# Introduction to Decision Science

DEMYSTIFYING DECISION SCIENCE

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# Welcome


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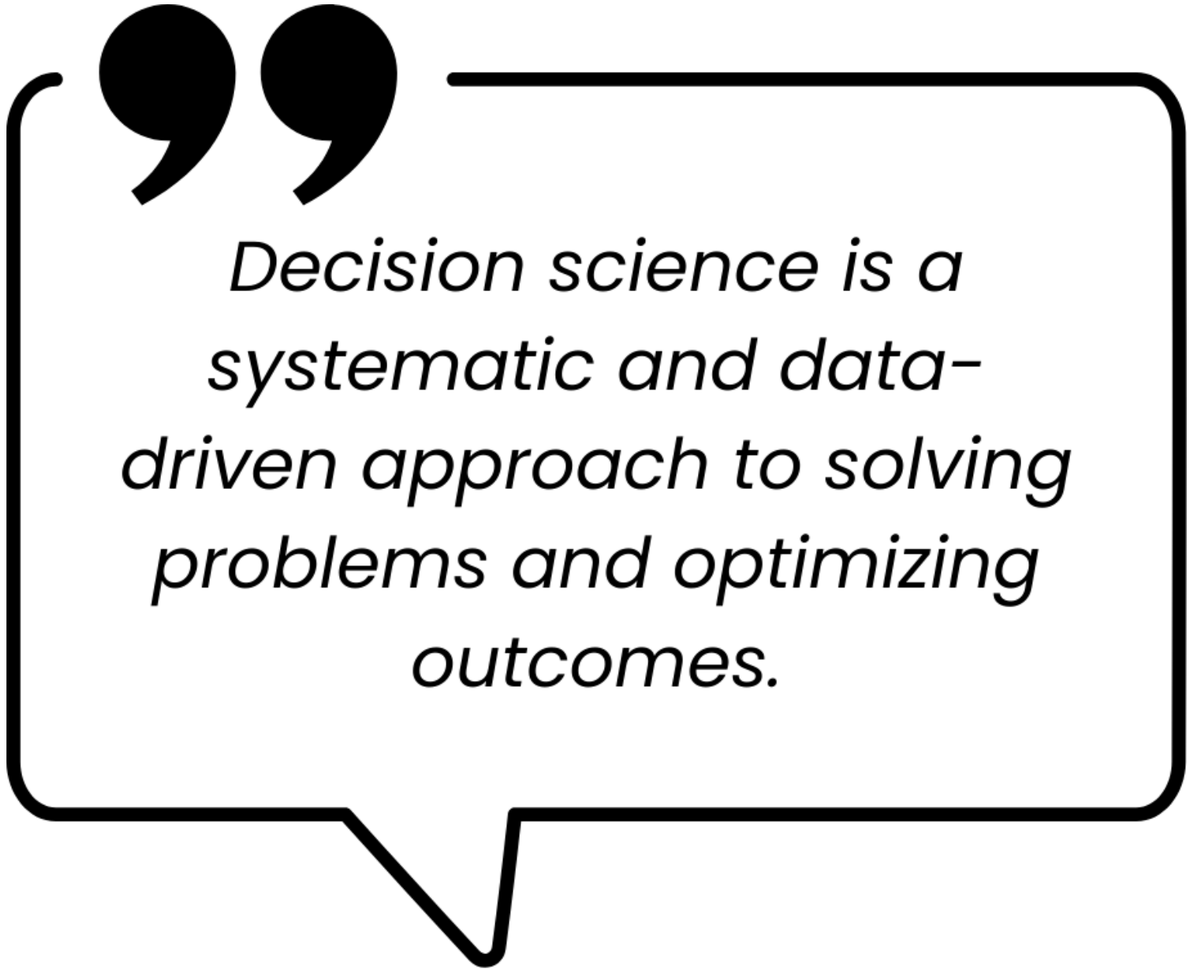
# What is Decision Science?

