

# R syntax in a nutshell – Part V

## Programming in R

- 3.1 Input and output
- 3.2 Conditional execution
- 3.3 Loops
- 3.4 User-defined functions
- 3.5 An alternative to loops – *sapply*

### 3.1 Input and output

`print(x)`

Prints the contents of an object `x`, nicely formatted.

`cat(..., file = "", sep = "")`

This function displays the contents of one or more R objects in a less sophisticated way, but enabling much more control over the output format.

**NB** that this function does not append a newline character that must be added explicitly to the output string as `"\n"`.

```
In [19]: x <- 5.8
cat("The result is",x,"N/m.\n",sep="****")
```

The result is\*\*\*5.8\*\*\*N/m.

`readline(prompt)`

Displays the prompt and then reads input from the keyboard:

```
> x <- readline("Enter x:\n")
Enter x:
> 5.8
> x
[1] "5.8"
```

This example shows that keyboard input is always in the form of a character vector of length 1. If required it has to be coerced to a numeric value using the function `as.numeric`:

```
> x <- as.numeric(x)
> x
[1] 5.8
```

### 3.2 Conditional execution

Conditional execution of R code can be achieved using:



`if(condition) expression1 else expression2`

If `condition` evaluates to `TRUE`, `expression1` is executed, otherwise `expression2` is run. Complicated commands may be grouped together in braces:

```
In [20]: x <- 3
y <- 0.5
if(x>2 & y<1){
  print(x)
  print(y)
}else{
  cat("Warning, x<=2 or y>=1!\n")
}

[1] 3
[1] 0.5
```

### 3.3 Loops

Sometimes it is useful to run some chunk of code repetitively in a loop. Due to the powerful indexing in R, loops are needed considerably less often than in any conventional programming language. They can be built using the statement:

#### ***for(variable in expression1) expression2***

`expression2` is a chunk of R code, usually grouped in braces to be executed once for each of the values of the control `variable`. The range of possible values for the variable is specified by a vector, `expression1`.

See the example, which calculates and prints the square roots of the sequence of numbers 1, 3, 5, 7, and 9:

```
In [21]: for(f in seq(1,10,by=2)){
  cat("Square root of", f, "is", sqrt(f), "\n")
}

Square root of 1 is 1
Square root of 3 is 1.732051
Square root of 5 is 2.236068
Square root of 7 is 2.645751
Square root of 9 is 3
```



Try to avoid loops if possible. Their execution in R tends to be time consuming and there are, usually, other alternatives. For instance here, thanks to the recycling rules in R, we can write:

```
In [22]: x <- seq(1,10,by=2)
ee <- paste("Square root of", x, "is", round(sqrt(x),6))
print(ee)

[1] "Square root of 1 is 1"          "Square root of 3 is 1.732051"
[3] "Square root of 5 is 2.236068"  "Square root of 7 is 2.645751"
[5] "Square root of 9 is 3"
```

Commands `apply`, `tapply` or `sapply` (below) are commonly a better approach.

#### ***while(condition) expression***

In this case, `expression` will be executed as long as the `condition` remains valid (i.e. is `TRUE`).

### repeat *expression*

This command is used in conjunction with a `break` statement (this is not a function and thus no brackets are required). In fact, the `break` statement can be used to terminate any loop, if necessary. The `next` statement can be invoked to discontinue one particular cycle and skip to the next one.

## 3.4 User-defined functions

User-defined functions provide a stylish way of extending the set of the available commands. In fact, much of the R itself is written in R! The function definition looks like:

**`function.name <- function(argument1, argument2, ...) expression`**

The `expression` is a chunk of R code, usually grouped in braces. In order to avoid confusion, the last statement should be `return(z)`, where `z` is an expression or variable name giving the value(s) to be returned by the function. If more values need to be returned, they can be assembled into a list object. For example, we can write a user-defined function calculating a geometric mean, defined as the  $n$ th root of the product of  $n$  numbers, and use it on some data: 
$$S = \sqrt[n]{\prod_{i=1}^n \{x_i\}}$$

```
In [23]: geo.mean <- function(x){
          out <- prod(x)^(1/length(x))
          return(out)
        }
sazava <- read.table("data/sazava.data", sep="\t")
print(geo.mean(sazava[, "SiO2"]))
```

```
[1] 57.49363
```

### 3.4.1 Arguments to functions

There are two possibilities for providing arguments to a R function. First, you can pass them in the order matching the function's definition. The second is to supply the arguments in the form `argument.name = value` in an arbitrary sequence. When writing a user-defined function, one can provide default values as in the following example:

```
In [24]: options(repr.plot.width=10, repr.plot.height=10)      # Setting the size of output
options(jupyter.plot_mimetypes = "image/png")                # Change mimetype to PNG

# Using image/svg+xml
# May not work in some browsers (but is optimal for Chrome, Firefox...)
options(repr.plot.width=5, repr.plot.height=5)
options(jupyter.plot_mimetypes = "image/svg+xml")
```

```
In [25]: my.plot <- function(x,y,symb="+",colour="red",cex=2){
          plot(x,y,pch=symb,col=colour,cex=cex)
        }
```

