Applied Bayesian Statistics

Class Assignment 2

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Packages

Note *This is Rmarkdown document which combines the entire code, outputs and text. If you don't have pacman installed, just get it once from CRAN and it will manage all the rest of the dependecies (for ever).*

```
# install.packages("pacman")
pacman::p_load(
  tidyverse, rjags, purrr, tidyr, broom,
  texreg, ggthemes, janitor, knitr
)
ggplot2::theme_set(theme_bw())
set.seed(2018)
```

Helper

Data

A reduced dataset of Student Panel Survey during the Lecture in Introduction to Political Methodology Winter term 2016/2017 at the University of Konstanz

- `poleff` Political Efficacy (Likert Score based on 7 items) A larger value = higher level of efficacy
- `friend` Number of alteri in friendship network
- `poldisc` Number of alteri in political discussion network
- `lr.self` Ideological orientation (left right self-placement) 1: Left <- -> 11: Right
- `lr.self.2` Ideological orientation (left right self-placement, second measurement) 1: Left <- -> 11: Right
- `univ.election` Vote intention at the next university election. 1: Yes; 0: other (No and DK)
- `polint` interest at university politics 1: not interested at all <- -> 5 strongly interested
- `tuition` opinion on the general tuition fee for German universities 1: support; 2: reject; 3: indifferent
- `acceptable` acceptable level of the tuition fee (in Euro per Semester) (Only those who support the tuition fee or indifferent)
- protest1 - protest6 willingness to participate a protest action against the general tuition fee 1: yes; 0: no
  - `protest1` demonstration in Konstanz
  - `protest2` demonstration in Stuttgart
  - `protest3` giving signature at petitions
  - `protest4` strike
  - `protest5` occupation of university buildings
  - `protest6` legal dispute at courts

```r
dat <- get(load("data/Bayes_Student_Survey.RData")) %>%
  drop_na(univ.election, lr.self)

dat %>% glimpse
```

```
## Observations: 158
## Variables: 17
## $ id            <dbl> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 1...
## $ male          <dbl> 1, 0, 1, 0, 1, 1, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, ...
## $ friend        <dbl> 5, 4, 6, 6, 0, 6, 9, 0, 0, 2, 0, 0, 9, 4, 1, 1, ...
## $ poldisc       <dbl> 7, 2, 1, 1, 0, 7, 3, 0, 0, 2, 0, 0, 11, 4, 0, 1,...
## $ poleff        <dbl> 25, 23, 23, 22, 23, 26, 26, 22, 21, 28, 13, 24, ...
## $ lr.self       <dbl> 2, 3, 8, 5, 8, 4, 6, 5, 7, 5, 6, 7, 2, 6, 5, 3, ...
## $ lr.self.2     <dbl> 3, NA, 8, 5, 7, 4, 6, 5, NA, 7, 8, NA, 3, 6, 6, ...
## $ univ.election <dbl> 1, 1, 0, 1, 0, 1, 1, 1, 0, 1, 0, 1, 1, 1, 0, 1, ...
## $ polint        <dbl> 4, 4, 2, 3, 1, 4, 4, 3, 1, 4, 3, 3, 3, 3, 3, 2, ...
## $ tuition       <dbl> 2, NA, 2, 2, 3, 2, 2, 2, NA, 3, 2, NA, 2, 2, 2, ...
## $ acceptable    <dbl> NA, NA, NA, NA, 25, NA, NA, NA, NA, 150, NA, NA,...
## $ protest1      <dbl> 1, NA, 0, 0, NA, 1, 1, 0, NA, NA, 0, NA, 1, 1, 0...
## $ protest2      <dbl> 0, NA, 0, 0, NA, 1, 0, 0, NA, NA, 0, NA, 1, 1, 1...
## $ protest3      <dbl> 1, NA, 1, 1, NA, 1, 1, 1, NA, NA, 1, NA, 1, 1, 1...
## $ protest4      <dbl> 0, NA, 0, 0, NA, 1, 0, 0, NA, NA, 0, NA, 1, 1, 0...
## $ protest5      <dbl> 0, NA, 0, 1, NA, 1, 0, 1, NA, NA, 0, NA, 1, 1, 0...
## $ protest6      <dbl> 0, NA, 0, 0, NA, 0, 0, 1, NA, NA, 0, NA, 1, 1, 1...
```

