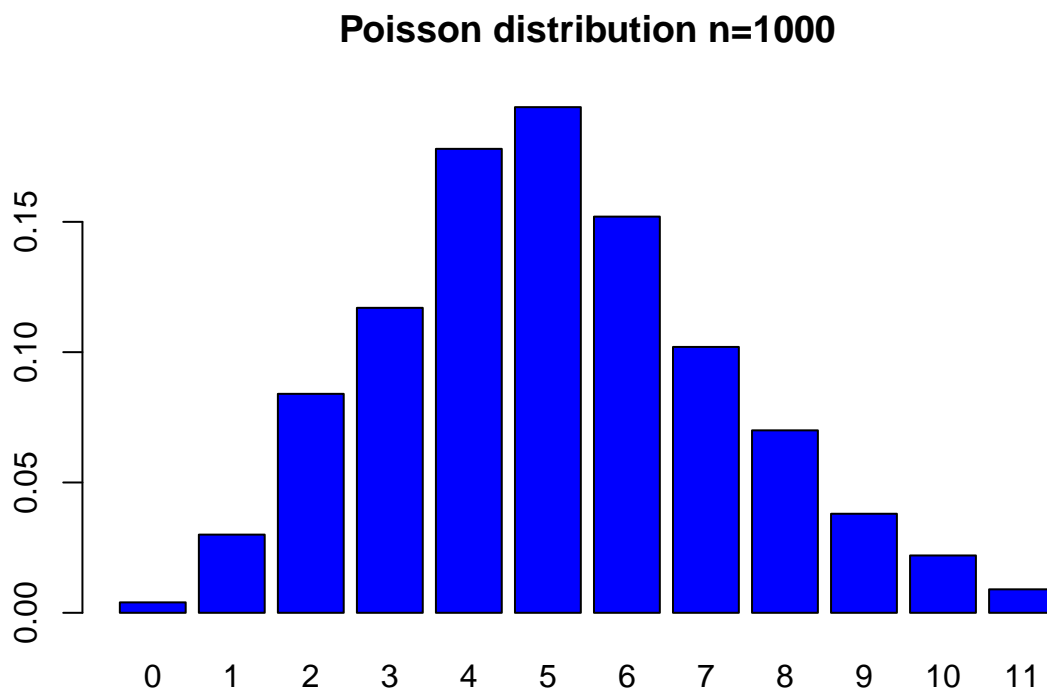# Grid Approximation and Highest Density Interval

```r
set.seed(1999)
n<-1000
lambda <- 5
data<-rpois(n, lambda)
barplot(table(data)/n,col="blue",main="Poisson distribution n=1000")
```


Poisson distribution n=1000

```r
Poisson_Dist<-function(x,lambda){
  p<-1
  for(i in 0:max(x)){
    p<-p*exp(-lambda)*lambda^i/factorial(i)
  }
  p
}
```

