Lecture 12: Polytomous IRT Models

Bayesian Psychometric Modeling

```
# Install/Load Packages ==========================================================
if (!require(R2jags)) install.packages("R2jags")
```

```
## Loading required package: R2jags
## Loading required package: rjags
## Loading required package: coda
## Linked to JAGS 4.3.0
## Loaded modules: basemod,bugs
##
## Attaching package: 'R2jags'
## The following object is masked from 'package:coda':
##
##     traceplot
```

```
library(R2jags)

if (!require(mvtnorm)) install.packages("mvtnorm")
```

```
## Loading required package: mvtnorm
```

```
library(mvtnorm)
```

Item Response Models for Polytomous Data: Example Analyses

Today's example is from a bootstrap resample of 177 undergradutes at a large state university in the midwest. The survey was a measure of 10 questions about their beliefs in various conspiracy theories that were being passed around the internet in the early 2010s. Additionally, gender was included in the survey.

All items responses were on a 5-point Likert scale where:

- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neither Agree or Disagree
- 4 = Agree
- 5 = Strongly Agree

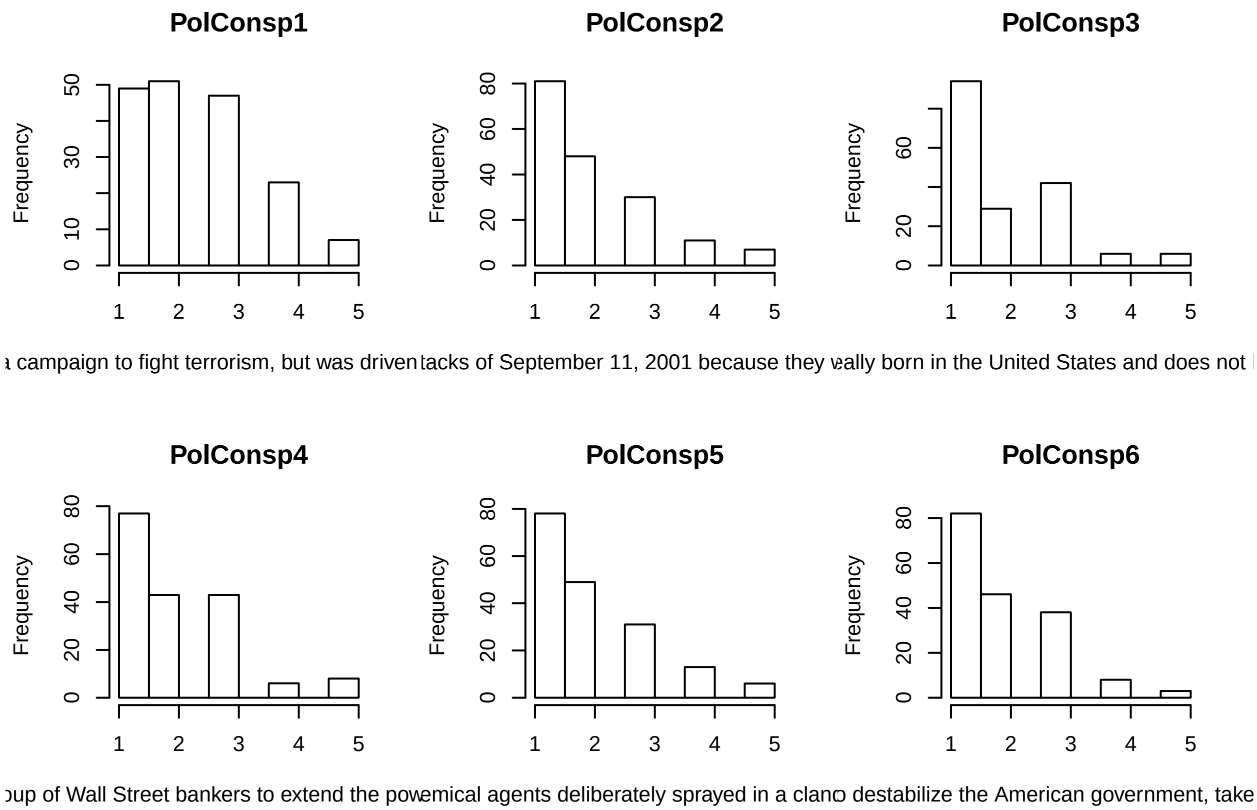
Questions:

1. The U.S. invasion of Iraq was not part of a campaign to fight terrorism, but was driven by oil companies and Jews in the U.S. and Israel.
2. Certain U.S. government officials planned the attacks of September 11, 2001 because they wanted the United States to go to war in the Middle East.
3. President Barack Obama was not really born in the United States and does not have an authentic Hawaiian birth certificate.
4. The current financial crisis was secretly orchestrated by a small group of Wall Street bankers to extend the power of the Federal Reserve and further their control of the world's economy.
5. Vapor trails left by aircraft are actually chemical agents deliberately sprayed in a clandestine program directed by government officials.

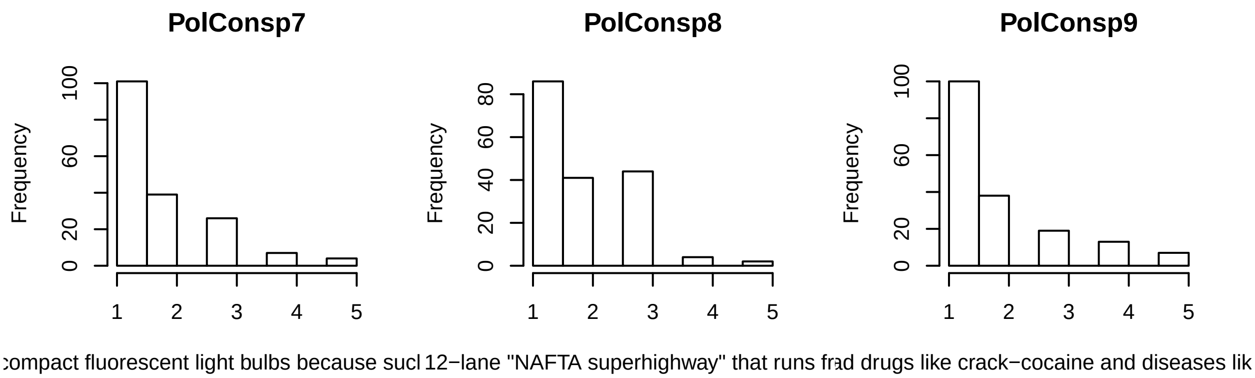
6. Billionaire George Soros is behind a hidden plot to destabilize the American government, take control of the media, and put the world under his control.
7. The U.S. government is mandating the switch to compact fluorescent light bulbs because such lights make people more obedient and easier to control.
8. Government officials are covertly Building a 12-lane "NAFTA superhighway" that runs from Mexico to Canada through America's heartland.
9. Government officials purposely developed and spread drugs like crack-cocaine and diseases like AIDS in order to destroy the African American community.
10. God sent Hurricane Katrina to punish America for its sins.

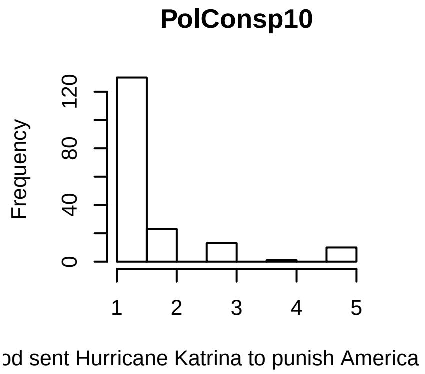
Also note: these analyses take an excessive amount of time to run. So, please follow along with the HTML file through class.

```
# read in data:
conspiracy = read.csv("conspiracies.csv")

par(mfrow = c(2,3))
# plot each item
hist(conspiracy$PolConsp1, main = "PolConsp1", xlab = "1. The U.S. invasion of Iraq was not part of a ca
hist(conspiracy$PolConsp2, main = "PolConsp2", xlab = "2. Certain U.S. government officials planned the
hist(conspiracy$PolConsp3, main = "PolConsp3", xlab = "3. President Barack Obama was not really born in
hist(conspiracy$PolConsp4, main = "PolConsp4", xlab = "4. The current financial crisis was secretly orch
hist(conspiracy$PolConsp5, main = "PolConsp5", xlab = "5. Vapor trails left by aircraft are actually che
hist(conspiracy$PolConsp6, main = "PolConsp6", xlab = "6. Billionaire George Soros is behind a hidden pl
```




```
hist(conspiracy$PolConsp7, main = "PolConsp7", xlab = "7. The U.S. government is mandating the switch to
hist(conspiracy$PolConsp8, main = "PolConsp8", xlab = "8. Government officials are covertly Building a 1
hist(conspiracy$PolConsp9, main = "PolConsp9", xlab = "9. Government officials purposely developed and s
hist(conspiracy$PolConsp10, main = "PolConsp10", xlab = "10. God sent Hurricane Katrina to punish Americ
```





Model 0: Unidimensional Confirmatory Factor Analysis Model (Lecture 9)

```
model00.function = function(){
  # measurement model specification
  for (person in 1:N){
    for (item in 1:I){
      mean[person, item] = mu[item] + lambda[item]*xfactor[person]
      X[person, item] ~ dnorm(mean[person,item], inv.psi[item])
    }
  }

  # prior distributions for the factor:
  for (person in 1:N){
    xfactor[person] ~ dnorm(0, 1)
  }

  # prior distributions for the measurement model mean/precision parameters
  for (item in 1:I){
    mu[item] ~ dnorm(mu.mean.0, mu.precision.0)
    inv.psi[item] ~ dgamma(psi.alpha.0, psi.beta.0[item])
  }

  # prior distributions for the loadings
  for (item in 1:I){
    lambda[item] ~ dnorm(lambda.mean.0, lambda.precision.0); T(0,)
  }
```

```
  for (item in 1:I){
    psi[item] <- 1/inv.psi[item]
  }

}
```

```
# model specs:
nItems = ncol(conspiracy[paste0("PolConsp", 1:10)])

# specification of prior values for measurement model parameters:
#   item means
mu.mean.0 = 3
mu.variance.0 = 1000
mu.precision.0 = 1 / mu.variance.0

#   Factor loadings
lambda.mean.0 = 0
lambda.variance.0 = 1000
lambda.precision.0 = 1 / lambda.variance.0

# unique variances
psi.df.0 = 1
psi.var.0 = apply(X = conspiracy[paste0("PolConsp", 1:10)], MARGIN = 2, FUN = var)
psi.alpha.0 = psi.df.0 / 2
psi.beta.0 = (psi.df.0 * psi.var.0) / 2

model00.data = list(
  N = nrow(conspiracy),
  X = conspiracy[paste0("PolConsp", 1:10)],
  I = nItems,
  mu.mean.0 = mu.mean.0,
  mu.precision.0 = mu.precision.0,
  lambda.mean.0 = lambda.mean.0,
  lambda.precision.0 = lambda.precision.0,
  psi.alpha.0 = psi.alpha.0,
  psi.beta.0 = psi.beta.0
)

model00.parameters = c("mu", "lambda",  "psi", "deviance", "xfactor")

model00.seed = 23022019
```

