BDA - Assignment 9

Contents

Install cmdStanR and import needed libraries and data

Fetch the data

```
# columns different machines rows  measurements
data("factory")
knitr::kable(factory)
```

V1	V2	V3	V4	V5	V6
83	117	101	105	79	57
92	109	93	119	97	92
92	114	92	116	103	104
46	104	86	102	79	77
67	87	67	116	92	100

1 Calculation of utilities

From Assignment 8, hierarchical models works best.

Hierarchical model include machine 7 prediction

```
writeLines(readLines("factory_hierA9.stan"))
```

```
## // Factory machines hierarchical model for loo and log_lik computation
## data {
##   int<lower=0> N; // number of measurement per machine
##   int<lower=0> J; // number of machines
##   matrix [N,J] y; //quality measurement in the specified J machine
## }
## parameters {
##   real alpha; // prior mean
##   real<lower=0> beta;// prior std
##   vector[J+1] mu;
##   real<lower=0> sigma;
## }
## model {
##   // hyper-priors
##   alpha ~ normal(100, 10);
##   beta  ~ normal(0, 10);
##   // priors
##
##   mu ~ normal(alpha, beta);
```

```
##   sigma ~ lognormal(0,3);
##
## // likelihood
##   for (j in 1:J){
##   y[,j] ~ normal(mu[j], sigma);
##   }
## }
## generated quantities{
##   vector[J] ypred;
##   real mu7;
##   real draw7;
##   vector[J] ypreds;
##   matrix[N,J] log_lik;
##   // 7 th machine mean prior
##   mu7 = normal_rng(alpha,beta);
##   // predictive distribution of the first 6 each machine
##   for (j in 1:J)
##   ypred[j] = normal_rng(mu[j],sigma);
##   // log-likelihood
##   for (i in 1:N){
##     for(j in 1:J){
##       log_lik[i][j] = normal_lpdf(y[i][j] | mu[j], sigma);
##     }
##   }
##   // predictive distribution of the 7 machine
##   for(j in 1:J){
##     ypreds[j]= normal_rng(mu[j],sigma);
##     }
##     draw7 = normal_rng(mu7,sigma);
## }
```

Prepare the data

```
data <- list(
y = factory,
N = nrow(factory),
J = ncol(factory)
)
```

Hierarchical model fitting data factory

```
hier <- cmdstan_model(stan_file = "factory_hierA9.stan")
```

```
draws_hier <- as_draws_df(model_hier$draws())
```

Utilities

The product price is 200€ Cost for production is 106€ Quality requirement for selling >= 85

```
utility <- function(draws){
  total <- length(draws)
  good = sum(draws >= 85)
  bad = total - good
  profit <- good/total*94 + bad/total*(-106)
  profit
```

```
}
```

```
ypreds <- model_hier$draws(c("ypred[1]","ypred[2]","ypred[3]",
"ypred[4]", "ypred[5]", "ypred[6]"), format="df")
utilities <- map(ypreds, utility)[1:6]
utilities
```

```
## $`ypred[1]`
## [1] -23.35
##
## $`ypred[2]`
## [1] 67.2
##
## $`ypred[3]`
## [1] 17.7
##
## $`ypred[4]`
## [1] 75.3
##
## $`ypred[5]`
## [1] 25.1
##
## $`ypred[6]`
## [1] 14.3
```

The results show the utilities from machine 1-6 is -23.2, 66.5, 17.7,74.2, 26.1 and 13.9.

Order of machines

The best to worst order of machines are Machine 4, 2, 5, 3, 6, 1

Prediction of 7th machine

```
utility(draws_hier$draw7)
```

```
## [1] 31
```

The utility for 7th machine is 31.8

Decision on buying

As the utility of 7th machine is positive and it is above the mean utility, I suggest to buy the 7th machine.