Likelihood

Dividing the data by the sum of data so it sums to 1? –> for simpler calculation for posterior

```r
Likelihood<-function(x){
  likeli<-NULL
  for( i in 0:max(x)){
     p<-Poisson_Dist(x,lambda=i)
     likeli<-rbind(likeli,c(i,p))
  }
  # note
  likeli[,2]<-likeli[,2]/sum(likeli[,2])

  likeli<-data.frame(likeli)
  names(likeli)<-c("lambda","Likelihood")
  likeli
}
```
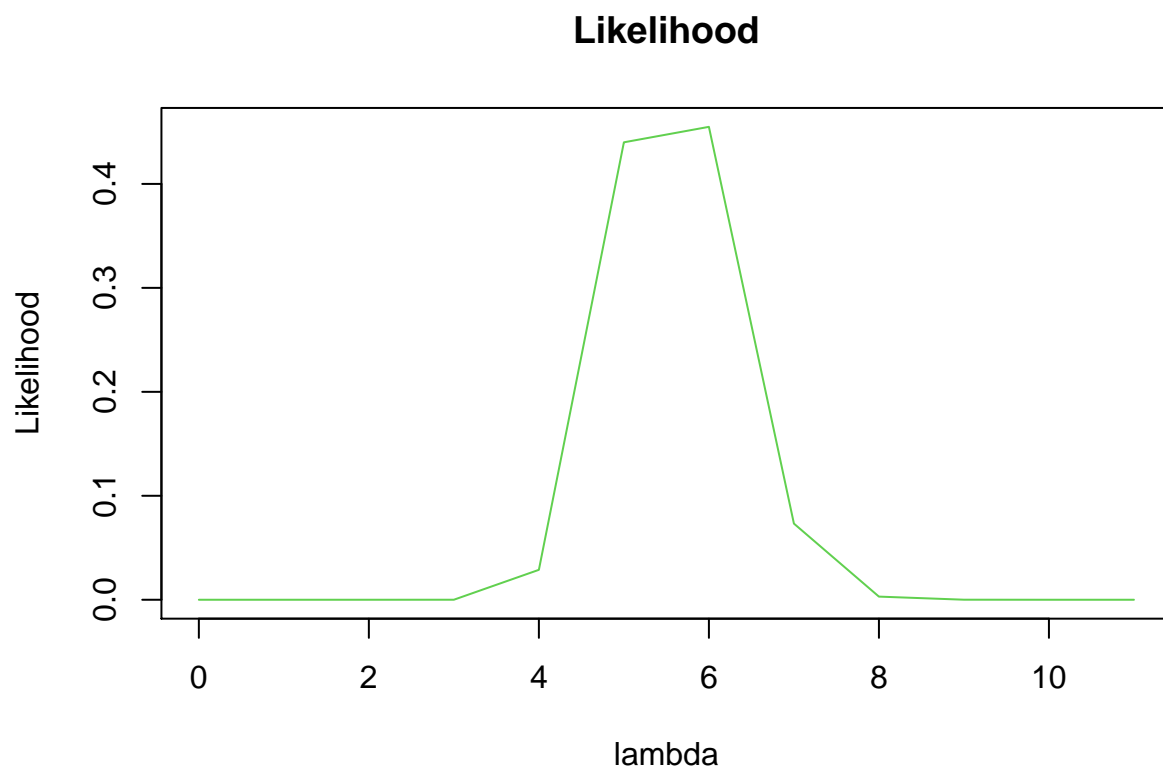
```r
LkPoi<-Likelihood(x=data)
plot(LkPoi,col=3,type="l",main="Likelihood")
```

