Calculating Probability Using R

BIO210 Biostatistics

Extra reading material for Lecture 20

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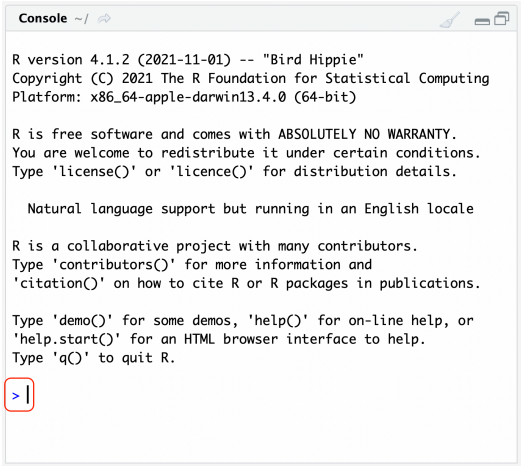
1 Calculating Probability Using R

As we gradually introduce more and more statistic concepts and tests, we will need to do quite a few complicated calculations. Some of them cannot be computed by hand or regular calculator; others can, but there are just too many steps and they are error-prone. Therefore, we introduce how to use the programming language **R** for the calculation of probabilities and related stuff. You don't really need to know how to write scripts in **R**. For now, you can just use it as a calculator.

Go to the SUSTech mirror of **R**: `https://mirrors.sustech.edu.cn/CRAN`. Download and install the program based on your operating system.

If you open the program, you will probably see a window like shown in the screenshot on the right-handside. The ">" mark that I highlighted at the bottom is your "prompt", where you can type commands. Like I said before, for now, you don't really need to know how to write scripts in **R**. You just use it as a probability calculator. Later on, we will see how to perform statistical tests.

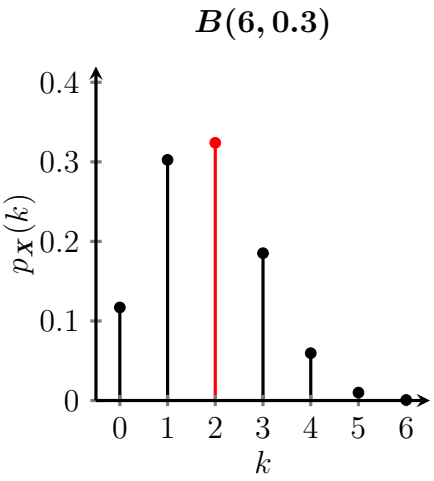


Since we already introduced how to calculate probability using **Excel**, we will use that as the comparison. Let's start with simple examples of three different distributions: $\boldsymbol{B(6, 0.3)}$, $\boldsymbol{Pois(2)}$ and $\boldsymbol{\mathcal{N}(1, 4)}$. In **R**, if you want the cumulative probability, the function always starts with "p"; if you want the probability mass/density, the function always starts with "d". For example, **pbinom**, **ppois**, and **pnorm** will give us the cumulative probability of the binomial, Poisson and normal distributions, respectively. They are like the ***.DIST** functions in **Excel** with the "cumulative" option set to "**TRUE** or **1**".

Similarly, the **dbinom**, **dpois** will give the exact probability of a binomial and Poisson distributions respectively, and **dnorm** will give you the probability density of a normal distribution. They are like the ***.DIST** functions in **Excel** with the "cumulative" option set to "**FALSE** or **0**".

If you want to do the opposite, that is, provide the cumulative probability and return the value of the random variable, the function always starts with "q", like **qbinom**, **qpois** and **qnorm**. They are like the "*.INV" functions in **Excel**.

