

# Constructing Decision Models

DECODING DECISION MODELING



Tiago Brasil  
Lead Data Engineer

# Decision Models

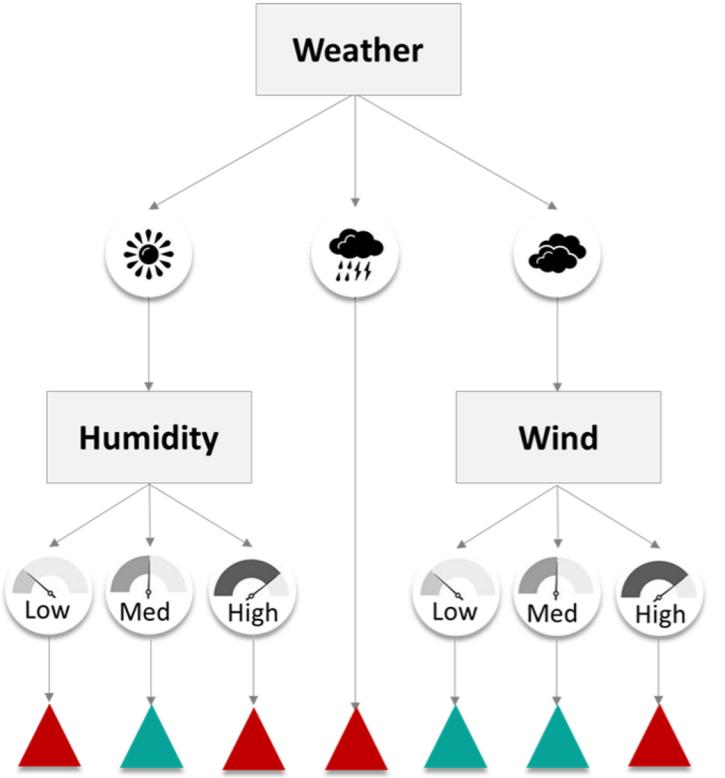
Decision modeling is a systematic approach to represent, analyze, and optimize the decision-making process.

These models formalize decision problems by structuring them into elements using:

- Graphical representations
- Mathematical operations
- Computational techniques



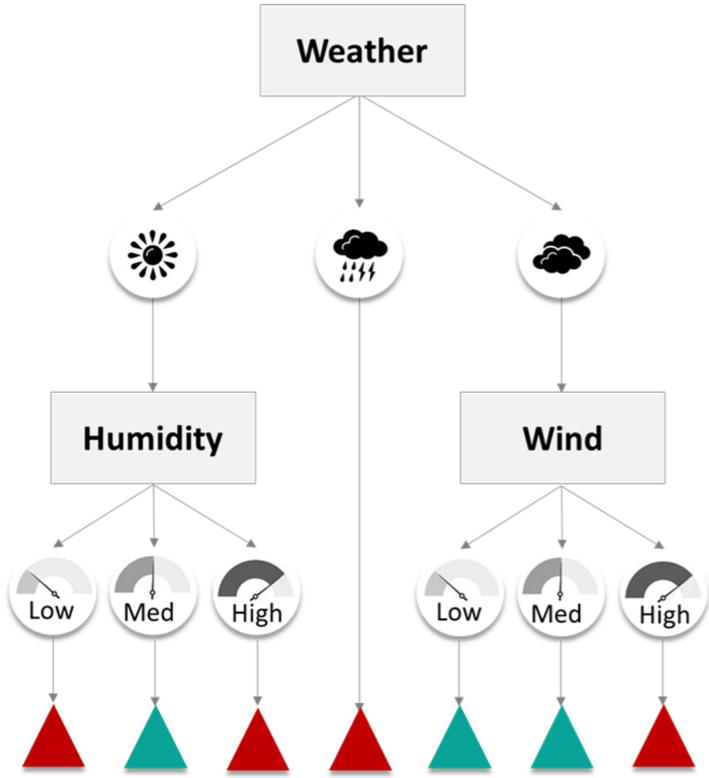
# Decision modeling techniques



## Decision Trees

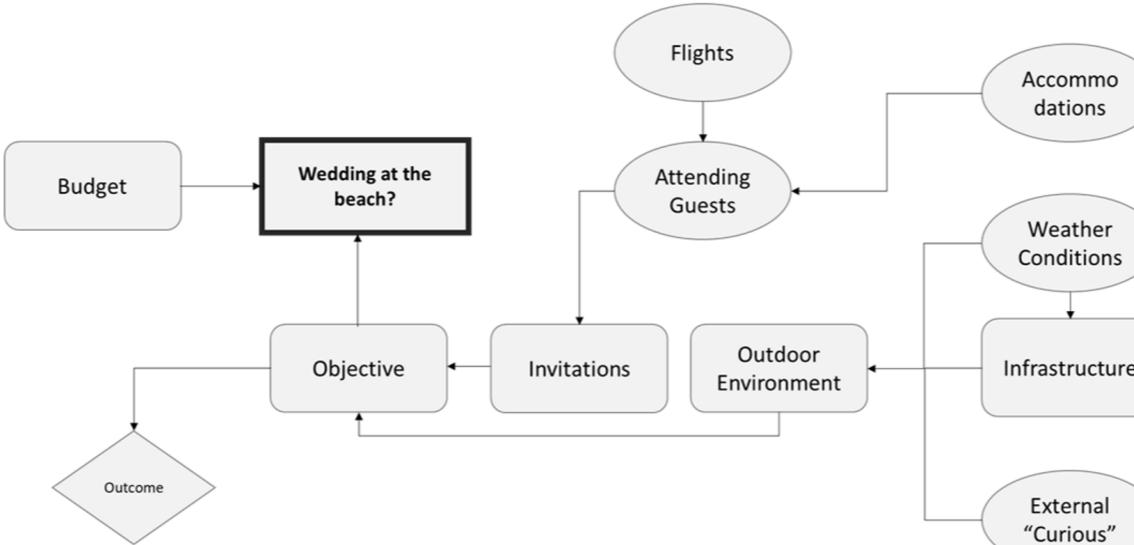
- Sequential choices
- Uncertain outcomes

# Decision modeling techniques



## Decision Trees

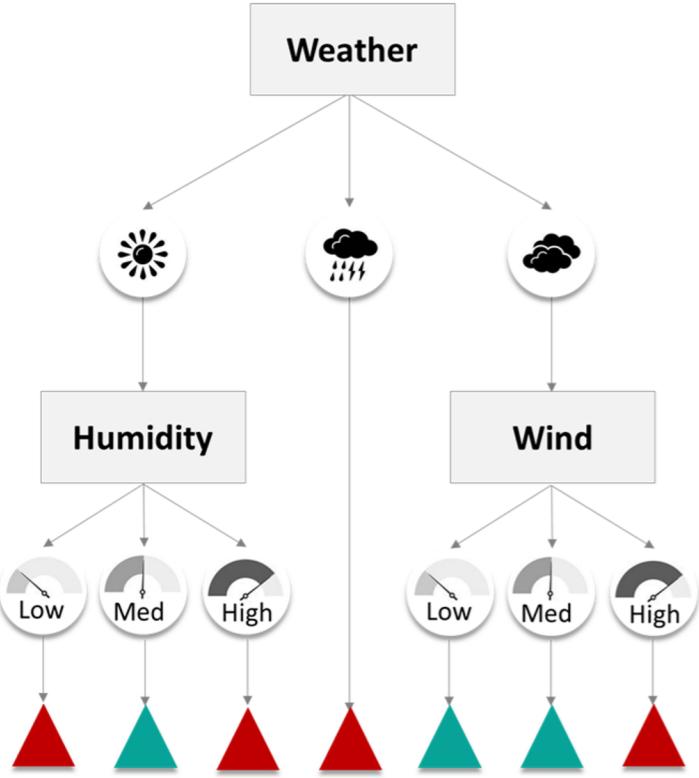
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## Influence Diagrams

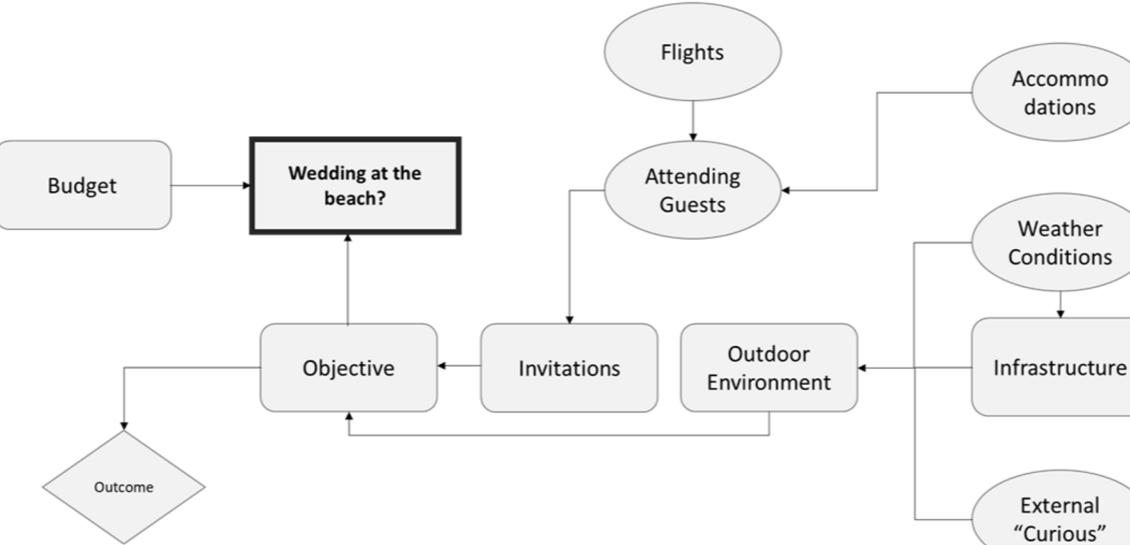
- Causal relationships

# Decision modeling techniques



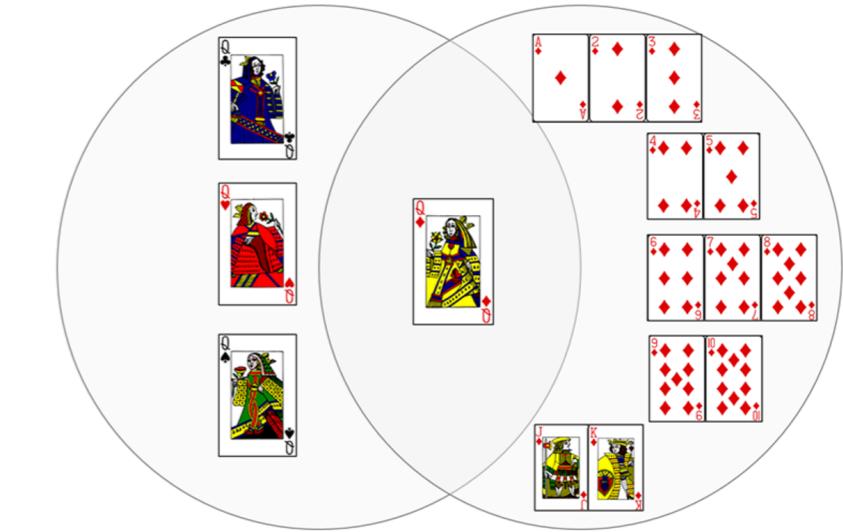
## Decision Trees

- Sequential choices
- Uncertain outcomes



## Influence Diagrams

- Causal relationships



## Probabilistic Models

- Probabilistic relationships

# Decision Trees

**Decision Nodes**

The decision to  
be made



# Decision Trees



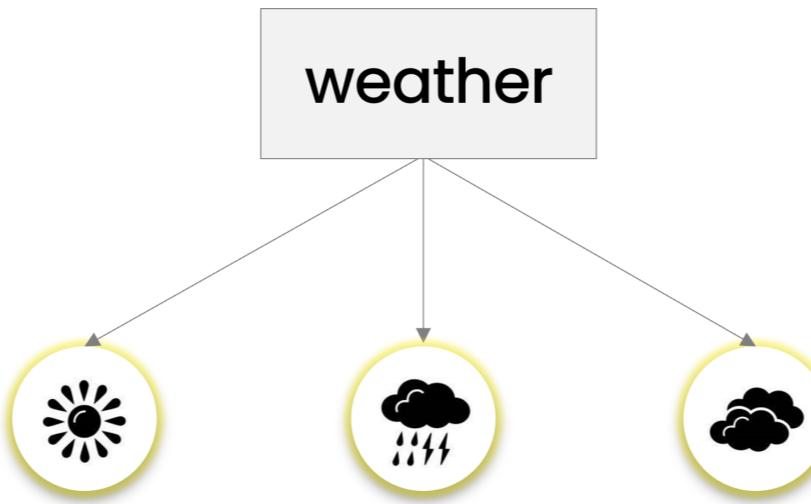
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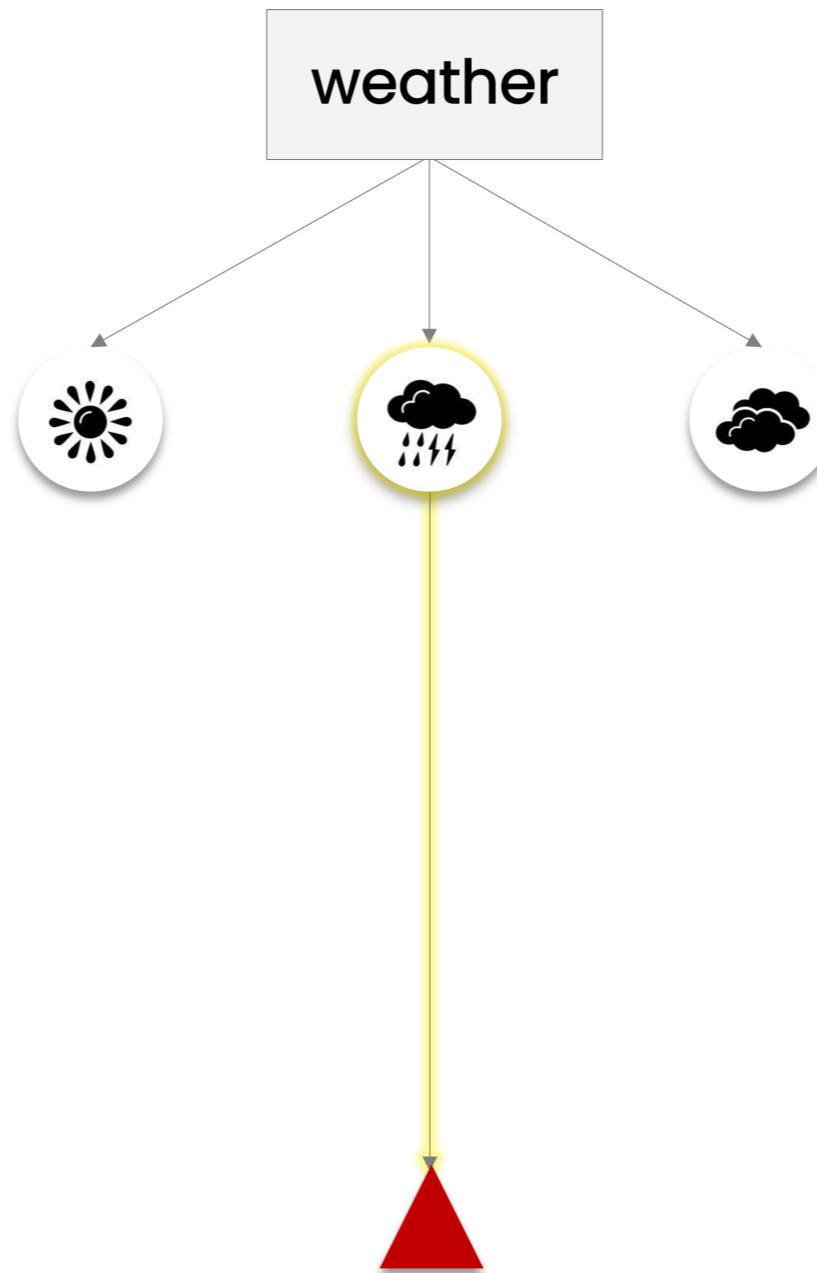
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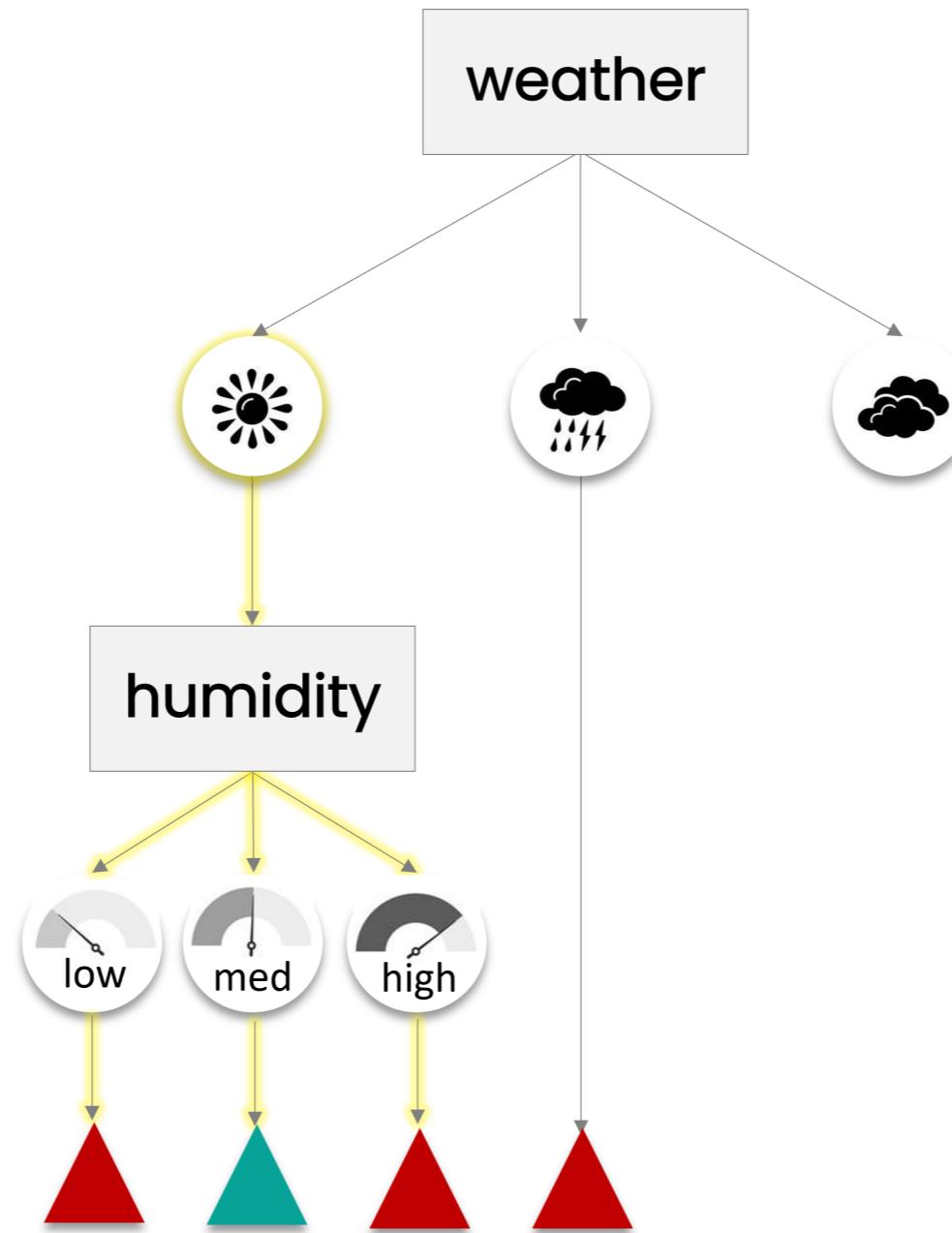
# Applying a Decision Tree



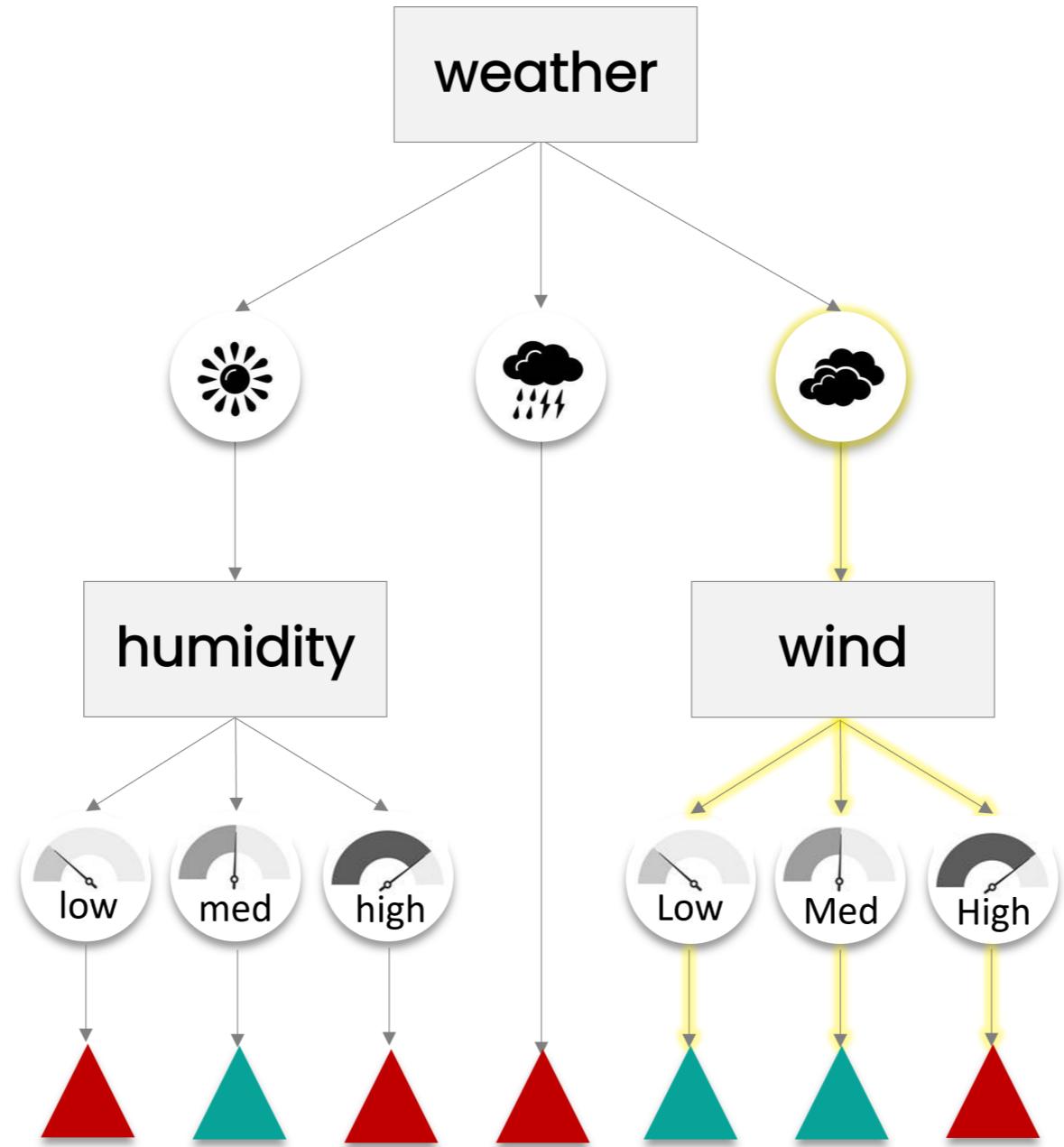
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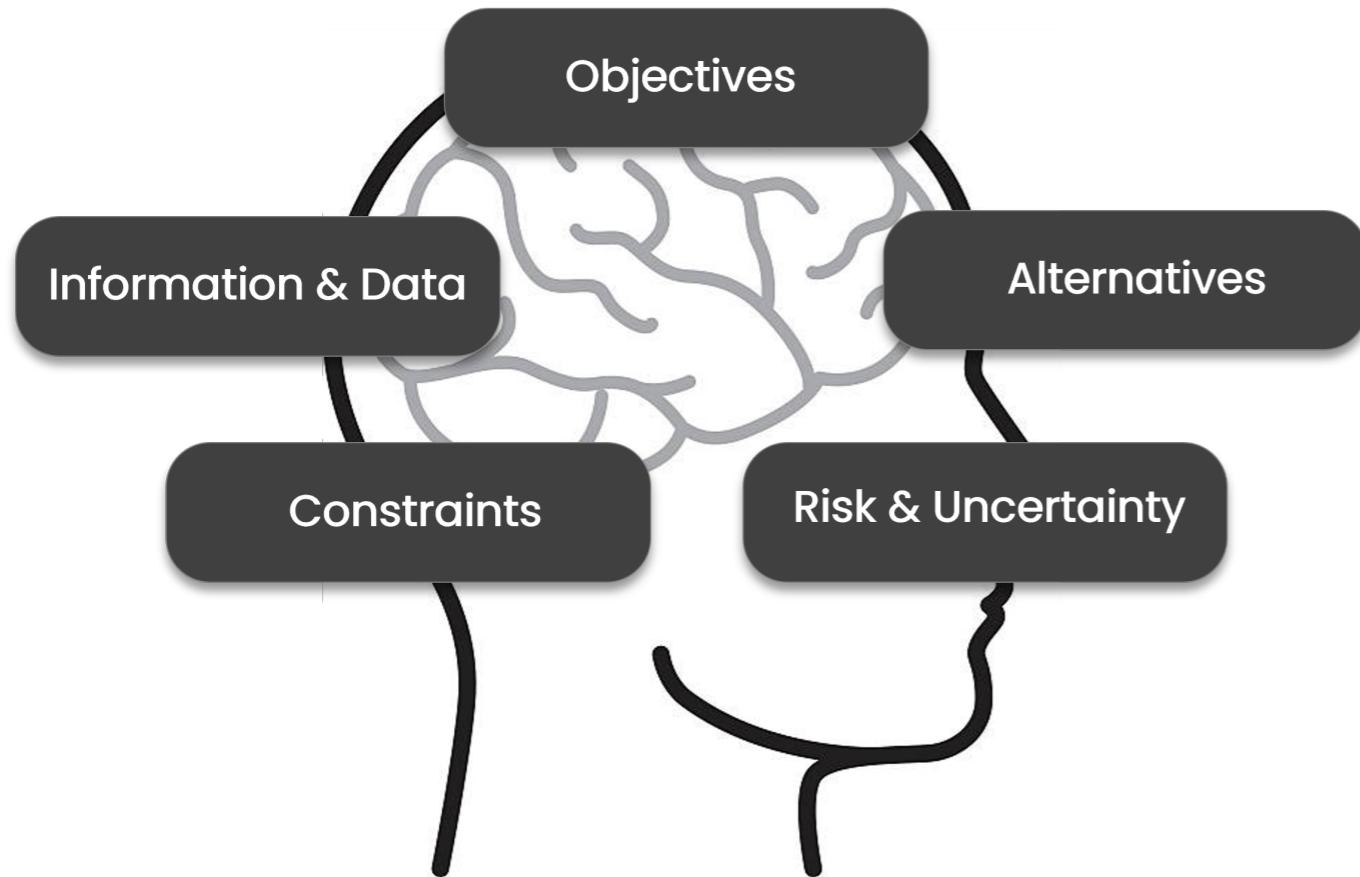