Likelihood


```r
LkPoi
```

```
##     lambda   Likelihood
## 1        0 0.000000e+00
## 2        1 2.278110e-26
## 3        2 1.032810e-11
## 4        3 2.657724e-05
## 5        4 2.876953e-02
## 6        5 4.400072e-01
## 7        6 4.548710e-01
```
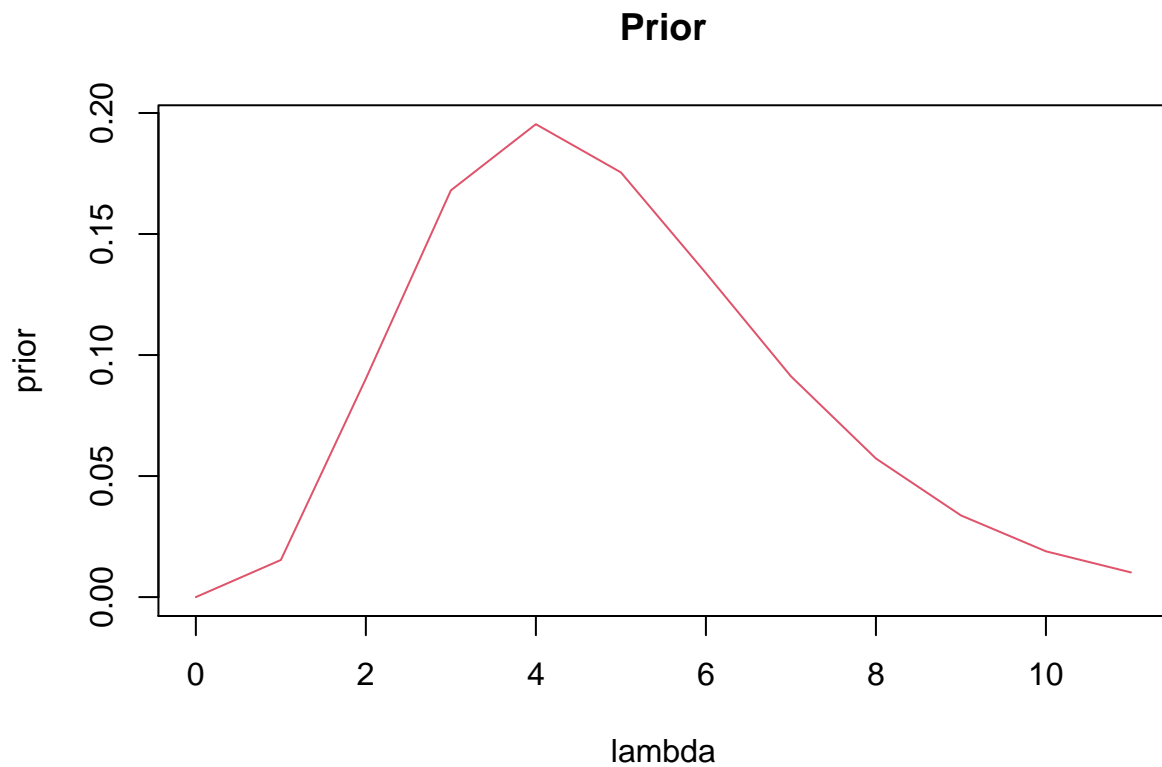
```
## 8         7 7.325589e-02
## 9         8 3.025362e-03
## 10        9 4.418857e-05
## 11       10 2.842959e-07
## 12       11 9.422237e-10
```
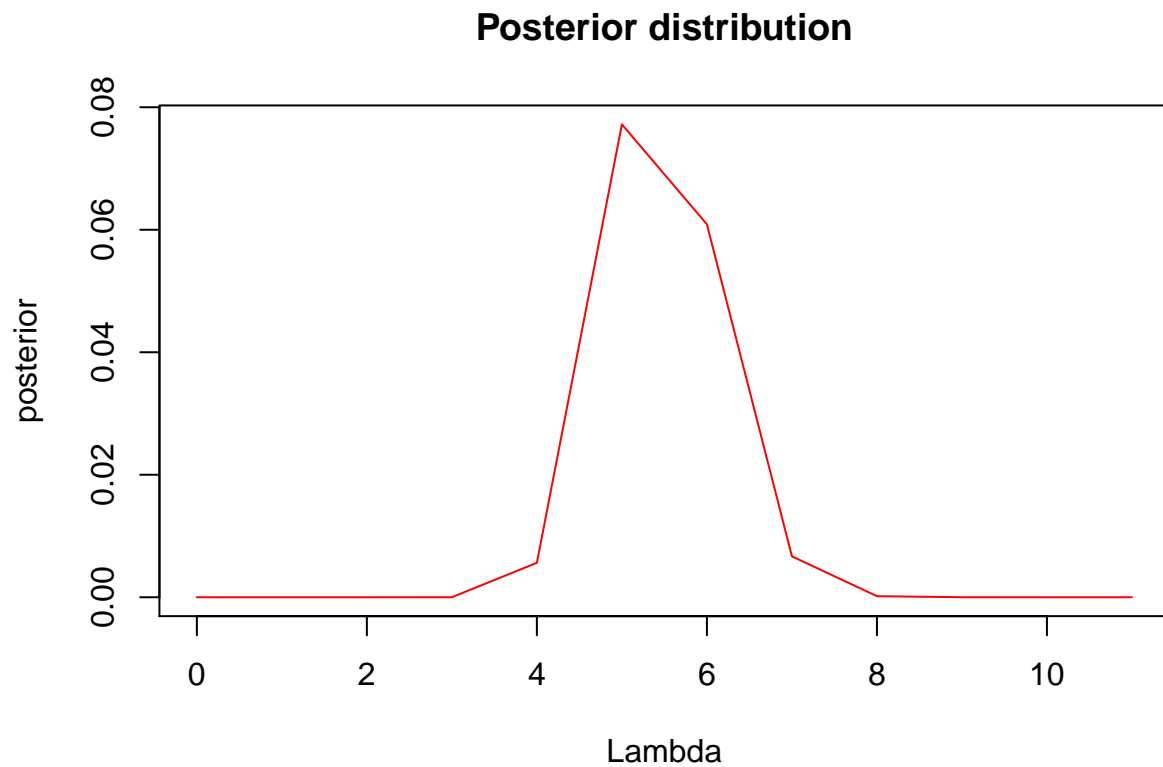
Prior

