Lab 7

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Question 1

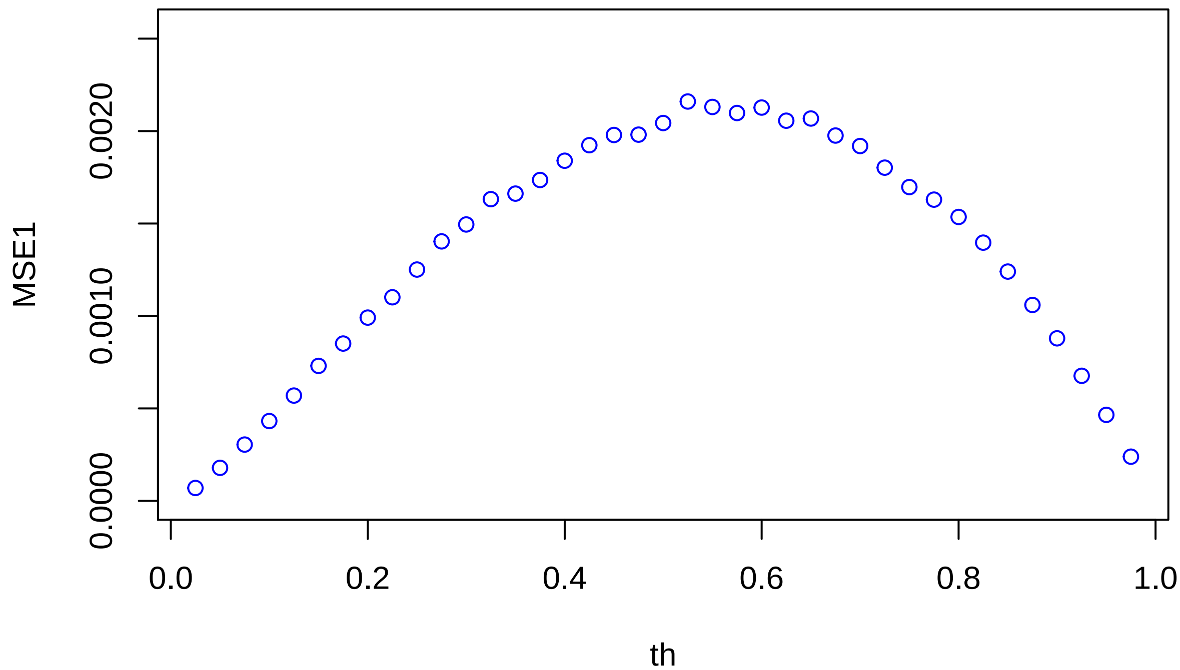
```
th = (1:39)/40
p.th = sqrt(th)
th.hat.1=th.hat.2=MSE1=MSE2=0
for (i in 1:39) {
  for (j in 1:10000) {
    samp <- rbinom(100, 2, p.th[i])
    th.hat.1[j] = mean(samp)/2
    th.hat.1[j] = th.hat.1[j]^2
    th.hat.2[j] = mean(samp==2)
  }
  mth1 = (th.hat.1 - th[i])^2
  mth2 = (th.hat.2 - th[i])^2
  MSE1[i] = mean(mth1)
  MSE2[i] = mean(mth2)
}
```

