

Basics of R : Borrowed from SWMS 2023

May 18, 2023

Name _____

SWMS-Worksheet 0 (Basic coding using R)

Due: May 26th, 2023, 4pm

At SWMS-2023, you will need to run R-code on your laptop computer or your mobile device. If you have a laptop then we *strongly recommend* that you bring it to the school to maximise learning. Please follow the instructions below and complete the worksheet by the due date.

Due: Please complete the Exercises 1,2, and 3 below. Send separate screenshots of each to swms@icts.res.in by **May 26th, 2023 at 4:00 pm**. *Completion of the Exercises 1,2,3 is mandatory for participation in SWMS 2023.*

1 Working with R and Rstudio

- If you are bringing your Laptop to the school then do the following:

Please install R-software and Rstudio on your laptop. Both are free and available online.

- (a) Download and install R from this website: <https://cran.icts.res.in/>
- (b) Download and install RStudio from this website: <https://posit.co/download/rstudio-desktop/>

Another source for detailed installation procedure for R and RStudio can be found [here](#). Once you run RStudio, the environment of RStudio should resemble the following image:

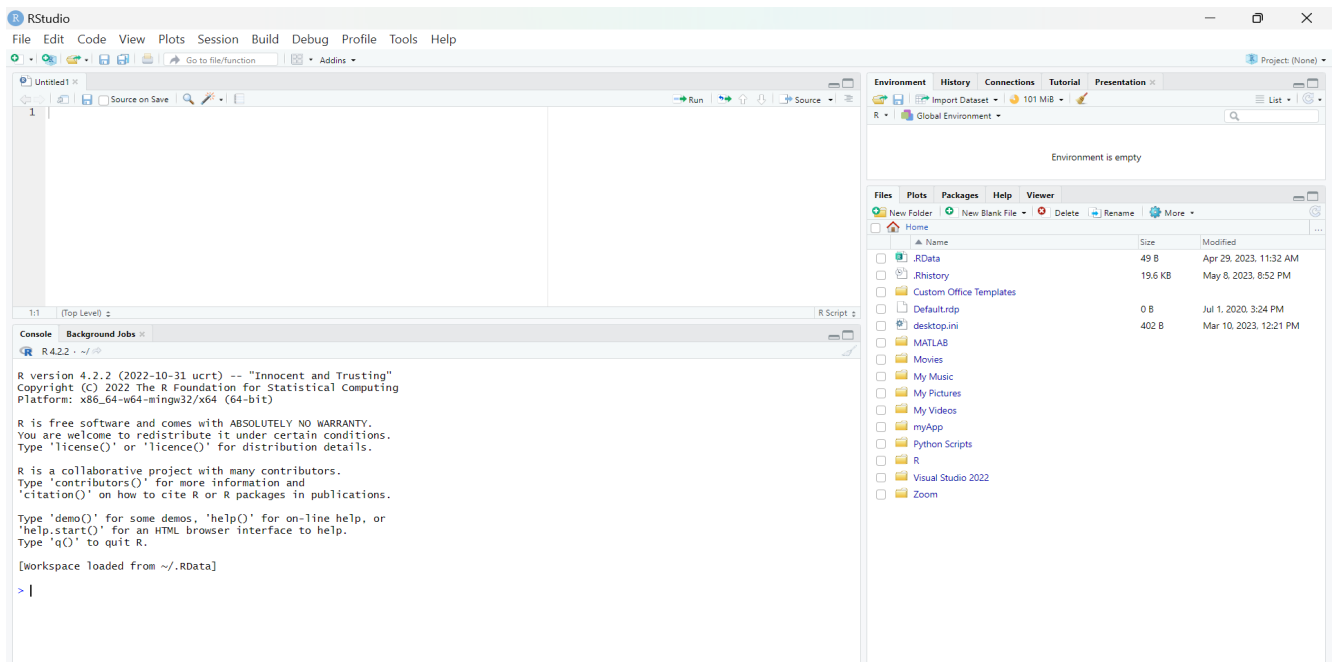


Figure 1: The RStudio environment

The white space on the upper left side is where you can write your code. Select the lines containing your code and click on the 'run' button. This will print the output of the code in the console (the white space on the lower left side). See Figure 3, for a simple example.

