R language and data analysis: Distribution

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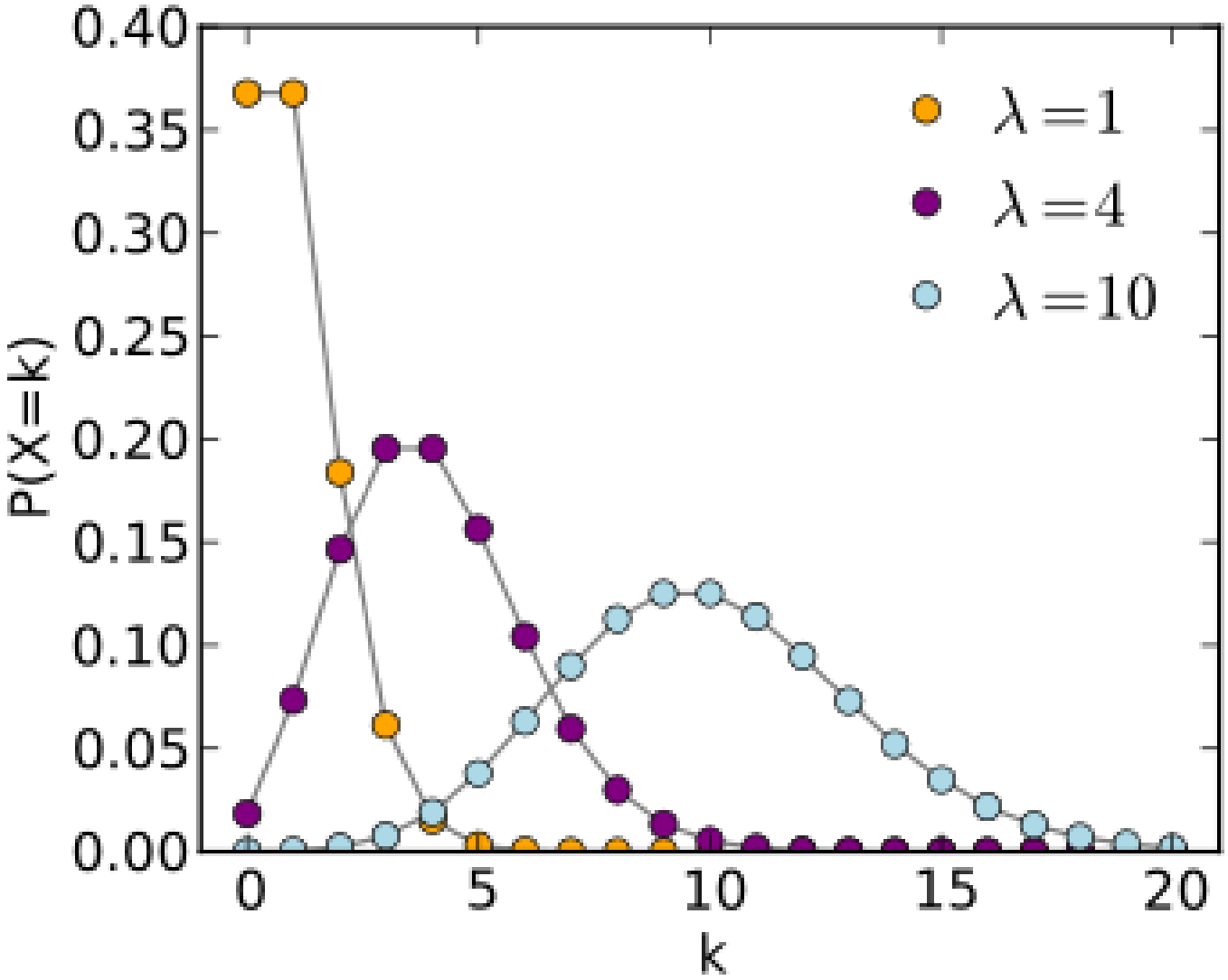
Distribution



Distribution

Distribution	Abbreviation	Distribution	Abbreviation
Beta	`beta`	Logistic	`logis`
Binomial	`binom`	Multinomial	`multinom`
Cauchy	`cauchy`	Negative binomial	`nbinom`
Chi-squared (noncentral)	`chisq`	Normal	`norm`
Exponential	`exp`	Poisson	`pois`
F	`f`	Wilcoxon Signed Rank	`signrank`
Gamma	`gamma`	T	`t`
Geometric	`geom`	Uniform	`unif`
Hypergeometric	`hyper`	Weibull	`weibull`
Lognormal	`lnorm`	Wilcoxon Rank Sum	`wilcox`

Four funtion for probability distribution

- `d` = density function
- `p` = distribution function
- `q` = quantile function
- `r` = random function

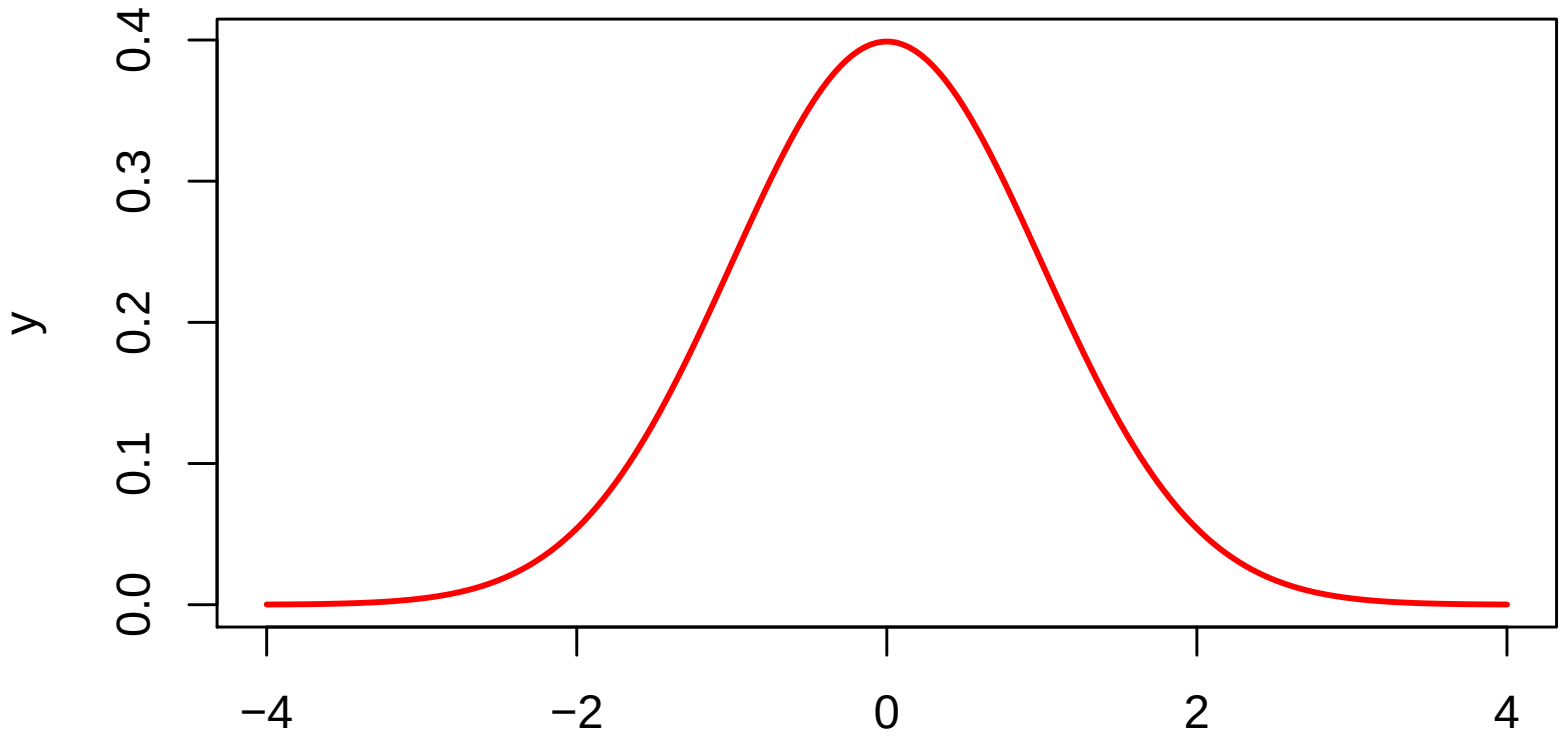
Normal distribution: pdf

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-(x-\mu)^2}{2\sigma}}$$

$$f(x) = \frac{1}{\sqrt{2\pi}} e^{\frac{-x^2}{2}}$$

Standard normal distribution: equation

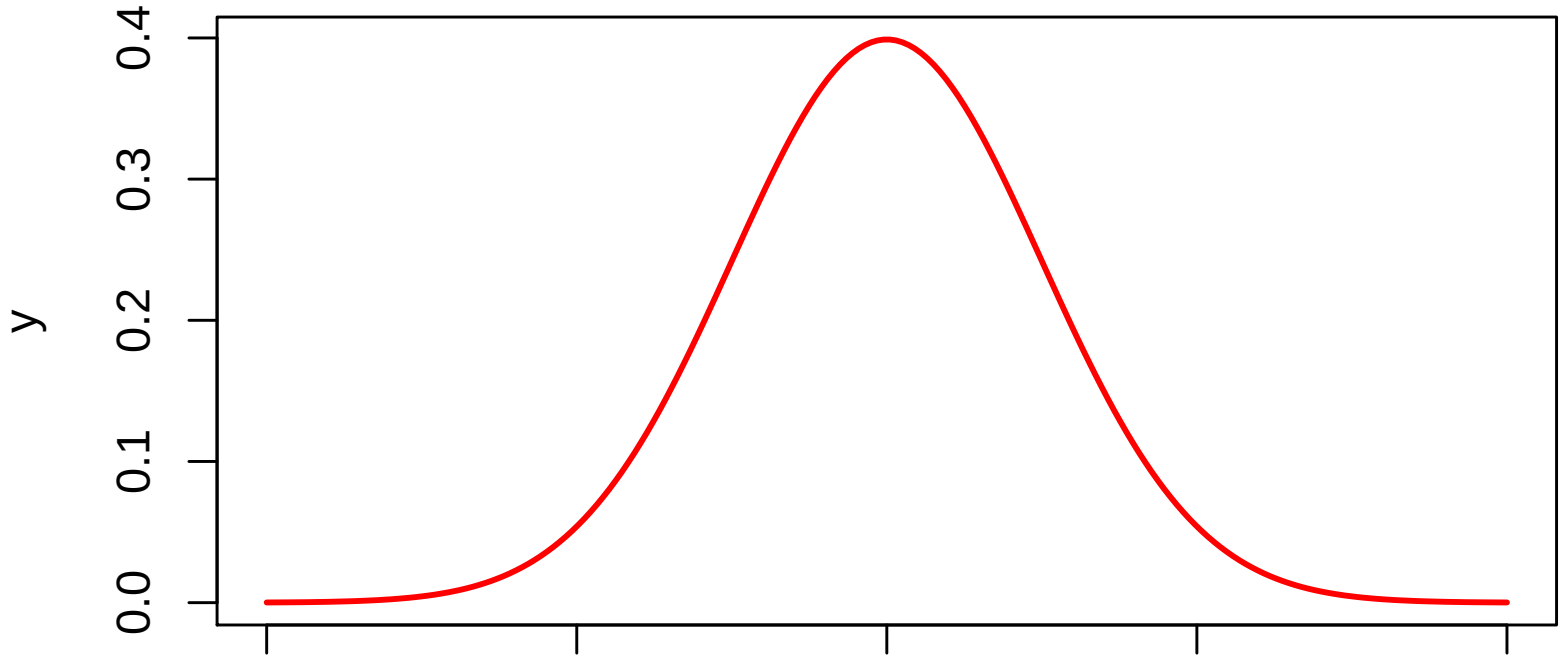
```
x=seq(-4,4,length=200)
y=1/sqrt(2*pi)*exp(-x^2/2)
plot(x,y,type="l",lwd=2,col="red")
```