Question 2

```
ymax = max(MSE1, MSE2)
```

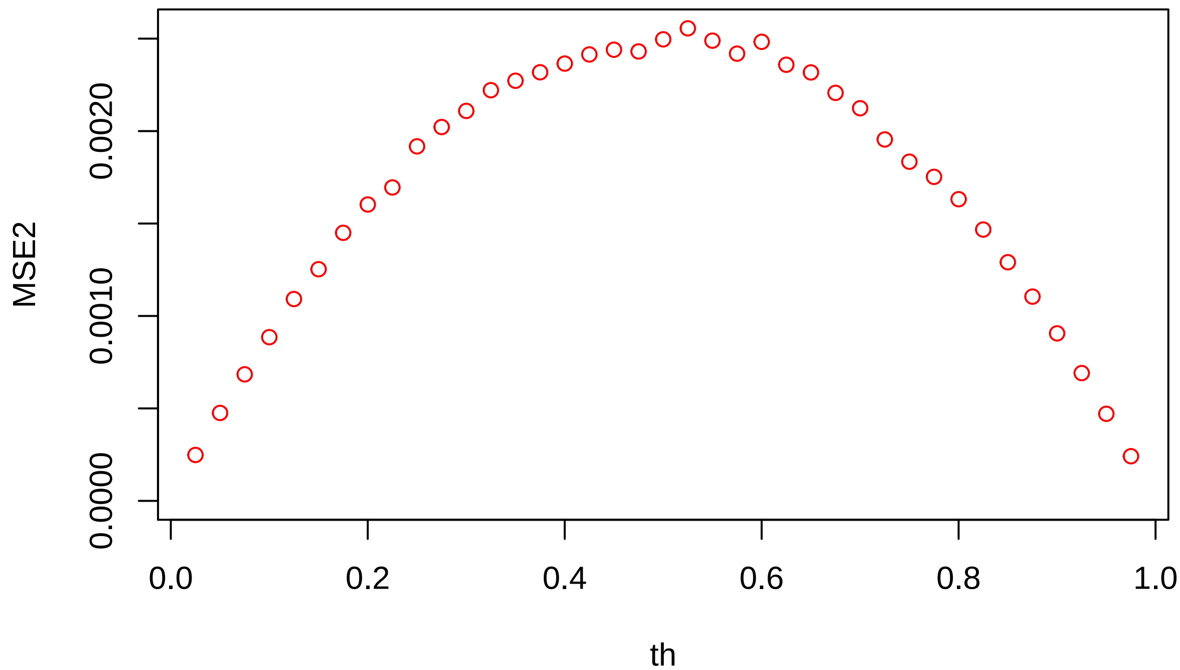
Question 3

```
plot(th,MSE1,col='blue',ylim=c(0,ymax))
```



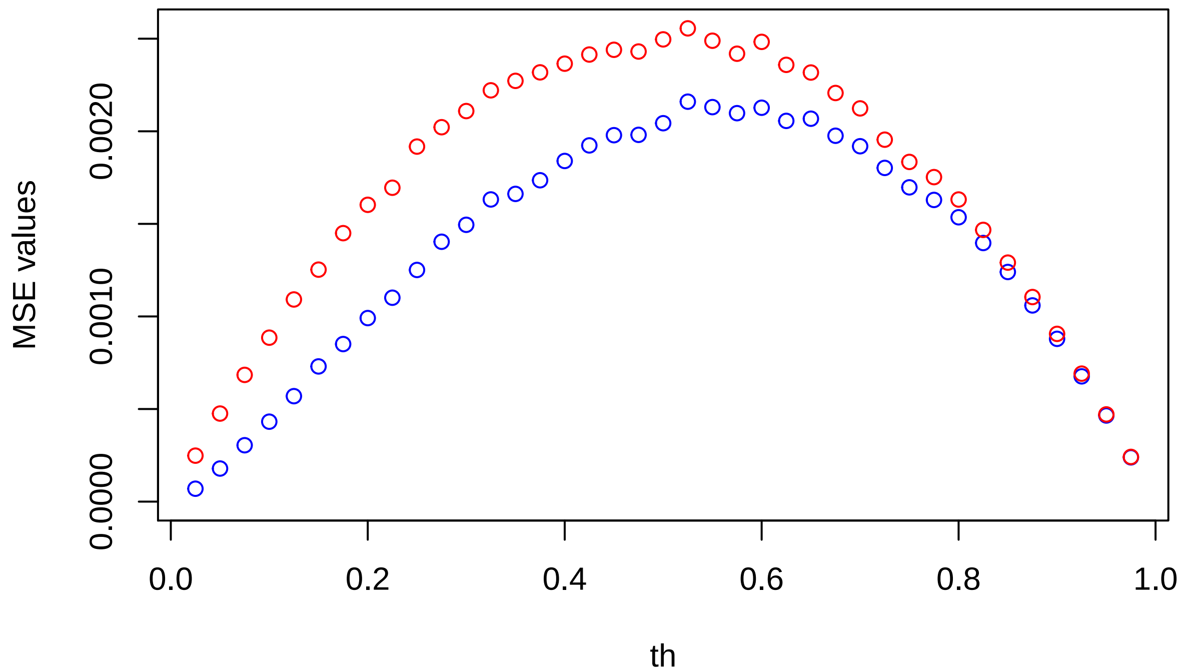
Question 4

```r
plot(th,MSE2,col='red',ylim=c(0,ymax))
```



Question 5

```
plot(th, MSE1, col='blue', ylim=c(0, ymax), xlab = 'th', ylab = 'MSE values')
points(th, MSE2, col='red')
```




```
summary(MSE1)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
## 6.968e-05 8.650e-04 1.536e-03 1.367e-03 1.950e-03 2.160e-03
```

```
summary(MSE2)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
## 0.0002415 0.0011790 0.0019170 0.0017100 0.0023380 0.0025560
```