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# Influence Diagrams

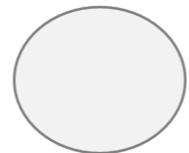
## The Decision Factors



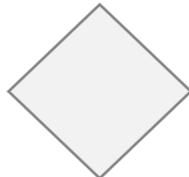
## Symbols in an Influence Diagram



Decision: The root question



Uncertainty: Unknown or uncontrolled variables



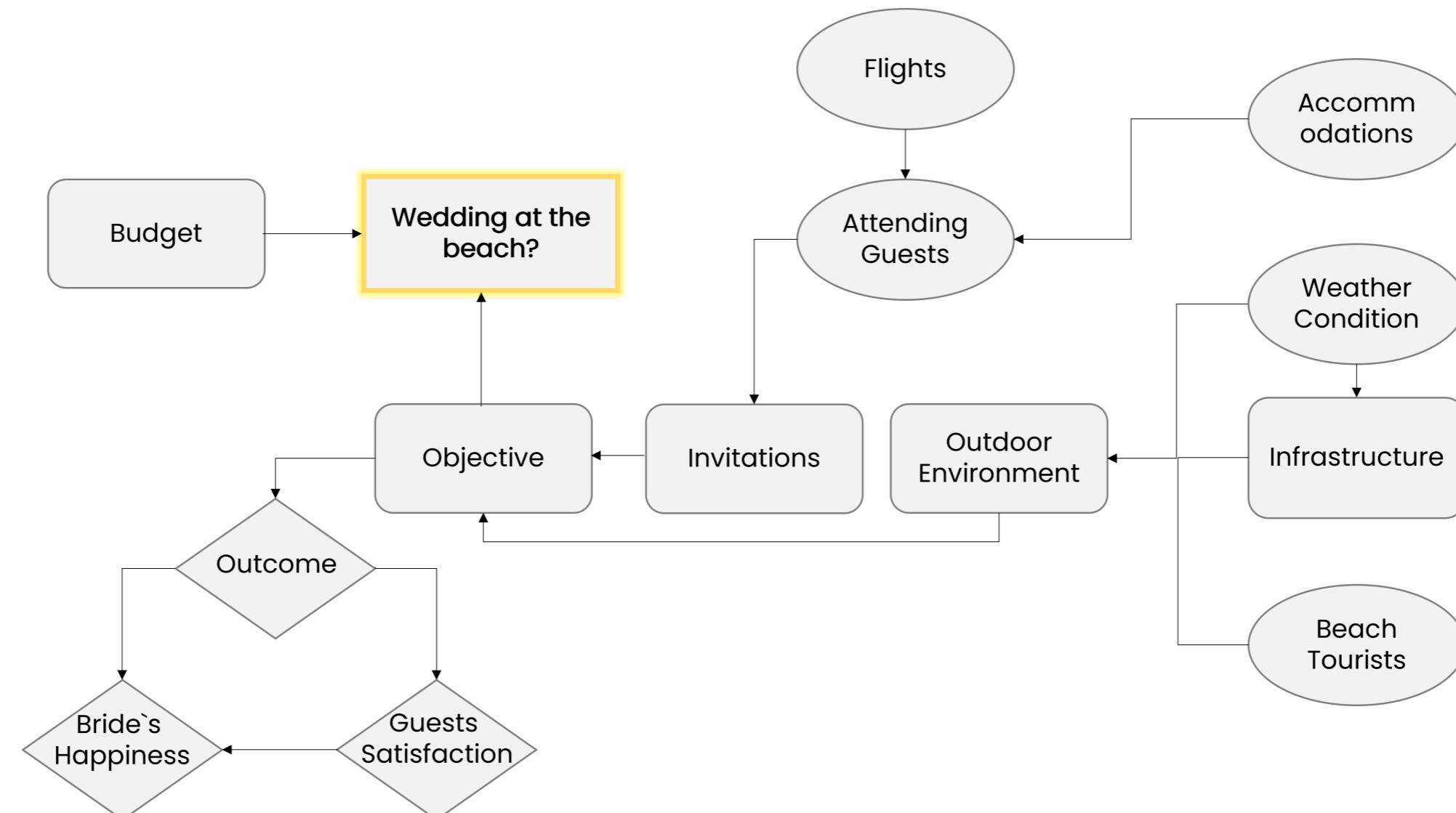
Value: Final Decision Outcome



Function: Calculated variables

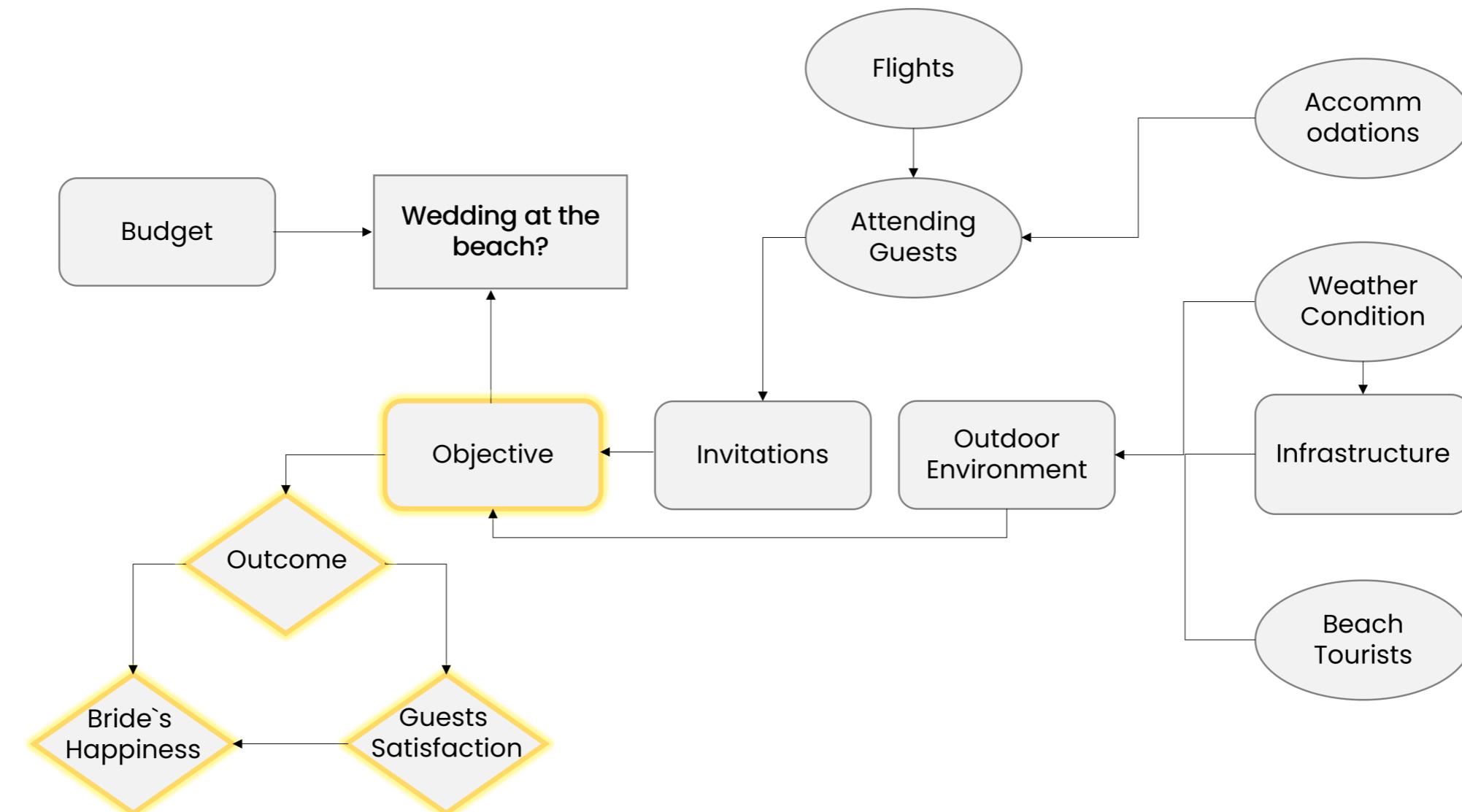
# Applying an Influence Diagram

The Millers are finally getting married! They're considering a beach wedding at sunset. What variables can influence this decision?



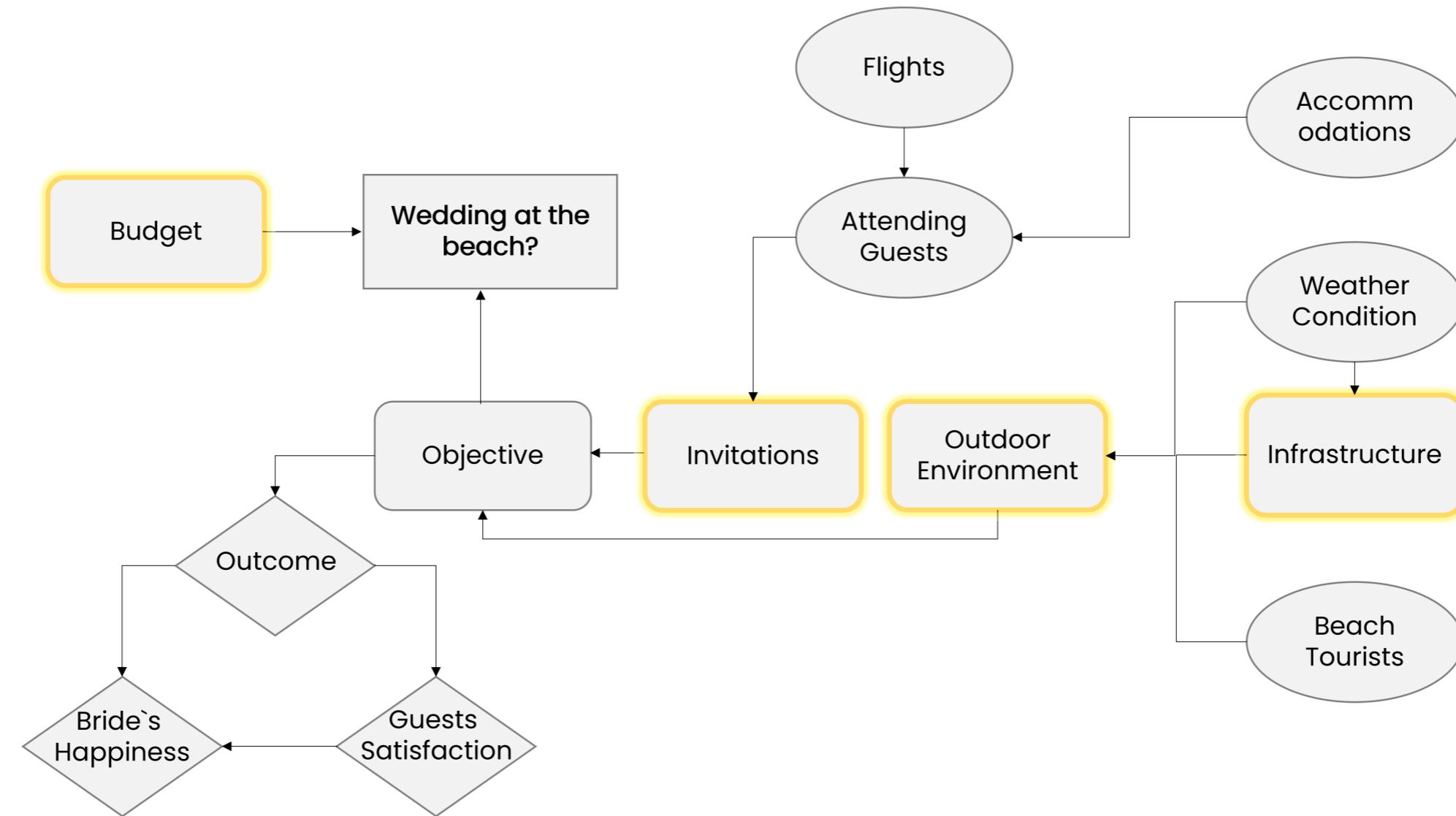
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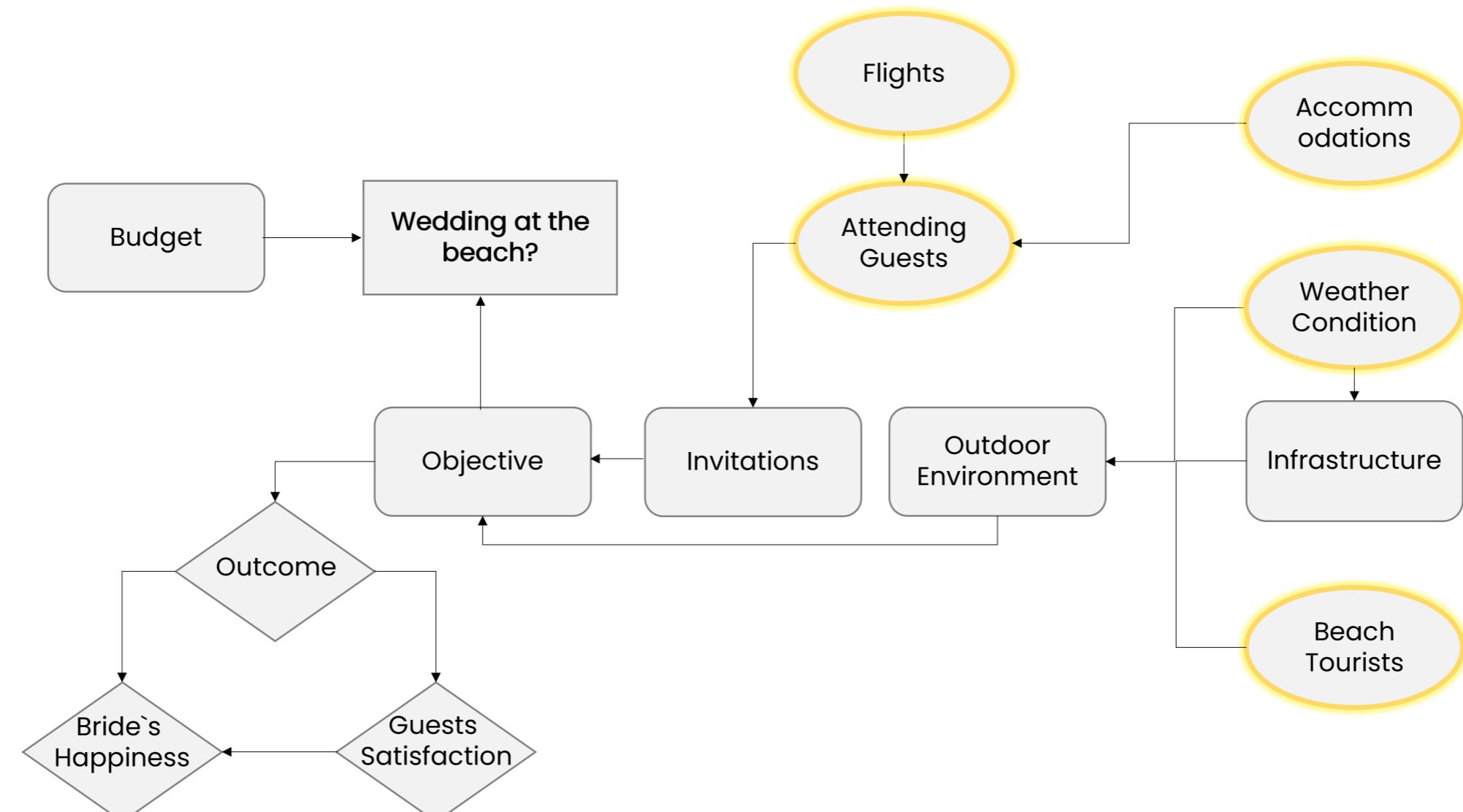
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# **Let's practice!**

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# Probabilities in Decision Models

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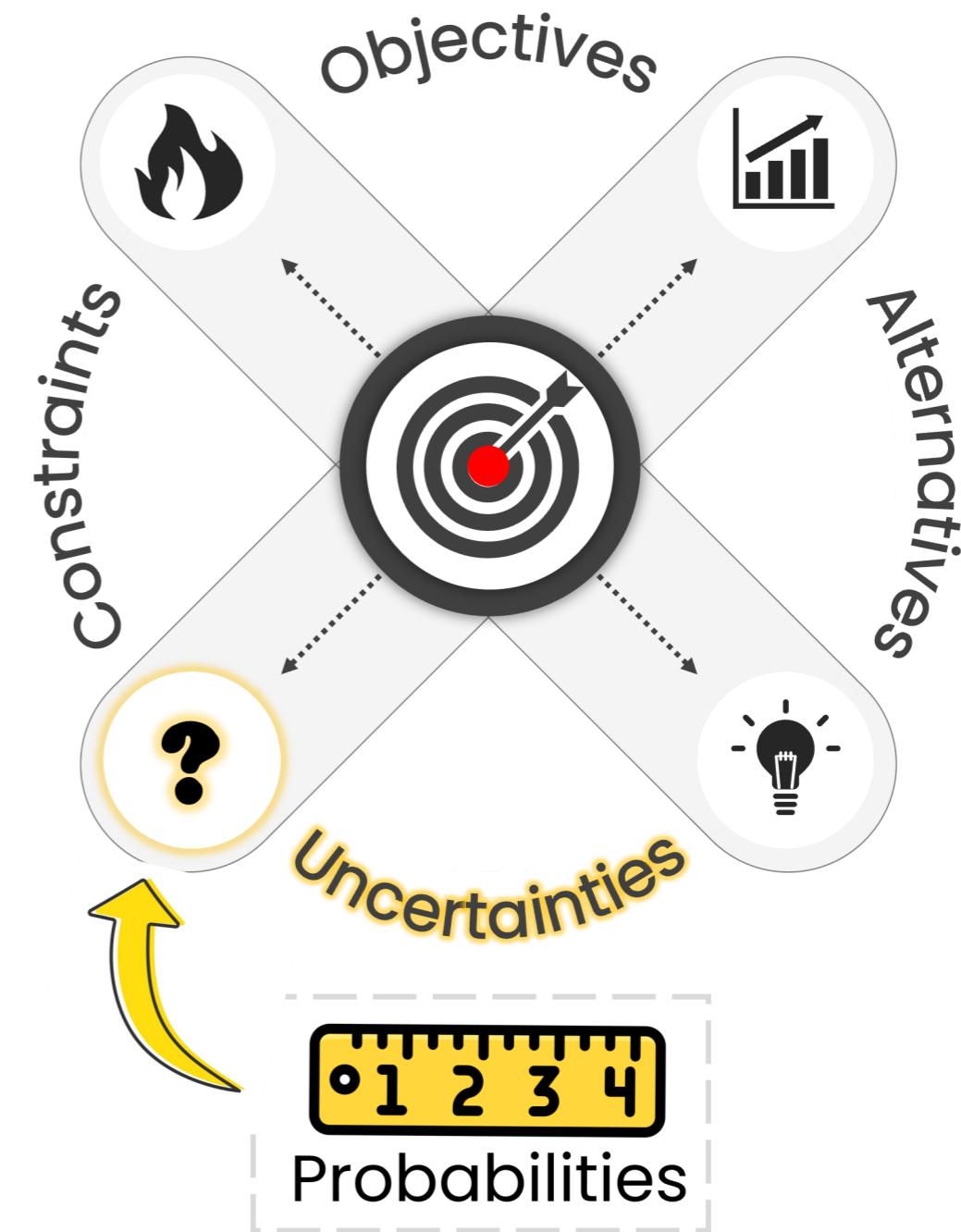
Tiago Brasil  
Lead Data Engineer

# Probabilistic Models

Probabilistic Models support decision-making by providing a **structured approach** to handle **uncertainties**.