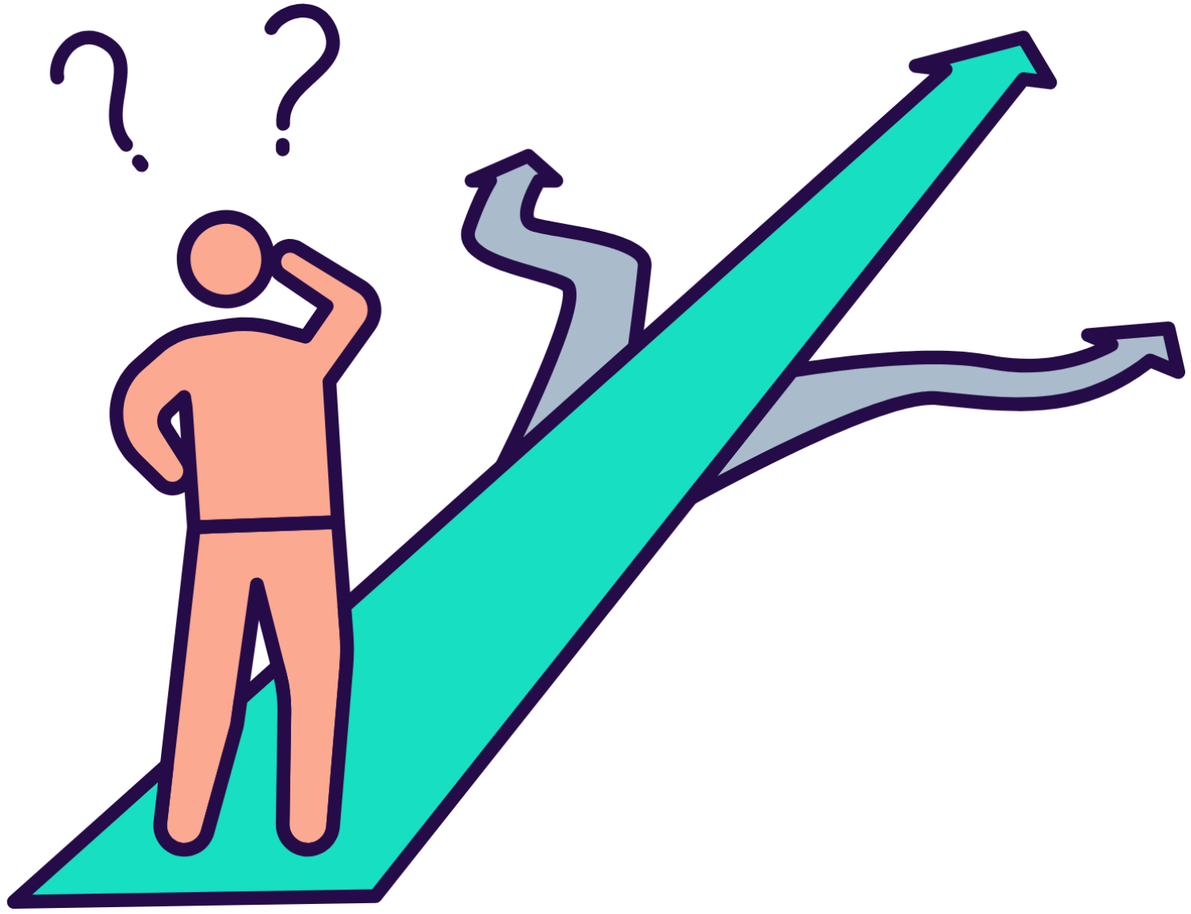
**Multidisciplinary field:**

- Mathematics
- Statistics
- Psychology
- Economics
- Computer Science



# Informed decisions

1. Define problem
2. Gather and analyze data
3. Develop and evaluate alternatives
4. Select and implement solution



# Why perfect rationality isn't realistic

**Traditional decision-making models assumed:**

- Perfect rationality
- Complete information
- Free from bias and emotion

**Bounded rationality:**

- Humans have cognitive limits
- Limited information and time
- Subject to emotions and biases