Standard normal distribution:dnorm function

- dnorm

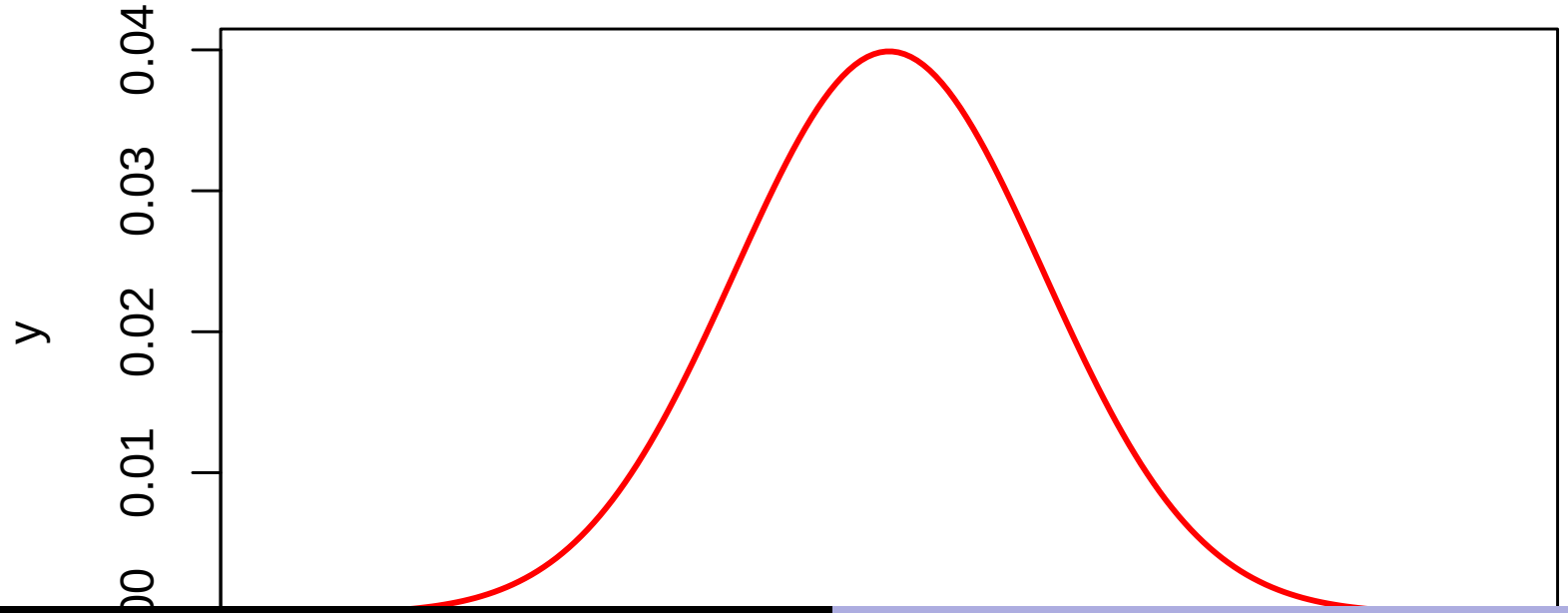
```
x=seq(-4,4,length=200)
y=dnorm(x,mean=0,sd=1)
plot(x,y,type="l",lwd=2,col="red")
```



Normal distribution:dnorm function

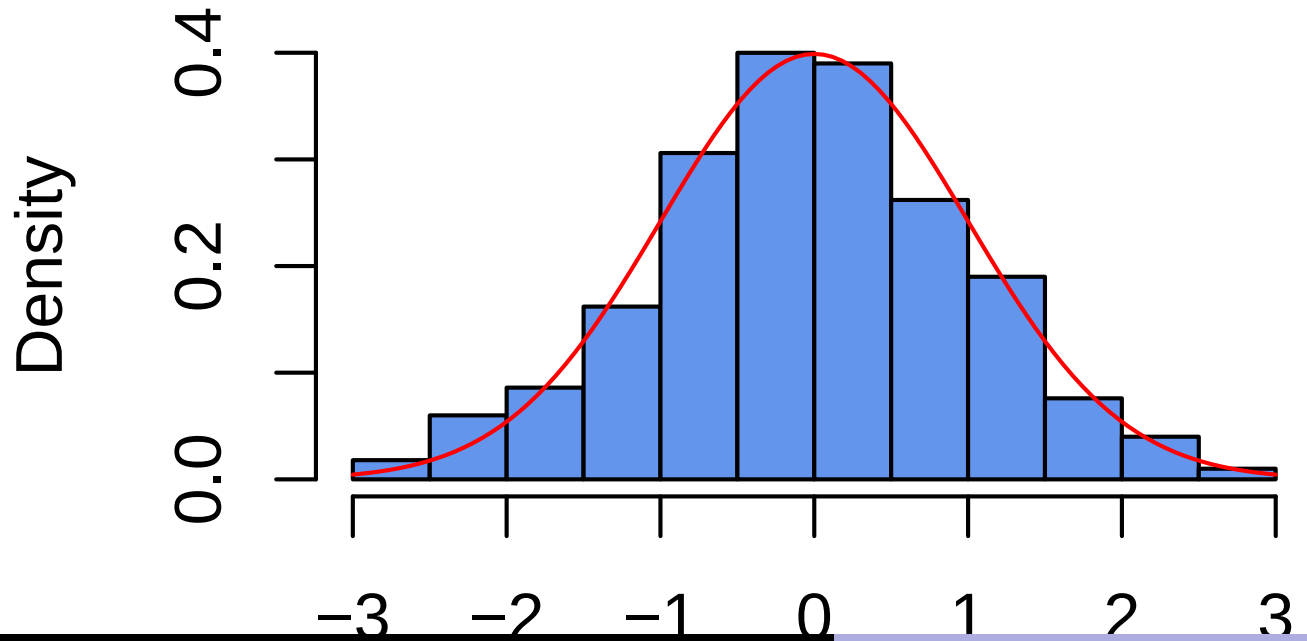
- dnorm

```
mean=20;sd=10
x=seq(mean-4*sd,mean+4*sd,length=200)
y=dnorm(x,mean,sd)
plot(x,y,type="l",lwd=2,col="red")
```



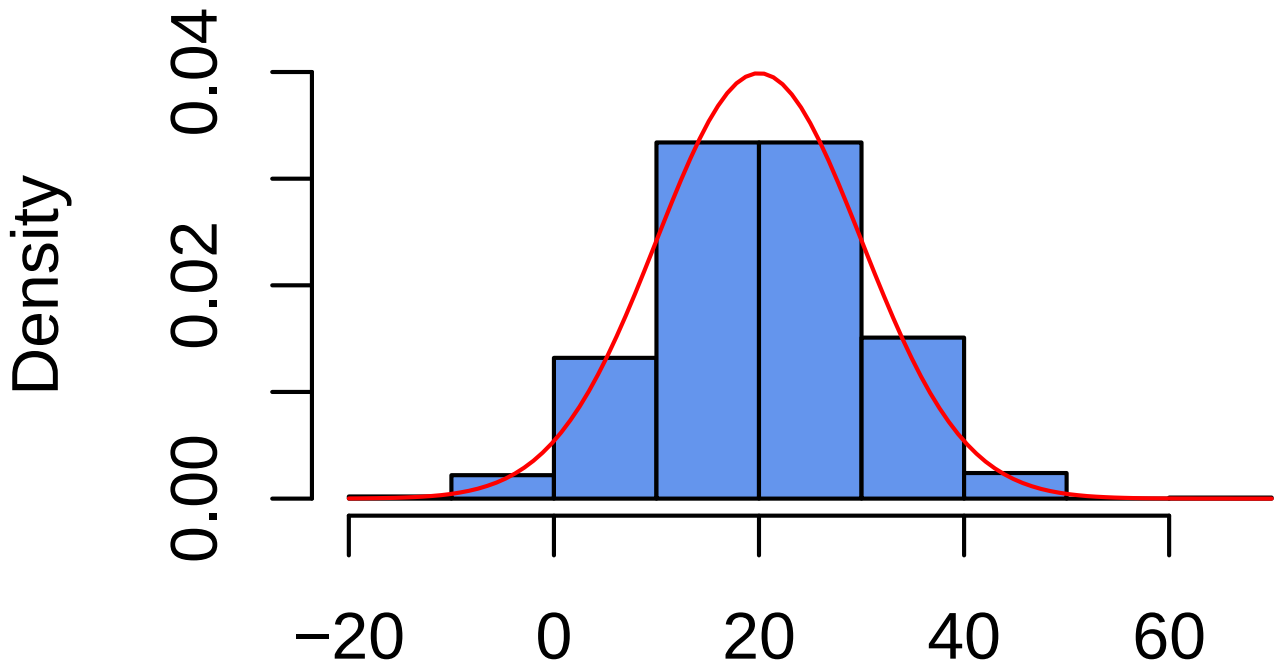
rnorm

```
par(mfrow=c(1,1))
x=seq(-4,4,length=200)
hist(rnorm(1000),freq=F,col="cornflowerblue",ylim=c(0,0.4),
curve(dnorm(x), add=TRUE, col="red")
```



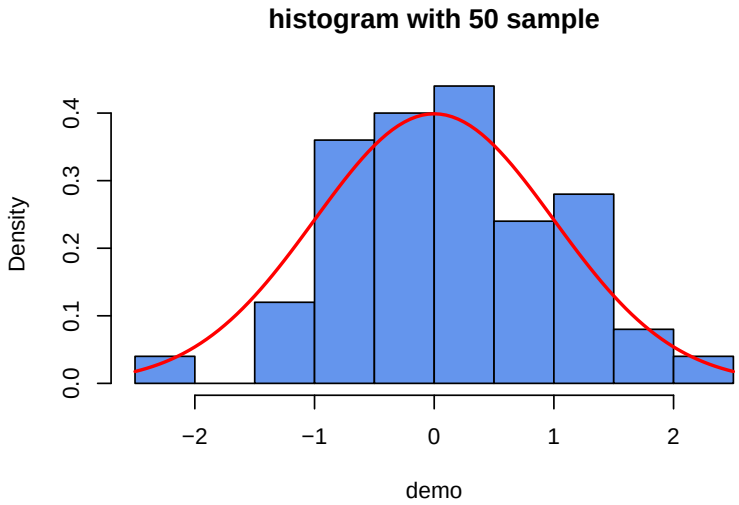
rnorm

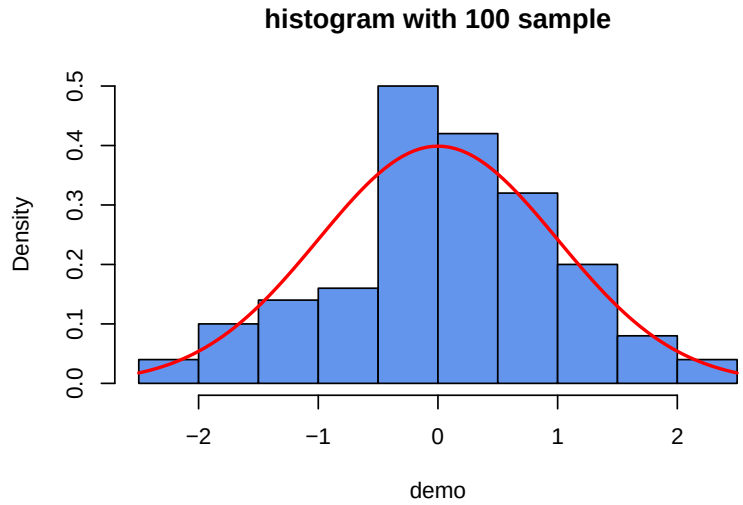
```
x=seq(-4,4,length=200)
hist(rnorm(1000,mean=20,sd=10),freq=F,col="cornflowerblue",
curve(dnorm(x,20,10), add=TRUE, col="red")
```

