

Discrete distributions	Random variable (z)	Parameters	Moments	R functions	JAGS functions for likelihood of data (y)	Conjugate relationship
Poisson $[z \lambda] = \frac{\lambda^z e^{-\lambda}}{z!}$	Counts of things that occur randomly over time or space, e.g., the number of birds in a forest stand, the number of fish in a kilometer of river, the number of prey captured per minute.	λ , the mean number of occurrences per time or space $\lambda = \mu$	$\mu = \lambda$ $\sigma^2 = \lambda$	dpois(x, lambda, log = FALSE) ppois(q, lambda) qpois(p, lambda), rpois(n, lambda)	$y[i] \sim \text{dpois}(\text{lambda})$	$P(\lambda y) = \text{gamma}\left(\alpha + \sum_{i=1}^n y_i, \beta + n\right)$
Binomial $[z \eta, \phi] = \binom{\eta}{z} \phi^z (1 - \phi)^{\eta - z}$ $\binom{\eta}{z} = \frac{\eta!}{z!(\eta - z)!}$ $[z \eta, \phi] \propto \phi^z (1 - \phi)^{\eta - z}$	Number of “successes” on a given number of trials, e.g., number of survivors in a sample of individuals, number of plots containing an exotic species from a sample, number of terrestrial pixels that are vegetated in an image.	η , the number of trials ϕ , the probability of a success $\phi = 1 - \sigma^2 / \mu$ $\eta = \mu^2 / (\mu - \sigma^2)$	$\mu = \eta \phi$ $\sigma^2 = \eta \phi (1 - \phi)$	dbinom(x, size, prob, log = FALSE) pbinom(q, size, prob) qbinom(p, size, prob) rbinom(n, size, prob)	$y[i] \sim \text{dbin}(p, n)$	$P(p y) = \text{beta}(\alpha + y, \beta + n - y)$
Bernoulli $[z \phi] = \phi^z (1 - \phi)^{1 - z}$	A special case of the binomial where the number of trials = 1 and the random variable can take on values 0 or 1. Widely used in survival analysis, occupancy models.	ϕ , the probability that the random variable = 1 $\phi = \mu$ $\phi = 1/2 + \frac{1}{2\sqrt{1 - 4\sigma^2}}$	$\mu = \phi$ $\sigma^2 = \phi (1 - \phi)$	dbinom(x, size=1, prob, log = FALSE) pbinom(q, size=1, prob) qbinom(p, size=1, prob) rbinom(n, size=1, prob) Note that size *must* = 1.	$y[i] \sim \text{dbern}(p)$	
Negative binomial $[z \lambda, \kappa] = \frac{\Gamma(z + \kappa)}{\Gamma(\kappa) z!} \left(\frac{\kappa}{\kappa + \lambda}\right)^\kappa \times \left(\frac{\lambda}{\kappa + \lambda}\right)^z$ (Read R help about alternative parameterization.)	Counts of things occurring randomly over time or space, as with the Poisson. Includes dispersion parameter κ allowing the variance to exceed the mean.	λ , the mean number of occurrences per time or space. κ , the dispersion parameter. $\lambda = \mu$ $\kappa = \frac{\mu^2}{\sigma^2 - \mu}$	$\mu = \lambda$ $\sigma^2 = \lambda + \frac{\lambda^2}{\kappa}$	dnbinom(x, size, mu) pnbinom(q, size, mu) qnbinom(p, mu) rnbinom(n, size, mu) Size is the dispersion parameter, κ	$y[i] \sim \text{dnegbin}(k / (k + \text{lambda}), k)$ Uses alternative parameterization. The variable k is the dispersion parameter.	
Multinomial $[\mathbf{z} \eta, \phi] = \eta! \prod_{i=1}^k \frac{\phi_i^{z_i}}{z_i!}$	Counts that fall into $k > 2$ categories, e.g., number of individuals in age classes, number of pixels in different landscape categories, number of species in trophic categories in a sample from a food web.	\mathbf{z} a vector giving the number of counts in each category, ϕ a vector of the probabilities of occurrence in each category, $\sum_{i=1}^k \phi_i = 1$, $\sum_{i=1}^k z_i = \eta$	$\mu_i = \eta \phi_i$ $\sigma_i^2 = \eta \phi_i (1 - \phi_i)$	rmultinom(n, size, prob) dmultinom(x, size, prob, log = FALSE)	$y[i,] \sim \text{dmulti}(p[], n)$	

Continuous Distributions	Random variable (z)	Parameters	Moments	R functions	JAGS function	Conjugate prior for	Vague Prior
Normal $[z \mu, \sigma^2] = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(z-\mu)^2}{2\sigma^2}}$	Continuously distributed quantities that can take on positive or negative values. Sums of things are normally distributed.	μ, σ^2	μ, σ^2	dnorm(x, mean, sd, log = FALSE) pnorm(q, mean, sd) qnorm(p, mean, sd) rnorm(n, mean, sd)	# tau = 1/sigma^2# #likelihood y[i]~dnorm(mu,tau) #prior theta ~ dnorm(mu,tau)	normal mean (with known variance)	dnorm(0,1E-6) #This is scale dependent.