# Data-driven decision-making

**Advantages of data-driven decisions:**

- Objective insights and clarity
- Identification of trends
- Accurate predictions and reduced uncertainty

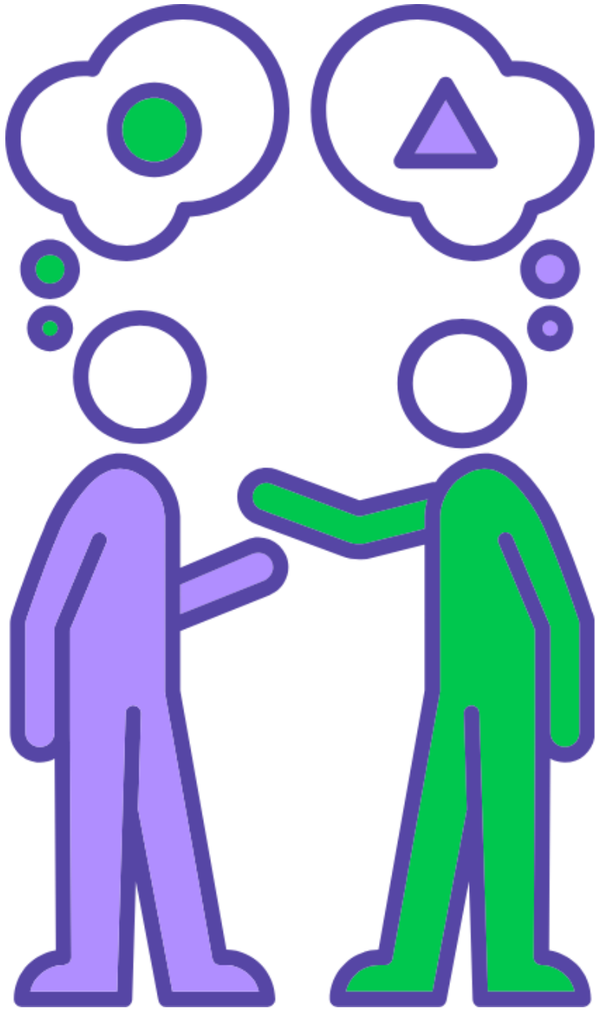
**Real-world example (Finance forecasting):**

- Data-driven guidance on investment choices
- Goal: Maximize growth, profitability, and minimize risk

# Unconscious bias

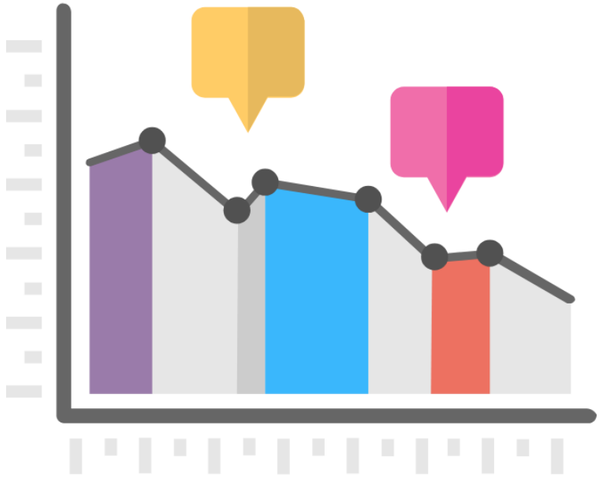
- **Confirmation bias:** Seeking information that supports existing beliefs
- **Anchoring bias:** Over-relying on initial information
- **Loss aversion:** Preferring to avoid losses over acquiring equivalent gains
- **Availability heuristic:** Overestimating likelihood of easily recalled events

*Decision science helps us to recognize and mitigate these biases*



# Descriptive analytics

- Uses data visualization and summary statistics
- Explains what happened historically