- If you do NOT have a laptop and plan to use your mobile device to run R then do the following:

Using a standard web-browser Firefox, Edge, Chrome, Brave etc, please create an account on [Rstudio.cloud](https://posit.cloud) using the url: <https://posit.cloud/>. For SWMS2023 the free version is enough. Once you have created you

account click on **New Project>New RStudio Project** and you are ready to start your coding journey. On your browser you should see the image below in Figure 2.

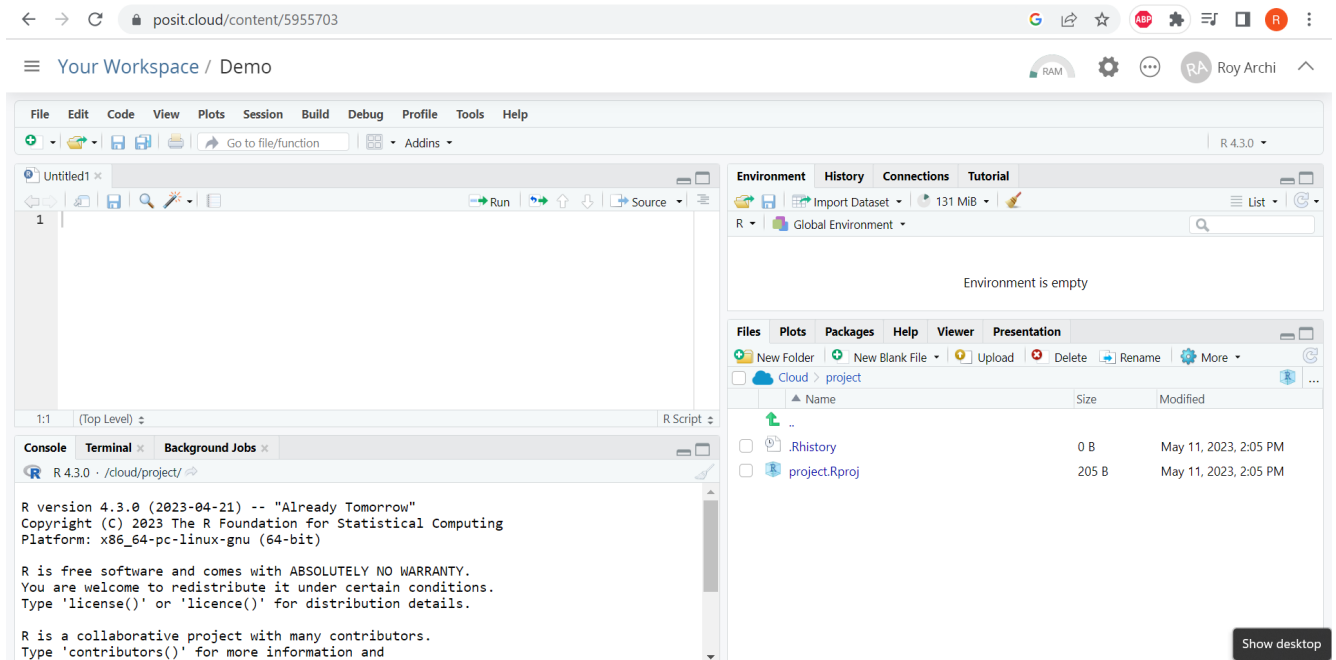


Figure 2: The RStudio Cloud environment

*Throughout this school you will need to access **RStudio.cloud**. Please (complete and) practice the worksheet below many times on this portal so that you are able to run R code efficiently.*

2 Using R as a calculator

One of the most straightforward uses of R is as a calculator. Let's start by looking at some basic examples of calculation in R. Type in $5+2$ as indicated in Figure 3 and run the same.