Here, we will use the R2jags `jags.parallel()` function, which will run somewhat faster (one chain per core):

```
model00.r2jags =  jags.parallel(
  data = model00.data,
  parameters.to.save = model00.parameters,
  model.file = model00.function,
  n.chains = 4,
  n.iter = 5000,
  n.thin = 1,
  n.burnin = 3000,
  jags.seed = model00.seed
)
```

```
model00.r2jags
```

```
## Inference for Bugs model at "model00.function", fit using jags,
##  4 chains, each with 5000 iterations (first 3000 discarded)
##  n.sims = 8000 iterations saved
##               mu.vect sd.vect    2.5%     25%     50%     75%   97.5%
## lambda[1]       0.751   0.148   0.584   0.684   0.738   0.795   0.937
## lambda[2]       0.886   0.165   0.727   0.820   0.871   0.924   1.059
## lambda[3]       0.815   0.149   0.659   0.750   0.802   0.856   0.987
## lambda[4]       0.859   0.157   0.701   0.792   0.845   0.899   1.025
## lambda[5]       1.014   0.180   0.866   0.950   0.997   1.047   1.170
## lambda[6]       0.914   0.155   0.776   0.856   0.898   0.945   1.057
## lambda[7]       0.779   0.143   0.636   0.719   0.765   0.813   0.937
## lambda[8]       0.867   0.153   0.740   0.811   0.853   0.895   1.002
## lambda[9]       0.875   0.165   0.714   0.807   0.861   0.914   1.050
## lambda[10]      0.686   0.146   0.527   0.622   0.674   0.729   0.861
## mu[1]           2.370   0.087   2.199   2.311   2.370   2.428   2.540
## mu[2]           1.956   0.087   1.783   1.899   1.957   2.014   2.126
## mu[3]           1.878   0.085   1.713   1.820   1.877   1.934   2.048
## mu[4]           2.013   0.086   1.844   1.957   2.013   2.070   2.181
## mu[5]           1.985   0.088   1.816   1.928   1.985   2.044   2.156
## mu[6]           1.894   0.079   1.742   1.843   1.894   1.947   2.050
## mu[7]           1.725   0.079   1.572   1.673   1.725   1.778   1.878
## mu[8]           1.844   0.076   1.699   1.795   1.844   1.894   1.990
## mu[9]           1.810   0.089   1.638   1.750   1.810   1.869   1.985
## mu[10]          1.521   0.083   1.362   1.466   1.520   1.575   1.685
## psi[1]          0.796   0.090   0.638   0.734   0.790   0.851   0.996
## psi[2]          0.544   0.074   0.430   0.499   0.538   0.583   0.686
## psi[3]          0.613   0.084   0.485   0.562   0.607   0.656   0.765
## psi[4]          0.575   0.077   0.456   0.527   0.570   0.617   0.721
## psi[5]          0.304   0.060   0.230   0.274   0.300   0.329   0.389
## psi[6]          0.262   0.056   0.200   0.237   0.259   0.282   0.335
## psi[7]          0.474   0.076   0.377   0.435   0.470   0.507   0.594
## psi[8]          0.236   0.057   0.181   0.214   0.233   0.254   0.302
## psi[9]          0.615   0.087   0.489   0.563   0.609   0.657   0.771
## psi[10]         0.708   0.095   0.568   0.650   0.701   0.756   0.878
## xfactor[1]      0.011   0.248  -0.479  -0.154   0.009   0.179   0.493
## xfactor[2]      1.510   0.277   0.969   1.333   1.511   1.690   2.051
## xfactor[3]      1.683   0.286   1.132   1.501   1.687   1.873   2.225
## xfactor[4]     -0.927   0.252  -1.420  -1.094  -0.920  -0.759  -0.441
## xfactor[5]      0.036   0.245  -0.447  -0.128   0.036   0.201   0.521
## xfactor[6]     -0.974   0.256  -1.471  -1.146  -0.977  -0.806  -0.454
## xfactor[7]     -0.342   0.247  -0.824  -0.507  -0.340  -0.175   0.144
## xfactor[8]     -0.057   0.248  -0.541  -0.223  -0.059   0.114   0.427
## xfactor[9]     -0.782   0.256  -1.298  -0.952  -0.779  -0.610  -0.285
## xfactor[10]     0.039   0.244  -0.443  -0.122   0.035   0.203   0.515
## xfactor[11]    -0.974   0.253  -1.467  -1.144  -0.975  -0.809  -0.466
## xfactor[12]     0.254   0.246  -0.226   0.088   0.251   0.416   0.744
## xfactor[13]    -0.739   0.253  -1.233  -0.909  -0.739  -0.571  -0.251
## xfactor[14]    -0.977   0.257  -1.485  -1.148  -0.977  -0.807  -0.460
## xfactor[15]    -0.833   0.254  -1.326  -1.006  -0.837  -0.659  -0.327
## xfactor[16]    -0.067   0.247  -0.566  -0.229  -0.065   0.100   0.400
## xfactor[17]    -0.065   0.243  -0.535  -0.231  -0.068   0.097   0.410
```

```
## xfactor[18]    -0.661  0.251  -1.157  -0.829  -0.658  -0.488  -0.178
## xfactor[19]     1.848  0.296   1.272   1.671   1.853   2.038   2.414
## xfactor[20]    -0.923  0.255  -1.409  -1.095  -0.924  -0.753  -0.418
## xfactor[21]    -0.251  0.247  -0.733  -0.418  -0.250  -0.080   0.222
## xfactor[22]    -0.977  0.257  -1.478  -1.149  -0.975  -0.807  -0.476
## xfactor[23]    -0.974  0.256  -1.467  -1.146  -0.975  -0.805  -0.461
## xfactor[24]    -0.978  0.259  -1.486  -1.152  -0.982  -0.806  -0.461
## xfactor[25]     0.535  0.247   0.066   0.365   0.534   0.699   1.026
## xfactor[26]     0.727  0.253   0.242   0.554   0.725   0.900   1.221
## xfactor[27]    -0.113  0.250  -0.607  -0.278  -0.112   0.056   0.376
## xfactor[28]     1.194  0.265   0.659   1.024   1.198   1.369   1.714
## xfactor[29]     0.880  0.256   0.369   0.710   0.877   1.053   1.390
## xfactor[30]     1.664  0.283   1.110   1.486   1.665   1.851   2.201
## xfactor[31]     0.538  0.254   0.045   0.367   0.535   0.711   1.043
## xfactor[32]    -0.424  0.250  -0.915  -0.585  -0.421  -0.253   0.054
## xfactor[33]     0.313  0.249  -0.166   0.144   0.310   0.480   0.817
## xfactor[34]    -0.971  0.257  -1.485  -1.144  -0.968  -0.797  -0.468
## xfactor[35]    -0.664  0.252  -1.162  -0.833  -0.665  -0.493  -0.179
## xfactor[36]    -0.792  0.254  -1.297  -0.960  -0.790  -0.621  -0.301
## xfactor[37]    -0.980  0.259  -1.498  -1.152  -0.974  -0.807  -0.467
## xfactor[38]    -0.214  0.246  -0.700  -0.377  -0.214  -0.047   0.264
## xfactor[39]    -0.974  0.253  -1.472  -1.142  -0.972  -0.804  -0.484
## xfactor[40]     0.041  0.248  -0.444  -0.124   0.040   0.208   0.530
## xfactor[41]    -0.976  0.255  -1.482  -1.146  -0.976  -0.810  -0.464
## xfactor[42]    -0.086  0.251  -0.589  -0.254  -0.083   0.085   0.400
## xfactor[43]    -0.646  0.246  -1.123  -0.812  -0.644  -0.482  -0.156
## xfactor[44]    -0.064  0.248  -0.546  -0.229  -0.066   0.098   0.420
## xfactor[45]     0.364  0.249  -0.122   0.197   0.360   0.534   0.858
## xfactor[46]     0.265  0.246  -0.223   0.100   0.264   0.429   0.762
## xfactor[47]     0.496  0.249   0.014   0.325   0.497   0.661   0.984
## xfactor[48]    -0.826  0.254  -1.320  -0.997  -0.826  -0.660  -0.319
## xfactor[49]    -0.976  0.254  -1.469  -1.151  -0.976  -0.808  -0.471
## xfactor[50]     0.162  0.253  -0.338  -0.007   0.161   0.330   0.655
## xfactor[51]    -0.976  0.257  -1.471  -1.151  -0.976  -0.807  -0.466
## xfactor[52]     0.323  0.244  -0.157   0.157   0.323   0.488   0.797
## xfactor[53]    -0.974  0.257  -1.469  -1.153  -0.972  -0.801  -0.478
## xfactor[54]     1.197  0.263   0.673   1.027   1.198   1.373   1.699
## xfactor[55]    -0.978  0.254  -1.471  -1.145  -0.977  -0.815  -0.468
## xfactor[56]    -0.971  0.255  -1.474  -1.144  -0.971  -0.799  -0.467
## xfactor[57]    -0.733  0.255  -1.236  -0.903  -0.732  -0.558  -0.235
## xfactor[58]    -0.972  0.255  -1.470  -1.143  -0.973  -0.807  -0.467
## xfactor[59]    -0.075  0.248  -0.558  -0.244  -0.072   0.094   0.411
## xfactor[60]    -0.639  0.254  -1.139  -0.812  -0.639  -0.468  -0.138
## xfactor[61]     1.366  0.270   0.840   1.188   1.371   1.543   1.892
## xfactor[62]     0.322  0.246  -0.149   0.155   0.321   0.487   0.803
## xfactor[63]    -0.976  0.256  -1.482  -1.148  -0.974  -0.804  -0.472
## xfactor[64]     1.363  0.269   0.832   1.188   1.367   1.543   1.871
## xfactor[65]     1.198  0.262   0.679   1.026   1.200   1.371   1.706
## xfactor[66]    -0.747  0.251  -1.256  -0.915  -0.746  -0.575  -0.265
## xfactor[67]     0.536  0.253   0.048   0.367   0.537   0.704   1.030
## xfactor[68]     0.841  0.256   0.341   0.673   0.838   1.011   1.344
## xfactor[69]    -0.534  0.253  -1.034  -0.704  -0.534  -0.362  -0.043
## xfactor[70]     0.874  0.255   0.372   0.707   0.870   1.042   1.378
## xfactor[71]     0.061  0.241  -0.417  -0.101   0.058   0.224   0.535
```

```
## xfactor[72]     1.034   0.263    0.508    0.857    1.037    1.213    1.536
## xfactor[73]    -0.017   0.245   -0.496   -0.179   -0.020    0.147    0.466
## xfactor[74]    -0.974   0.256   -1.470   -1.144   -0.975   -0.808   -0.451
## xfactor[75]    -0.971   0.256   -1.481   -1.142   -0.974   -0.802   -0.463
## xfactor[76]     3.217   0.356    2.579    3.027    3.223    3.433    3.848
## xfactor[77]    -0.783   0.255   -1.291   -0.948   -0.782   -0.612   -0.283
## xfactor[78]     1.133   0.261    0.626    0.956    1.133    1.308    1.648
## xfactor[79]     1.850   0.294    1.274    1.667    1.859    2.041    2.412
## xfactor[80]     0.598   0.255    0.097    0.430    0.597    0.770    1.102
## xfactor[81]     0.040   0.245   -0.443   -0.126    0.042    0.201    0.524
## xfactor[82]     0.013   0.250   -0.484   -0.156    0.016    0.181    0.506
## xfactor[83]    -0.970   0.255   -1.468   -1.144   -0.969   -0.804   -0.465
## xfactor[84]     1.559   0.277    1.011    1.382    1.563    1.741    2.094
## xfactor[85]     0.203   0.250   -0.290    0.035    0.203    0.371    0.701
## xfactor[86]    -0.978   0.257   -1.484   -1.148   -0.980   -0.805   -0.463
## xfactor[87]     0.171   0.251   -0.323    0.001    0.171    0.336    0.665
## xfactor[88]    -0.316   0.248   -0.813   -0.480   -0.312   -0.146    0.156
## xfactor[89]    -0.974   0.253   -1.469   -1.141   -0.971   -0.804   -0.472
## xfactor[90]     0.826   0.253    0.322    0.656    0.827    0.998    1.319
## xfactor[91]    -0.838   0.256   -1.353   -1.008   -0.836   -0.668   -0.338
## xfactor[92]     1.044   0.262    0.529    0.869    1.044    1.218    1.562
## xfactor[93]     0.011   0.250   -0.475   -0.154    0.010    0.182    0.499
## xfactor[94]     2.573   0.322    1.976    2.388    2.581    2.776    3.162
## xfactor[95]     1.640   0.279    1.090    1.466    1.644    1.823    2.172
## xfactor[96]     0.315   0.246   -0.163    0.144    0.315    0.481    0.803
## xfactor[97]     0.264   0.246   -0.220    0.098    0.262    0.427    0.748
## xfactor[98]    -0.973   0.254   -1.468   -1.143   -0.974   -0.802   -0.477
## xfactor[99]     1.192   0.264    0.666    1.020    1.195    1.367    1.707
## xfactor[100]   -0.924   0.254   -1.425   -1.097   -0.925   -0.753   -0.426
## xfactor[101]   -0.705   0.254   -1.210   -0.876   -0.702   -0.533   -0.218
## xfactor[102]    2.784   0.334    2.185    2.591    2.794    2.994    3.386
## xfactor[103]   -0.665   0.252   -1.164   -0.833   -0.665   -0.495   -0.170
## xfactor[104]    0.856   0.267    0.333    0.674    0.852    1.033    1.388
## xfactor[105]   -0.090   0.251   -0.584   -0.258   -0.092    0.075    0.399
## xfactor[106]    1.116   0.265    0.588    0.946    1.113    1.292    1.640
## xfactor[107]    1.557   0.278    1.024    1.379    1.556    1.738    2.096
## xfactor[108]    0.827   0.254    0.336    0.658    0.826    0.994    1.339
## xfactor[109]    1.018   0.261    0.499    0.847    1.016    1.191    1.540
## xfactor[110]    0.041   0.247   -0.452   -0.125    0.041    0.206    0.531
## xfactor[111]    0.112   0.245   -0.367   -0.053    0.109    0.272    0.604
## xfactor[112]   -0.642   0.250   -1.130   -0.814   -0.647   -0.471   -0.150
## xfactor[113]    0.365   0.248   -0.112    0.197    0.359    0.535    0.852
## xfactor[114]   -0.324   0.248   -0.806   -0.493   -0.321   -0.153    0.163
## xfactor[115]    0.858   0.269    0.329    0.679    0.856    1.041    1.386
## xfactor[116]   -0.173   0.249   -0.671   -0.335   -0.171   -0.006    0.320
## xfactor[117]    0.063   0.249   -0.427   -0.103    0.061    0.232    0.555
## xfactor[118]    0.323   0.245   -0.146    0.155    0.321    0.484    0.808
## xfactor[119]   -0.834   0.254   -1.335   -1.001   -0.830   -0.665   -0.336
## xfactor[120]   -0.976   0.255   -1.483   -1.149   -0.972   -0.806   -0.480
## xfactor[121]    0.197   0.253   -0.300    0.028    0.194    0.366    0.707
## xfactor[122]   -0.640   0.254   -1.151   -0.811   -0.635   -0.467   -0.158
## xfactor[123]    1.199   0.262    0.693    1.027    1.197    1.371    1.712
## xfactor[124]    1.023   0.258    0.519    0.854    1.024    1.194    1.526
## xfactor[125]   -0.976   0.256   -1.479   -1.148   -0.974   -0.805   -0.471
```

```
## xfactor[126]   -0.641   0.252   -1.149   -0.809   -0.638   -0.470   -0.160
## xfactor[127]    1.117   0.262    0.604    0.940    1.119    1.293    1.635
## xfactor[128]   -0.837   0.252   -1.334   -1.006   -0.836   -0.671   -0.340
## xfactor[129]   -0.666   0.256   -1.165   -0.840   -0.664   -0.494   -0.171
## xfactor[130]    1.850   0.289    1.296    1.669    1.851    2.036    2.408
## xfactor[131]   -0.344   0.246   -0.826   -0.509   -0.343   -0.178    0.145
## xfactor[132]    1.638   0.279    1.089    1.463    1.643    1.819    2.173
## xfactor[133]   -0.974   0.258   -1.479   -1.145   -0.975   -0.802   -0.454
## xfactor[134]    2.568   0.319    1.993    2.385    2.575    2.770    3.158
## xfactor[135]   -0.779   0.251   -1.281   -0.947   -0.773   -0.610   -0.293
## xfactor[136]   -0.975   0.255   -1.477   -1.146   -0.973   -0.809   -0.471
## xfactor[137]    0.762   0.256    0.277    0.587    0.760    0.930    1.272
## xfactor[138]   -0.782   0.251   -1.283   -0.949   -0.779   -0.612   -0.292
## xfactor[139]    0.052   0.247   -0.430   -0.110    0.053    0.215    0.540
## xfactor[140]   -0.053   0.243   -0.536   -0.214   -0.047    0.110    0.421
## xfactor[141]   -0.838   0.253   -1.335   -1.008   -0.837   -0.668   -0.343
## xfactor[142]   -0.975   0.256   -1.481   -1.145   -0.976   -0.802   -0.462
## xfactor[143]   -0.974   0.254   -1.473   -1.141   -0.971   -0.807   -0.473
## xfactor[144]    0.806   0.255    0.306    0.632    0.809    0.977    1.302
## xfactor[145]   -0.977   0.257   -1.484   -1.149   -0.978   -0.806   -0.473
## xfactor[146]    0.596   0.253    0.109    0.426    0.594    0.765    1.092
## xfactor[147]    0.839   0.257    0.328    0.666    0.837    1.014    1.337
## xfactor[148]    0.125   0.251   -0.372   -0.043    0.124    0.292    0.618
## xfactor[149]   -0.977   0.255   -1.478   -1.147   -0.978   -0.809   -0.469
## xfactor[150]   -0.977   0.258   -1.482   -1.149   -0.979   -0.804   -0.459
## xfactor[151]   -0.639   0.253   -1.140   -0.811   -0.637   -0.468   -0.149
## xfactor[152]   -0.975   0.257   -1.473   -1.149   -0.977   -0.801   -0.468
## xfactor[153]    1.513   0.272    0.979    1.335    1.514    1.693    2.042
## xfactor[154]   -0.926   0.257   -1.421   -1.102   -0.924   -0.754   -0.409
## xfactor[155]   -0.978   0.256   -1.477   -1.153   -0.978   -0.806   -0.467
## xfactor[156]   -0.827   0.256   -1.323   -1.001   -0.826   -0.654   -0.315
## xfactor[157]   -0.833   0.258   -1.347   -1.005   -0.836   -0.661   -0.329
## xfactor[158]   -0.025   0.243   -0.517   -0.185   -0.022    0.138    0.448
## xfactor[159]    0.595   0.255    0.103    0.423    0.595    0.765    1.100
## xfactor[160]   -0.974   0.257   -1.475   -1.151   -0.976   -0.804   -0.455
## xfactor[161]    1.280   0.268    0.757    1.104    1.279    1.457    1.810
## xfactor[162]    0.166   0.250   -0.332    0.002    0.163    0.335    0.656
## xfactor[163]   -0.974   0.253   -1.462   -1.142   -0.977   -0.803   -0.464
## xfactor[164]   -0.544   0.252   -1.036   -0.716   -0.542   -0.371   -0.056
## xfactor[165]    0.158   0.252   -0.334   -0.011    0.155    0.326    0.660
## xfactor[166]   -0.972   0.256   -1.474   -1.144   -0.972   -0.805   -0.461
## xfactor[167]    0.311   0.246   -0.163    0.145    0.308    0.474    0.789
## xfactor[168]    1.357   0.270    0.833    1.178    1.353    1.542    1.882
## xfactor[169]   -0.351   0.251   -0.841   -0.520   -0.347   -0.179    0.129
## xfactor[170]    0.113   0.244   -0.372   -0.050    0.112    0.275    0.596
## xfactor[171]   -0.742   0.253   -1.237   -0.914   -0.741   -0.570   -0.241
## xfactor[172]    0.194   0.249   -0.291    0.029    0.191    0.362    0.686
## xfactor[173]    0.596   0.255    0.108    0.422    0.596    0.766    1.095
## xfactor[174]   -0.703   0.249   -1.190   -0.871   -0.705   -0.533   -0.215
## xfactor[175]   -0.666   0.250   -1.168   -0.829   -0.667   -0.496   -0.175
## xfactor[176]   -0.781   0.254   -1.275   -0.952   -0.781   -0.608   -0.286
## xfactor[177]   -0.434   0.251   -0.934   -0.603   -0.433   -0.261    0.048
## deviance     3674.969  41.486 3632.752 3658.913 3673.474 3688.687 3720.761
##                Rhat n.eff
```

```
## lambda[1]     1.001  4300
## lambda[2]     1.001  8000
## lambda[3]     1.001  8000
## lambda[4]     1.001  8000
## lambda[5]     1.001  8000
## lambda[6]     1.001  7500
## lambda[7]     1.001  8000
## lambda[8]     1.001  6300
## lambda[9]     1.001  8000
## lambda[10]    1.001  4600
## mu[1]         1.001  8000
## mu[2]         1.001  4900
## mu[3]         1.001  8000
## mu[4]         1.001  7600
## mu[5]         1.001  8000
## mu[6]         1.001  8000
## mu[7]         1.001  8000
## mu[8]         1.001  8000
## mu[9]         1.001  8000
## mu[10]        1.001  8000
## psi[1]        1.001  4300
## psi[2]        1.001  8000
## psi[3]        1.001  8000
## psi[4]        1.001  5700
## psi[5]        1.002  3100
## psi[6]        1.001  8000
## psi[7]        1.001  8000
## psi[8]        1.001  3700
## psi[9]        1.002  2400
## psi[10]       1.001  8000
## xfactor[1]    1.001  8000
## xfactor[2]    1.001  8000
## xfactor[3]    1.001  8000
## xfactor[4]    1.001  8000
## xfactor[5]    1.001  3900
## xfactor[6]    1.001  8000
## xfactor[7]    1.001  8000
## xfactor[8]    1.001  5200
## xfactor[9]    1.001  5900
## xfactor[10]   1.001  8000
## xfactor[11]   1.001  8000
## xfactor[12]   1.001  8000
## xfactor[13]   1.001  8000
## xfactor[14]   1.001  7200
## xfactor[15]   1.001  4200
## xfactor[16]   1.001  8000
## xfactor[17]   1.001  8000
## xfactor[18]   1.001  8000
## xfactor[19]   1.002  3100
## xfactor[20]   1.001  8000
## xfactor[21]   1.001  7400
## xfactor[22]   1.001  3700
## xfactor[23]   1.001  8000
## xfactor[24]   1.001  8000
```

```
## xfactor[25]  1.001  7700
## xfactor[26]  1.001  8000
## xfactor[27]  1.001  8000
## xfactor[28]  1.001  8000
## xfactor[29]  1.001  8000
## xfactor[30]  1.002  8000
## xfactor[31]  1.001  8000
## xfactor[32]  1.001  4900
## xfactor[33]  1.001  8000
## xfactor[34]  1.001  4600
## xfactor[35]  1.001  4200
## xfactor[36]  1.001  8000
## xfactor[37]  1.001  3400
## xfactor[38]  1.001  8000
## xfactor[39]  1.001  3500
## xfactor[40]  1.001  8000
## xfactor[41]  1.001  8000
## xfactor[42]  1.001  8000
## xfactor[43]  1.001  8000
## xfactor[44]  1.001  5800
## xfactor[45]  1.001  8000
## xfactor[46]  1.001  8000
## xfactor[47]  1.001  6000
## xfactor[48]  1.001  8000
## xfactor[49]  1.001  8000
## xfactor[50]  1.001  3900
## xfactor[51]  1.002  3000
## xfactor[52]  1.002  2900
## xfactor[53]  1.001  8000
## xfactor[54]  1.002  2100
## xfactor[55]  1.001  8000
## xfactor[56]  1.001  3700
## xfactor[57]  1.001  8000
## xfactor[58]  1.001  5400
## xfactor[59]  1.001  5500
## xfactor[60]  1.001  8000
## xfactor[61]  1.001  8000
## xfactor[62]  1.001  8000
## xfactor[63]  1.001  8000
## xfactor[64]  1.001  8000
## xfactor[65]  1.001  8000
## xfactor[66]  1.002  3000
## xfactor[67]  1.001  6500
## xfactor[68]  1.001  7700
## xfactor[69]  1.001  8000
## xfactor[70]  1.001  8000
## xfactor[71]  1.001  8000
## xfactor[72]  1.001  7000
## xfactor[73]  1.001  8000
## xfactor[74]  1.001  8000
## xfactor[75]  1.001  8000
## xfactor[76]  1.002  3100
## xfactor[77]  1.001  6200
## xfactor[78]  1.001  8000
```

```
## xfactor[79]  1.001  5800
## xfactor[80]  1.001  8000
## xfactor[81]  1.001  5500
## xfactor[82]  1.001  8000
## xfactor[83]  1.001  8000
## xfactor[84]  1.001  8000
## xfactor[85]  1.001  6800
## xfactor[86]  1.001  8000
## xfactor[87]  1.001  8000
## xfactor[88]  1.001  4000
## xfactor[89]  1.001  8000
## xfactor[90]  1.001  8000
## xfactor[91]  1.001  8000
## xfactor[92]  1.001  8000
## xfactor[93]  1.001  8000
## xfactor[94]  1.001  8000
## xfactor[95]  1.001  8000
## xfactor[96]  1.001  8000
## xfactor[97]  1.001  5000
## xfactor[98]  1.001  8000
## xfactor[99]  1.001  8000
## xfactor[100] 1.001  8000
## xfactor[101] 1.001  8000
## xfactor[102] 1.001  8000
## xfactor[103] 1.001  8000
## xfactor[104] 1.001  8000
## xfactor[105] 1.001  3800
## xfactor[106] 1.001  8000
## xfactor[107] 1.001  8000
## xfactor[108] 1.001  5100
## xfactor[109] 1.001  3700
## xfactor[110] 1.001  6100
## xfactor[111] 1.001  4500
## xfactor[112] 1.001  8000
## xfactor[113] 1.001  4800
## xfactor[114] 1.001  5600
## xfactor[115] 1.002  2800
## xfactor[116] 1.001  7200
## xfactor[117] 1.001  8000
## xfactor[118] 1.001  8000
## xfactor[119] 1.001  7000
## xfactor[120] 1.001  8000
## xfactor[121] 1.002  3100
## xfactor[122] 1.001  3900
## xfactor[123] 1.001  8000
## xfactor[124] 1.001  3900
## xfactor[125] 1.001  8000
## xfactor[126] 1.001  4200
## xfactor[127] 1.001  8000
## xfactor[128] 1.001  8000
## xfactor[129] 1.001  5600
## xfactor[130] 1.001  8000
## xfactor[131] 1.002  3100
## xfactor[132] 1.001  8000
```

```
## xfactor[133] 1.001  8000
## xfactor[134] 1.001  6100
## xfactor[135] 1.001  8000
## xfactor[136] 1.001  8000
## xfactor[137] 1.001  8000
## xfactor[138] 1.001  6500
## xfactor[139] 1.001  5300
## xfactor[140] 1.001  8000
## xfactor[141] 1.002  3000
## xfactor[142] 1.001  8000
## xfactor[143] 1.001  6800
## xfactor[144] 1.001  8000
## xfactor[145] 1.001  8000
## xfactor[146] 1.001  8000
## xfactor[147] 1.001  8000
## xfactor[148] 1.001  8000
## xfactor[149] 1.001  8000
## xfactor[150] 1.001  8000
## xfactor[151] 1.001  8000
## xfactor[152] 1.001  8000
## xfactor[153] 1.001  8000
## xfactor[154] 1.001  4400
## xfactor[155] 1.002  2100
## xfactor[156] 1.001  8000
## xfactor[157] 1.001  8000
## xfactor[158] 1.001  8000
## xfactor[159] 1.001  6500
## xfactor[160] 1.001  8000
## xfactor[161] 1.001  6500
## xfactor[162] 1.001  4400
## xfactor[163] 1.001  8000
## xfactor[164] 1.001  6800
## xfactor[165] 1.001  4500
## xfactor[166] 1.001  8000
## xfactor[167] 1.001  6600
## xfactor[168] 1.001  8000
## xfactor[169] 1.001  3600
## xfactor[170] 1.001  6000
## xfactor[171] 1.001  6300
## xfactor[172] 1.001  5200
## xfactor[173] 1.001  8000
## xfactor[174] 1.001  8000
## xfactor[175] 1.002  3200
## xfactor[176] 1.001  8000
## xfactor[177] 1.001  6500
## deviance     1.001  8000
##
## For each parameter, n.eff is a crude measure of effective sample size,
## and Rhat is the potential scale reduction factor (at convergence, Rhat=1).
##
## DIC info (using the rule, pD = var(deviance)/2)
## pD = 860.8 and DIC = 4535.7
## DIC is an estimate of expected predictive error (lower deviance is better).
```

Convergence looks good. Let's look at model fit using a posterior predictive model check:

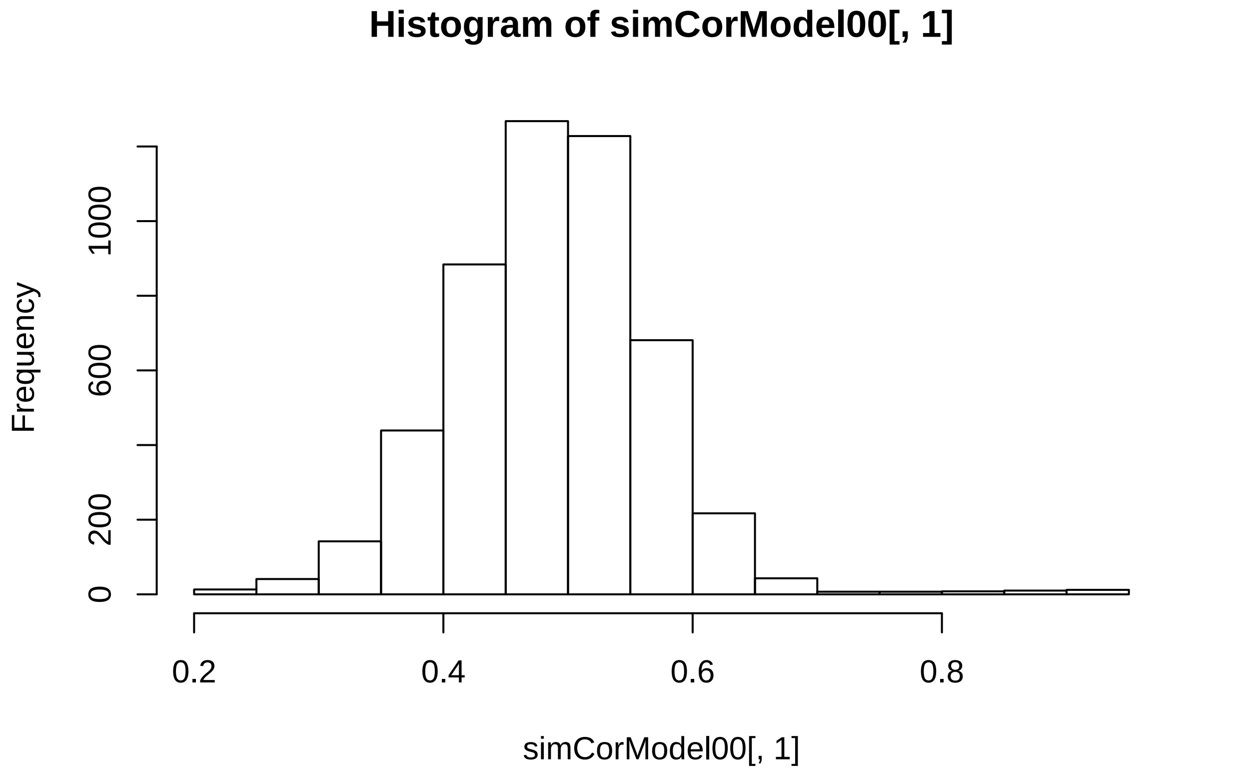
```
# list number of simulated data sets
nSimulatedDataSets = 5000

# create one large matrix of posterior value by disentangling chains
model00.Posterior.all = model00.r2jags$BUGSoutput$sims.matrix

# determine columns of posterior that go into each model matrix
muCols = grep(x = colnames(model00.Posterior.all), pattern = "mu")
lambdaCols = grep(x = colnames(model00.Posterior.all), pattern = "lambda")
psiCols = grep(x = colnames(model00.Posterior.all), pattern = "psi")

# save simulated correlations:
simCorModel00 = matrix(data = NA, nrow = nSimulatedDataSets, ncol = nItems*(nItems-1)/2)

# loop through data sets (can be sped up with functions and lapply)
pb = txtProgressBar()
sim = 1
for (sim in 1:nSimulatedDataSets){

  # draw sample from one iteration of posterior chain
  iternum = sample(x = 1:nrow(model00.Posterior.all), size = 1, replace = TRUE)

  # get parameters for that sample: put into factor model matrices for easier generation of data
  mu = matrix(data = model00.Posterior.all[iternum, muCols], ncol = 1)
  lambda = matrix(data = model00.Posterior.all[iternum, lambdaCols], ncol = 1)
  psi = diag(model00.Posterior.all[iternum, psiCols])

  # create model-implied mean and covariance matrix (marginal for X)
  meanVec = mu
  covMat = lambda %*% t(lambda) + psi

  # randomly draw data with same sample size from MVN with mean=meanVec and cov=covMat
  simData = rmvnorm(n = nrow(conspiracy), mean = meanVec, sigma = covMat)

  # create sample statistics from simulated data (we'll use correlation matrix, starting with upper tri
  simCorModel00[sim,] = matrix(data = c(cor(simData)[upper.tri(cor(simData))]), nrow = 1)

  setTxtProgressBar(pb = pb, value = sim/nSimulatedDataSets)
}
```

```
## ==========================================================================
```