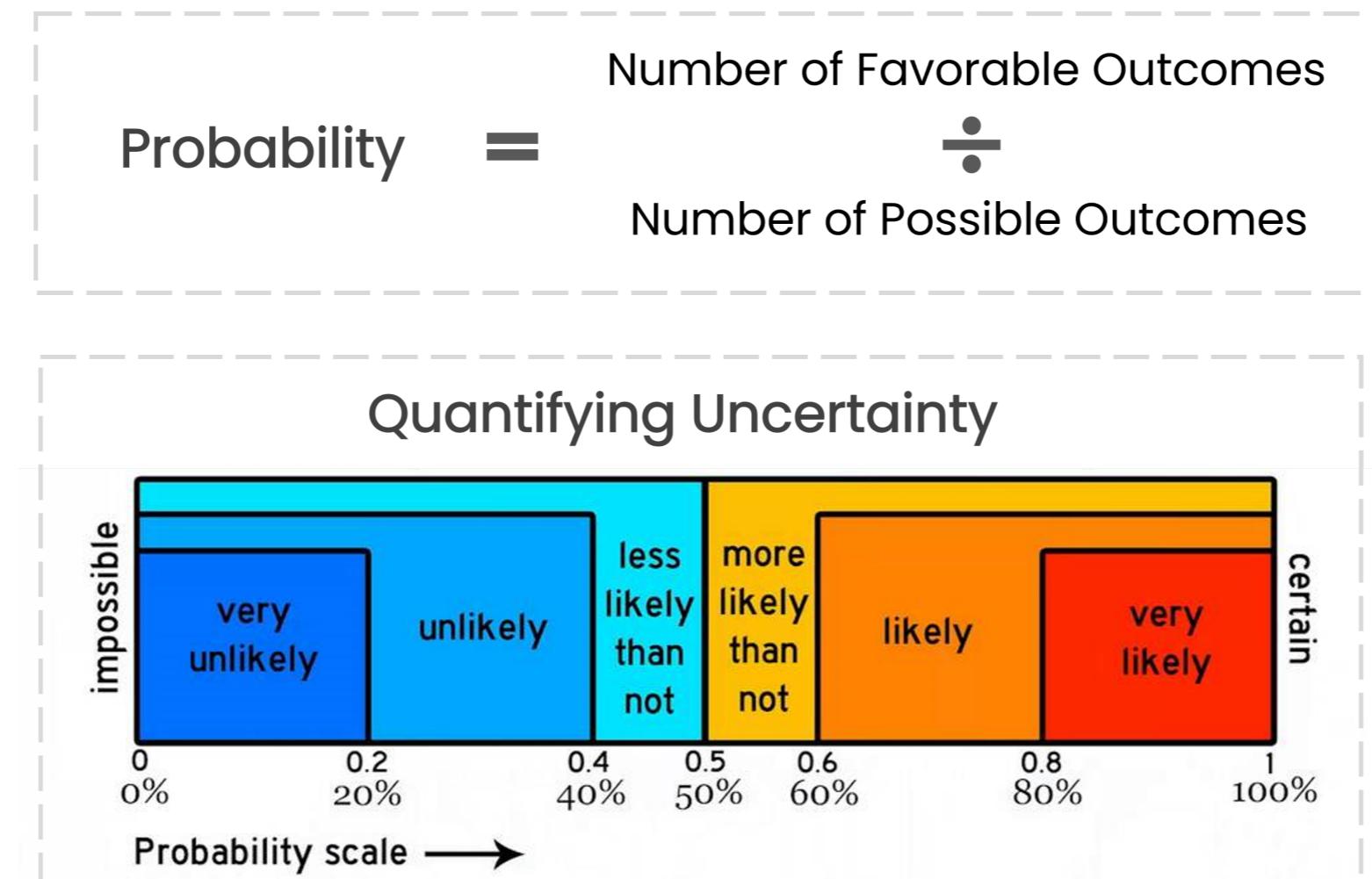
By applying probabilities in decision models we can:

- Quantify uncertainties by assigning values between 0 and 1 to **express the likelihood of outcomes**



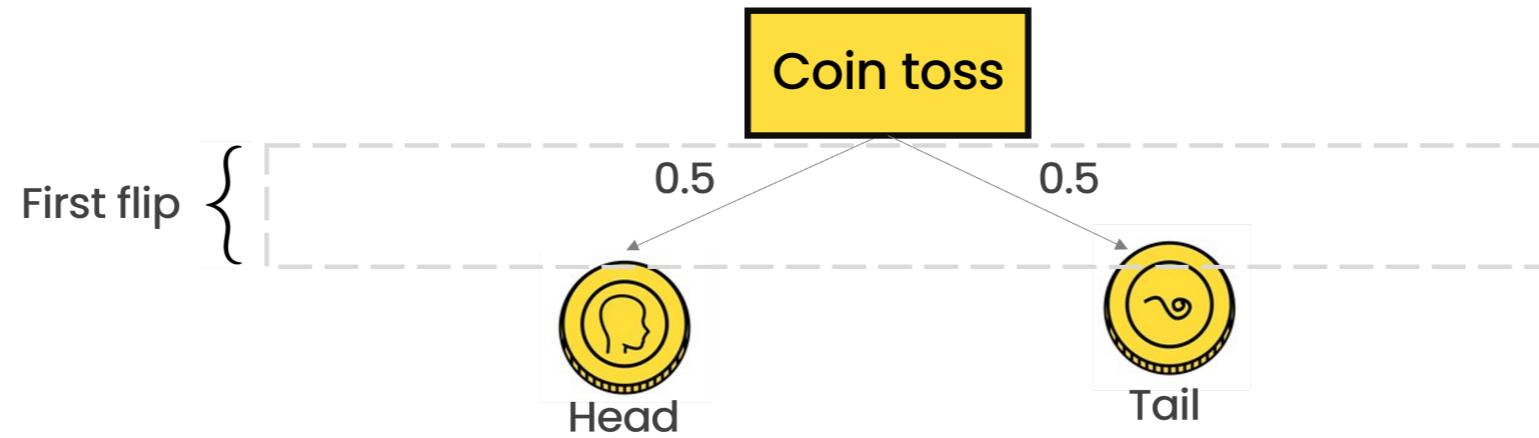
# Probabilities and uncertainties

Probabilities allow decision-makers to quantify uncertainties by assigning numerical values to the likelihood of different outcomes occurring.



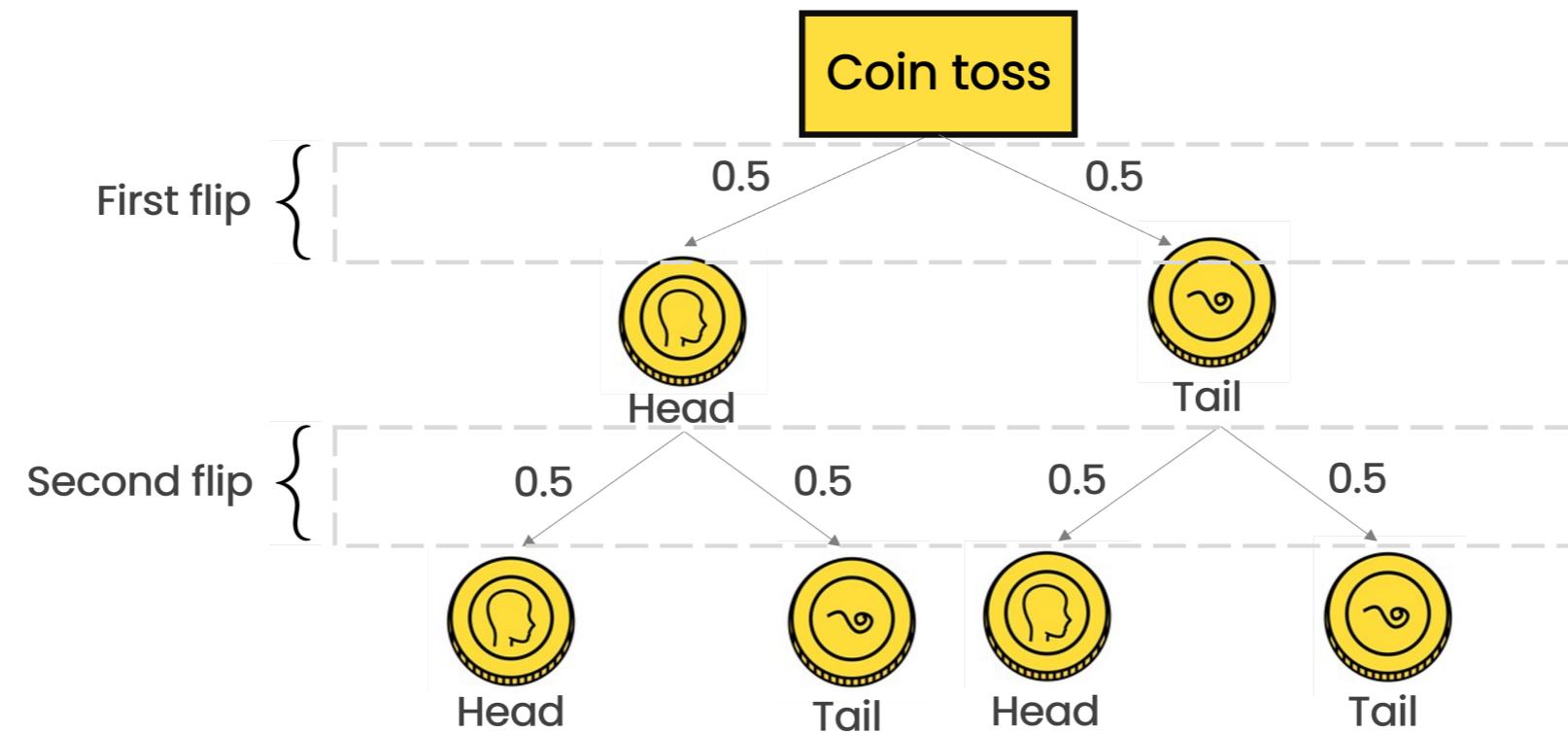
# Probabilities in a coin toss

In a standard coin with heads on one side, and tails on the other, let's find the likelihood of the coin landing on heads twice consecutively.



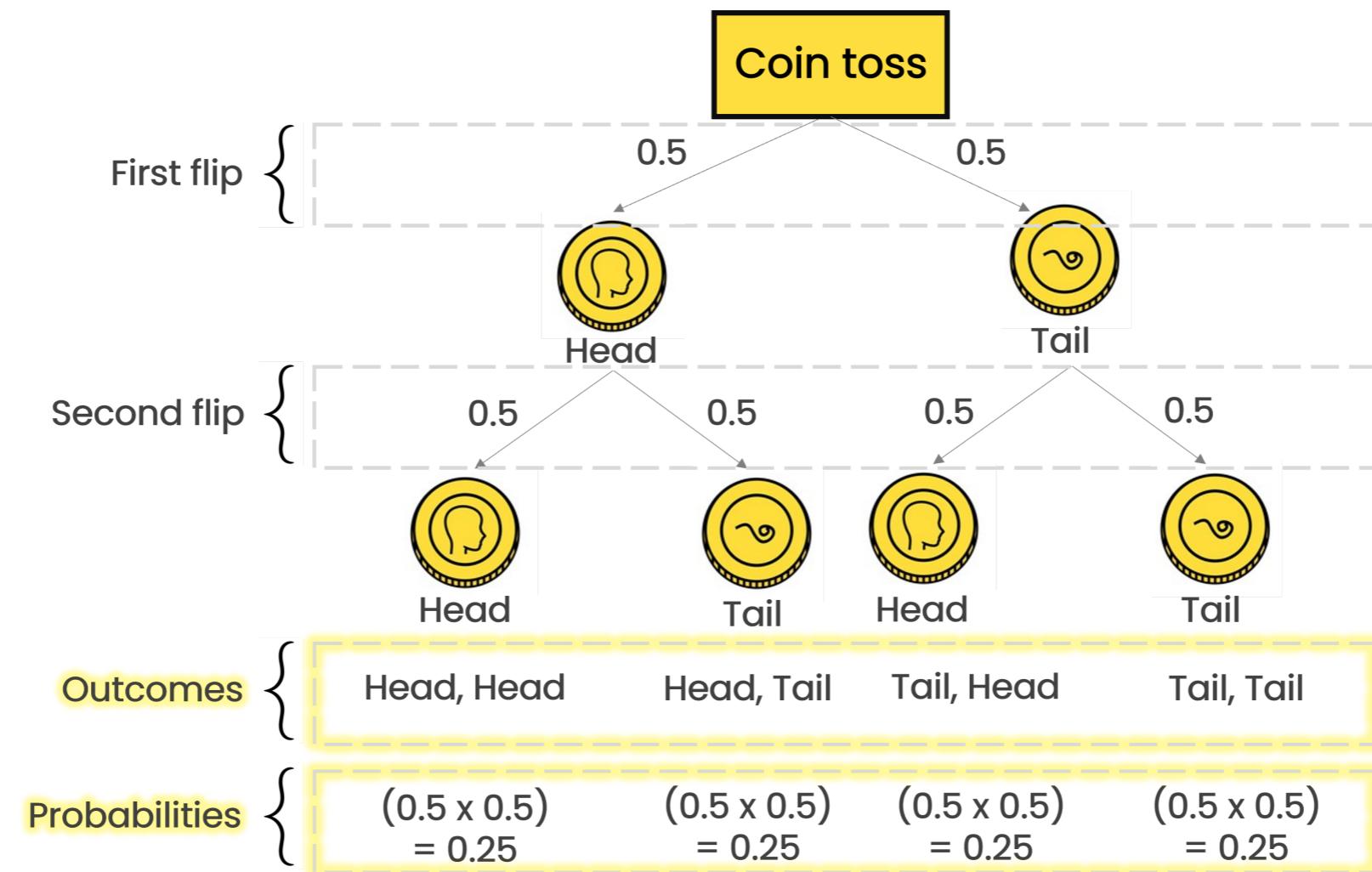
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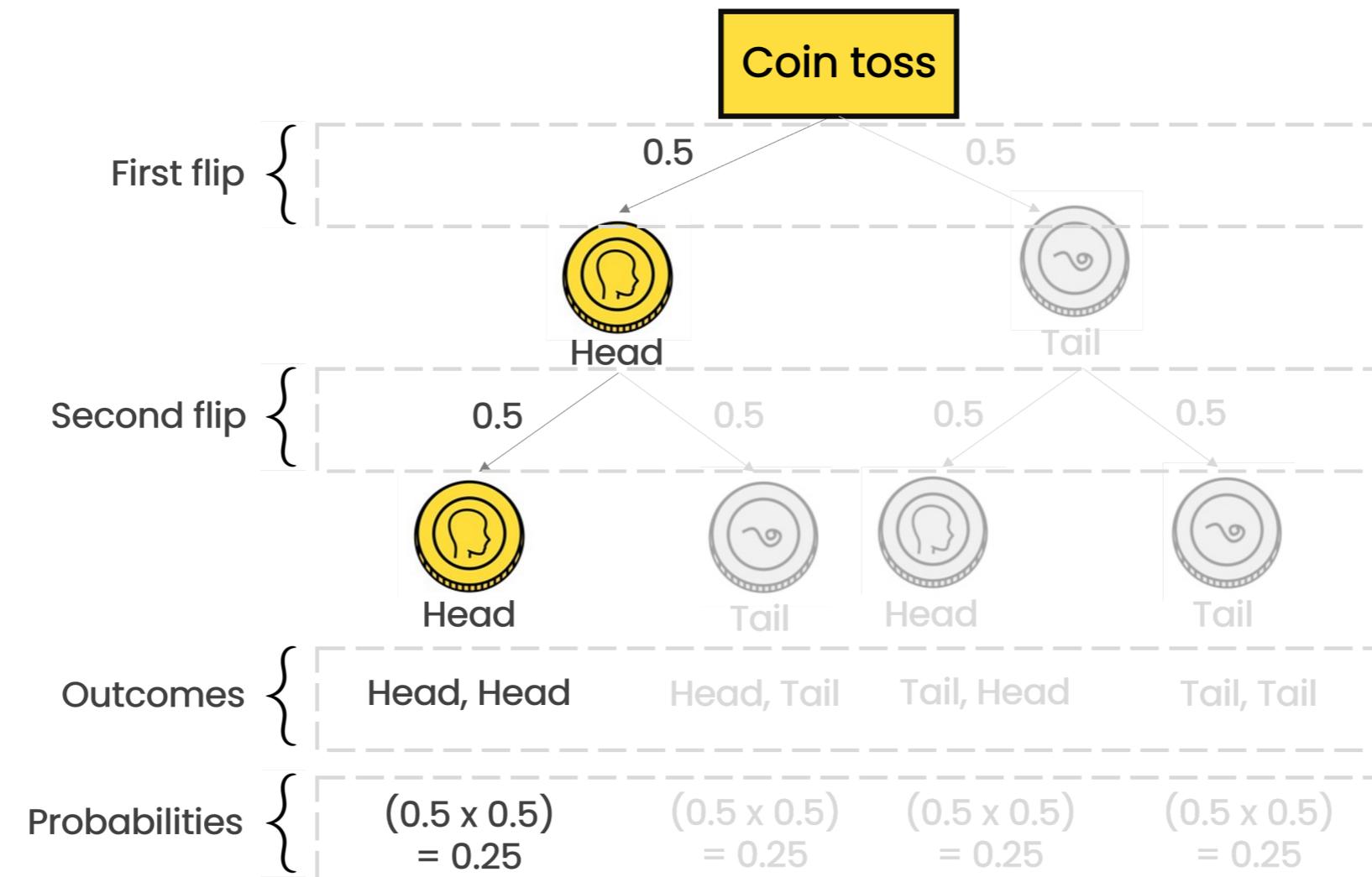
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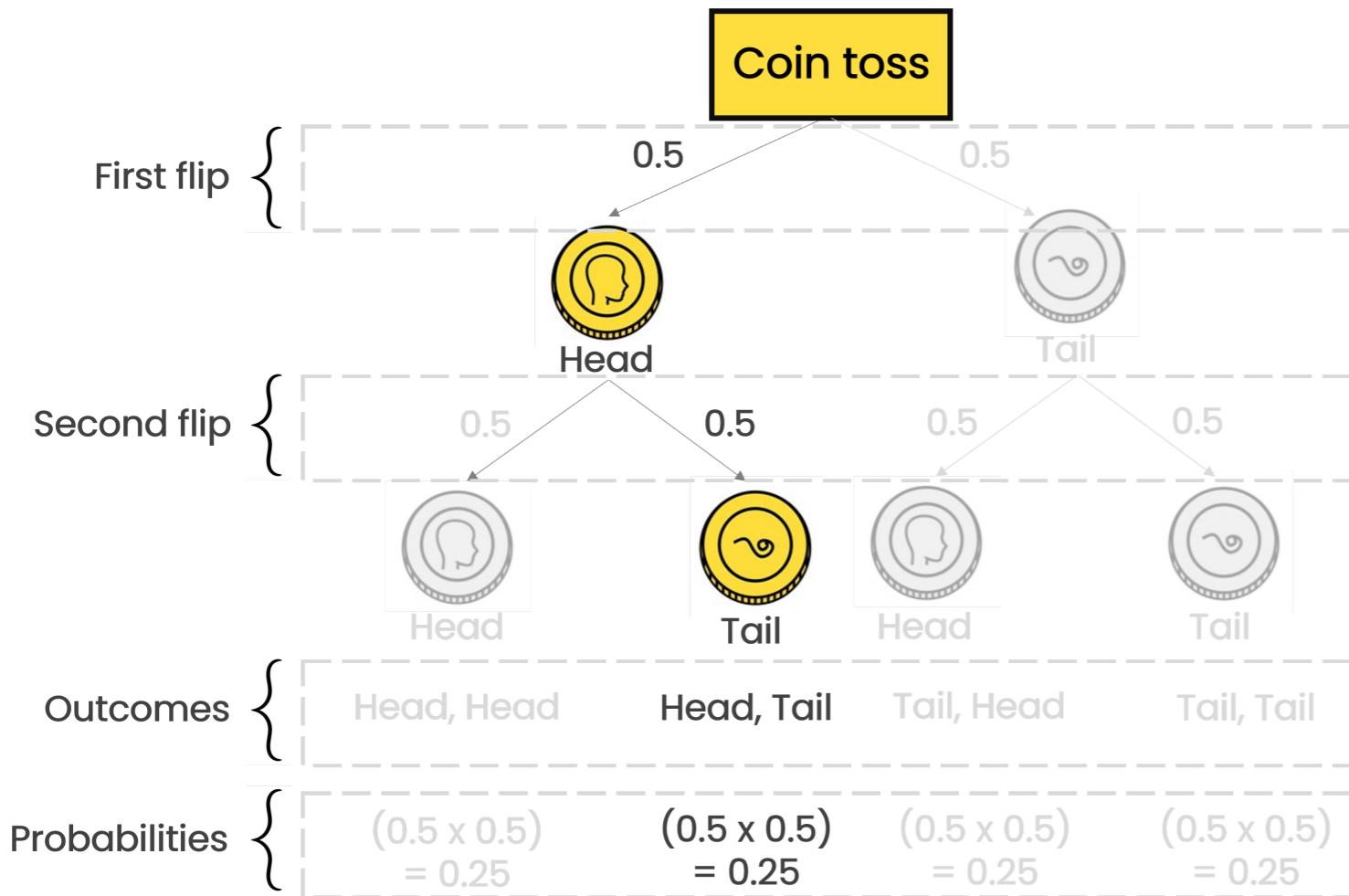


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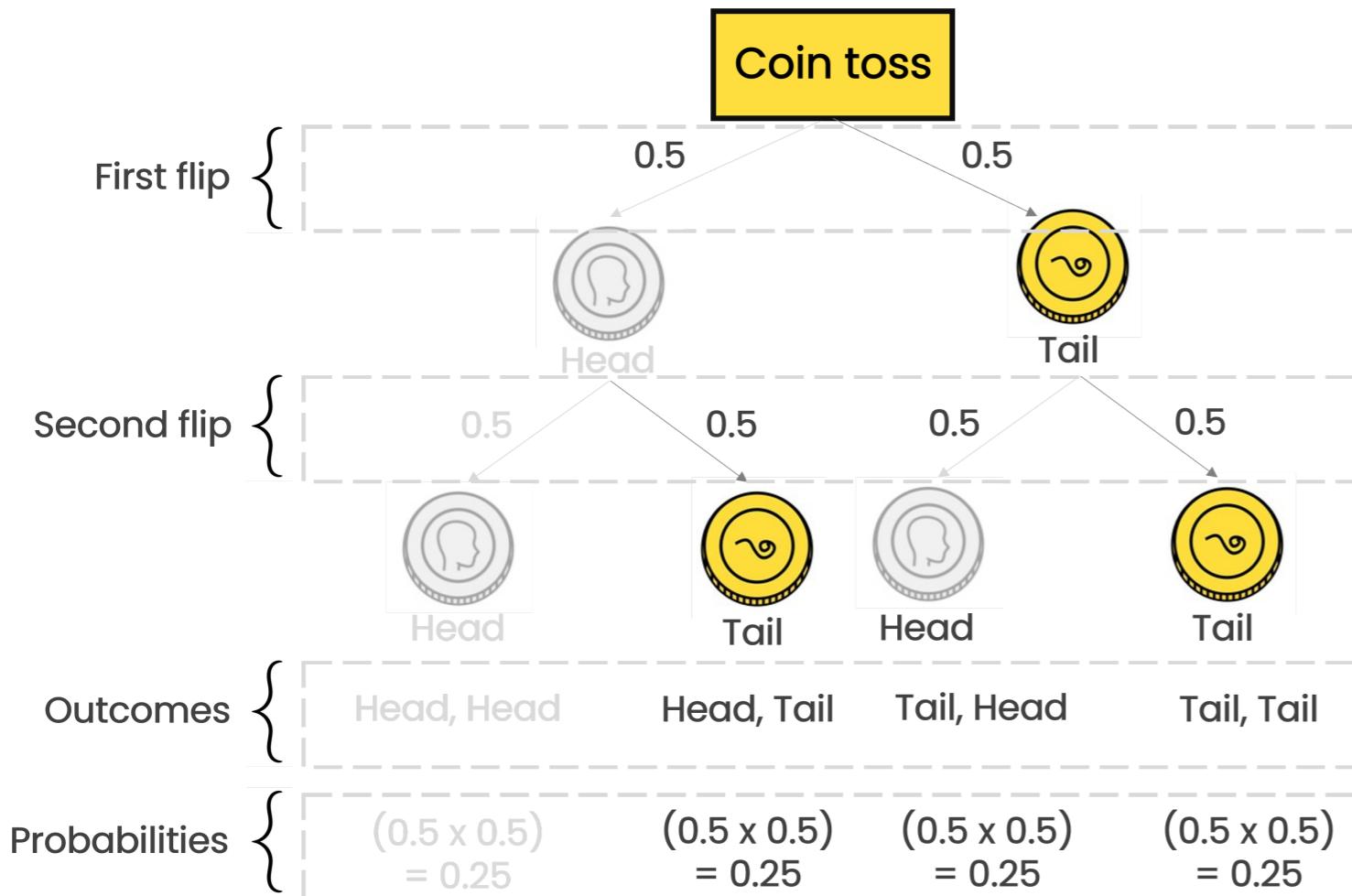
# Probabilities in a coin toss



