1. boral Model

site i
species j
latent factor k

Y_{ij} is true occurrence, assuming perfect detection
Φ: CDF of standard normal

$$\begin{aligned} Y_{ij} &\sim Bern(\Phi(v_{ij})) \\ v_{ij} &= \eta_{i.}\lambda_{j.} \\ \eta_{i.} &\sim MVN(0, I_K)^* \\ \lambda_{j,k} &\sim N(0, 10) \end{aligned}$$

*considered the random effects
Think of $\lambda_{k,j}$ as species-specific coefficients for unobserved covariates $\eta_{i.}$ at the site level. They introduce correlation between species: $v_{i.} \sim MVN(0, \Lambda\Lambda')$.

Note: ignoring fixed effects of observable covariates for now