And such a function then can be called in a number of ways, for instance:

```
In [26]: x.coord<-c(1,12,15,3)
          y.coord<-c(2,24,30,6)
          my.plot(x.coord,y.coord,colour="blue")
```

```

<svg xmlns="http://www.w3.org/2000/svg" xmlns:xlink="http://www.w3.org/1999/xlink"
width="360pt" height="360pt" viewBox="0 0 360 360" version="1.1"> <defs> <g> <symbol
overflow="visible" id="glyph0-0"> <path style="stroke:none;" d="M 3 0 L 3 -15 L 15 -15 L 15 0
Z M 3.375 -0.375 L 14.625 -0.375 L 14.625 -14.625 L 3.375 -14.625 Z M 3.375 -0.375 "/>
</symbol> <symbol overflow="visible" id="glyph0-1"> <path style="stroke:none;" d="M
6.011719 -2.777344 L 6.011719 -7.488281 L 1.335938 -7.488281 L 1.335938 -9.457031 L
6.011719 -9.457031 L 6.011719 -14.132813 L 8.003906 -14.132813 L 8.003906 -9.457031 L
12.679688 -9.457031 L 12.679688 -7.488281 L 8.003906 -7.488281 L 8.003906 -2.777344 Z M
6.011719 -2.777344 "/> </symbol> <symbol overflow="visible" id="glyph1-0"> <path
style="stroke:none;" d="M 1.5 0 L 1.5 -7.5 L 7.5 -7.5 L 7.5 0 Z M 1.6875 -0.1875 L 7.3125 -0.1875
L 7.3125 -7.3125 L 1.6875 -7.3125 Z M 1.6875 -0.1875 "/> </symbol> <symbol
overflow="visible" id="glyph1-1"> <path style="stroke:none;" d="M 6.039063 -1.015625 L
6.039063 0 L 0.363281 0 C 0.355469 -0.253906 0.394531 -0.496094 0.484375 -0.734375 C
0.628906 -1.117188 0.859375 -1.5 1.179688 -1.875 C 1.492188 -2.25 1.953125 -2.683594 2.5625
-3.175781 C 3.492188 -3.941406 4.125 -4.546875 4.453125 -4.992188 C 4.78125 -5.4375
4.945313 -5.859375 4.945313 -6.265625 C 4.945313 -6.679688 4.792969 -7.03125 4.496094
-7.320313 C 4.191406 -7.601563 3.804688 -7.746094 3.328125 -7.75 C 2.820313 -7.746094
2.414063 -7.59375 2.109375 -7.292969 C 1.804688 -6.984375 1.648438 -6.5625 1.648438
-6.03125 L 0.5625 -6.140625 C 0.632813 -6.945313 0.910156 -7.558594 1.398438 -7.988281 C
1.878906 -8.410156 2.53125 -8.625 3.351563 -8.625 C 4.171875 -8.625 4.824219 -8.394531
5.308594 -7.9375 C 5.789063 -7.480469 6.027344 -6.914063 6.03125 -6.242188 C 6.027344
-5.894531 5.957031 -5.558594 5.820313 -5.226563 C 5.675781 -4.890625 5.441406 -4.539063
5.117188 -4.175781 C 4.789063 -3.804688 4.25 -3.300781 3.492188 -2.664063 C 2.859375
-2.128906 2.453125 -1.769531 2.273438 -1.582031 C 2.09375 -1.394531 1.945313 -1.203125
1.828125 -1.015625 Z M 6.039063 -1.015625 "/> </symbol> <symbol overflow="visible"
id="glyph1-2"> <path style="stroke:none;" d="M 3.878906 0 L 3.878906 -2.054688 L 0.152344
-2.054688 L 0.152344 -3.023438 L 4.070313 -8.589844 L 4.933594 -8.589844 L 4.933594
-3.023438 L 6.09375 -3.023438 L 6.09375 -2.054688 L 4.933594 -2.054688 L 4.933594 0 Z M
3.878906 -3.023438 L 3.878906 -6.898438 L 1.1875 -3.023438 Z M 3.878906 -3.023438 "/>
</symbol> <symbol overflow="visible" id="glyph1-3"> <path style="stroke:none;" d="M
5.96875 -6.484375 L 4.921875 -6.40625 C 4.828125 -6.8125 4.695313 -7.113281 4.523438
-7.304688 C 4.234375 -7.605469 3.882813 -7.757813 3.46875 -7.757813 C 3.132813 -7.757813
2.835938 -7.664063 2.585938 -7.476563 C 2.25 -7.234375 1.988281 -6.878906 1.796875
-6.414063 C 1.605469 -5.949219 1.507813 -5.289063 1.5 -4.429688 C 1.753906 -4.8125 2.0625
-5.097656 2.433594 -5.289063 C 2.796875 -5.472656 3.183594 -5.566406 3.585938 -5.570313 C
4.289063 -5.566406 4.886719 -5.308594 5.382813 -4.792969 C 5.875 -4.277344 6.121094
-3.609375 6.125 -2.789063 C 6.121094 -2.25 6.003906 -1.746094 5.773438 -1.285156 C 5.539063
-0.820313 5.222656 -0.46875 4.816406 -0.222656 C 4.410156 0.0234375 3.949219 0.144531
3.433594 0.148438 C 2.554688 0.144531 1.835938 -0.175781 1.285156 -0.820313 C 0.726563
-1.46875 0.449219 -2.535156 0.453125 -4.019531 C 0.449219 -5.675781 0.757813 -6.882813
1.371094 -7.640625 C 1.902344 -8.296875 2.621094 -8.625 3.53125 -8.625 C 4.207031 -8.625
4.761719 -8.433594 5.195313 -8.054688 C 5.625 -7.675781 5.882813 -7.152344 5.96875
-6.484375 Z M 1.664063 -2.78125 C 1.664063 -2.417969 1.738281 -2.070313 1.894531 -1.738281
C 2.042969 -1.40625 2.261719 -1.152344 2.542969 -0.980469 C 2.820313 -0.800781 3.109375
-0.714844 3.414063 -0.71875 C 3.859375 -0.714844 4.242188 -0.894531 4.566406 -1.257813 C
4.882813 -1.613281 5.042969 -2.101563 5.046875 -2.726563 C 5.042969 -3.316406 4.886719
-3.785156 4.570313 -4.128906 C 4.25 -4.46875 3.851563 -4.640625 3.375 -4.640625 C 2.898438
-4.640625 2.492188 -4.46875 2.160156 -4.128906 C 1.828125 -3.785156 1.664063 -3.335938
1.664063 -2.78125 Z M 1.664063 -2.78125 "/> </symbol> <symbol overflow="visible"
id="glyph1-4"> <path style="stroke:none;" d="M 2.121094 -4.65625 C 1.683594 -4.816406
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-6.410156 C 0.832031 -7.035156 1.054688 -7.558594 1.503906 -7.984375 C 1.953125 -8.410156
2.550781 -8.625 3.296875 -8.625 C 4.042969 -8.625 4.648438 -8.40625 5.109375 -7.972656 C
5.566406 -7.535156 5.792969 -7.003906 5.796875 -6.382813 C 5.792969 -5.976563 5.6875
-5.628906 5.480469 -5.339844 C 5.269531 -5.042969 4.953125 -4.816406 4.53125 -4.65625 C
5.054688 -4.480469 5.457031 -4.203125 5.734375 -3.824219 C 6.007813 -3.4375 6.144531
-2.980469 6.148438 -2.453125 C 6.144531 -1.714844 5.886719 -1.097656 5.367188 -0.601563 C
4.84375 -0.101563 4.160156 0.144531 3.316406 0.148438 C 2.46875 0.144531 1.785156