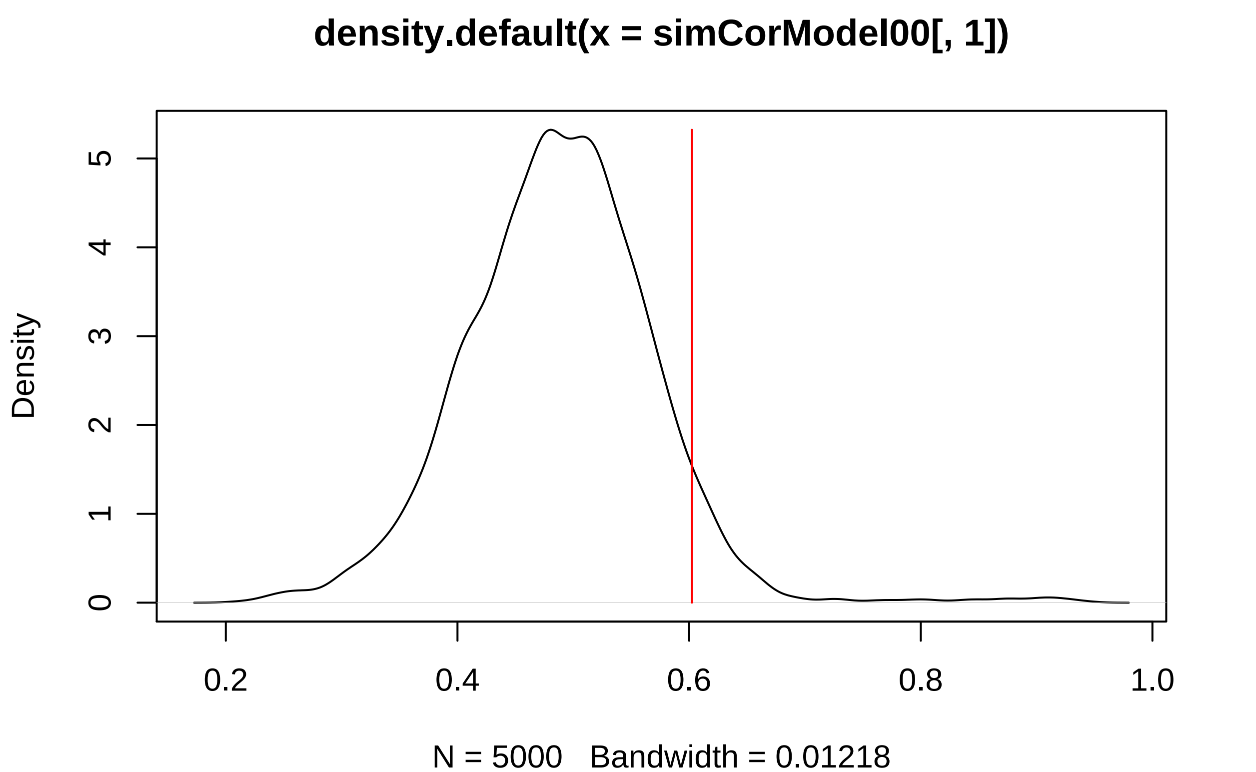
```
close(pb)
```

```
# label values of simCor to ensure we have the right comparison
corNames = NULL
for (i in 1:(ncol(simData)-1)){
  for (j in (i+1):ncol(simData)){
    corNames = c(corNames, paste0("cor", i, "." , j))
  }
}
colnames(simCorModel00) = corNames

# show how one correlation compares to distribution of simulated correlations
```

```
dataCor = cor(conspiracy[paste0("PolConsp", 1:10)])
hist(simCorModel00[,1])
```




```
plot(density(simCorModel00[,1]))
lines(x = c(dataCor[1,2], dataCor[1,2]), y = c(0, max(density(simCorModel00[,1])$y)), col = 2)
```



```r
quantile(simCorModel00[,1])
```

```
##        0%       25%       50%       75%      100%
## 0.2091762 0.4375199 0.4874779 0.5371624 0.9431007
```

```r
mean(simCorModel00[,1])
```

```
## [1] 0.4878302
```

```r
dataCor[1,2]
```

```
## [1] 0.6024186
```

```r
# create quantiles of correlations to see where each observed correlation falls
corQuantiles00 = NULL

# compute the quantiles of the observed correlations:
col = 1
for (i in 1:(ncol(simData)-1)){
  for (j in (i+1):ncol(simData)){
    # get empirical CDF of simulated correlation distribution
    corEcdf = ecdf(simCorModel00[,col])
    corQuantiles00 = rbind(corQuantiles00, c(i, j, summary(corEcdf), dataCor[i,j], corEcdf(dataCor[i,j])

    col = col + 1
  }
}
colnames(corQuantiles00)[1:2] = c("Item 1", "Item 2")
colnames(corQuantiles00)[9:10] = c("ObsCor", "CorPctile")
corQuantiles00[which(corQuantiles00[,10] > .975 | corQuantiles00[,10] < .025),]
```

```
##       Item 1 Item 2      Min.   1st Qu.    Median      Mean   3rd Qu.
##  [1,]      1      9 0.4117070 0.6319619 0.6699822 0.6691924 0.7087404
##  [2,]      1     10 0.3591084 0.5854847 0.6288890 0.6274306 0.6701442
##  [3,]      2      3 0.3928988 0.6114420 0.6528753 0.6516249 0.6920191
##  [4,]      2      7 0.3870122 0.6068369 0.6489110 0.6473148 0.6885404
##  [5,]      2      8 0.5282056 0.7325984 0.7634605 0.7617004 0.7915899
##  [6,]      2     10 0.3039078 0.5228995 0.5691872 0.5686070 0.6143829
##  [7,]      3      9 0.4257234 0.6262976 0.6658009 0.6640968 0.7026819
##  [8,]      4      6 0.5796993 0.7323067 0.7623820 0.7612385 0.7915427
##  [9,]      4      7 0.5675814 0.7252968 0.7575311 0.7557252 0.7870264
## [10,]      5      6 0.1589861 0.4844779 0.5329104 0.5320083 0.5792610
## [11,]      5      8 0.3871866 0.6088166 0.6511497 0.6490466 0.6901622
## [12,]      6      8 0.1060496 0.3469812 0.4023580 0.4018682 0.4537093
## [13,]      7      8 0.1210683 0.4162649 0.4672561 0.4678412 0.5183566
##            Max.    ObsCor CorPctile
##  [1,] 0.9713456 0.4420860    0.0006
##  [2,] 0.9734552 0.2568334    0.0000
##  [3,] 0.9665182 0.5176819    0.0194
##  [4,] 0.9641322 0.4721628    0.0056
##  [5,] 0.9793645 0.6317705    0.0058
##  [6,] 0.9558203 0.4121264    0.0158
##  [7,] 0.9666723 0.3912734    0.0000
##  [8,] 0.9819038 0.6251455    0.0038
##  [9,] 0.9787926 0.4676834    0.0000
## [10,] 0.9629036 0.7366890    0.9916
```

```
## [11,] 0.9759855 0.7641703    0.9760
## [12,] 0.9366972 0.7557355    0.9950
## [13,] 0.9503379 0.6611475    0.9886
```

Model 1: Unidimensional Graded Response Model with Normal Ogive

```
# marker item:
model01.function = function(){

  # measurement model specification
    for (person in 1:N){
      for (item in 1:I){

        # form cumulative probability item response functions
        CProb[person, item, 1] <- 1
        for (cat in 2:C[item]){
          CProb[person, item, cat] <- phi(a[item]*(theta[person]-b[item, (cat-1)]))
        }

        # form probability response is equal to each category
        for (cat in 1:(C[item] - 1)){
          Prob[person, item, cat] <- CProb[person, item, cat] - CProb[person, item, cat+1]
        }
        Prob[person, item, C[item]] <- CProb[person, item, C[item]]

        X[person, item] ~ dcat(Prob[person, item, 1:C[item]])
      }
    }

  # prior distributions for the factor:
    for (person in 1:N){
      theta[person] ~ dnorm(0, 1)
    }

  # prior distributions for the measurement model mean/precision parameters
    for (item in 1:I){

      # create parameters that are unbounded, then sort
      for (cat in 1:(C[item]-1)){
        b.star[item, cat] ~ dnorm(b.mean.0, b.precision.0)
      }
      b[item, 1:(C[item]-1)] <- sort(b.star[item, 1:(C[item]-1)])

      # loadings are set to be all positive
      a[item] ~ dnorm(a.mean.0, a.precision.0);T(0,)

    }

}
```

```
nItems = 10

# specification of prior values for measurement model parameters:
```

```r
#   item intercepts
b.mean.0 = 0
b.variance.0 = 100
b.precision.0 = 1 / b.variance.0

#   Factor loadings -- these are the discriminations
a.mean.0 = 0
a.variance.0 = 100
a.precision.0 = 1 / a.variance.0

# next, create data for JAGS to use:
model01.data = list(
  N = nrow(conspiracy),
  X = conspiracy,
  C = unlist(apply(X = conspiracy[,1:10], MARGIN = 2, FUN = max)),
  I = 10,
  b.mean.0 = b.mean.0,
  b.precision.0 = b.precision.0,
  a.mean.0 = a.mean.0,
  a.precision.0 = a.precision.0
)

model01.init = function(){
  list("a" = runif(10, 1, 2),
       "b.star" = cbind(rep(1, 10), rep(0, 10), rep(-1, 10), rep(-2, 10)))
}

model01.parameters = c("a", "b",  "theta")

model01.seed = 16042019
```

