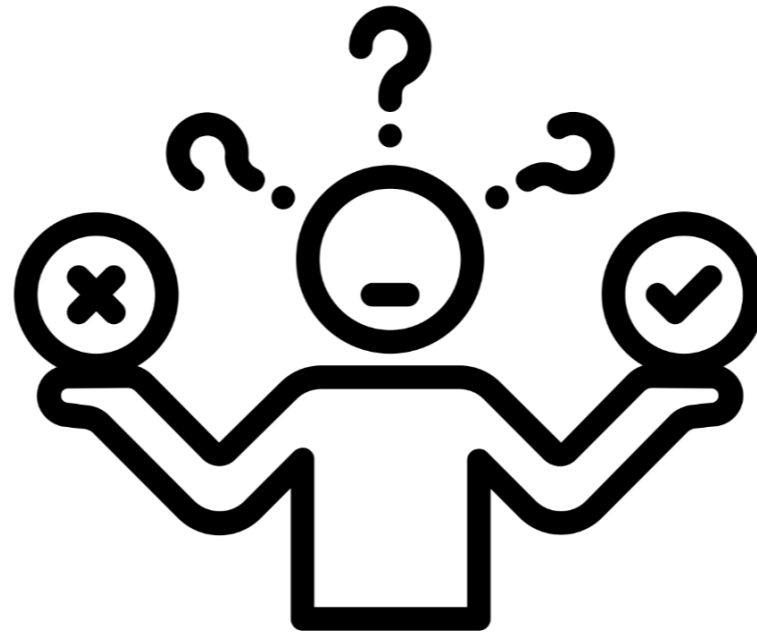# Cognitive biases

CONQUERING DATA BIAS

Konstantinos Kattidis
Data Analytics Lead

Beyond data collection bias

- Data bias can manifest in during data analysis, model development and interpretation

- Cognitive biases are **systematic patterns of deviation** from norm or rationality in judgment

Confirmation bias

The tendency to seek, interpret, and remember information in a way that confirms pre-existing beliefs or hypotheses
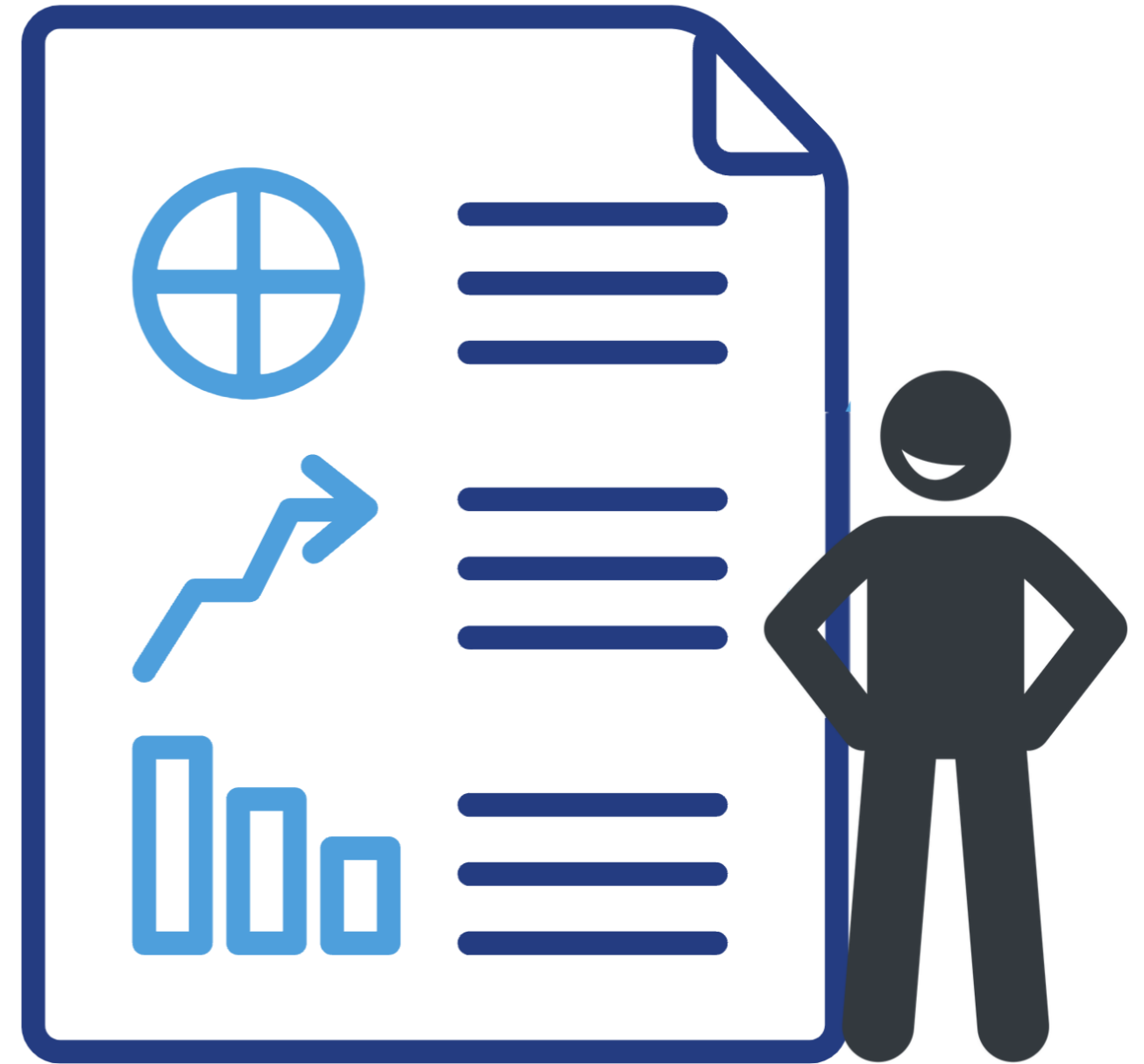
- This distorts the interpretation of results and hinders the discovery of novel insights