Lognormal $[z \alpha, \beta] = \frac{1}{z\sqrt{2\pi\beta^2}} e^{-\frac{(\ln z - \alpha)^2}{2\beta^2}}$	Continuously distributed quantities with non-negative values. Random variables that have the property that their logs are normally distributed. Thus if z is normally distributed then $\exp(z)$ is lognormally distributed. Products of things are lognormally distributed.	α , the mean of z on the log scale β , the standard deviation of z on the log scale $\alpha = \log(\text{median}(z))$ $\alpha = \ln(\mu) - \frac{1}{2} \ln\left(\frac{\sigma^2 + \mu^2}{\mu^2}\right)$ $\beta = \sqrt{\ln\left(\frac{\sigma^2 + \mu^2}{\mu^2}\right)}$	$\mu = e^{\alpha + \frac{\beta^2}{2}}$ $\text{median}(z) = e^\alpha$ $\sigma^2 = \left(e^{\beta^2} - 1\right) e^{2\alpha + \beta^2}$	dlnorm(x, meanlog, sdlog) plnorm(q, meanlog, sdlog) qlnorm(p, meanlog, sdlog) rlnorm(n, meanlog, sdlog)	#likelihood y[i]~dlnorm(alpha,tau) #prior theta~ dlnorm(alpha,tau)		
Gamma $[z \alpha, \beta] = \frac{\beta^\alpha}{\Gamma(\alpha)} z^{\alpha-1} e^{-\beta z}$ $\Gamma(\alpha) = \int_0^\infty t^{\alpha-1} e^{-t} dt$	The time required for a specified number of events to occur in a Poisson process. Any continuous quantity that is non-negative.	α = shape β = rate $\alpha = \frac{\mu^2}{\sigma^2}$ $\beta = \frac{\mu}{\sigma^2}$ Note–be very careful about rate, defined as above, and scale = $\frac{1}{\beta}$.	$\mu = \frac{\alpha}{\beta}$ $\sigma^2 = \frac{\alpha}{\beta^2}$	dgamma(x, shape, rate, log = FALSE) pgamma(q, shape, rate) qgamma(p, shape, rate) rgamma(n, shape, rate)	#likelihood y[i]~ dgamma(r,n) #prior theta~dgamma(r,n)	1) Poisson mean 2) normal precision (1/variance) 3) n parameter (rate) in the gamma distribution	dgamma(.001,.001)
Beta $[z \alpha, \beta] = B z^{\alpha-1} (1-z)^{\beta-1}$ $B = \frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)}$	Continuous random variables that can take on values between 0 and 1–any random variable that can be expressed as a proportion; e.g., survival, proportion of landscape invaded by exotic.	$\alpha = \frac{(\mu^2 - \mu^3 - \mu\sigma^2)}{\sigma^2}$ $\beta = \frac{\mu - 2\mu^2 + \mu^3 - \sigma^2 + \mu\sigma^2}{\sigma^2}$	$\mu = \frac{\alpha}{\alpha+\beta}$ $\sigma^2 = \frac{\alpha\beta}{(\alpha+\beta)^2(\alpha+\beta+1)}$	dbeta(x, shape1, shape2) pbeta(q, shape1, shape2) qbeta(p, shape1, shape2) rbeta(n, shape1, shape2)	#likelihood y[i] ~ dbeta(alpha, beta) #prior theta ~ dbeta(alpha, beta)	p in binomial distribution	dbeta(1,1)
Dirichlet $[z \alpha] = \frac{\Gamma\left(\sum_{i=1}^k \alpha_i\right)}{\prod_{j=1}^k \Gamma(\alpha_j)} \times \prod_{j=1}^k z_j^{\alpha_j-1}$	Vectors of > 2 elements of continuous random variables that can take on values between 0 and 1 and that sum to one.	$\alpha_i = \mu_i \alpha_0$ $\alpha_0 = \sum_{i=1}^k \alpha_i$	$\mu_i = \frac{\alpha_i}{\sum_{i=1}^k \alpha_i}$ $\sigma_i^2 = \frac{\alpha_i(\alpha_0 - \alpha_i)}{\alpha_0^2(\alpha_0 + 1)}$	library(gtools) rdirichlet(n, alpha) ddirichlet(x, alpha)	#likelihood y[]~ddrich(alpha[]) p[] ~ ddrich(alpha[]) y, alpha, p are vectors	vector \mathbf{p} in multinomial distribution	ddrich(1,1,1...1)
Uniform $[z \alpha, \beta] = \begin{cases} \frac{1}{\beta-\alpha} & \text{for } \alpha \leq z \leq \beta, \\ 0 & \text{for } z < \alpha \text{ or } z > \beta \end{cases}$	Any real number.	α = lower limit β = upper limit $\alpha = \mu - \sigma\sqrt{3}$ $\beta = \mu + \sigma\sqrt{3}$	$\mu = \frac{\alpha+\beta}{2}$ $\sigma^2 = \frac{(\beta-\alpha)^2}{12}$	dunif(x, min, max, log = FALSE) punif(q, min, max) qunif(p, min, max) runif(n, min, max)	#prior theta~dunif(a,b)		a and b such that posterior is “more than entirely” between a and b