ST 540 HW 4

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```
library(purrr)
library(tidyr)
library(dplyr)
library(knitr)

#raw data for study
player<- c("Russell Westbrook","James Harden", "Kawhi Leonard", "Lebron
James", "Isaiah Thomas", "Stephen Curry", "Giannis Antetokounmpo", "John
Wall", "Anthony Davis", "Kevin Durant")
overall<- c(.845, .847, .880, .674, .909, .898, .770, .801, .802, .875)
cMakes<- c(64, 72, 55, 27, 75, 24, 28, 66, 40, 13)
cAtt<- c(75,95,63, 39, 83, 26, 41, 82, 54, 16)
id<- c(1:10)

#construct list of all vectors
data<- list( "player" = player, "overall"= overall, "cMakes" = cMakes,
"cAtt"= cAtt, "id" = id)
```

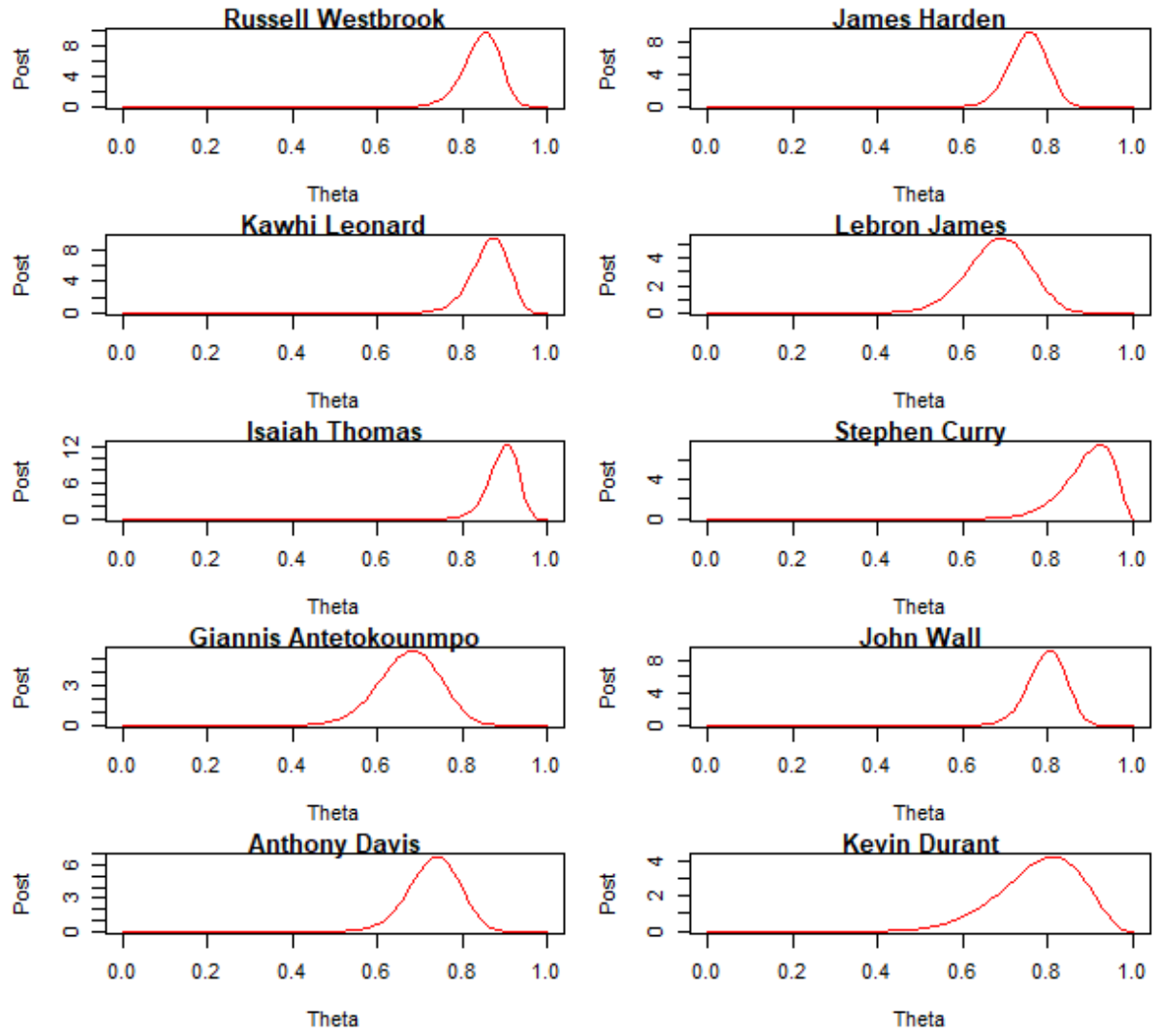
(A)

My prior is a Beta(1,1) because we are supposed to use a uniform prior with a binominal likelihood. Since this is a conjugate prior the result of this is a Beta(y + 1, n-y + 1) posterior.

(B)

```
#theta
m<- seq(0,1, by = .01)

#function for posterior
betaPost<-function( x,n){
  a= x +1
  b = n-x + 1
  cbind("x" = m, "y" = dbeta(m, a ,b ))%>%return()
}

#create a list of all the posteriror to be plotted
clutch<- pmap(data, ~betaPost( ..3, ..4))

#plotting posteriror
op <- par(pty="m", mfrow=c(5, 2), mar=c(4.2, 4.2, 1, 1))

  for(i in 1:length(player)){
```

```
      plot(x = clutch[[i]][,1],y = clutch[[i]][,2], type = "l",col = "red",
xlab = "Theta", ylab= "Post", main = player[i])
  }
```




```
par(op)
```

(C)