- For instance:
  - A marketing manager analyzing customer feedback about a new product

  - Overlooking negative feedback that challenges their belief in its success

Overconfidence bias

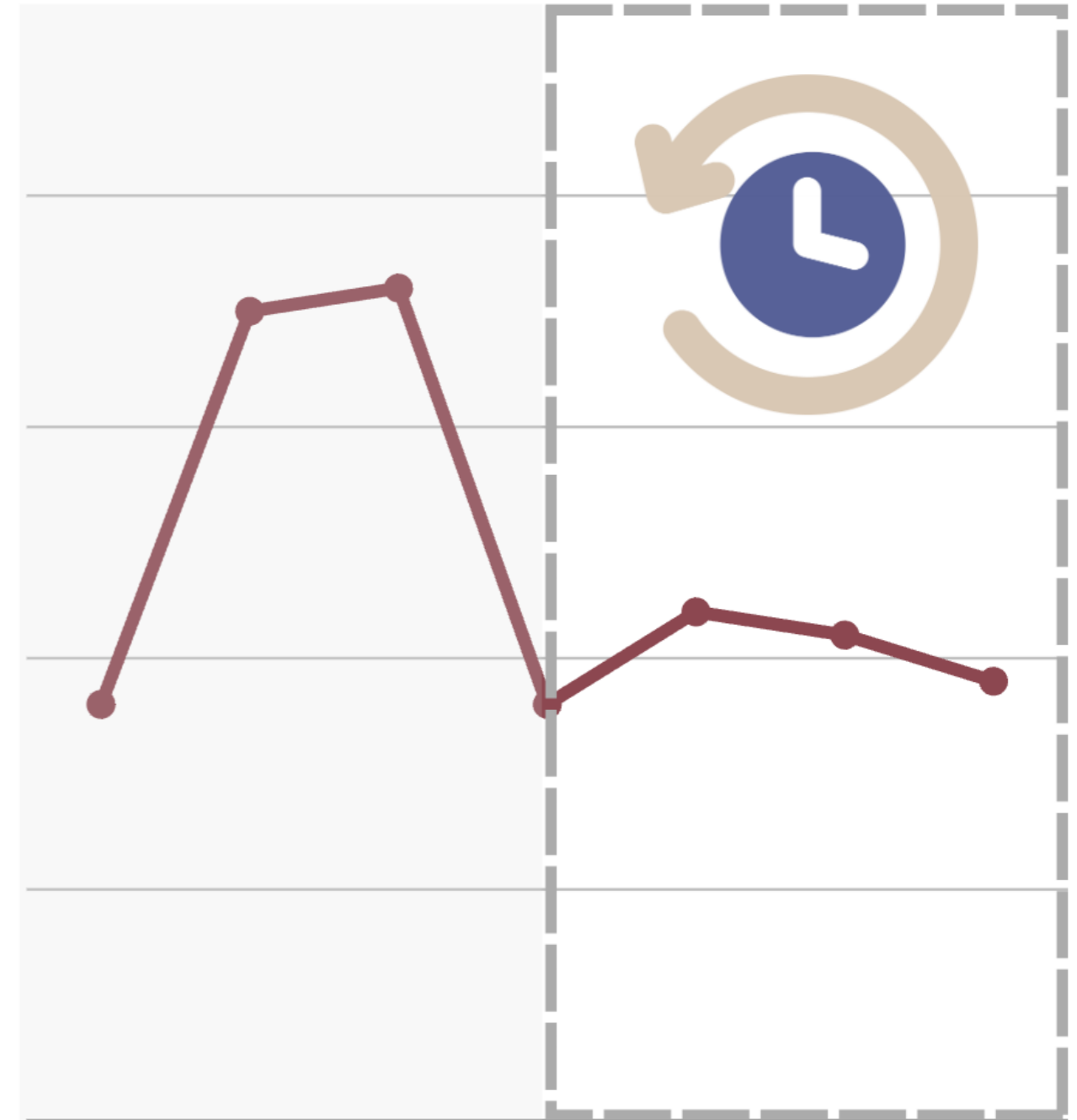The tendency to overestimate one's own abilities, knowledge, or judgments

- This bias can lead analysts to be overly confident in the accuracy or reliability of their findings

Recency bias

The tendency to give more weight or importance to recent events or information when making judgments or decisions

- It can lead analysts to prioritize recent data points or trends over historical data

- Potentially overlooking long-term patterns or trends that may be relevant to the analysis

Memory bias

Sculpting the past to fit the present

> The ways in which our memories can be distorted or influenced by various factors

- A sales manager reviewing past sales performance

- Remembering successful outcomes while downplaying or forgetting instances where similar tactics failed

Availability heuristic

Influence of easily accessible information

> A mental shortcut that relies on immediate examples that come to a person's mind when making judgments or decisions

- For example:
  - A risk analyst overestimating the likelihood of a data breach
  - Because recent news headlines have highlighted similar incidents

Anchoring bias

Influence of initial reference points

Occurs when individuals rely too heavily on initial information, when making decisions or estimations

- For example:
  - An analyst starts with an initial estimate of a parameter

  - Unconsciously adjusting their subsequent estimates or interpretations around that initial anchor

The feedback loop of cognitive biases

- Cognitive biases often lead to the reinforcement of existing beliefs and perspectives

- This often creates a **feedback loop,** where individuals consistently encounter information that aligns with their views

- It further solidifies their beliefs over time

- It leads to closed-mindedness and a resistance to considering alternative perspectives

Let's practice!