shape: Alpha rate: Beta

```r
prior<-dgamma(x=0:max(data),shape=5,rate=1)
plot(x=0:max(data),y=prior,col=2,type="l", main="Prior",xlab="lambda")
```


Posterior

```r
Posterior<-function(x,a){
  i<-seq(0,max(x))
  p<-Likelihood(x)$Likelihood*dgamma(i,shape=a,rate=1)
  Post<-data.frame(i,p)
  names(Post)<-c("Lambda","posterior")
  Post
  }
```

```r
Post <- Posterior(x=data, a=lambda)
plot(Post,col="red",type="l", main= "Posterior distribution")
```

Posterior distribution


```r
library(bayestestR)
map_estimate(Post)
```

```
## MAP Estimate
##
## Parameter | MAP_Estimate
## ------------------------
## Lambda    |         5.48
## posterior |         0.00
```
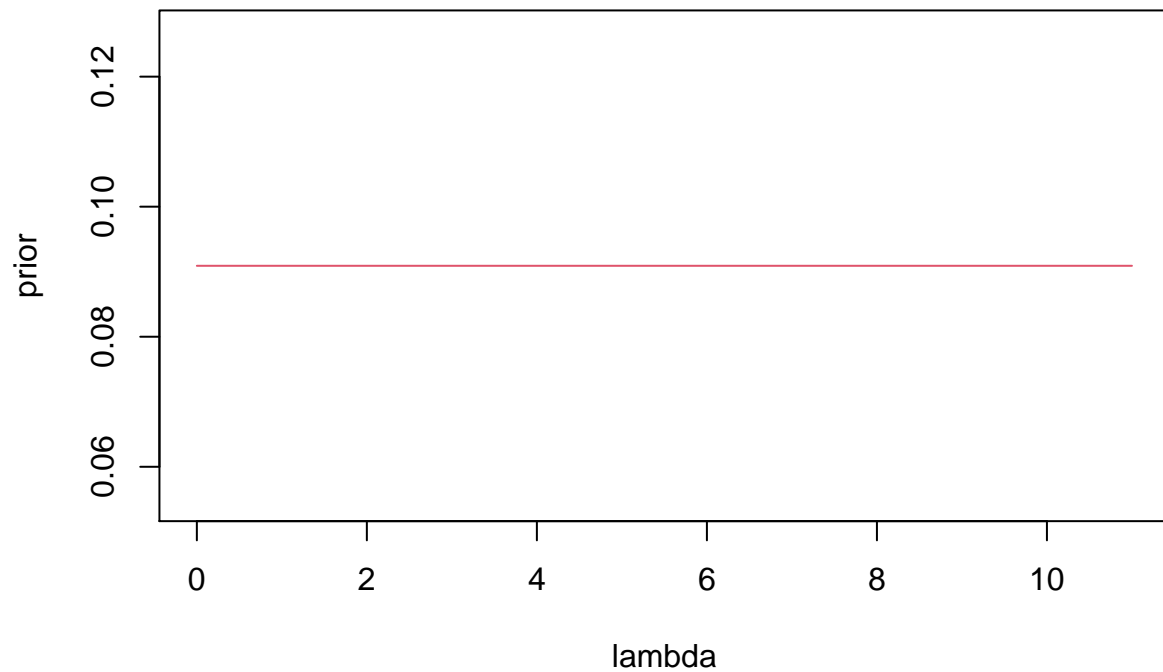
```r
ci_hdi <- ci(Post$Lambda, method = "ETI")
ci_hdi
```

```
## 95% ETI: [0.28, 10.72]
```