Here, we will use the R2jags `jags.parallel()` function, which will run somewhat faster (one chain per core):

```r
model01.r2jags =  jags.parallel(
  data = model01.data,
  inits = model01.init,
  parameters.to.save = model01.parameters,
  model.file = model01.function,
  n.chains = 4,
  n.iter = 5000,
  n.thin = 1,
  n.burnin = 3000,
  jags.seed = model01.seed
)

model01.r2jags
```

```
## Inference for Bugs model at "model01.function", fit using jags,
##  4 chains, each with 5000 iterations (first 3000 discarded)
##  n.sims = 8000 iterations saved
##            mu.vect sd.vect    2.5%      25%      50%      75%    97.5%
## a[1]          0.956   0.122    0.727    0.872    0.954    1.036    1.207
## a[2]          1.357   0.179    1.021    1.234    1.349    1.473    1.732
## a[3]          1.170   0.163    0.868    1.056    1.164    1.276    1.509
## a[4]          1.377   0.175    1.051    1.256    1.371    1.488    1.733
```

```
## a[5]          2.148   0.305   1.610   1.940   2.124   2.333   2.809
## a[6]          2.205   0.298   1.688   1.994   2.187   2.392   2.852
## a[7]          1.410   0.202   1.043   1.275   1.398   1.537   1.840
## a[8]          2.350   0.359   1.749   2.100   2.324   2.570   3.126
## a[9]          1.342   0.190   0.994   1.210   1.330   1.463   1.746
## a[10]         1.230   0.214   0.858   1.077   1.212   1.368   1.690
## b[1,1]       -0.885   0.174  -1.240  -0.999  -0.878  -0.766  -0.560
## b[2,1]       -0.113   0.122  -0.357  -0.195  -0.113  -0.029   0.122
## b[3,1]        0.164   0.123  -0.082   0.081   0.166   0.246   0.401
## b[4,1]       -0.163   0.123  -0.412  -0.244  -0.162  -0.080   0.073
## b[5,1]       -0.127   0.106  -0.333  -0.201  -0.127  -0.054   0.076
## b[6,1]       -0.036   0.108  -0.246  -0.106  -0.036   0.036   0.171
## b[7,1]        0.286   0.117   0.059   0.207   0.286   0.364   0.512
## b[8,1]        0.043   0.105  -0.165  -0.028   0.046   0.115   0.245
## b[9,1]        0.253   0.123   0.010   0.169   0.253   0.335   0.496
## b[10,1]       0.890   0.147   0.620   0.790   0.882   0.982   1.199
## b[1,2]        0.333   0.138   0.060   0.241   0.332   0.427   0.603
## b[2,2]        0.854   0.134   0.610   0.760   0.847   0.942   1.132
## b[3,2]        0.749   0.138   0.493   0.653   0.745   0.839   1.037
## b[4,2]        0.692   0.125   0.456   0.606   0.691   0.771   0.953
## b[5,2]        0.719   0.114   0.501   0.643   0.716   0.790   0.959
## b[6,2]        0.734   0.112   0.522   0.658   0.731   0.806   0.964
## b[7,2]        1.033   0.150   0.751   0.933   1.028   1.125   1.347
## b[8,2]        0.693   0.110   0.482   0.620   0.690   0.764   0.919
## b[9,2]        1.046   0.149   0.768   0.946   1.038   1.141   1.350
## b[10,2]       1.496   0.206   1.143   1.351   1.475   1.626   1.943
## b[1,3]        1.423   0.200   1.068   1.285   1.411   1.548   1.854
## b[2,3]        1.628   0.193   1.289   1.493   1.614   1.751   2.052
## b[3,3]        2.014   0.258   1.545   1.836   1.998   2.177   2.559
## b[4,3]        1.768   0.204   1.399   1.624   1.752   1.895   2.210
## b[5,3]        1.417   0.153   1.137   1.314   1.412   1.509   1.746
## b[6,3]        1.708   0.172   1.394   1.590   1.702   1.817   2.073
## b[7,3]        1.953   0.235   1.531   1.793   1.936   2.100   2.457
## b[8,3]        2.003   0.208   1.629   1.862   1.992   2.129   2.470
## b[9,3]        1.576   0.195   1.225   1.442   1.563   1.698   1.995
## b[10,3]       2.052   0.283   1.560   1.849   2.029   2.225   2.687
## b[1,4]        2.578   0.343   2.002   2.333   2.550   2.787   3.333
## b[2,4]        2.227   0.271   1.768   2.038   2.203   2.397   2.825
## b[3,4]        2.532   0.327   1.965   2.306   2.504   2.729   3.232
## b[4,4]        2.097   0.243   1.670   1.927   2.078   2.248   2.622
## b[5,4]        2.035   0.222   1.637   1.885   2.024   2.174   2.511
## b[6,4]        2.343   0.251   1.898   2.170   2.328   2.500   2.881
## b[7,4]        2.606   0.327   2.045   2.378   2.581   2.800   3.306
## b[8,4]        2.650   0.301   2.119   2.432   2.631   2.843   3.297
## b[9,4]        2.266   0.278   1.783   2.071   2.249   2.434   2.882
## b[10,4]       2.166   0.298   1.644   1.955   2.141   2.353   2.846
## theta[1]      0.235   0.236  -0.235   0.083   0.237   0.388   0.697
## theta[2]      1.418   0.245   0.945   1.249   1.413   1.581   1.903
## theta[3]      1.557   0.244   1.085   1.392   1.558   1.719   2.042
## theta[4]     -1.089   0.449  -2.085  -1.367  -1.051  -0.768  -0.325
## theta[5]      0.352   0.224  -0.090   0.204   0.350   0.499   0.788
## theta[6]     -1.463   0.590  -2.808  -1.818  -1.403  -1.040  -0.487
## theta[7]     -0.054   0.245  -0.560  -0.213  -0.050   0.107   0.419
## theta[8]      0.253   0.229  -0.197   0.100   0.253   0.406   0.711
```

```
## theta[9]     -0.626  0.336  -1.357  -0.836  -0.601  -0.394  -0.034
## theta[10]     0.355  0.224  -0.089   0.204   0.355   0.507   0.792
## theta[11]    -1.446  0.563  -2.696  -1.793  -1.389  -1.038  -0.494
## theta[12]     0.503  0.226   0.055   0.350   0.505   0.653   0.939
## theta[13]    -0.547  0.315  -1.208  -0.745  -0.530  -0.329   0.026
## theta[14]    -1.446  0.574  -2.719  -1.797  -1.384  -1.040  -0.485
## theta[15]    -0.727  0.347  -1.461  -0.946  -0.709  -0.482  -0.112
## theta[16]     0.220  0.235  -0.242   0.064   0.222   0.376   0.688
## theta[17]     0.218  0.234  -0.251   0.065   0.224   0.373   0.673
## theta[18]    -0.387  0.274  -0.948  -0.564  -0.378  -0.197   0.115
## theta[19]     1.646  0.258   1.159   1.473   1.638   1.814   2.169
## theta[20]    -1.100  0.464  -2.103  -1.389  -1.066  -0.763  -0.301
## theta[21]     0.089  0.235  -0.378  -0.063   0.088   0.247   0.549
## theta[22]    -1.464  0.584  -2.738  -1.816  -1.404  -1.053  -0.491
## theta[23]    -1.464  0.574  -2.722  -1.821  -1.415  -1.049  -0.486
## theta[24]    -1.442  0.558  -2.672  -1.794  -1.387  -1.038  -0.511
## theta[25]     0.660  0.236   0.215   0.498   0.657   0.821   1.126
## theta[26]     0.822  0.229   0.387   0.666   0.819   0.974   1.272
## theta[27]     0.139  0.243  -0.365  -0.016   0.141   0.301   0.604
## theta[28]     1.201  0.242   0.744   1.037   1.196   1.363   1.689
## theta[29]     0.950  0.237   0.492   0.787   0.949   1.110   1.422
## theta[30]     1.480  0.255   0.993   1.306   1.475   1.648   1.987
## theta[31]     0.669  0.230   0.215   0.517   0.667   0.818   1.134
## theta[32]    -0.144  0.259  -0.662  -0.315  -0.140   0.028   0.355
## theta[33]     0.507  0.227   0.071   0.356   0.507   0.655   0.958
## theta[34]    -1.470  0.577  -2.756  -1.824  -1.414  -1.050  -0.514
## theta[35]    -0.386  0.282  -0.974  -0.569  -0.375  -0.187   0.133
## theta[36]    -0.633  0.331  -1.342  -0.836  -0.613  -0.402  -0.045
## theta[37]    -1.468  0.596  -2.811  -1.824  -1.401  -1.037  -0.492
## theta[38]     0.103  0.232  -0.368  -0.043   0.109   0.258   0.542
## theta[39]    -1.457  0.575  -2.718  -1.817  -1.402  -1.035  -0.499
## theta[40]     0.355  0.228  -0.083   0.202   0.355   0.507   0.807
## theta[41]    -1.468  0.596  -2.784  -1.833  -1.403  -1.042  -0.477
## theta[42]     0.153  0.240  -0.333  -0.003   0.157   0.316   0.620
## theta[43]    -0.354  0.267  -0.890  -0.533  -0.348  -0.173   0.164
## theta[44]     0.227  0.231  -0.231   0.070   0.228   0.379   0.684
## theta[45]     0.528  0.230   0.089   0.372   0.529   0.686   0.976
## theta[46]     0.490  0.226   0.051   0.337   0.490   0.639   0.938
## theta[47]     0.628  0.228   0.187   0.476   0.626   0.781   1.075
## theta[48]    -0.818  0.381  -1.622  -1.056  -0.793  -0.553  -0.154
## theta[49]    -1.453  0.572  -2.729  -1.813  -1.401  -1.040  -0.506
## theta[50]     0.355  0.238  -0.110   0.194   0.356   0.514   0.825
## theta[51]    -1.470  0.575  -2.743  -1.822  -1.421  -1.058  -0.501
## theta[52]     0.547  0.226   0.104   0.396   0.547   0.696   0.998
## theta[53]    -1.452  0.567  -2.703  -1.805  -1.406  -1.040  -0.499
## theta[54]     1.204  0.243   0.730   1.038   1.202   1.366   1.692
## theta[55]    -1.460  0.579  -2.719  -1.831  -1.408  -1.042  -0.495
## theta[56]    -1.452  0.576  -2.723  -1.808  -1.390  -1.035  -0.525
## theta[57]    -0.521  0.293  -1.139  -0.705  -0.508  -0.319   0.017
## theta[58]    -1.460  0.580  -2.775  -1.799  -1.399  -1.052  -0.498
## theta[59]     0.176  0.237  -0.290   0.017   0.175   0.335   0.636
## theta[60]    -0.351  0.269  -0.897  -0.525  -0.346  -0.167   0.165
## theta[61]     1.286  0.245   0.807   1.118   1.282   1.451   1.775
## theta[62]     0.559  0.221   0.130   0.410   0.559   0.709   0.994
```

```
## theta[63]    -1.448   0.567   -2.657   -1.804   -1.389   -1.046   -0.494
## theta[64]     1.304   0.247    0.826    1.138    1.301    1.470    1.802
## theta[65]     1.205   0.239    0.747    1.044    1.199    1.366    1.694
## theta[66]    -0.546   0.313   -1.212   -0.745   -0.528   -0.332    0.028
## theta[67]     0.672   0.235    0.212    0.513    0.669    0.824    1.145
## theta[68]     0.904   0.238    0.444    0.745    0.900    1.060    1.382
## theta[69]    -0.250   0.265   -0.795   -0.422   -0.240   -0.071    0.254
## theta[70]     0.968   0.239    0.519    0.801    0.963    1.127    1.447
## theta[71]     0.330   0.226   -0.108    0.178    0.327    0.478    0.779
## theta[72]     1.011   0.233    0.563    0.850    1.011    1.167    1.458
## theta[73]     0.253   0.227   -0.200    0.103    0.256    0.404    0.697
## theta[74]    -1.457   0.580   -2.740   -1.817   -1.395   -1.038   -0.481
## theta[75]    -1.451   0.569   -2.693   -1.803   -1.397   -1.037   -0.490
## theta[76]     2.882   0.355    2.237    2.635    2.862    3.101    3.630
## theta[77]    -0.629   0.329   -1.330   -0.836   -0.606   -0.406   -0.041
## theta[78]     1.156   0.240    0.708    0.989    1.153    1.318    1.640
## theta[79]     1.642   0.256    1.160    1.466    1.634    1.812    2.161
## theta[80]     0.676   0.240    0.203    0.515    0.680    0.830    1.152
## theta[81]     0.299   0.226   -0.142    0.147    0.296    0.452    0.744
## theta[82]     0.239   0.234   -0.218    0.081    0.238    0.398    0.694
## theta[83]    -1.474   0.588   -2.794   -1.829   -1.408   -1.056   -0.489
## theta[84]     1.448   0.246    0.988    1.281    1.436    1.610    1.963
## theta[85]     0.411   0.230   -0.033    0.258    0.407    0.565    0.864
## theta[86]    -1.464   0.578   -2.744   -1.824   -1.400   -1.042   -0.505
## theta[87]     0.412   0.226   -0.032    0.260    0.409    0.566    0.858
## theta[88]     0.005   0.240   -0.462   -0.157    0.010    0.168    0.466
## theta[89]    -1.464   0.577   -2.754   -1.824   -1.402   -1.048   -0.526
## theta[90]     0.917   0.233    0.481    0.757    0.915    1.068    1.379
## theta[91]    -0.732   0.352   -1.477   -0.955   -0.710   -0.492   -0.092
## theta[92]     1.023   0.242    0.558    0.860    1.021    1.182    1.503
## theta[93]     0.238   0.235   -0.219    0.085    0.240    0.396    0.693
## theta[94]     2.217   0.272    1.725    2.029    2.208    2.392    2.786
## theta[95]     1.482   0.246    1.006    1.315    1.483    1.644    1.963
## theta[96]     0.552   0.227    0.119    0.399    0.546    0.705    1.008
## theta[97]     0.484   0.225    0.041    0.334    0.485    0.635    0.922
## theta[98]    -1.455   0.576   -2.742   -1.811   -1.398   -1.044   -0.491
## theta[99]     1.203   0.244    0.740    1.037    1.194    1.360    1.710
## theta[100]   -1.102   0.453   -2.094   -1.387   -1.065   -0.778   -0.320
## theta[101]   -0.441   0.294   -1.046   -0.631   -0.428   -0.242    0.101
## theta[102]    2.388   0.292    1.845    2.184    2.378    2.586    2.964
## theta[103]   -0.380   0.279   -0.948   -0.560   -0.372   -0.188    0.144
## theta[104]    0.855   0.228    0.419    0.697    0.851    1.010    1.307
## theta[105]    0.160   0.240   -0.320   -0.003    0.161    0.325    0.626
## theta[106]    1.099   0.244    0.630    0.934    1.096    1.262    1.591
## theta[107]    1.444   0.250    0.965    1.275    1.440    1.603    1.950
## theta[108]    0.906   0.231    0.460    0.748    0.905    1.063    1.370
## theta[109]    1.046   0.240    0.588    0.884    1.041    1.201    1.527
## theta[110]    0.354   0.221   -0.075    0.208    0.355    0.502    0.792
## theta[111]    0.407   0.224   -0.030    0.254    0.405    0.559    0.849
## theta[112]   -0.396   0.289   -1.002   -0.579   -0.382   -0.201    0.140
## theta[113]    0.584   0.227    0.144    0.431    0.582    0.736    1.029
## theta[114]    0.004   0.239   -0.462   -0.157    0.005    0.165    0.471
## theta[115]    0.852   0.236    0.389    0.693    0.847    1.008    1.325
## theta[116]    0.146   0.231   -0.310   -0.006    0.151    0.301    0.598
```

```
## theta[117]    0.326   0.221   -0.113    0.179    0.324    0.471    0.769
## theta[118]    0.552   0.230    0.110    0.397    0.551    0.706    1.006
## theta[119]   -0.820   0.378   -1.641   -1.055   -0.783   -0.551   -0.169
## theta[120]   -1.456   0.572   -2.690   -1.814   -1.408   -1.043   -0.494
## theta[121]    0.443   0.241   -0.027    0.287    0.443    0.598    0.930
## theta[122]   -0.405   0.291   -1.014   -0.586   -0.390   -0.203    0.121
## theta[123]    1.198   0.238    0.740    1.039    1.191    1.354    1.677
## theta[124]    1.060   0.239    0.591    0.898    1.061    1.218    1.542
## theta[125]   -1.470   0.592   -2.793   -1.830   -1.407   -1.042   -0.488
## theta[126]   -0.407   0.286   -1.013   -0.591   -0.394   -0.211    0.116
## theta[127]    1.101   0.252    0.613    0.932    1.096    1.264    1.610
## theta[128]   -0.732   0.347   -1.473   -0.956   -0.709   -0.490   -0.112
## theta[129]   -0.378   0.276   -0.935   -0.559   -0.372   -0.188    0.140
## theta[130]    1.654   0.242    1.201    1.489    1.648    1.817    2.142
## theta[131]   -0.051   0.243   -0.534   -0.210   -0.051    0.112    0.415
## theta[132]    1.480   0.250    1.015    1.306    1.476    1.645    1.984
## theta[133]   -1.465   0.582   -2.755   -1.817   -1.401   -1.049   -0.500
## theta[134]    2.209   0.274    1.699    2.025    2.197    2.389    2.780
## theta[135]   -0.628   0.327   -1.332   -0.830   -0.605   -0.399   -0.047
## theta[136]   -1.460   0.598   -2.825   -1.826   -1.392   -1.020   -0.499
## theta[137]    0.857   0.235    0.397    0.700    0.856    1.014    1.321
## theta[138]   -0.626   0.324   -1.322   -0.830   -0.603   -0.400   -0.051
## theta[139]    0.320   0.231   -0.138    0.167    0.321    0.474    0.778
## theta[140]    0.248   0.228   -0.197    0.094    0.254    0.402    0.693
## theta[141]   -0.734   0.351   -1.482   -0.955   -0.712   -0.487   -0.112
## theta[142]   -1.449   0.573   -2.706   -1.805   -1.395   -1.030   -0.504
## theta[143]   -1.468   0.586   -2.785   -1.818   -1.401   -1.052   -0.501
## theta[144]    0.907   0.233    0.448    0.748    0.905    1.062    1.365
## theta[145]   -1.451   0.577   -2.730   -1.805   -1.395   -1.029   -0.485
## theta[146]    0.678   0.240    0.215    0.515    0.675    0.834    1.148
## theta[147]    0.903   0.236    0.454    0.743    0.899    1.055    1.382
## theta[148]    0.352   0.238   -0.116    0.192    0.352    0.514    0.812
## theta[149]   -1.455   0.566   -2.744   -1.792   -1.388   -1.051   -0.522
## theta[150]   -1.450   0.577   -2.709   -1.808   -1.393   -1.040   -0.475
## theta[151]   -0.409   0.282   -1.011   -0.590   -0.396   -0.215    0.117
## theta[152]   -1.463   0.574   -2.713   -1.823   -1.399   -1.050   -0.521
## theta[153]    1.424   0.249    0.947    1.258    1.419    1.585    1.921
## theta[154]   -1.107   0.460   -2.101   -1.396   -1.061   -0.779   -0.329
## theta[155]   -1.448   0.568   -2.712   -1.799   -1.388   -1.032   -0.495
## theta[156]   -0.814   0.373   -1.629   -1.045   -0.791   -0.556   -0.146
## theta[157]   -0.816   0.376   -1.631   -1.044   -0.792   -0.552   -0.148
## theta[158]    0.252   0.225   -0.201    0.106    0.255    0.402    0.688
## theta[159]    0.719   0.231    0.272    0.562    0.717    0.871    1.181
## theta[160]   -1.462   0.592   -2.795   -1.822   -1.399   -1.041   -0.462
## theta[161]    1.276   0.235    0.821    1.115    1.275    1.433    1.748
## theta[162]    0.411   0.227   -0.034    0.262    0.408    0.562    0.856
## theta[163]   -1.452   0.570   -2.712   -1.795   -1.388   -1.042   -0.522
## theta[164]   -0.293   0.277   -0.851   -0.475   -0.283   -0.108    0.235
## theta[165]    0.358   0.232   -0.101    0.201    0.358    0.515    0.812
## theta[166]   -1.459   0.573   -2.733   -1.813   -1.402   -1.050   -0.505
## theta[167]    0.506   0.227    0.056    0.356    0.505    0.654    0.947
## theta[168]    1.302   0.248    0.833    1.134    1.297    1.468    1.806
## theta[169]   -0.036   0.255   -0.551   -0.206   -0.031    0.142    0.445
## theta[170]    0.405   0.225   -0.037    0.254    0.408    0.555    0.847
```

```
## theta[171]   -0.607   0.332   -1.326   -0.813   -0.583   -0.377   -0.011
## theta[172]    0.448   0.226    0.001    0.298    0.447    0.600    0.893
## theta[173]    0.686   0.241    0.219    0.522    0.680    0.846    1.165
## theta[174]   -0.446   0.298   -1.078   -0.635   -0.429   -0.237    0.096
## theta[175]   -0.379   0.275   -0.952   -0.555   -0.368   -0.187    0.129
## theta[176]   -0.622   0.329   -1.310   -0.829   -0.606   -0.398   -0.017
## theta[177]   -0.091   0.241   -0.583   -0.250   -0.085    0.073    0.370
## deviance   2836.278  22.703 2793.943 2820.668 2835.497 2850.868 2883.072
##             Rhat n.eff
## a[1]       1.015   170
## a[2]       1.011   240
## a[3]       1.014   190
## a[4]       1.008   330
## a[5]       1.020   140
## a[6]       1.006   490
## a[7]       1.010   290
## a[8]       1.007   430
## a[9]       1.011   250
## a[10]      1.012   230
## b[1,1]     1.002  1600
## b[2,1]     1.021   120
## b[3,1]     1.022   120
## b[4,1]     1.019   140
## b[5,1]     1.026   100
## b[6,1]     1.031    89
## b[7,1]     1.040    71
## b[8,1]     1.032    87
## b[9,1]     1.033    83
## b[10,1]    1.045    66
## b[1,2]     1.025   100
## b[2,2]     1.057    55
## b[3,2]     1.048    64
## b[4,2]     1.047    63
## b[5,2]     1.057    51
## b[6,2]     1.061    49
## b[7,2]     1.046    61
## b[8,2]     1.066    48
## b[9,2]     1.053    57
## b[10,2]    1.042    70
## b[1,3]     1.040    69
## b[2,3]     1.048    62
## b[3,3]     1.044    65
## b[4,3]     1.038    73
## b[5,3]     1.080    38
## b[6,3]     1.049    59
## b[7,3]     1.036    77
## b[8,3]     1.043    63
## b[9,3]     1.041    71
## b[10,3]    1.036    81
## b[1,4]     1.028    95
## b[2,4]     1.035    78
## b[3,4]     1.038    73
## b[4,4]     1.030    90
## b[5,4]     1.056    52
```

```
## b[6,4]      1.028   100
## b[7,4]      1.023   110
## b[8,4]      1.025   110
## b[9,4]      1.023   110
## b[10,4]     1.035    83
## theta[1]    1.011   250
## theta[2]    1.021   130
## theta[3]    1.022   120
## theta[4]    1.001  6900
## theta[5]    1.012   220
## theta[6]    1.002  2000
## theta[7]    1.002  1500
## theta[8]    1.009   300
## theta[9]    1.001  3500
## theta[10]   1.010   280
## theta[11]   1.001  8000
## theta[12]   1.008   340
## theta[13]   1.002  1800
## theta[14]   1.001  7200
## theta[15]   1.005   650
## theta[16]   1.009   310
## theta[17]   1.011   260
## theta[18]   1.004   880
## theta[19]   1.032    87
## theta[20]   1.002  2000
## theta[21]   1.009   310
## theta[22]   1.001  3800
## theta[23]   1.005   650
## theta[24]   1.002  1800
## theta[25]   1.009   300
## theta[26]   1.008   380
## theta[27]   1.008   360
## theta[28]   1.023   120
## theta[29]   1.017   160
## theta[30]   1.014   190
## theta[31]   1.012   230
## theta[32]   1.004   700
## theta[33]   1.011   260
## theta[34]   1.002  1500
## theta[35]   1.002  1700
## theta[36]   1.002  2900
## theta[37]   1.001  3400
## theta[38]   1.004   690
## theta[39]   1.001  3500
## theta[40]   1.009   310
## theta[41]   1.002  2300
## theta[42]   1.011   240
## theta[43]   1.006   490
## theta[44]   1.005   570
## theta[45]   1.008   330
## theta[46]   1.009   320
## theta[47]   1.012   220
## theta[48]   1.002  2500
## theta[49]   1.001  8000
```

```
## theta[50]  1.012   230
## theta[51]  1.001  8000
## theta[52]  1.018   150
## theta[53]  1.002  1500
## theta[54]  1.015   180
## theta[55]  1.001  7200
## theta[56]  1.001  4500
## theta[57]  1.006   500
## theta[58]  1.001  3900
## theta[59]  1.011   250
## theta[60]  1.005   580
## theta[61]  1.013   210
## theta[62]  1.014   190
## theta[63]  1.002  2500
## theta[64]  1.019   140
## theta[65]  1.017   150
## theta[66]  1.002  1700
## theta[67]  1.013   210
## theta[68]  1.011   260
## theta[69]  1.002  1400
## theta[70]  1.014   190
## theta[71]  1.008   340
## theta[72]  1.014   190
## theta[73]  1.007   400
## theta[74]  1.001  5400
## theta[75]  1.001  8000
## theta[76]  1.018   150
## theta[77]  1.001  3800
## theta[78]  1.016   170
## theta[79]  1.021   130
## theta[80]  1.013   200
## theta[81]  1.009   320
## theta[82]  1.012   230
## theta[83]  1.002  2100
## theta[84]  1.018   150
## theta[85]  1.009   300
## theta[86]  1.001  3800
## theta[87]  1.013   210
## theta[88]  1.006   510
## theta[89]  1.002  2400
## theta[90]  1.010   320
## theta[91]  1.002  3100
## theta[92]  1.018   150
## theta[93]  1.008   340
## theta[94]  1.024   110
## theta[95]  1.020   140
## theta[96]  1.014   190
## theta[97]  1.010   270
## theta[98]  1.001  3500
## theta[99]  1.016   170
## theta[100] 1.002  2000
## theta[101] 1.001  3500
## theta[102] 1.015   180
## theta[103] 1.003   950
```

```
## theta[104] 1.016   180
## theta[105] 1.010   270
## theta[106] 1.015   170
## theta[107] 1.026   100
## theta[108] 1.015   180
## theta[109] 1.019   170
## theta[110] 1.006   510
## theta[111] 1.011   250
## theta[112] 1.002  2000
## theta[113] 1.013   210
## theta[114] 1.007   410
## theta[115] 1.014   190
## theta[116] 1.007   420
## theta[117] 1.010   270
## theta[118] 1.011   250
## theta[119] 1.002  1700
## theta[120] 1.001  5100
## theta[121] 1.007   380
## theta[122] 1.003  1300
## theta[123] 1.017   160
## theta[124] 1.013   210
## theta[125] 1.003  1200
## theta[126] 1.001  8000
## theta[127] 1.017   170
## theta[128] 1.002  3100
## theta[129] 1.002  2400
## theta[130] 1.020   130
## theta[131] 1.005   550
## theta[132] 1.016   170
## theta[133] 1.001  5800
## theta[134] 1.025   110
## theta[135] 1.001  5800
## theta[136] 1.001  8000
## theta[137] 1.014   190
## theta[138] 1.002  2000
## theta[139] 1.012   230
## theta[140] 1.016   170
## theta[141] 1.001  8000
## theta[142] 1.001  8000
## theta[143] 1.002  2400
## theta[144] 1.012   220
## theta[145] 1.003  1300
## theta[146] 1.008   350
## theta[147] 1.014   200
## theta[148] 1.012   220
## theta[149] 1.004   810
## theta[150] 1.002  1700
## theta[151] 1.002  2300
## theta[152] 1.002  1700
## theta[153] 1.020   130
## theta[154] 1.002  3300
## theta[155] 1.001  8000
## theta[156] 1.002  1900
## theta[157] 1.001  7000
```

```
## theta[158] 1.012   220
## theta[159] 1.014   190
## theta[160] 1.002  2800
## theta[161] 1.017   160
## theta[162] 1.010   270
## theta[163] 1.001  4400
## theta[164] 1.004   680
## theta[165] 1.013   200
## theta[166] 1.001  8000
## theta[167] 1.011   250
## theta[168] 1.021   130
## theta[169] 1.009   300
## theta[170] 1.013   210
## theta[171] 1.002  1600
## theta[172] 1.010   260
## theta[173] 1.013   210
## theta[174] 1.002  1500
## theta[175] 1.003  1300
## theta[176] 1.002  1500
## theta[177] 1.006   470
## deviance   1.003  1300
##
## For each parameter, n.eff is a crude measure of effective sample size,
## and Rhat is the potential scale reduction factor (at convergence, Rhat=1).
##
## DIC info (using the rule, pD = var(deviance)/2)
## pD = 257.2 and DIC = 3093.5
## DIC is an estimate of expected predictive error (lower deviance is better).
```

Now, let's look at model fit. We will have to use a slightly different version of the syntax from before:

```
# list number of simulated data sets
nSimulatedDataSets = 5000

# create one large matrix of posterior values
model01.Posterior.all = model01.r2jags$BUGSoutput$sims.matrix
dim(model01.Posterior.all)
```

```
## [1] 8000  228
```

```
# determine columns of posterior that go into each model matrix
# colnames(model01.Posterior.all)
aCols = 1:10
bCols = grep(x = colnames(model01.Posterior.all), pattern = "b")

# save simulated correlations:
simCorModel01 = matrix(data = NA, nrow = nSimulatedDataSets, ncol = nItems*(nItems-1)/2)

# loop through data sets (can be sped up with functions and lapply)
pb = txtProgressBar()
sim = 1
for (sim in 1:nSimulatedDataSets){

  # draw sample from one iteration of posterior chain
  iternum = sample(x = 1:nrow(model01.Posterior.all), size = 1, replace = TRUE)
```

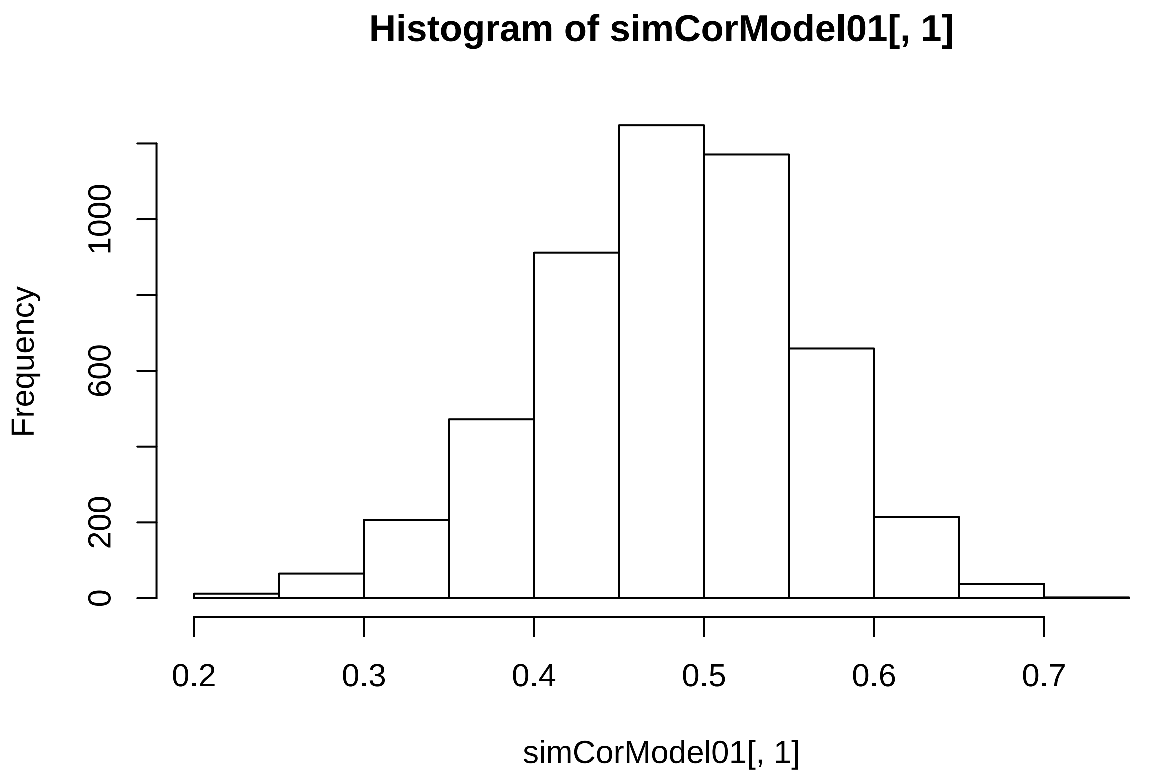
```r
  # get parameters for that sample: put into factor model matrices for easier generation of data
  a = matrix(data = model01.Posterior.all[iternum, aCols], ncol = 1)
  b = matrix(data = model01.Posterior.all[iternum, bCols], ncol = 4)

  # generate sample of thetas from theta distribution
  theta = matrix(data = rnorm(n = nrow(conspiracy), mean = 0, sd = 1), nrow = nrow(conspiracy), ncol =

  # calculate cumulative probits:
  CProb = array(data = 1, dim = c(nrow(conspiracy), 10, 5))
  Prob = array(data = 0, dim = c(nrow(conspiracy), 10, 5))

  item=1
  for (item in 1:10){
    for (cat in 2:5){
      CProb[,item, cat] = matrix(pnorm(a[item]*(theta-b[item,cat-1])))
    }
  }


  # calculate probits
  cat = 1
  for (cat in 1:4){
    Prob[,,cat] = CProb[,,cat] - CProb[,,cat+1]
  }
  Prob[,,5] = CProb[,,5]
  CProb[1,1,1:5]

  simData = matrix(data = NA, nrow = nrow(conspiracy), ncol = 10)
  item = 1
  for (item in 1:10){
    for (person in 1:nrow(conspiracy)){
      simData[person, item] = sample(x = 1:5, size = 1, prob = Prob[person, item, 1:5])
    }
  }

  # calculate the value of SRMR using simulated data's covariance matrix and observed covariance matrix
  simCorModel01[sim,] = matrix(data = c(cor(simData)[upper.tri(cor(simData))]), nrow = 1)

  setTxtProgressBar(pb = pb, value = sim/nSimulatedDataSets)
}
```

```
## ===========================================================================
```