CONQUERING DATA BIAS

Reporting bias

CONQUERING DATA BIAS

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Unveiling reporting bias

- Reporting bias affects how data is presented to others

- It occurs when the decision to publish or emphasize analysis findings is influenced by the nature and direction of the results

- Reporting bias can manifest in different forms, each with its own implications for data analysis

Scenario: reporting marketing results

- A marketing manager analyzing sales data

- Selectively includes data from high-performing product lines in his reports

- He highlights positive trends and minimizes negative ones, painting a rosy picture of the company's performance

- Leading to misguided strategic decisions

Selective reporting: highlighting the positive

- The scenario illustrates **selective reporting** or otherwise called, **cherry-picking**

- It refers to intentionally or unintentionally excluding data that does not align with a predetermined conclusion or desired outcome

- This bias can lead to skewed or misleading interpretations of the available data

Publication bias: favoring significant results

It occurs when studies with statistically significant results are more likely to be published than those with nonsignificant findings

- It can lead to an overrepresentation of studies showing positive outcomes

- Resulting in skewed understanding of the true effect of interventions or treatments

Spin bias: distorting the narrative

- It involves how the included data are presented or interpreted

- It involves exaggerating the significance of findings or downplaying limitations

- For instance:
  - A company press release spinning modest sales growth as a major success story

  - Hiding underlying challenges

The origins of reporting bias

- Reporting bias occurs from various factors

- These include:
  - Intentional manipulation

  - Inadvertent oversight

  - Systemic issues within organizations

- This can lead to misguided policies, wasted resources, and erosion of trust

Let's practice!

CONQUERING DATA BIAS

Bias in algorithms

CONQUERING DATA BIAS
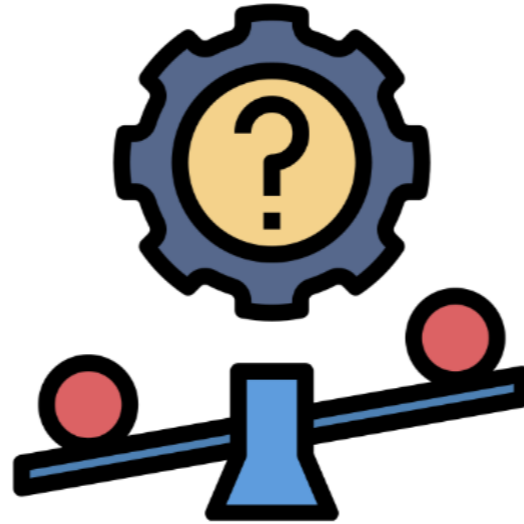
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AI and data bias

AI has various use cases:

- Personalized recommendations

- Route navigation

What happens if algorithms become **biased** against certain groups, such as **gender or race**?
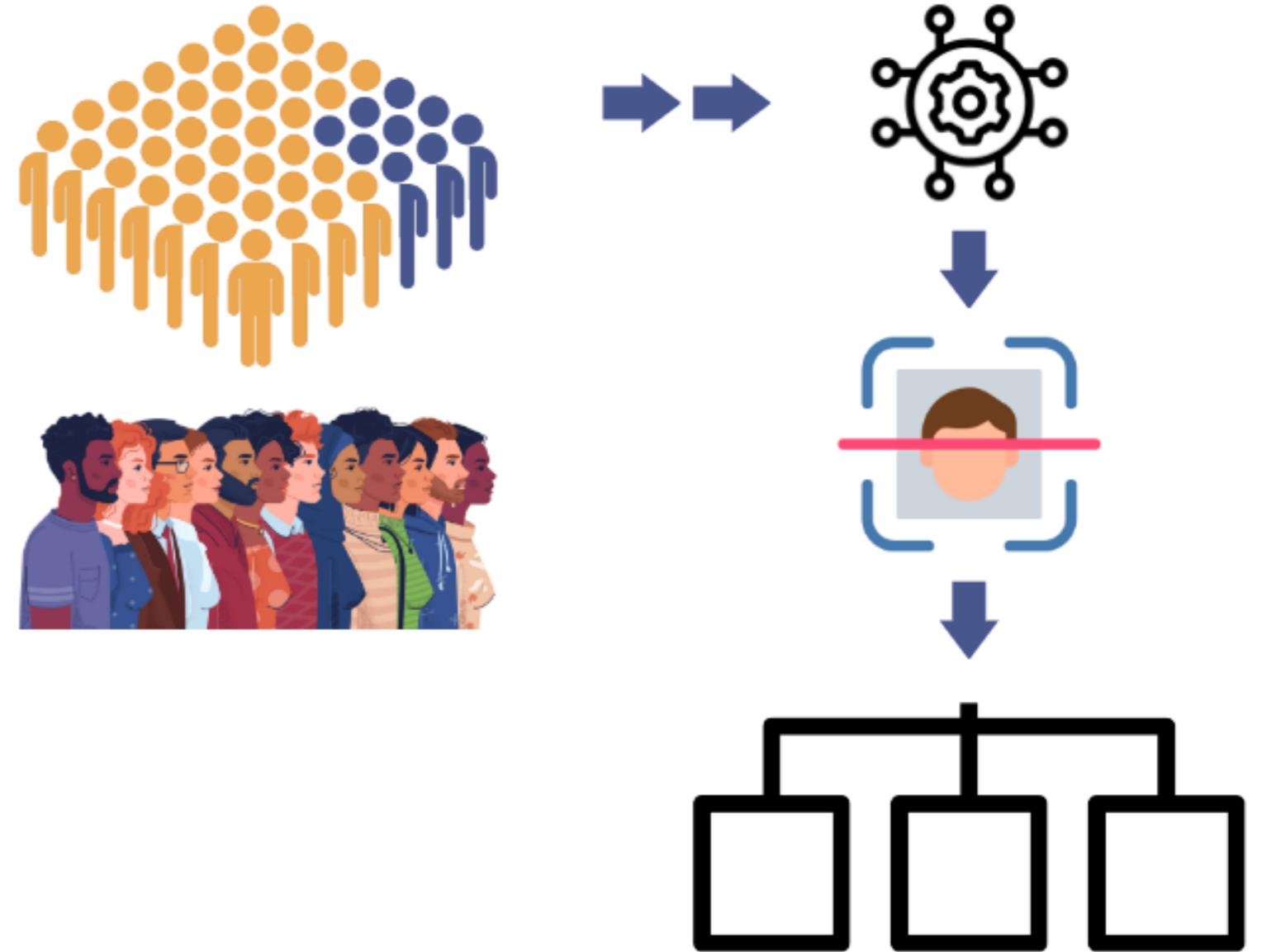
Algorithmic bias

