**STT 380**

**In-Class Activity 20**

1. The sample code deals with the case where the prior is a Beta(2, 2) distribution, and then there are 14 games with 9 wins.

    a. Rewrite the code so that there are 8 chains. Rewrite the code to consider the case where the prior is a Beta(5, 5) distribution. Be sure to include the correct beta distribution plot for comparison.

```
i.   `beta.binom.model <- "
ii.  data {
iii. int<lower = 0, upper = 14> X;
iv.  }
v.   parameters {
vi.  real<lower = 0, upper = 1> theta;
vii. }
viii.model {
ix.  X ~ binomial(14, theta);
x.   theta ~ beta(5,5);
xi.  }
xii. "
xiii.options(width=60)
xiv. sim.posterior <- stan(model_code = beta.binom.model,
xv.                  data = list(X = 9),
xvi.                 chains = 8,
xvii.                 iter = 5000*2,
xviii.                seed=12345)
xix.
xx. round(as.array(sim.posterior, pars = "theta"),4) %>%
xxi.  head(6)
xxii.
xxiii.mcmc_trace(sim.posterior,pars = "theta", size= 0.1)
```

xxiv.

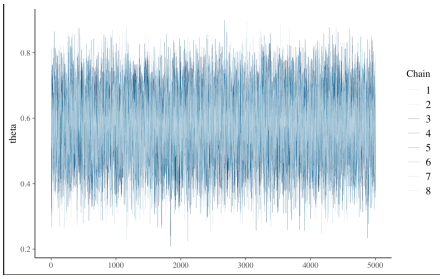
xxv.mcmc_dens(sim.posterior, pars = "theta") +

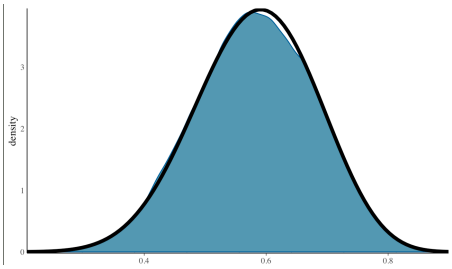
xxvi. yaxis_text(TRUE) +

xxvii. ylab("density") +

xxviii. stat_function(fun = function(x) dbeta(x, 14, 10),

xxix. col = "black",size = 2)




b. Rewrite the original code to consider the case where you play 20 games and win 15. Be sure to include the correct beta distribution plot for comparison.

i. beta.binom.model <- "

ii. data {

iii. int<lower = 0, upper = 20> X;

iv. }

v. parameters {

vi. real<lower = 0, upper = 1> theta;

vii. }

viii.model {

ix. X ~ binomial(20, theta);

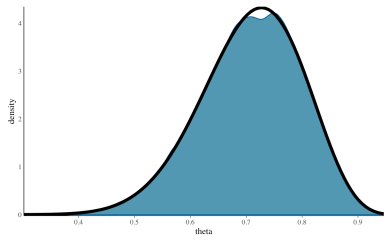
x. theta ~ beta(2, 2);

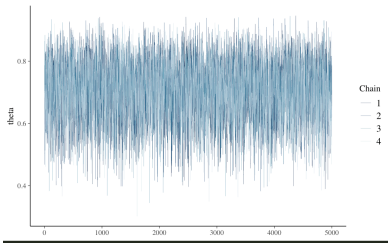
xi. }

xii. "

xiii.options(width=60)

```
xiv. sim.posterior <- stan(model_code = beta.binom.model,
xv.                  data = list(X = 15),
xvi.                 chains = 4,
xvii.                 iter = 5000*2,
xviii.                seed=12345)
xix.round(as.array(sim.posterior, pars = "theta"),4) %>%
xx.   head(6)
xxi.
xxii.mcmc_trace(sim.posterior,pars = "theta", size= 0.1)
xxiii.
xxiv.mcmc_dens(sim.posterior, pars = "theta") +
xxv.  yaxis_text(TRUE) +
xxvi.  ylab("density") +
xxvii.  stat_function(fun = function(x) dbeta(x, 17, 7),
xxviii.              col = "black",size = 2)
```