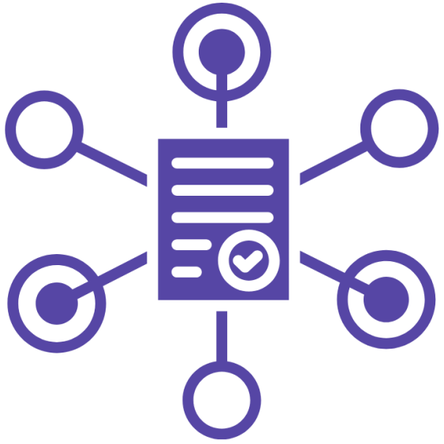
# Prescriptive analytics

- Uses optimization and simulation
- Recommends best actions based on historical data analysis

**Decision science** offers a structured framework for informed decision-making

Success comes from:

- Clearly understanding the decision-making process
- Recognizing and managing human limitations and biases
- Leveraging data-driven techniques to improve outcomes



# Let's practice!

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# Introduction to decision-making

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# Decision Science in action

Decision Science impacts many domains:

- **Business:** Determining successful product launches
- **Healthcare:** Developing personalized treatment plans

**In this video, we'll explore:**

- Data-driven decision-making tools and techniques
- Methods to solve complex problems effectively
- Frameworks to facilitate a systematic approach to decision-making

# Applying decision-making frameworks

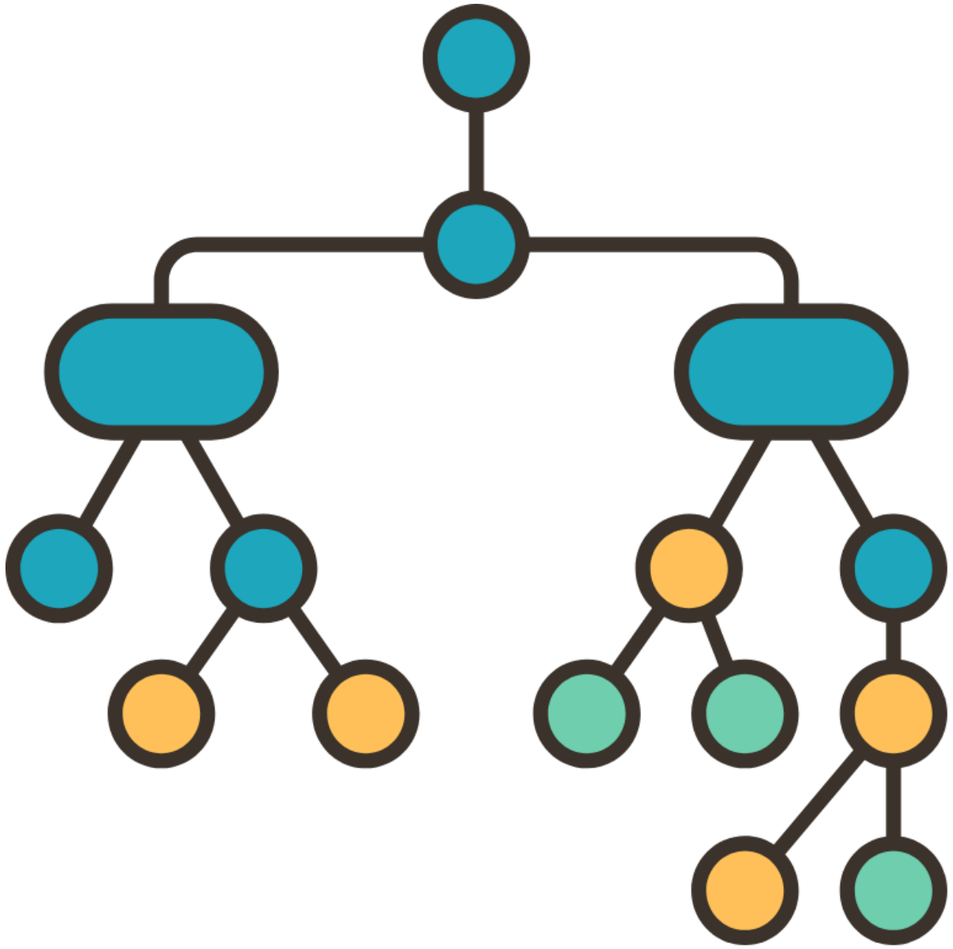

**Scenario:**

- Job A: Higher salary, requires relocation
- Job B: Lower salary, better work-life balance