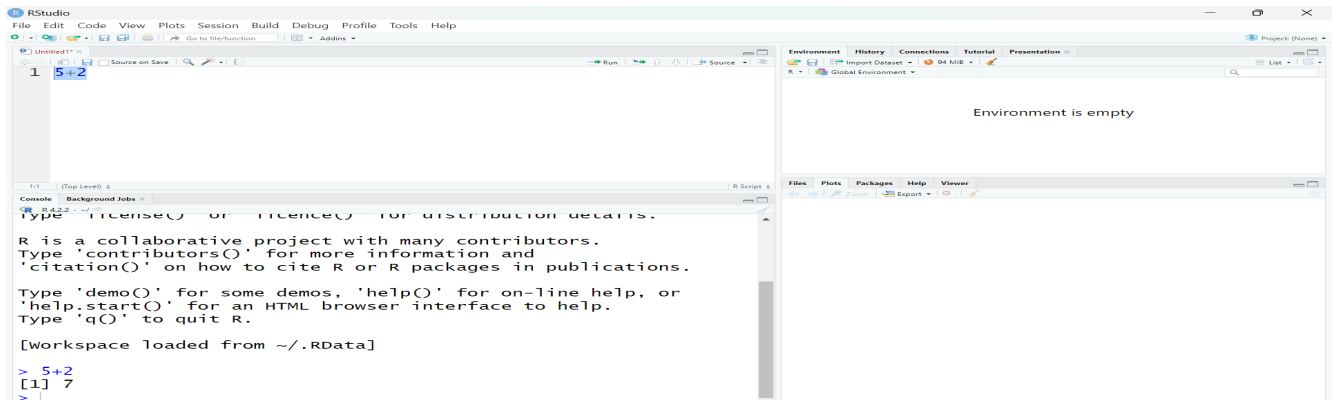


Figure 3: Selecting the line $5+2$ on the script and clicking on run prints the command and output in the console

2.1 Basic arithmetic operations

Declare the variable x to have value 1 and y to have value 2 using the syntax $x \leftarrow 1$ and $y \leftarrow 2$ respectively (see Figure 4). Now compute $x+y$ and run the entire code to see the output on the console.

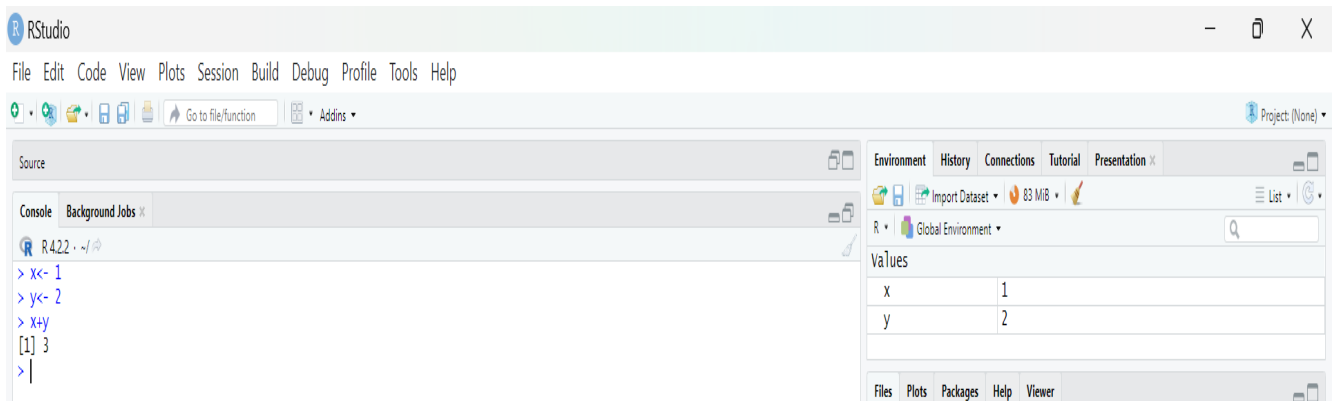


Figure 4: Adding two numbers in R

You can similarly perform subtraction, multiplication and division via the syntax $x-y$, $x*y$, and x/y respectively. You can also compute other functions of the declared variable x .