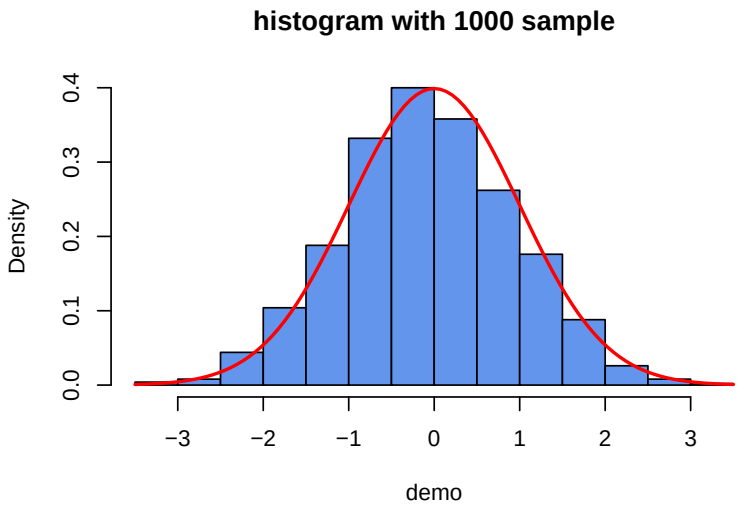


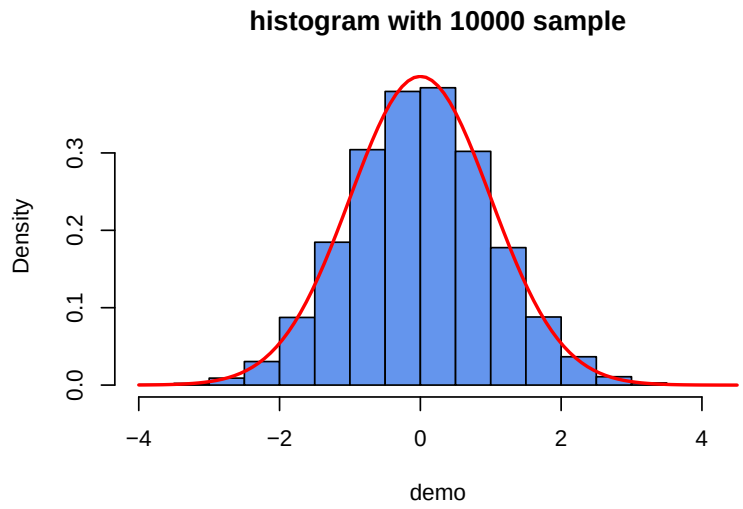
normal distribution

- sample size





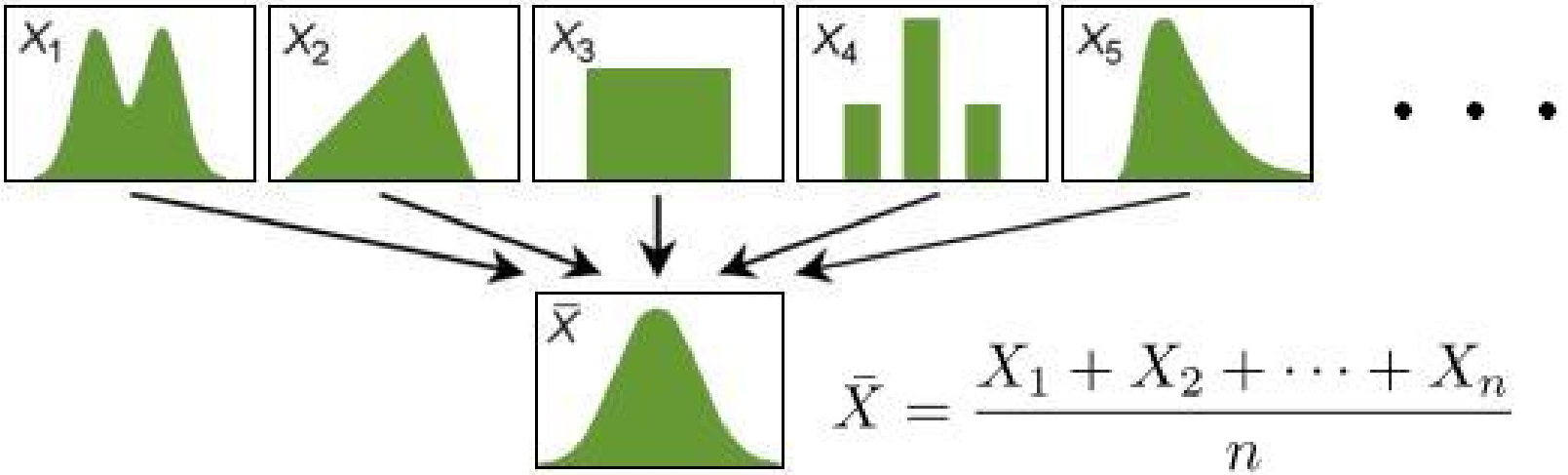




normal distribution

```
par(mfrow=c(2,2))
func<-function(x){
demo<-rnorm(x,mean=0,sd=1)
hist(demo, freq=FALSE,breaks=70,col="cornflowerblue",
     main=paste("histogram with",x,'sample'))
curve(dnorm(x), add=TRUE, col="red", lwd=2)
}
sapply(c(50,100,1000,10000),func)
```

central limit theorem (CLT)



$$\bar{X} = \frac{X_1 + X_2 + \cdots + X_n}{n}$$

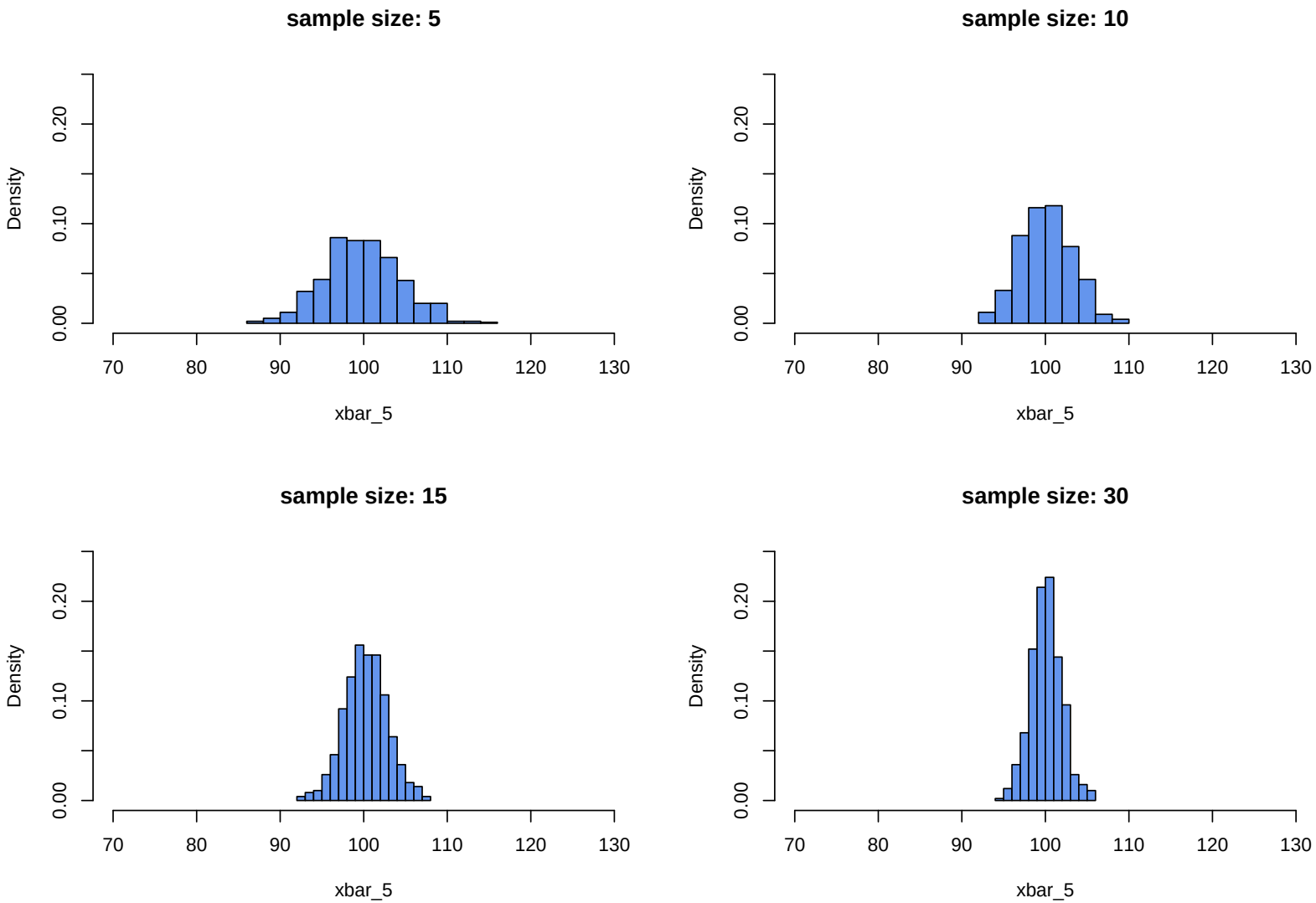
sample

```
library(readxl)
EAI<-read_excel("EAI.xls")
sample(EAI$Salary,size = 30,replace = F)
```

```
 [1] 55173.3 51316.0 50641.1 53283.7 52600.4 46940.1 49528.
[10] 51153.7 49589.6 48246.8 49968.5 50806.9 53462.4 53545.
[19] 44714.0 58532.7 45365.8 46682.9 52620.0 51860.1 55460.
[28] 44912.1 51406.0 55811.1
```

