1. Define the Bayesian interpretation of probability.

2. Define probability of a union of two events with equation.

3. What is joint probability? What is its formula?

4. What is chain rule of probability?

5. What is conditional probability means? What is the formula of it?

6. What are continuous random variables?

7. What are Bernoulli distributions? What is the formula of it?

8. What is binomial distribution? What is the formula?

9. What is Poisson distribution? What is the formula?

10. Define covariance.

11. Define correlation

12. Define sampling with replacement. Give example.

13. What is sampling without replacement? Give example.

14. What is hypothesis? Give example.

### **1. Bayesian Interpretation of Probability**

**Bayesian Interpretation of Probability:**

* **Definition:** The Bayesian interpretation views probability as a measure of belief or certainty about an event. It is subjective and incorporates prior knowledge or beliefs (prior probability) and updates these beliefs based on new evidence (likelihood) to obtain a revised probability (posterior probability).
* **Formula (Bayes' Theorem):**P(A∣B)=P(B∣A)⋅P(A)P(B)P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B)}P(A∣B)=P(B)P(B∣A)⋅P(A)​  
  Where:
  + P(A∣B)P(A|B)P(A∣B) is the posterior probability of event A given event B.
  + P(B∣A)P(B|A)P(B∣A) is the likelihood of event B given event A.
  + P(A)P(A)P(A) is the prior probability of event A.
  + P(B)P(B)P(B) is the marginal probability of event B.

### **2. Probability of a Union of Two Events**

**Probability of a Union of Two Events:**

* **Definition:** The probability that at least one of two events occurs.
* **Formula:**P(A∪B)=P(A)+P(B)−P(A∩B)P(A \cup B) = P(A) + P(B) - P(A \cap B)P(A∪B)=P(A)+P(B)−P(A∩B)  
  Where:
  + P(A∪B)P(A \cup B)P(A∪B) is the probability of the union of events A and B.
  + P(A)P(A)P(A) and P(B)P(B)P(B) are the probabilities of events A and B, respectively.
  + P(A∩B)P(A \cap B)P(A∩B) is the probability of the intersection of events A and B.

### **3. Joint Probability**

**Joint Probability:**

* **Definition:** The probability that both of two events occur simultaneously.
* **Formula:**P(A∩B)=P(A)⋅P(B∣A)P(A \cap B) = P(A) \cdot P(B|A)P(A∩B)=P(A)⋅P(B∣A)  
  Where:
  + P(A∩B)P(A \cap B)P(A∩B) is the joint probability of events A and B.
  + P(B∣A)P(B|A)P(B∣A) is the conditional probability of B given A.

### **4. Chain Rule of Probability**

**Chain Rule of Probability:**

* **Definition:** The chain rule allows the calculation of joint probabilities of a sequence of events by decomposing it into a product of conditional probabilities.
* **Formula:**P(A1,A2,…,An)=P(A1)⋅P(A2∣A1)⋅P(A3∣A1,A2)⋯P(An∣A1,A2,…,An−1)P(A\_1, A\_2, \ldots, A\_n) = P(A\_1) \cdot P(A\_2|A\_1) \cdot P(A\_3|A\_1, A\_2) \cdots P(A\_n|A\_1, A\_2, \ldots, A\_{n-1})P(A1​,A2​,…,An​)=P(A1​)⋅P(A2​∣A1​)⋅P(A3​∣A1​,A2​)⋯P(An​∣A1​,A2​,…,An−1​)

### **5. Conditional Probability**

**Conditional Probability:**

* **Definition:** The probability of an event occurring given that another event has already occurred.
* **Formula:**P(A∣B)=P(A∩B)P(B)P(A|B) = \frac{P(A \cap B)}{P(B)}P(A∣B)=P(B)P(A∩B)​  
  Where:
  + P(A∣B)P(A|B)P(A∣B) is the probability of event A given that event B has occurred.
  + P(A∩B)P(A \cap B)P(A∩B) is the joint probability of events A and B.
  + P(B)P(B)P(B) is the probability of event B.