```

```

-0.101563 1.265625 -0.605469 C 0.742188 -1.105469 0.480469 -1.734375 0.484375 -2.484375 C
0.480469 -3.039063 0.621094 -3.503906 0.910156 -3.886719 C 1.191406 -4.261719 1.597656
-4.519531 2.121094 -4.65625 Z M 1.910156 -6.445313 C 1.910156 -6.039063 2.039063 -5.707031
2.300781 -5.449219 C 2.5625 -5.191406 2.902344 -5.0625 3.320313 -5.0625 C 3.722656 -5.0625
4.054688 -5.1875 4.320313 -5.445313 C 4.578125 -5.695313 4.710938 -6.011719 4.710938
-6.386719 C 4.710938 -6.773438 4.574219 -7.097656 4.308594 -7.363281 C 4.035156 -7.625
3.703125 -7.757813 3.3125 -7.757813 C 2.90625 -7.757813 2.574219 -7.628906 2.308594
-7.371094 C 2.042969 -7.113281 1.910156 -6.804688 1.910156 -6.445313 Z M 1.570313
-2.476563 C 1.570313 -2.175781 1.640625 -1.886719 1.785156 -1.605469 C 1.925781 -1.324219
2.136719 -1.105469 2.421875 -0.949219 C 2.699219 -0.792969 3.003906 -0.714844 3.328125
-0.71875 C 3.832031 -0.714844 4.246094 -0.878906 4.578125 -1.207031 C 4.902344 -1.53125
5.066406 -1.941406 5.070313 -2.445313 C 5.066406 -2.945313 4.898438 -3.367188 4.5625
-3.703125 C 4.222656 -4.035156 3.800781 -4.199219 3.292969 -4.203125 C 2.792969 -4.199219
2.378906 -4.035156 2.058594 -3.710938 C 1.730469 -3.378906 1.570313 -2.96875 1.570313
-2.476563 Z M 1.570313 -2.476563 "/> </symbol> <symbol overflow="visible" id="glyph1-5">
<path style="stroke:none;" d="M 4.46875 0 L 3.414063 0 L 3.414063 -6.71875 C 3.160156
-6.476563 2.828125 -6.234375 2.414063 -5.996094 C 2 -5.75 1.628906 -5.570313 1.304688
-5.449219 L 1.304688 -6.46875 C 1.894531 -6.742188 2.410156 -7.078125 2.851563 -7.476563 C
3.292969 -7.871094 3.605469 -8.253906 3.789063 -8.625 L 4.46875 -8.625 Z M 4.46875 0 "/>
</symbol> <symbol overflow="visible" id="glyph1-6"> <path style="stroke:none;" d="M 0.5
-4.234375 C 0.496094 -5.246094 0.601563 -6.0625 0.8125 -6.6875 C 1.019531 -7.304688
1.328125 -7.785156 1.742188 -8.121094 C 2.148438 -8.457031 2.667969 -8.625 3.296875 -8.625
C 3.757813 -8.625 4.164063 -8.53125 4.511719 -8.347656 C 4.855469 -8.160156 5.140625
-7.890625 5.371094 -7.542969 C 5.59375 -7.191406 5.773438 -6.765625 5.90625 -6.265625 C
6.035156 -5.761719 6.097656 -5.085938 6.101563 -4.234375 C 6.097656 -3.226563 5.996094
-2.414063 5.789063 -1.796875 C 5.578125 -1.175781 5.265625 -0.695313 4.859375 -0.359375 C
4.445313 -0.0195313 3.925781 0.144531 3.296875 0.148438 C 2.464844 0.144531 1.816406
-0.148438 1.347656 -0.742188 C 0.78125 -1.457031 0.496094 -2.621094 0.5 -4.234375 Z M
1.582031 -4.234375 C 1.582031 -2.824219 1.746094 -1.886719 2.074219 -1.417969 C 2.402344
-0.949219 2.808594 -0.714844 3.296875 -0.71875 C 3.777344 -0.714844 4.183594 -0.949219
4.519531 -1.421875 C 4.847656 -1.886719 5.015625 -2.824219 5.015625 -4.234375 C 5.015625
-5.648438 4.847656 -6.589844 4.519531 -7.054688 C 4.183594 -7.515625 3.773438 -7.746094
3.289063 -7.75 C 2.800781 -7.746094 2.414063 -7.542969 2.125 -7.136719 C 1.761719 -6.613281
1.582031 -5.644531 1.582031 -4.234375 Z M 1.582031 -4.234375 "/> </symbol> <symbol
overflow="visible" id="glyph1-7"> <path style="stroke:none;" d="M 0.0859375 0 L 2.359375
-3.234375 L 0.257813 -6.222656 L 1.578125 -6.222656 L 2.53125 -4.765625 C 2.710938
-4.484375 2.855469 -4.253906 2.964844 -4.066406 C 3.136719 -4.324219 3.292969 -4.550781
3.4375 -4.75 L 4.488281 -6.222656 L 5.75 -6.222656 L 3.597656 -3.292969 L 5.914063 0 L
4.617188 0 L 3.339844 -1.933594 L 3 -2.453125 L 1.367188 0 Z M 0.0859375 0 "/> </symbol>
<symbol overflow="visible" id="glyph2-0"> <path style="stroke:none;" d="M 0 -1.5 L -7.5 -1.5
L -7.5 -7.5 L 0 -7.5 Z M -0.1875 -1.6875 L -0.1875 -7.3125 L -7.3125 -7.3125 L -7.3125 -1.6875 Z
M -0.1875 -1.6875 "/> </symbol> <symbol overflow="visible" id="glyph2-1"> <path
style="stroke:none;" d="M -2.25 -0.5 L -2.34375 -1.605469 C -1.804688 -1.683594 -1.398438
-1.871094 -1.125 -2.175781 C -0.851563 -2.472656 -0.714844 -2.835938 -0.71875 -3.257813 C
-0.714844 -3.765625 -0.90625 -4.195313 -1.292969 -4.546875 C -1.671875 -4.898438 -2.179688
-5.074219 -2.820313 -5.074219 C -3.414063 -5.074219 -3.890625 -4.902344 -4.242188
-4.566406 C -4.589844 -4.226563 -4.761719 -3.785156 -4.765625 -3.242188 C -4.761719
-2.898438 -4.683594 -2.59375 -4.53125 -2.320313 C -4.375 -2.046875 -4.175781 -1.832031
-3.929688 -1.675781 L -4.0625 -0.6875 L -8.472656 -1.515625 L -8.472656 -5.789063 L
-7.464844 -5.789063 L -7.464844 -2.359375 L -5.15625 -1.898438 C -5.515625 -2.414063
-5.695313 -2.953125 -5.695313 -3.523438 C -5.695313 -4.269531 -5.433594 -4.902344
-4.914063 -5.421875 C -4.394531 -5.933594 -3.726563 -6.191406 -2.914063 -6.195313 C
-2.132813 -6.191406 -1.460938 -5.964844 -0.898438 -5.515625 C -0.199219 -4.960938 0.144531
-4.210938 0.148438 -3.257813 C 0.144531 -2.476563 -0.0703125 -1.835938 -0.507813 -1.34375
C -0.941406 -0.84375 -1.523438 -0.5625 -2.25 -0.5 Z M -2.25 -0.5 "/> </symbol> <symbol
overflow="visible" id="glyph2-2"> <path style="stroke:none;" d="M 0 -4.46875 L 0 -3.414063 L
-6.71875 -3.414063 C -6.476563 -3.160156 -6.234375 -2.828125 -5.996094 -2.414063 C -5.75 -2
-5.570313 -1.628906 -5.449219 -1.304688 L -6.46875 -1.304688 C -6.742188 -1.894531