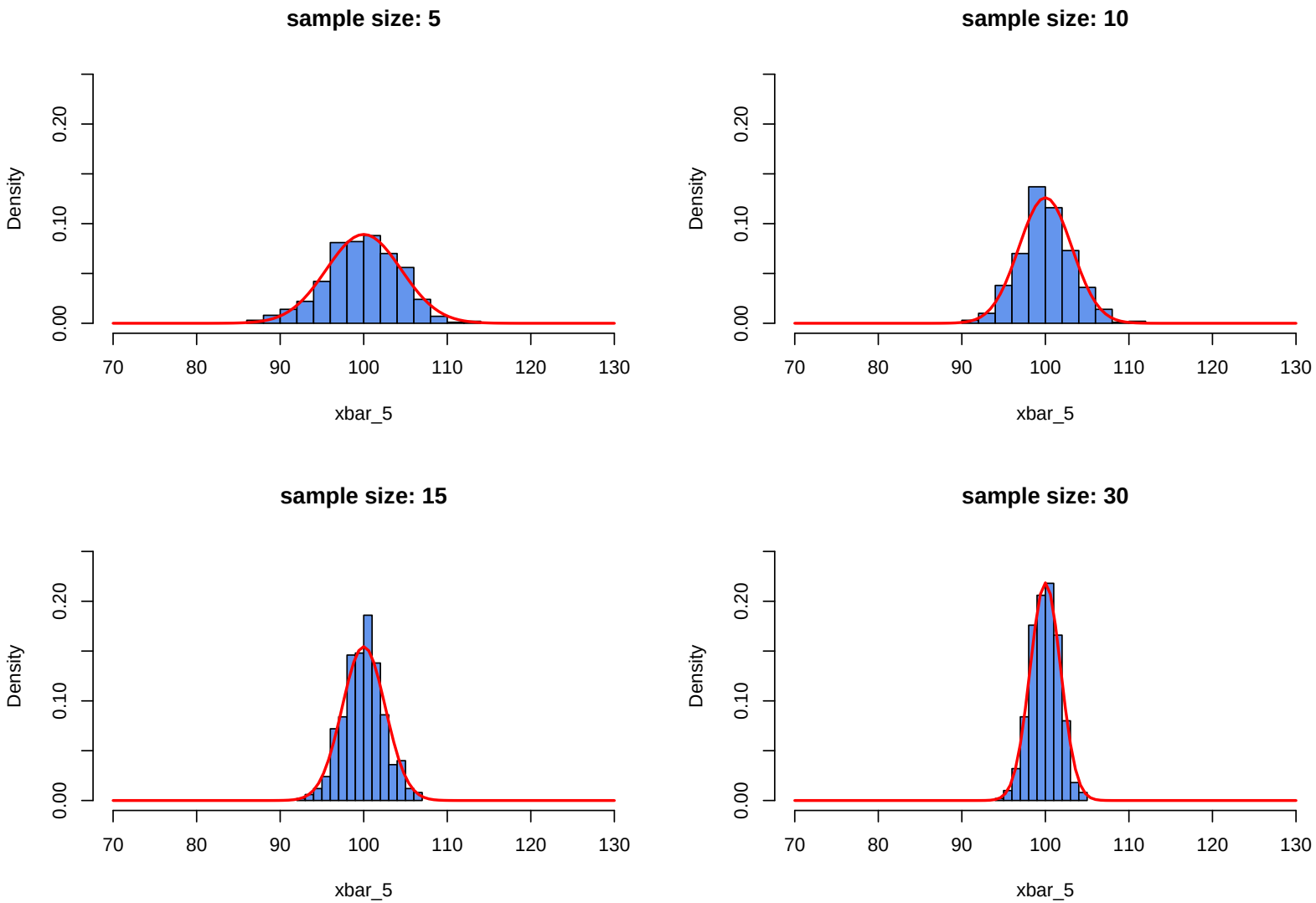
Sample from normal distribution

500 times sampling from a normal population with mean 100 and sd 20.



Sample from normal distribution

500 times sampling from a normal population with mean 100 and sd 20.



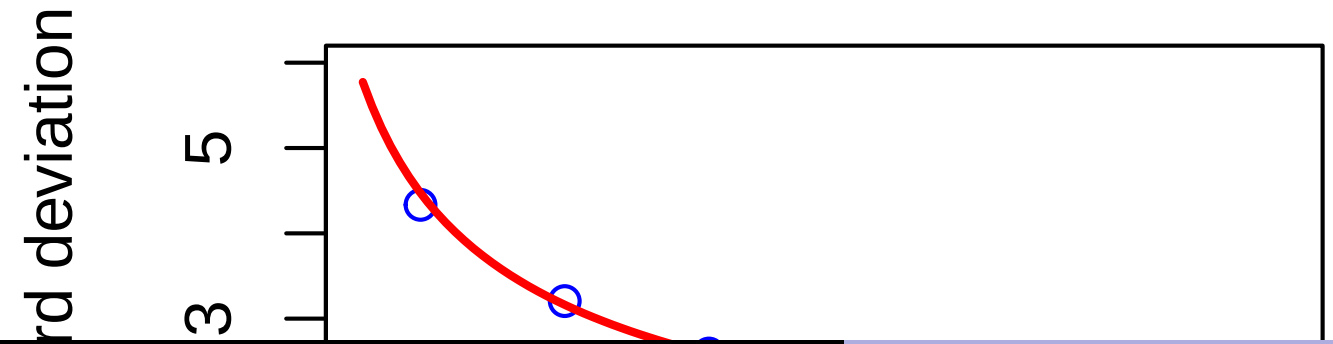
Sample from normal distribution

500 times sampling from a population with mean 100 and sd 20.

```
par(mfrow=c(2,2))
mu=100; sigma=10
clt<-function(n){
xbar=rep(NA,500)
for (i in 1:500) {
  xbar[i]=mean(rnorm(n,mean=mu,sd=sigma))
  }
hist(xbar,prob=TRUE,breaks=12,xlim=c(70,130),
     ylim=c(0,0.25),col='cornflowerblue',main=paste(
       "sample size:",n))
curve(dnorm(x,mu,sigma/sqrt(n)), add=TRUE,
      col="red", lwd=2)
return(xbar)
}
result<-sapply(c(5,10,15,30),clt)
```

standard error

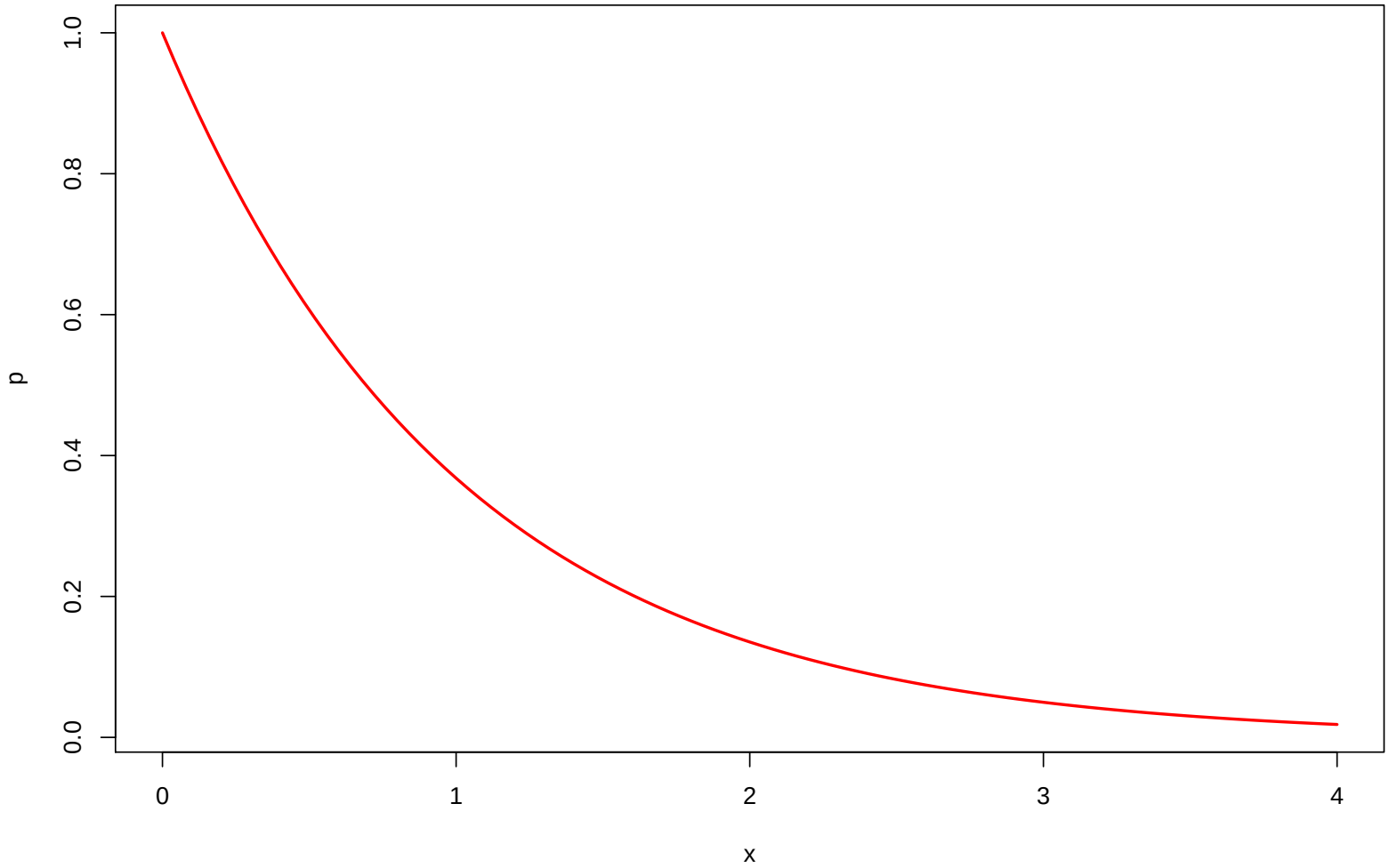
```
par(mfrow=c(1,1))
results<-read.csv('result.csv')
ssizes=c(5,10,15,30)
plot(ssizes,apply(result,2,sd),col='blue',
xlab="sample size",ylab="standard deviation",
xlim=c(3,35),ylim=c(1,6))
x=seq(2,32,length=200)
curve(10/sqrt(x),add=TRUE,type="l",lwd=2,col="red")
```



expotential distribution

$$f(x) = \lambda e^{-\lambda x}$$

expotential distribution

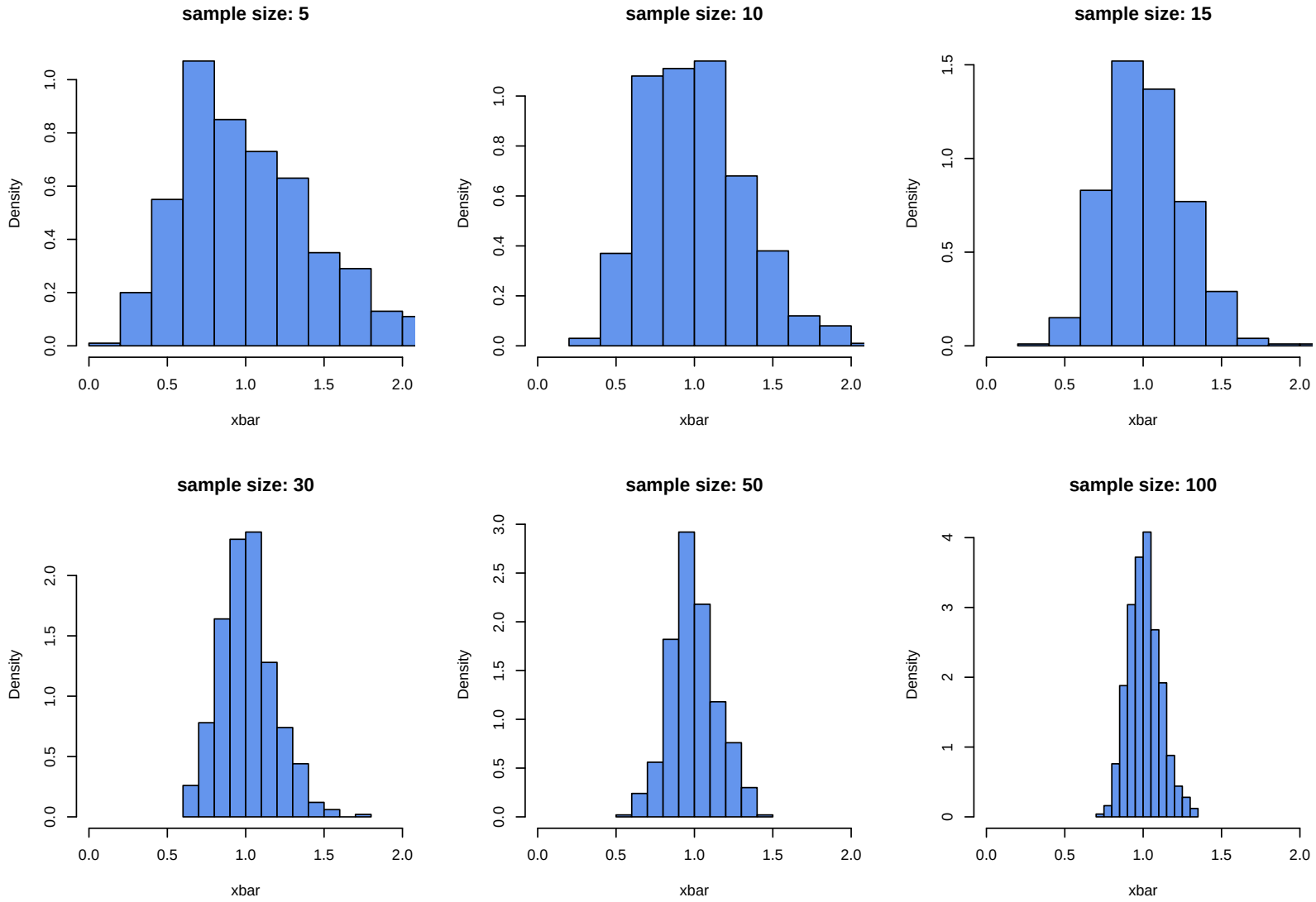


expotential distribution

```
par(mfrow=c(1,1))
curve(dexp(x,rate=1),0,4,lwd=2,col="red",ylab="p")
```

