Placenta Previa - In class activity (F15)

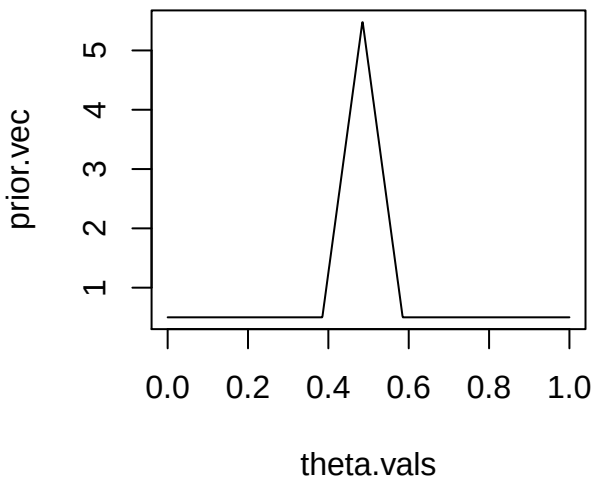
Assess evidence for whether the proportion of female births in the population of placenta previa births is less than 0.485 (the proportion of female births in the general population). An early study in Germany found that of a total of 980 placenta previa births, 437 were female.

1. Write a function to calculate densities of the piecewise linear prior.

```
prior.fun <- function(theta) {
    if(theta <= 0.385 | theta >= 0.585) {out <- 0.5}
    if(theta > 0.385 & theta <=0.485) {out <- 0.5 + (theta-.385)*50}
    if(theta > 0.485 & theta < 0.585) {out <- 0.5 + 5 - (theta-0.485)*50}
    return(out)
       }
 #test function
   prior.fun(0.02)

## [1] 0.5
```

2. Plot the prior

```
#Define grid over support of theta on which to evaluate functions
theta.vals <- seq(0,1,length=1000)
prior.vec <- apply(cbind(theta.vals), 1, prior.fun)

plot(theta.vals, prior.vec, type="l")
```

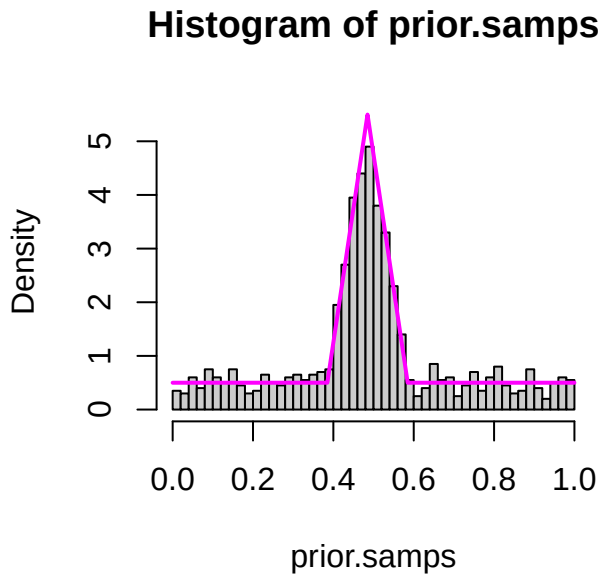


3. Use numerical integration to check that it integrates to 1. You can just use rectangles, but play around with different grid sizes.

```
step.length <- theta.vals[2] - theta.vals[1]
sum(prior.vec*step.length)

## [1] 1.0005
```

4. Use a grid approximation to sample from the prior. Display the 1000 draws and overlay the pdf.

```
grid.theta <- seq(0,1,length=10000)
prior.vec <-  apply(cbind(grid.theta), 1, prior.fun)
grid.samp.probs <- prior.vec/sum(prior.vec)
prior.samps <- sample(grid.theta, size=1000, prob=grid.samp.probs, replace=TRUE)

hist(prior.samps, nclass=50, col=gray(0.8), freq=FALSE, ylim=c(0,5.5))
  lines(grid.theta, prior.vec, col="magenta", lwd=2)
```




```
##Try for 10,000 samples too
```

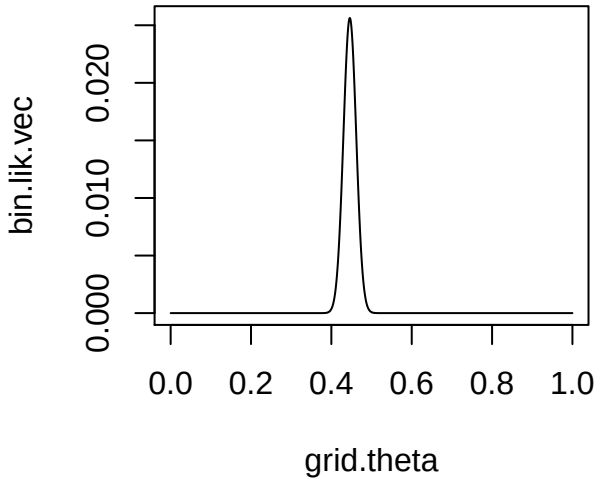
5. Using the 1000 draws, compare the approximate values obtained via summarizing these draws to the analytical results for: mean, median, $Pr(\theta < 0.385)$, and $Pr(0.385 < \theta < 0.485)$.

