Probability Distributions and its Applications

Style	Name	Formula	Applications and general features
Discrete	Binomial distribution	$Bi(n \mid N) = \binom{N}{n} p^n q^{N-n}$	This is used for 2 choices of counted distribution, such as coin toss.
	Poisson distribution	$Po(k;\lambda) = \frac{\lambda^k e^{-\lambda}}{k!}$: λ is the number of occurrence per range.	This is for a small occurrence probability with a certain range or interval.
	Geometric distribution	$Ge(k) = (1-p)^{k-1} p$ after the first success, $Ge(k) = (1-p)^k p$	The distribution expresses the waiting time for occurrence.
	Negative binomial distribution (Pascal distribution)	$NBi(p,r;k) = \binom{k+r-1}{r-1} p^r (1-p)^k$ *r*-1 success and *k* failure	Generalized binomial distribution
	Multinomial distribution	$Milti(x,n,p) = \frac{n!}{x_1! \cdots x_k!} p_1^{x_1} \cdots p_k^{x_k}$ when $\sum_{i=1}^{k} x_i = n$ otherwise $Multi(x,n,p) = 0$	Generalized binomial distribution
Continuous	Normal distribution (Gaussian distribution)	$N(x,\mu,\sigma) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left[\frac{-(x-\mu)^2}{2\sigma^2}\right]$	This is for a general statistical data with a large amount.
	Exponential distribution	$Ex(\lambda;x) = \begin{cases} \lambda \exp[-\lambda x] & x \geq 0 \\ 0 & x < 0 \end{cases}$	This expresses the time between events.
	Gamma distribution	The probability density function: $f(x;k,\theta) = \frac{1}{\theta^k \Gamma(k)} x^{k-1} e^{-\frac{x}{\theta}}$	Generalized exponential distribution, which is tested for χ-square distribution
	Beta distribution	The probability density function: $f(x;\alpha,\beta) = \frac{1}{B(\alpha,\beta)} x^{\alpha-1}(1-x)^{\beta-1}$	The distribution which expresses a probability to exceed a certain range

	Log-normal distribution	The probability density function: $f(x;\mu,\sigma)=\frac{1}{x\sigma\sqrt{2\pi}}e^{-\frac{(\ln x-\mu)^2}{2\sigma^2}}$, $x>0$	This can be used a distribution of stock prices.
	Multivariate normal distribution	The probability density function with *d*-dimensions: $N(x,\mu,\Sigma)=\frac{1}{\sqrt{\lvert\Sigma\rvert(2\pi)^d}}$ $\times\exp\left[-\frac{1}{2}(x-\mu)\Sigma^{-1}(x-\mu)'\right]$	Normal distribution with multiple variables (dimensions)
	Dirichlet distribution	The probability density function: $f(x;\boldsymbol{\alpha})=\frac{1}{B(\boldsymbol{\alpha})}\prod_{i=1}x_i^{\alpha_i-1}$	Extension of beta distribution
	Wishart distribution	The probability density function: $f(\mathbf{A})=\frac{\lvert\mathbf{A}\rvert^{\frac{1}{2}(n-p-1)}\exp\left[-\frac{1}{2}\mathrm{tr}(\boldsymbol{\Sigma}^{-1}\mathbf{A})\right]}{2^{\frac{pn}{2}}\pi^{\frac{p(p-1)}{4}}\lvert\boldsymbol{\Sigma}\rvert^{\frac{n}{2}}\prod_{i=1}^{p}\Gamma\left(\frac{n-i+1}{2}\right)}$ where $\mathbf{A}=\sum_{i=1}^{n}\mathbf{x}_i\mathbf{x}_i^{'}$.	Multi-dimensional chi-square distribution