Distributions in R

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Contents

1 General Remarks

R provides a set of statistical tables in order to evaluate

probability density functions using the prefix `d-`,

cumulative distribution functions using the prefix `p-`,

quantiles using the prefix `q-`

and a set of routines in order to perform

simulations using the prefix `r-`

for the distributions

Distribution	**R Name**	**Arguments**
binomial	`binom`	*size, prob*
normal	`norm`	*mean, sd*
chi-squared	`chisq`	*df, ncp*
t	`t`	*df, ncp*
F	`f`	*df1, df2, ncp*

among others.

2 Normal Distribution

We consider the standard normally distributed random variable $Z \sim \mathcal{N}(0,1)$ and calculate

the value $\phi(1) = 0.2419707$ of its probability density $\phi(t) = \frac{1}{\sqrt{2\cdot\pi}} \cdot e^{-\frac{t^2}{2}}$ by

```
dnorm(1)
```

the value $\Phi(1.73) = \mathbb{P}[Z \leq 1.73] = 0.9581849$ of its cumulative probability function $\Phi(z) = \mathbb{P}[Z \leq z] = \int_{-\infty}^{z} \phi(t)dt$ by

```
pnorm(1.73)
```

the value $z_{0.9} = 1.281552$ of its 0.90-quantile by

```
qnorm(0.9)
```

and get a random sample of size 50 out of a standard normally distributed population

```
x<-rnorm(50)
hist(x)
stem(x)
```

We now consider the normally distributed random variable $X \sim \mathcal{N}(3,4^2)$ with mean 3 and standard deviation 4 and calculate

the value $f(7) = 0.06049268$ of its probability density $f(t) = \frac{1}{\sigma} \cdot \phi\left(\frac{t-\mu}{\sigma}\right) = \frac{1}{\sigma\sqrt{2\cdot\pi}} \cdot e^{-\frac{1}{2}\left(\frac{t-\mu}{\sigma}\right)^2}$ by

```
dnorm(7,mean=3,sd=4)
dnorm(7,3,4)
```

the probability $\mathbb{P}[X \leq -2] = \Phi\left(\frac{-2-3}{4}\right) = 0.1056498$ by

```
pnorm(-2,3,4)
pnorm((-2-3)/4)
```

the probability $\mathbb{P}[X \geq 10] = 1 - \mathbb{P}[X \leq 10] = 1 - \Phi\left(\frac{10-3}{4}\right) = 0.04005916$ by

```
pnorm(10,3,4,lower.tail=FALSE)
1-pnorm(10,3,4)
1-pnorm((10-3)/4)
```

the probability $\mathbb{P}[1 \leq X \leq 5] = \mathbb{P}[X \leq 5] - \mathbb{P}[X \leq 1] = \Phi\left(\frac{5-3}{4}\right) - \Phi\left(\frac{1-3}{4}\right) = 0.3829249$ by

```
pnorm(5,3,4) - pnorm(1,3,4)
pnorm((5-3)/4) - pnorm((1-3)/4)
```

the value $q_{0.9} = 3 + z_{0.9} \cdot 4 = 8.126206$ of its 0.90-quantile by

```
qnorm(0.9,3,4)
3+qnorm(0.9)*4
```

and get a random sample of size 50 out of a normally distributed population with mean $\mu = 3$ and standard deviation $\sigma = 4$

```
x<-rnorm(50,3,4)
hist(x)
stem(x)
```

3 χ^2-Distribution

We consider the χ^2-distributed random variable $X \sim \chi^2_{10}$ with $\nu = 10$ degrees of freedom and calculate

its 0.95 quantile $\chi^2_{10,0.95} = 18.30704$ by

```
qchisq(0.95,10)
```

the probability $\mathbb{P}[X \geq 15] = 1 - \mathbb{P}[X \leq 15] = 0.1320619$ by

```
pchisq(15,10,lower.tail=FALSE)
1-pchisq(15,10)
```

4 t-Distribution

We consider the t-distributed random variable $X \sim t_{10}$ with $\nu = 10$ degrees of freedom and calculate

its 0.95 quantile $t_{10,0.95} = 1.812461$ by

```
qt(0.95,10)
```

the probability $\mathbb{P}[X \geq 1.5] = 1 - \mathbb{P}[X \leq 1.5] = 0.08225366$ by

```
pt(1.5,10,lower.tail=FALSE)
1-pt(1.5,10)
```

5 F-Distribution

We consider the F-distributed random variable $X \sim F_{2,10}$ with $m = 2$ degrees of freedom in the numerator and $n = 10$ degrees of freedom in the denumerator and calculate

its 0.95 quantile $F_{2,10,0.95} = 4.102821$ by

```
qf(0.95,2,10)
```

the probability $\mathbb{P}[X \geq 5] = 1 - \mathbb{P}[X \leq 5] = 0.03125$ by

```
pf(5,2,10,lower.tail=FALSE)
1-pf(5,2,10)
```

6 Binomial Distribution

We consider the binomial distributed random variable $X \sim BIN(10, 0.2)$ and

calculate the value $\mathbb{P}[X = 3] = 0.2013266$ of the probability mass function $\mathbb{P}[X = k] = \begin{pmatrix} 10 \\ k \end{pmatrix} \cdot 0.2^k \cdot 0.8^{10-k}$ by

```
choose(10,3)*0.2∧3*0.8∧7
dbinom(3,10,0.2)
```

evaluate the probabilities $\mathbb{P}[X = k]$ for $k = 0, 1, \ldots, 10$ by

```
k<-0:10
pxk<-dbinom(k,10,0.2)
```

in order to get the distribution with its mode

```
cbind(k,pxk)
k[which.max(pxk)]
```

and plot its point graph

```
plot(0:10,dbinom(0:10,10,0.2),type="h")
```

```
abline(0,0)
```

calculate the value $F(3) = \mathbb{P}[X \leq 3] = 0.8791261$ of the cumulative distribution function $F(x) = \mathbb{P}[X \leq x] = \sum_{k=0}^{x} \left(\begin{array}{c} 10 \\ k \end{array} \right) \cdot 0.2^k \cdot 0.8^{10-k}$ by

```
sum(dbinom(0:3,10,0.2))
pbinom(3,10,0.2)
pbinom(3,10,0.2,lower.tail=TRUE)
```

plot the cumulative distribution function as a point graph

```
plot(0:10,pbinom(0:10,10,0.2),type="s")
```

calculate $\mathbb{P}[X > 3] = 1 - \mathbb{P}[X \leq 3] = \mathbb{P}[X \geq 4] = 1 - \mathbb{P}[X < 4] = 0.1208739$ by

```
sum(dbinom(4:10,10,0.2))
1-pbinom(3,10,0.2)
pbinom(3,10,0.2,lower.tail=FALSE)
```

evaluate the third quartile q_3 respectively the 0.75-quantile $q_{0.75}$ by

```
cbind(0:10,pbinom(0:10,10,0.2))
qbinom(0.75,10,0.2)
```

get a random sample of size 50 out of a population

```
x<-rbinom(50,10,0.2)
hist(x)
stem(x)
```