TUTORIAL CO1: Probability – Addition, Multiplication, and Bayes' Theorem

Introduction

Probability is the chance that something will happen. We write it as P(A), where A is an event.
- P(A) = 1 means it will surely happen
- P(A) = 0 means it will never happen
- P(A) = 0.5 means maybe it will happen

Question 1: What is the Addition Rule in Probability?

Answer:
The Addition Rule is used to find the probability that event A or event B happens.

Formula:
$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

Explanation:
If A and B can happen at the same time, we subtract the overlap so it's not counted twice.

Math Example:
P(A) = 0.6 (chance of rain)
P(B) = 0.5 (chance of thunder)
$P(A \cap B) = 0.3$ (chance of both rain and thunder)
$P(A \cup B) = 0.6 + 0.5 - 0.3 = 0.8$

Python Code:

```
P_A = 0.6
P_B = 0.5
P_A_and_B = 0.3

P_A_or_B = P_A + P_B - P_A_and_B
print("P(A ∪ B) =", P_A_or_B)
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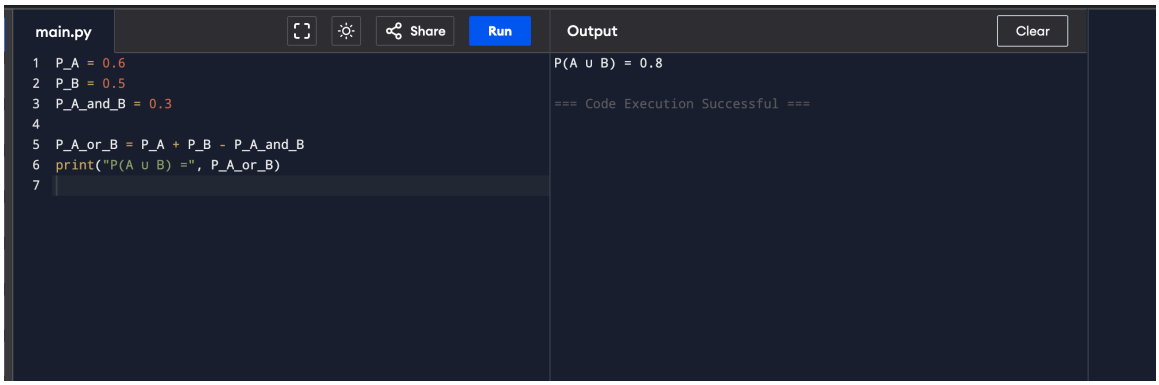
Output:
P(A ∪ B) = 0.8



Question 2: What is the Multiplication Rule in Probability?

Answer:

The Multiplication Rule is used to find the probability that both A and B happen, written as P(A ∩ B).

There are two types of multiplication rules:

Case 1: Independent Events
Events that do not affect each other.

Formula:
P(A ∩ B) = P(A) × P(B)

Example:
P(A) = 0.6 (winning a toss)
P(B) = 0.5 (winning a dice game)
P(A ∩ B) = 0.6 × 0.5 = 0.3