```

```
-7.078125 -2.410156 -7.476563 -2.851563 C -7.871094 -3.292969 -8.253906 -3.605469 -8.625
-3.789063 L -8.625 -4.46875 Z M 0 -4.46875 "/> </symbol> <symbol overflow="visible"
id="glyph2-3"> <path style="stroke:none;" d="M -4.234375 -0.5 C -5.246094 -0.496094 -6.0625
-0.601563 -6.6875 -0.8125 C -7.304688 -1.019531 -7.785156 -1.328125 -8.121094 -1.742188 C
-8.457031 -2.148438 -8.625 -2.667969 -8.625 -3.296875 C -8.625 -3.757813 -8.53125 -4.164063
-8.347656 -4.511719 C -8.160156 -4.855469 -7.890625 -5.140625 -7.542969 -5.371094 C
-7.191406 -5.59375 -6.765625 -5.773438 -6.265625 -5.90625 C -5.761719 -6.035156 -5.085938
-6.097656 -4.234375 -6.101563 C -3.226563 -6.097656 -2.414063 -5.996094 -1.796875
-5.789063 C -1.175781 -5.578125 -0.695313 -5.265625 -0.359375 -4.859375 C -0.0195313
-4.445313 0.144531 -3.925781 0.148438 -3.296875 C 0.144531 -2.464844 -0.148438 -1.816406
-0.742188 -1.347656 C -1.457031 -0.78125 -2.621094 -0.496094 -4.234375 -0.5 Z M -4.234375
-1.582031 C -2.824219 -1.582031 -1.886719 -1.746094 -1.417969 -2.074219 C -0.949219
-2.402344 -0.714844 -2.808594 -0.71875 -3.296875 C -0.714844 -3.777344 -0.949219 -4.183594
-1.421875 -4.519531 C -1.886719 -4.847656 -2.824219 -5.015625 -4.234375 -5.015625 C
-5.648438 -5.015625 -6.589844 -4.847656 -7.054688 -4.519531 C -7.515625 -4.183594
-7.746094 -3.773438 -7.75 -3.289063 C -7.746094 -2.800781 -7.542969 -2.414063 -7.136719
-2.125 C -6.613281 -1.761719 -5.644531 -1.582031 -4.234375 -1.582031 Z M -4.234375
-1.582031 "/> </symbol> <symbol overflow="visible" id="glyph2-4"> <path
style="stroke:none;" d="M -1.015625 -6.039063 L 0 -6.039063 L 0 -0.363281 C -0.253906
-0.355469 -0.496094 -0.394531 -0.734375 -0.484375 C -1.117188 -0.628906 -1.5 -0.859375
-1.875 -1.179688 C -2.25 -1.492188 -2.683594 -1.953125 -3.175781 -2.5625 C -3.941406
-3.492188 -4.546875 -4.125 -4.992188 -4.453125 C -5.4375 -4.78125 -5.859375 -4.945313
-6.265625 -4.945313 C -6.679688 -4.945313 -7.03125 -4.792969 -7.320313 -4.496094 C
-7.601563 -4.191406 -7.746094 -3.804688 -7.75 -3.328125 C -7.746094 -2.820313 -7.59375
-2.414063 -7.292969 -2.109375 C -6.984375 -1.804688 -6.5625 -1.648438 -6.03125 -1.648438 L
-6.140625 -0.5625 C -6.945313 -0.632813 -7.558594 -0.910156 -7.988281 -1.398438 C -8.410156
-1.878906 -8.625 -2.53125 -8.625 -3.351563 C -8.625 -4.171875 -8.394531 -4.824219 -7.9375
-5.308594 C -7.480469 -5.789063 -6.914063 -6.027344 -6.242188 -6.03125 C -5.894531
-6.027344 -5.558594 -5.957031 -5.226563 -5.820313 C -4.890625 -5.675781 -4.539063
-5.441406 -4.175781 -5.117188 C -3.804688 -4.789063 -3.300781 -4.25 -2.664063 -3.492188 C
-2.128906 -2.859375 -1.769531 -2.453125 -1.582031 -2.273438 C -1.394531 -2.09375 -1.203125
-1.945313 -1.015625 -1.828125 Z M -1.015625 -6.039063 "/> </symbol> <symbol
overflow="visible" id="glyph2-5"> <path style="stroke:none;" d="M -2.265625 -0.503906 L
-2.40625 -1.558594 C -1.808594 -1.679688 -1.378906 -1.882813 -1.113281 -2.175781 C
-0.847656 -2.464844 -0.714844 -2.820313 -0.71875 -3.242188 C -0.714844 -3.734375 -0.886719
-4.152344 -1.234375 -4.496094 C -1.574219 -4.832031 -2 -5.003906 -2.515625 -5.007813 C
-2.996094 -5.003906 -3.394531 -4.847656 -3.710938 -4.535156 C -4.023438 -4.21875 -4.183594
-3.816406 -4.183594 -3.328125 C -4.183594 -3.128906 -4.144531 -2.878906 -4.066406
-2.585938 L -4.992188 -2.703125 C -4.984375 -2.765625 -4.980469 -2.824219 -4.980469
-2.871094 C -4.980469 -3.320313 -5.097656 -3.722656 -5.332031 -4.085938 C -5.566406
-4.441406 -5.925781 -4.621094 -6.414063 -4.625 C -6.800781 -4.621094 -7.121094 -4.492188
-7.375 -4.230469 C -7.628906 -3.964844 -7.757813 -3.625 -7.757813 -3.21875 C -7.757813
-2.804688 -7.628906 -2.464844 -7.371094 -2.191406 C -7.113281 -1.917969 -6.726563
-1.742188 -6.210938 -1.664063 L -6.398438 -0.609375 C -7.105469 -0.738281 -7.652344
-1.03125 -8.042969 -1.488281 C -8.429688 -1.941406 -8.625 -2.507813 -8.625 -3.195313 C
-8.625 -3.660156 -8.523438 -4.09375 -8.324219 -4.488281 C -8.121094 -4.878906 -7.847656
-5.179688 -7.5 -5.390625 C -7.148438 -5.601563 -6.777344 -5.707031 -6.390625 -5.707031 C
-6.019531 -5.707031 -5.683594 -5.605469 -5.378906 -5.40625 C -5.074219 -5.207031 -4.832031
-4.914063 -4.652344 -4.523438 C -4.535156 -5.03125 -4.289063 -5.425781 -3.921875 -5.707031
C -3.546875 -5.988281 -3.085938 -6.128906 -2.539063 -6.128906 C -1.785156 -6.128906
-1.148438 -5.855469 -0.628906 -5.308594 C -0.105469 -4.761719 0.152344 -4.070313 0.152344
-3.234375 C 0.152344 -2.476563 -0.0703125 -1.847656 -0.519531 -1.355469 C -0.96875
