The FlexBayes Package

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FlexBayes is an R package for modeling data in the Bayesian paradigm (Gelman et. al. 2004)

FlexBayes is a Markov Chain Monte Carlo (MCMC) engine implemented in C++

Provides functions for fitting the following models

- `bhlm` Hierarchical linear mixed model
- `bhpm` Hierarchical Poisson mixed model
- `bhhm` Hierarchical binomial (logistic) mixed model

Thanks

- TIBCO Software, Inc. for open sourcing FlexBayes
- The coda package (MCMC structures and diagnostics)
- Chapter 7 of Scherer & Martin makes extensive use of FlexBayes
bhlm fits a two-stage **hierarchical linear mixed effects** model

First-level model:

\[ y_{ij} \sim N(\theta_{ij}, \sigma_j^2) \]

[the subscripts refer to observation \( i \) in group \( j \)]

Link function:

\[ \theta_{ij} = m_{ij} \gamma + x_{ij} \beta_j \]

[\( \gamma \) is fixed effects, \( \beta_j \) is random effects]

Second-level model:

\[ \beta_j = z_j \alpha + u_j \]

where \( u_j \sim N_r(0, \tau^2 V) \)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Supported prior distributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha, \gamma$</td>
<td>normal, $t$, non-informative (flat)</td>
</tr>
<tr>
<td>$\sigma_j^2$</td>
<td>inverse chi-squared, uniform shrinkage, non-informative power, DuMouchel</td>
</tr>
<tr>
<td>$\tau^2$</td>
<td>inverse chi-squared, uniform shrinkage, non-informative power, DuMouchel</td>
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<tr>
<td>$\tau^2 V$</td>
<td>inverse Wishart</td>
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Bayes Alphas and Betas

- $x_{ij}$ empty $\implies$ first-level fixed effects $\implies$ Bayes linear model

- Let $\gamma = (\alpha, \beta)$

- Example: the single-factor market model

$$r_t = \alpha + \beta r_{mt} + \epsilon$$

- $r_t$ returns on an individual stock (Microsoft, 2012)
- $r_{mt}$ overall market returns (2012)

- Fit the Bayes linear model with non-informative priors

```r
> bhlm(rt ~ rmt, data = df)

              Mean       S.D.
(Intercept) -0.0004702 0.0006032
rmt          1.0750000 0.0792600
SIGMA       0.0098630 0.0004426
```
Bayes Alphas and Betas: non-informative prior
Informative priors for $\alpha$ and $\beta$

$$
\begin{bmatrix} \alpha \\ \beta \end{bmatrix} \sim \mathcal{N}_2 \left( \begin{bmatrix} 0 \\ 1 \end{bmatrix}, \begin{bmatrix} 0.001^2 & 0 \\ 0 & 0.1^2 \end{bmatrix} \right)
$$

Fitting the Bayes linear model with informative priors

```r
> coef.prior <- fbprior("normal", c(0, 1),
                        diag(c(1e-3^2, 0.1^2)))
> info.prior <- bhlm.prior(fixed = coef.prior)
> bayes.fit <- bhlm(rt ~ rmt, data = df,
                   prior = info.prior)
```
Bayes Alphas and Betas: non-informative prior
Final Remarks

- The FlexBayes package lives on R-Forge
  
  http://flexbayes.r-forge.r-project.org

- To install FlexBayes
  
  install.packages("FlexBayes",
  repos="http://R-Forge.R-project.org")

References