6. Write a function for calculating values of the likelihood function with θ as the first argument.

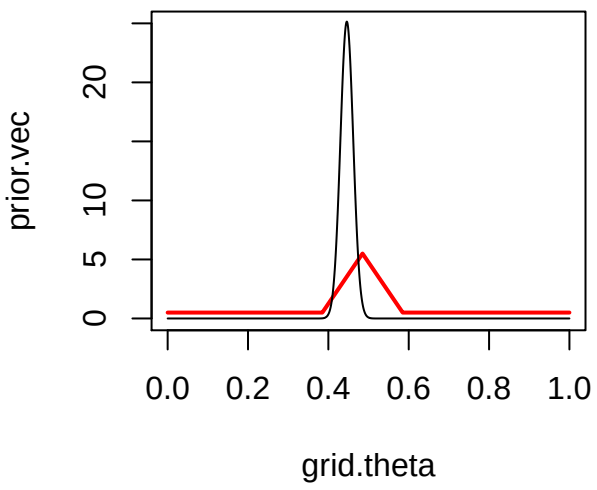
```
binom.lik.fun <- function(theta, y, n) { dbinom(y,n,theta) }
```

7. Plot the likelihood function on the same plot as the prior distribution

```
  #Evaluate the likelihood at each value of theta in theta.vals
  bin.lik.vec <- apply(cbind(grid.theta), 1, binom.lik.fun, y=437, n=980)

  #plot the likelihood
    plot(grid.theta, bin.lik.vec, type="l")
```




```
  #Plot likelihood and prior on same plot
   step <- grid.theta[2]-grid.theta[1]
   nc.lik <- sum(bin.lik.vec*step)
   nc.lik

## [1] 0.001019368

   norm.lik.vec <- bin.lik.vec/nc.lik
    plot(grid.theta, prior.vec, lwd=2, col=2, type="l", ylim=c(0,25))
      lines(grid.theta, norm.lik.vec)
```



8. Add a vertical dashed or dotted line on the plot at the MLE

```
abline(v=(437/980), lty=2) #line at sample proportion
```

9. Write a function to get values of the posterior distribution up to a proportionality constant (or combine output from your functions for the prior and the likelihood)

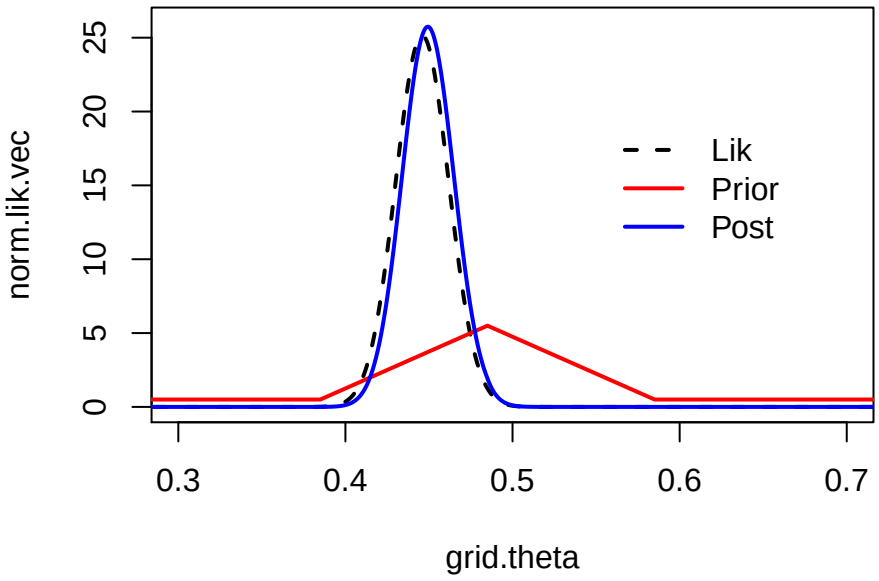
```
## Not writing new function, just combining output from above
lik.times.prior <- bin.lik.vec*prior.vec
 #plot(grid.theta, lik.times.prior, type="l")
```

10. Normalize the posterior distribution (if you haven't already)

```
 nc.post <- sum(lik.times.prior*step)
 post.vec <- lik.times.prior/nc.post
```

11. Plot the prior, likelihood, and posterior on the same plot with different colors or line types and a legible legend.

```
plot(grid.theta, norm.lik.vec, type="n", ylim=c(0,26), xlim=c(0.3,0.7))
   lines(grid.theta, norm.lik.vec, col=1, lwd=2, lty=2)
   lines(grid.theta, prior.vec, col=2, lwd=2)
   lines(grid.theta, post.vec, col="blue", lwd=2)
   legend(0.55,20, legend=c("Lik","Prior","Post"), col=c(1,2,"blue"), lwd=2,
          lty=c(2,1,1), bty="n")
```



12. Compare the posterior to those obtained from the $Beta(1,1)$ and the $Beta(0.5,0.5)$. Discuss the results.

13. Use a grid approximation to draw samples from the posterior distribution obtained using the piecewise linear prior. Obtain the sample median, sample mean, sample mode, 0.04 quantile, 0.96 quantile, and approximate the $Pr(\theta < 0.485)$. Compare these summaries with results using the $Beta(1,1)$ and the $Beta(0.5,0.5)$.

14. Could you use a histogram as a prior distribution? How?

15. If you have time, come up with another Beta distribution reflecting beliefs similar to that going into the piecewise linear prior. Compare previously obtained posterior distributions to this one.

16. What are some possible reasons to assess sensititivy of posterior inference to prior specification?