**DISCRETE DISTRIBUTIONS**

- **Uniform Distribution**

- **Bernoulli Trial:** $\Omega = \{\text{success, failure}\}$. $P(\text{success}) = p$, $P(\text{failure}) = q = 1 - p$.

- **Bernoulli Distribution** $B = B(1, p)$: $P(B = 1) = p$, $P(B = 0) = 1 - p = q$.

- **Binomial Distribution** $B(n, p)$: Repeat Bernoulli trial independently for $n$ times, and let $B(n, p)$ be the number of successes. Then
  
  $$
P[B(n, p) = x] = \binom{n}{x} p^x (1 - p)^{n-x}.
  $$

- **Geometric Distribution:** In the repeated trials,

  - Let $X$ be the number of failures until the first success. Then $P(X = x) = (1 - p)^x p$
  
  - Let $Y$ be the number of trials on which the first success occurs. Then $P(Y = y) = (1 - p)^{y-1} p$

- **Negative Binomial Distribution:** Let $X$ be the number of failures until the $r$th success. Then
  
  $$
P(X = x) = \binom{r + x - 1}{r - 1} p^r (1 - p)^x.
  $$

- **Poisson Distribution:** $P(X = x) = \frac{e^{-\lambda} \lambda^x}{x!}$.

- **Hypergeometric Distribution:** Among total $M$ objects, $K$ are good and $M - K$ are bad. A sample of $n$ objects is selected without replacement. Let $X$ be the number of good ones in the sample. Then
  
  $$
P(X = x) = \binom{K}{x} \binom{M - K}{n - x} \binom{M}{n}.
  $$

- **Multinomial Distribution:** An experiment has $k$ outcomes with probabilities $p_1, p_2, \ldots, p_k$ respectively. Repeat the experiment $n$ times independently. Let $X_i$ be the number of times that the $i$th outcome occurs. Then
  
  $$
P(X_1 = x_1, X_2 = x_2, \ldots, X_k = x_k) = \frac{n!}{x_1! \cdots x_k!} \cdot p_1^{x_1} \cdots p_k^{x_k}.
  $$