| **Discrete** | **Description** | **Mean** $E(X)=\mu$ | **Variance** $Var(X)=\sigma^2$ | **PMF** $P(X=x)$ | **CDF** $F(X)=P(X\le x)$ |
|---|---|---|---|---|---|
| **Uniform** $X\sim \text{Discrete Uni}(a,b)$ | Each of the $n$ outcomes has an equal probability. | $\frac{a+b}{2}$ | $\frac{(b-a+1)^2-1}{12}$ | $\frac{1}{b-a+1}, a\le k\le b$ | $\frac{\lfloor x\rfloor-a+1}{b-a+1}, a\le x\le b$ |
| **Bernoulli** $X\sim \text{Ber}(p)$ | A single binary outcome, success (1) with probability $p$ and failure (0) with probability $1-p$. | $p$ | $p(1-p)$ | $p^x(1-p)^{1-x}, x\in\{0,1\}$ | $\begin{cases}0, & x<0\\ 1-p, & 0\le x<1\\ 1, & x\ge 1\end{cases}$ |
| **Binomial** $X\sim \text{Bin}(n,p)$ | The sum of $n$ independent Bernoulli trials with success probability $p$. | $np$ | $np(1-p)$ | $\binom{n}{x}p^x(1-p)^{n-x}$ | $\sum_{k=0}^{x} P(X=k)$ |
| **Negative Binomial** $X\sim \text{NegBin}(r,p)$ | The number of trials required to achieve $r$ successes in independent Bernoulli trials with success probability $p$. | $\frac{r}{p}$ | $\frac{r(1-p)}{p^2}$ | $\binom{x-1}{r-1}p^r(1-p)^{x-r}$ | $\sum_{k=r}^{x} P(X=k)$ |
| **Geometric** $X\sim \text{Geo}(p)$ | The number of trials until the first success in independent Bernoulli trials with success probability $p$. | $\frac{1}{p}$ | $\frac{1-p}{p^2}$ | $p(1-p)^{x-1}$ | $1-(1-p)^x$ |
| **Hypergeometric** $X\sim \text{HypGeo}(n,N,M)$ | The number of successes in a sample of size $n$ drawn without replacement from a population of size $N$ containing $M$ successes. | $n\frac{M}{N}$ | $n\frac{M}{N}\left(1-\frac{M}{N}\right)\frac{N-n}{N-1}$ | $\frac{\binom{M}{x}\binom{N-M}{n-x}}{\binom{N}{n}}$ | $\sum_{k=0}^{x} P(X=k)$ |
| **Poisson** $X\sim \text{Poi}(\lambda)$ | Models the number of events occurring in a fixed interval of time or space with a known average rate $\lambda$. | $\lambda$ | $\lambda$ | $\frac{\lambda^x e^{-\lambda}}{x!}$ | $\sum_{k=0}^{x} P(X=k)$ |

| **Continuous** | **Description** | **Mean** $E(X)=\mu$ | **Variance** $Var(X)=\sigma^2$ | **PDF** $f(x)$ | **CDF** $F(X)=P(X\le x)$ |
|---|---|---|---|---|---|
| **Uniform** $X\sim \text{Uni}(a,b)$ | A continuous distribution where all outcomes in the range $[a,b]$ are equally likely. | $\frac{a+b}{2}$ | $\frac{(b-a)^2}{12}$ | $\frac{1}{b-a},\quad a\le x\le b$ | $\frac{x-a}{b-a},\quad a\le x\le b$ |
| **Beta** $X\sim \text{Beta}(\alpha,\beta)$ | A family of distributions defined on $[0,1]$, often used in Bayesian statistics. | $\frac{\alpha}{\alpha+\beta}$ | $\frac{\alpha\beta}{(\alpha+\beta)^2(\alpha+\beta+1)}$ | $x^{\alpha-1}(1-x)^{\beta-1}\frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)}$ | $\frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)}\int_0^x t^{\alpha-1}(1-t)^{\beta-1}\,dt$ |
| **Normal** $X\sim \mathcal{N}(\mu,\sigma^2)$ | A symmetric bell-shaped distribution used extensively in statistics. | $\mu$ | $\sigma^2$ | $\frac{1}{\sigma\sqrt{2\pi}}\exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$ | $\Phi\left(\frac{x-\mu}{\sigma}\right)$ |
| **Lognormal** $X\sim \text{Lognormal}(\mu,\sigma^2)$ | A distribution where the logarithm of the variable follows a normal distribution. | $e^{\mu+\sigma^2/2}$ | $e^{2\mu+\sigma^2}(e^{\sigma^2}-1)$ | $\frac{1}{x\sigma\sqrt{2\pi}}\exp\left(-\frac{(\ln x-\mu)^2}{2\sigma^2}\right)$ | $\Phi\left(\frac{\ln x-\mu}{\sigma}\right)$ |
| **Gamma** $X\sim \text{Gamma}(\alpha,\beta)$ | A distribution modelling waiting times and generalising the exponential distribution. | $\alpha\beta$ | $\alpha\beta^2$ | $\frac{x^{\alpha-1}e^{-x/\beta}}{\Gamma(\alpha)\beta^\alpha},\quad x>0$ | $\frac{1}{\Gamma(\alpha)\beta^\alpha}\int_0^x t^{\alpha-1}e^{-t/\beta}dt$ |
| **Exponential** $X\sim \text{Exp}(\lambda)\sim\text{Exp}(\beta)$ | A special case of the Gamma distribution modelling the time until an event occurs. | $\frac{1}{\lambda}=\beta$ | $\frac{1}{\lambda^2}=\beta^2$ | $\lambda e^{-\lambda x}=\frac{1}{\beta}e^{-x/\beta}$ | $1-e^{-\lambda x}=1-e^{-x/\beta}$ |