## Other probabilities

Getting heads first and tails second:  
 $(0.5 \times 0.5) = 0.25$

# Probabilities in a coin toss



## Other probabilities

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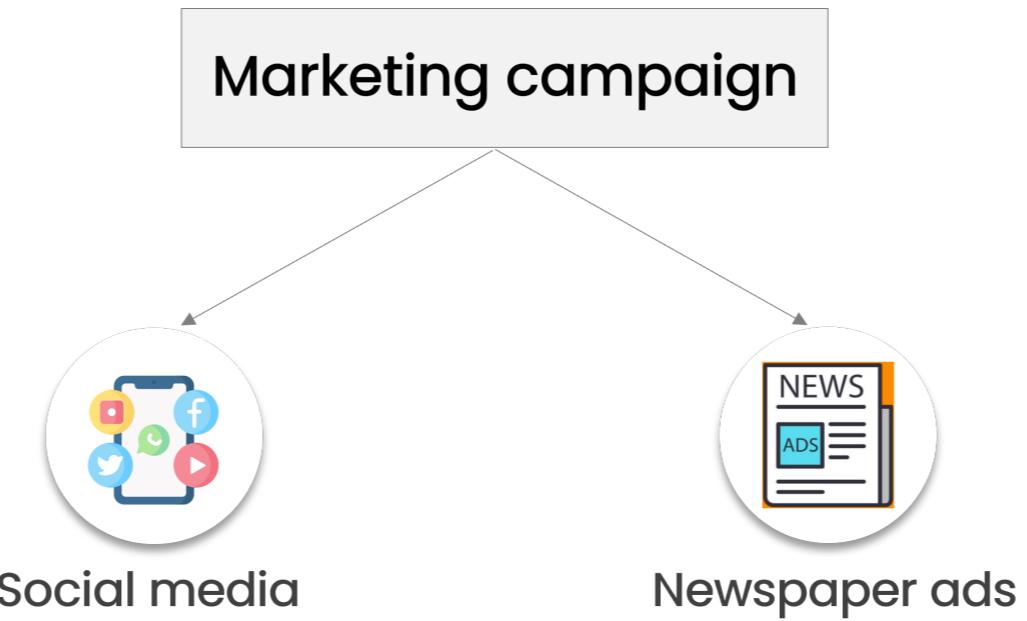
$$(0.5 \times 0.5) = 0.25$$

Getting at least one tails from two consecutive flips:

$$(0.25 + 0.25 + 0.25) = 0.75$$

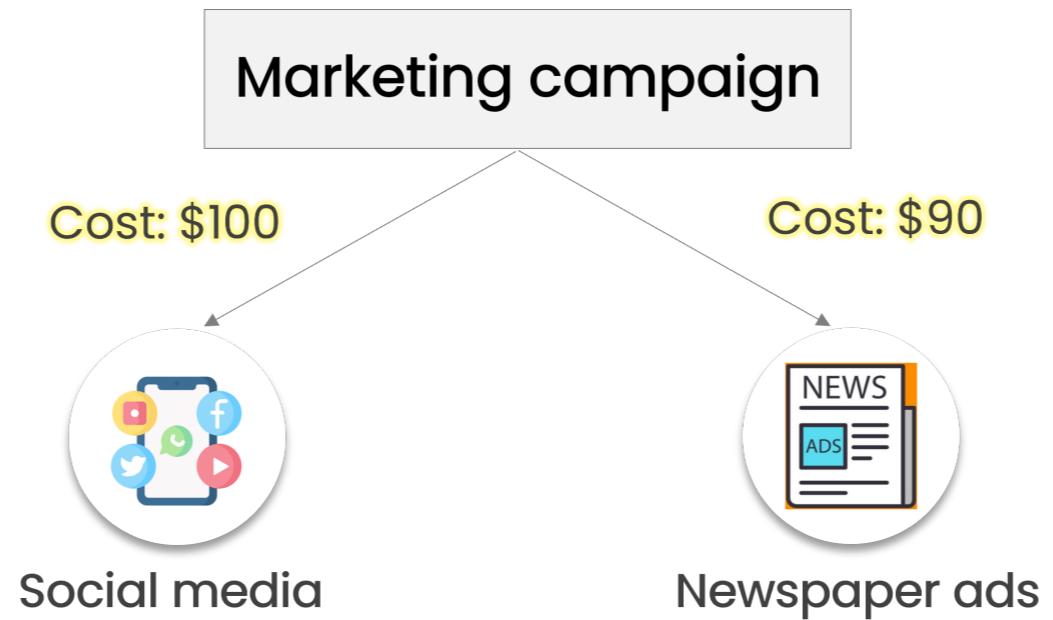
# Building a Probabilistic Decision Model

The marketing team of a retail company is deciding **where to launch the next campaign**.



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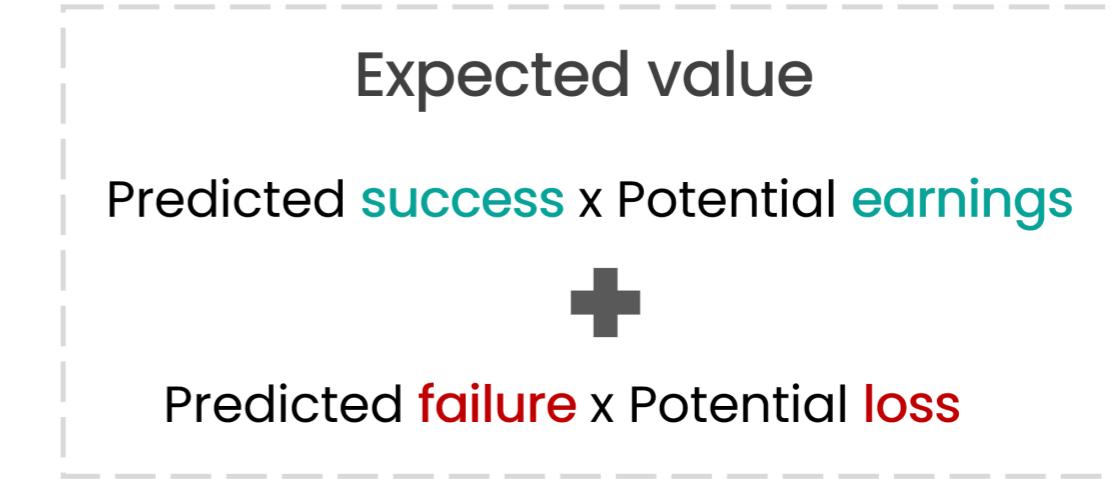


# Building a Probabilistic Decision Model

The marketing team of a retail company is deciding where to launch the next campaign.



# Evaluating expected value



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## Expected value

Predicted **success** x Potential **earnings**



Predicted **failure** x Potential **loss**



## Social media

$$(0.5 \times \$900 = \$450)$$

$$(0.5 \times -\$300 = -\$150)$$

$$\underline{\$300}$$

# Evaluating expected value



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### Social media

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### Newspaper ads

$$(0.5 \times \$810 = \$405)$$

$$(0.5 \times -\$140 = -\$70)$$

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# **Let's practice!**

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# Data analytics for Decision Models

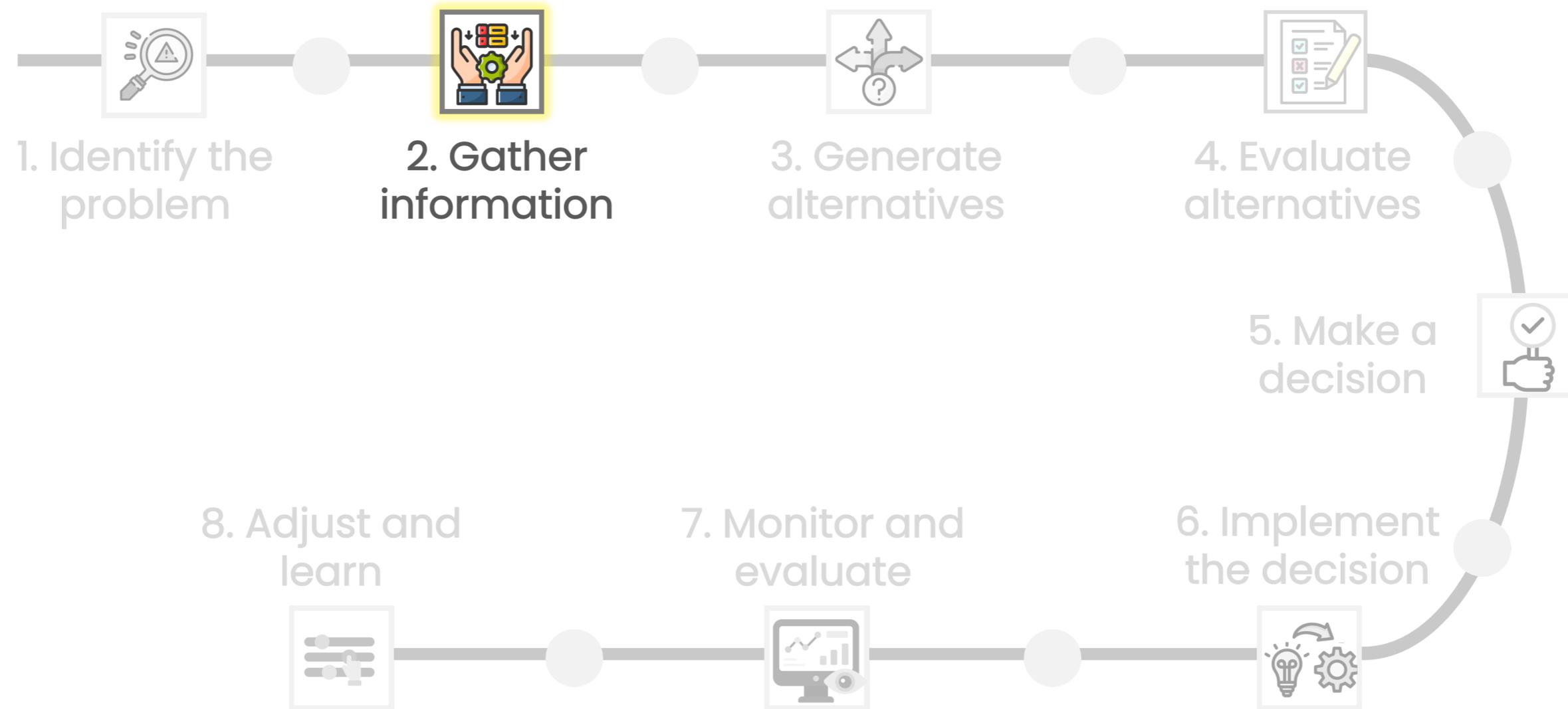
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Lead Data Engineer

# Informed decisions, better outcomes

Data analytics involves collecting, transforming, and analyzing data to extract **valuable information** that can be used to make better decisions.

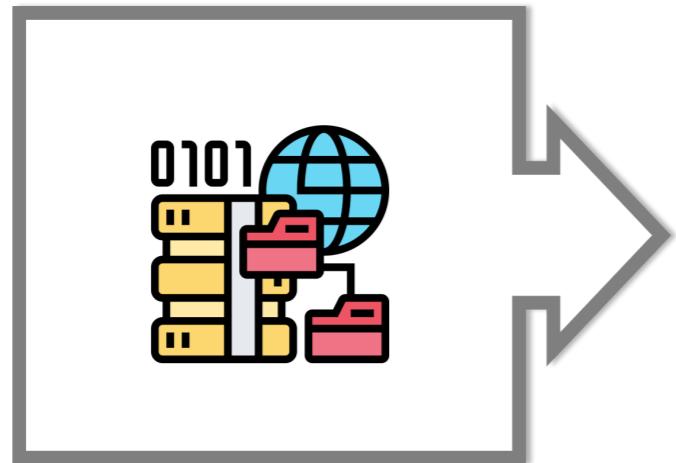


# Navigating the data journey

Data requires a comprehensive journey of analysis and processing to transform into valuable, actionable information.

1st

Data Gathering

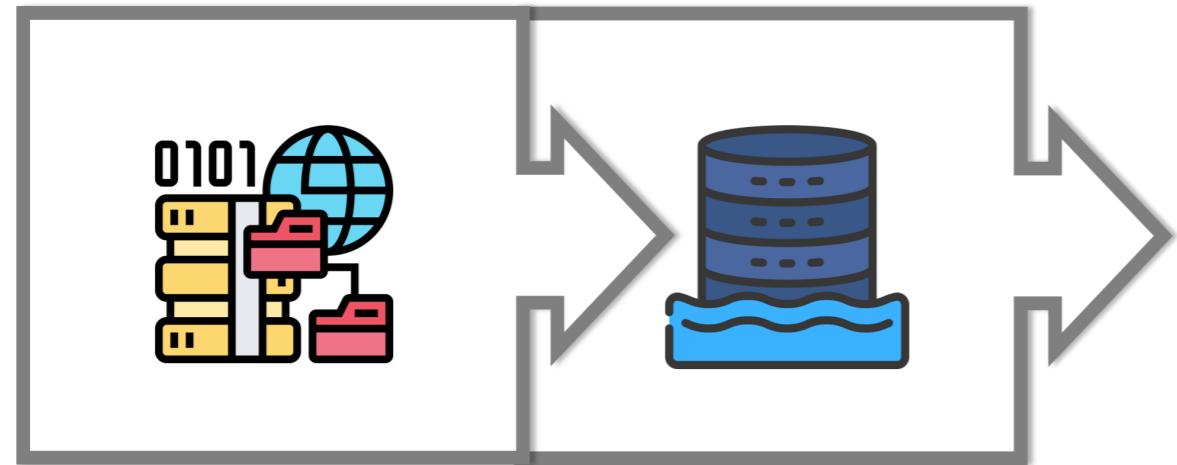


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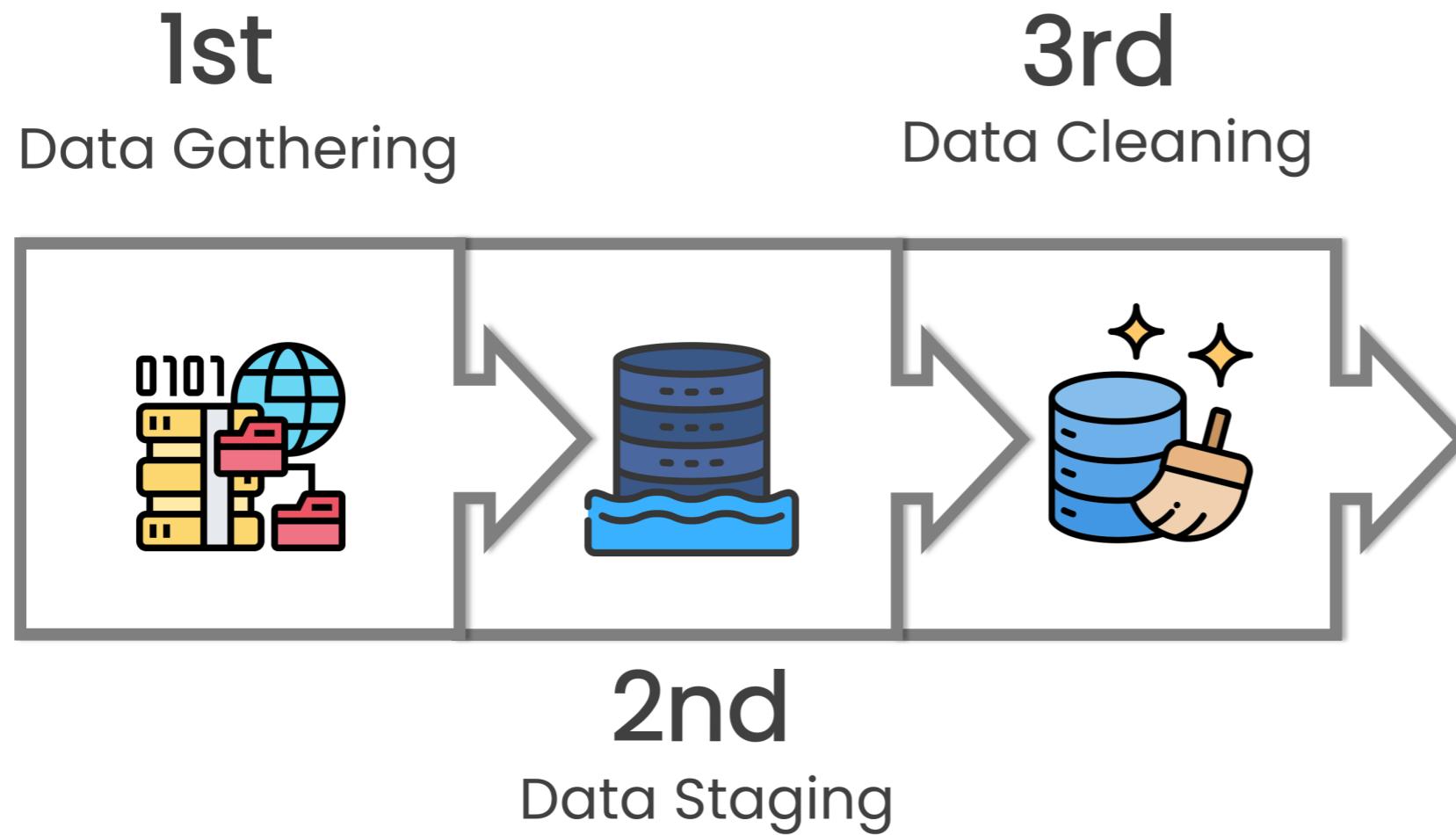


2nd

Data Staging

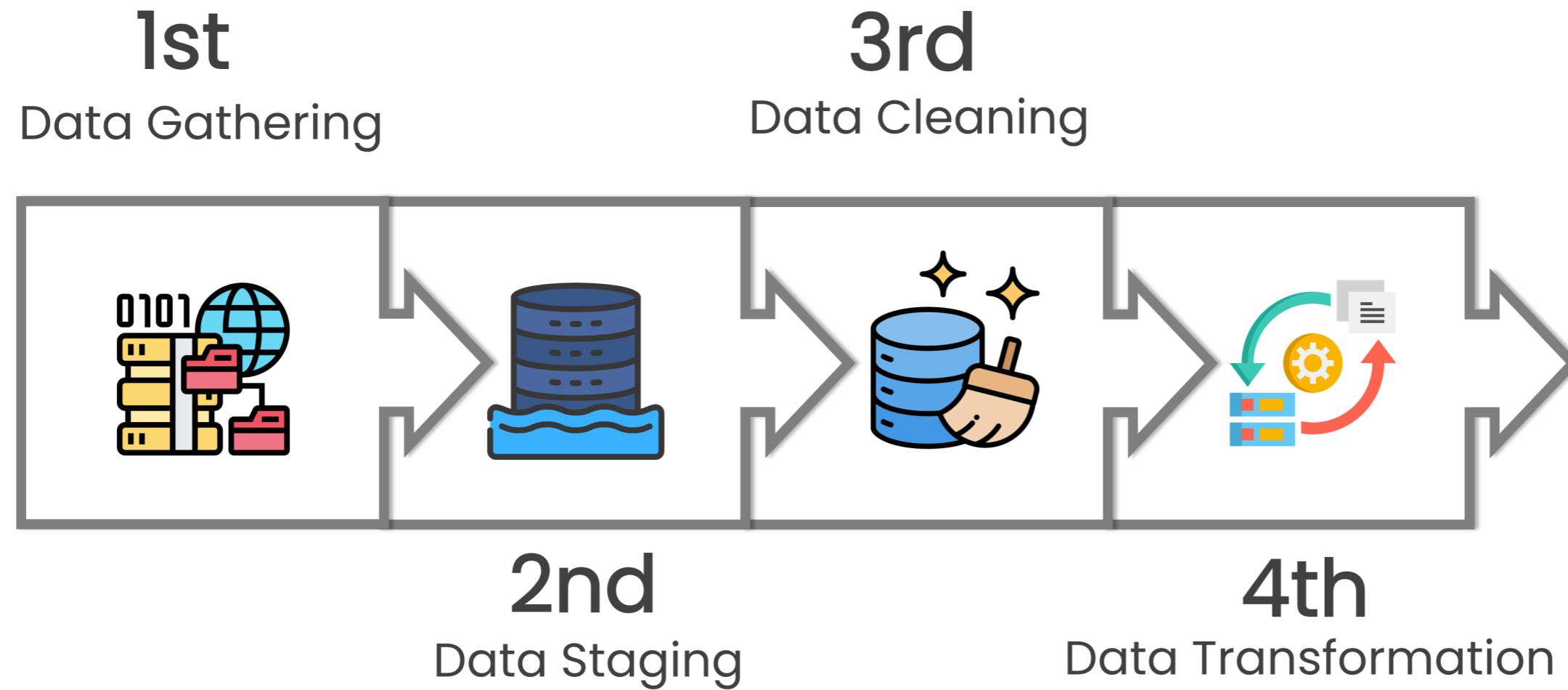
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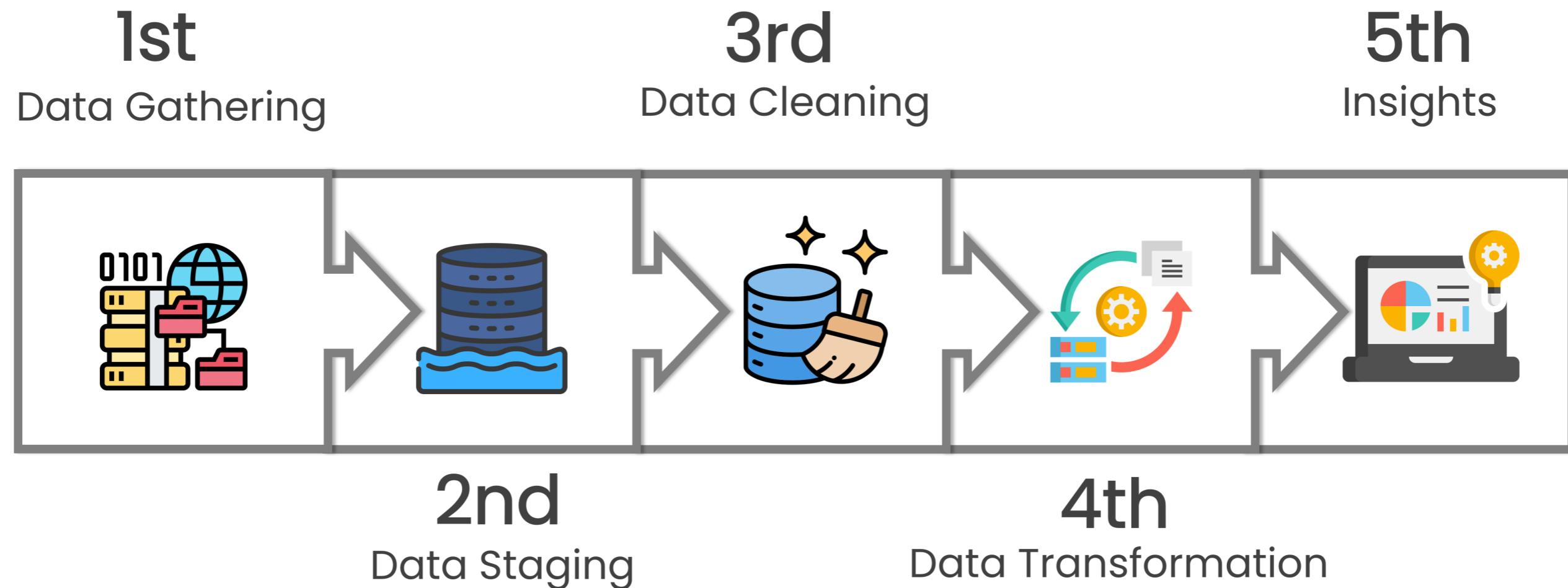
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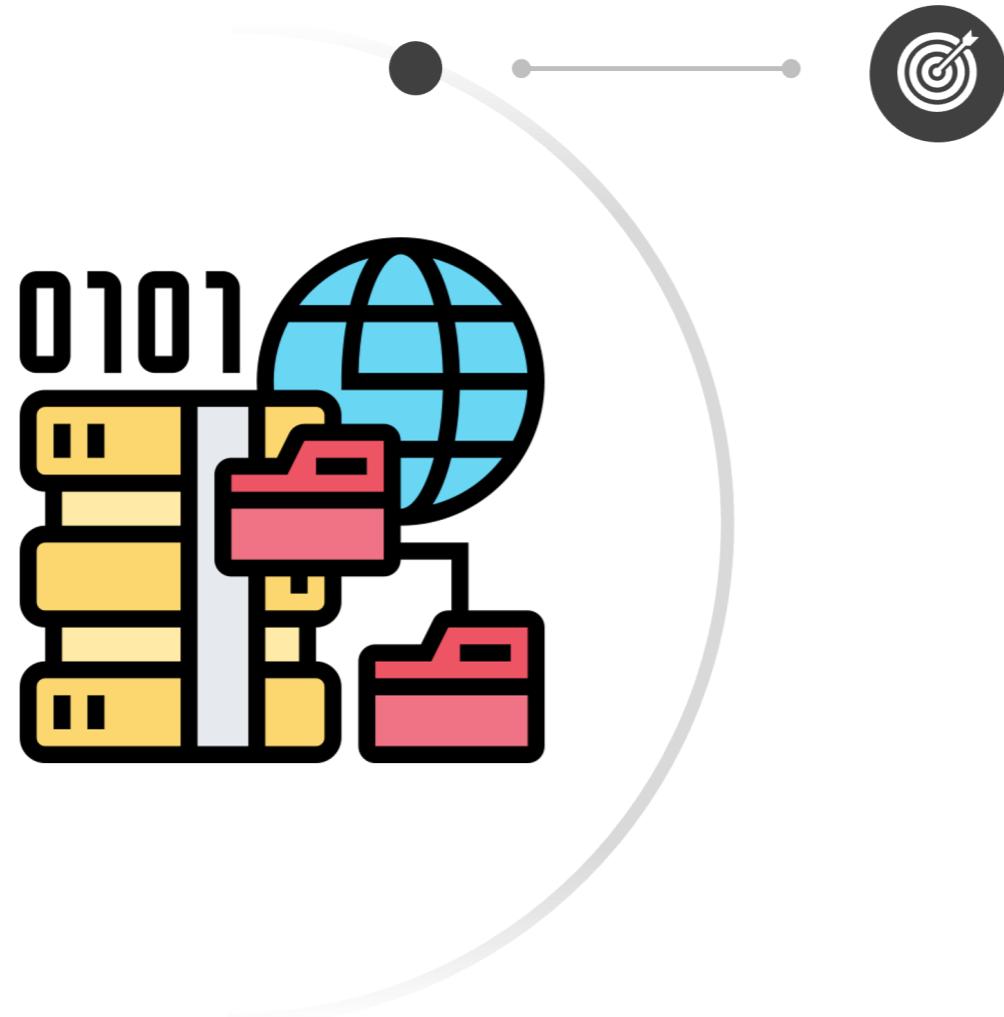
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# Data gathering