Just to give you some visual explanation of typical calculations:

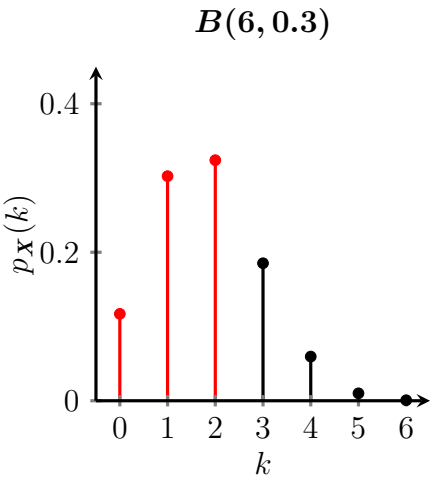


Excel:

BINOM.DIST(2, 6, 0.3, FALSE)

R:

dbinom(x = 2, size = 6, prob = 0.3)

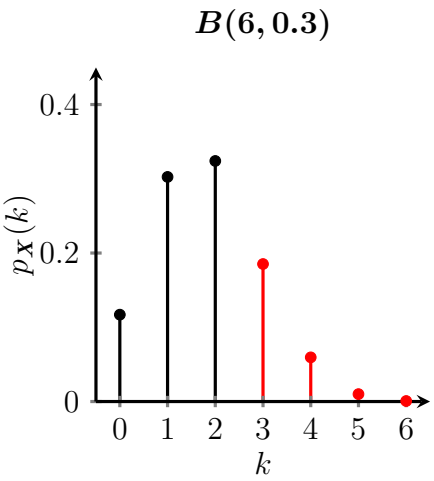


Excel:

BINOM.DIST(2, 6, 0.3, TRUE)

R:

pbinom(q = 2, size = 6, prob = 0.3, lower.tail = T)

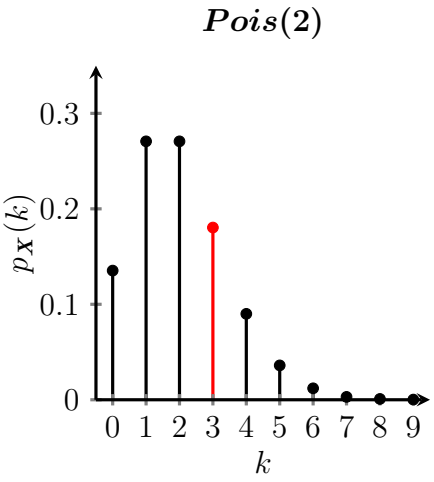


Excel:

1 - BINOM.DIST(2, 6, 0.3, TRUE)

R:

pbinom(q=2, size=6, prob=0.3, lower.tail=FALSE)

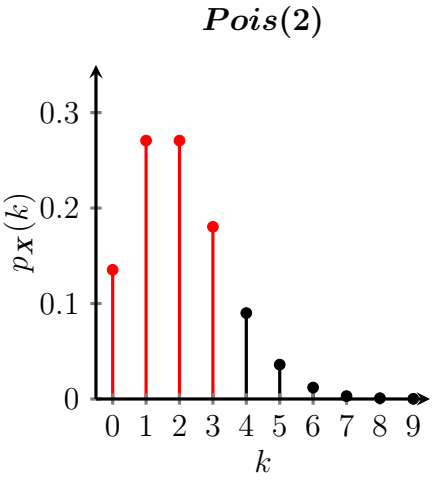


Excel:

POISSON.DIST(3, 2, FALSE)

R:

dpois(x = 3, lambda = 2)

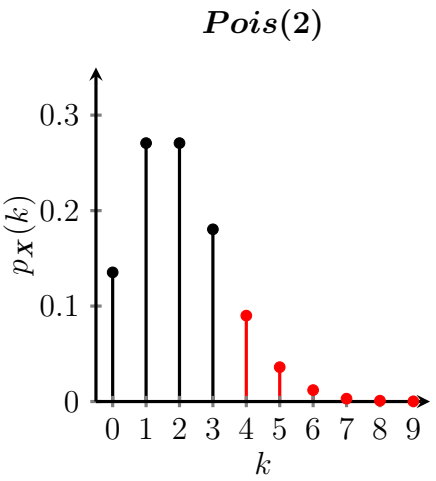


Excel:

POISSON.DIST(3, 2, TRUE)

R:

ppois(q = 3, lambda = 2, lower.tail = TRUE)

