Algorithm 1 GraphR algorithm

Input: $\mathbf{Y}, \mathbf{X}$, tolerance

Output: Covariate dependent edges

while $\zeta >$ tolerance **do**

for i in $1:p$ **do**

for l in $1:q$ **do**

Set $q_{\text{vb}}(\tau_{il}) \sim \Gamma\left(a_\tau + \frac{p-1}{2}, b_\tau + \frac{1}{2}\sum_{j\neq i}^{p} \mathbb{E}_{-\tau_{il}}\left(b_{ijl}\right)^2\right)$

end for

for j in $1:p$ and $j \neq i; l$ in $1:q$ **do**

Set $q_{\text{vb}}(\pi_{ijl}) \sim \text{Beta}\left(\mathbb{E}_{-\pi_{ijl}}(s_{ijl}) + a_\pi, b_\pi - \mathbb{E}_{-\pi_{ijl}}(s_{ijl}) + 1\right)$

end for

Set $q_{\text{vb}}(\omega_{ii}) \sim \text{GIG}\left(\frac{n+2}{2}, \|Y_i\|^2, \mathbb{E}_{-\omega_{ii}}\| \sum_{j\neq i}^{p}\sum_{s=1}^{q} b_{ijl}s_{ijl}X_l \odot Y_j\|^2\right)$

for j in $1:p$ and $j \neq i; l$ in $1:q$ **do**

$\beta_{ijl} = b_{ijl}s_{ijl}$

Set $q_{\text{vb}}(b_{ijl}|s_{ijl}) \sim \mathbb{N}\left(\mu(s_{ijl}), \sigma^2(s_{ijl})\right)$ where

$\sigma^2(s_{ijl}) = \left[\mathbb{E}_{-b_{ijl}|s_{ijl}}(\frac{1}{\omega_{ii}})\|X_l \odot Y_j\|^2 s_{ijl} + \mathbb{E}_{-b_{ijl}|s_{ijl}}(\tau_{il})\right]^{-1}$

$\mu(s_{ijl}) = -\sigma^2(s_{ijl})\left\{\left[Y_i + \mathbb{E}_{-b_{ijl}|s_{ijl}}\left(\frac{1}{\omega_{ii}}M^{-s}_{-(i,j)}\right)\right]^T [Z_s \odot Y_j]s_{ijl}\right\}$

Set $q_{vb}(s_{ijl}) \sim \text{Ber}(\psi_{ijl})$ where:

$\psi_{ijl} = \mathbb{E}_{-s_{ijl}}\text{logit}(\pi_{ijl}) + \frac{1}{2}log\mathbb{E}_{-s_{ijl}}\tau_{il} -$

$\frac{1}{2}log\left[\mathbb{E}_{-s_{ijl}}(\frac{1}{\omega_{ii}})\|X_l \odot Y_j\|^2 + \mathbb{E}_{-s_{ijl}}(\tau_{il})\right] +$

$\frac{1}{2}\left[\mathbb{E}_{-s_{ijl}}(\frac{1}{\omega_{ii}})\|X_l \odot Y_j\|^2 + \mathbb{E}_{-s_{ijl}}(\tau_{il})\right]^{-1} \times$

$\left[(X_l \odot Y_j)^T(Y_i + \mathbb{E}_{-s_{ijl}}\left[\frac{1}{\omega_{ii}}\right]\mathbb{E}_{-s_{ijl}}M^{-s}_{-(i,j)})\right]^2$

end for

end for

ζ: maximum value of expectation difference for parameters before and after updates.

end while