Table 3.2 Multivariate distributions available in WinBUGS

Distribution name	WinBUGS syntax	Probability or density function $f(x)$	Mean	Variance/covariance
		Discrete distributions		
(19) Multinomial	`x[1:K] ~ dmulti(p[], N)`	$N!\left(\prod_{i=1}^{K} x_i!\right)^{-1} \prod_{i=1}^{K} p_i^{x_i}$	$E(X_i) = Np_i$	$V(X_i) = Np_i(1-p_i)$ $\text{Cov}(X_i, X_j) = -Np_ip_j$
		Continuous distributions		
(20) Dirichlet	`x[1:K] ~ ddirch(a[])`	$\Gamma(a)\left[\prod_{i=1}^{K} \Gamma(a_i)\right]^{-1} \prod_{i=1}^{K} x_i^{a_i-1}$	$E(X_i) = a_i/a$	$V(X_i) = a_i(a-a_i)/[a^2(a+1)]$ $\text{Cov}(X_i, X_j) = -a_ia_j/[a^2(a+1)]$
(21) Multivariate normal	`x[1:K] ~ dmnorm(mu[], T[,])`	$(2\pi)^{-K/2}\lvert\boldsymbol{T}\rvert^{1/2}\exp\left[-\frac{1}{2}(\boldsymbol{x}-\boldsymbol{\mu})^T\boldsymbol{T}(\boldsymbol{x}-\boldsymbol{\mu})\right]$	$E(\boldsymbol{X}) = \boldsymbol{\mu}$	$V(\boldsymbol{X}) = \boldsymbol{T}^{-1}$
(22) Multivariate Student's t	`x[1:K] ~ dmt(mu[], T[,], v)`	$\left\{(v\pi)^{-K/2}\Gamma[(v+K)/2]\lvert\boldsymbol{T}\rvert^{1/2}/\Gamma(v/2)\right\}$ $\times\left[1+v^{-1}(\boldsymbol{x}-\boldsymbol{\mu})^T\boldsymbol{T}(\boldsymbol{x}-\boldsymbol{\mu})\right]^{-(v+K)/2}$	$E(\boldsymbol{X}) = \boldsymbol{\mu}$	$V(\boldsymbol{X}) = v(v-2)^{-1}\boldsymbol{T}^{-1}$
(23) Wishart	`x[1:K,1:K] ~ dwish(R[,], v)`	$\lvert\boldsymbol{R}\rvert^{v/2}\lvert\boldsymbol{x}\rvert^{(v-K-1)/2}\exp\left[-\frac{1}{2}\text{Tr}(\boldsymbol{Rx})\right]$	$E(X_{ij}) = vA_{ij}$	$\text{Cov}(X_{ij}, X_{km}) = v(A_{ik}A_{jm} + A_{im}A_{jk})$

Key: **(19)** $x[\,]$ and $p[\,]$ are vectors of dimension K with elements $x[i] = x_i = 0, 1, 2, \ldots$ and $p[i] = p_i \in (0,1)$ with $\sum_{i=1}^{K} x_i = N$ and $\sum_{i=1}^{K} p_i = 1$; **(20)** $x[\,]$ and $a[\,]$ are vectors of dimension K with elements $x[i] = x_i \in (0,1)$ and $a[i] = a_i > 0$ with $\sum_{i=1}^{K} x_i = 1$ and $a = \sum_{i=1}^{K} a_i$; **(21, 22)** $x[\,]$ and $mu[\,]$ ($\boldsymbol{x}$ and $\boldsymbol{\mu}$) are vectors of dimension K with elements $x[i] = x_i \in (0,1)$ and $\mu[i] = \mu_i \in \mathbf{R}$. $T[\,]$ (and $\boldsymbol{T}$) is a $K \times K$ symmetric precision matrix with elements $T[i,j] = \tau_{ij} > 0$; $v > 0$; **(23)** $x[,]$ and $R[,]$ ($\boldsymbol{x}$ and $\boldsymbol{R}$) are $K \times K$ positive-definite (symmetric) matrices with elements $x[i,j] = x_{ij}$ and $R[i,j] = R_{ij}$; A_{ij} are the element of the matrix $\boldsymbol{A} = \boldsymbol{R}^{-1}$; $v > 0$. **Also** μ_i: mean of X_i; $V(X_i)$, $\text{Cov}(X_i, X_i)$: variance of X_i; $\text{Cov}(X_i, X_j)$: covariance between X_i and X_j.