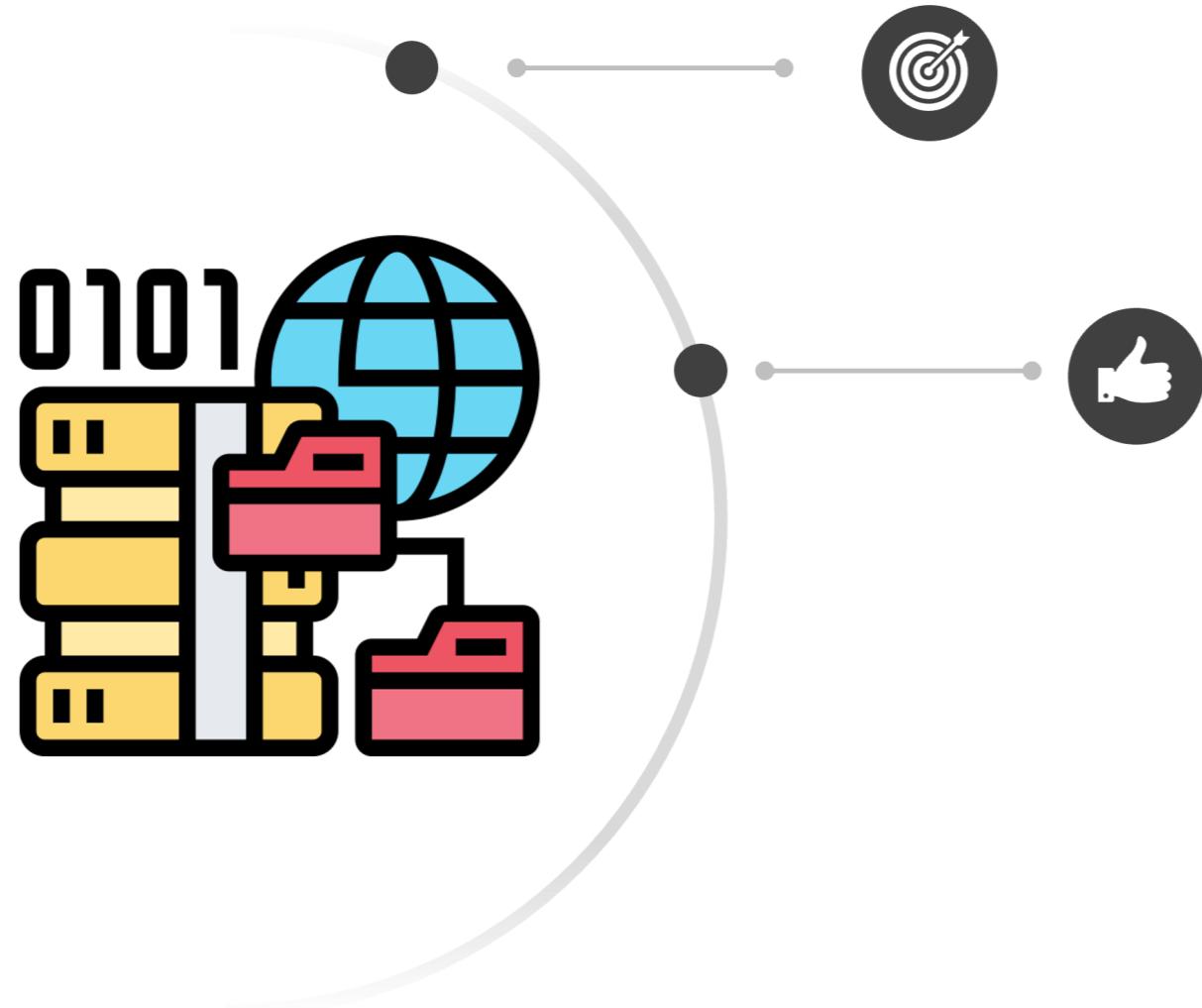
Identify and collect **relevant data** from multiple trusted sources.



Focus on the decision problem

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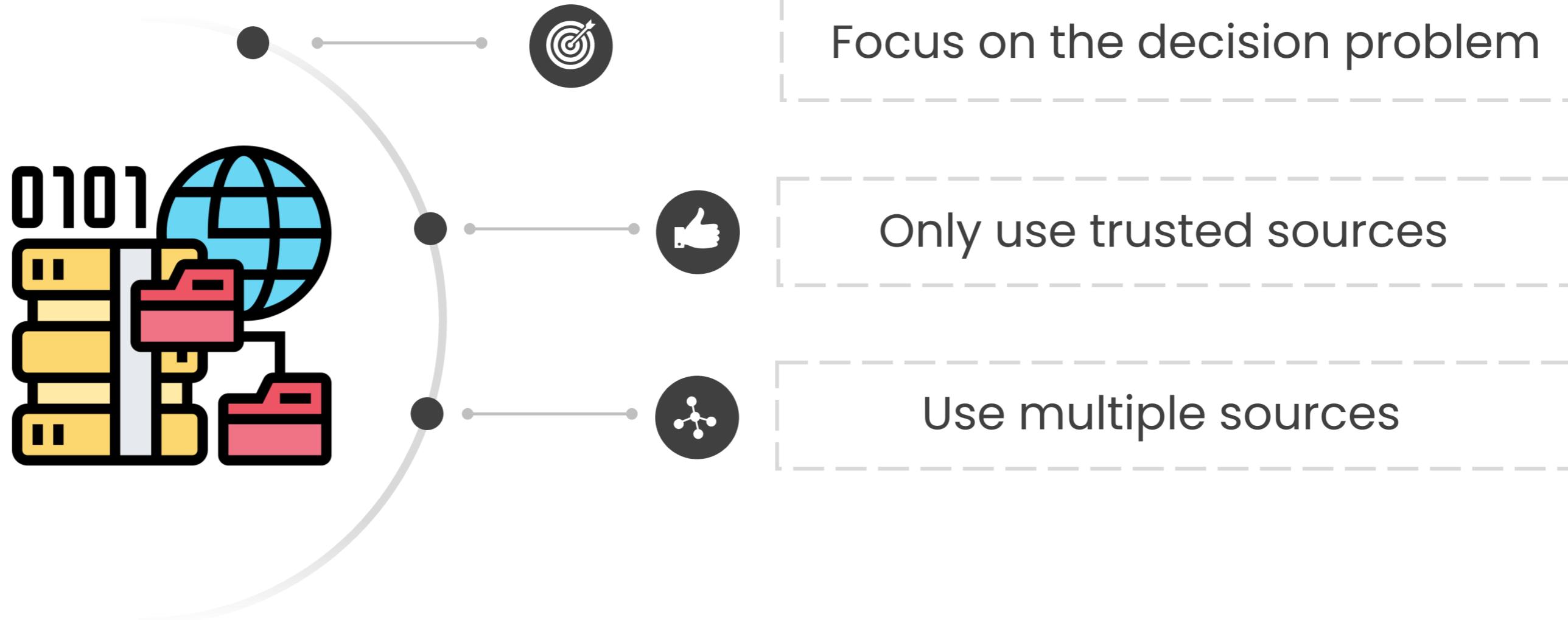


Focus on the decision problem

Only use trusted sources

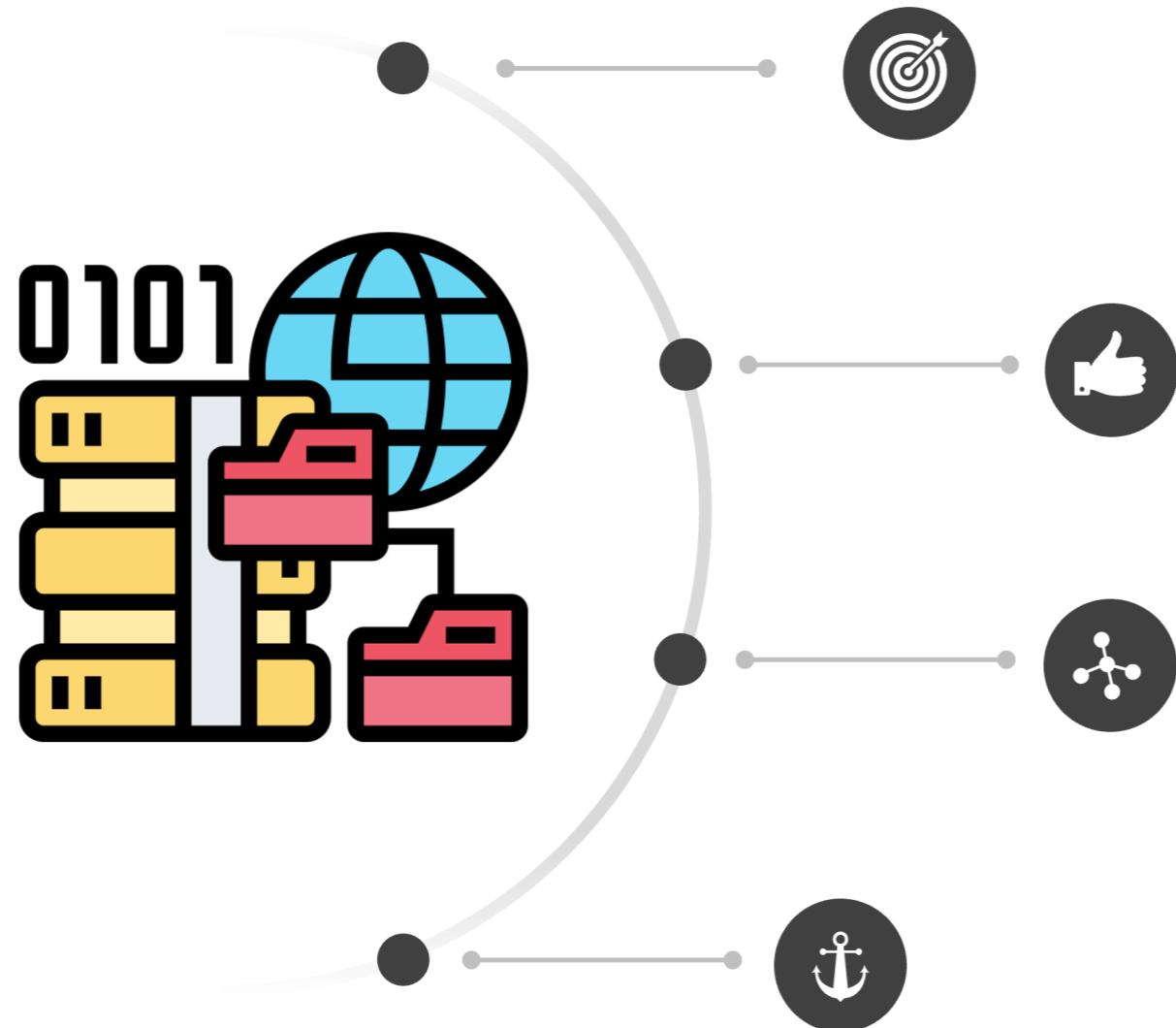
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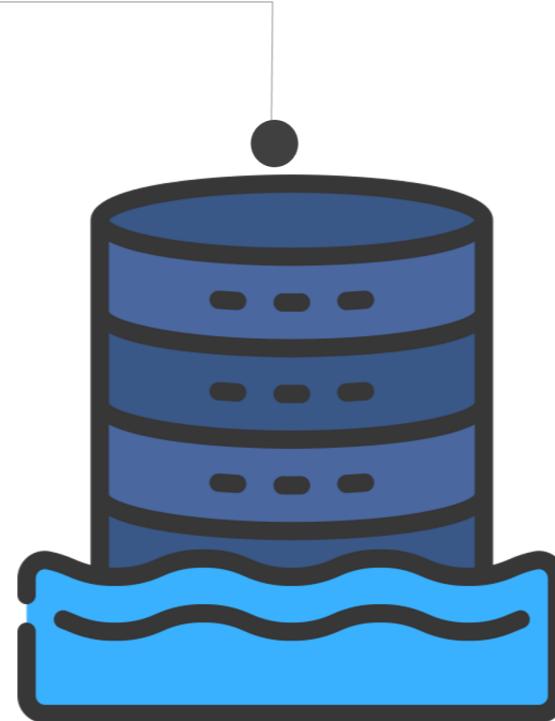
Use multiple sources

Maintain ethical standards

# Data staging

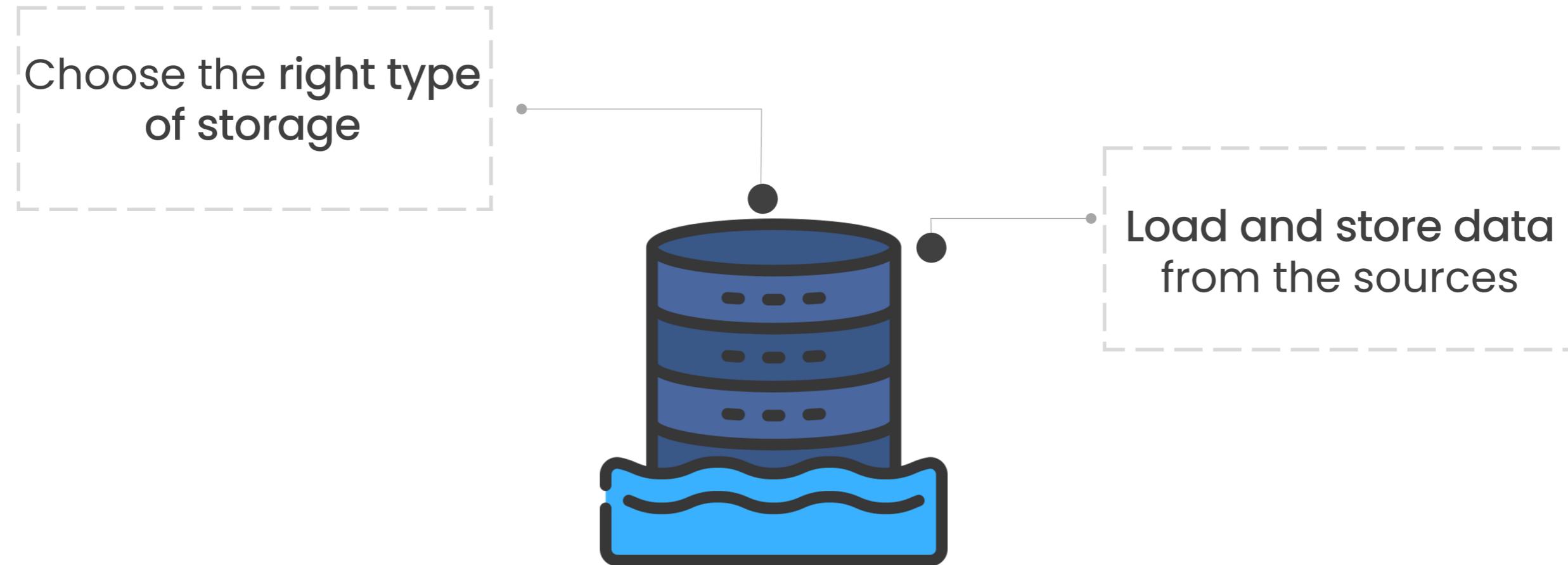
Store, organize, and protect collected data in a structured format.

Choose the right type  
of storage



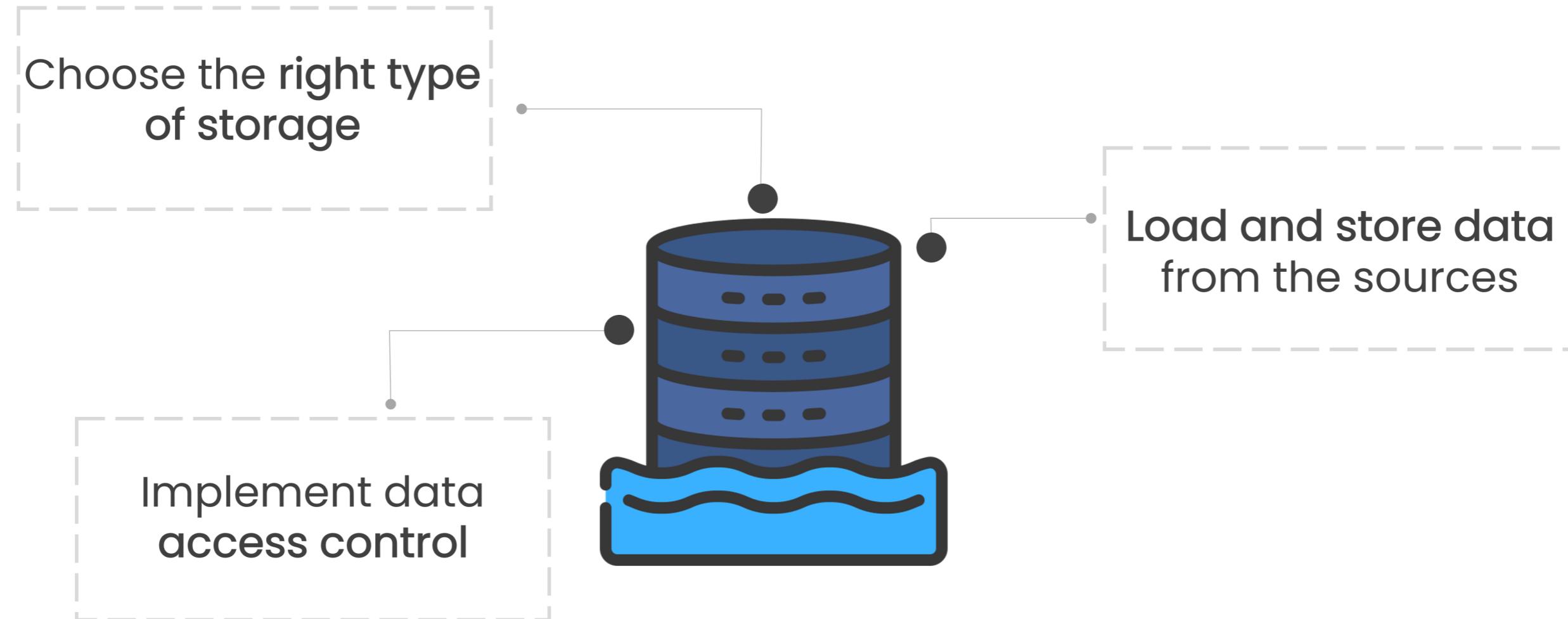
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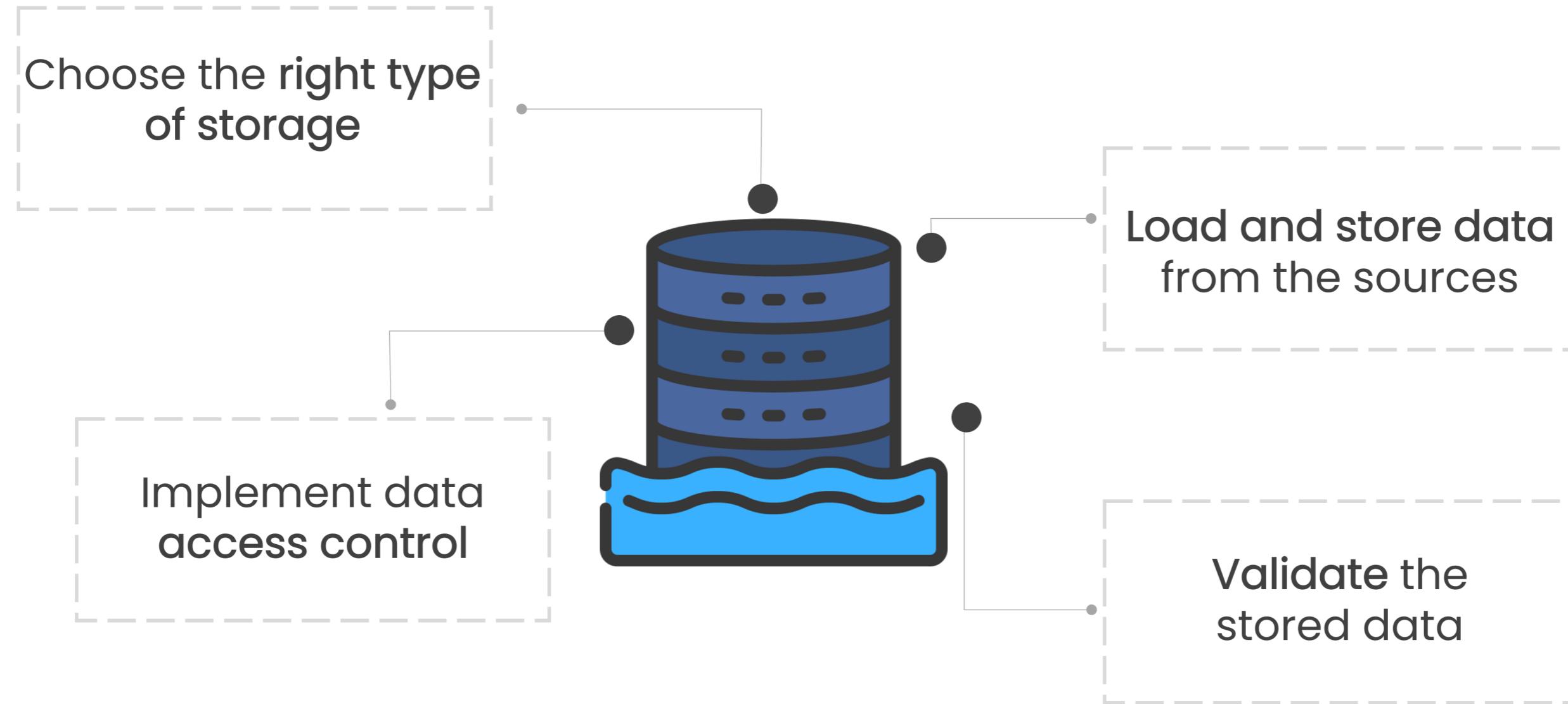
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# Data cleaning