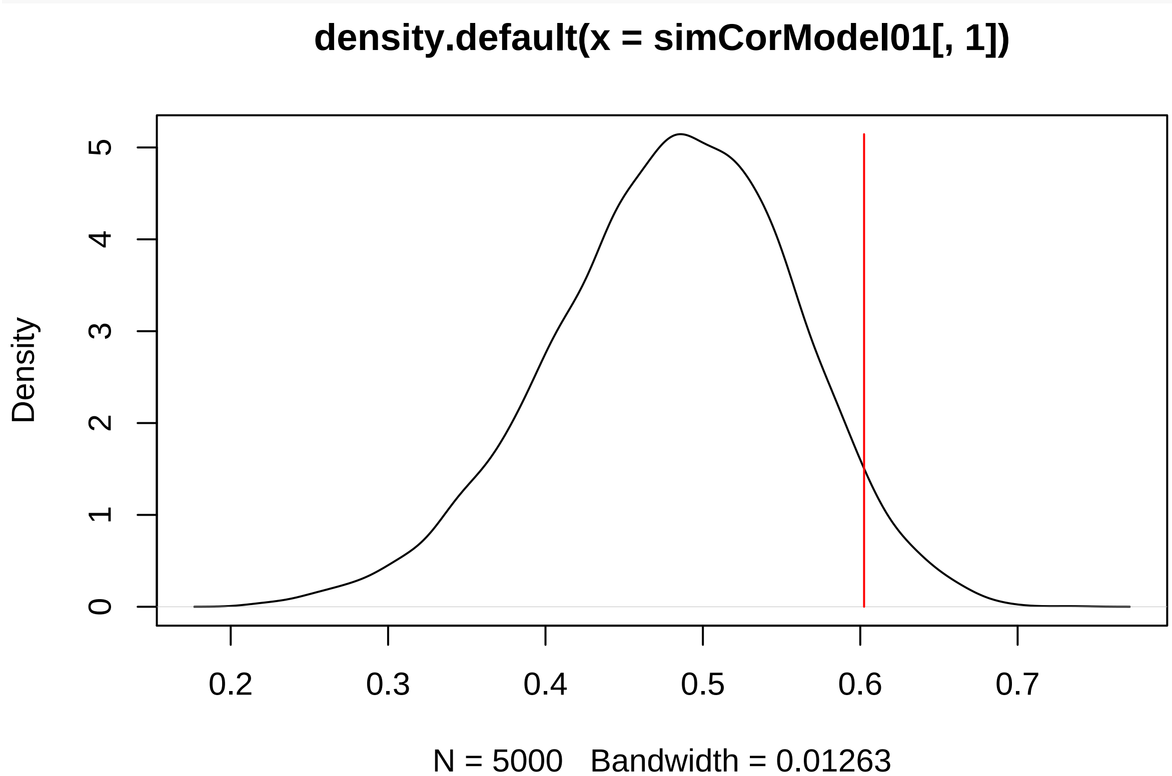
```r
close(pb)
```

```r
# label values of simCor to ensure we have the right comparison
corNames = NULL
for (i in 1:(ncol(simData)-1)){
  for (j in (i+1):ncol(simData)){
    corNames = c(corNames, paste0("cor", i, "." , j))
  }
}
colnames(simCorModel01) = corNames

# show how one correlation compares to distribution of simulated correlations
```

```r
dataCor = cor(conspiracy[paste0("PolConsp", 1:10)])
hist(simCorModel01[,1])
```




```r
plot(density(simCorModel01[,1]))
lines(x = c(dataCor[1,2], dataCor[1,2]), y = c(0, max(density(simCorModel01[,1])$y)), col = 2)
```



```r
quantile(simCorModel01[,1])
```

```
##        0%       25%       50%       75%      100%
## 0.2147166 0.4312211 0.4839567 0.5345384 0.7333613
```

```r
mean(simCorModel01[,1])
```

```
## [1] 0.4801843
```

```r
dataCor[1,2]
```

```
## [1] 0.6024186
```

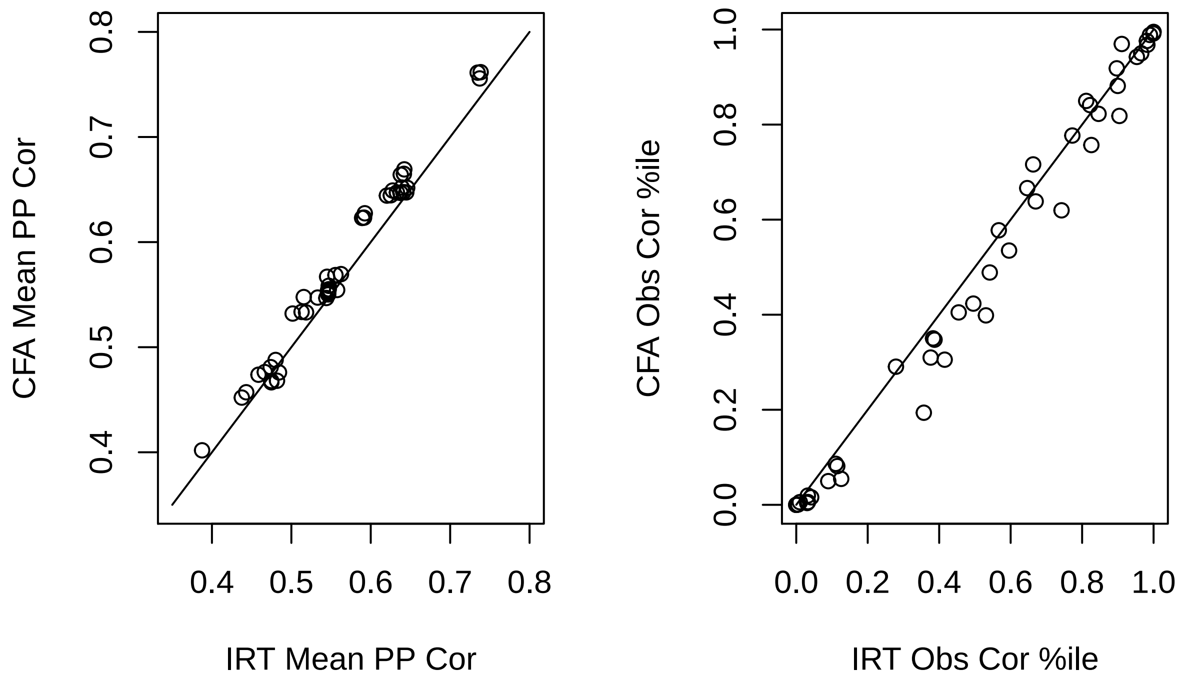
```r
# create quantiles of correlations to see where each observed correlation falls
corQuantiles01 = NULL

# compute the quantiles of the observed correlations:
col = 1
for (i in 1:(ncol(simData)-1)){
  for (j in (i+1):ncol(simData)){
    # get empirical CDF of simulated correlation distribution
    corEcdf = ecdf(simCorModel01[,col])
    corQuantiles01 = rbind(corQuantiles01, c(i, j, summary(corEcdf), dataCor[i,j], corEcdf(dataCor[i,j]

    col = col + 1
  }
}
colnames(corQuantiles01)[1:2] = c("Item 1", "Item 2")
colnames(corQuantiles01)[9:10] = c("ObsCor", "CorPctile")
corQuantiles01[which(corQuantiles01[,10] > .975 | corQuantiles01[,10] < .025),]
```

```
##       Item 1 Item 2       Min.   1st Qu.    Median      Mean   3rd Qu.
##  [1,]      1      9 0.34401536 0.5992937 0.6462750 0.6422553 0.6910058
##  [2,]      1     10 0.26057285 0.5462726 0.5979875 0.5925123 0.6455279
##  [3,]      2      7 0.32339456 0.6029418 0.6482925 0.6447489 0.6904856
##  [4,]      3      9 0.34054250 0.5957699 0.6413118 0.6377681 0.6840831
##  [5,]      4      7 0.51805914 0.7057271 0.7399064 0.7371902 0.7733680
##  [6,]      4      9 0.13969998 0.4064567 0.4622122 0.4585950 0.5138863
##  [7,]      5      6 0.16717379 0.4474257 0.5059778 0.5016398 0.5596069
##  [8,]      5      8 0.29885990 0.5813994 0.6310968 0.6275652 0.6792783
##  [9,]      6      8 0.06179991 0.3337139 0.3906750 0.3875696 0.4433237
## [10,]      7      8 0.11536725 0.4185912 0.4783598 0.4746910 0.5365093
##            Max.    ObsCor CorPctile
##  [1,] 0.8527140 0.4420860    0.0052
##  [2,] 0.8167962 0.2568334    0.0000
##  [3,] 0.8131779 0.4721628    0.0100
##  [4,] 0.8229751 0.3912734    0.0008
##  [5,] 0.9036194 0.4676834    0.0000
##  [6,] 0.7046256 0.6108052    0.9826
##  [7,] 0.7596247 0.7366890    0.9992
##  [8,] 0.8461370 0.7641703    0.9812
##  [9,] 0.6340107 0.7557355    1.0000
## [10,] 0.7464009 0.6611475    0.9898
```

Comparing Model 0 (CFA) with Model 1 (IRT)

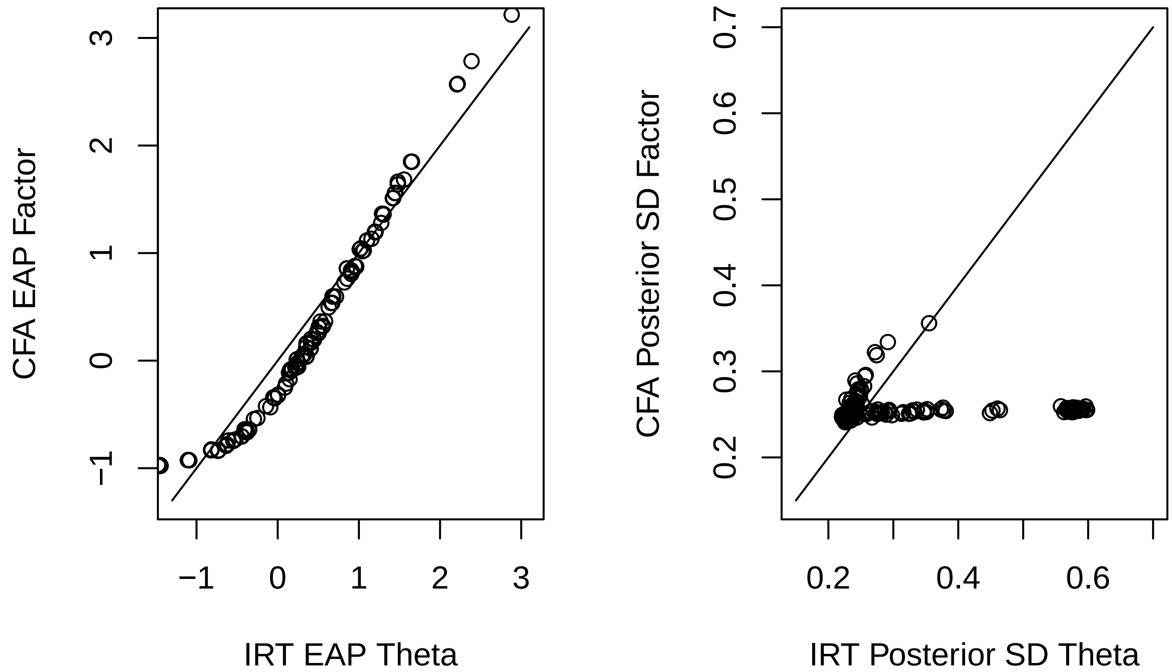
We can look at our results to see if there is a big difference in model fit or values of parameters:

```
par(mfrow = c(1,2))
# comparing results for model fit:
plot(x=corQuantiles01[,6], y=corQuantiles00[,6], xlab = "IRT Mean PP Cor", ylab = "CFA Mean PP Cor", yl
lines(c(.35,.8), c(.35,.8))
plot(x=corQuantiles01[,10], y=corQuantiles00[,10], xlab = "IRT Obs Cor %ile", ylab = "CFA Obs Cor %ile"
lines(c(0,1), c(0,1))
```

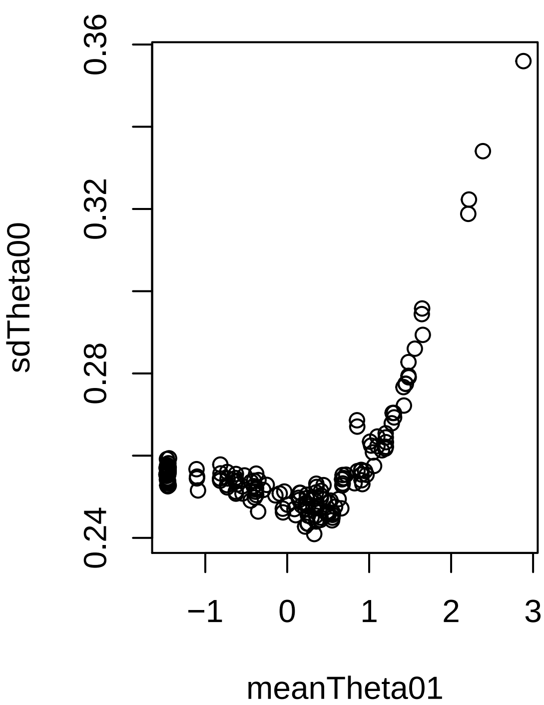


Now, let's look at how the latent trait estimates compared:

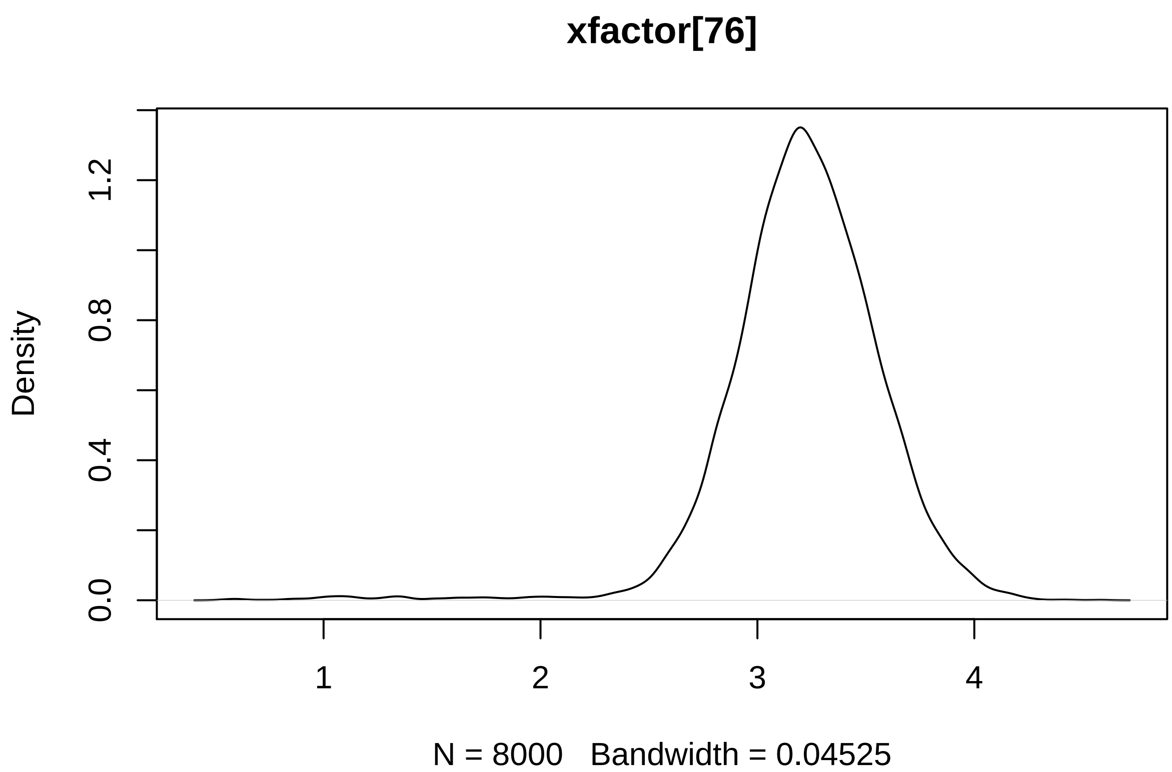
```
ThetaCols00 = grep(x = colnames(model00.Posterior.all), pattern = "xfactor")
meanTheta00 = apply(X = model00.Posterior.all[,ThetaCols00], MARGIN = 2, FUN = mean)
sdTheta00 = apply(X = model00.Posterior.all[,ThetaCols00], MARGIN = 2, FUN = sd)

ThetaCols01 = grep(x = colnames(model01.Posterior.all), pattern = "theta")
meanTheta01 = apply(X = model01.Posterior.all[,ThetaCols01], MARGIN = 2, FUN = mean)
sdTheta01 = apply(X = model01.Posterior.all[,ThetaCols01], MARGIN = 2, FUN = sd)

par(mfrow = c(1,2))
# comparing results for model fit:
plot(x=meanTheta01, y=meanTheta00, xlab = "IRT EAP Theta", ylab = "CFA EAP Factor", ylim = c(-1.3, 3.1)
lines(c(-1.3, 3.1),c(-1.3, 3.1))
plot(x=sdTheta01, y=sdTheta00, xlab = "IRT Posterior SD Theta", ylab = "CFA Posterior SD Factor", ylim
lines(c(.15, .7),c(.15, .7))
```




```r
plot(x=meanTheta01, y=sdTheta00)

par(mfrow = c(1,1))
```




```r
plot(density(model00.Posterior.all[, which(colnames(model00.Posterior.all) ==names(which.max(sdTheta00))
```




```
conspiracy[76,]
```

```
##    PolConsp1 PolConsp2 PolConsp3 PolConsp4 PolConsp5 PolConsp6 PolConsp7
## 76         2         5         5         5         5         5         5
##    PolConsp8 PolConsp9 PolConsp10 female
## 76         5         5          5      0
```

Model 2: Unidimensional Generalized Partial Model

```
# marker item:
model02.function = function(){

  # measurement model specification
    for (person in 1:N){
      for (item in 1:I){

        for (cat in 1:C[I]){
          eta[person, item, cat] <- a[item] * (theta[person] - b[item, cat])
          psum[person, item, cat] <- sum(eta[person, item, 1:cat])
          exp.psum[person, item, cat] <- exp(psum[person, item, cat])
          prob[person, item, cat] <- exp.psum[person, item, cat]/sum(exp.psum[person, item, 1:C[item]])
        }

        X[person, item] ~ dcat(prob[person, item, 1:C[item]])
      }
    }

  # prior distributions for the factor:
```

```
    for (person in 1:N){
      theta[person] ~ dnorm(0, 1)
    }

  # prior distributions for the measurement model mean/precision parameters
    for (item in 1:I){

      b[item, 1] <- 0

      # create parameters that are unbounded, then sort
      for (cat in 2:C[item]){
        b[item, cat] ~ dnorm(b.mean.0, b.precision.0)
      }

      # loadings are set to be all positive
      a[item] ~ dnorm(a.mean.0, a.precision.0);T(0,)

    }

}
```

```
nItems = 10

# specification of prior values for measurement model parameters:
#   item intercepts
b.mean.0 = 0
b.variance.0 = 100
b.precision.0 = 1 / b.variance.0

#   Factor loadings -- these are the discriminations
a.mean.0 = 0
a.variance.0 = 100
a.precision.0 = 1 / a.variance.0

# next, create data for JAGS to use:
model02.data = list(
  N = nrow(conspiracy),
  X = conspiracy,
  C = unlist(apply(X = conspiracy[,1:10], MARGIN = 2, FUN = max)),
  I = 10,
  b.mean.0 = b.mean.0,
  b.precision.0 = b.precision.0,
  a.mean.0 = a.mean.0,
  a.precision.0 = a.precision.0
)

model02.init = function(){
  list("a" = runif(10, 1, 2),
       "b" = cbind(rep(NA, 10), rep(1, 10), rep(0, 10), rep(-1, 10), rep(-2, 10)))
}

model02.parameters = c("a", "b",  "theta")

model02.seed = 16042019 + 1
```