**Decision-making challenge:**

- Gut feeling versus structured evaluation
- Systematic assessment of pros and cons

# Decision trees



**A structured, tree-like decision framework**

- Applicable to a variety of problems
- Can include probabilities and uncertainties
- Provides a visual representation of the decision

# Expected value


- **Expected value:** Calculates the average outcome considering probabilities of outcomes
- **Example: Investing in a startup**
  - Success: substantial returns
  - Failure: financial loss
  - Expected value clarifies the overall worth of the investment
- **Importance in decision trees:**
  - Enables informed, strategically optimized decisions

## Game theory

- Analyzes strategic interactions
- Outcomes depend on decisions of multiple individuals
- Used in economics, politics, biology

Used to understand how individuals make decisions in competitive situations

## A/B testing

- Experimental approach comparing outcomes between groups
- Randomly assigns participants to different conditions
- Commonly used in marketing, web design, product development

Used to test which choice is likely to succeed

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# Framing and problem definition

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# The first step - framing the problem

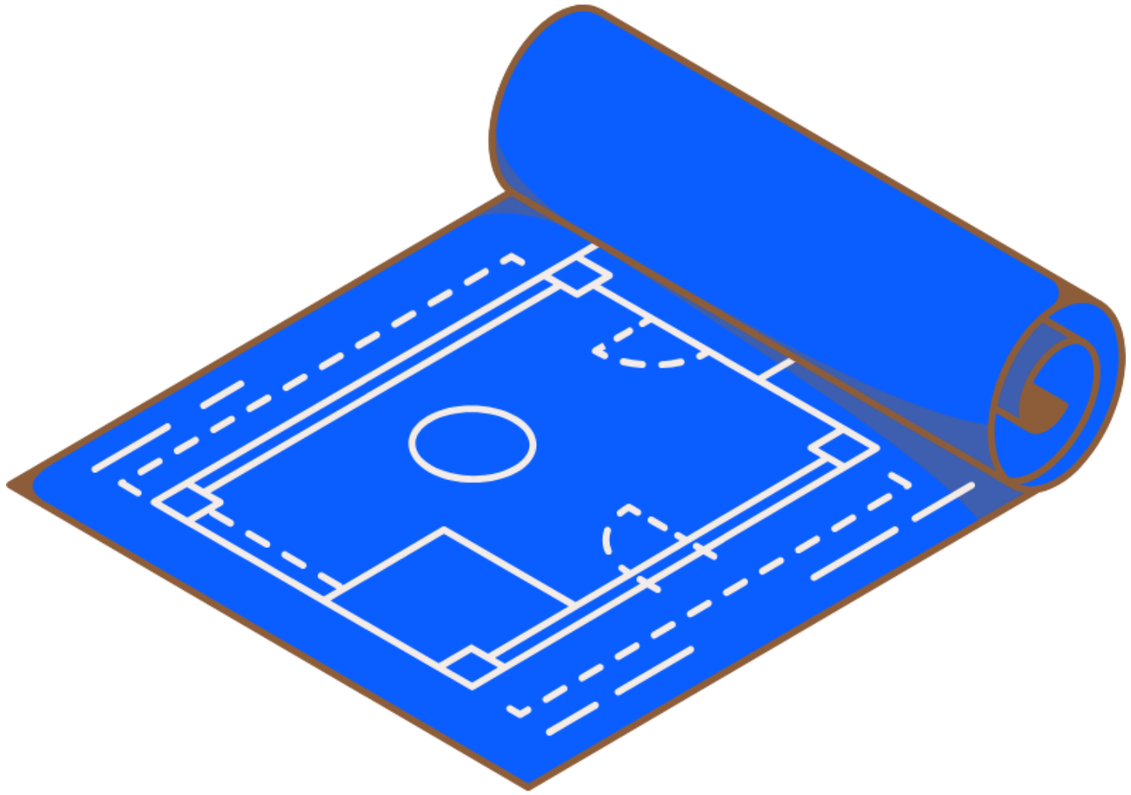
- First and most critical step
  - Guides data collection, analysis, and decision-making