```
#function for summary
postSum<-function( x,n, nam, over){
  a= x +1
  b = n-x + 1
  #mean
  pMean=a/(a+b)
  #std
  pStd = sqrt((a*b)/(((a+b)**2)*(a+b+1)))
  #credible interval
  ci = qbeta(c(.025, .975), a,b)
  #lower bound credible interval
```

```
  lowCi=ci[1]
  #upper bound credible interval
  hiCi=ci[2]
  #portion less than .05
  less= pbeta(.5,a,b)
  cbind("name" = nam, "overAll"= over, "pMean" = pMean, "pStd" = pStd,
"lowCi"= lowCi, "hiCi"= hiCi, "less"= less)%>%
    as.data.frame%>%
      return()
}

#creating dataframe with summary
df_c<- pmap_df(data, ~postSum(..3,..4, ..5, ..2))

#adding players names
df_c$name<- player[df_c$name]

df_c%>%kable(caption = "Summary Of Player's Posterior")
```

Summary Of Player's Posterior

name	overAll	pMean	pStd	lowCi	hiCi	less
Russell Westbrook	0.845	0.8441558	0.0410685	0.7557660	0.9156623	0.0000000
James Harden	0.847	0.7525773	0.0435895	0.6625065	0.8327883	0.0000002
Kawhi Leonard	0.880	0.8615385	0.0425138	0.7684737	0.9336259	0.0000000
Lebron James	0.674	0.6829268	0.0718029	0.5346837	0.8142710	0.0082945
Isaiah Thomas	0.909	0.8941176	0.0331787	0.8209403	0.9498226	0.0000000
Stephen Curry	0.898	0.8928571	0.0574346	0.7571017	0.9764725	0.0000028
Giannis Antetokounmpo	0.770	0.6744186	0.0706429	0.5291394	0.8043320	0.0097602
John Wall	0.801	0.7976190	0.0435786	0.7059140	0.8759195	0.0000000
Anthony Davis	0.802	0.7321429	0.0586560	0.6099716	0.8386204	0.0001776
Kevin Durant	0.875	0.7777778	0.0953772	0.5656821	0.9318923	0.0063629

(D)

```
#checking to see if the overall matches the posterior
df_d<- pmap_df(data, ~{cbind("name" = ..5, "pBelow" = pbeta(..2,..3+ 1,..4 -
..3 + 1), "pAbove" = 1- pbeta(..2,..3+ 1,..4 - ..3 + 1))}%>%as.data.frame)

#adding names and orginal overall to table
df_d$overAll<- overall[df_d$name]
df_d$name<- player[df_d$name]
```

```r
df_d[-3]%>%
  arrange(pBelow)%>%
    kable(caption = "%Percentage above and below Overall")
```

%Percentage above and below Overall

name	pBelow	overAll
Lebron James	0.4354453	0.674
Stephen Curry	0.4706771	0.898
Russell Westbrook	0.4792879	0.845
John Wall	0.5092366	0.801
Kawhi Leonard	0.6402441	0.880
Isaiah Thomas	0.6446247	0.909
Kevin Durant	0.8457459	0.875
Anthony Davis	0.8866639	0.802
Giannis Antetokounmpo	0.9166567	0.770
James Harden	0.9909792	0.847

There is a high probability the overall matches the clutch for James Harden. With Kawhi Leonard, Isaiah Thomas, Kevin Durant, Anthony Davis, and Giannis Antetokounmpo the `pBelow` gives probability that the overall scores are less than the clutch percentage. While for Lebron, Stephen and Russel their probability suggest that clutch percentage should be greater than the overall.

(E)

I don't think the data is sensitive to this prior since we are told that we are dealing with a large sample. So given the large sample size our posterior mean gets closer to the sample proportion. Therefore I think the prior has minimal effect.

MCMC

```r
#seed so experiment can be reproduced
set.seed(100)

#function that allows for random draws
mcmc<- function(x,n){
  a= x +1
  b = n-x + 1
  rbeta(100000, a,b)%>% return()
}

# Using the data data frame with raw information, random draws were made for
each of the 10 players
df_e<- pmap(data, ~mcmc(..3,..4))
```

```r
#a matrix to hold all the comparison scores for each player
l<-matrix(nrow= 10, ncol = 10)
#comparison
for(i in 1:10){
  var<- double(10)
  for(j in 1:10){
    #all players were compared to each other and
    #scores were recorded
    l[i,j]= (mean(df_e[[i]]> df_e[[j]]))
  }
}

#transofm each player results so it can be analysed row wise
tr<- t(l)

#max score of each player was determined and the player was recorded
rank<- as.integer(rep(0,10))
per<- as.double(rep(0, 10))
for(i in 1:10){
  rank[i]= tr[i,]%>%which.max()
  per[i] = tr[i,]%>%max()

}

#summary of best player against each player
results<- data.frame("Player" = player, "Best Score" = player[rank],
"Percentage" = per)
results%>%kable(caption = "Best Player for one on one comparison")
```

Best Player for one on one comparison

Player	Best.Score	Percentage
Russell Westbrook	Isaiah Thomas	0.83010
James Harden	Isaiah Thomas	0.99498
Kawhi Leonard	Isaiah Thomas	0.72593
Lebron James	Isaiah Thomas	0.99777
Isaiah Thomas	Stephen Curry	0.53190
Stephen Curry	Isaiah Thomas	0.46810
Giannis Antetokounmpo	Isaiah Thomas	0.99877
John Wall	Isaiah Thomas	0.96284
Anthony Davis	Isaiah Thomas	0.99341
Kevin Durant	Isaiah Thomas	0.88361

Using simulation we see that Isaiah Thomas has the best free throw when compared to all players except Stephen Curry. Stephen Curry is the only player to beat Isaiah Thomas, therefore Stephen Curry is the best player.