Here, we will use the R2jags `jags.parallel()` function, which will run somewhat faster (one chain per core):

```
model02.r2jags =  jags.parallel(
  data = model02.data,
  inits = model02.init,
  parameters.to.save = model02.parameters,
  model.file = model02.function,
  n.chains = 4,
  n.iter = 2000,
  n.thin = 1,
  n.burnin = 1000,
  jags.seed = model02.seed
)

model02.r2jags
```

```
## Inference for Bugs model at "model02.function", fit using jags,
##  4 chains, each with 2000 iterations (first 1000 discarded)
##  n.sims = 4000 iterations saved
##             mu.vect sd.vect   2.5%    25%    50%    75%  97.5%
## a[1]          0.996   0.174  0.671  0.873  0.991  1.113  1.347
## a[2]          1.608   0.273  1.110  1.419  1.591  1.778  2.193
## a[3]          1.228   0.203  0.871  1.084  1.213  1.355  1.657
## a[4]          1.639   0.275  1.160  1.441  1.622  1.817  2.219
## a[5]          3.048   0.565  2.128  2.651  2.991  3.382  4.281
## a[6]          3.414   0.629  2.332  2.966  3.370  3.806  4.761
## a[7]          1.641   0.298  1.115  1.433  1.621  1.828  2.277
## a[8]          3.502   0.702  2.281  3.027  3.431  3.929  5.034
## a[9]          1.463   0.288  0.955  1.256  1.449  1.646  2.068
## a[10]         1.153   0.252  0.692  0.982  1.140  1.314  1.708
## b[1,1]        0.000   0.000  0.000  0.000  0.000  0.000  0.000
## b[2,1]        0.000   0.000  0.000  0.000  0.000  0.000  0.000
## b[3,1]        0.000   0.000  0.000  0.000  0.000  0.000  0.000
## b[4,1]        0.000   0.000  0.000  0.000  0.000  0.000  0.000
## b[5,1]        0.000   0.000  0.000  0.000  0.000  0.000  0.000
## b[6,1]        0.000   0.000  0.000  0.000  0.000  0.000  0.000
## b[7,1]        0.000   0.000  0.000  0.000  0.000  0.000  0.000
## b[8,1]        0.000   0.000  0.000  0.000  0.000  0.000  0.000
## b[9,1]        0.000   0.000  0.000  0.000  0.000  0.000  0.000
## b[10,1]       0.000   0.000  0.000  0.000  0.000  0.000  0.000
## b[1,2]       -0.582   0.242 -1.033 -0.745 -0.589 -0.431 -0.074
## b[2,2]        0.117   0.164 -0.186  0.008  0.110  0.221  0.463
## b[3,2]        0.840   0.261  0.404  0.655  0.820  1.000  1.404
## b[4,2]        0.096   0.170 -0.219 -0.024  0.089  0.206  0.445
## b[5,2]       -0.045   0.119 -0.281 -0.125 -0.046  0.037  0.184
## b[6,2]        0.032   0.115 -0.202 -0.042  0.036  0.113  0.244
## b[7,2]        0.586   0.184  0.268  0.456  0.571  0.697  0.996
## b[8,2]        0.126   0.117 -0.109  0.050  0.128  0.202  0.354
## b[9,2]        0.630   0.205  0.279  0.486  0.613  0.753  1.094
## b[10,2]       1.726   0.415  1.091  1.443  1.665  1.933  2.729
## b[1,3]        0.239   0.239 -0.244  0.086  0.247  0.394  0.705
## b[2,3]        0.841   0.188  0.481  0.717  0.835  0.959  1.213
## b[3,3]        0.214   0.244 -0.290  0.064  0.231  0.376  0.664
## b[4,3]        0.496   0.172  0.148  0.387  0.500  0.613  0.826
## b[5,3]        0.751   0.129  0.508  0.665  0.750  0.839  1.010
```

```
## b[6,3]         0.717   0.118    0.482    0.640    0.717    0.795    0.951
## b[7,3]         0.946   0.192    0.551    0.824    0.944    1.076    1.328
## b[8,3]         0.665   0.114    0.443    0.587    0.667    0.739    0.884
## b[9,3]         1.118   0.240    0.683    0.952    1.109    1.273    1.621
## b[10,3]        1.265   0.345    0.625    1.030    1.258    1.485    1.993
## b[1,4]         1.461   0.321    0.893    1.243    1.434    1.642    2.168
## b[2,4]         1.644   0.285    1.133    1.448    1.624    1.820    2.265
## b[3,4]         2.641   0.471    1.854    2.310    2.604    2.923    3.676
## b[4,4]         2.250   0.373    1.630    1.990    2.211    2.473    3.089
## b[5,4]         1.373   0.176    1.054    1.251    1.363    1.484    1.747
## b[6,4]         1.683   0.193    1.340    1.554    1.671    1.802    2.093
## b[7,4]         2.004   0.346    1.427    1.764    1.976    2.197    2.789
## b[8,4]         2.033   0.262    1.605    1.850    2.007    2.186    2.617
## b[9,4]         1.301   0.307    0.715    1.102    1.291    1.490    1.908
## b[10,4]        3.861   1.451    1.895    2.834    3.558    4.577    7.773
## b[1,5]         2.379   0.531    1.453    2.011    2.324    2.699    3.589
## b[2,5]         1.711   0.370    1.024    1.466    1.700    1.948    2.487
## b[3,5]         1.372   0.536    0.318    1.018    1.366    1.719    2.449
## b[4,5]         1.193   0.395    0.359    0.957    1.201    1.445    1.970
## b[5,5]         1.799   0.246    1.338    1.636    1.787    1.950    2.311
## b[6,5]         2.086   0.307    1.548    1.869    2.067    2.275    2.729
## b[7,5]         1.921   0.471    1.031    1.603    1.904    2.220    2.917
## b[8,5]         2.175   0.372    1.487    1.928    2.152    2.409    2.977
## b[9,5]         1.816   0.395    1.071    1.565    1.802    2.054    2.660
## b[10,5]       -1.113   1.468   -5.011   -1.872   -0.841   -0.062    0.923
## theta[1]       0.283   0.228   -0.190    0.139    0.289    0.438    0.706
## theta[2]       1.344   0.222    0.923    1.193    1.341    1.489    1.785
## theta[3]       1.448   0.217    1.032    1.305    1.443    1.598    1.870
## theta[4]      -1.165   0.504   -2.237   -1.488   -1.114   -0.802   -0.329
## theta[5]       0.343   0.231   -0.125    0.190    0.351    0.498    0.786
## theta[6]      -1.456   0.599   -2.745   -1.829   -1.397   -1.029   -0.444
## theta[7]      -0.004   0.249   -0.520   -0.165    0.006    0.168    0.456
## theta[8]       0.275   0.229   -0.175    0.125    0.270    0.428    0.724
## theta[9]      -0.659   0.391   -1.459   -0.900   -0.624   -0.386    0.010
## theta[10]      0.332   0.218   -0.096    0.188    0.333    0.478    0.750
## theta[11]     -1.457   0.601   -2.794   -1.822   -1.400   -1.022   -0.446
## theta[12]      0.499   0.215    0.077    0.352    0.495    0.642    0.918
## theta[13]     -0.580   0.378   -1.400   -0.813   -0.547   -0.322    0.087
## theta[14]     -1.460   0.593   -2.774   -1.829   -1.414   -1.038   -0.457
## theta[15]     -0.807   0.420   -1.716   -1.071   -0.772   -0.514   -0.085
## theta[16]      0.247   0.231   -0.202    0.095    0.245    0.398    0.712
## theta[17]      0.251   0.223   -0.198    0.104    0.251    0.399    0.685
## theta[18]     -0.443   0.345   -1.217   -0.655   -0.409   -0.212    0.185
## theta[19]      1.563   0.228    1.146    1.406    1.548    1.709    2.043
## theta[20]     -1.164   0.528   -2.353   -1.497   -1.115   -0.779   -0.310
## theta[21]      0.085   0.245   -0.418   -0.071    0.103    0.254    0.522
## theta[22]     -1.459   0.591   -2.732   -1.832   -1.410   -1.042   -0.449
## theta[23]     -1.451   0.600   -2.738   -1.813   -1.393   -1.033   -0.425
## theta[24]     -1.462   0.599   -2.743   -1.849   -1.410   -1.010   -0.449
## theta[25]      0.679   0.222    0.251    0.530    0.682    0.826    1.108
## theta[26]      0.842   0.218    0.402    0.698    0.843    0.984    1.280
## theta[27]      0.235   0.234   -0.234    0.081    0.241    0.398    0.682
## theta[28]      1.155   0.216    0.737    1.009    1.152    1.301    1.583
## theta[29]      0.944   0.215    0.536    0.795    0.943    1.092    1.364
```

```
## theta[30]     1.433   0.221    1.003    1.284    1.428    1.580    1.868
## theta[31]     0.693   0.215    0.284    0.552    0.691    0.836    1.128
## theta[32]    -0.104   0.282   -0.698   -0.280   -0.084    0.093    0.398
## theta[33]     0.517   0.217    0.099    0.372    0.520    0.659    0.937
## theta[34]    -1.462   0.604   -2.795   -1.847   -1.410   -1.027   -0.438
## theta[35]    -0.427   0.331   -1.141   -0.628   -0.397   -0.202    0.152
## theta[36]    -0.652   0.380   -1.459   -0.893   -0.622   -0.389    0.025
## theta[37]    -1.466   0.608   -2.811   -1.838   -1.403   -1.026   -0.430
## theta[38]     0.112   0.238   -0.369   -0.043    0.113    0.276    0.577
## theta[39]    -1.477   0.609   -2.854   -1.855   -1.428   -1.039   -0.442
## theta[40]     0.334   0.228   -0.123    0.183    0.340    0.485    0.776
## theta[41]    -1.450   0.608   -2.831   -1.810   -1.401   -1.017   -0.431
## theta[42]     0.228   0.245   -0.304    0.072    0.244    0.394    0.688
## theta[43]    -0.379   0.324   -1.073   -0.589   -0.355   -0.152    0.175
## theta[44]     0.256   0.227   -0.202    0.109    0.260    0.406    0.695
## theta[45]     0.564   0.218    0.128    0.425    0.569    0.708    0.975
## theta[46]     0.498   0.218    0.070    0.355    0.496    0.644    0.928
## theta[47]     0.647   0.216    0.215    0.505    0.646    0.791    1.076
## theta[48]    -0.866   0.453   -1.869   -1.128   -0.823   -0.545   -0.123
## theta[49]    -1.471   0.596   -2.747   -1.845   -1.424   -1.049   -0.445
## theta[50]     0.449   0.224   -0.001    0.303    0.451    0.601    0.894
## theta[51]    -1.457   0.583   -2.727   -1.804   -1.409   -1.057   -0.444
## theta[52]     0.554   0.220    0.117    0.410    0.555    0.704    0.974
## theta[53]    -1.443   0.585   -2.734   -1.818   -1.402   -1.014   -0.455
## theta[54]     1.160   0.222    0.734    1.012    1.150    1.306    1.612
## theta[55]    -1.453   0.603   -2.798   -1.838   -1.401   -1.013   -0.438
## theta[56]    -1.447   0.599   -2.777   -1.810   -1.393   -1.026   -0.429
## theta[57]    -0.555   0.368   -1.363   -0.785   -0.523   -0.298    0.074
## theta[58]    -1.474   0.602   -2.789   -1.855   -1.426   -1.041   -0.432
## theta[59]     0.245   0.241   -0.236    0.086    0.250    0.416    0.701
## theta[60]    -0.390   0.321   -1.086   -0.584   -0.368   -0.165    0.173
## theta[61]     1.251   0.216    0.837    1.107    1.245    1.395    1.679
## theta[62]     0.559   0.218    0.137    0.405    0.558    0.711    0.983
## theta[63]    -1.480   0.600   -2.797   -1.842   -1.430   -1.036   -0.472
## theta[64]     1.241   0.215    0.826    1.100    1.237    1.383    1.675
## theta[65]     1.154   0.211    0.750    1.009    1.150    1.295    1.568
## theta[66]    -0.562   0.372   -1.374   -0.780   -0.524   -0.307    0.077
## theta[67]     0.688   0.216    0.276    0.539    0.684    0.831    1.131
## theta[68]     0.897   0.210    0.498    0.752    0.894    1.039    1.308
## theta[69]    -0.257   0.292   -0.870   -0.439   -0.241   -0.047    0.261
## theta[70]     0.938   0.216    0.534    0.789    0.933    1.082    1.380
## theta[71]     0.343   0.224   -0.098    0.193    0.349    0.493    0.767
## theta[72]     1.031   0.226    0.593    0.877    1.031    1.183    1.491
## theta[73]     0.276   0.226   -0.177    0.128    0.278    0.432    0.696
## theta[74]    -1.475   0.613   -2.806   -1.867   -1.418   -1.032   -0.463
## theta[75]    -1.473   0.618   -2.809   -1.858   -1.410   -1.039   -0.406
## theta[76]     2.673   0.365    2.042    2.418    2.648    2.907    3.461
## theta[77]    -0.653   0.386   -1.508   -0.888   -0.622   -0.374    0.003
## theta[78]     1.107   0.214    0.679    0.964    1.100    1.249    1.535
## theta[79]     1.562   0.224    1.134    1.409    1.556    1.711    2.016
## theta[80]     0.705   0.215    0.277    0.557    0.706    0.853    1.123
## theta[81]     0.320   0.225   -0.134    0.171    0.327    0.471    0.755
## theta[82]     0.292   0.234   -0.170    0.138    0.293    0.451    0.753
## theta[83]    -1.448   0.589   -2.717   -1.809   -1.398   -1.013   -0.461
```

```
## theta[84]     1.372  0.222   0.942   1.219   1.370   1.517   1.816
## theta[85]     0.459  0.219   0.040   0.310   0.457   0.607   0.888
## theta[86]    -1.478  0.610  -2.807  -1.867  -1.423  -1.033  -0.435
## theta[87]     0.426  0.219  -0.021   0.284   0.433   0.573   0.841
## theta[88]     0.013  0.256  -0.527  -0.154   0.026   0.189   0.481
## theta[89]    -1.466  0.600  -2.715  -1.861  -1.434  -1.029  -0.426
## theta[90]     0.904  0.226   0.464   0.754   0.905   1.052   1.335
## theta[91]    -0.823  0.437  -1.779  -1.099  -0.783  -0.517  -0.052
## theta[92]     1.021  0.218   0.582   0.877   1.017   1.164   1.445
## theta[93]     0.284  0.228  -0.169   0.134   0.289   0.439   0.722
## theta[94]     1.995  0.239   1.548   1.829   1.986   2.150   2.485
## theta[95]     1.409  0.222   0.985   1.258   1.400   1.556   1.865
## theta[96]     0.559  0.220   0.114   0.414   0.560   0.704   0.991
## theta[97]     0.499  0.222   0.052   0.351   0.509   0.649   0.910
## theta[98]    -1.459  0.603  -2.814  -1.823  -1.392  -1.039  -0.456
## theta[99]     1.148  0.217   0.710   1.002   1.154   1.294   1.563
## theta[100]   -1.148  0.534  -2.360  -1.462  -1.091  -0.771  -0.261
## theta[101]   -0.460  0.346  -1.221  -0.668  -0.429  -0.219   0.142
## theta[102]    2.151  0.265   1.664   1.965   2.141   2.322   2.702
## theta[103]   -0.433  0.344  -1.195  -0.644  -0.408  -0.185   0.166
## theta[104]    0.954  0.229   0.494   0.799   0.959   1.115   1.390
## theta[105]    0.220  0.240  -0.271   0.068   0.222   0.376   0.678
## theta[106]    1.099  0.213   0.692   0.953   1.097   1.244   1.513
## theta[107]    1.362  0.218   0.935   1.216   1.356   1.505   1.805
## theta[108]    0.892  0.220   0.454   0.744   0.895   1.038   1.325
## theta[109]    1.021  0.211   0.611   0.882   1.021   1.162   1.430
## theta[110]    0.339  0.218  -0.096   0.194   0.343   0.487   0.756
## theta[111]    0.383  0.217  -0.048   0.237   0.385   0.532   0.803
## theta[112]   -0.396  0.333  -1.106  -0.603  -0.368  -0.164   0.169
## theta[113]    0.572  0.212   0.159   0.428   0.574   0.714   0.993
## theta[114]    0.020  0.250  -0.500  -0.137   0.033   0.188   0.483
## theta[115]    0.949  0.222   0.522   0.801   0.944   1.096   1.395
## theta[116]    0.146  0.242  -0.363  -0.005   0.152   0.309   0.598
## theta[117]    0.345  0.226  -0.109   0.202   0.347   0.498   0.774
## theta[118]    0.553  0.223   0.110   0.406   0.558   0.705   0.975
## theta[119]   -0.843  0.435  -1.787  -1.108  -0.803  -0.538  -0.095
## theta[120]   -1.481  0.608  -2.821  -1.868  -1.423  -1.032  -0.445
## theta[121]    0.441  0.224   0.005   0.289   0.443   0.590   0.869
## theta[122]   -0.381  0.317  -1.046  -0.583  -0.358  -0.162   0.181
## theta[123]    1.147  0.214   0.725   1.004   1.143   1.292   1.569
## theta[124]    1.029  0.213   0.625   0.885   1.029   1.175   1.449
## theta[125]   -1.467  0.611  -2.825  -1.854  -1.417  -1.023  -0.440
## theta[126]   -0.387  0.336  -1.101  -0.593  -0.369  -0.154   0.216
## theta[127]    1.101  0.221   0.684   0.952   1.099   1.245   1.556
## theta[128]   -0.820  0.438  -1.811  -1.075  -0.775  -0.509  -0.094
## theta[129]   -0.437  0.340  -1.184  -0.641  -0.403  -0.205   0.159
## theta[130]    1.569  0.221   1.157   1.417   1.561   1.709   2.016
## theta[131]   -0.003  0.254  -0.532  -0.169   0.008   0.168   0.476
## theta[132]    1.410  0.218   1.005   1.263   1.404   1.549   1.858
## theta[133]   -1.468  0.612  -2.840  -1.863  -1.417  -1.019  -0.437
## theta[134]    1.995  0.243   1.550   1.829   1.983   2.147   2.498
## theta[135]   -0.648  0.383  -1.535  -0.873  -0.612  -0.391   0.010
## theta[136]   -1.461  0.610  -2.766  -1.849  -1.411  -1.014  -0.417
## theta[137]    0.862  0.215   0.431   0.715   0.868   1.007   1.281
```

```
## theta[138]   -0.664   0.390   -1.553   -0.891   -0.636   -0.390    0.006
## theta[139]    0.368   0.233   -0.099    0.217    0.372    0.524    0.819
## theta[140]    0.269   0.236   -0.219    0.116    0.278    0.427    0.702
## theta[141]   -0.820   0.444   -1.830   -1.098   -0.773   -0.494   -0.078
## theta[142]   -1.453   0.609   -2.770   -1.848   -1.397   -1.008   -0.420
## theta[143]   -1.469   0.621   -2.872   -1.842   -1.409   -1.025   -0.427
## theta[144]    0.878   0.212    0.476    0.733    0.877    1.019    1.299
## theta[145]   -1.460   0.606   -2.856   -1.825   -1.388   -1.025   -0.473
## theta[146]    0.704   0.220    0.283    0.555    0.706    0.852    1.129
## theta[147]    0.897   0.211    0.477    0.756    0.893    1.036    1.311
## theta[148]    0.431   0.226   -0.035    0.281    0.435    0.591    0.856
## theta[149]   -1.467   0.602   -2.766   -1.832   -1.417   -1.036   -0.463
## theta[150]   -1.497   0.618   -2.843   -1.859   -1.438   -1.054   -0.445
## theta[151]   -0.387   0.332   -1.120   -0.583   -0.356   -0.154    0.192
## theta[152]   -1.477   0.597   -2.725   -1.860   -1.424   -1.039   -0.454
## theta[153]    1.347   0.215    0.933    1.198    1.346    1.492    1.782
## theta[154]   -1.153   0.525   -2.306   -1.484   -1.096   -0.773   -0.270
## theta[155]   -1.440   0.595   -2.741   -1.815   -1.380   -1.015   -0.448
## theta[156]   -0.836   0.439   -1.833   -1.084   -0.780   -0.531   -0.108
## theta[157]   -0.831   0.422   -1.752   -1.098   -0.793   -0.529   -0.112
## theta[158]    0.274   0.229   -0.186    0.128    0.280    0.427    0.712
## theta[159]    0.727   0.229    0.281    0.573    0.730    0.880    1.172
## theta[160]   -1.453   0.614   -2.845   -1.830   -1.388   -1.012   -0.418
## theta[161]    1.196   0.218    0.778    1.044    1.199    1.341    1.624
## theta[162]    0.432   0.222   -0.007    0.279    0.433    0.583    0.853
## theta[163]   -1.474   0.614   -2.784   -1.864   -1.417   -1.029   -0.441
## theta[164]   -0.235   0.292   -0.869   -0.415   -0.215   -0.036    0.278
## theta[165]    0.443   0.225   -0.013    0.293    0.448    0.593    0.869
## theta[166]   -1.474   0.593   -2.758   -1.848   -1.436   -1.057   -0.442
## theta[167]    0.520   0.223    0.063    0.369    0.525    0.670    0.949
## theta[168]    1.256   0.212    0.841    1.113    1.255    1.396    1.674
## theta[169]   -0.004   0.249   -0.531   -0.163    0.005    0.166    0.452
## theta[170]    0.387   0.226   -0.054    0.237    0.385    0.540    0.835
## theta[171]   -0.563   0.375   -1.428   -0.779   -0.528   -0.300    0.061
## theta[172]    0.457   0.213    0.043    0.315    0.455    0.603    0.874
## theta[173]    0.704   0.212    0.299    0.559    0.701    0.847    1.129
## theta[174]   -0.458   0.341   -1.178   -0.673   -0.438   -0.218    0.144
## theta[175]   -0.445   0.336   -1.172   -0.646   -0.423   -0.208    0.148
## theta[176]   -0.647   0.381   -1.472   -0.882   -0.619   -0.384    0.020
## theta[177]   -0.092   0.269   -0.667   -0.260   -0.080    0.091    0.406
## deviance   2881.014  23.635 2837.042 2864.978 2879.756 2896.030 2930.208
##             Rhat n.eff
## a[1]       1.001  4000
## a[2]       1.004   890
## a[3]       1.006   490
## a[4]       1.008   320
## a[5]       1.007   400
## a[6]       1.009   280
## a[7]       1.005   630
## a[8]       1.002  3700
## a[9]       1.009   300
## a[10]      1.009   320
## b[1,1]     1.000     1
## b[2,1]     1.000     1
```

```
## b[3,1]      1.000     1
## b[4,1]      1.000     1
## b[5,1]      1.000     1
## b[6,1]      1.000     1
## b[7,1]      1.000     1
## b[8,1]      1.000     1
## b[9,1]      1.000     1
## b[10,1]     1.000     1
## b[1,2]      1.002  2000
## b[2,2]      1.003   980
## b[3,2]      1.009   290
## b[4,2]      1.001  2600
## b[5,2]      1.009   510
## b[6,2]      1.004   720
## b[7,2]      1.003  1200
## b[8,2]      1.007   500
## b[9,2]      1.005   560
## b[10,2]     1.007   510
## b[1,3]      1.002  1300
## b[2,3]      1.002  2100
## b[3,3]      1.011   270
## b[4,3]      1.001  4000
## b[5,3]      1.004  1300
## b[6,3]      1.005   690
## b[7,3]      1.005  1400
## b[8,3]      1.003  1500
## b[9,3]      1.002  2500
## b[10,3]     1.003   990
## b[1,4]      1.003  1400
## b[2,4]      1.004  1100
## b[3,4]      1.003   840
## b[4,4]      1.009   300
## b[5,4]      1.006   480
## b[6,4]      1.004   670
## b[7,4]      1.005  1400
## b[8,4]      1.004  1500
## b[9,4]      1.012   250
## b[10,4]     1.021   130
## b[1,5]      1.002  1300
## b[2,5]      1.003  1500
## b[3,5]      1.002  1900
## b[4,5]      1.005   540
## b[5,5]      1.006   490
## b[6,5]      1.009   350
## b[7,5]      1.003  1200
## b[8,5]      1.002  2000
## b[9,5]      1.005   880
## b[10,5]     1.026   150
## theta[1]    1.001  2900
## theta[2]    1.001  4000
## theta[3]    1.005   550
## theta[4]    1.003   930
## theta[5]    1.001  4000
## theta[6]    1.002  2500
```

```
## theta[7]    1.001  4000
## theta[8]    1.002  1400
## theta[9]    1.001  4000
## theta[10]   1.004  1800
## theta[11]   1.001  4000
## theta[12]   1.001  3300
## theta[13]   1.004   740
## theta[14]   1.001  4000
## theta[15]   1.001  3800
## theta[16]   1.001  4000
## theta[17]   1.002  2100
## theta[18]   1.002  2000
## theta[19]   1.004   650
## theta[20]   1.001  3600
## theta[21]   1.002  1500
## theta[22]   1.002  2300
## theta[23]   1.002  3600
## theta[24]   1.005   790
## theta[25]   1.006   420
## theta[26]   1.002  2100
## theta[27]   1.001  4000
## theta[28]   1.006   540
## theta[29]   1.002  2200
## theta[30]   1.001  4000
## theta[31]   1.005   610
## theta[32]   1.002  2200
## theta[33]   1.001  3600
## theta[34]   1.001  4000
## theta[35]   1.002  1900
## theta[36]   1.001  3100
## theta[37]   1.001  3200
## theta[38]   1.002  4000
## theta[39]   1.002  2000
## theta[40]   1.003  1300
## theta[41]   1.002  1300
## theta[42]   1.001  4000
## theta[43]   1.003  1200
## theta[44]   1.001  4000
## theta[45]   1.001  3900
## theta[46]   1.003  1000
## theta[47]   1.001  4000
## theta[48]   1.005  1000
## theta[49]   1.001  4000
## theta[50]   1.005   590
## theta[51]   1.003  1000
## theta[52]   1.006   500
## theta[53]   1.002  2200
## theta[54]   1.004  1100
## theta[55]   1.001  3200
## theta[56]   1.003   950
## theta[57]   1.002  1300
## theta[58]   1.004  1900
## theta[59]   1.002  1300
## theta[60]   1.001  4000
```

```
## theta[61]  1.003   940
## theta[62]  1.004   700
## theta[63]  1.001  4000
## theta[64]  1.003  1300
## theta[65]  1.005   740
## theta[66]  1.001  4000
## theta[67]  1.005   790
## theta[68]  1.001  3700
## theta[69]  1.004   750
## theta[70]  1.001  4000
## theta[71]  1.001  2600
## theta[72]  1.004  1800
## theta[73]  1.001  4000
## theta[74]  1.003   990
## theta[75]  1.001  4000
## theta[76]  1.003   960
## theta[77]  1.004  1200
## theta[78]  1.001  4000
## theta[79]  1.005   570
## theta[80]  1.002  1300
## theta[81]  1.002  2200
## theta[82]  1.001  4000
## theta[83]  1.002  4000
## theta[84]  1.003  1500
## theta[85]  1.003   900
## theta[86]  1.001  2700
## theta[87]  1.001  3500
## theta[88]  1.001  4000
## theta[89]  1.002  2000
## theta[90]  1.011   860
## theta[91]  1.002  2000
## theta[92]  1.003  3300
## theta[93]  1.002  2200
## theta[94]  1.004   800
## theta[95]  1.003  1200
## theta[96]  1.005   570
## theta[97]  1.003  1100
## theta[98]  1.002  1900
## theta[99]  1.006   610
## theta[100] 1.001  4000
## theta[101] 1.003   950
## theta[102] 1.002  1700
## theta[103] 1.007   660
## theta[104] 1.006   600
## theta[105] 1.003  1700
## theta[106] 1.004  1300
## theta[107] 1.001  4000
## theta[108] 1.002  3800
## theta[109] 1.003  1200
## theta[110] 1.001  4000
## theta[111] 1.001  4000
## theta[112] 1.002  3600
## theta[113] 1.001  3800
## theta[114] 1.004  1200
```

```
## theta[115] 1.003   920
## theta[116] 1.002  1400
## theta[117] 1.001  4000
## theta[118] 1.001  4000
## theta[119] 1.002  1600
## theta[120] 1.001  4000
## theta[121] 1.001  4000
## theta[122] 1.002  1400
## theta[123] 1.001  2900
## theta[124] 1.004  4000
## theta[125] 1.002  2200
## theta[126] 1.004  1400
## theta[127] 1.002  2900
## theta[128] 1.001  4000
## theta[129] 1.003  1000
## theta[130] 1.003  1000
## theta[131] 1.001  3700
## theta[132] 1.001  4000
## theta[133] 1.001  4000
## theta[134] 1.003  1000
## theta[135] 1.002  2200
## theta[136] 1.002  2500
## theta[137] 1.014   740
## theta[138] 1.002  1500
## theta[139] 1.002  1400
## theta[140] 1.004   840
## theta[141] 1.001  4000
## theta[142] 1.003  2400
## theta[143] 1.001  4000
## theta[144] 1.005   590
## theta[145] 1.001  4000
## theta[146] 1.001  4000
## theta[147] 1.003  2500
## theta[148] 1.002  3800
## theta[149] 1.001  3400
## theta[150] 1.003  1500
## theta[151] 1.003  1400
## theta[152] 1.002  1400
## theta[153] 1.002  1700
## theta[154] 1.003  1700
## theta[155] 1.002  1300
## theta[156] 1.002  4000
## theta[157] 1.001  4000
## theta[158] 1.001  3900
## theta[159] 1.001  4000
## theta[160] 1.001  4000
## theta[161] 1.002  1900
## theta[162] 1.001  3600
## theta[163] 1.002  4000
## theta[164] 1.003   970
## theta[165] 1.004  1200
## theta[166] 1.002  4000
## theta[167] 1.002  2300
## theta[168] 1.002  1500
```

```
## theta[169] 1.001  4000
## theta[170] 1.001  4000
## theta[171] 1.004   870
## theta[172] 1.003  1000
## theta[173] 1.002  4000
## theta[174] 1.001  4000
## theta[175] 1.003  1100
## theta[176] 1.001  4000
## theta[177] 1.002  1700
## deviance   1.002  2200
##
## For each parameter, n.eff is a crude measure of effective sample size,
## and Rhat is the potential scale reduction factor (at convergence, Rhat=1).
##
## DIC info (using the rule, pD = var(deviance)/2)
## pD = 279.1 and DIC = 3160.1
## DIC is an estimate of expected predictive error (lower deviance is better).
```