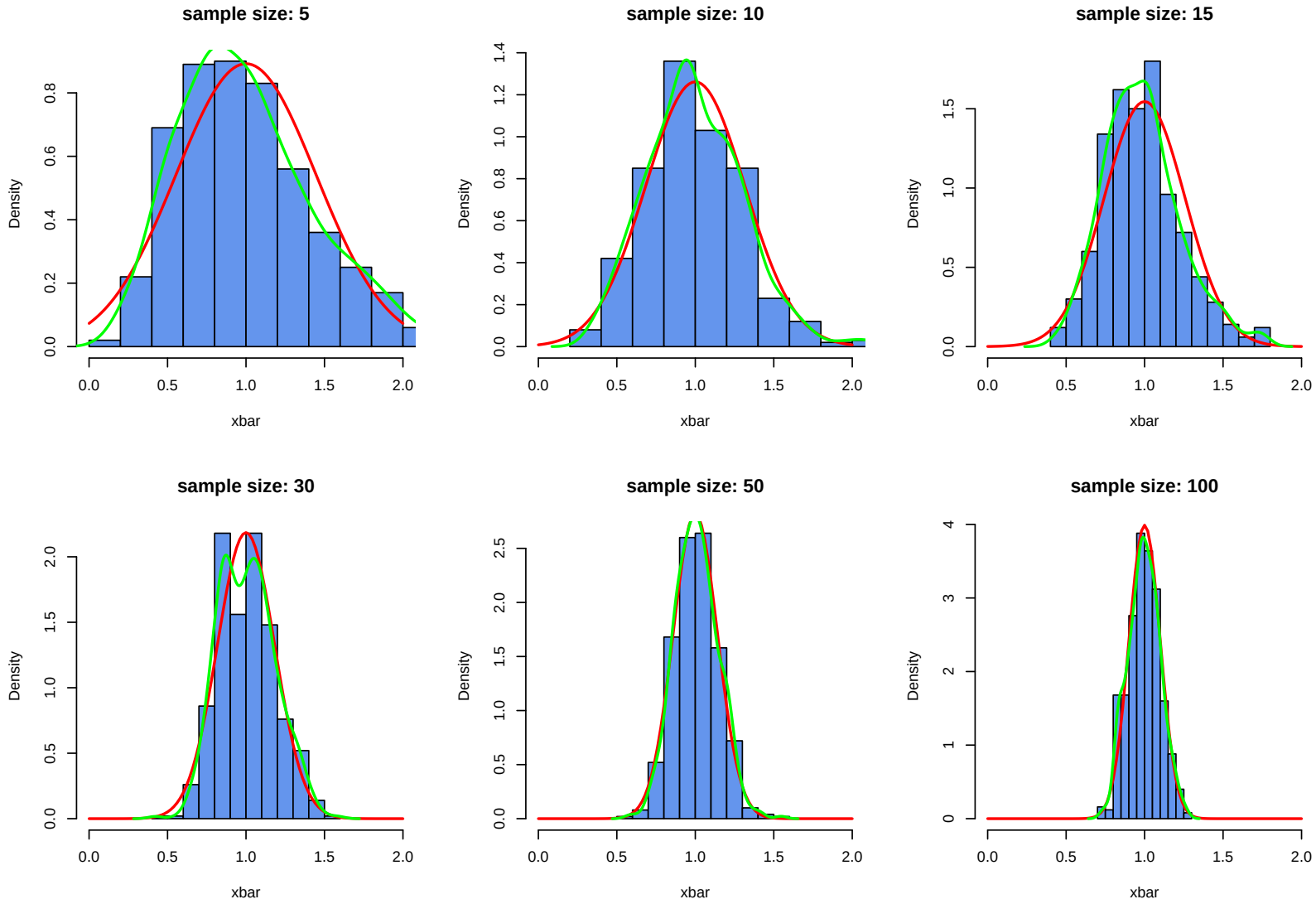
expotential distribution sampling

500 times sampleing from expotential distribution with $lembda = 1$



expotential distribution sampling

500 times sampleing from expotential distribution with $lembda = 1$

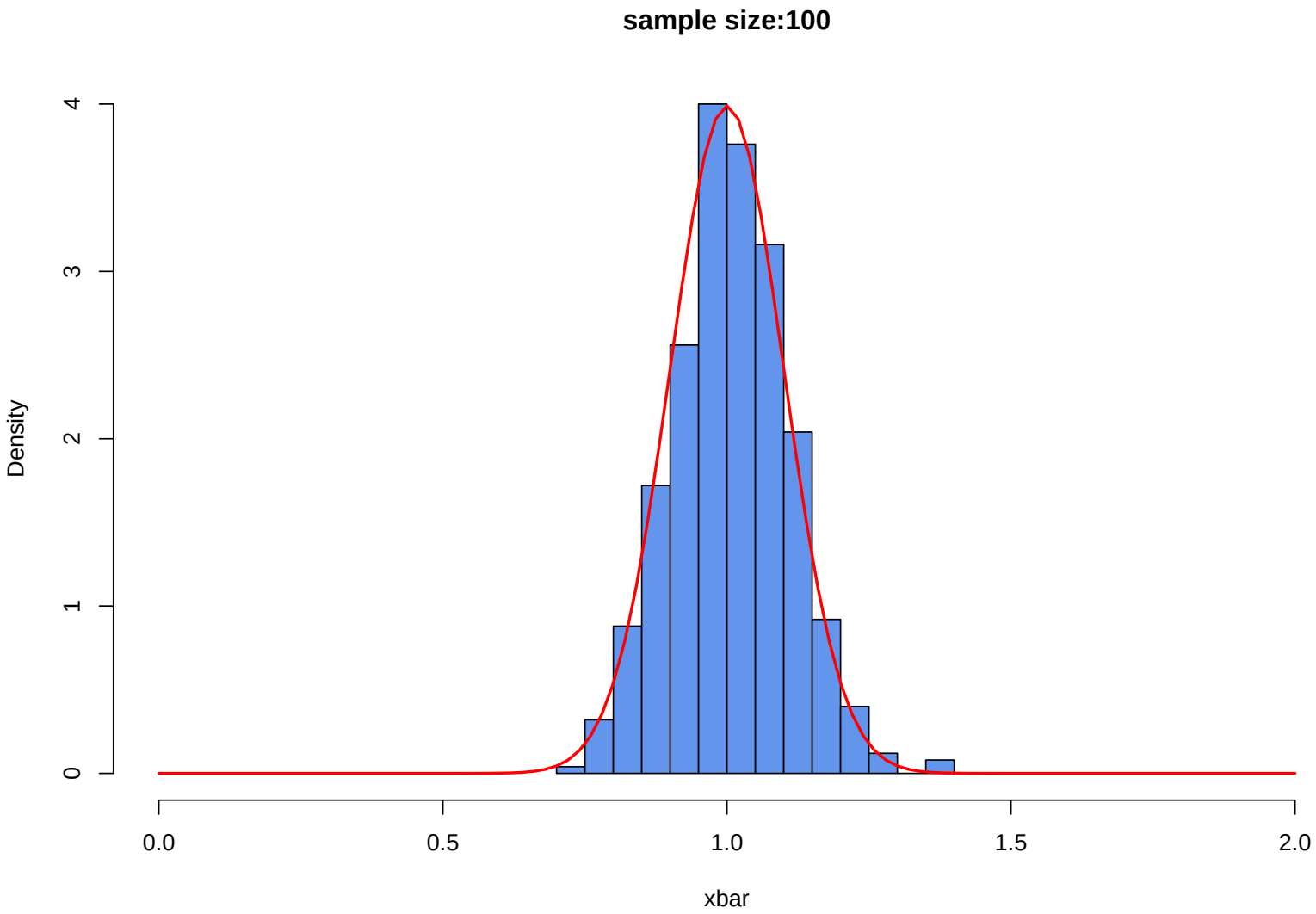


expotential distribution sampling

500 times sampleing from expotential distribution with $lembda = 1$

```
par(mfrow=c(2,3))
clt_e<-function(n,lambda=1){
xbar=rep(0,500);rate=1
for (i in 1:500) {
  xbar[i]=mean(rexp(n,rate=1))
  }
hist(xbar,prob=TRUE,breaks=12,xlim=c(0,2),
     main=paste("sample size:",n),col='cornflowerblue')
curve(dnorm(x,rate,rate/sqrt(n)), add=TRUE,
      col="red", lwd=2)
return(xbar)
}
result<-sapply(c(5,10,15,30,50,100),clt_e)
```