-0.855469 -1.550781 -0.574219 -2.265625 -0.503906 Z M -2.265625 -0.503906 "/> </symbol>
<symbol overflow="visible" id="glyph2-6"> <path style="stroke:none;" d="M 2.398438
-0.742188 L 1.40625 -0.625 C 1.46875 -0.855469 1.5 -1.058594 1.5 -1.230469 C 1.5 -1.464844
1.460938 -1.652344 1.382813 -1.792969 C 1.304688 -1.933594 1.195313 -2.046875 1.054688
-2.140625 C 0.949219 -2.203125 0.6875 -2.3125 0.269531 -2.460938 C 0.207031 -2.480469
0.121094 -2.511719 0.0117188 -2.554688 L -6.222656 -0.195313 L -6.222656 -1.328125 L
```

```

-2.617188 -2.625 C -2.160156 -2.789063 -1.679688 -2.9375 -1.179688 -3.078125 C -1.660156
-3.195313 -2.132813 -3.339844 -2.59375 -3.507813 L -6.222656 -4.839844 L -6.222656
-5.894531 L 0.105469 -3.527344 C 0.789063 -3.273438 1.257813 -3.074219 1.515625 -2.9375 C
1.863281 -2.746094 2.117188 -2.53125 2.28125 -2.292969 C 2.4375 -2.046875 2.519531
-1.757813 2.523438 -1.421875 C 2.519531 -1.214844 2.476563 -0.988281 2.398438 -0.742188 Z
M 2.398438 -0.742188 "/> </symbol> </g> </defs> <g id="surface1"> <rect x="0" y="0"
width="360" height="360" style="fill:rgb(100%,100%,100%);fill-opacity:1;stroke:none;"/> <g
style="fill:rgb(0%,0%,100%);fill-opacity:1;"> <use xlink:href="#glyph0-1" x="62.058594"
y="286.589844"/> </g> <g style="fill:rgb(0%,0%,100%);fill-opacity:1;"> <use
xlink:href="#glyph0-1" x="259.011719" y="121.066406"/> </g> <g
style="fill:rgb(0%,0%,100%);fill-opacity:1;"> <use xlink:href="#glyph0-1" x="312.726563"
y="75.921875"/> </g> <g style="fill:rgb(0%,0%,100%);fill-opacity:1;"> <use
xlink:href="#glyph0-1" x="97.867188" y="256.492188"/> </g> <path style="fill:none;stroke-
width:0.75;stroke-linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-
opacity:1;stroke-miterlimit:10;" d="M 86.972656 286.558594 L 301.828125 286.558594 "/>
<path style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 86.972656
286.558594 L 86.972656 293.761719 "/> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"
d="M 122.78125 286.558594 L 122.78125 293.761719 "/> <path style="fill:none;stroke-
width:0.75;stroke-linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-
opacity:1;stroke-miterlimit:10;" d="M 158.589844 286.558594 L 158.589844 293.761719 "/>
<path style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 194.398438
286.558594 L 194.398438 293.761719 "/> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"
d="M 230.210938 286.558594 L 230.210938 293.761719 "/> <path style="fill:none;stroke-
width:0.75;stroke-linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-
opacity:1;stroke-miterlimit:10;" d="M 266.019531 286.558594 L 266.019531 293.761719 "/>
<path style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 301.828125
286.558594 L 301.828125 293.761719 "/> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use
xlink:href="#glyph1-1" x="83.636719" y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-
opacity:1;"> <use xlink:href="#glyph1-2" x="119.445313" y="312.480469"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph1-3" x="155.253906"
y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph1-
4" x="191.0625" y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use
xlink:href="#glyph1-5" x="223.539063" y="312.480469"/> <use xlink:href="#glyph1-6"
x="230.212891" y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use
xlink:href="#glyph1-5" x="259.347656" y="312.480469"/> <use xlink:href="#glyph1-1"
x="266.021484" y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use
xlink:href="#glyph1-5" x="295.15625" y="312.480469"/> <use xlink:href="#glyph1-2"
x="301.830078" y="312.480469"/> </g> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"
d="M 59.039063 255.5625 L 59.039063 67.464844 "/> <path style="fill:none;stroke-
width:0.75;stroke-linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-
opacity:1;stroke-miterlimit:10;" d="M 59.039063 255.5625 L 51.839844 255.5625 "/> <path
style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 59.039063
217.941406 L 51.839844 217.941406 "/> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"
d="M 59.039063 180.324219 L 51.839844 180.324219 "/> <path style="fill:none;stroke-
width:0.75;stroke-linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-
opacity:1;stroke-miterlimit:10;" d="M 59.039063 142.703125 L 51.839844 142.703125 "/> <path
style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 59.039063
105.085938 L 51.839844 105.085938 "/> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"