It appears the GPCM model fits slightly better than the GRM for these data. We won't do the posterior predictive model check on this one as it will likely fit just as well.

Model 3: Nominal Response Model

```
# marker item:
model03.function = function(){

  # measurement model specification
    for (person in 1:N){
      for (item in 1:I){

        for (cat in 1:C[I]){
          cnum[person, item, cat] <- exp(a[item, cat] * (theta[person] - b[item, cat]))
          prob[person, item, cat] <- cnum[person, item, cat]/sum(cnum[person, item, 1:C[item]])
        }

        X[person, item] ~ dcat(prob[person, item, 1:C[item]])
      }
    }

  # prior distributions for the factor:
    for (person in 1:N){
      theta[person] ~ dnorm(0, 1)
    }

  # prior distributions for the measurement model mean/precision parameters
    for (item in 1:I){

      # create parameters that are unbounded, then sort
      for (cat in 1:(C[item]-1)){
        b[item, cat+1] ~ dnorm(b.mean.0, b.precision.0)
        a[item, cat+1] ~ dnorm(a.mean.0, a.precision.0)
      }
      b[item, 1] <- 0
```

```
      a[item, 1] <- 0

    }

}
```

```
nItems = 10

# specification of prior values for measurement model parameters:
#   item intercepts
b.mean.0 = 0
b.variance.0 = 1
b.precision.0 = 1 / b.variance.0

#   Factor loadings -- these are the discriminations
a.mean.0 = 0
a.variance.0 = 1
a.precision.0 = 1 / a.variance.0

# next, create data for JAGS to use:
model03.data = list(
  N = nrow(conspiracy),
  X = conspiracy,
  C = unlist(apply(X = conspiracy[,1:10], MARGIN = 2, FUN = max)),
  I = 10,
  b.mean.0 = b.mean.0,
  b.precision.0 = b.precision.0,
  a.mean.0 = a.mean.0,
  a.precision.0 = a.precision.0
)

model03.init = function(){
  list("a" = cbind(rep(NA, 10), runif(10), runif(10), runif(10), runif(10)),
       "b" = cbind(rep(NA, 10), runif(10), runif(10), runif(10), runif(10)))
}

model03.parameters = c("a", "b",  "theta")

model03.seed = 16042019 + 2
```

