Engineering Probability — The Science of Uncertainty in Engineering

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Course: Engineering Analysis & Numerical
Level: Undergraduate 📈 💼

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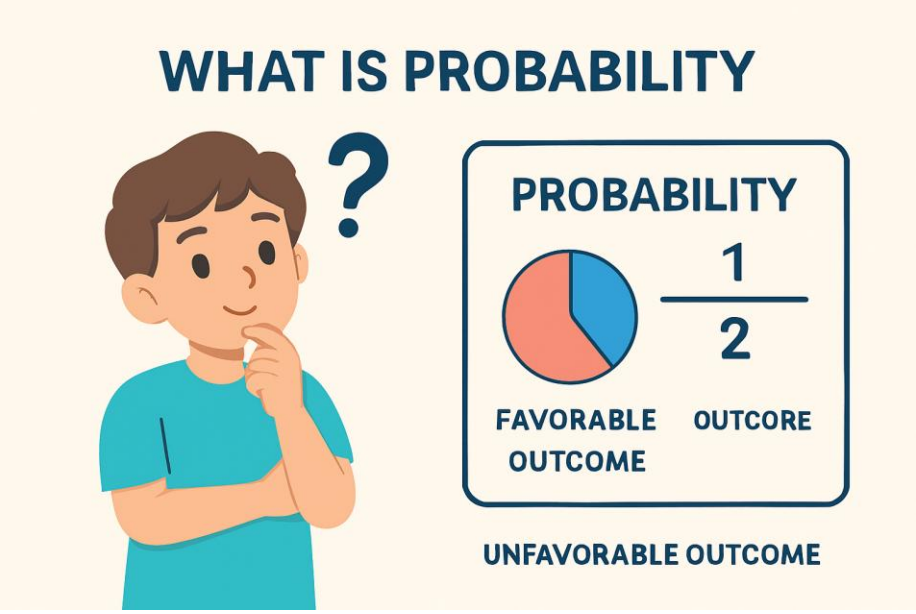
1 Introduction



Engineers often face *uncertainty*:

- Will a pump fail?
- Will a well produce oil?

Probability gives us a **quantitative way** to describe and manage this uncertainty.

So, probability is the **measure of how likely an event is to occur**.

It ranges from 0 (impossible) to 1 (certain).

Formula For any event:

$$P(\text{Event}) = \frac{\text{Number of favorable outcomes}}{\text{Total number of possible outcomes}}$$

- ## Engineering Probability Example:

Oil Well Productivity: An engineer drills **10 oil wells**, and **6 of them produce oil**. **Calculating Probability**

The probability that a randomly selected well is productive is:

$$P(\text{productive}) = \frac{\text{Number of productive wells}}{\text{Total wells}} = \frac{6}{10} = 0.6$$

This means there's a **60% chance** that a newly drilled well under similar geological and operational conditions will be productive

Applications in Real Life

- **Engineering**: Predicting system reliability or failure rates.
- **Medicine**: Estimating treatment success.
- **Finance**: Assessing investment risks.
- **Weather Forecasting**: Predicting rain or storms.

2 Core Concepts

Concept	Meaning	Example (Oil Engineering)
Experiment	Any process with an uncertain outcome	Drilling a new well
Sample Space (S)	All possible outcomes	{productive, dry}
Event (E)	A subset of outcomes	E = {productive}
Probability (P)	Measure of chance	P(E) = 0.6

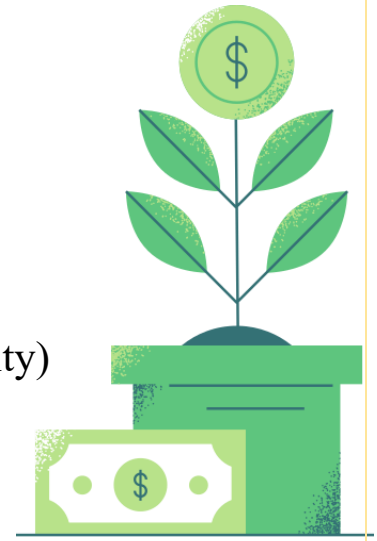
3 Probability Rules:

Rule	Description	Example
1	$0 \leq P(E) \leq 1$	Probability must be between 0 and 1. $P(\text{oil}) = 0.7 \rightarrow$ 70% chance
2	$P(S) = 1$	Total probability of all outcomes = 1. $P(P) + P(D) = 0.6 + 0.4 = 1$
3	$P(A \cup B) = P(A) + P(B) - P(A \cap B)$	Addition Rule for overlapping events. $0.6 + 0.4 - 0.25 = 0.75$
4	$P(A \cap B) = P(A) \cdot P(B)$ (if independent)	Multiplication Rule for independent events. $0.1 \cdot 0.1 = 0.1$

Engineering Probability Example

In a drilling project, the probability that a well produces oil is **0.6**, and the probability it's deep (over 3000 m) is **0.4**.

what's the probability that a well is both deep **and** productive?



Scenario

- $P(\text{Productive}) = 0.6$
- $P(\text{Deep}) = 0.4$
- Events are **independent** (depth doesn't affect productivity)

Step-by-Step Solution

We use the **Multiplication Rule**:

$$P(\text{Deep and Productive}) = P(\text{Deep}) \cdot P(\text{Productive}) = 0.4 \cdot 0.6 = 0.24$$

Final Answer:

There's a **24% chance** that a randomly selected well is **both deep and productive**.

Rule 3:

P(A or B) = P(A) + P(B) – P(A and B)

This is the **Addition Rule**:

It tells us the probability that **at least one** of two events occurs.

We *subtract the overlap* because we counted it twice when we added P(A) and P(B).

Education Context Example:

- **Event A**: Student knows Python → $P(A) = 0.4$
- **Event B**: Student knows Excel → $P(B) = 0.5$
- **Event A and B**: Student knows both → $P(A \cap B) = 0.2$

What is the probability that a student knows either Python, Excel, or both?

$$P(A \cup B) = 0.4 + 0.5 - 0.2 = 0.7$$

70% chance a student knows either Python, Excel, or both.

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Weather Forecast (Environmental Context)

- **Event A**: It rains today → $P(A) = 0.3$
- **Event B**: It's windy today → $P(B) = 0.4$
- **Event A and B**: It's both rainy and windy → $P(A \cap B) = 0.1$

What is the probability that either It rains today, It's windy today, or both?

Deliver on link below:

https://classroom.google.com/c/ODE1MTc5MzkxMzQ2/a/ODI4OTQyNDEwMjk4/details

End of lecture Part1

4 Permutations & Combinations