1 Estimate the parameters of a binary logit model.

You can choose a dependent variable and one independent variable from the dataset for yourself.

```r
binary_model1 <- "model{
  for (i in 1:N){
    y[i] ~ dbern(p[i])
    logit(p[i]) <- ystar[i]
    ystar[i] <- alpha + beta * x[i]
  }

  alpha ~ dnorm(0,0.0001)
  beta ~ dnorm(0,0.0001)
}"


write(binary_model1, "bivariate_binary_model1.bug")
```

```r
jags.data <- list(
  y = dat$univ.election,
  x = dat$lr.self,
  N = nrow(dat)
)

jags.inits <- 1:5 %>%
  map(~ list(beta = runif(1, min = 0, max = 1)))
```

```
fit_binary_1 <- jags.model(
  file = "bivariate_binary_model1.bug",
  inits = jags.inits,
  data = jags.data,
  n.chains = length(jags.inits)
)
```

```
## Compiling model graph
##    Resolving undeclared variables
##    Allocating nodes
## Graph information:
##    Observed stochastic nodes: 158
##    Unobserved stochastic nodes: 2
##    Total graph size: 351
##
## Initializing model
```

2 Calculate DIC of the logit model above by computing the log-likelihood value by using JAGS.

You can orient yourself the code on the slide 7.18, but you have to care about which distribution the logit model assumes.

```
binary_model2 <- "model{
  for (i in 1:N){
    y[i] ~ dbern(p[i])
    logit(p[i]) <- ystar[i]
    ystar[i] <- alpha + beta * x[i]
    ### LL for Binary Data - From: https://data.princeton.edu/wws509/notes/c3.pdf
    ll[i] <- y[i]*log(p[i]) + (1 - y[i]) * log(1 - p[i])
  }

  alpha ~ dnorm(0,0.0001)
  beta ~ dnorm(0,0.0001)

  LL <- sum(ll[])
}"


write(binary_model2, "bivariate_binary_model2.bug")

fit_binary_2 <- jags.model(
  file = "bivariate_binary_model2.bug",
  inits = jags.inits,
  data = jags.data,
  n.chains = length(jags.inits)
)
```

```
## Compiling model graph
##    Resolving undeclared variables
```

```
##    Allocating nodes
## Graph information:
##    Observed stochastic nodes: 158
##    Unobserved stochastic nodes: 2
##    Total graph size: 443
##
## Initializing model
```

```
fit_binary_2_list <- coda.samples(
  fit_binary_2,
  variable.names = c("alpha", "beta", "LL"),
  n.iter = 5000,
  thin = 5
)

## Average LL and Deviance
LL <- fit_binary_2_list %>% map(~.x[,"LL"])
LL %>% map_dbl(mean)
```

```
## [1] -98.23319 -98.26477 -98.26811 -98.26949 -98.25403
```

```
Deviances <- LL %>% map(~ .x * -2)
Deviances %>% map_dbl(mean)
```

```
## [1] 196.4664 196.5295 196.5362 196.5390 196.5081
```

3 Calculate DIC of the logit model above by using dic.samples().

```
binary_dic <- dic.samples(fit_binary_1, n.iter = 2000, thin = 1)
binary_dic
```

```
## Mean deviance:  196.6
## penalty 2.063
## Penalized deviance: 198.6
```

```
binary_dic_list <- coda.samples(
  fit_binary_1,
  variable.names=c("alpha", "beta", "deviance", "LL"),
  n.iter = 2000,
  thin = 1
)
```

```
## Warning in FUN(X[[i]], ...): Failed to set trace monitor for LL
## Variable LL not found
```