Here, we will use the R2jags `jags.parallel()` function, which will run somewhat faster (one chain per core):

```
model03.r2jags =  jags.parallel(
  data = model03.data,
  inits = model03.init,
  parameters.to.save = model03.parameters,
  model.file = model03.function,
  n.chains = 4,
  n.iter = 2000,
  n.thin = 1,
  n.burnin = 1000,
  jags.seed = model03.seed
)

model03.r2jags
```

```
## Inference for Bugs model at "model03.function", fit using jags,
##  4 chains, each with 2000 iterations (first 1000 discarded)
##  n.sims = 4000 iterations saved
##              mu.vect sd.vect    2.5%      25%      50%      75%    97.5%
## a[1,1]        0.000   0.000   0.000    0.000    0.000    0.000    0.000
## a[2,1]        0.000   0.000   0.000    0.000    0.000    0.000    0.000
## a[3,1]        0.000   0.000   0.000    0.000    0.000    0.000    0.000
## a[4,1]        0.000   0.000   0.000    0.000    0.000    0.000    0.000
## a[5,1]        0.000   0.000   0.000    0.000    0.000    0.000    0.000
## a[6,1]        0.000   0.000   0.000    0.000    0.000    0.000    0.000
## a[7,1]        0.000   0.000   0.000    0.000    0.000    0.000    0.000
## a[8,1]        0.000   0.000   0.000    0.000    0.000    0.000    0.000
## a[9,1]        0.000   0.000   0.000    0.000    0.000    0.000    0.000
## a[10,1]       0.000   0.000   0.000    0.000    0.000    0.000    0.000
## a[1,2]        1.166   0.258   0.664    0.985    1.163    1.347    1.677
## a[2,2]        1.186   0.227   0.761    1.031    1.181    1.334    1.639
## a[3,2]        1.350   0.267   0.868    1.160    1.340    1.530    1.894
## a[4,2]        1.530   0.258   1.058    1.350    1.525    1.699    2.060
## a[5,2]        1.350   0.256   0.869    1.169    1.338    1.518    1.869
## a[6,2]        1.684   0.275   1.160    1.500    1.674    1.858    2.265
## a[7,2]        1.233   0.235   0.806    1.070    1.227    1.392    1.708
## a[8,2]        1.394   0.260   0.916    1.213    1.386    1.556    1.934
## a[9,2]        1.277   0.242   0.839    1.111    1.270    1.434    1.778
## a[10,2]       1.404   0.285   0.884    1.210    1.388    1.592    1.998
## a[1,3]        1.745   0.298   1.210    1.529    1.740    1.944    2.357
## a[2,3]        2.284   0.369   1.617    2.025    2.259    2.512    3.052
## a[3,3]        1.491   0.268   0.988    1.309    1.483    1.663    2.053
## a[4,3]        2.220   0.317   1.643    2.001    2.214    2.425    2.888
## a[5,3]        2.726   0.397   2.021    2.446    2.703    2.972    3.582
## a[6,3]        2.583   0.358   1.906    2.339    2.572    2.823    3.331
## a[7,3]        1.907   0.334   1.300    1.681    1.896    2.113    2.584
## a[8,3]        2.447   0.375   1.781    2.187    2.420    2.674    3.281
## a[9,3]        2.022   0.388   1.318    1.752    2.002    2.266    2.843
## a[10,3]       1.733   0.366   1.062    1.475    1.716    1.964    2.490
## a[1,4]        1.369   0.299   0.794    1.166    1.359    1.557    1.979
## a[2,4]        1.744   0.370   1.095    1.474    1.728    1.988    2.528
## a[3,4]        2.058   0.457   1.233    1.741    2.041    2.339    3.030
## a[4,4]        1.909   0.422   1.135    1.615    1.893    2.181    2.789
## a[5,4]        2.237   0.423   1.464    1.944    2.227    2.516    3.107
## a[6,4]        2.839   0.504   1.861    2.496    2.839    3.189    3.823
## a[7,4]        1.927   0.424   1.182    1.627    1.905    2.195    2.808
## a[8,4]        2.649   0.579   1.559    2.247    2.645    3.029    3.802
## a[9,4]        1.593   0.336   0.994    1.357    1.579    1.815    2.291
## a[10,4]       1.978   0.467   1.186    1.644    1.942    2.278    2.966
## a[1,5]        2.640   0.507   1.727    2.284    2.610    2.951    3.750
## a[2,5]        2.705   0.535   1.672    2.346    2.695    3.056    3.789
## a[3,5]        2.543   0.526   1.589    2.180    2.520    2.890    3.669
## a[4,5]        2.212   0.468   1.326    1.882    2.204    2.525    3.167
## a[5,5]        3.294   0.620   2.050    2.879    3.301    3.724    4.473
## a[6,5]        2.855   0.629   1.627    2.417    2.839    3.271    4.113
## a[7,5]        2.683   0.592   1.576    2.270    2.670    3.067    3.905
## a[8,5]        2.722   0.643   1.537    2.278    2.700    3.159    3.992
```

```
## a[9,5]        2.277   0.478    1.371    1.942    2.265    2.600    3.232
## a[10,5]       2.102   0.447    1.261    1.797    2.086    2.395    3.029
## b[1,1]        0.000   0.000    0.000    0.000    0.000    0.000    0.000
## b[2,1]        0.000   0.000    0.000    0.000    0.000    0.000    0.000
## b[3,1]        0.000   0.000    0.000    0.000    0.000    0.000    0.000
## b[4,1]        0.000   0.000    0.000    0.000    0.000    0.000    0.000
## b[5,1]        0.000   0.000    0.000    0.000    0.000    0.000    0.000
## b[6,1]        0.000   0.000    0.000    0.000    0.000    0.000    0.000
## b[7,1]        0.000   0.000    0.000    0.000    0.000    0.000    0.000
## b[8,1]        0.000   0.000    0.000    0.000    0.000    0.000    0.000
## b[9,1]        0.000   0.000    0.000    0.000    0.000    0.000    0.000
## b[10,1]       0.000   0.000    0.000    0.000    0.000    0.000    0.000
## b[1,2]       -0.767   0.227   -1.206   -0.914   -0.771   -0.618   -0.320
## b[2,2]       -0.034   0.203   -0.419   -0.175   -0.038    0.099    0.377
## b[3,2]        0.639   0.232    0.235    0.485    0.626    0.776    1.138
## b[4,2]       -0.100   0.178   -0.429   -0.223   -0.106    0.018    0.252
## b[5,2]       -0.194   0.193   -0.550   -0.325   -0.201   -0.070    0.208
## b[6,2]       -0.104   0.170   -0.413   -0.222   -0.111    0.002    0.254
## b[7,2]        0.533   0.217    0.153    0.384    0.521    0.663    0.979
## b[8,2]        0.098   0.199   -0.250   -0.033    0.082    0.217    0.531
## b[9,2]        0.529   0.212    0.154    0.382    0.518    0.660    0.990
## b[10,2]       1.356   0.258    0.911    1.181    1.336    1.509    1.936
## b[1,3]       -0.398   0.187   -0.757   -0.527   -0.399   -0.273   -0.030
## b[2,3]        0.472   0.158    0.176    0.364    0.467    0.574    0.793
## b[3,3]        0.374   0.183    0.038    0.253    0.362    0.487    0.750
## b[4,3]        0.101   0.153   -0.191   -0.004    0.096    0.205    0.407
## b[5,3]        0.373   0.159    0.066    0.270    0.373    0.477    0.697
## b[6,3]        0.221   0.147   -0.049    0.118    0.219    0.316    0.529
## b[7,3]        0.807   0.180    0.479    0.687    0.795    0.913    1.195
## b[8,3]        0.276   0.142    0.004    0.179    0.272    0.371    0.557
## b[9,3]        0.969   0.188    0.627    0.840    0.963    1.086    1.354
## b[10,3]       1.620   0.265    1.174    1.437    1.599    1.769    2.232
## b[1,4]       -0.048   0.274   -0.545   -0.231   -0.065    0.120    0.525
## b[2,4]        0.958   0.267    0.510    0.777    0.936    1.113    1.548
## b[3,4]        1.476   0.286    0.981    1.277    1.450    1.643    2.129
## b[4,4]        1.076   0.303    0.562    0.865    1.045    1.253    1.739
## b[5,4]        0.665   0.210    0.289    0.520    0.656    0.794    1.119
## b[6,4]        0.867   0.205    0.473    0.728    0.859    1.004    1.288
## b[7,4]        1.503   0.284    1.025    1.306    1.475    1.669    2.158
## b[8,4]        1.293   0.259    0.825    1.117    1.278    1.449    1.847
## b[9,4]        1.223   0.279    0.765    1.031    1.194    1.386    1.870
## b[10,4]       2.591   0.444    1.848    2.278    2.555    2.843    3.581
## b[1,5]        0.833   0.265    0.338    0.652    0.828    1.007    1.378
## b[2,5]        1.151   0.215    0.740    1.010    1.147    1.288    1.581
## b[3,5]        1.456   0.240    1.018    1.285    1.452    1.608    1.954
## b[4,5]        0.909   0.261    0.464    0.738    0.888    1.055    1.474
## b[5,5]        1.069   0.213    0.652    0.927    1.073    1.203    1.500
## b[6,5]        1.242   0.273    0.750    1.055    1.226    1.403    1.843
## b[7,5]        1.677   0.257    1.220    1.502    1.660    1.840    2.226
## b[8,5]        1.553   0.317    1.013    1.337    1.529    1.736    2.257
## b[9,5]        1.448   0.235    1.023    1.292    1.433    1.595    1.943
## b[10,5]       1.682   0.244    1.262    1.523    1.663    1.815    2.231
## theta[1]     -0.043   0.382   -0.804   -0.301   -0.044    0.220    0.704
## theta[2]      1.283   0.468    0.420    0.967    1.263    1.580    2.256
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## theta[3]      1.190   0.469    0.335    0.858    1.172    1.496    2.166
## theta[4]     -1.426   0.529   -2.537   -1.768   -1.399   -1.050   -0.471
## theta[5]      0.367   0.372   -0.361    0.123    0.361    0.615    1.104
## theta[6]     -1.790   0.599   -3.050   -2.176   -1.753   -1.365   -0.766
## theta[7]     -0.549   0.401   -1.350   -0.816   -0.542   -0.275    0.211
## theta[8]      0.082   0.375   -0.638   -0.165    0.076    0.328    0.825
## theta[9]     -1.024   0.464   -2.002   -1.313   -0.997   -0.700   -0.194
## theta[10]     0.366   0.374   -0.381    0.113    0.364    0.617    1.119
## theta[11]    -1.795   0.598   -3.090   -2.167   -1.746   -1.369   -0.751
## theta[12]     0.781   0.390    0.030    0.513    0.773    1.043    1.567
## theta[13]    -0.987   0.459   -1.963   -1.281   -0.964   -0.670   -0.149
## theta[14]    -1.791   0.621   -3.152   -2.173   -1.745   -1.363   -0.673
## theta[15]    -1.143   0.476   -2.172   -1.440   -1.110   -0.824   -0.280
## theta[16]     0.112   0.374   -0.632   -0.139    0.101    0.364    0.862
## theta[17]     0.106   0.372   -0.613   -0.150    0.116    0.359    0.812
## theta[18]    -0.856   0.440   -1.777   -1.132   -0.841   -0.545   -0.055
## theta[19]     2.045   0.578    0.964    1.636    2.034    2.423    3.231
## theta[20]    -1.435   0.529   -2.556   -1.765   -1.413   -1.065   -0.489
## theta[21]    -0.089   0.391   -0.865   -0.348   -0.086    0.165    0.673
## theta[22]    -1.788   0.608   -3.065   -2.179   -1.754   -1.352   -0.707
## theta[23]    -1.775   0.578   -2.993   -2.148   -1.761   -1.369   -0.688
## theta[24]    -1.786   0.608   -3.073   -2.171   -1.750   -1.355   -0.709
## theta[25]     0.615   0.395   -0.146    0.357    0.608    0.869    1.408
## theta[26]     0.723   0.398   -0.037    0.459    0.711    0.979    1.541
## theta[27]    -0.211   0.393   -0.991   -0.479   -0.199    0.048    0.535
## theta[28]     1.816   0.517    0.849    1.477    1.797    2.128    2.898
## theta[29]     0.970   0.411    0.153    0.696    0.964    1.247    1.788
## theta[30]     1.403   0.472    0.515    1.085    1.388    1.711    2.372
## theta[31]     0.726   0.408   -0.045    0.450    0.712    0.989    1.577
## theta[32]    -0.597   0.401   -1.436   -0.844   -0.577   -0.335    0.138
## theta[33]     0.550   0.389   -0.197    0.285    0.552    0.805    1.333
## theta[34]    -1.784   0.600   -3.056   -2.158   -1.749   -1.358   -0.730
## theta[35]    -0.868   0.434   -1.779   -1.143   -0.842   -0.570   -0.079
## theta[36]    -0.957   0.445   -1.887   -1.248   -0.930   -0.650   -0.145
## theta[37]    -1.805   0.597   -3.046   -2.186   -1.762   -1.384   -0.749
## theta[38]     0.005   0.371   -0.727   -0.238    0.016    0.265    0.700
## theta[39]    -1.764   0.594   -3.037   -2.142   -1.741   -1.351   -0.708
## theta[40]     0.362   0.374   -0.358    0.105    0.356    0.608    1.127
## theta[41]    -1.791   0.578   -3.044   -2.161   -1.762   -1.386   -0.760
## theta[42]    -0.211   0.381   -0.986   -0.453   -0.202    0.052    0.518
## theta[43]    -0.805   0.423   -1.707   -1.075   -0.775   -0.516   -0.026
## theta[44]     0.103   0.377   -0.633   -0.143    0.106    0.354    0.824
## theta[45]     0.070   0.379   -0.688   -0.185    0.076    0.316    0.797
## theta[46]     0.548   0.389   -0.220    0.288    0.547    0.804    1.295
## theta[47]     0.692   0.394   -0.101    0.432    0.693    0.959    1.459
## theta[48]    -1.349   0.519   -2.468   -1.682   -1.315   -0.973   -0.427
## theta[49]    -1.773   0.595   -3.040   -2.134   -1.738   -1.359   -0.704
## theta[50]    -0.078   0.393   -0.881   -0.332   -0.070    0.182    0.689
## theta[51]    -1.794   0.607   -3.109   -2.178   -1.761   -1.369   -0.724
## theta[52]     0.708   0.388   -0.018    0.446    0.705    0.959    1.498
## theta[53]    -1.812   0.584   -3.064   -2.166   -1.769   -1.405   -0.783
## theta[54]     1.822   0.506    0.896    1.460    1.798    2.158    2.869
## theta[55]    -1.801   0.586   -3.074   -2.172   -1.759   -1.384   -0.764
## theta[56]    -1.795   0.581   -3.000   -2.169   -1.768   -1.383   -0.752
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## theta[57]    -1.047   0.460   -2.026   -1.339   -1.023   -0.727   -0.217
## theta[58]    -1.797   0.613   -3.115   -2.188   -1.741   -1.369   -0.717
## theta[59]    -0.262   0.382   -1.034   -0.509   -0.252   -0.012    0.474
## theta[60]    -0.799   0.437   -1.705   -1.085   -0.787   -0.498    0.001
## theta[61]     1.619   0.482    0.712    1.283    1.600    1.942    2.601
## theta[62]     0.696   0.396   -0.076    0.440    0.690    0.950    1.499
## theta[63]    -1.798   0.601   -3.109   -2.171   -1.756   -1.369   -0.726
## theta[64]     1.459   0.462    0.587    1.146    1.449    1.756    2.403
## theta[65]     1.816   0.493    0.916    1.475    1.801    2.119    2.864
## theta[66]    -0.984   0.454   -1.928   -1.269   -0.962   -0.669   -0.145
## theta[67]     0.737   0.415   -0.072    0.467    0.725    1.001    1.594
## theta[68]     1.109   0.439    0.310    0.801    1.094    1.391    2.030
## theta[69]    -0.815   0.439   -1.766   -1.094   -0.798   -0.503   -0.002
## theta[70]     1.210   0.439    0.373    0.914    1.197    1.490    2.123
## theta[71]     0.332   0.385   -0.396    0.079    0.330    0.579    1.099
## theta[72]     0.773   0.407    0.008    0.492    0.766    1.038    1.600
## theta[73]     0.180   0.386   -0.594   -0.075    0.183    0.438    0.943
## theta[74]    -1.777   0.585   -2.970   -2.160   -1.747   -1.371   -0.741
## theta[75]    -1.804   0.593   -3.073   -2.183   -1.764   -1.380   -0.758
## theta[76]     2.621   0.757    1.079    2.131    2.642    3.146    4.077
## theta[77]    -1.025   0.464   -1.959   -1.326   -1.007   -0.701   -0.193
## theta[78]     1.392   0.458    0.531    1.089    1.371    1.691    2.330
## theta[79]     2.057   0.575    0.996    1.653    2.032    2.421    3.241
## theta[80]     0.504   0.398   -0.272    0.236    0.496    0.776    1.287
## theta[81]     0.209   0.373   -0.531   -0.045    0.214    0.462    0.923
## theta[82]    -0.040   0.377   -0.783   -0.275   -0.041    0.207    0.686
## theta[83]    -1.797   0.589   -3.021   -2.180   -1.760   -1.376   -0.765
## theta[84]     0.980   0.446    0.142    0.669    0.971    1.275    1.884
## theta[85]     0.252   0.381   -0.505    0.001    0.257    0.513    0.977
## theta[86]    -1.782   0.576   -3.017   -2.158   -1.759   -1.372   -0.731
## theta[87]     0.508   0.383   -0.249    0.255    0.509    0.755    1.271
## theta[88]    -0.295   0.390   -1.087   -0.541   -0.296   -0.036    0.456
## theta[89]    -1.797   0.597   -3.062   -2.177   -1.758   -1.363   -0.755
## theta[90]     1.090   0.411    0.321    0.815    1.084    1.359    1.932
## theta[91]    -1.130   0.482   -2.152   -1.438   -1.103   -0.800   -0.257
## theta[92]     0.827   0.398    0.067    0.557    0.816    1.090    1.625
## theta[93]    -0.035   0.376   -0.781   -0.291   -0.024    0.228    0.666
## theta[94]     2.510   0.713    1.072    2.033    2.543    3.008    3.856
## theta[95]     1.424   0.456    0.533    1.104    1.413    1.722    2.338
## theta[96]     0.700   0.405   -0.070    0.420    0.698    0.965    1.509
## theta[97]     0.546   0.387   -0.227    0.292    0.540    0.811    1.310
## theta[98]    -1.792   0.586   -3.045   -2.160   -1.751   -1.378   -0.738
## theta[99]     1.834   0.509    0.916    1.482    1.819    2.152    2.908
## theta[100]   -1.430   0.532   -2.582   -1.759   -1.395   -1.060   -0.486
## theta[101]   -0.749   0.428   -1.638   -1.018   -0.744   -0.457    0.033
## theta[102]    2.749   0.709    1.276    2.277    2.778    3.237    4.096
## theta[103]   -0.855   0.441   -1.763   -1.144   -0.837   -0.550   -0.034
## theta[104]    0.531   0.411   -0.224    0.249    0.523    0.799    1.378
## theta[105]   -0.189   0.397   -0.985   -0.452   -0.193    0.071    0.594
## theta[106]    1.325   0.448    0.489    1.020    1.311    1.624    2.215
## theta[107]    0.994   0.445    0.169    0.684    0.976    1.277    1.877
## theta[108]    1.097   0.421    0.296    0.812    1.078    1.376    1.951
## theta[109]    1.466   0.475    0.557    1.155    1.449    1.767    2.455
## theta[110]    0.358   0.384   -0.393    0.096    0.361    0.619    1.097
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## theta[111]    0.537   0.389   -0.232    0.271    0.542    0.803    1.303
## theta[112]   -1.061   0.475   -2.080   -1.363   -1.030   -0.729   -0.224
## theta[113]    0.770   0.390    0.040    0.505    0.767    1.032    1.563
## theta[114]   -0.314   0.388   -1.100   -0.570   -0.308   -0.045    0.405
## theta[115]    0.524   0.396   -0.247    0.263    0.515    0.776    1.345
## theta[116]    0.043   0.378   -0.706   -0.206    0.041    0.288    0.799
## theta[117]    0.347   0.368   -0.368    0.096    0.339    0.592    1.099
## theta[118]    0.708   0.398   -0.048    0.441    0.686    0.972    1.529
## theta[119]   -1.367   0.518   -2.495   -1.689   -1.345   -1.002   -0.452
## theta[120]   -1.792   0.579   -3.037   -2.148   -1.757   -1.390   -0.754
## theta[121]    0.094   0.384   -0.657   -0.165    0.098    0.344    0.846
## theta[122]   -1.073   0.465   -2.039   -1.372   -1.054   -0.755   -0.226
## theta[123]    1.823   0.505    0.883    1.475    1.800    2.147    2.893
## theta[124]    1.598   0.481    0.719    1.264    1.589    1.919    2.575
## theta[125]   -1.820   0.606   -3.149   -2.194   -1.772   -1.388   -0.775
## theta[126]   -1.069   0.483   -2.097   -1.376   -1.032   -0.737   -0.196
## theta[127]    1.314   0.448    0.423    1.014    1.315    1.615    2.202
## theta[128]   -1.058   0.480   -2.076   -1.351   -1.029   -0.738   -0.178
## theta[129]   -0.863   0.447   -1.802   -1.142   -0.834   -0.561   -0.063
## theta[130]    1.464   0.467    0.585    1.153    1.453    1.770    2.432
## theta[131]   -0.543   0.399   -1.391   -0.794   -0.531   -0.273    0.201
## theta[132]    1.413   0.477    0.516    1.083    1.402    1.731    2.358
## theta[133]   -1.817   0.605   -3.150   -2.185   -1.774   -1.395   -0.753
## theta[134]    2.503   0.714    1.111    2.027    2.494    2.996    3.906
## theta[135]   -1.032   0.473   -2.034   -1.326   -1.006   -0.704   -0.184
## theta[136]   -1.798   0.598   -3.137   -2.176   -1.748   -1.385   -0.731
## theta[137]    0.962   0.413    0.132    0.684    0.962    1.237    1.789
## theta[138]   -1.015   0.472   -2.011   -1.308   -0.996   -0.689   -0.162
## theta[139]    0.359   0.379   -0.382    0.101    0.363    0.618    1.080
## theta[140]    0.092   0.398   -0.691   -0.169    0.096    0.359    0.862
## theta[141]   -1.140   0.476   -2.135   -1.446   -1.112   -0.819   -0.255
## theta[142]   -1.790   0.611   -3.083   -2.189   -1.742   -1.361   -0.730
## theta[143]   -1.797   0.578   -2.997   -2.181   -1.764   -1.379   -0.761
## theta[144]    1.389   0.445    0.543    1.081    1.380    1.676    2.305
## theta[145]   -1.790   0.596   -3.048   -2.171   -1.760   -1.358   -0.723
## theta[146]    0.505   0.395   -0.281    0.243    0.492    0.765    1.309
## theta[147]    1.099   0.433    0.278    0.804    1.077    1.383    1.993
## theta[148]   -0.197   0.401   -0.998   -0.445   -0.187    0.077    0.562
## theta[149]   -1.792   0.602   -3.091   -2.166   -1.755   -1.358   -0.731
## theta[150]   -1.806   0.594   -3.057   -2.182   -1.763   -1.392   -0.749
## theta[151]   -1.056   0.470   -2.058   -1.346   -1.032   -0.734   -0.182
## theta[152]   -1.805   0.606   -3.094   -2.194   -1.763   -1.379   -0.748
## theta[153]    1.349   0.451    0.491    1.044    1.348    1.637    2.263
## theta[154]   -1.437   0.539   -2.614   -1.773   -1.403   -1.057   -0.515
## theta[155]   -1.800   0.611   -3.073   -2.188   -1.759   -1.369   -0.690
## theta[156]   -1.341   0.511   -2.441   -1.656   -1.319   -0.991   -0.411
## theta[157]   -1.340   0.506   -2.416   -1.667   -1.318   -0.985   -0.427
## theta[158]    0.178   0.377   -0.561   -0.075    0.178    0.426    0.917
## theta[159]    0.514   0.379   -0.215    0.259    0.509    0.771    1.266
## theta[160]   -1.799   0.607   -3.103   -2.188   -1.754   -1.387   -0.709
## theta[161]    1.507   0.450    0.676    1.206    1.491    1.804    2.429
## theta[162]    0.515   0.388   -0.229    0.249    0.511    0.782    1.292
## theta[163]   -1.794   0.597   -3.050   -2.182   -1.746   -1.374   -0.737
## theta[164]   -0.879   0.448   -1.835   -1.172   -0.855   -0.572   -0.067
```

```
## theta[165]   -0.083   0.381   -0.843   -0.332   -0.082    0.162    0.669
## theta[166]   -1.789   0.579   -3.004   -2.150   -1.760   -1.386   -0.739
## theta[167]    0.564   0.385   -0.159    0.315    0.560    0.800    1.361
## theta[168]    1.447   0.468    0.586    1.118    1.427    1.761    2.391
## theta[169]   -0.264   0.398   -1.046   -0.532   -0.253    0.009    0.499
## theta[170]    0.554   0.382   -0.211    0.295    0.559    0.812    1.293
## theta[171]   -1.316   0.532   -2.453   -1.655   -1.276   -0.946   -0.360
## theta[172]    0.401   0.384   -0.344    0.149    0.390    0.643    1.178
## theta[173]    0.507   0.389   -0.235    0.242    0.496    0.771    1.313
## theta[174]   -0.729   0.432   -1.665   -1.004   -0.706   -0.429    0.029
## theta[175]   -0.862   0.452   -1.773   -1.155   -0.836   -0.550   -0.008
## theta[176]   -1.008   0.469   -1.972   -1.314   -0.992   -0.688   -0.120
## theta[177]   -0.296   0.396   -1.099   -0.548   -0.290   -0.023    0.462
## deviance   3052.838  32.769 2990.003 3030.077 3052.344 3074.712 3119.399
##             Rhat n.eff
## a[1,1]     1.000     1
## a[2,1]     1.000     1
## a[3,1]     1.000     1
## a[4,1]     1.000     1
## a[5,1]     1.000     1
## a[6,1]     1.000     1
## a[7,1]     1.000     1
## a[8,1]     1.000     1
## a[9,1]     1.000     1
## a[10,1]    1.000     1
## a[1,2]     1.003   930
## a[2,2]     1.006   420
## a[3,2]     1.002  2000
## a[4,2]     1.009   310
## a[5,2]     1.013   210
## a[6,2]     1.003   990
## a[7,2]     1.004   630
## a[8,2]     1.012   230
## a[9,2]     1.006   470
## a[10,2]    1.006   460
## a[1,3]     1.009   340
## a[2,3]     1.005   560
## a[3,3]     1.003  3500
## a[4,3]     1.009   290
## a[5,3]     1.007   560
## a[6,3]     1.008   350
## a[7,3]     1.005   580
## a[8,3]     1.012   220
## a[9,3]     1.004   640
## a[10,3]    1.001  2900
## a[1,4]     1.003   900
## a[2,4]     1.007   360
## a[3,4]     1.002  1600
## a[4,4]     1.002  1600
## a[5,4]     1.006   540
## a[6,4]     1.003  1500
## a[7,4]     1.002  1800
## a[8,4]     1.002  1600
## a[9,4]     1.006   500
```

```
## a[10,4]     1.002  2000
## a[1,5]      1.004   900
## a[2,5]      1.004  1100
## a[3,5]      1.004   640
## a[4,5]      1.002  4000
## a[5,5]      1.010   280
## a[6,5]      1.002  2200
## a[7,5]      1.007   380
## a[8,5]      1.002  2000
## a[9,5]      1.002  1900
## a[10,5]     1.011   280
## b[1,1]      1.000     1
## b[2,1]      1.000     1
## b[3,1]      1.000     1
## b[4,1]      1.000     1
## b[5,1]      1.000     1
## b[6,1]      1.000     1
## b[7,1]      1.000     1
## b[8,1]      1.000     1
## b[9,1]      1.000     1
## b[10,1]     1.000     1
## b[1,2]      1.002  1800
## b[2,2]      1.007   360
## b[3,2]      1.003  3800
## b[4,2]      1.002  1700
## b[5,2]      1.005   820
## b[6,2]      1.015   180
## b[7,2]      1.005   590
## b[8,2]      1.003  1200
## b[9,2]      1.006   490
## b[10,2]     1.005   510
## b[1,3]      1.002  1900
## b[2,3]      1.011   250
## b[3,3]      1.001  4000
## b[4,3]      1.004   740
## b[5,3]      1.009   310
## b[6,3]      1.007   410
## b[7,3]      1.006   510
## b[8,3]      1.004   800
## b[9,3]      1.011   270
## b[10,3]     1.001  3800
## b[1,4]      1.002  1400
## b[2,4]      1.011   270
## b[3,4]      1.003  1300
## b[4,4]      1.006   430
## b[5,4]      1.007   390
## b[6,4]      1.015   220
## b[7,4]      1.003   920
## b[8,4]      1.012   220
## b[9,4]      1.007   560
## b[10,4]     1.002  2400
## b[1,5]      1.007  1300
## b[2,5]      1.008   390
## b[3,5]      1.001  4000
```

```
## b[4,5]      1.010   280
## b[5,5]      1.011   270
## b[6,5]      1.002  1400
## b[7,5]      1.005   730
## b[8,5]      1.004   820
## b[9,5]      1.011   320
## b[10,5]     1.005   710
## theta[1]    1.001  2700
## theta[2]    1.001  3000
## theta[3]    1.004   780
## theta[4]    1.001  4000
## theta[5]    1.002  1500
## theta[6]    1.001  4000
## theta[7]    1.002  4000
## theta[8]    1.003  1200
## theta[9]    1.002  2200
## theta[10]   1.001  4000
## theta[11]   1.002  1600
## theta[12]   1.001  3000
## theta[13]   1.005   870
## theta[14]   1.001  4000
## theta[15]   1.002  1900
## theta[16]   1.001  4000
## theta[17]   1.002  3700
## theta[18]   1.002  1800
## theta[19]   1.003   880
## theta[20]   1.001  2500
## theta[21]   1.001  4000
## theta[22]   1.001  3600
## theta[23]   1.003  1000
## theta[24]   1.001  4000
## theta[25]   1.002  1600
## theta[26]   1.002  1800
## theta[27]   1.002  4000
## theta[28]   1.003  3100
## theta[29]   1.002  1800
## theta[30]   1.006   460
## theta[31]   1.002  1400
## theta[32]   1.002  1600
## theta[33]   1.001  3500
## theta[34]   1.001  4000
## theta[35]   1.003  1200
## theta[36]   1.006   490
## theta[37]   1.001  2900
## theta[38]   1.002  1900
## theta[39]   1.002  2300
## theta[40]   1.002  1300
## theta[41]   1.001  3000
## theta[42]   1.002  2000
## theta[43]   1.001  4000
## theta[44]   1.002  1800
## theta[45]   1.002  2300
## theta[46]   1.002  1300
## theta[47]   1.002  1800
```

```
## theta[48]  1.001  3300
## theta[49]  1.002  3200
## theta[50]  1.001  4000
## theta[51]  1.003   930
## theta[52]  1.001  4000
## theta[53]  1.001  4000
## theta[54]  1.001  4000
## theta[55]  1.002  2200
## theta[56]  1.001  4000
## theta[57]  1.001  3900
## theta[58]  1.002  1700
## theta[59]  1.001  2800
## theta[60]  1.005   640
## theta[61]  1.001  2900
## theta[62]  1.001  4000
## theta[63]  1.001  4000
## theta[64]  1.002  1700
## theta[65]  1.001  4000
## theta[66]  1.001  2900
## theta[67]  1.004   680
## theta[68]  1.002  2300
## theta[69]  1.002  1800
## theta[70]  1.002  1600
## theta[71]  1.004   810
## theta[72]  1.003  1200
## theta[73]  1.002  1500
## theta[74]  1.001  4000
## theta[75]  1.001  4000
## theta[76]  1.010   270
## theta[77]  1.002  2300
## theta[78]  1.002  1700
## theta[79]  1.008   360
## theta[80]  1.005   510
## theta[81]  1.005   600
## theta[82]  1.003  1100
## theta[83]  1.001  3000
## theta[84]  1.001  4000
## theta[85]  1.001  2900
## theta[86]  1.006   430
## theta[87]  1.002  1700
## theta[88]  1.002  2000
## theta[89]  1.002  2400
## theta[90]  1.001  4000
## theta[91]  1.004   810
## theta[92]  1.001  4000
## theta[93]  1.001  2500
## theta[94]  1.005  1200
## theta[95]  1.001  4000
## theta[96]  1.002  2600
## theta[97]  1.003  1100
## theta[98]  1.002  2500
## theta[99]  1.004  1400
## theta[100] 1.001  3700
## theta[101] 1.003   900
```

```
## theta[102] 1.006   540
## theta[103] 1.003   950
## theta[104] 1.003   900
## theta[105] 1.002  1500
## theta[106] 1.004   810
## theta[107] 1.002  1800
## theta[108] 1.003  1200
## theta[109] 1.002  4000
## theta[110] 1.003  1300
## theta[111] 1.004   890
## theta[112] 1.003  1600
## theta[113] 1.002  1500
## theta[114] 1.001  4000
## theta[115] 1.005   600
## theta[116] 1.001  3100
## theta[117] 1.002  2700
## theta[118] 1.001  3200
## theta[119] 1.003  1500
## theta[120] 1.001  4000
## theta[121] 1.004  4000
## theta[122] 1.003  1200
## theta[123] 1.001  4000
## theta[124] 1.001  2600
## theta[125] 1.002  2400
## theta[126] 1.002  1400
## theta[127] 1.003  1000
## theta[128] 1.003  1100
## theta[129] 1.002  2800
## theta[130] 1.002  1700
## theta[131] 1.001  3400
## theta[132] 1.001  4000
## theta[133] 1.001  4000
## theta[134] 1.005  1100
## theta[135] 1.002  2100
## theta[136] 1.001  4000
## theta[137] 1.001  4000
## theta[138] 1.002  1300
## theta[139] 1.001  4000
## theta[140] 1.003  1200
## theta[141] 1.002  1700
## theta[142] 1.002  1800
## theta[143] 1.002  1600
## theta[144] 1.004   640
## theta[145] 1.001  4000
## theta[146] 1.002  1300
## theta[147] 1.001  4000
## theta[148] 1.003  1100
## theta[149] 1.001  3200
## theta[150] 1.002  4000
## theta[151] 1.002  1800
## theta[152] 1.001  2600
## theta[153] 1.001  4000
## theta[154] 1.001  3800
## theta[155] 1.002  3000
```

```
## theta[156] 1.001  3000
## theta[157] 1.003  1000
## theta[158] 1.002  1500
## theta[159] 1.001  2600
## theta[160] 1.002  2100
## theta[161] 1.008   530
## theta[162] 1.002  1800
## theta[163] 1.001  4000
## theta[164] 1.004   880
## theta[165] 1.003  1100
## theta[166] 1.001  4000
## theta[167] 1.002  2000
## theta[168] 1.003   970
## theta[169] 1.002  4000
## theta[170] 1.001  3700
## theta[171] 1.002  1400
## theta[172] 1.001  2800
## theta[173] 1.001  4000
## theta[174] 1.001  2900
## theta[175] 1.002  2300
## theta[176] 1.001  4000
## theta[177] 1.003  1100
## deviance   1.001  4000
##
## For each parameter, n.eff is a crude measure of effective sample size,
## and Rhat is the potential scale reduction factor (at convergence, Rhat=1).
##
## DIC info (using the rule, pD = var(deviance)/2)
## pD = 537.0 and DIC = 3589.8
## DIC is an estimate of expected predictive error (lower deviance is better).
```