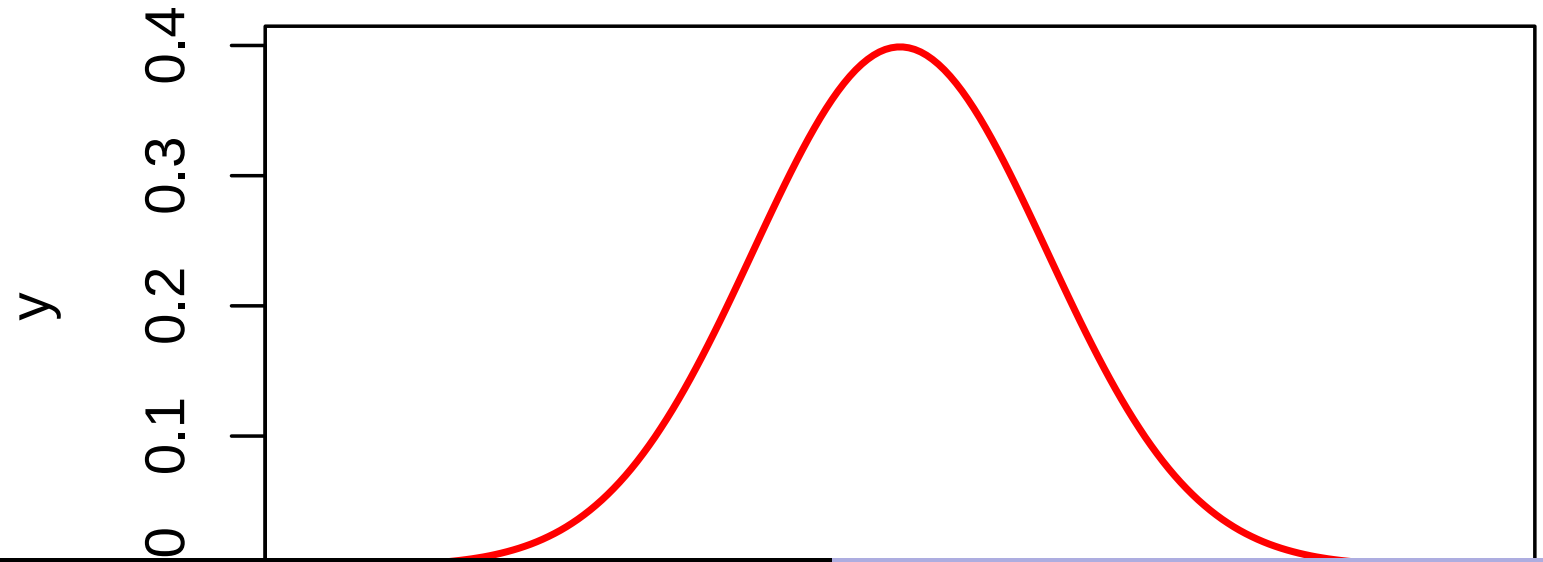
sample size = 100



probability density function

- dnorm

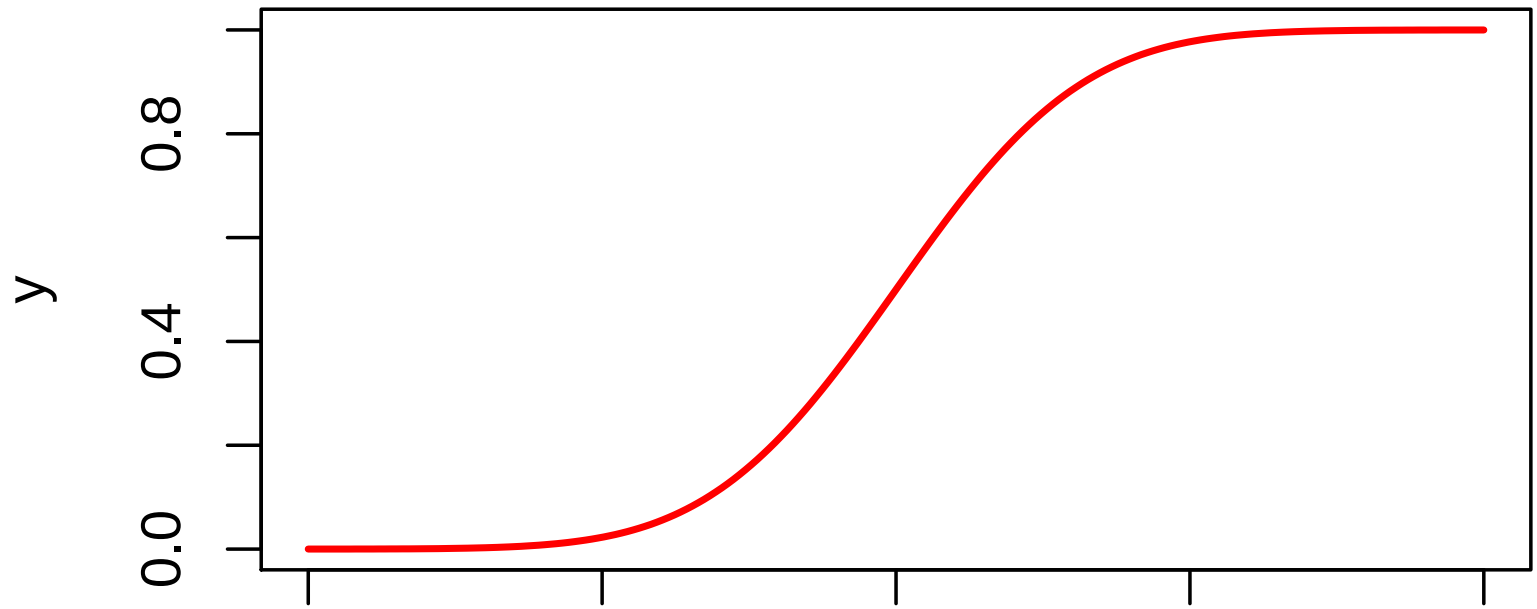
```
# with dnorm
x=seq(-4,4,length=200)
y=dnorm(x,mean=0,sd=1)
plot(x,y,type="l",lwd=2,col="red")
```



cumulative density function

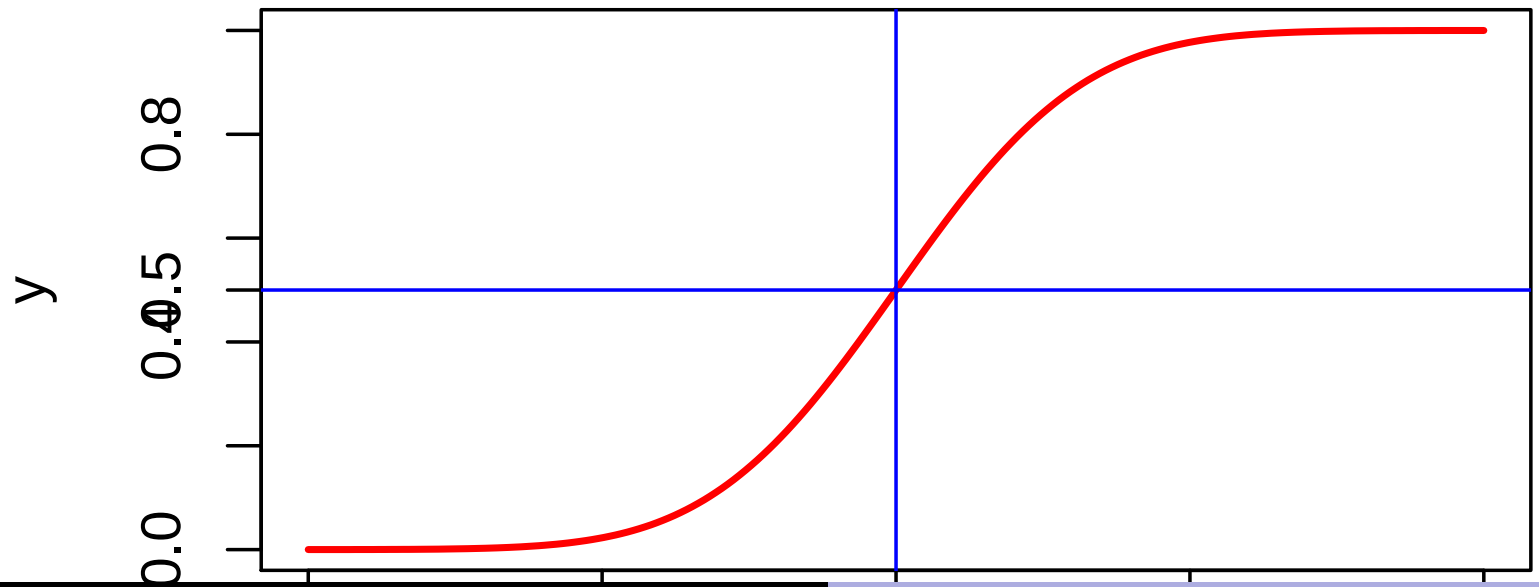
- pnorm

```
x=seq(-4,4,length=200)
y=pnorm(x,mean=0,sd=1)
plot(x,y,type="l",lwd=2,col="red")
```



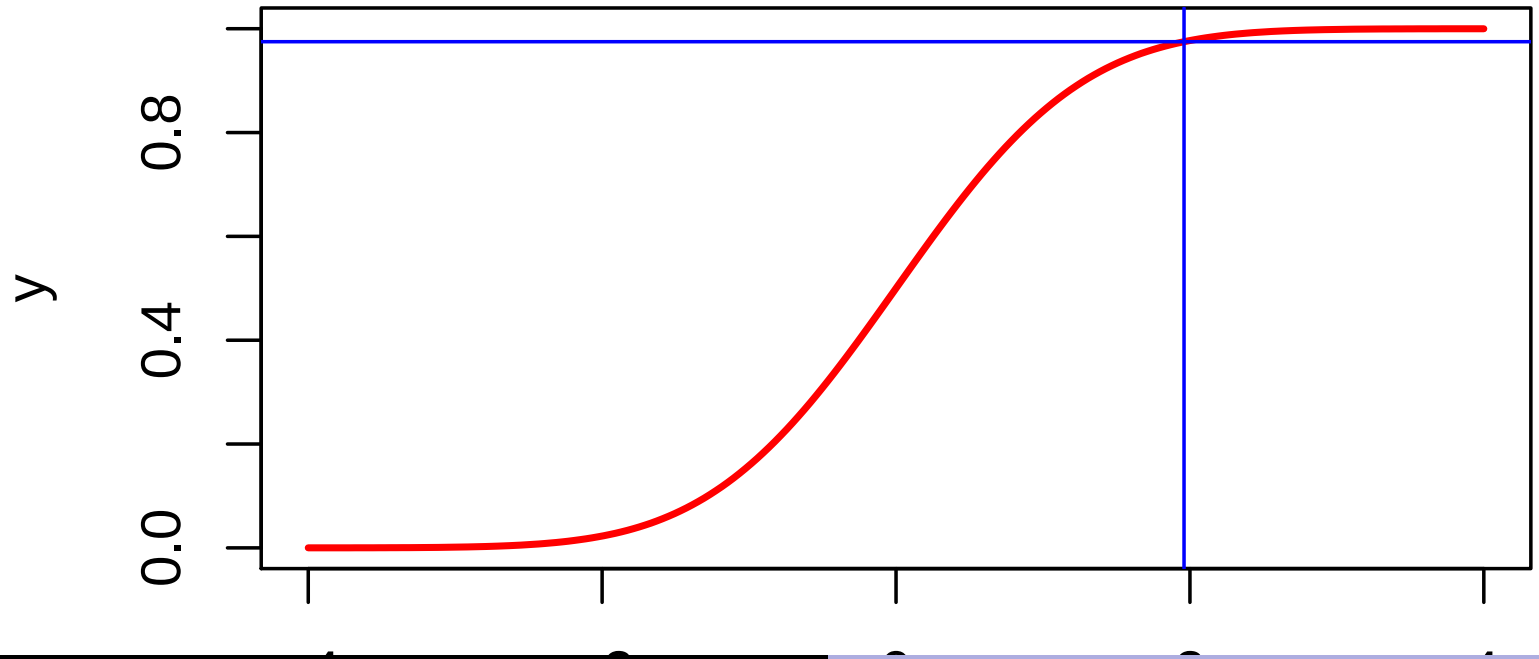
cdf:pnorm

```
x=seq(-4,4,length=200)
y=pnorm(x,mean=0,sd=1)
plot(x,y,type="l",lwd=2,col="red")
axis(2, at=0.5);abline(v=0, col="blue")
abline(h=0.5,col='blue')
```