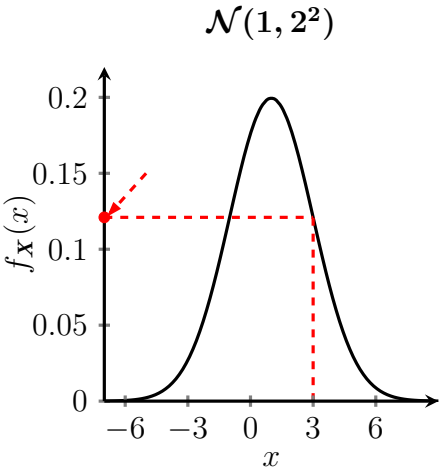


Excel:

1 - POISSON.DIST(3, 2, TRUE)

R:

ppois(q = 3, lambda = 2, lower.tail = FALSE)

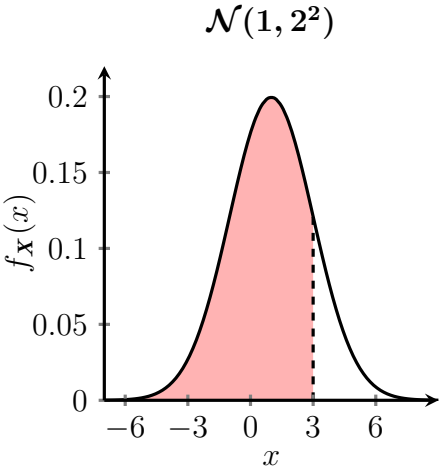


Excel:

NORM.DIST(3, 1, 2, FALSE)

R:

dnorm(x = 3, mean = 1, sd = 2)

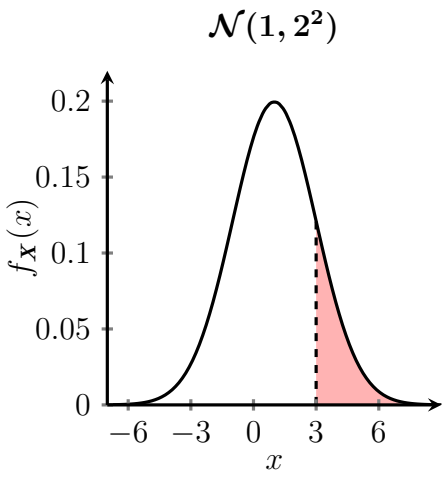


Excel:

NORM.DIST(3, 1, 2, TRUE)

R:

pnorm(q = 3, mean = 1, sd = 2, lower.tail = TRUE)



Excel:

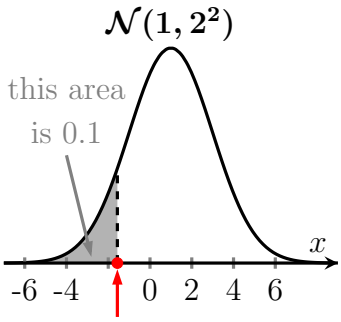
1 - NORM.DIST(3, 1, 2, TRUE)

R:

pnorm(q = 3, mean = 1, sd = 2, lower.tail = FALSE)

2 Find x with certain probability in a normal distribution

Again, using the function from **Excel** as a comparison, visually:

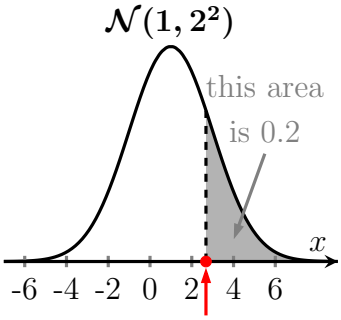


Excel:

NORM.INV(0.1, 1, 2)

R:

qnorm(p = 0.1, mean = 1, sd = 2, lower.tail = TRUE)



Excel:

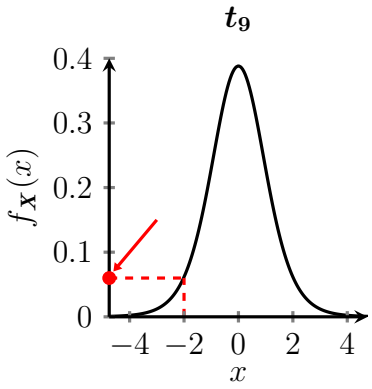
NORM.INV(0.8, 1, 2)

R:

qnorm(p = 0.2, mean = 1, sd = 2, lower.tail = FALSE)

3 More Complicated Distributions

For more complicated distributions that we will encounter later in the course, the principle is exactly the same.

