Prediction and Bayesian Inference: Coding Exercise

Contrasts and Functions of Parameters   Bayesian inference also allows easy computation of contrasts and more generally functions of parameters.

Consider the contrast (predicted mean difference) between a weekend day with `max_tmp` = 20 and a weekday with `max_tmp` = 30. This would be a difficult problem to solve analytically, but it is straightforward using simulation.

Note that a contrast of this sort (or any time), could also be calculated from a classical perspective, but, strictly speaking, the simulation approach is not permitted. Rather an analytical calculation, likely with a normal approximation (delta method?) would be necessary.

1. Fit the model.

```
beer <- read_csv('http://math.montana.edu/ahoegh/Data/Brazil_cerveja.csv')
```

```
## Parsed with column specification:
## cols(
##   consumed = col_double(),
##   precip = col_double(),
##   max_tmp = col_double(),
##   weekend = col_double()
## )
```

```
stan_fit2 <- stan_glm(consumed ~ weekend + max_tmp, data = beer, refresh = 0)
print(stan_fit2)
```

```
## stan_glm
##  family:       gaussian [identity]
##  formula:      consumed ~ weekend + max_tmp
##  observations: 365
##  predictors:   3
## ------
##             Median MAD_SD
## (Intercept) 5.9    0.8
## weekend     5.2    0.3
## max_tmp     0.7    0.0
##
## Auxiliary parameter(s):
##       Median MAD_SD
## sigma 2.4    0.1
##
## ------
## * For help interpreting the printed output see ?print.stanreg
## * For info on the priors used see ?prior_summary.stanreg
```

2. Extract the simulations.

```
contrast_sims <- as.matrix(stan_fit2)
```

3. Compare differences

```
diff_consumed <- as.numeric(contrast_sims %*% matrix(c(1,1,20,0)) -
    contrast_sims %*% matrix(c(1,0,30,0)))
```
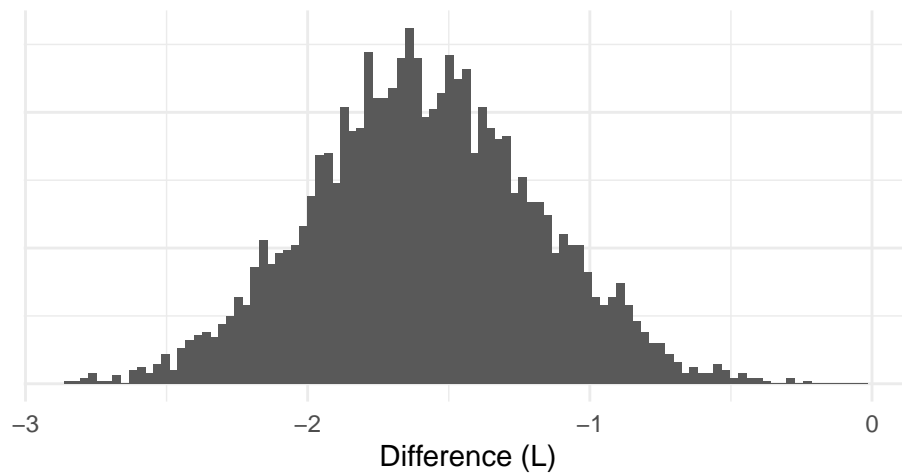
4. Calculate interval and plot difference

```
##       2.5%      97.5%
## -2.3697248 -0.8006437
```

```
## Warning: Removed 1 rows containing missing values (geom_bar).
```


Distribution for predicted mean consumption
20 degree Weekend – 30 degree Weekday

Prediction

1. Predict the expected (or average) consumption for max temperature of 25, weekend = 1, and precip = 0.

```
pred_model <- stan_glm(consumed ~ max_tmp + weekend + precip, data = beer, refresh = 0)
print(pred_model)
```

```
## stan_glm
##  family:       gaussian [identity]
##  formula:      consumed ~ max_tmp + weekend + precip
##  observations: 365
##  predictors:   4
## ------
##             Median MAD_SD
## (Intercept)  6.4    0.8
## max_tmp      0.7    0.0
## weekend      5.2    0.3
## precip      -0.1    0.0
##
## Auxiliary parameter(s):
##       Median MAD_SD
## sigma 2.3    0.1
##
## ------
## * For help interpreting the printed output see ?print.stanreg
## * For info on the priors used see ?prior_summary.stanreg
```

```
x_prime <- tibble(max_tmp = 25, weekend = 1, precip = 0)
predictions <- posterior_linpred(pred_model, newdata = x_prime) %>% as.numeric()
predictions %>% quantile( probs = c(.025, .975))
```

```
##      2.5%    97.5%
## 27.84351 28.80178
```

```
predictions
```

```
##     [1] 27.92066 28.24490 28.32739 28.23617 28.16383 28.28802 28.35905 28.40543
##     [9] 28.35858 28.30274 28.41231 28.04354 28.20528 28.36624 28.31603 28.40058
##    [17] 28.42276 28.21313 28.16797 28.48088 28.36376 28.26480 28.36755 28.29147
##    [25] 28.21546 28.44002 28.31556 28.18435 28.40769 28.38884 28.67488 28.58219
##    [33] 28.58219 28.07096 28.45455 28.22925 28.04818 28.03964 28.06192 28.77654
##    [41] 27.78853 28.94526 28.42356 28.19895 28.43391 28.40884 28.32602 28.50379
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##    [73] 27.99435 27.50760 27.47715 28.08477 28.30472 28.47036 28.45287 28.19905
##    [81] 28.17678 28.50157 28.51440 28.12477 28.10626 28.52445 28.27576 28.36140
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```
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```

```
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```
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```

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```

2. Predict the consumption for a new day with a max temperature of 25, weekday = 1, and precip = 0.

```
daily_pred <- posterior_predict(pred_model, newdata = x_prime) %>% as.numeric()
daily_pred %>% quantile( probs = c(.025, .975))
```

```
##     2.5%    97.5%
## 23.76225 32.78500
```

3. Create a figure to show a comparison of the predicted distributions.

```
library(ggridges)
```

```
## Warning: package 'ggridges' was built under R version 4.0.2
```

```
tibble( values = c(predictions,daily_pred), `Prediction Type` = rep(c('average prediction','individual 
                                                   each = length(predictions))) %>%
  ggplot(aes(x = values, y = `Prediction Type`, fill = `Prediction Type`)) + geom_density_ridges2(scale
  scale_y_discrete(expand = c(0.01, .01,0.01,.7)) + ggtitle('Predicted Beer Consumption in Brazil \n fo
  ylab('') + xlab('liters of beer') +
  theme_bw() + theme(legend.position = "none") +
  scale_fill_manual(values = c("#00AFBB", "#E7B800"))
```

```
## Picking joint bandwidth of 0.221
```