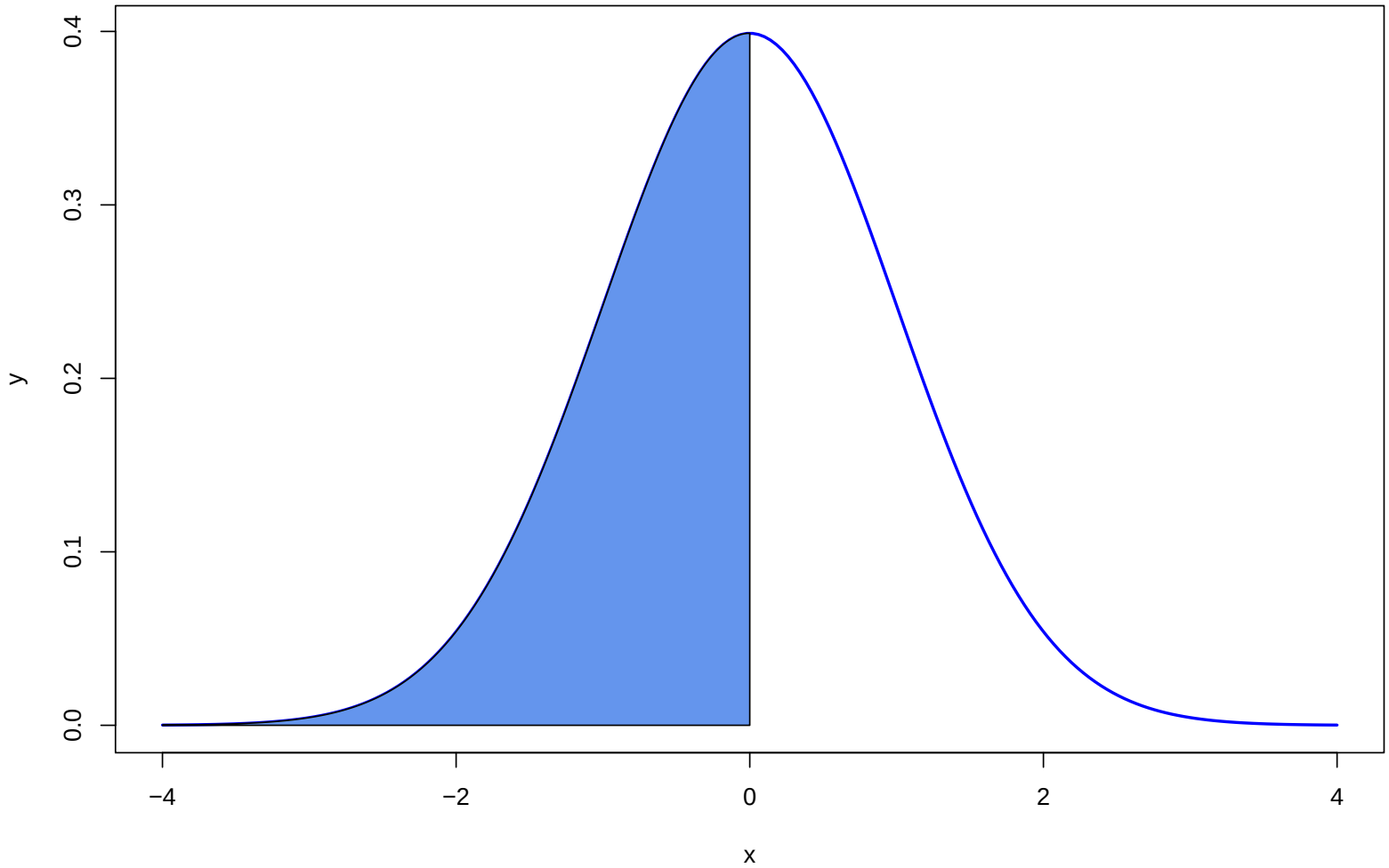


pnorm

```
x=seq(-4,4,length=200)
y=pnorm(x,mean=0,sd=1)
plot(x,y,type="l",lwd=2,col="red")
abline(v=1.96, col="blue");abline(h=0.975,col='blue')
```

