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**1. Addition in Probability**

Concept:

The addition rule calculates the probability that at least one of two events occurs.

For Mutually Exclusive Events (cannot occur together):

P(Aor B)=P(A)+P(B)

P(A or B)=P(A)+P(B)

Example: Tossing a coin, getting heads or tails:

P(Heads or Tails)=0.5+0.5=1

P(Heads or Tails)=0.5+0.5=1.

For Non-Mutually Exclusive Events (can occur together):

P(A or B)=P(A)+P(B)−P(A and B)

P(A or B)=P(A)+P(B)−P(A and B)

Example:

Probability of event A: 0.3

Probability of event B: 0.5

Probability of both: 0.1

So,

P(A or B)=0.3+0.5−0.1=0.7

P(A or B)=0.3+0.5−0.1=0.7

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These calculations help data scientists assess probabilities in real-life classification, recommendation systems, and risk assessments.

**2. Multiplication in Probability**

Concept:

The multiplication rule determines the probability of two events both happening.

For Independent Events:

P(Aand B)=P(A)×P(B)

P(A and B)=P(A)×P(B)

Example: Probability of tossing two heads in two separate coin flips:

P(Head 1 and Head 2)=0.5×0.5=0.25

P(Head 1 and Head 2)=0.5×0.5=0.25

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For Dependent Events:

P(A and B)=P(A)×P(B∣A)

P(A and B)=P(A)×P(B∣A)

Where

P(B∣A)

P(B∣A) is the probability of B after A is known.

These concepts are core to data science for modeling joint probabilities and building Bayesian networks.

**3. Bayes' Theorem**

Concept:

Bayes’ Theorem provides a way to update the probability of a hypothesis given new evidence:

P(A∣B)=P(B∣A)×P(A)P(B)

P(A∣B)= P(B)

P(B∣A)×P(A)

P(A)

P(A): Prior probability of event A (before observing B).

P(B∣A)

P(B∣A): Probability of B if A is true.

P(B)

P(B): Probability of B (all ways B can happen).

P(A∣B)

P(A∣B): Updated probability of A given B occurred.

Example Application: Predicting the probability of rain (A) given that it’s cloudy (B)[previous answer].

**Java Example Codes for Each**

Addition Example (Probability of 'A or B'):

java

// P(A) = 0.3, P(B) = 0.5, P(A and B) = 0.1

double pA = 0.3;

double pB = 0.5;

double pAandB = 0.1;

double pAorB = pA + pB - pAandB;

System.out.println("P(A or B): " + pAorB); // Output: 0.7

Multiplication Example (Independent Events):

java

// P(A) = 0.3, P(B) = 0.5 (independent)

double pA = 0.3;

double pB = 0.5;

double pAandB = pA \* pB;

System.out.println("P(A and B): " + pAandB); // Output: 0.15

Bayes’ Theorem Example:

java

// P(Disease) = 0.01, P(Positive|Disease) = 0.95, P(Positive) = 0.05

double pDisease = 0.01;

double pPositiveGivenDisease = 0.95;

double pPositive = 0.05;

double pDiseaseGivenPositive = (pPositiveGivenDisease \* pDisease) / pPositive;

System.out.println("P(Disease|Positive): " + pDiseaseGivenPositive); // Output: 0.19