```



```
d="M 59.039063 67.464844 L 51.839844 67.464844 "/> <g style="fill:rgb(0%,0%,0%);fill-
opacity:1;"> <use xlink:href="#glyph2-1" x="41.761719" y="258.898438"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-2" x="41.761719"
y="224.613281"/> <use xlink:href="#glyph2-3" x="41.761719" y="217.939453"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-2" x="41.761719"
y="186.996094"/> <use xlink:href="#glyph2-1" x="41.761719" y="180.322266"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-4" x="41.761719"
y="149.375"/> <use xlink:href="#glyph2-3" x="41.761719" y="142.701172"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-4" x="41.761719"
y="111.757813"/> <use xlink:href="#glyph2-1" x="41.761719" y="105.083984"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-5" x="41.761719"
y="74.136719"/> <use xlink:href="#glyph2-3" x="41.761719" y="67.462891"/> </g> <path
style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 59.039063
286.558594 L 329.761719 286.558594 L 329.761719 59.039063 L 59.039063 59.039063 Z M
59.039063 286.558594 "/> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use
xlink:href="#glyph1-7" x="191.398438" y="341.28125"/> </g> <g style="fill:rgb(0%,0%,0%);fill-
opacity:1;"> <use xlink:href="#glyph2-6" x="12.960938" y="175.800781"/> </g> </g> </svg>
```