Algorithmic bias arises when algorithms produce **systematic** and **repeatable** errors that result in unfair outcomes, favoring one group over another
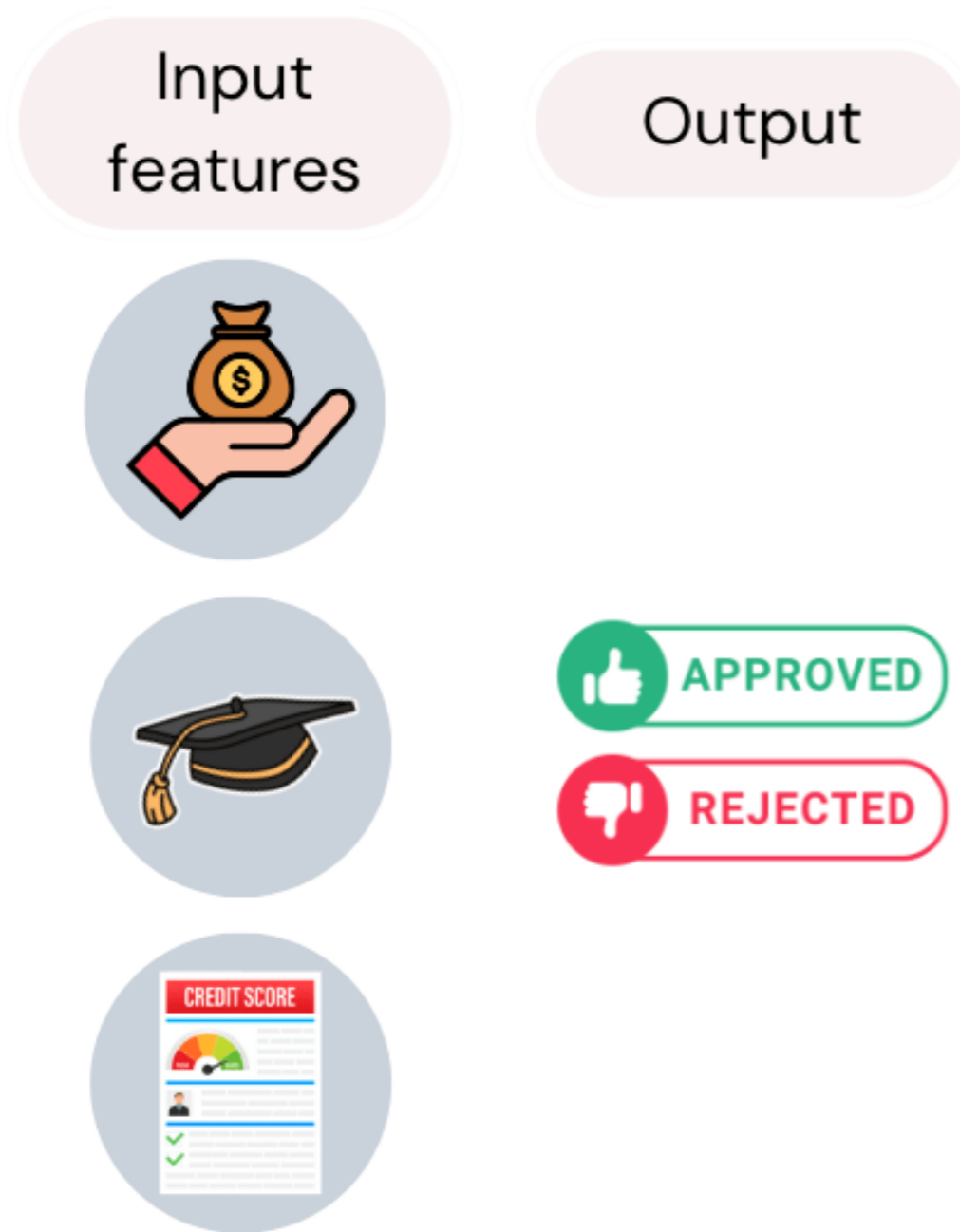
- It encompasses various types of biases that can emerge during the development and deployment of algorithms

Bias during algorithm training

- Algorithmic bias is often initiated through **bias in data collection**

- If the training data is **not representative or is biased,** the algorithm may learn and perpetuate those biases

- For example: **not having adequate representation** of diverse groups in a facial recognition algorithm