c. Rewrite the code from (a) to consider the case where there are only 100 iterations (50 burn-in, 50 counted). How does the trace plot look? How does the density plot compare to the corresponding beta distribution?

```
i.  beta.binom.model <- "
ii.  data {
iii.  int<lower = 0, upper = 20> X;
```

```
  }
  parameters {
  real<lower = 0, upper = 1> theta;
  }
  model {
  X ~ binomial(20, theta);
  theta ~ beta(2, 2);
  }
  "
  options(width=60)
  sim.posterior <- stan(model_code = beta.binom.model,
                        data = list(X = 15),
                        chains = 4,
                         iter = 5000*2,
                         seed=12345)
  round(as.array(sim.posterior, pars = "theta"),4) %>%
  head(6)

  mcmc_trace(sim.posterior,pars = "theta", size= 0.1)

  mcmc_dens(sim.posterior, pars = "theta") +
  yaxis_text(TRUE) +
  ylab("density") +
  stat_function(fun = function(x) dbeta(x, 17, 7),
                col = "black",size = 2)


```

xxxiii.c. Rewrite the code from (a) to consider the case where there are only 100 iterations (50 burn-in, 50 counted). How does the trace plot look? How does the density plot compare to the corresponding beta distribution?

xxxiv.```{r}

xxxv.beta.binom.model <- "

xxxvi.data {

xxxvii.int<lower = 0, upper = 14> X;

xxxviii.}

xxxix.parameters {

xl. real<lower = 0, upper = 1> theta;

xli. }

xlii.model {

xliii.X ~ binomial(14, theta);

xliv.theta ~ beta(5,5);

xlv.}

xlvi."

xlvii.options(width=60)

xlviii.sim.posterior <- stan(model_code = beta.binom.model,

xlix. data = list(X = 9),

l. chains = 8,

li. iter = 50*2,

lii. seed=12345)

liii.

liv. round(as.array(sim.posterior, pars = "theta"),4) %>%

lv. head(6)

lvi.

lvii.mcmc_trace(sim.posterior,pars = "theta", size= 0.1)

lviii.

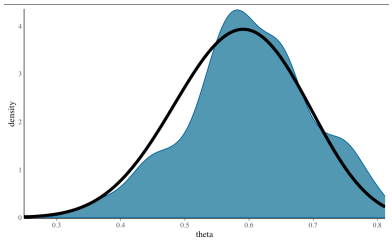
lix. mcmc_dens(sim.posterior, pars = "theta") +

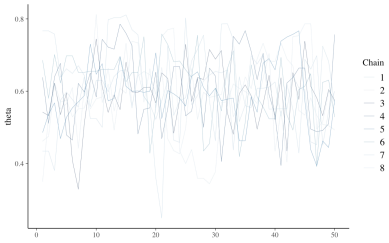
lx. yaxis_text(TRUE) +

lxi. ylab("density") +

lxii. stat_function(fun = function(x) dbeta(x, 14, 10),

lxiii. col = "black",size = 2)




d. For (b) print out the sim.posterior and compare the quantile values shown to that of the actual posterior beta distribution.

i. beta.binom.model <- "

ii. data {

iii. int<lower = 0, upper = 20> X;

iv. }

v. parameters {

vi. real<lower = 0, upper = 1> theta;

vii. }

viii. model {

ix. X ~ binomial(20, theta);

x. theta ~ beta(2, 2);

xi. }

xii. "

xiii. options(width=60)

xiv. sim.posterior <- stan(model_code = beta.binom.model,

xv. data = list(X = 15),

xvi. chains = 4,

xvii. iter = 5000*2,

xviii. seed=12345)

xix.print(sim.posterior)

1. mean se_mean sd 2.5% 25% 50% 75%
2. theta 0.71 0.00 0.09 0.52 0.65 0.71 0.77
3. lp__ -15.00 0.01 0.73 -17.09 -15.17 -14.72 -14.54
4. 97.5% n_eff Rhat
5. theta 0.87 7200 1
6. lp__ -14.49 8487 1

xx. qbeta(0.25,17,7) = 0.6489291

xxi.qbeta(.025,17,7) = 0.515948

xxii.qbeta(.975,17,7) = 0.8678971

xxiii.qbeta(.50,17,7) = 0.7142015

xxiv.qbeta(.75,17,7) = 0.7739542