### **6. Continuous Random Variables**

**Continuous Random Variables:**

* **Definition:** Random variables that can take any value within a continuous range or interval. They are characterized by a probability density function (PDF) rather than a probability mass function (PMF).
* **Example:** The height of a person, which can take any value within a range (e.g., 150 cm to 200 cm).

### **7. Bernoulli Distribution**

**Bernoulli Distribution:**

* **Definition:** A discrete probability distribution of a random variable which takes the value 1 with probability ppp and the value 0 with probability 1−p1 - p1−p. It models a single binary outcome.
* **Formula:**P(X=x)=px⋅(1−p)1−xP(X = x) = p^x \cdot (1 - p)^{1 - x}P(X=x)=px⋅(1−p)1−x  
  Where:
  + xxx can be 0 or 1.
  + ppp is the probability of success (1).

### **8. Binomial Distribution**

**Binomial Distribution:**

* **Definition:** A discrete probability distribution that models the number of successes in a fixed number of independent Bernoulli trials.
* **Formula:**P(X=k)=(nk)⋅pk⋅(1−p)n−kP(X = k) = \binom{n}{k} \cdot p^k \cdot (1 - p)^{n - k}P(X=k)=(kn​)⋅pk⋅(1−p)n−k  
  Where:
  + nnn is the number of trials.
  + kkk is the number of successes.
  + ppp is the probability of success.

### **9. Poisson Distribution**

**Poisson Distribution:**

* **Definition:** A discrete probability distribution that models the number of events occurring within a fixed interval of time or space, given the events occur with a known constant mean rate and independently of the time since the last event.
* **Formula:**P(X=k)=λk⋅e−λk!P(X = k) = \frac{\lambda^k \cdot e^{-\lambda}}{k!}P(X=k)=k!λk⋅e−λ​  
  Where:
  + λ\lambdaλ is the average rate (mean number of occurrences).
  + kkk is the number of occurrences.
  + eee is the base of the natural logarithm.

### **10. Covariance**

**Covariance:**

* **Definition:** A measure of how much two random variables change together. It indicates the direction of the linear relationship between the variables.
* **Formula:**Cov(X,Y)=1n−1∑i=1n(Xi−Xˉ)(Yi−Yˉ)\text{Cov}(X, Y) = \frac{1}{n-1} \sum\_{i=1}^n (X\_i - \bar{X})(Y\_i - \bar{Y})Cov(X,Y)=n−11​i=1∑n​(Xi​−Xˉ)(Yi​−Yˉ)  
  Where:
  + XiX\_iXi​ and YiY\_iYi​ are individual sample points.
  + Xˉ\bar{X}Xˉ and Yˉ\bar{Y}Yˉ are the means of X and Y.

### **11. Correlation**

**Correlation:**

* **Definition:** A statistical measure that describes the strength and direction of a linear relationship between two variables.
* **Formula:**Corr(X,Y)=Cov(X,Y)σX⋅σY\text{Corr}(X, Y) = \frac{\text{Cov}(X, Y)}{\sigma\_X \cdot \sigma\_Y}Corr(X,Y)=σX​⋅σY​Cov(X,Y)​  
  Where:
  + Cov(X,Y)\text{Cov}(X, Y)Cov(X,Y) is the covariance between X and Y.
  + σX\sigma\_XσX​ and σY\sigma\_YσY​ are the standard deviations of X and Y.

### **12. Sampling with Replacement**

**Sampling with Replacement:**

* **Definition:** A method where each sample drawn from the population is replaced before the next draw, allowing the same sample to be selected more than once.
* **Example:** Drawing cards from a deck and replacing each card back into the deck before drawing the next card.

### **13. Sampling without Replacement**

**Sampling without Replacement:**

* **Definition:** A method where each sample drawn from the population is not replaced, meaning each sample can only be selected once.
* **Example:** Drawing names from a hat where each name is not put back into the hat after being drawn.

### **14. Hypothesis**

**Hypothesis:**

* **Definition:** A statement or assumption that can be tested through experimentation or observation. It is used to make predictions or draw conclusions based on data.
* **Example:** A hypothesis might state, "Increasing the amount of sunlight a plant receives will lead to faster growth." This hypothesis can be tested by comparing the growth rates of plants exposed to different amounts of sunlight.