Exercise 1: Please enter the following commands, run them and describe the output.

- $x \leftarrow 4$ and $\text{sqrt}(x)$
- $x \leftarrow 4$ and $x+5$

2.2 Vector valued variables in R

A variable x can also store a vector via the syntax $x \leftarrow c(1,2,3)$ (for example). The operations on vector-valued variables are done component-wise. For example, as can be seen from Figure 5, $x+y$ prints a vector that is obtained by adding corresponding components of x and y vector. Similarly $\log(x)$ prints the natural logarithm of each component of x .

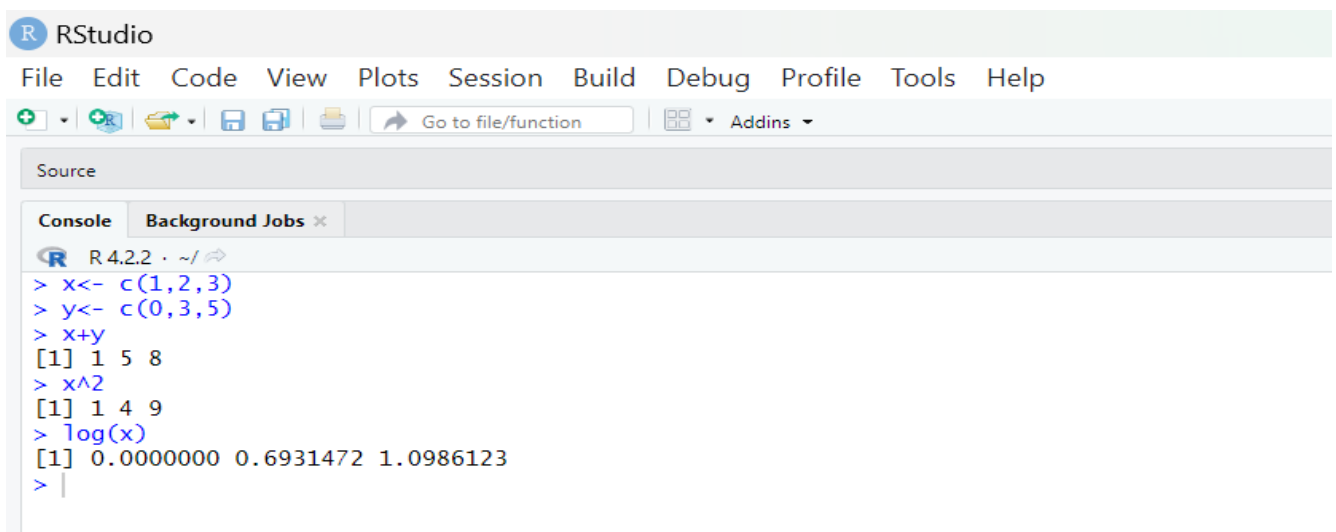


Figure 5: Dealing with vector-valued variables in R

Exercise 2: Please enter the following commands, run them and describe the output.

- `y <- c(9,16,25)` and `sqrt(y)`
- `y <- c(9,16,25)` and `y +5`

2.3 Plots in R

Plots in R can be made using the `plot()` function. The function takes as input the variable to be plotted on the x-axis and the variable to be plotted in the y-axis as (also see Figure 6),

```
x <- 1:10; y <- x^2; plot(x,y,type='l')
```

There are also many other types of plots one can make in R with simple commands, which we would learn in the upcoming sessions.