**Identify and correct errors, inconsistencies, or missing values in the dataset.**

Identify and  
correct errors



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Remove  
irrelevant data



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Deal with  
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Remove  
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Deduplicate  
data



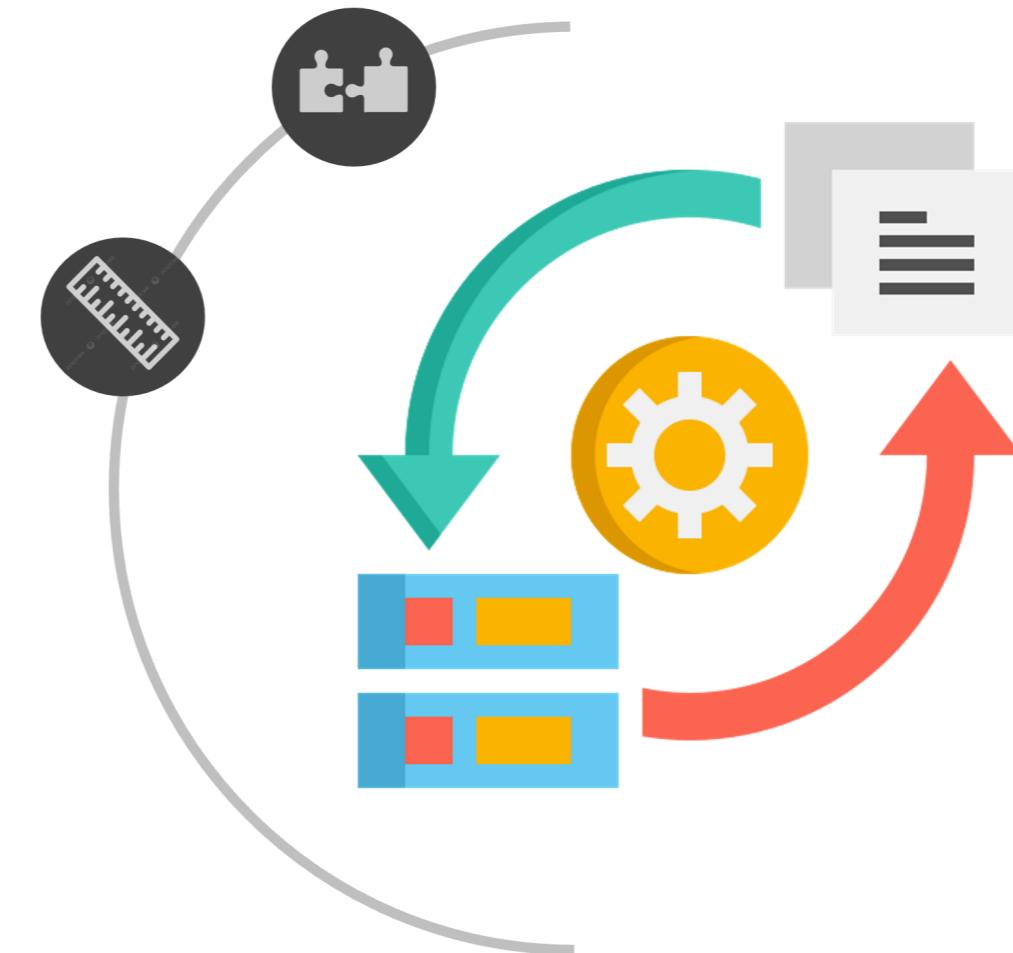
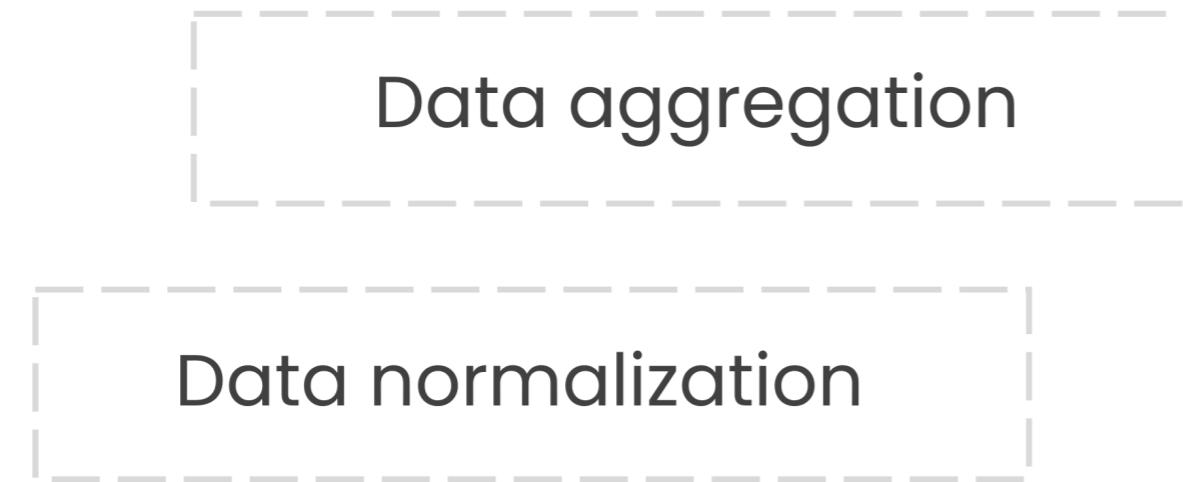
# Data transformation

Restructure the data to make it suitable for analysis.



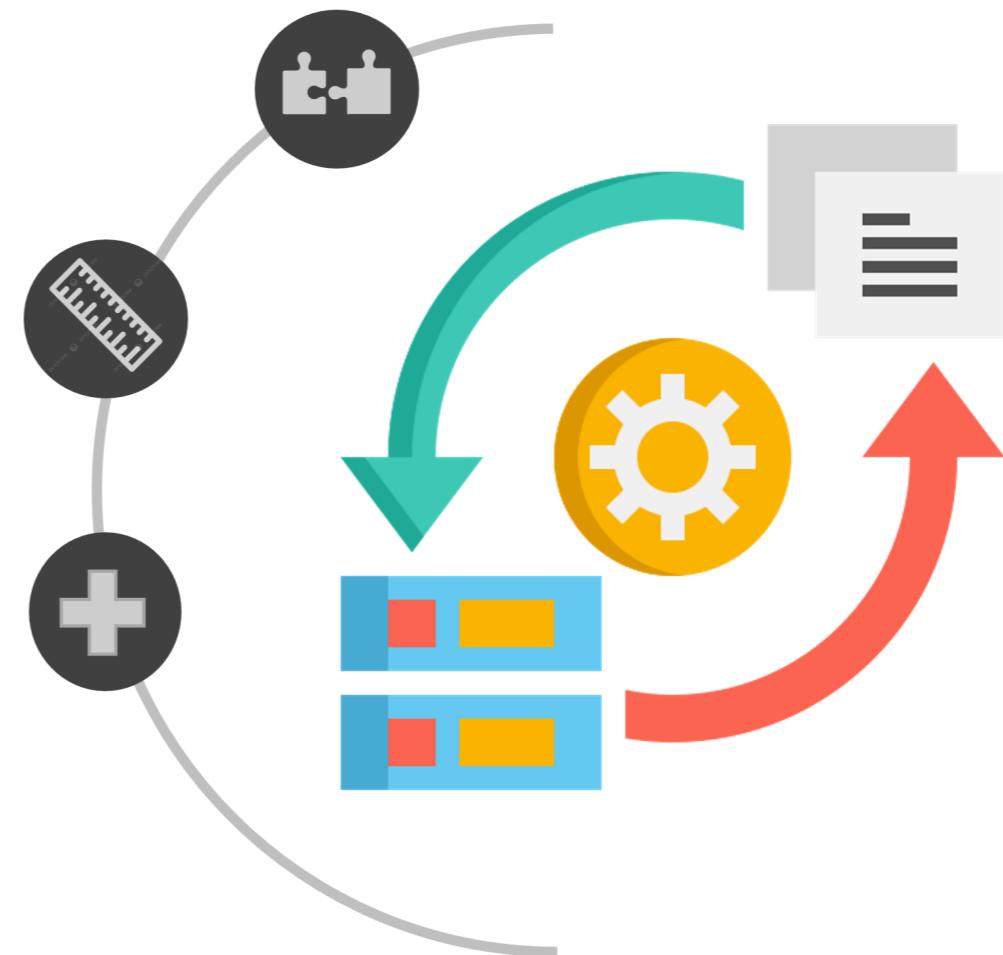
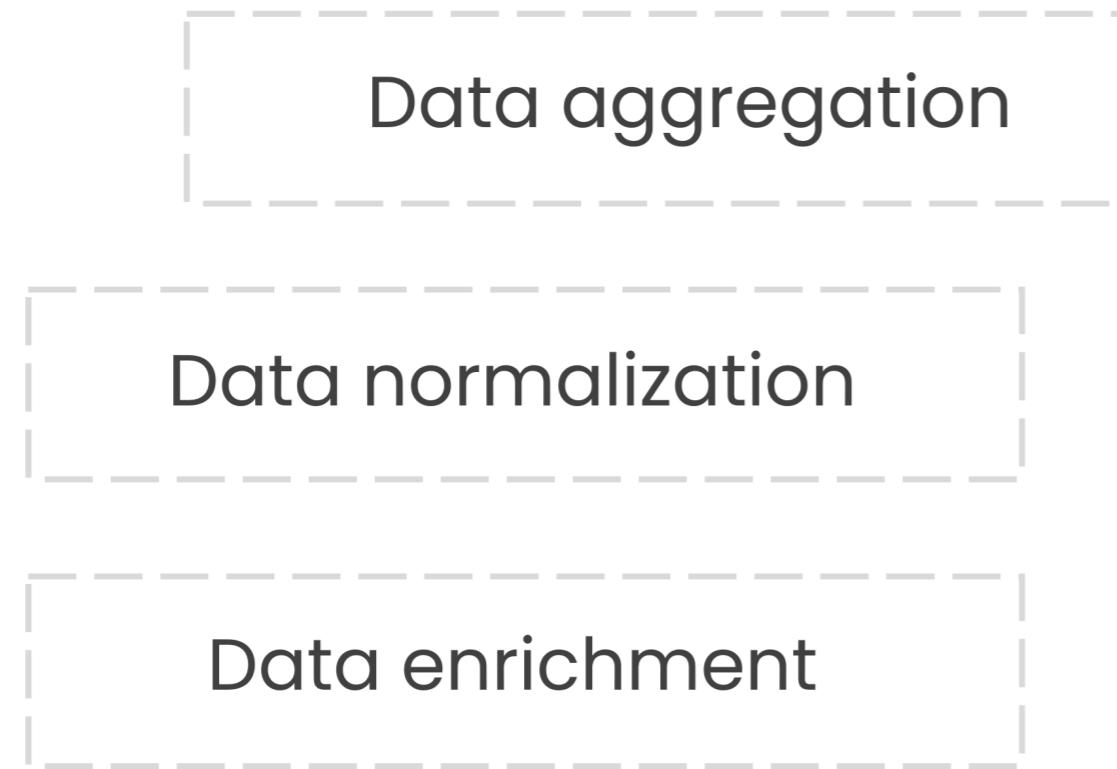
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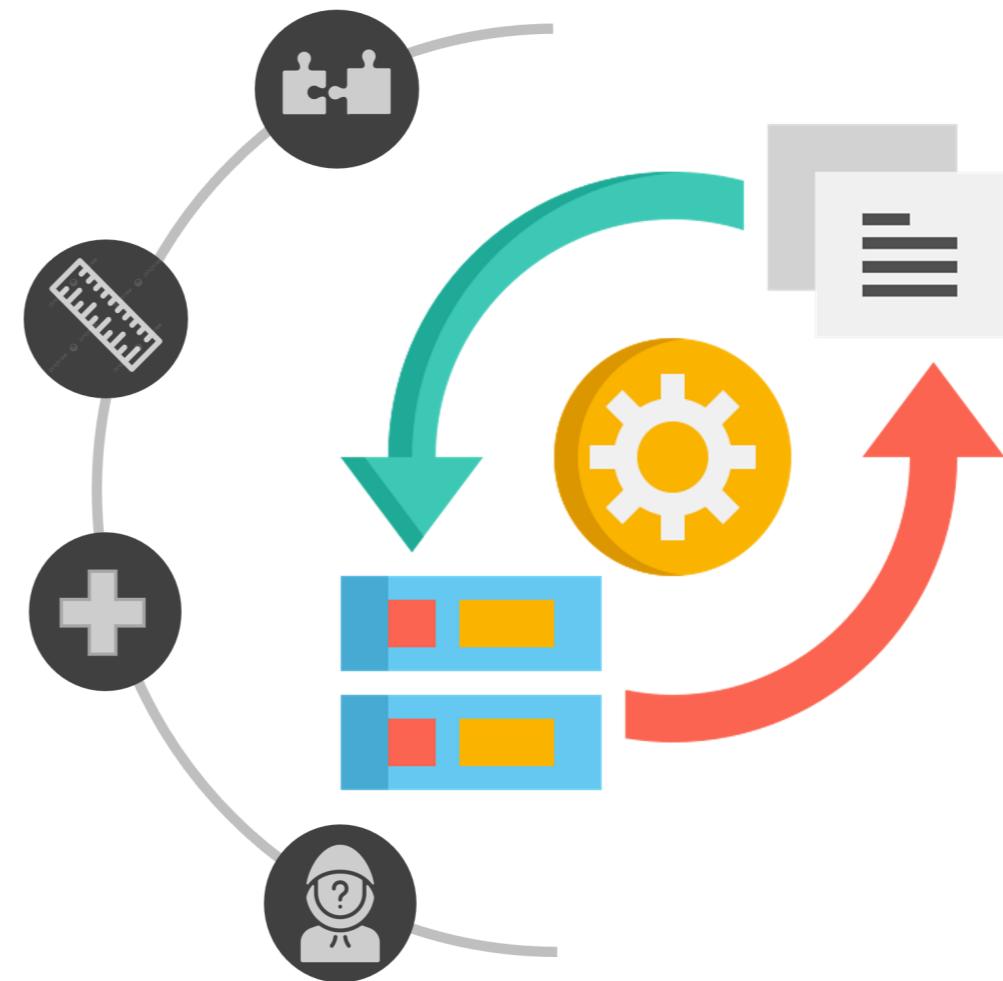
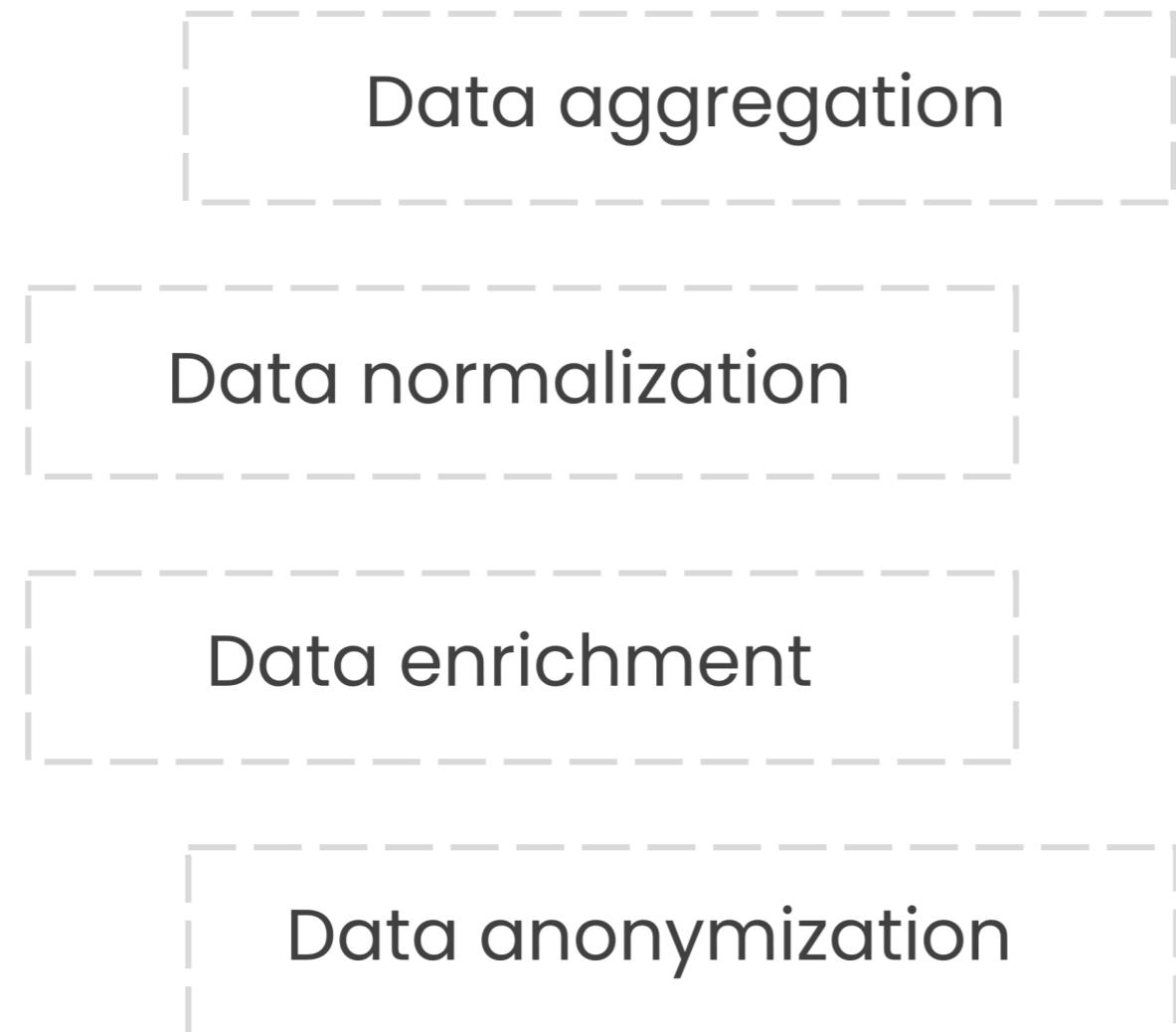
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# Generate insights

Produce relevant insights and extract valuable information from the data.



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# Sensitivity Analysis for Decision Models

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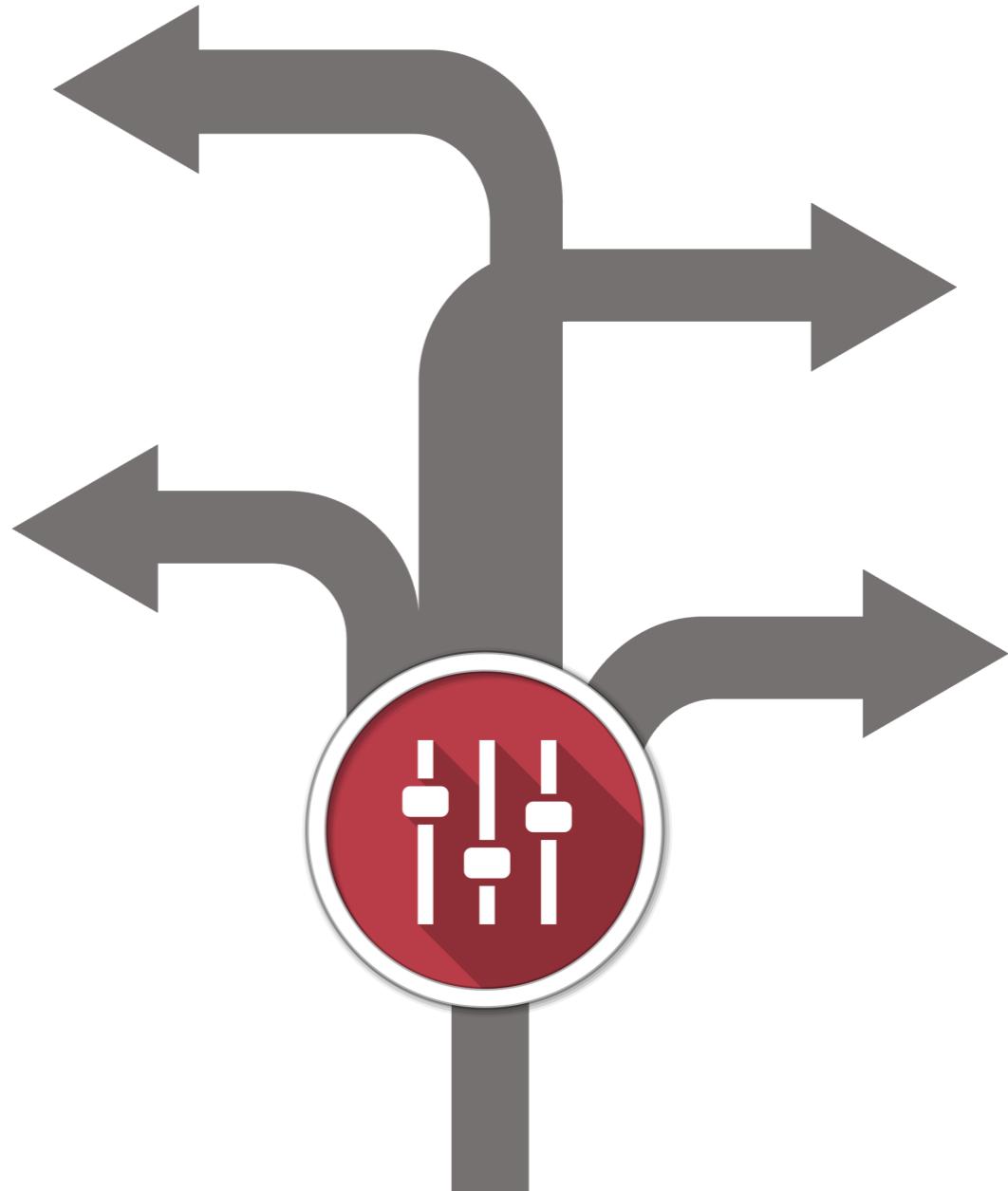
Tiago Brasil  
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# Sensitivity Analysis for Decision Models

Sensitivity analysis is a technique in decision modeling to **examine how changes in input variables impact the output or outcomes of the model.**

This strategy enables:

- Variable examination
- Scenario testing
- Decision support



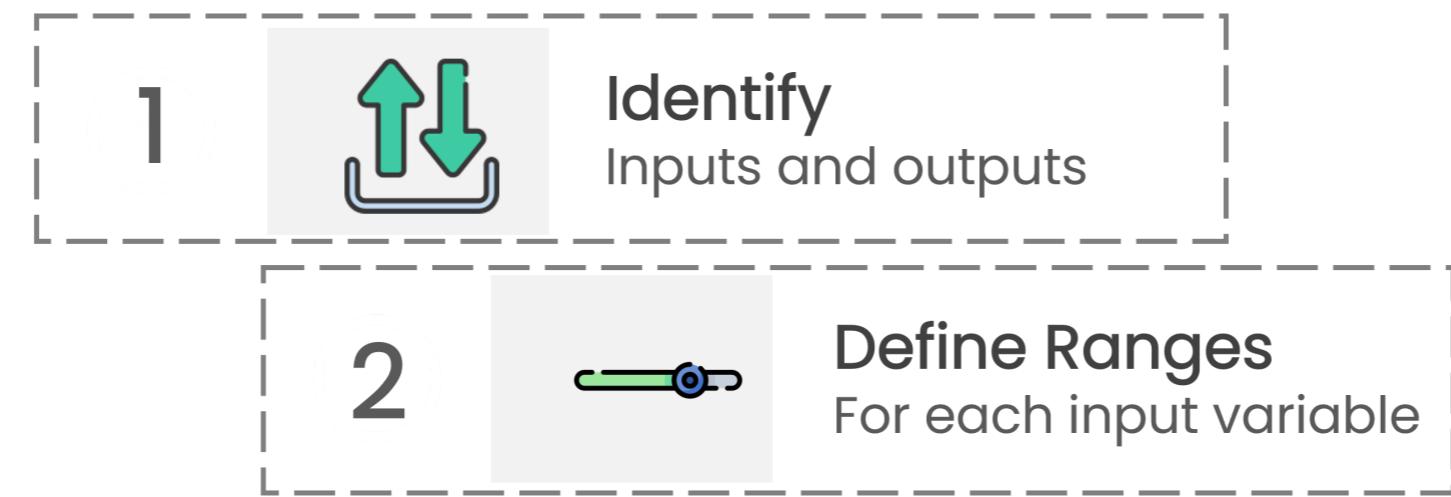
# Exploring Sensitivity Analysis

Sensitivity Analysis helps **identify which inputs have the most significant influence** on the decision outputs and to what extent.