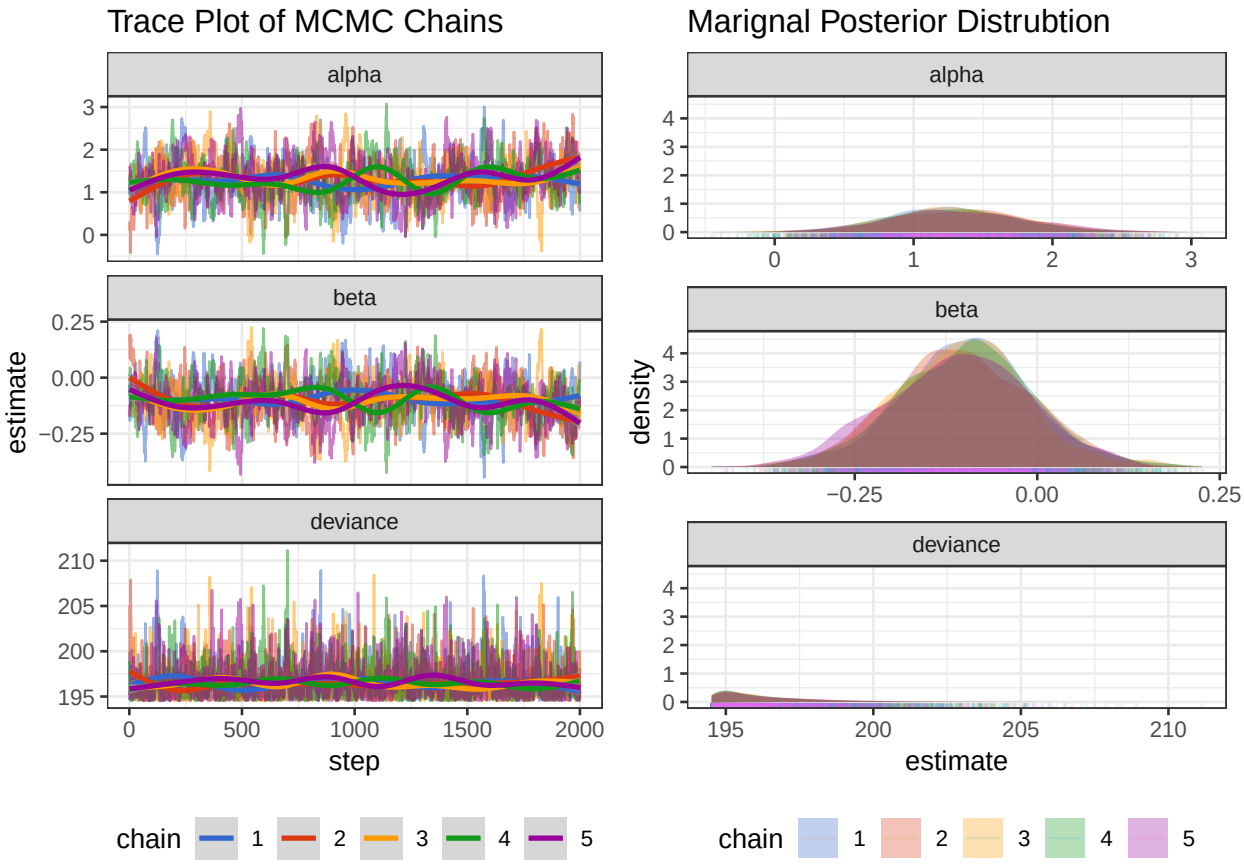
```
# No LL aviable?
# binary_dic_list %>%
#   map(~mean(.x[, "LL"]))

binary_dic_list %>%
  map(~mean(.x[, "deviance"]))
```

```
## [[1]]
## [1] 196.4438
##
## [[2]]
## [1] 196.4428
##
## [[3]]
## [1] 196.4557
##
## [[4]]
## [1] 196.4345
##
## [[5]]
## [1] 196.6067
```

```
plot_jags_model(binary_dic_list, terms = c("alpha", "beta", "deviance"))
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```




```
sessionInfo()
```

```
## R version 3.5.1 (2018-07-02)
```

```
## Platform: x86_64-apple-darwin15.6.0 (64-bit)
## Running under: macOS High Sierra 10.13.6
##
## Matrix products: default
## BLAS: /Library/Frameworks/R.framework/Versions/3.5/Resources/lib/libRblas.0.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/3.5/Resources/lib/libRlapack.dylib
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] bindrcpp_0.2.2  knitr_1.20      janitor_1.1.1   ggthemes_4.0.1
##  [5] texreg_1.36.23  broom_0.5.0     rjags_4-8       coda_0.19-2
##  [9] forcats_0.3.0   stringr_1.3.1   dplyr_0.7.8     purrr_0.2.5
## [13] readr_1.1.1     tidyr_0.8.2     tibble_2.0.0    ggplot2_3.1.0
## [17] tidyverse_1.2.1
##
## loaded via a namespace (and not attached):
##  [1] tidyselect_0.2.5 haven_1.1.2      lattice_0.20-35  colorspace_1.3-2
##  [5] htmltools_0.3.6  mgcv_1.8-24      yaml_2.2.0       utf8_1.1.4
##  [9] rlang_0.3.0.1    pillar_1.3.1     glue_1.3.0       withr_2.1.2
## [13] modelr_0.1.2     readxl_1.1.0     bindr_0.1.1      plyr_1.8.4
## [17] munsell_0.5.0    gtable_0.2.0     cellranger_1.1.0 rvest_0.3.2
## [21] evaluate_0.12    labeling_0.3     fansi_0.4.0      Rcpp_1.0.0
## [25] scales_1.0.0     backports_1.1.3  jsonlite_1.6     gridExtra_2.3
## [29] hms_0.4.2        digest_0.6.18    stringi_1.2.4    grid_3.5.1
## [33] rprojroot_1.3-2  cli_1.0.1        tools_3.5.1      magrittr_1.5
## [37] lazyeval_0.2.1   pacman_0.5.0     crayon_1.3.4     pkgconfig_2.0.2
## [41] Matrix_1.2-14    xml2_1.2.0       lubridate_1.7.4  assertthat_0.2.0
## [45] rmarkdown_1.10   httr_1.4.0       rstudioapi_0.8   R6_2.3.0
## [49] nlme_3.1-137     compiler_3.5.1
```