But it is also obvious that:

```
my.plot(x.coord,y.coord,"blue")
```

will not work as intended because the third parameter will be interpreted as parameter `symb`, i.e. a plotting character and a red 'b' will be plotted.

```
In [27]: my.plot(x.coord,y.coord,"blue")
```

```

<svg xmlns="http://www.w3.org/2000/svg" xmlns:xlink="http://www.w3.org/1999/xlink"
width="360pt" height="360pt" viewBox="0 0 360 360" version="1.1"> <defs> <g> <symbol
overflow="visible" id="glyph0-0"> <path style="stroke:none;" d="M 3 0 L 3 -15 L 15 -15 L 15 0
Z M 3.375 -0.375 L 14.625 -0.375 L 14.625 -14.625 L 3.375 -14.625 Z M 3.375 -0.375 "/>
</symbol> <symbol overflow="visible" id="glyph0-1"> <path style="stroke:none;" d="M
3.527344 0 L 1.570313 0 L 1.570313 -17.179688 L 3.679688 -17.179688 L 3.679688 -11.050781 C
4.570313 -12.167969 5.707031 -12.726563 7.089844 -12.726563 C 7.855469 -12.726563
8.578125 -12.570313 9.261719 -12.261719 C 9.945313 -11.953125 10.507813 -11.519531
10.949219 -10.960938 C 11.390625 -10.402344 11.738281 -9.730469 11.988281 -8.941406 C
12.238281 -8.152344 12.363281 -7.308594 12.363281 -6.410156 C 12.363281 -4.277344
11.835938 -2.628906 10.78125 -1.464844 C 9.726563 -0.300781 8.460938 0.28125 6.984375
0.28125 C 5.515625 0.28125 4.363281 -0.332031 3.527344 -1.558594 Z M 3.503906 -6.316406 C
3.503906 -4.824219 3.707031 -3.746094 4.113281 -3.082031 C 4.777344 -1.996094 5.675781
-1.453125 6.808594 -1.453125 C 7.730469 -1.453125 8.527344 -1.851563 9.199219 -2.652344 C
9.871094 -3.453125 10.207031 -4.648438 10.207031 -6.234375 C 10.207031 -7.859375 9.882813
-9.058594 9.238281 -9.832031 C 8.59375 -10.605469 7.816406 -10.992188 6.902344 -10.992188
C 5.980469 -10.992188 5.183594 -10.589844 4.511719 -9.789063 C 3.839844 -8.988281
3.503906 -7.832031 3.503906 -6.316406 Z M 3.503906 -6.316406 "/> </symbol> <symbol
overflow="visible" id="glyph1-0"> <path style="stroke:none;" d="M 1.5 0 L 1.5 -7.5 L 7.5 -7.5 L
7.5 0 Z M 1.6875 -0.1875 L 7.3125 -0.1875 L 7.3125 -7.3125 L 1.6875 -7.3125 Z M 1.6875 -0.1875
"/> </symbol> <symbol overflow="visible" id="glyph1-1"> <path style="stroke:none;" d="M
6.039063 -1.015625 L 6.039063 0 L 0.363281 0 C 0.355469 -0.253906 0.394531 -0.496094
0.484375 -0.734375 C 0.628906 -1.117188 0.859375 -1.5 1.179688 -1.875 C 1.492188 -2.25
1.953125 -2.683594 2.5625 -3.175781 C 3.492188 -3.941406 4.125 -4.546875 4.453125
-4.992188 C 4.78125 -5.4375 4.945313 -5.859375 4.945313 -6.265625 C 4.945313 -6.679688
4.792969 -7.03125 4.496094 -7.320313 C 4.191406 -7.601563 3.804688 -7.746094 3.328125
-7.75 C 2.820313 -7.746094 2.414063 -7.59375 2.109375 -7.292969 C 1.804688 -6.984375
1.648438 -6.5625 1.648438 -6.03125 L 0.5625 -6.140625 C 0.632813 -6.945313 0.910156
-7.558594 1.398438 -7.988281 C 1.878906 -8.410156 2.53125 -8.625 3.351563 -8.625 C 4.171875
-8.625 4.824219 -8.394531 5.308594 -7.9375 C 5.789063 -7.480469 6.027344 -6.914063 6.03125
-6.242188 C 6.027344 -5.894531 5.957031 -5.558594 5.820313 -5.226563 C 5.675781 -4.890625
5.441406 -4.539063 5.117188 -4.175781 C 4.789063 -3.804688 4.25 -3.300781 3.492188
-2.664063 C 2.859375 -2.128906 2.453125 -1.769531 2.273438 -1.582031 C 2.09375 -1.394531
1.945313 -1.203125 1.828125 -1.015625 Z M 6.039063 -1.015625 "/> </symbol> <symbol
overflow="visible" id="glyph1-2"> <path style="stroke:none;" d="M 3.878906 0 L 3.878906
-2.054688 L 0.152344 -2.054688 L 0.152344 -3.023438 L 4.070313 -8.589844 L 4.933594
-8.589844 L 4.933594 -3.023438 L 6.09375 -3.023438 L 6.09375 -2.054688 L 4.933594 -2.054688
L 4.933594 0 Z M 3.878906 -3.023438 L 3.878906 -6.898438 L 1.1875 -3.023438 Z M 3.878906
-3.023438 "/> </symbol> <symbol overflow="visible" id="glyph1-3"> <path
style="stroke:none;" d="M 5.96875 -6.484375 L 4.921875 -6.40625 C 4.828125 -6.8125 4.695313
-7.113281 4.523438 -7.304688 C 4.234375 -7.605469 3.882813 -7.757813 3.46875 -7.757813 C
3.132813 -7.757813 2.835938 -7.664063 2.585938 -7.476563 C 2.25 -7.234375 1.988281
-6.878906 1.796875 -6.414063 C 1.605469 -5.949219 1.507813 -5.289063 1.5 -4.429688 C
1.753906 -4.8125 2.0625 -5.097656 2.433594 -5.289063 C 2.796875 -5.472656 3.183594
-5.566406 3.585938 -5.570313 C 4.289063 -5.566406 4.886719 -5.308594 5.382813 -4.792969 C
5.875 -4.277344 6.121094 -3.609375 6.125 -2.789063 C 6.121094 -2.25 6.003906 -1.746094
5.773438 -1.285156 C 5.539063 -0.820313 5.226563 -0.46875 4.816406 -0.222656 C 4.410156
0.0234375 3.949219 0.144531 3.433594 0.148438 C 2.554688 0.144531 1.835938 -0.175781
1.285156 -0.820313 C 0.726563 -1.46875 0.449219 -2.535156 0.453125 -4.019531 C 0.449219
-5.675781 0.757813 -6.882813 1.371094 -7.640625 C 1.902344 -8.296875 2.621094 -8.625
3.53125 -8.625 C 4.207031 -8.625 4.761719 -8.433594 5.195313 -8.054688 C 5.625 -7.675781
5.882813 -7.152344 5.96875 -6.484375 Z M 1.664063 -2.78125 C 1.664063 -2.417969 1.738281
-2.070313 1.894531 -1.738281 C 2.042969 -1.40625 2.261719 -1.152344 2.542969 -0.980469 C
2.820313 -0.800781 3.109375 -0.714844 3.414063 -0.71875 C 3.859375 -0.714844 4.242188
-0.894531 4.566406 -1.257813 C 4.882813 -1.613281 5.042969 -2.101563 5.046875 -2.726563 C
5.042969 -3.316406 4.886719 -3.785156 4.570313 -4.128906 C 4.25 -4.46875 3.851563
-4.640625 3.375 -4.640625 C 2.898438 -4.640625 2.492188 -4.46875 2.160156 -4.128906 C
1.828125 -3.785156 1.664063 -3.335938 1.664063 -2.78125 Z M 1.664063 -2.78125 "/>

