ADVANCED BAYESIAN MODELING

DIC for 2016 Polls Data: Hierarchical Model

DIC for the full hierarchical model

$$
\begin{aligned}
y_j \mid \theta_j &\sim \mathrm{N}(\theta_j, \sigma_j^2) \qquad j = 1, \ldots, 7 \\
\theta_j \mid \mu, \tau &\sim \mathrm{N}(\mu, \tau^2) \qquad j = 1, \ldots, 7 \\
\mu &\sim \text{flat on } (-\infty, \infty) \\
\tau &\sim \text{flat on } (0, \infty)
\end{aligned}
$$

must be approximated by Monte Carlo ...

We use JAGS with approximating model (`polls2016dic.bug`)

```
model {

  for (j in 1:length(y)) {
    y[j] ~ dnorm(theta[j], 1/sigma[j]^2)
    theta[j] ~ dnorm(mu, 1/tau^2)
  }

  mu ~ dunif(-1000,1000)
  tau ~ dunif(0,1000)

}
```

```
> library(rjags)
...

> m <- jags.model("polls2016dic.bug", d, n.chains=2)
...

> update(m, 2500)  # burn-in
  |**************************************************| 100%

> load.module("dic")  # provides deviance monitoring
module dic loaded

> x <- coda.samples(m, c("theta","deviance"), n.iter=100000)
  |**************************************************| 100%

> sx <- summary(x)
```

Now approximate deviance evaluated at posterior mean, and the posterior mean and variance of the deviance:

```
> theta.means <- sx$statistics[paste("theta[",1:nrow(d),"]", sep=""),"Mean"]

> deviance.Bayes <- -2 * sum(dnorm(d$y, theta.means, d$sigma, log=TRUE))

> deviance.mean <- sx$statistics["deviance","Mean"]

> deviance.var <- sx$statistics["deviance","SD"]^2
```

Compute p_{DIC}, p_{DICalt}, and both versions of DIC:

```
> ( pDIC <- -deviance.Bayes + deviance.mean )
[1] 3.189162

> ( pDICalt <- 0.5 * deviance.var )
[1] 3.066157

> ( DIC <- deviance.Bayes + 2*pDIC )
[1] 26.88917

> ( DICalt <- deviance.Bayes + 2*pDICalt )
[1] 26.64316
```

JAGS offers an alternative (slightly modified) version of DIC, at the cost of some extra iterations for approximation:

```
> dic.samples(m, 100000)  # m needs at least 2 chains
  |**************************************************| 100%
Mean deviance:  23.71
penalty 3.274
Penalized deviance: 26.99
```

This alternative DIC is due to Plummer (2002).

DIC Model Comparison

Model	p_{DIC}	p_{DICalt}	DIC	DIC_{alt}
Complete Pooling	1.0	1.0	25.4	25.4
Hierarchical	3.2	3.1	26.9	26.6
No Pooling	7.0	7.0	31.2	31.2

Best model is complete pooling, but hierarchical isn't much worse.

Hierarchical model effectively has about 3 parameters, due to partial pooling.