**Building without a blueprint:**

- Without a clear problem definition, projects become disorganized and ineffective

**Without a well-defined problem:**

- Wasted resources
- Misdirected analyses
- Failing solutions



**5 Whys:**

- Repeatedly ask "why" to uncover the root cause
- Example: Declining sales -> Poor service -> Ineffective marketing

**Fishbone Diagrams:**

- Visual tool that categorizes potential causes
- Common categories: people, process, technology

**SMART Goals:**

- Frame problems using Specific, Measurable, Achievable, Relevant, and Time-bound criteria
- Helps set clear direction and define success

**SMART goals best practices:**

- Clearly define your target audience or subject
- Establish measurable criteria for success (e.g., KPIs, specific outcomes)

# Context is crucial

- **Business objective:**
  - Define the specific goal the decision aims to achieve
  - Examples: increase revenue, reduce costs, improve satisfaction, speed up service
- **Constraints:**
  - Identify limitations that may impact solutions
  - Examples: budget, timeline, staffing, IT infrastructure, ethical concerns
- **Stakeholders:**
  - Recognize who is affected or involved
  - Examples: decision-makers, data owners, end users

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# Ethical considerations in decision-making

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# The responsibility of Data Science

- Data Science empowers decisions across industries
- Ethical use is essential for trust and fairness

# Case Study: Optum

- **Optum's algorithm unintentionally favored healthier patients**
  - Designed to predict care needs, it prioritized those with higher healthcare spending
- **Bias emerged from flawed data assumptions**
  - Using spending as a proxy for need led to racial disparities, disadvantaging those with less access to care

## Fairness

## Privacy and security

## Transparency and reproducibility

## The social impact of data

# Bias in machine learning models


**Bias in = Bias out**

- Machine learning models reflect the biases and gaps in the data they are trained on

**Fairness can be measured**

- Evaluate model performance across different groups to assess fairness

# Protecting data

Decision scientists and organizations must ensure secure and responsible data handling

**Involves:**

- Secure infrastructure with updated protections
- Restricted access: only minimum data needed per role
- Consent-based data collection for personal data

**Why it matters:**

- Breaches reduce trust
- Can lead to lawsuits
- Damage reputation and profitability

## Transparency

Ensures clarity and accountability

- Report data sources, cleaning steps, analysis methods, collected metrics, and uncertainty levels

## Reproducibility

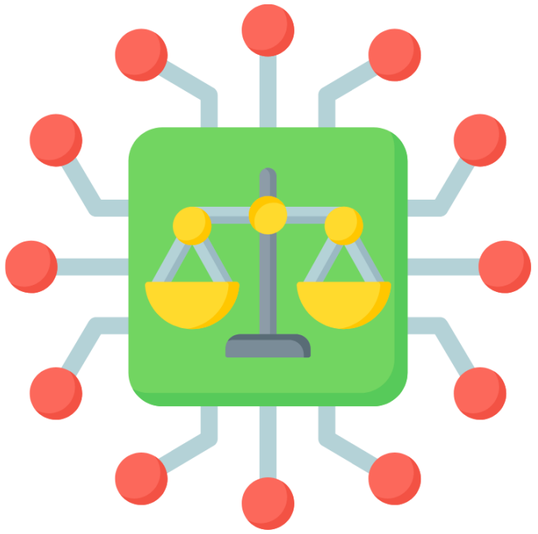
Reproducibility builds trust and credibility

- Others should be able to repeat the analysis with the same data and methods and get the same results

# Ethics at the heart of decision science

Ethical considerations are integral to responsible decision science

- Ethics is not optional - it's essential
- Prioritize fairness, justice, and benefit
- Apply ethical principles across the data lifecycle



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