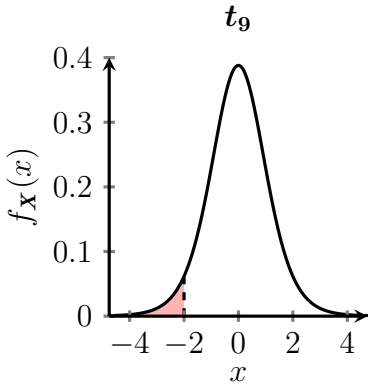


Excel:

T.DIST(-2, 9, FALSE)

R:

dt(x = -2, df = 9)

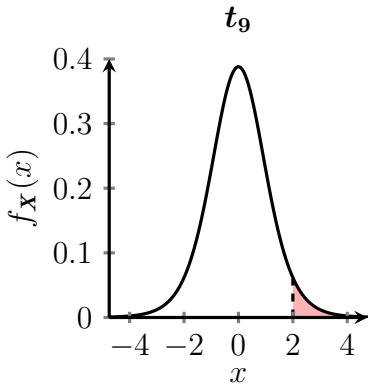


Excel:

T.DIST(-2, 9, TRUE)

R:

pt(q = -2, df = 9, lower.tail = TRUE)

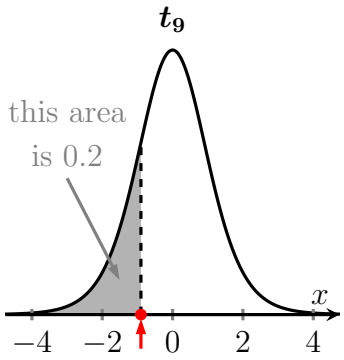


Excel:

1 - T.DIST(2, 9, TRUE)

R:

pt(q = -2, df = 9, lower.tail = FALSE)

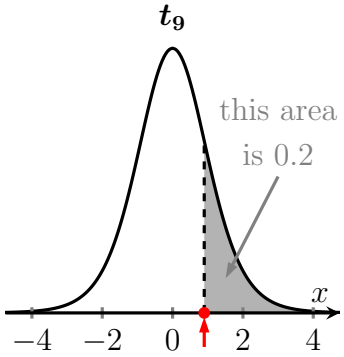


Excel:

T.INV(0.2, 9)

R:

qt(p = 0.2, df = 9, lower.tail = TRUE)

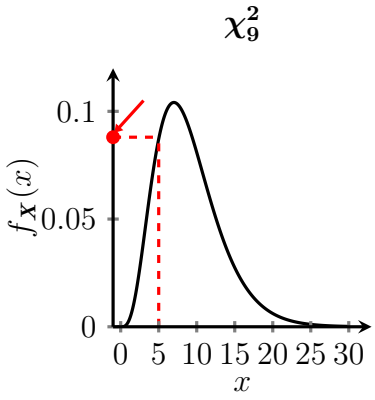


Excel:

T.INV(0.8, 9)

R:

qt(p = 0.2, df = 9, lower.tail = FALSE)

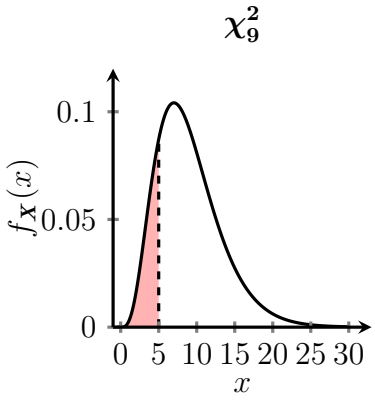


Excel:

CHISQ.DIST(5, 9, FALSE)

R:

dchisq(x = 5, df = 9)

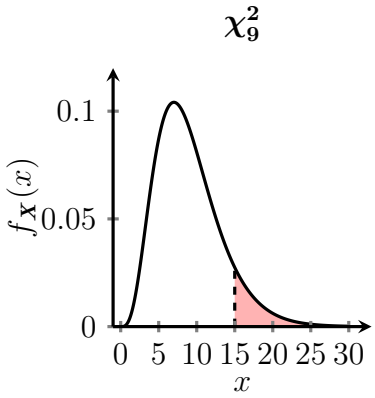


Excel:

CHISQ.DIST(5, 9, TRUE)

R:

pchisq(q = 5, df = 9, lower.tail = TRUE)

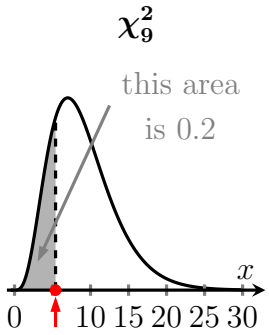


Excel:

1 - CHISQ.DIST(15, 9, TRUE)

R:

pchisq(q = 15, df = 9, lower.tail = FALSE)

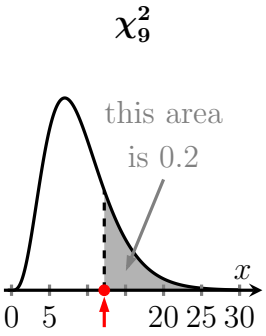


Excel:

CHISQ.INV(0.2, 9)

R:

qchisq(p = 0.2, df = 9, lower.tail = TRUE)

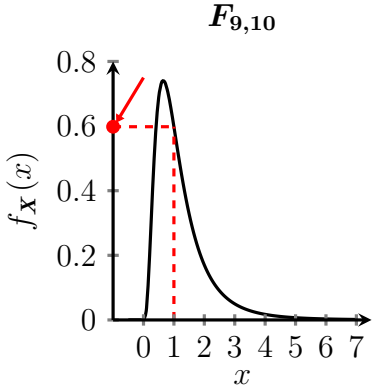


Excel:

CHISQ.INV(0.8, 9)

R:

qchisq(p = 0.2, df = 9, lower.tail = FALSE)

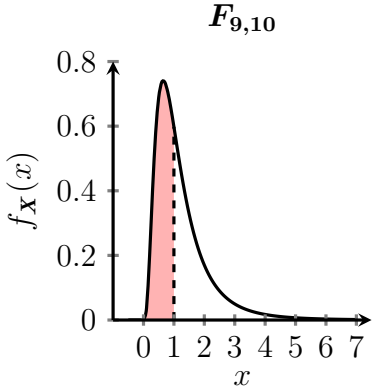


Excel:

F.DIST(1, 9, 10, FALSE)

R:

df(x = 1, df1 = 9, df2 = 10)

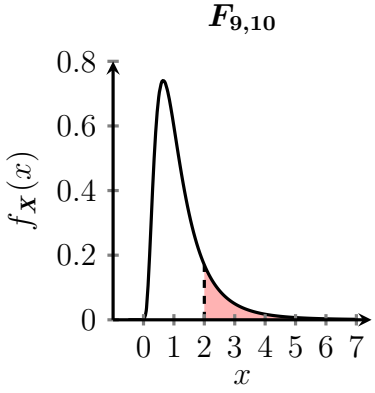


Excel:

F.DIST(1, 9, 10, TRUE)

R:

pf(q = 1, df1 = 9, df2 = 10, lower.tail = TRUE)

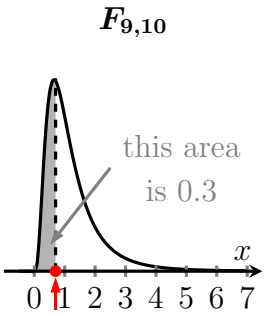


Excel:

1 - F.DIST(2, 9, 10, TRUE)

R:

pf(q = 2, df1 = 9, df2 = 10, lower.tail = FALSE)

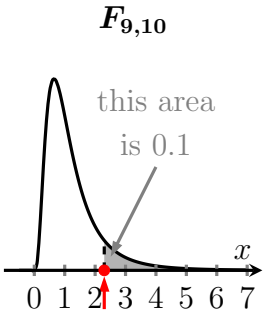


Excel:

F.INV(0.3, 9, 10)

R:

qf(p = 0.3, df1 = 9, df2 = 10, lower.tail = TRUE)



Excel:

=F.INV(0.9, 9, 10)

R:

qf(p = 0.1, df1 = 9, df2 = 10, lower.tail = FALSE)