① ⓐ Logistic Regression

$$\text{Logit}\left[\text{Prob}\left[Y_i = 1\right]\right] = \sum_{j=1}^{p} x_{ij}\beta_j$$

prior for $\beta_j \sim N(0, 10)$

Yes, MCMC sampler has converged

ⓑ

$$\text{Logit}\left[\text{Prob}\left[Y_i = 1\right]\right] = \sum_{j=1}^{p} x_{ij}\beta_j + \alpha_{s_i}$$

α_λ iid Normal $(0, z^2)$

priors

$\beta_j \sim N(0, 10)$

$z^2 \sim \text{Inv-Gamma}(0.01, 0.01)$

② $Y_i \sim P_1 \text{Nor}(mu_1, \sigma_1^2) + P_2 N(mu_2, \sigma_2^2)$
$\qquad + P_3 N(mu_3 + \sigma_1^2)$

priors for mu's $\sim$ normal $(0, 1000)$

σ_k^2's $\sim$ Inv gam $(0.01, 0.01)$

p's $\sim$ Dirichlet

③④ for DIC, and WAIC

I have used inbuilt function

④ Yes, it is fit well. using
posterior predictive checks
test statistic
$$var(Y)$$
$$mean(Y)$$

⑤ I have used rjags for this
problem.

I found DIC, WAIC value for
Compare
and I found L = 4 is best.