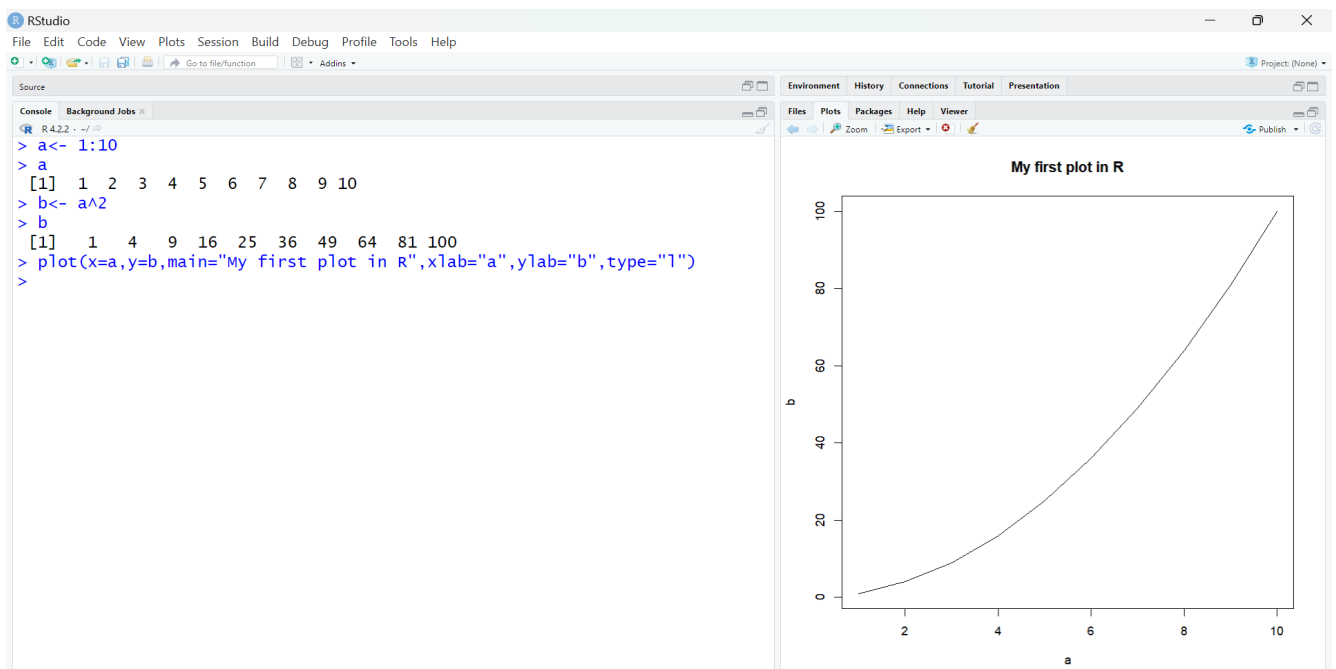


Figure 6: Simple plots in R. Inside the `plot()` function we specify the parameter `x` to be `a`, which denotes the variable to be plotted on x-axis, the parameter `y` to be `b`, which is the variable to be plotted in y-axis, `main` is specified as the title of the plot while the parameters `xlab` and `ylab` are the labels of the x and y axis respectively.

NOTE: Check out [this link](#) to see how you can make your plot more colorful.

Exercise 3: Please enter the following commands, run them and describe the output.

- `x <- seq(1,10, by =1) ; y <- sqrt(x); plot(x,y, type="o")`
- `x <- seq(1,10,by=1); y <- x^3; plot(x,y,type="p")`

~~The DUE part of Worksheet 0 is over. The below is an enrichment worksheet. You can encouraged to do it but it it not mandatory.~~

You are encouraged to complete this but this part is NOT due as part of the earlier worksheet.

3 Quick Tutorials

Go over Section 1.5 in this link <https://www.isibang.ac.in/~athreya/psweur/chapters/01.pdf> and run all the commands in that Section. This will help you get familiarized with the coding language.