Since θ_1 has overall lower values, it is closer to being uniform than θ_2 so therefore θ_1 is the better estimation procedure

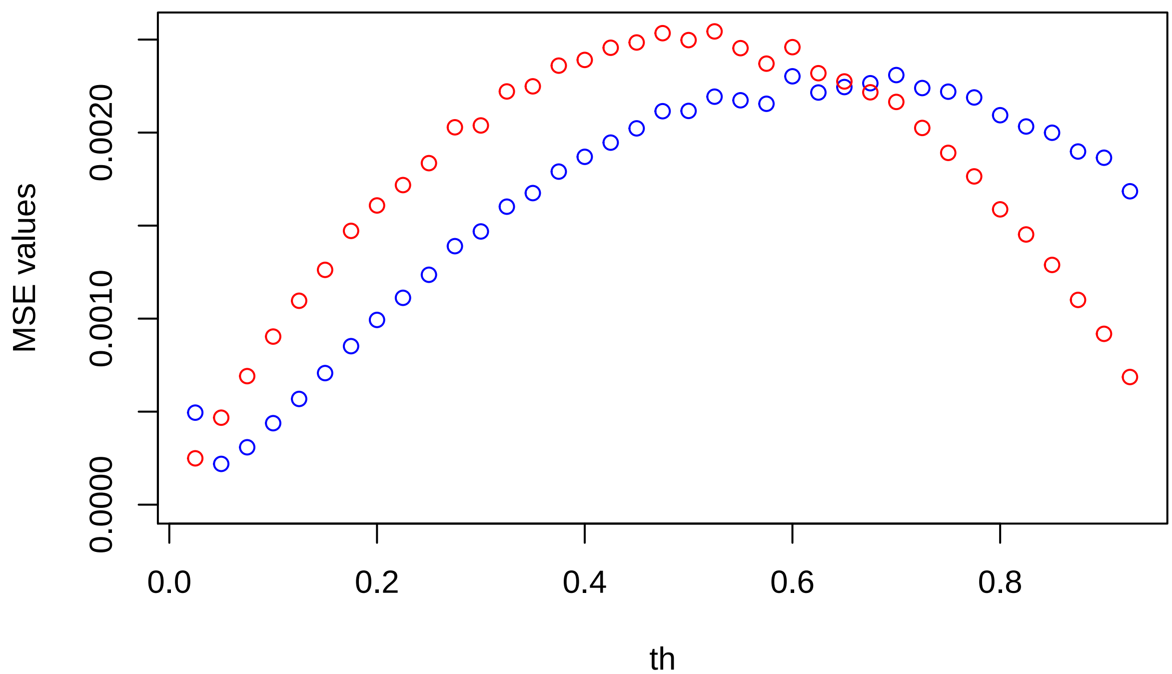
Question 6

```
th.2 = (1:37)/40
p.th.2 = sqrt( (40*th.2-1)/36)
th.hat.1.2=th.hat.2.2=MSE1.2=MSE2.2=0
for (i in 1:37) {
  for (j in 1:10000) {
    pop = rep(c(p.th.2[i], 0.5), c(9,1))
    random.p = sample(pop, size=100, replace=T)
    samp.2 = rbinom(100, 2, random.p)
    th.hat.1.2[j] = mean(samp.2)/2
    th.hat.1.2[j] = th.hat.1.2[j]^2
```

```r
    th.hat.2.2[j] = mean(samp.2==2)
  }
  mth1.2 = (th.hat.1.2 - th.2[i])^2
  mth2.2 = (th.hat.2.2 - th.2[i])^2
  MSE1.2[i] = mean(mth1.2)
  MSE2.2[i] = mean(mth2.2)
}

ymax.2 = max(MSE1.2, MSE2.2)

plot(th.2, MSE1.2, col='blue', ylim=c(0, ymax.2), xlab = 'th', ylab = 'MSE values')
points(th.2, MSE2.2, col='red')
```



Question 7

```r
summary(MSE1.2)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
## 0.0002191 0.0012360 0.0018980 0.0016490 0.0021740 0.0023090
```

```r
summary(MSE2.2)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
## 0.0002491 0.0012890 0.0020250 0.0017860 0.0023600 0.0025440
```

It seems that in this case, θ_2 is larger at first but then slopes sharply below θ_1, while θ_1 remains semi-flat in its curve as th $\to 1$. Due to this, I looked at the summary of MSE1.2 and MSE2.2, and it seems as though θ_1 is a slightly better approximation due to its lower mean error, however the difference in error is very small and it seems as though, in some cases, θ_2 would be a better model to approximate by