify the number, or fraction, of items to be returned in the sample.
- **replace=** parameter specifies whether sampling is done with (True) or without (False) replacement.
- **random_state=** parameter optionally sets the random number generator seed for reproducible sampling.
- **weights** controls the likelihood of each row (or column) being selected. Weights can be a list/array of values or a column name in the DataFrame. The weights do not need to sum to 1; Pandas normalizes them automatically.
- **axis**= The axis to sample
- **ignore_index**= reset the index to 0,1,2,3…

```
DataFrame.sample(n=None, frac=None, replace=False, weights=None,
random_state=None, axis=None, ignore_index=False)
```

# PYTHON EXAMPLES, SAMPLING

- https://colab.research.google.com/github/rhodes-byu/cs180-winter25/blob/main/notebooks/06-sampling.ipynb

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# IS OUR SAMPLE SIGNIFICANTLY DIFFERENT THAN THE POPULATION?

- https://colab.research.google.com/github/rhodes-byu/cs180-winter25/blob/main/notebooks/07-stat-significance.ipynb

In the case of a **one-sample t-test** (where you are comparing the sample mean against a known population mean), the equation becomes:

$$t = \frac{\overline{X} - \mu}{\frac{S}{\sqrt{n}}}$$

Where:

- $\overline{X}$ is the sample mean,
- $\mu$ is the population mean,
- $S$ is the sample standard deviation,
- $n$ is the sample size.

This formula tests whether the sample mean $\overline{X}$ significantly differs from the population mean $\mu$. The denominator represents the **standard error** of the mean.

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