This PDF file: https://www.isid.ac.in/simdeepayan/R-tutorials/labs/02_language_lab.pdf, has details of the R coding environment. Please try to try the same on Rstudio.

Please listen to the talk from SWMS 2018:

https://www.youtube.com/watch?v=J_l7gZZdyeg&list=PL04QVxpjcnjg7rHKfBVcjHcaFheJdMSSP

3.1 Matrix valued variables in R

To declare a matrix-valued variable in R, write the matrix entries as a vector and then specify the rows/columns of the matrix. For example `x<- matrix(c(1,2,3,4,5,6),nrow=2)` stores the matrix

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}.$$

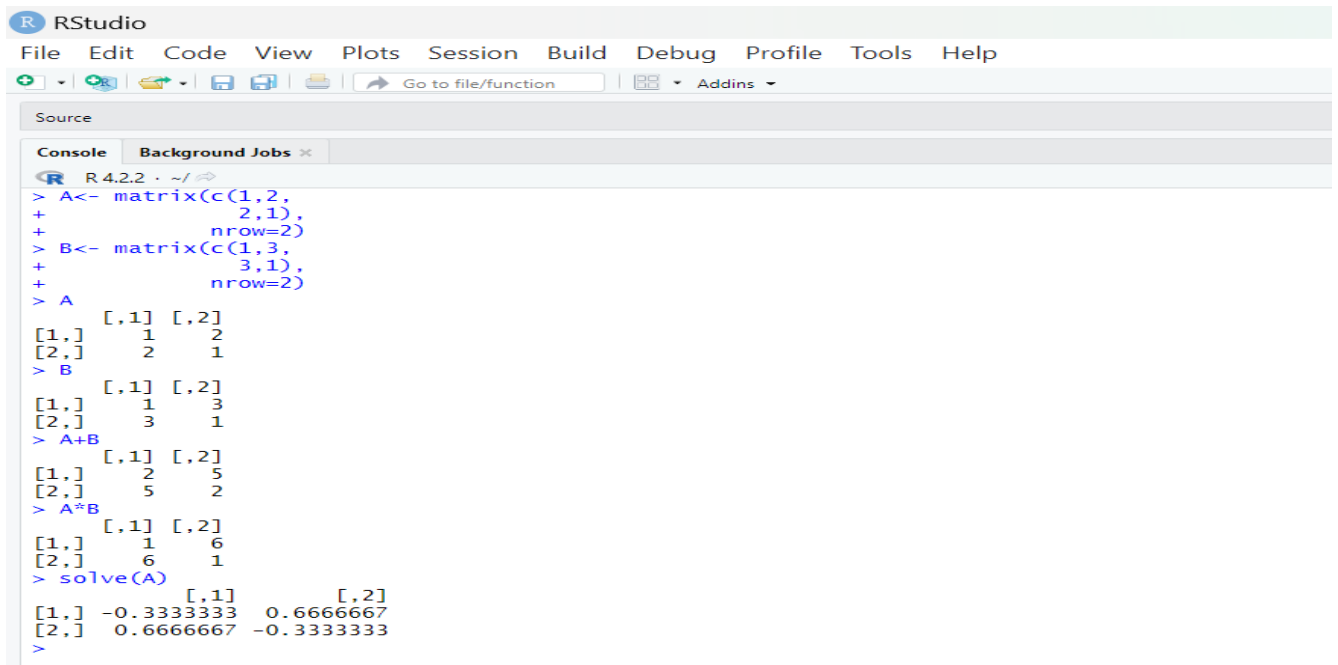
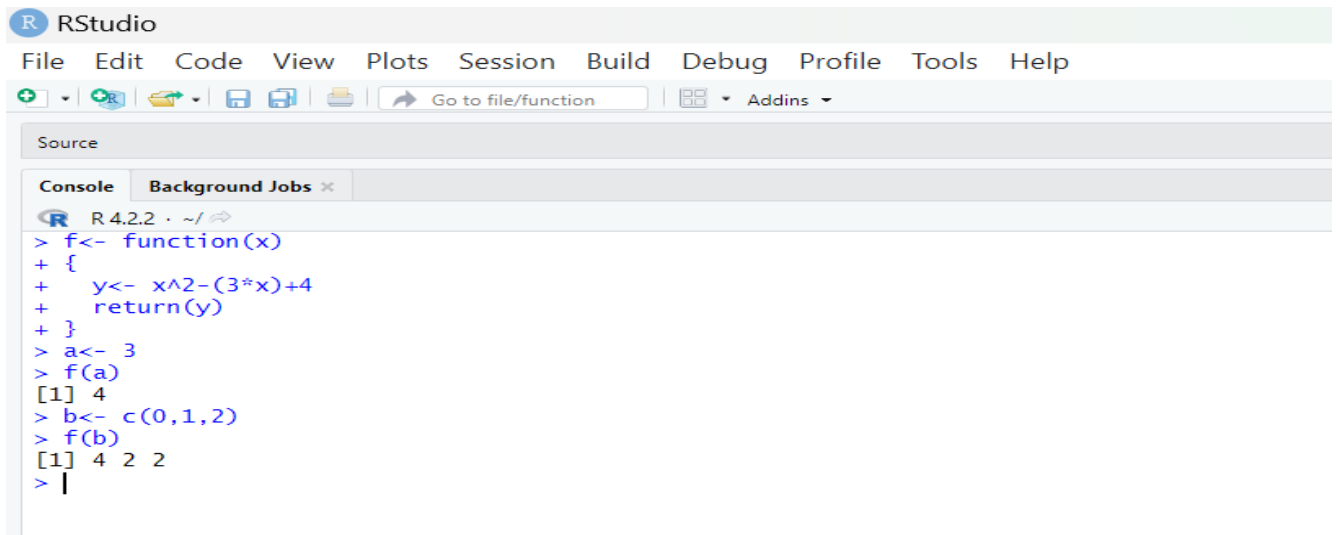