Bias in feature selection
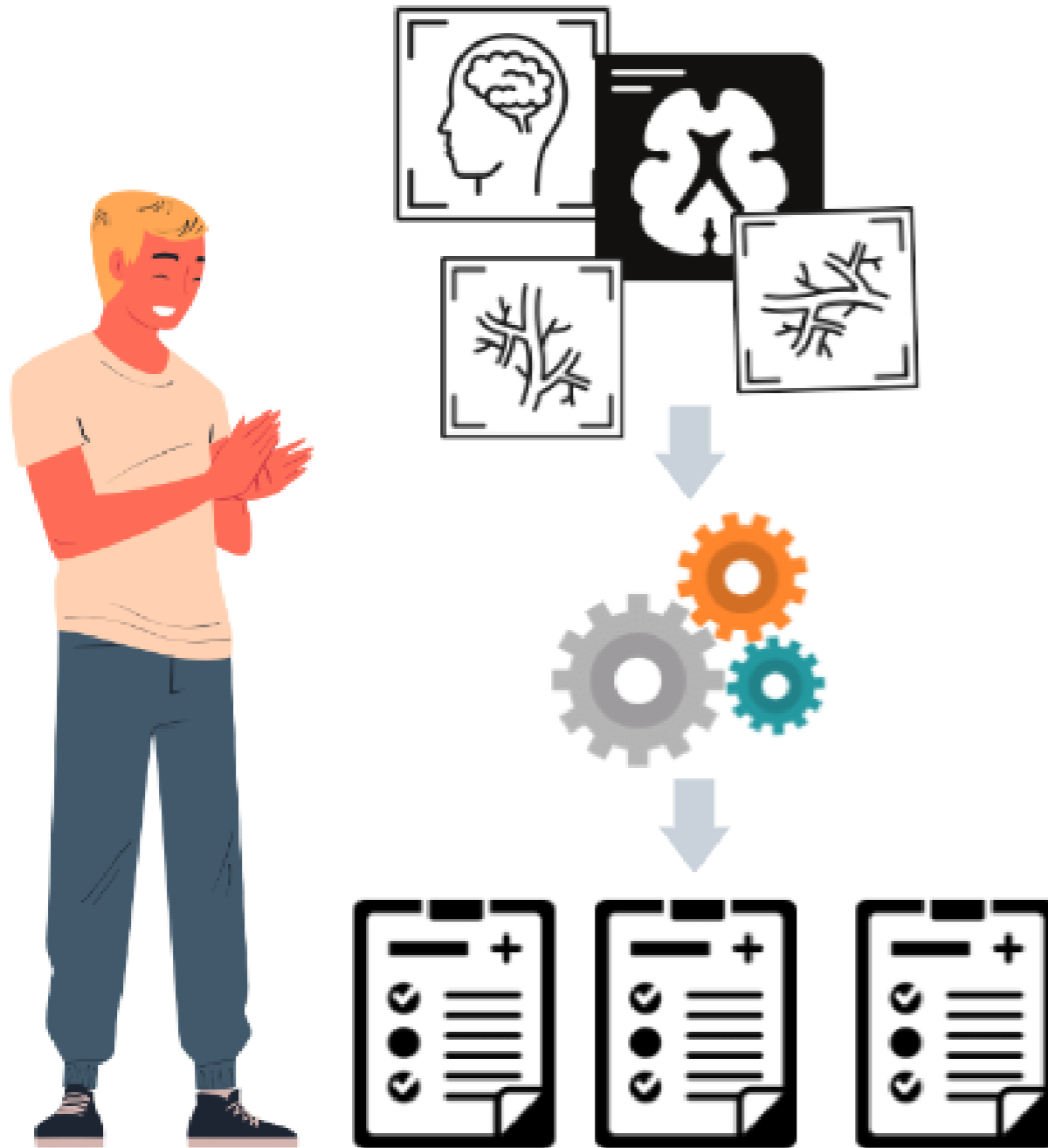
Input features

Output

APPROVED

REJECTED

- Feature selection bias happens when certain **features are chosen** for inclusion based on criteria that may lead to **unfair or discriminatory outcomes**

- Such features are race, gender, or other protected characteristics

- For example, an algorithm designed for predicting loan approvals may assume that income is the only relevant factor

Evaluation bias

- Using a non-representative dataset during the **testing phase** of an algorithm can lead to evaluation bias

- For example:
  - A movie recommendation algorithm

  - Testing performance based on only one genre

  - Missing the fact that it might not work well for other genres like romance or comedy

Automation bias

The tendency of individuals to rely too heavily on automated systems

- For example:
  - A medical diagnostic system is used to **analyze medical images,** such as MRIs
  - Automation bias occur if the system's results are trusted **without reviewing or confirming the findings**
  - This could lead to **incorrect diagnoses**

Let's practice!

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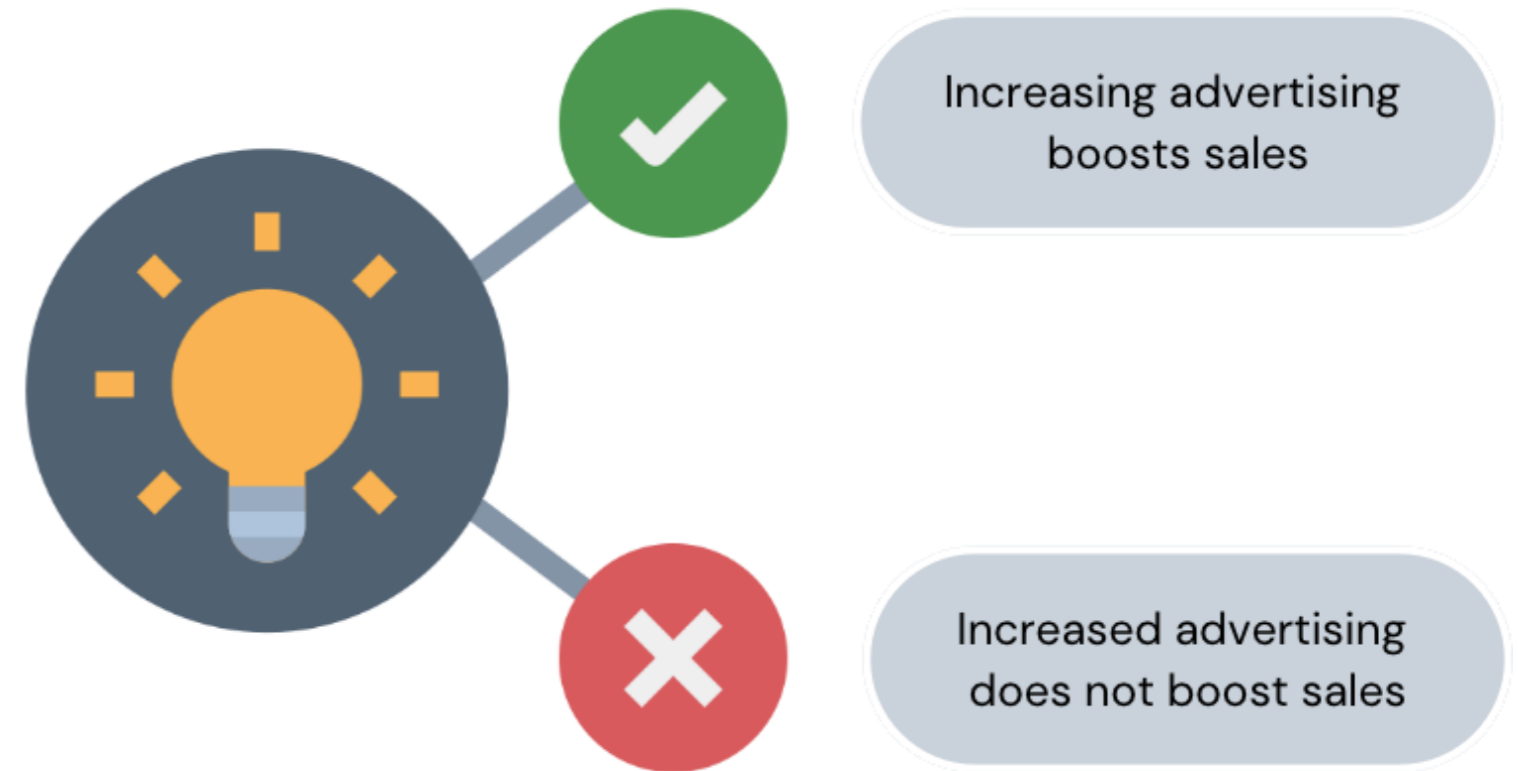
Mitigating bias in data analysis