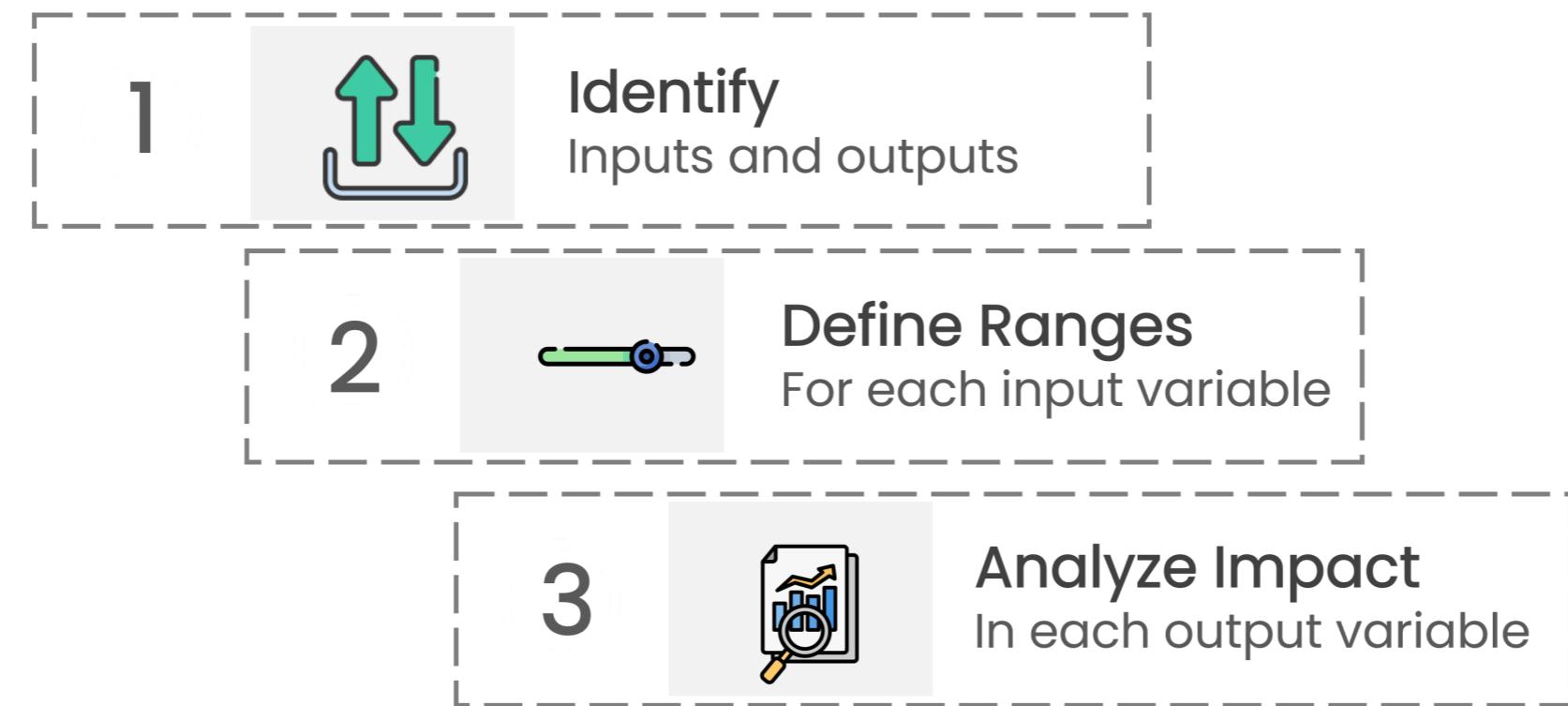
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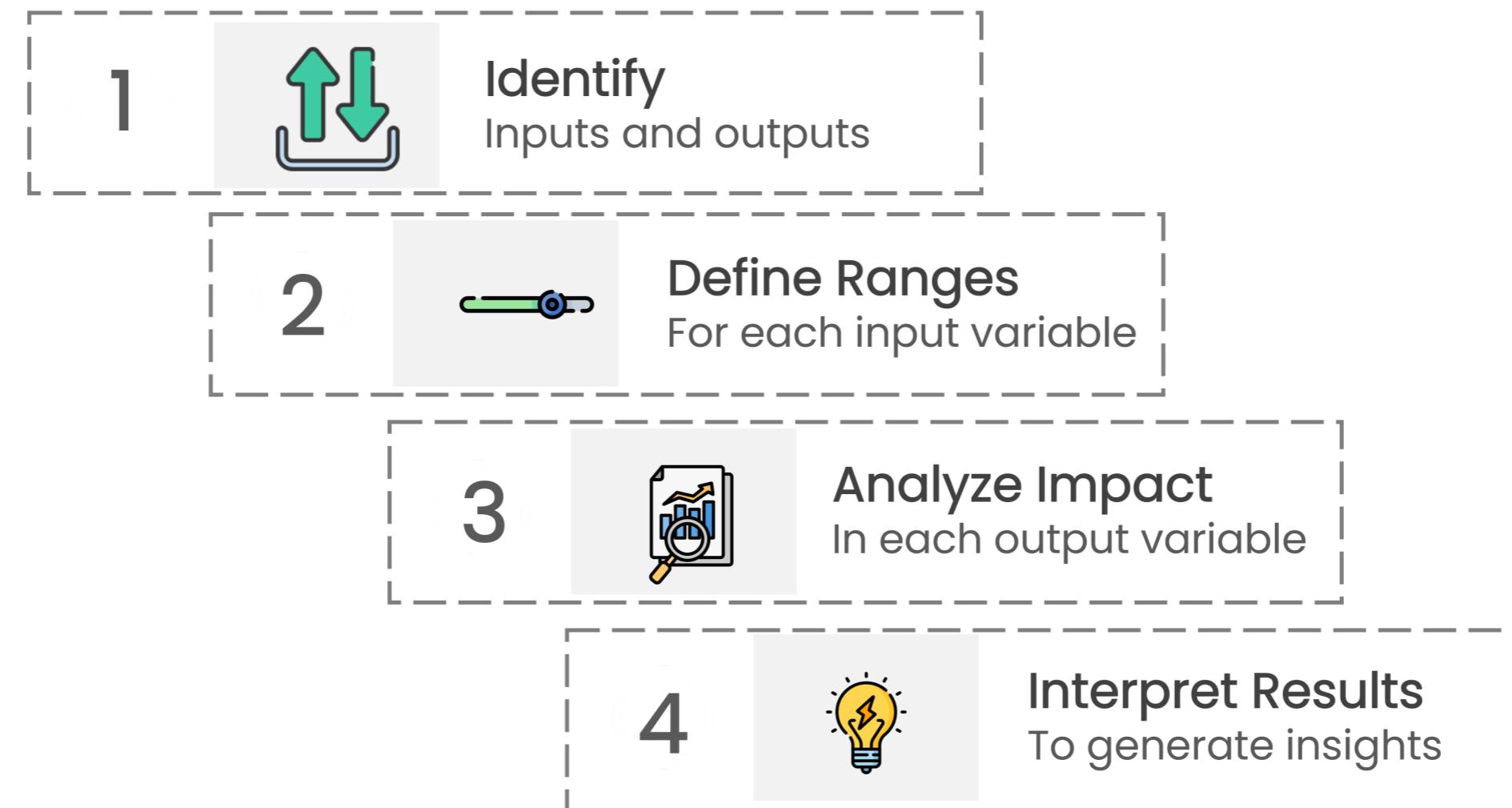
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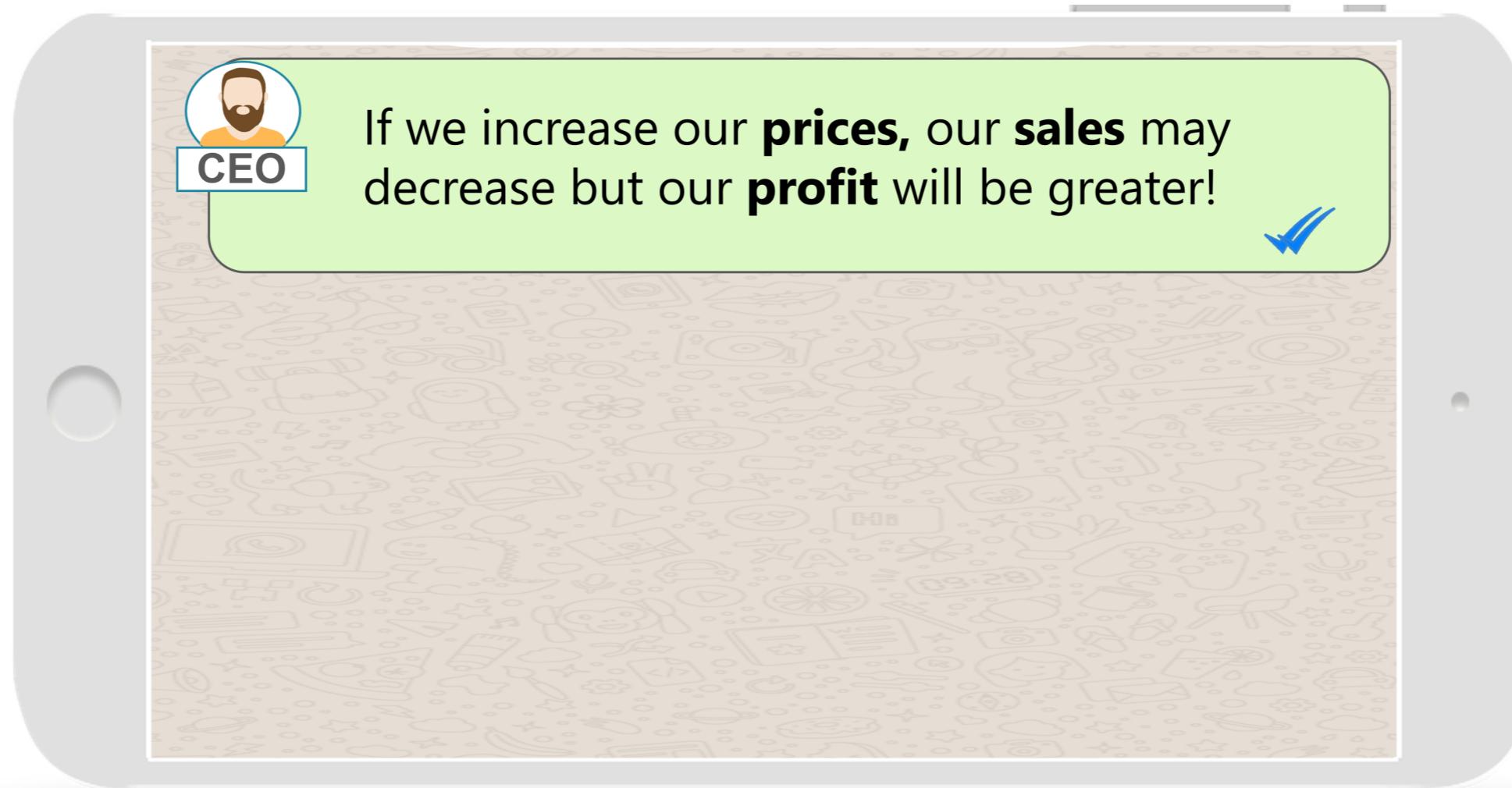
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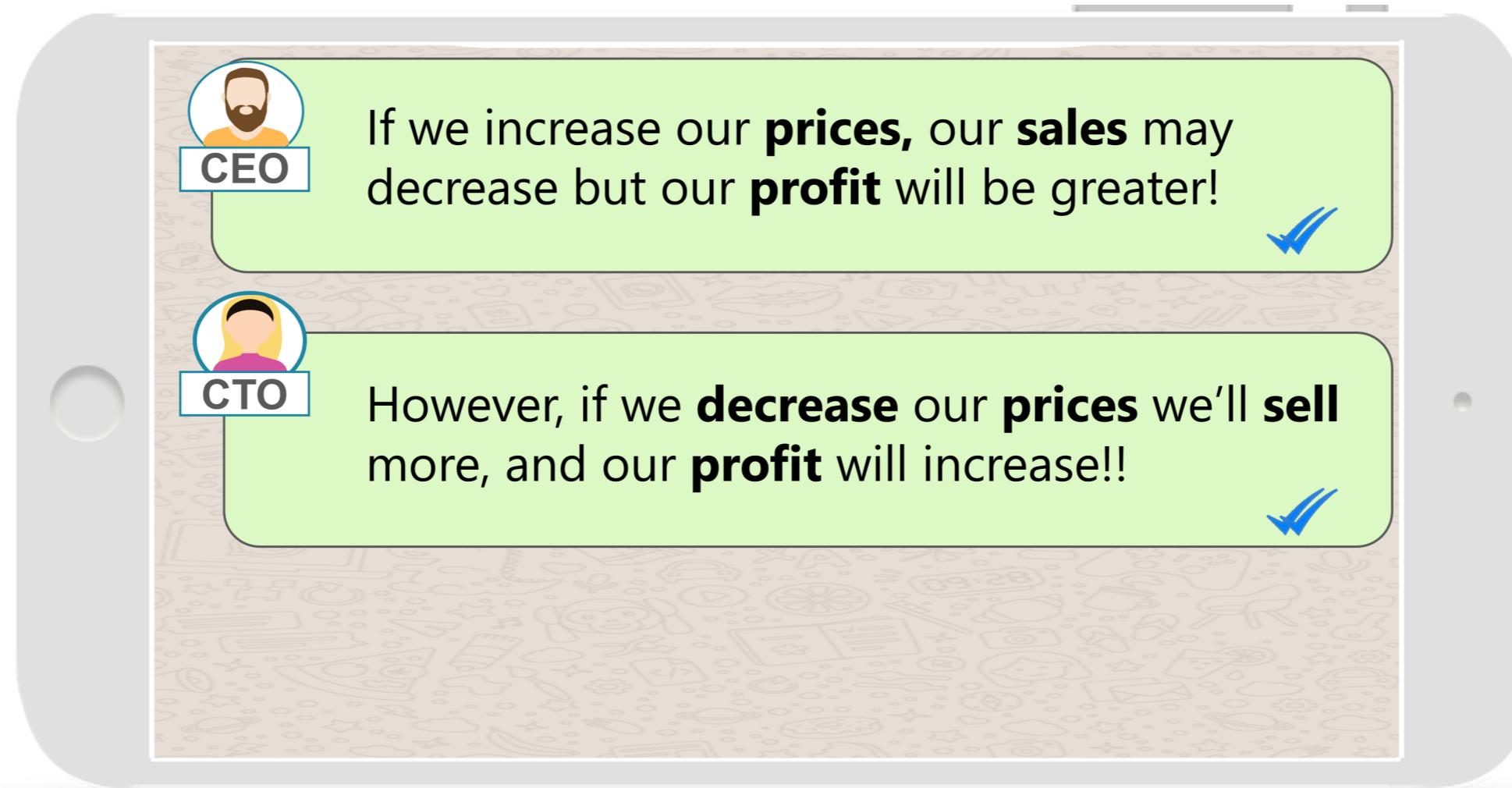
# Applying Sensitivity Analysis

Two executives at the Mattress King are text messaging about the sales strategy:



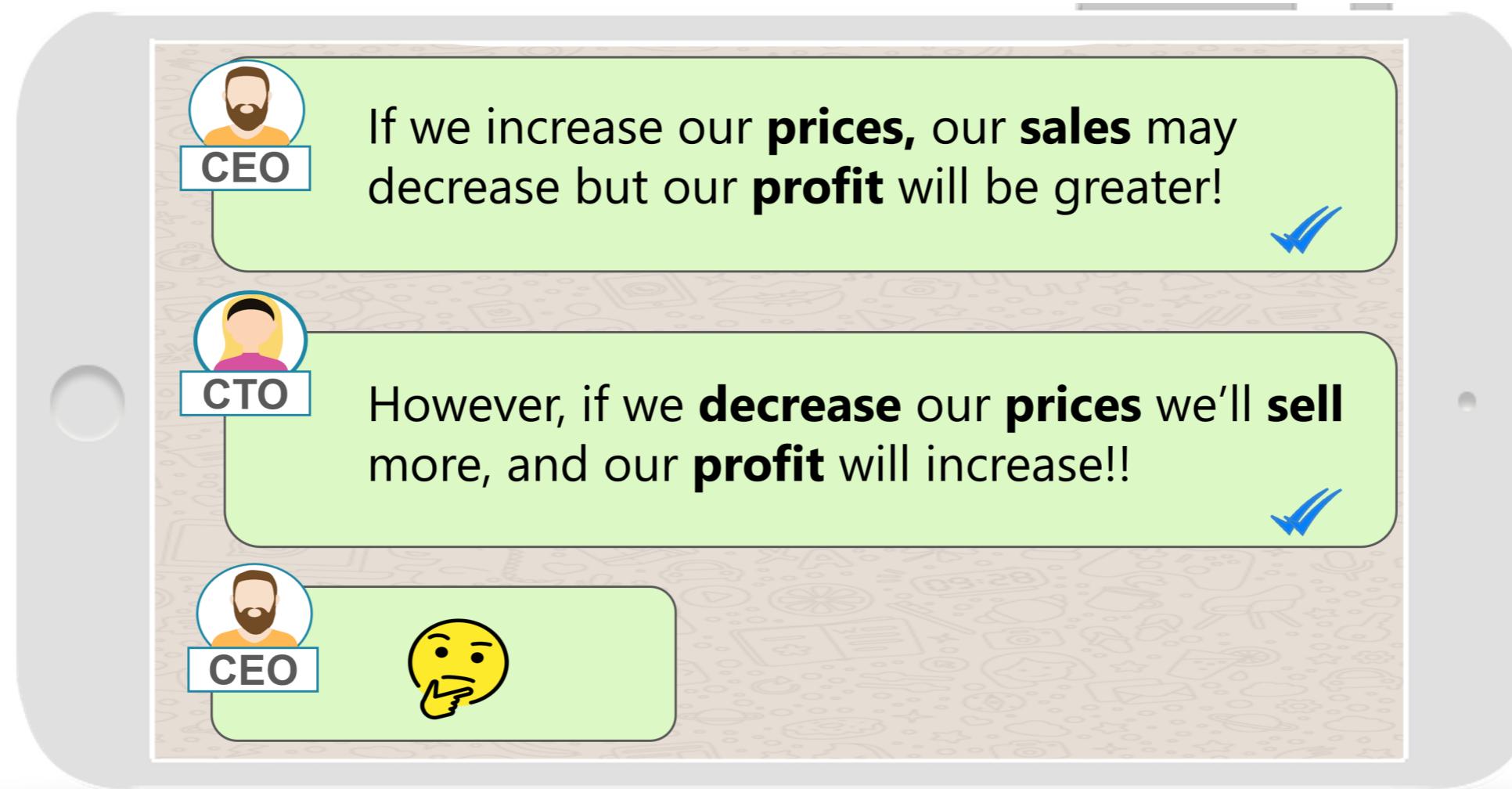
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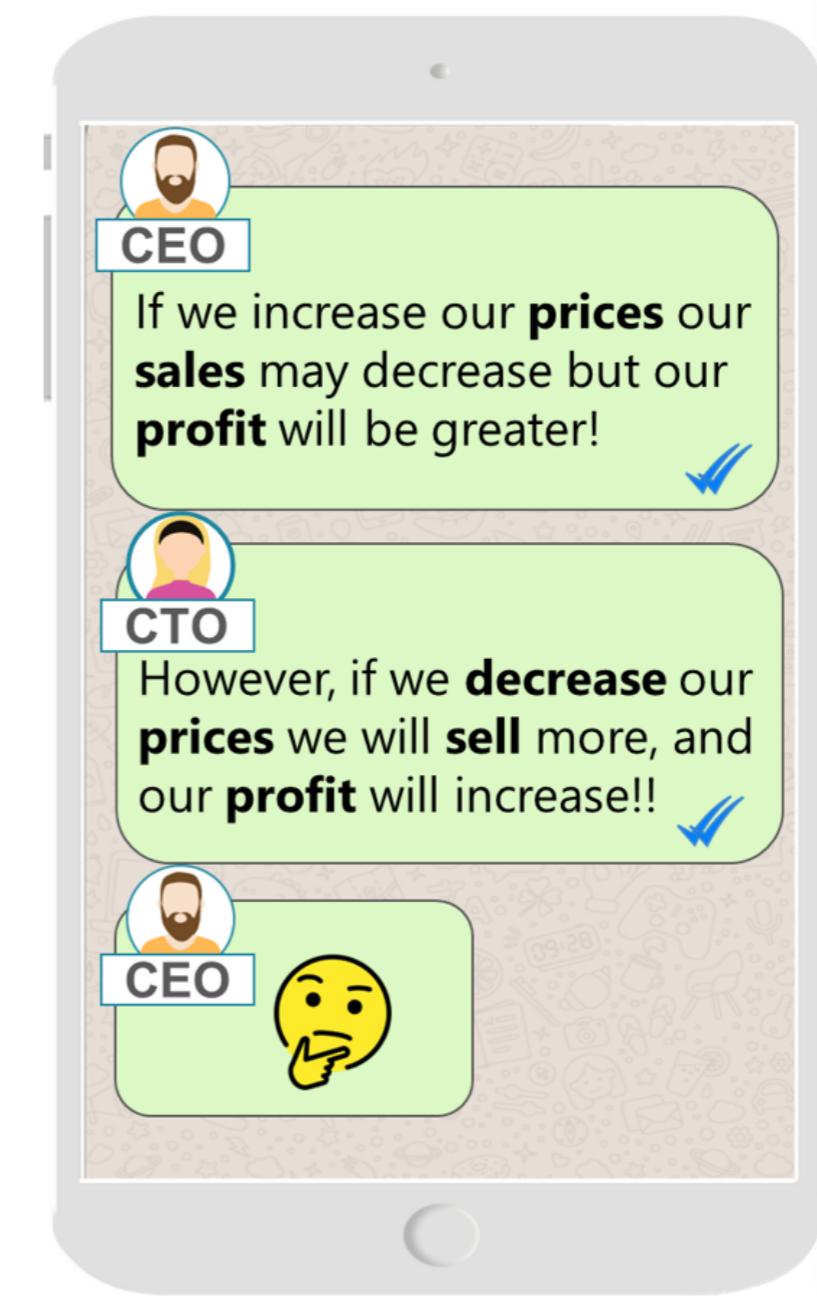
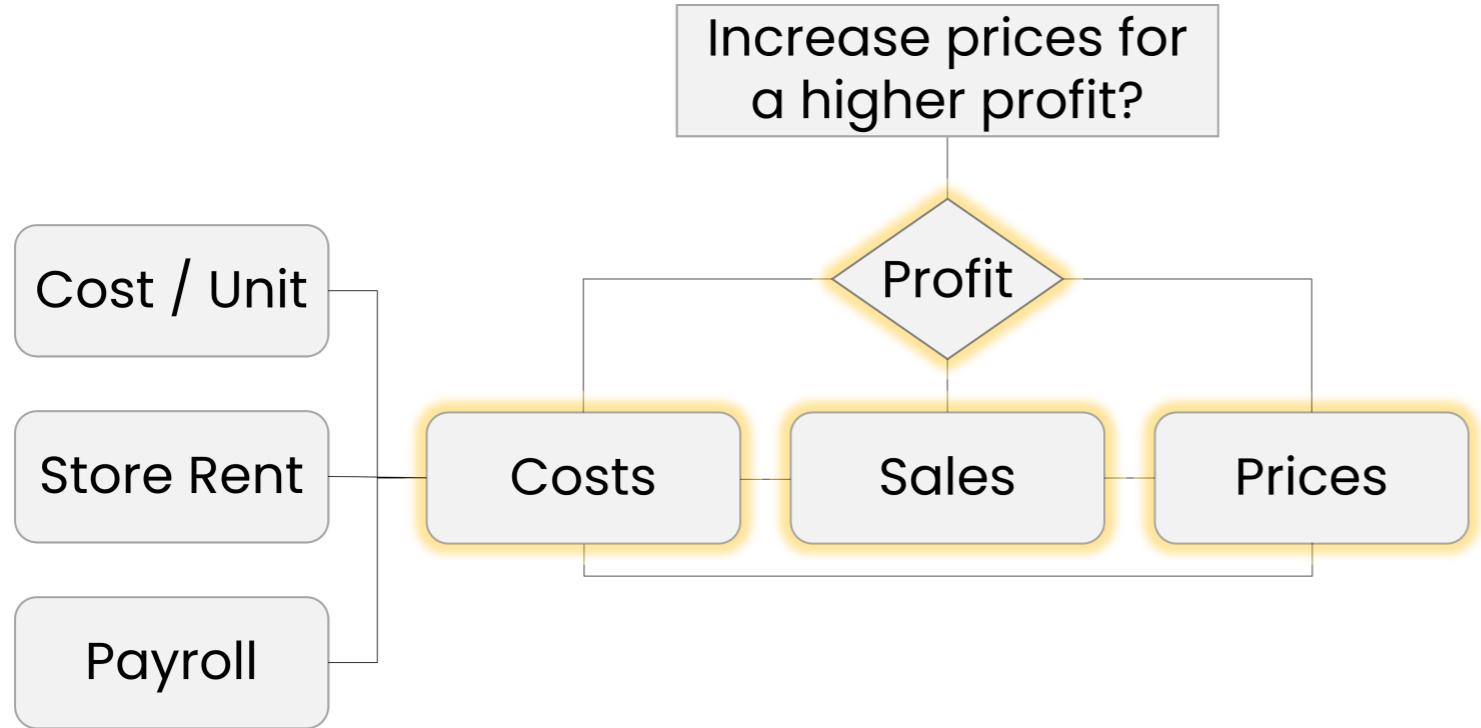