Prior 2

```r
prior<-dunif(x=0:max(data),0,max(data))
plot(x=0:max(data),y=prior,col=2,type="l", main="Prior",xlab="lambda")
```
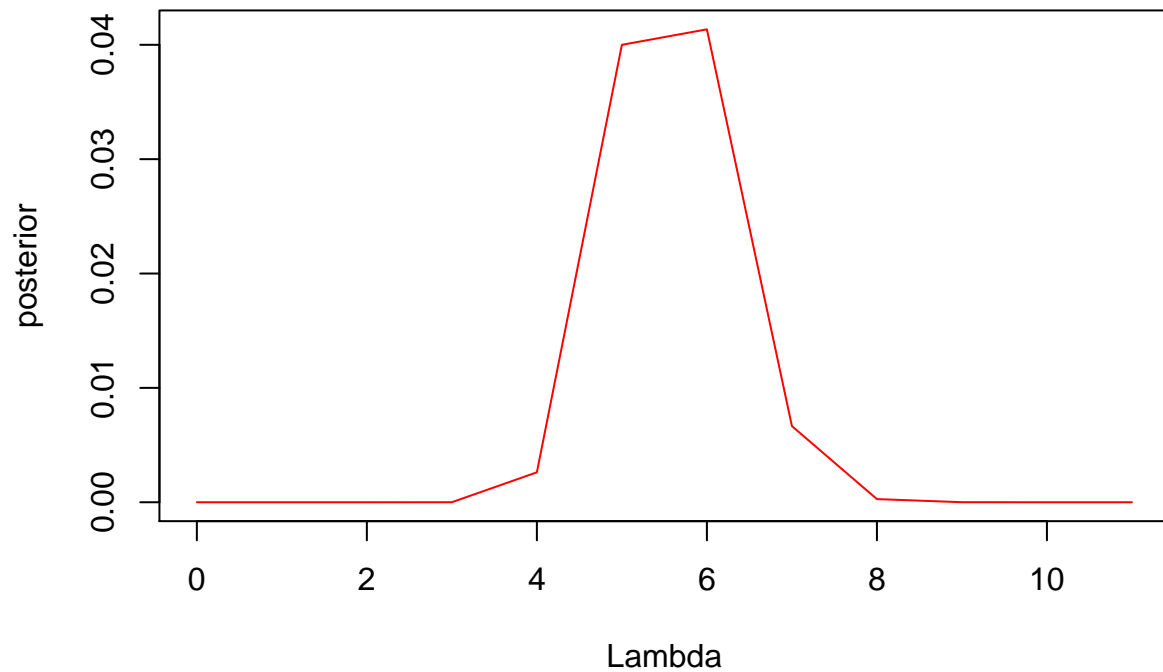
Prior

Posterior

```r
Posterior<-function(x,a){
  i<-seq(0,max(x))
  p<-Likelihood(x)$Likelihood*dunif(x=0:max(x),0,max(x))
  Post<-data.frame(i,p)
  names(Post)<-c("Lambda","posterior")
  Post
  }
```

```r
Post <- Posterior(x=data, a=lambda)
plot(Post,col="red",type="l", main= "Posterior distribution")
```

Posterior distribution


```r
library(bayestestR)
map_estimate(Post)
```

```
## MAP Estimate
##
## Parameter | MAP_Estimate
## ------------------------
## Lambda    |         5.48
## posterior |     4.04e-05
```

```r
ci_hdi <- ci(Post$Lambda, method = "HDI")
```

```
## Warning in .hdi(x, ci = i, verbose = verbose): `ci` is too large or x does not
## contain enough data points, returning NAs.
```

```r
ci_hdi
```

```
## 95% HDI:
```