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Conquering cognitive biases

- Actively challenge assumptions

- Remain receptive to alternative interpretations of the data

- Look at a belief we hold, and search out ways in which we are wrong

- This approach is called **negative hypothesis testing**

Increasing advertising boosts sales

Increased advertising does not boost sales
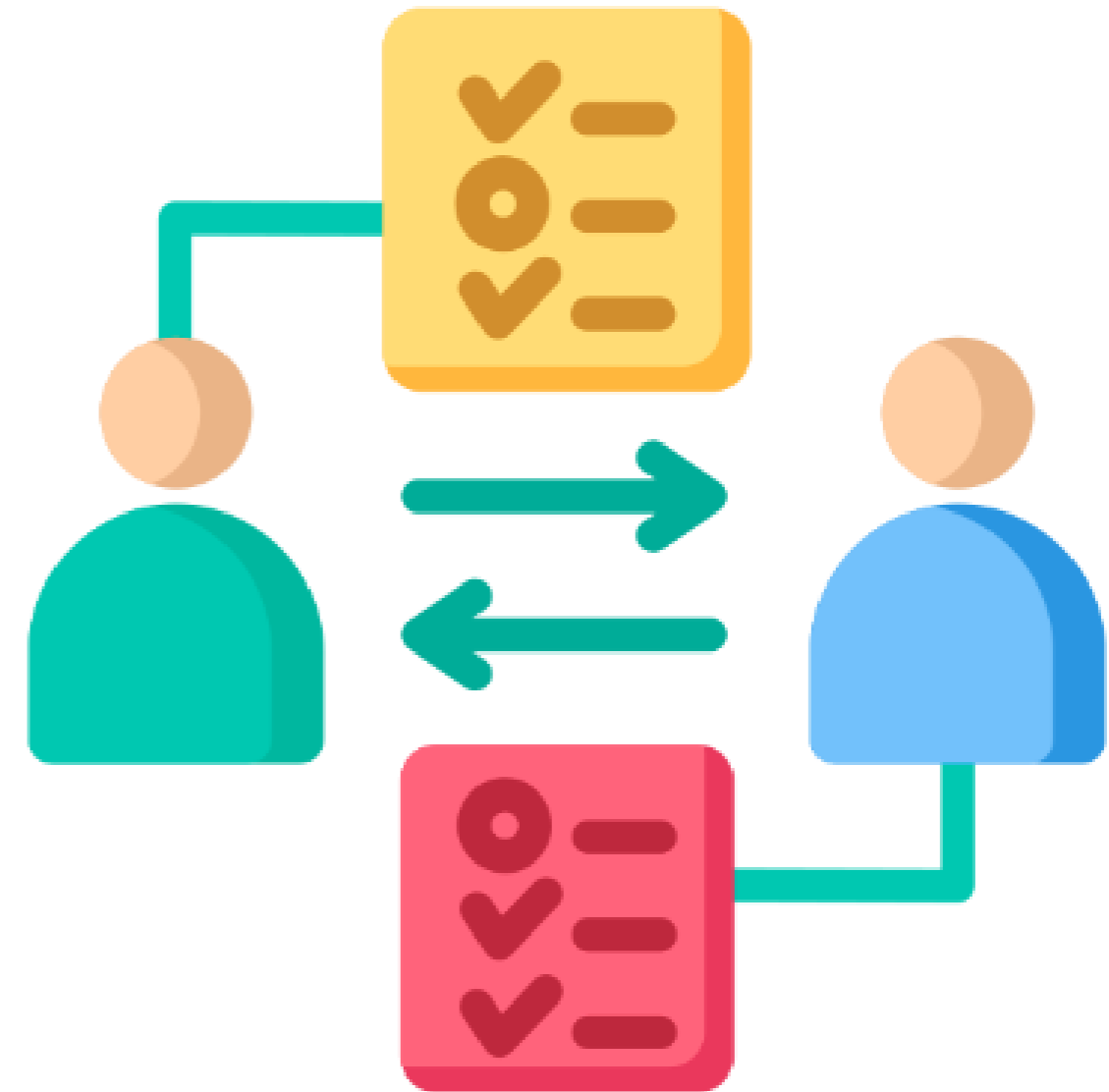
Addressing reporting bias