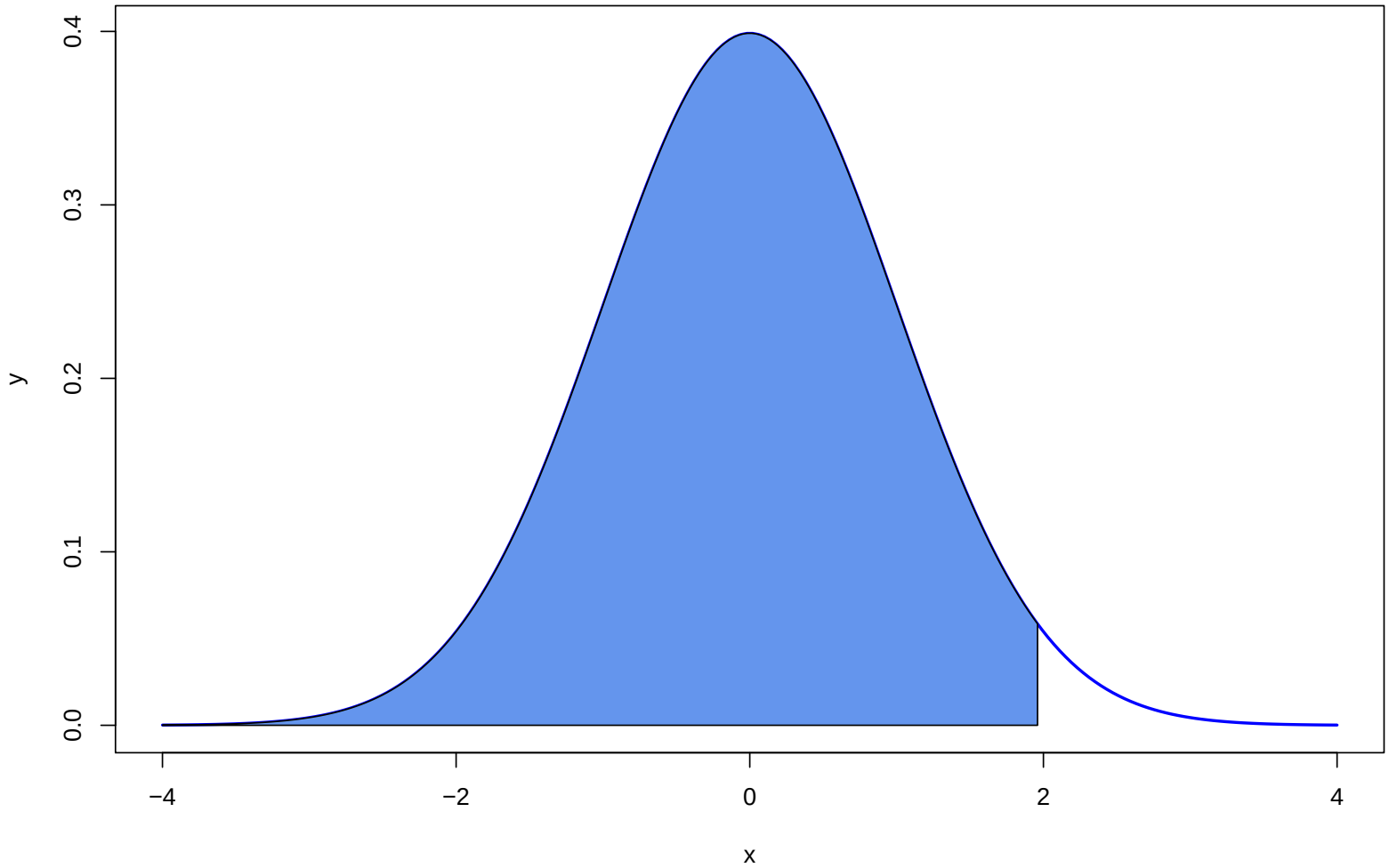


pdf vs. cdf



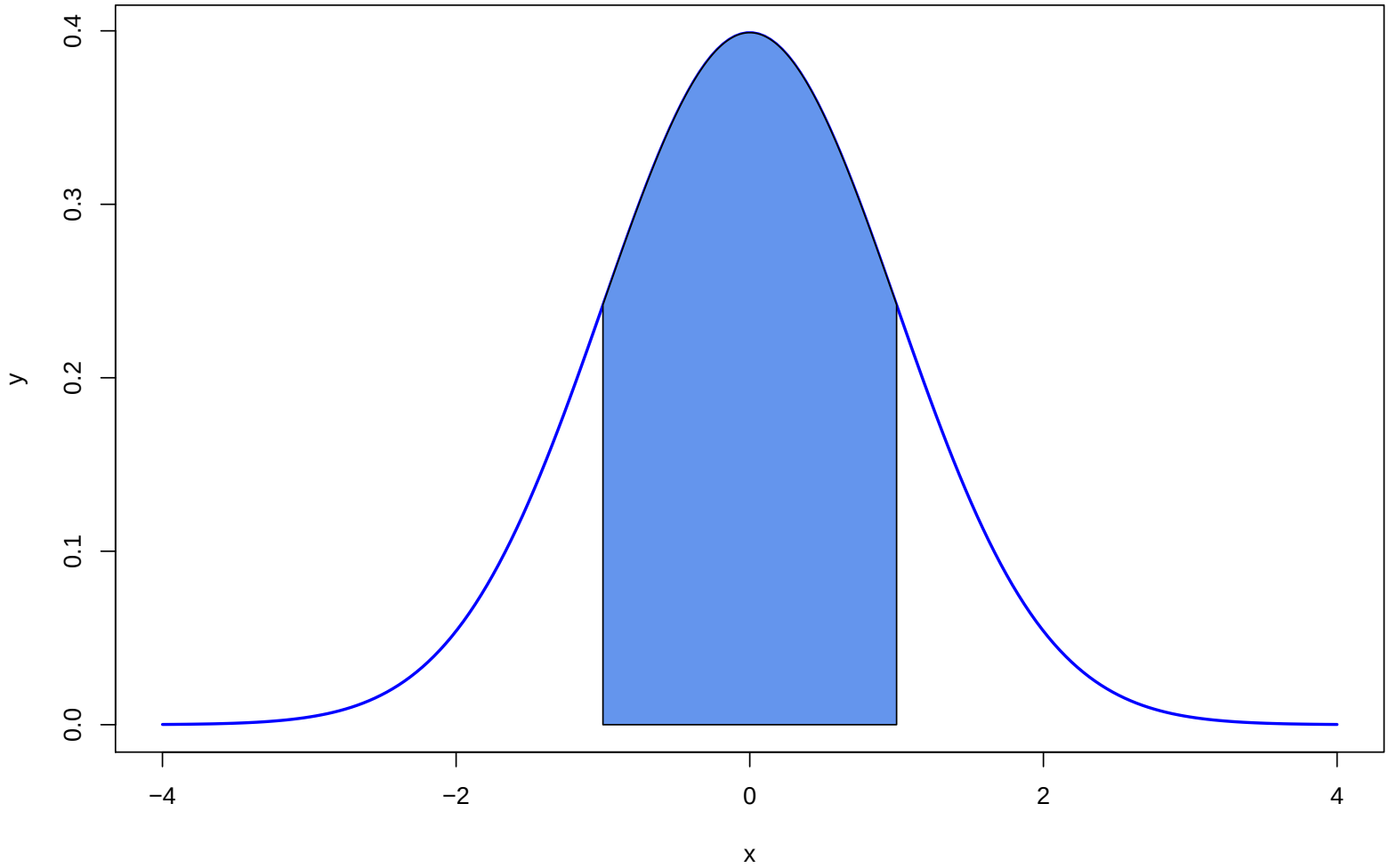

```
pnorm(0)
```

pnorm: 1.96




```
pnorm(1.96)
```

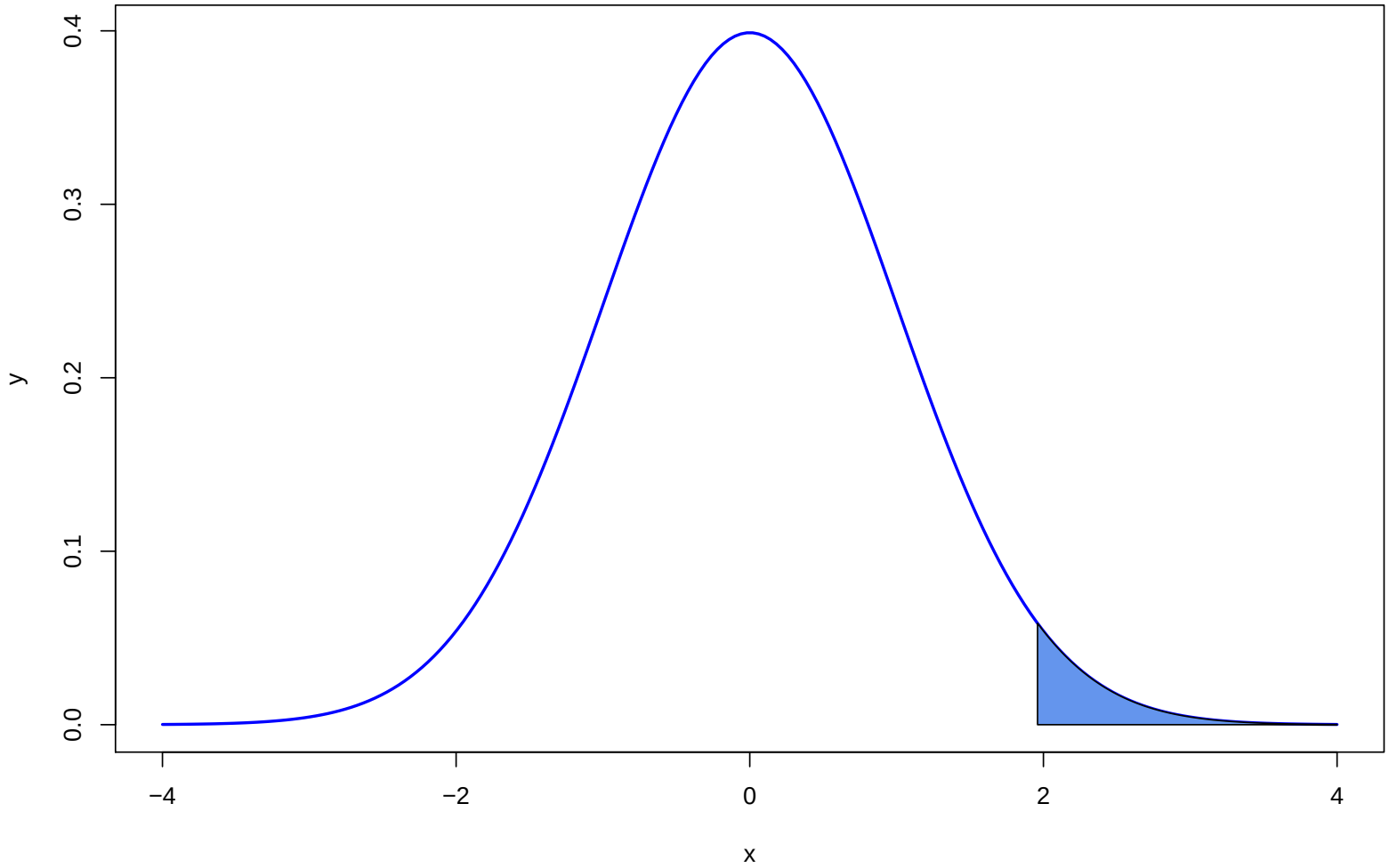
pnorm



```r
pnorm(1)-pnorm(-1)
```

```
[1] 0.6826895
```

dnorm



```r
pnorm(-1.96)
```

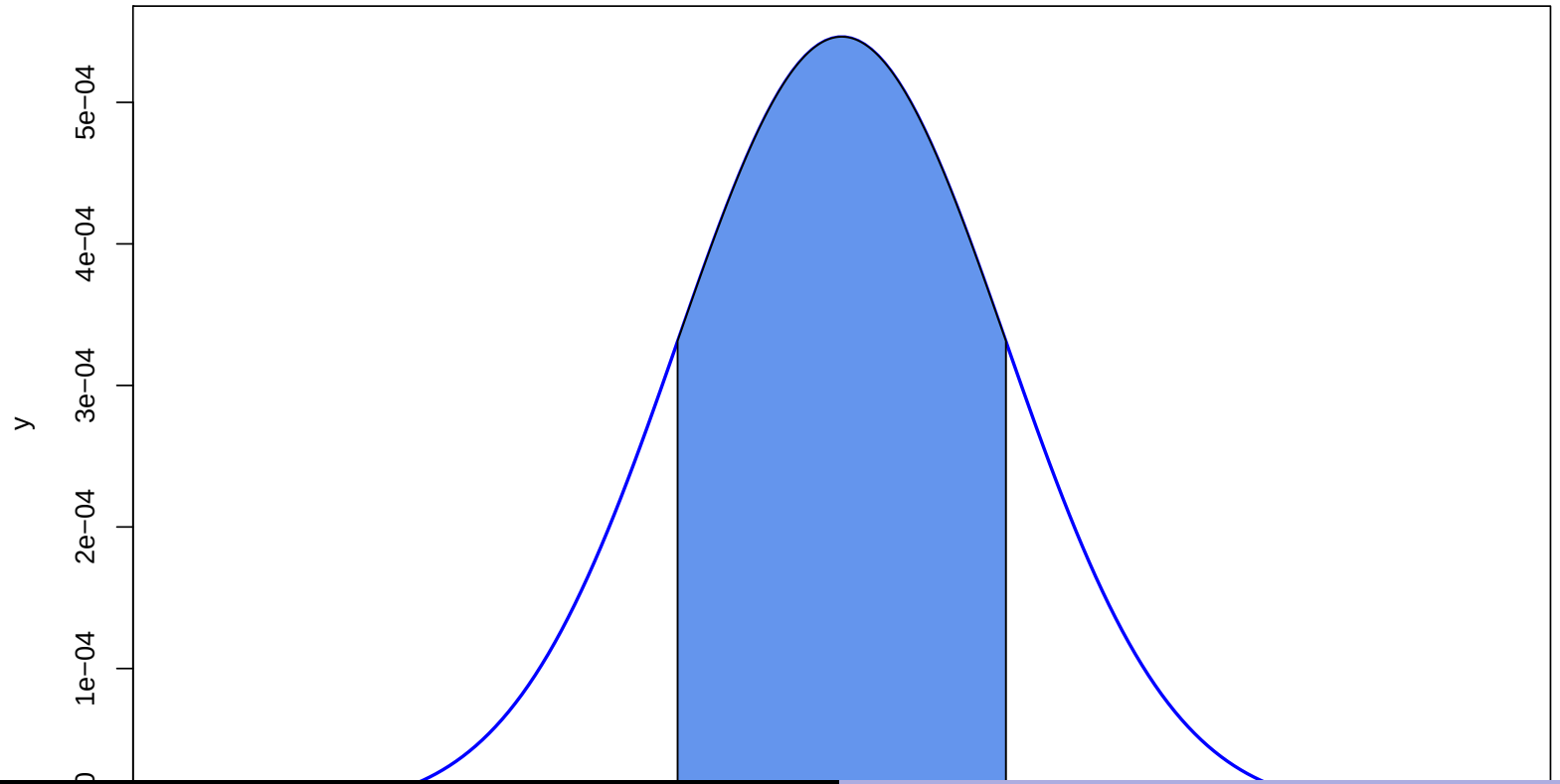
```
[1] 0.0249979
```

```r
1-pnorm(1.96)
```

```
[1] 0.0249979
```

example

$$mu = 51800$$
$$sd = \frac{4000}{\sqrt{30}}$$
$$range 51300\ 51800$$



example

```
mu=51800;variance<-4000;s=30
sigma=variance/sqrt(s)# sd of sample mean
z1<-(52300-mu)/sigma
z2<-(51300-mu)/sigma
pnorm(z1)-pnorm(z2)
```

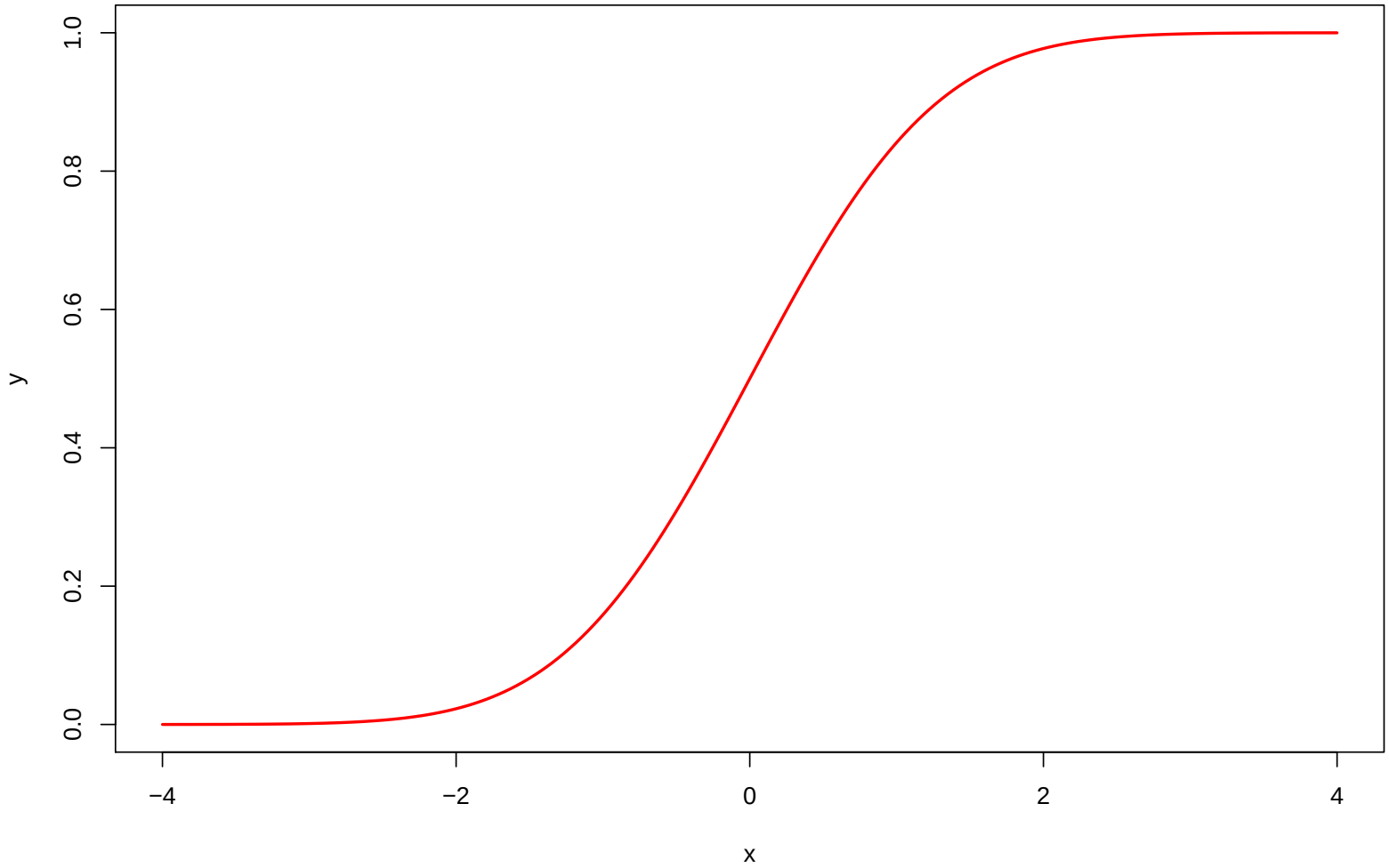
```
[1] 0.5064372
```

example:method 2

```
pnorm(mu+500,mu,sigma)-pnorm(mu-500,mu,sigma)
```

```
[1] 0.5064372
```

pnorm



qnorm

```
#95%
qnorm(0.975)
```

```
[1] 1.959964
```

```
#pvalue2sided
2*pnorm(-1.96)
```

```
[1] 0.04999579
```

```
#99%
qnorm(0.995)
```

```
[1] 2.575829
```

```
#90%
qnorm(0.95)
```

four funtion for probability distribution

- `d` = density function
- `p` = distribution function
- `q` = quantile function
- `r` = random function