Discrete Distributions

Distribution	Notation and parameters	$P(X = x)$	Summaries
Binomial	$X \sim \mathrm{Bin}(n, p)$ $n > 0$ integer: number of trials $0 \leq p \leq 1$ probability of success	$\binom{n}{x} p^x (1-p)^{n-x}$ $x = 0, 1, \ldots, n$	$E[X] = np$ $\mathrm{var}(X) = np(1-p)$ $\mathrm{mode}(X) = \lfloor (n+1)p \rfloor$
Geometric	$X \sim \mathrm{Geo}(p)$ $0 < p < 1$	$p(1-p)^x$ $x = 0, 1, 2, \ldots$	$E[X] = \frac{1-p}{p}$ $\mathrm{var}(X) = \frac{1-p}{p^2}$
Poisson	$X \sim \mathrm{Po}(\lambda)$ rate $\lambda > 0$	$\frac{1}{x!} \lambda^x \exp(-\lambda)$ $x = 0, 1, 2, \ldots$	$E[X] = \lambda$ $\mathrm{var}(X) = \lambda$ $\mathrm{mode}(X) = \lfloor \lambda \rfloor$

Continuous Distributions

Distribution	Notation and parameters	Density	Summaries
Beta	$X \sim \mathrm{Beta}(\alpha, \beta)$ $a > 0, b > 0$	$\frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)} x^{\alpha-1} (1-x)^{\beta-1}$ $0 \leq x \leq 1$	$E[X] = \frac{\alpha}{\alpha+\beta}$ $\mathrm{var}(X) = \frac{\alpha\beta}{(\alpha+\beta)^2(\alpha+\beta+1)}$ $\mathrm{mode}(X) = \frac{\alpha-1}{\alpha+\beta-2}$
Exponential	$X \sim \mathrm{Exp}(\lambda)$ $\lambda > 0$ inverse scale *The Exponential distribution is equivalent to Gamma*$(1, \lambda)$	$\lambda \exp(-\lambda x)$ $x > 0$	$E[X] = \frac{1}{\lambda}$ $\mathrm{var}(X) = \frac{1}{\lambda^2}$ $\mathrm{mode}(X) = 0$
Chi-Squared	$X \sim \chi^2_\nu$ $\nu > 0$ degrees of freedom *The Chi-squared distribution is equivalent to Gamma*$(\frac{\nu}{2}, \frac{1}{2})$	$\frac{2^{-\nu/2}}{\Gamma(\nu/2)} x^{\nu/2-1} e^{-x/2}$ $x > 0$	$E[X] = \nu$ $\mathrm{var}(X) = 2\nu$ $\mathrm{mode}(X) = \nu - 2$, $\nu \geq 2$

Distribution	Notation and parameters	Density	Summaries
Gamma	$X \sim \text{Gamma}(\alpha, \beta)$ $\alpha > 0$ shape $\beta > 0$ inverse scale	$\frac{\beta^\alpha}{\Gamma(\alpha)} x^{\alpha-1} e^{-\beta x}$ $x > 0$	$E[X] = \frac{\alpha}{\beta}$ $\text{var}(X) = \frac{\alpha}{\beta^2}$ $\text{mode}(X) = \frac{\alpha-1}{\beta}$, $\alpha \geq 1$
Inverse-Gamma	$X \sim \text{Inv-gamma}(\alpha, \beta)$ $\alpha > 0$ shape $\beta > 0$ scale	$\frac{\beta^\alpha}{\Gamma(\alpha)} x^{-(\alpha+1)} e^{-\beta/x}$ $x > 0$	$E[X] = \frac{\beta}{\alpha-1}$ for $\alpha > 1$ $\text{var}(X) = \frac{\beta^2}{(\alpha-1)^2(\alpha-2)}$ for $\alpha > 2$ $\text{mode}(X) = \frac{\beta}{\alpha+1}$
Normal - univariate	$X \sim N(\mu, \sigma^2)$ μ location $\sigma > 0$ scale	$\frac{1}{\sqrt{2\pi\sigma^2}} \exp\left\{-\frac{1}{2\sigma^2}(x-\mu)^2\right\}$ $-\infty < x < \infty$	$E[X] = \mu$ $\text{var}(X) = \sigma^2$ $\text{mode}(X) = \mu$
Normal - multivariate	$\mathbf{X} \sim N_p(\boldsymbol{\mu}, \Sigma)$ $\mathbf{X} = (X_1, X_2, \ldots, X_p)^T$ Σ symmetric, positive definite $p \times p$ matrix	$(2\pi)^{-p/2} \lvert\Sigma\rvert^{-1/2}$ $\times \exp\left\{-\frac{1}{2}(\mathbf{x} - \boldsymbol{\mu})^T \Sigma^{-1} (\mathbf{x} - \boldsymbol{\mu})\right\}$	$E[\mathbf{X}] = \boldsymbol{\mu}$ $\text{var}(\mathbf{X}) = \Sigma$ $\text{mode}(\mathbf{X}) = \boldsymbol{\mu}$
t-distribution (non-central)	$X \sim t_\nu(\mu, \sigma^2)$ $\nu > 0$ degrees of freedom μ location $\sigma > 0$ scale	$\frac{\Gamma((\nu+1)/2)}{\Gamma(\nu/2)\sigma\sqrt{\nu\pi}} (1 + \frac{1}{\nu}(\frac{x-\mu}{\sigma})^2)^{-(\nu+1)/2}$ $-\infty < x < \infty$	$E[X] = \mu$, $\nu > 1$ $\text{var}(X) = \frac{\nu}{\nu-2}\sigma^2$, $\nu > 2$ $\text{mode}(X) = \mu$
Uniform	$X \sim U(a, b)$ boundaries a, b $b > a$	$\frac{1}{b-a}$ $a \leq x \leq b$	$E[X] = \frac{1}{2}(a+b)$ $\text{var}(X) = \frac{1}{12}(b-a)^2$

Based on Appendix A of Bayesian Data Analysis, *A. Gelman, J. Carlin, H. Stern and D. Rubin*