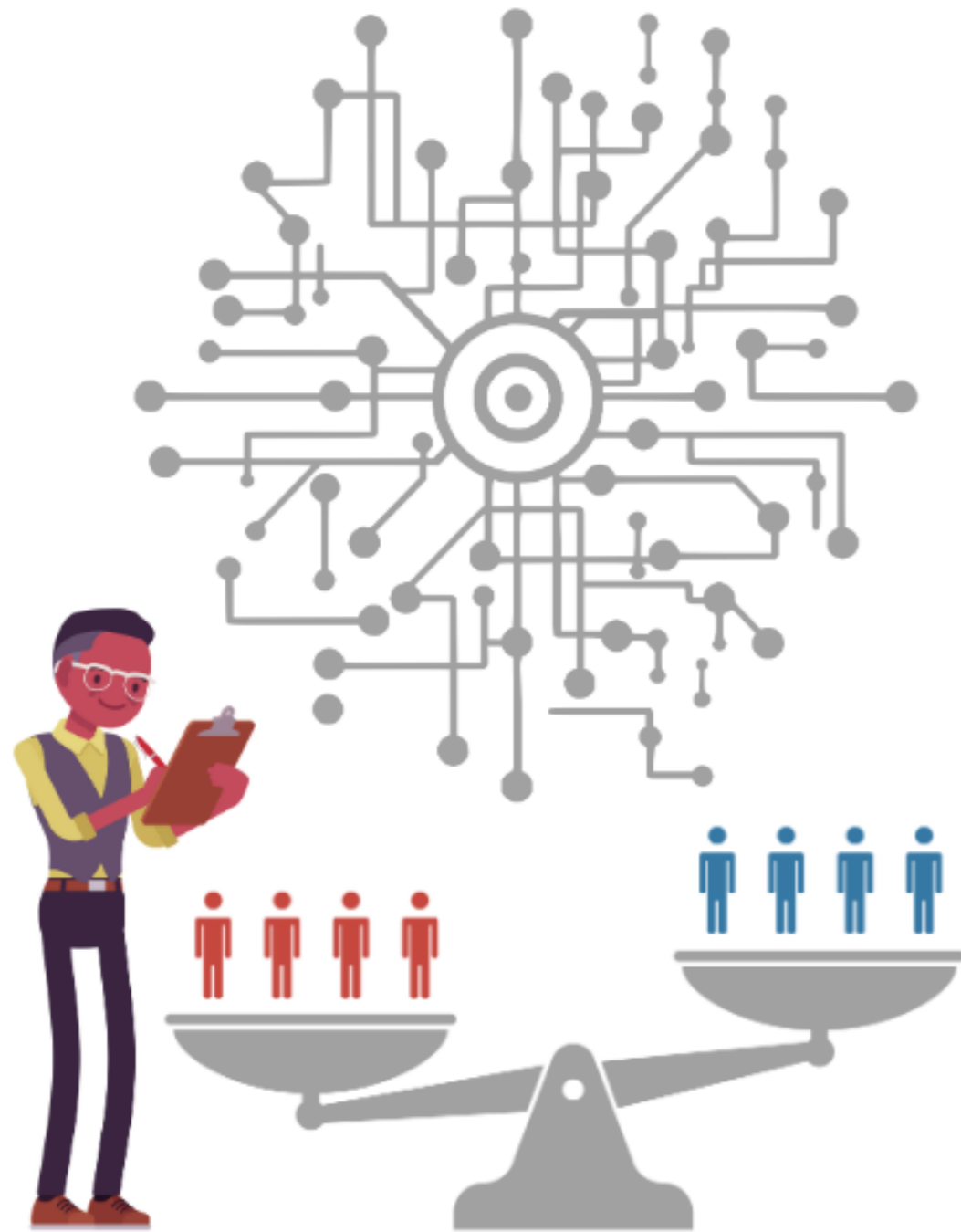- Organizations should foster a culture of **transparency, accountability, and ethical conduct**

- Implementing **standardized reporting protocols**

- This can help ensure that data reporting is impartial and comprehensive

Decision-making processes

- Implementing structured decision-making processes that encourage critical thinking and diverse perspectives
  - Conducting **peer reviews**
  - Seeking **feedback** on analysis methodologies
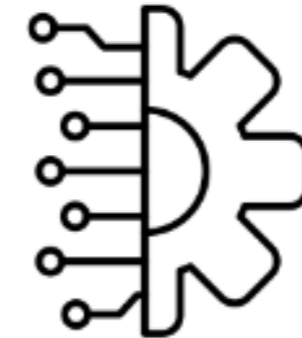
Combating bias in algorithms

- Organizations should prioritize fairness, transparency, and accountability in algorithm development and deployment

- Rigorously **assessing training data** for representativeness and diversity

- **Evaluating algorithm performance** across diverse demographic groups

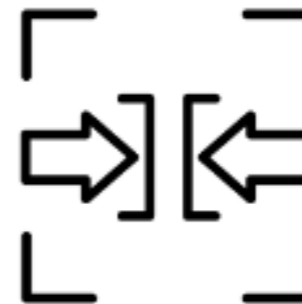- **Promoting ethical awareness** among data scientists

Bias-aware algorithm design

- Thoughtful feature engineering
  - Selecting and crafting features in an algorithm that consider different perspectives and attributes

- Fairness constraints
  - Incorporating fairness considerations directly into the model training process

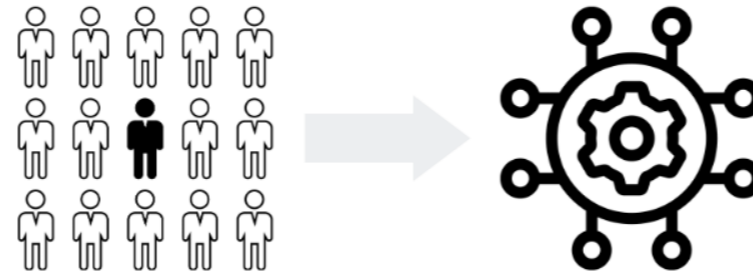 - For example, an algorithm ensuring a similar distribution across gender, or income categories

