

# Probability Models and Axioms

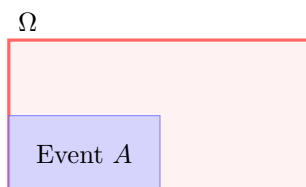
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## 1 Sample Space, Likelihood, and Events

The **Sample Space** (denoted as  $\Omega$ ) is the set of all possible outcomes. We assign a **probability** to these outcomes to represent their likelihood.

An **Event** is a subset of the sample space. Think of the sample space as a cake and an event as cream cheese spread on it. If the cream cheese spreads over the entire cake, the probability is 1.



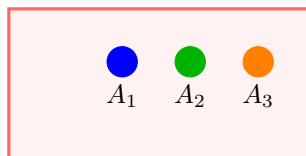
## 2 Union

A **union** ( $\cup$ ) is the merging of subsets. Like mixing two flavors of cream cheese, the union includes regions with only flavor A, only flavor B, and the region where they overlap.

### 2.1 Axiom of Additivity

If events  $A_1, A_2, \dots, A_n$  are **disjoint** (they do not overlap), the probability of their union is the sum of their individual probabilities:

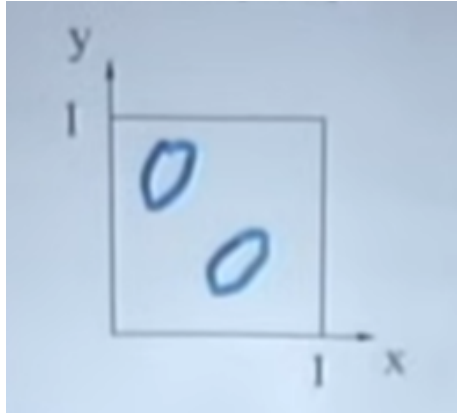
$$P(A_1 \cup A_2 \cup \dots \cup A_n) = P(A_1) + P(A_2) + \dots + P(A_n)$$



### 3 Discrete vs. Continuous Uniform Law

In a Discrete Uniform Law, every individual outcome has the same probability (like a fair die). In a Continuous Uniform Law, the sample space is infinite (like a 2D plane).

In the continuous case:



- **Uniform Law:** Probability is proportional to the area.
- $P(A) = \frac{\text{Area}(A)}{\text{Total Area of } \Omega}$

If two different regions have the same area, they have the same probability.