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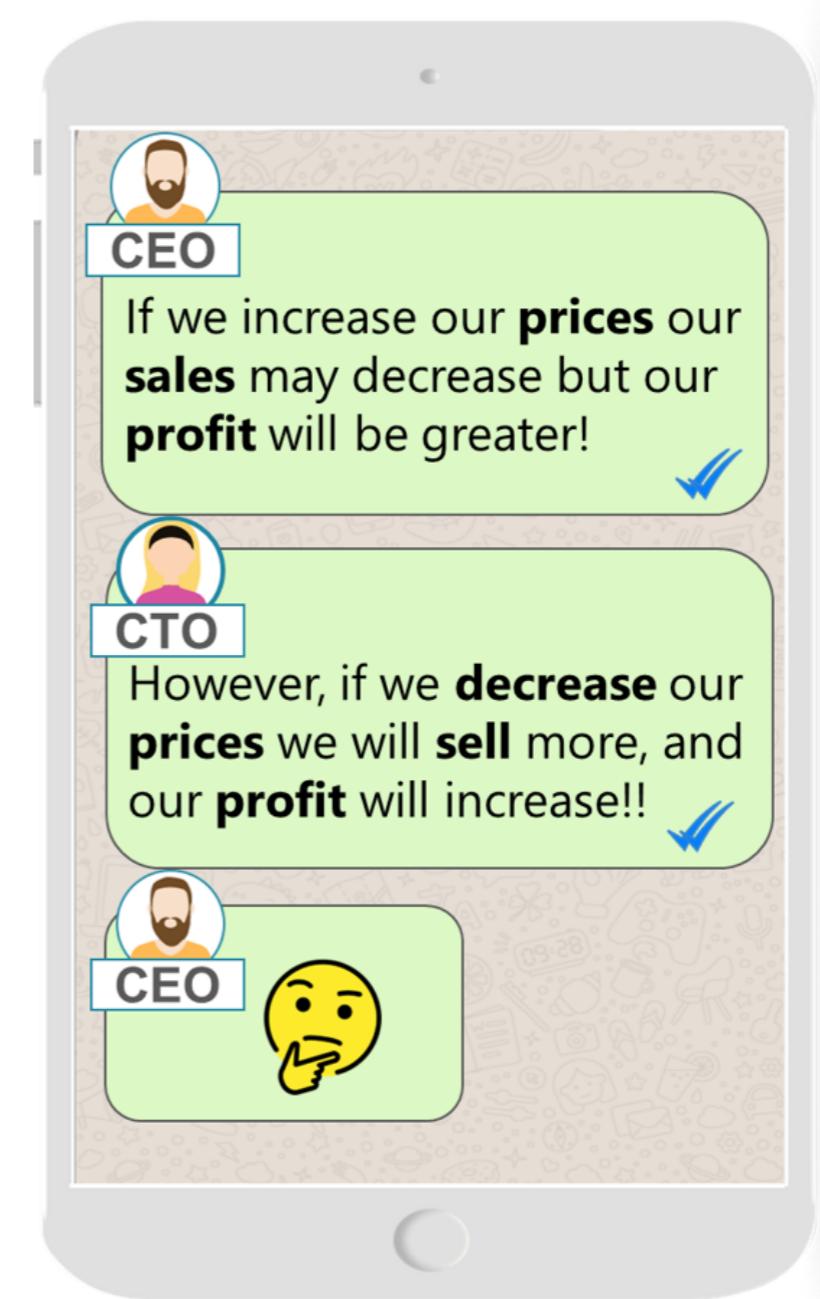
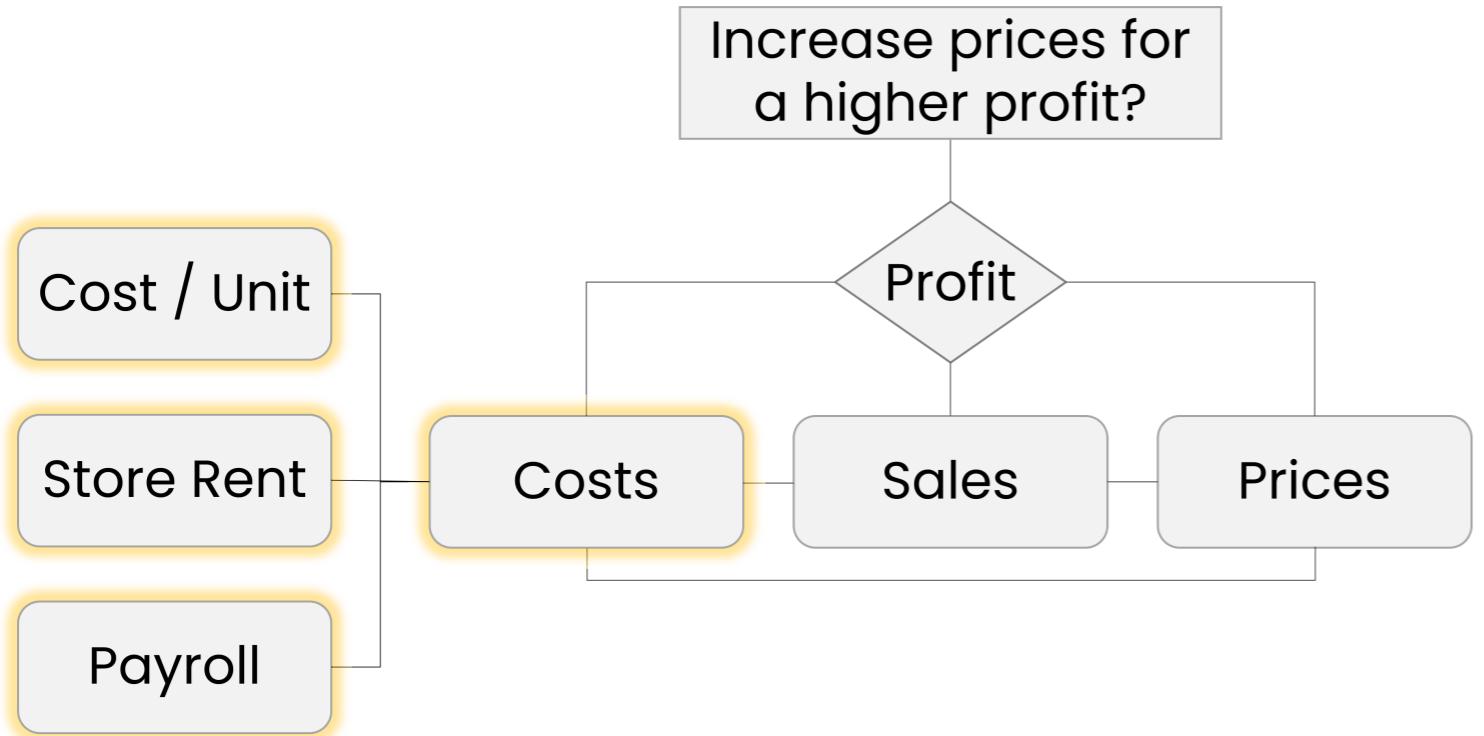
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# Identifying inputs and outputs



# Identifying inputs and outputs



# Classifying variables

## Fixed Variables

- ⌚ Payroll ----- \$50,000
- ⌚ Store rent ---- \$10,000
- ⌚ Cost per mattress - \$50

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## Floating Variables

- ⌚ Mattress price ----- \$150
- ⌚ Mattress sold ----- 1,000

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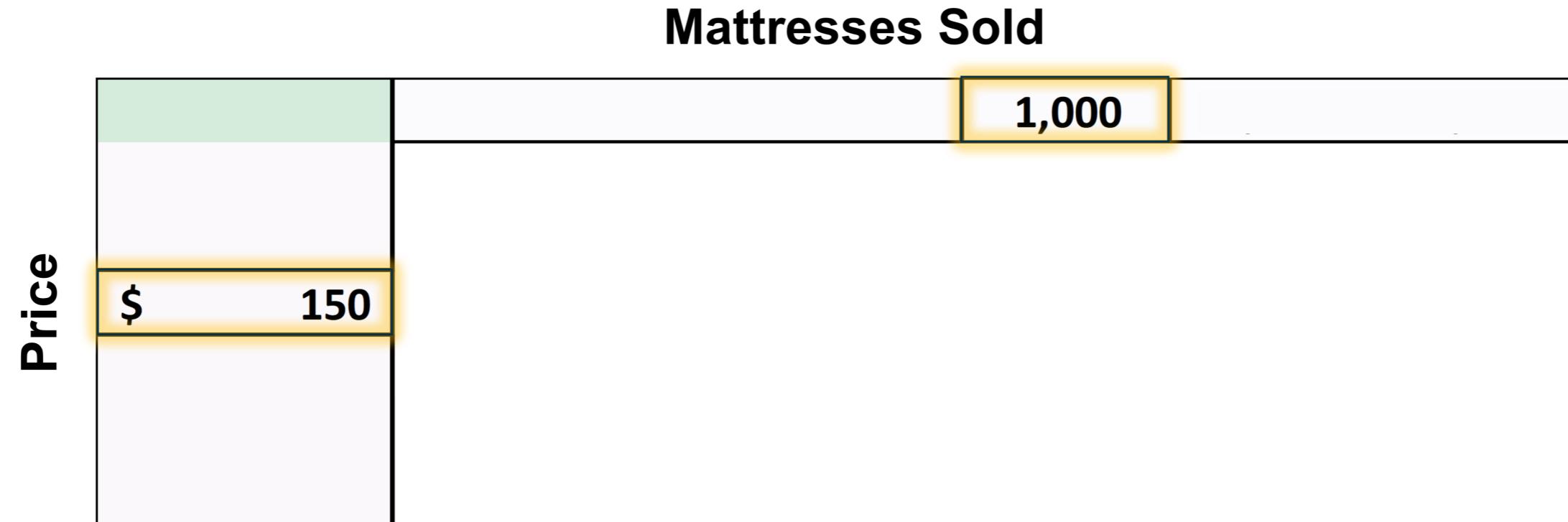
(Mattress price x Mattress sold)

—  
(Payroll + Store rent + (Cost per mattress x Mattress sold))

Profit

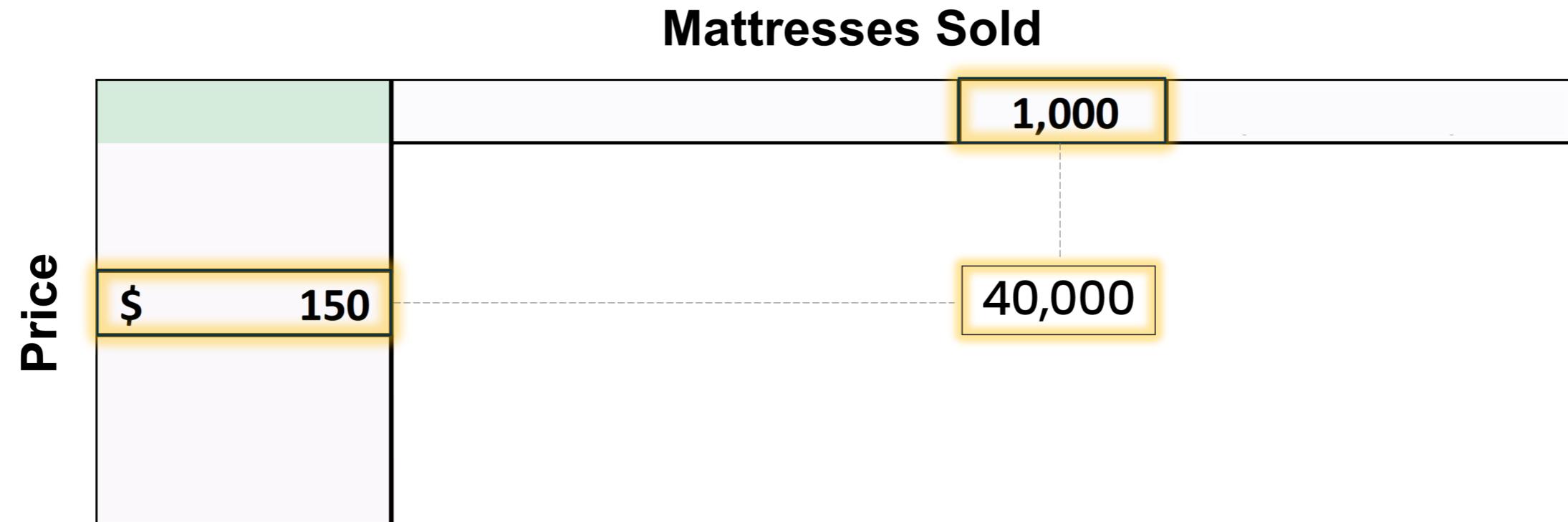
# Defining ranges of variables

$$\frac{(\text{Mattress price} \times \text{Mattress sold}) - (\text{Payroll} + \text{Store rent} + (\text{Cost per mattress} \times \text{Mattress sold}))}{\text{Profit}}$$



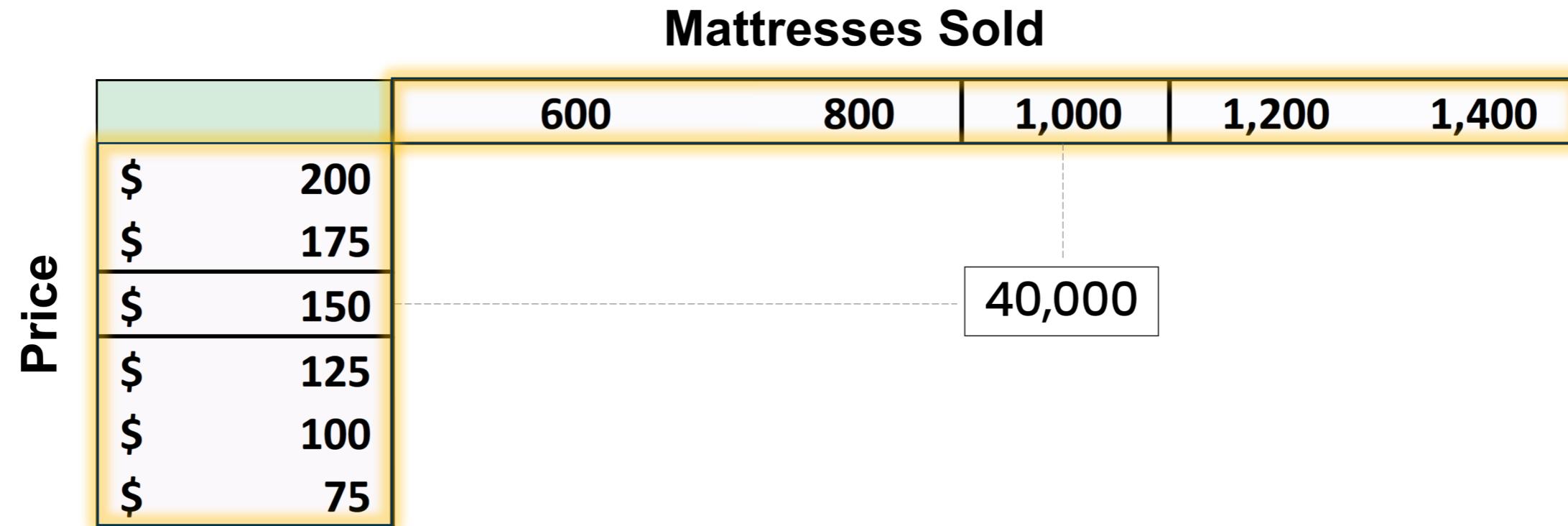
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$$\frac{(\text{Mattress price} \times \text{Mattress sold}) - (\text{Payroll} + \text{Store rent} + (\text{Cost per mattress} \times \text{Mattress sold}))}{\text{Profit}}$$



# Defining ranges of variables

$$\frac{(\text{Mattress price} \times \text{Mattress sold}) - (\text{Payroll} + \text{Store rent} + (\text{Cost per mattress} \times \text{Mattress sold}))}{\text{Profit}}$$



# Calculating the impact of variables

$$\frac{(\text{Mattress price} \times \text{Mattress sold}) - (\text{Payroll} + \text{Store rent} + (\text{Cost per mattress} \times \text{Mattress sold}))}{\text{Profit}}$$

		Mattresses Sold				
		600	800	1,000	1,200	1,400
Price	\$ 200	30,000	60,000	90,000	120,000	150,000
	\$ 175	15,000	40,000	65,000	90,000	115,000
	\$ 150	0	20,000	40,000	60,000	80,000
	\$ 125	-15,000	0	15,000	30,000	45,000
	\$ 100	-30,000	-20,000	-10,000	0	10,000
	\$ 75	-45,000	-40,000	-35,000	-30,000	-25,000

# Generating conclusions and insights

Mattresses Sold

		600	800	1,000	1,200	1,400
Price	\$ 200	30,000	60,000	90,000	120,000	150,000
	\$ 175	15,000	40,000	65,000	90,000	115,000
	\$ 150	0	20,000	40,000	60,000	80,000
	\$ 125	-15,000	0	15,000	30,000	45,000
	\$ 100	-30,000	-20,000	-10,000	0	10,000
	\$ 75	-45,000	-40,000	-35,000	-30,000	-25,000

## Increase price to \$175

The store would need to sell at least 800 mattresses to match or increase the current profit of \$40,000.

# Generating conclusions and insights

Mattresses Sold

Price	Mattresses Sold					
	600	800	1,000	1,200	1,400	
\$ 200	30,000	60,000	90,000	120,000	150,000	
\$ 175	15,000	40,000	65,000	90,000	115,000	
\$ 150	0	20,000	40,000	60,000	80,000	
\$ 125	-15,000	0	15,000	30,000	45,000	
\$ 100	-30,000	-20,000	-10,000	0	10,000	
\$ 75	-45,000	-40,000	-35,000	-30,000	-25,000	

Increase price to \$175

The store would need to sell at least 800 mattresses to match or increase the current profit of \$40,000.

Increase price to \$200

The store would need to sell approximately 700 mattresses to match or increase the current profit of \$40,000.

# Generating conclusions and insights

Mattresses Sold

Price		Mattresses Sold				
		600	800	1,000	1,200	1,400
\$ 200		30,000	60,000	90,000	120,000	150,000
\$ 175		15,000	40,000	65,000	90,000	115,000
\$ 150		0	20,000	40,000	60,000	80,000
\$ 125		-15,000	0	15,000	30,000	45,000
\$ 100		-30,000	-20,000	-10,000	0	10,000
\$ 75		-45,000	-40,000	-35,000	-30,000	-25,000

Decrease price to \$125

The store would need to sell approximately 1400 mattresses to match or increase the current profit of \$40,000.

# Generating conclusions and insights

Mattresses Sold

Price		Mattresses Sold				
		600	800	1,000	1,200	1,400
\$ 200		30,000	60,000	90,000	120,000	150,000
\$ 175		15,000	40,000	65,000	90,000	115,000
\$ 150		0	20,000	40,000	60,000	80,000
\$ 125		-15,000	0	15,000	30,000	45,000
\$ 100		-30,000	-20,000	-10,000	0	10,000
\$ 75		-45,000	-40,000	-35,000	-30,000	-25,000

Decrease price to \$125

The store would need to sell approximately 1400 mattresses to match or increase the current profit of \$40,000.

Decrease price to \$100

Even If the store sold 1,400 mattresses, that would reduce the current profit to \$10,000 (75% reduction).

# **Let's practice!**

**DECODING DECISION MODELING**