Feature engineering

Fairness constraints

Exposing algorithmic bias

- Adversarial training
  - Involves training models against adversarial examples specifically designed to expose and mitigate bias

- Bias audits
  - Involves systematically evaluating models for bias using specialized techniques and metrics (e.g demographic parity)

Incorporating explainable AI

- Explainable AI plays an important role in mitigating bias

- It can provide insights into **how algorithms arrive at their decisions**

- Data users can identify and address potential biases more effectively

Integrating mitigation strategies

- Organizations should adopt a holistic approach that integrates strategies for addressing these biases

- This is how they can enhance the integrity, reliability, and fairness of their data analyses

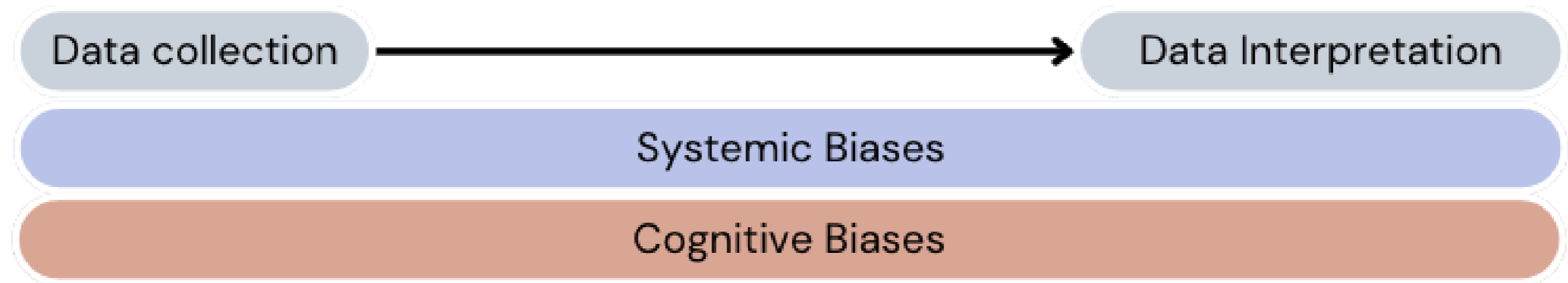# Let's practice!

CONQUERING DATA BIAS

Wrap-up

CONQUERING DATA BIAS

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Chapter 1: Understanding data bias

| Data collection | ———————————→ | Data Interpretation |

Systemic Biases

Cognitive Biases

- You unraveled the concept of data bias, exploring its development and prevalence throughout the data lifecycle

- You examined its impact on decision-making and identified various types of data bias
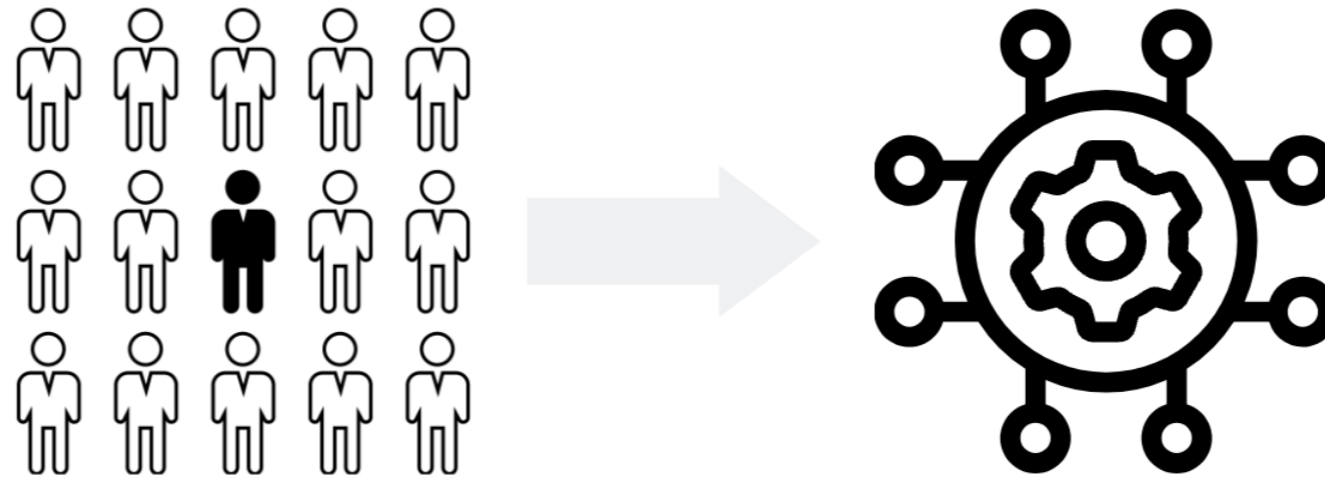
Chapter 2: Bias in data collection

- You learned to **recognize and address** selection bias, historical bias, and measurement bias

- You **explored strategies** for ensuring diverse and representative datasets

(sampling, stratified sampling, data augmentation, and standardized measurement tools)

Chapter 3: Bias in data analysis

- You explored **cognitive biases** like confirmation bias and anchoring

- You learned about **reporting bias** and its implications and how **algorithmic biases** can affect model development and outcomes

- You mastered techniques to **detect and mitigate bias**

Bringing it all together and next steps

- You're now equipped to conduct more ethical, accurate, and fair data analyses!

- Continue to explore:
  - Introduction to Data Ethics
  - Introduction to Data Privacy
  - Responsible AI Practices

Congratulations!

CONQUERING DATA BIAS