Python Code:

P_A = 0.6
P_B = 0.5

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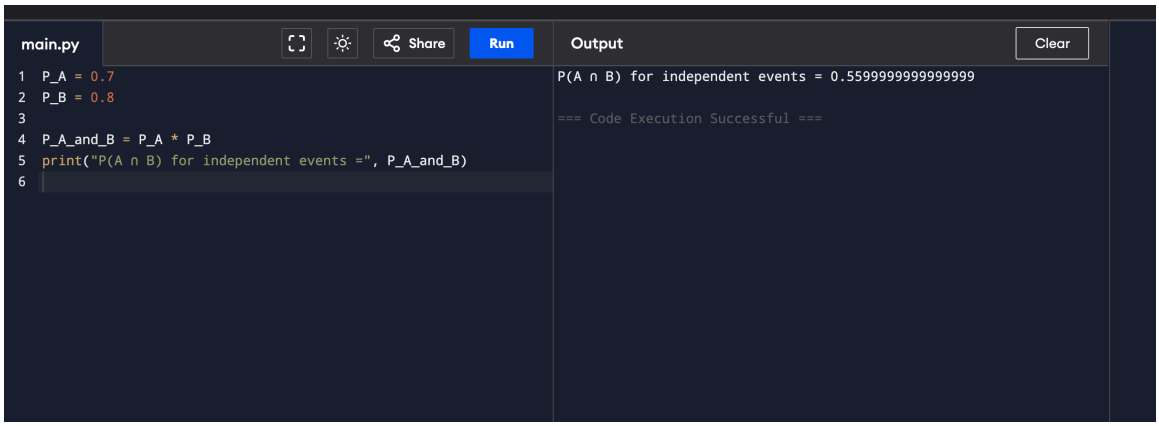
P_A_and_B = P_A * P_B
print("P(A ∩ B) =", P_A_and_B)

Output:
P(A ∩ B) = 0.3



Case 2: Dependent Events
Events where the outcome of A affects the outcome of B.

Formula:
P(A ∩ B) = P(A) × P(B | A)

Example:
P(A) = 0.4 (drawing red card first)
P(B | A) = 0.3 (drawing second red card after first)
P(A ∩ B) = 0.4 × 0.3 = 0.12

Python Code:

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P_A = 0.4
P_B_given_A = 0.3

P_A_and_B = P_A * P_B_given_A
print("P(A ∩ B) =", P_A_and_B)

Output:
P(A ∩ B) = 0.12

Question 3: What is Bayes' Theorem in Probability?
Answer:
Bayes' Theorem helps to find the reverse probability — the chance of event A happening given that B has already happened.

Formula:
P(A | B) = [P(B | A) × P(A)] / P(B)

Explanation:
It is useful when we already know the result (B), and want to find out the real cause (A).

Math Example:
P(A) = 0.01 (has disease)
P(B | A) = 0.95 (test positive if sick)
P(B) = 0.05 (test positive overall)
P(A | B) = (0.95 × 0.01) / 0.05 = 0.19

Python Code:

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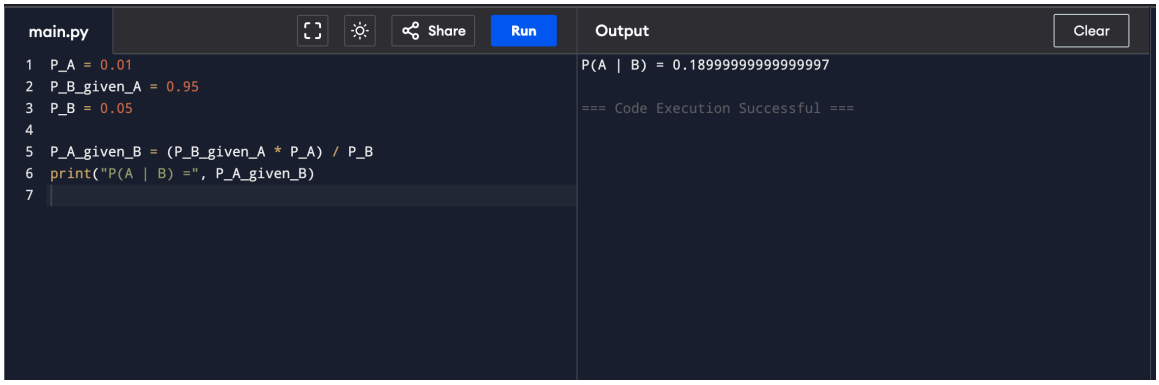
P_A = 0.01
P_B_given_A = 0.95
P_B = 0.05

P_A_given_B = (P_B_given_A * P_A) / P_B
print("P(A | B) =", P_A_given_B)

Output:
P(A | B) = 0.19



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