Figure 7: A and B are two matrices, A+B adds them, A*B multiplies the two matrices and the function solve(A) computes the inverse of the matrix A

3.2 Creating functions with R

Apart from the built-in function, you can also declare your own functions in R. For example in fig. 8, f is declared as a function (using the function(x) syntax) of x which calculates $x^2 - 3x + 4$ and returns the value. Note that when applied to a vector-valued variable b, it returns the values of the function evaluated at each component of b.



```
RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Source
Console Background Jobs x
R 4.2.2 · ~/
> f<- function(x)
+ {
+   y<- x^2-(3*x)+4
+   return(y)
+ }
> a<- 3
> f(a)
[1] 4
> b<- c(0,1,2)
> f(b)
[1] 4 2 2
> |
```

Figure 8: Defining and evaluating simple functions in R

3.3 Further Problems to Solve

You can answer Questions 1, 2 and 3 either by just reporting the value or by sending the screenshot of your console. For Questions 4-6, a screenshot of the code and output is necessary.

1. Find the value of $\sqrt{23}$ up to 4 decimal places.
2. Evaluate the value of $\frac{9}{44}$ up to 4 decimal places.
3. Let $x \leftarrow c(-15, -11, -4, 0, 7, 9, 16, 23)$ and find the mean, median, and standard deviation of x . (Hint: Use the functions `mean()`, `median()` and `sd()`).
4. Take $x=1:1000$ and plot $f(x) = \log(x) - 1$.
5. Write a function that takes as input the radius of a circle and evaluates its area. Check if the function works for circles with radius $r = 1.5, 2, 2.5, 4$. (Hint: The area of a circle with radius r is πr^2 where $\pi = \frac{22}{7}$).
6. Write a function that takes as input a real number and evaluates its reciprocal. Check if it works for $x = 1, 2, 3, 4, 7$.