```

```

</symbol> <symbol overflow="visible" id="glyph1-4"> <path style="stroke:none;" d="M
2.121094 -4.65625 C 1.683594 -4.816406 1.359375 -5.046875 1.148438 -5.34375 C 0.9375
-5.640625 0.832031 -5.996094 0.832031 -6.410156 C 0.832031 -7.035156 1.054688 -7.558594
1.503906 -7.984375 C 1.953125 -8.410156 2.550781 -8.625 3.296875 -8.625 C 4.042969 -8.625
4.648438 -8.40625 5.109375 -7.972656 C 5.566406 -7.535156 5.792969 -7.003906 5.796875
-6.382813 C 5.792969 -5.976563 5.6875 -5.628906 5.480469 -5.339844 C 5.269531 -5.042969
4.953125 -4.816406 4.53125 -4.65625 C 5.054688 -4.480469 5.457031 -4.203125 5.734375
-3.824219 C 6.007813 -3.4375 6.144531 -2.980469 6.148438 -2.453125 C 6.144531 -1.714844
5.886719 -1.097656 5.367188 -0.601563 C 4.84375 -0.101563 4.160156 0.144531 3.316406
0.148438 C 2.46875 0.144531 1.785156 -0.101563 1.265625 -0.605469 C 0.742188 -1.105469
0.480469 -1.734375 0.484375 -2.484375 C 0.480469 -3.039063 0.621094 -3.503906 0.910156
-3.886719 C 1.191406 -4.261719 1.597656 -4.519531 2.121094 -4.65625 Z M 1.910156 -6.445313
C 1.910156 -6.039063 2.039063 -5.707031 2.300781 -5.449219 C 2.5625 -5.191406 2.902344
-5.0625 3.320313 -5.0625 C 3.722656 -5.0625 4.054688 -5.1875 4.320313 -5.445313 C 4.578125
-5.695313 4.710938 -6.011719 4.710938 -6.386719 C 4.710938 -6.773438 4.574219 -7.097656
4.308594 -7.363281 C 4.035156 -7.625 3.703125 -7.757813 3.3125 -7.757813 C 2.90625
-7.757813 2.574219 -7.628906 2.308594 -7.371094 C 2.042969 -7.113281 1.910156 -6.804688
1.910156 -6.445313 Z M 1.570313 -2.476563 C 1.570313 -2.175781 1.640625 -1.886719
1.785156 -1.605469 C 1.925781 -1.324219 2.136719 -1.105469 2.421875 -0.949219 C 2.699219
-0.792969 3.003906 -0.714844 3.328125 -0.71875 C 3.832031 -0.714844 4.246094 -0.878906
4.578125 -1.207031 C 4.902344 -1.53125 5.066406 -1.941406 5.070313 -2.445313 C 5.066406
-2.945313 4.898438 -3.367188 4.5625 -3.703125 C 4.222656 -4.035156 3.800781 -4.199219
3.292969 -4.203125 C 2.792969 -4.199219 2.378906 -4.035156 2.058594 -3.710938 C 1.730469
-3.378906 1.570313 -2.96875 1.570313 -2.476563 Z M 1.570313 -2.476563 "/> </symbol>
<symbol overflow="visible" id="glyph1-5"> <path style="stroke:none;" d="M 4.46875 0 L
3.414063 0 L 3.414063 -6.71875 C 3.160156 -6.476563 2.828125 -6.234375 2.414063 -5.996094
C 2 -5.75 1.628906 -5.570313 1.304688 -5.449219 L 1.304688 -6.46875 C 1.894531 -6.742188
2.410156 -7.078125 2.851563 -7.476563 C 3.292969 -7.871094 3.605469 -8.253906 3.789063
-8.625 L 4.46875 -8.625 Z M 4.46875 0 "/> </symbol> <symbol overflow="visible" id="glyph1-
6"> <path style="stroke:none;" d="M 0.5 -4.234375 C 0.496094 -5.246094 0.601563 -6.0625
0.8125 -6.6875 C 1.019531 -7.304688 1.328125 -7.785156 1.742188 -8.121094 C 2.148438
-8.457031 2.667969 -8.625 3.296875 -8.625 C 3.757813 -8.625 4.164063 -8.53125 4.511719
-8.347656 C 4.855469 -8.160156 5.140625 -7.890625 5.371094 -7.542969 C 5.59375 -7.191406
5.773438 -6.765625 5.90625 -6.265625 C 6.035156 -5.761719 6.097656 -5.085938 6.101563
-4.234375 C 6.097656 -3.226563 5.996094 -2.414063 5.789063 -1.796875 C 5.578125 -1.175781
5.265625 -0.695313 4.859375 -0.359375 C 4.445313 -0.0195313 3.925781 0.144531 3.296875
0.148438 C 2.464844 0.144531 1.816406 -0.148438 1.347656 -0.742188 C 0.78125 -1.457031
0.496094 -2.621094 0.5 -4.234375 Z M 1.582031 -4.234375 C 1.582031 -2.824219 1.746094
-1.886719 2.074219 -1.417969 C 2.402344 -0.949219 2.808594 -0.714844 3.296875 -0.71875 C
3.777344 -0.714844 4.183594 -0.949219 4.519531 -1.421875 C 4.847656 -1.886719 5.015625
-2.824219 5.015625 -4.234375 C 5.015625 -5.648438 4.847656 -6.589844 4.519531 -7.054688 C
4.183594 -7.515625 3.773438 -7.746094 3.289063 -7.75 C 2.800781 -7.746094 2.414063
-7.542969 2.125 -7.136719 C 1.761719 -6.613281 1.582031 -5.644531 1.582031 -4.234375 Z M
1.582031 -4.234375 "/> </symbol> <symbol overflow="visible" id="glyph1-7"> <path
style="stroke:none;" d="M 0.0859375 0 L 2.359375 -3.234375 L 0.257813 -6.222656 L 1.578125
-6.222656 L 2.53125 -4.765625 C 2.710938 -4.484375 2.855469 -4.253906 2.964844 -4.066406 C
3.136719 -4.324219 3.292969 -4.550781 3.4375 -4.75 L 4.488281 -6.222656 L 5.75 -6.222656 L
3.597656 -3.292969 L 5.914063 0 L 4.617188 0 L 3.339844 -1.933594 L 3 -2.453125 L 1.367188 0
Z M 0.0859375 0 "/> </symbol> <symbol overflow="visible" id="glyph2-0"> <path
style="stroke:none;" d="M 0 -1.5 L -7.5 -1.5 L -7.5 -7.5 L 0 -7.5 Z M -0.1875 -1.6875 L -0.1875
-7.3125 L -7.3125 -7.3125 L -7.3125 -1.6875 Z M -0.1875 -1.6875 "/> </symbol> <symbol
overflow="visible" id="glyph2-1"> <path style="stroke:none;" d="M -2.25 -0.5 L -2.34375
-1.605469 C -1.804688 -1.683594 -1.398438 -1.871094 -1.125 -2.175781 C -0.851563 -2.472656
-0.714844 -2.835938 -0.71875 -3.257813 C -0.714844 -3.765625 -0.90625 -4.195313 -1.292969
-4.546875 C -1.671875 -4.898438 -2.179688 -5.074219 -2.820313 -5.074219 C -3.414063
-5.074219 -3.890625 -4.902344 -4.242188 -4.566406 C -4.589844 -4.226563 -4.761719
-3.785156 -4.765625 -3.242188 C -4.761719 -2.898438 -4.683594 -2.59375 -4.53125 -2.320313 C
-4.375 -2.046875 -4.175781 -1.832031 -3.929688 -1.675781 L -4.0625 -0.6875 L -8.472656

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-1.515625 L -8.472656 -5.789063 L -7.464844 -5.789063 L -7.464844 -2.359375 L -5.15625  
-1.898438 C -5.515625 -2.414063 -5.695313 -2.953125 -5.695313 -3.523438 C -5.695313  
-4.269531 -5.433594 -4.902344 -4.914063 -5.421875 C -4.394531 -5.933594 -3.726563  
-6.191406 -2.914063 -6.195313 C -2.132813 -6.191406 -1.460938 -5.964844 -0.898438  
-5.515625 C -0.199219 -4.960938 0.144531 -4.210938 0.148438 -3.257813 C 0.144531 -2.476563  
-0.0703125 -1.835938 -0.507813 -1.34375 C -0.941406 -0.84375 -1.523438 -0.5625 -2.25 -0.5 Z  
M -2.25 -0.5 "/> </symbol> <symbol overflow="visible" id="glyph2-2"> <path  
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-3.160156 -6.234375 -2.828125 -5.996094 -2.414063 C -5.75 -2 -5.570313 -1.628906 -5.449219  
-1.304688 L -6.46875 -1.304688 C -6.742188 -1.894531 -7.078125 -2.410156 -7.476563  
-2.851563 C -7.871094 -3.292969 -8.253906 -3.605469 -8.625 -3.789063 L -8.625 -4.46875 Z M 0  
-4.46875 "/> </symbol> <symbol overflow="visible" id="glyph2-3"> <path  
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-0.8125 C -7.304688 -1.019531 -7.785156 -1.328125 -8.121094 -1.742188 C -8.457031 -2.148438  
-8.625 -2.667969 -8.625 -3.296875 C -8.625 -3.757813 -8.53125 -4.164063 -8.347656 -4.511719  
C -8.160156 -4.855469 -7.890625 -5.140625 -7.542969 -5.371094 C -7.191406 -5.59375  
-6.765625 -5.773438 -6.265625 -5.90625 C -5.761719 -6.035156 -5.085938 -6.097656 -4.234375  
-6.101563 C -3.226563 -6.097656 -2.414063 -5.996094 -1.796875 -5.789063 C -1.175781  
-5.578125 -0.695313 -5.265625 -0.359375 -4.859375 C -0.0195313 -4.445313 0.144531  
-3.925781 0.148438 -3.296875 C 0.144531 -2.464844 -0.148438 -1.816406 -0.742188 -1.347656  
C -1.457031 -0.78125 -2.621094 -0.496094 -4.234375 -0.5 Z M -4.234375 -1.582031 C -2.824219  
-1.582031 -1.886719 -1.746094 -1.417969 -2.074219 C -0.949219 -2.402344 -0.714844  
-2.808594 -0.71875 -3.296875 C -0.714844 -3.777344 -0.949219 -4.183594 -1.421875 -4.519531  
C -1.886719 -4.847656 -2.824219 -5.015625 -4.234375 -5.015625 C -5.648438 -5.015625  
-6.589844 -4.847656 -7.054688 -4.519531 C -7.515625 -4.183594 -7.746094 -3.773438 -7.75  
-3.289063 C -7.746094 -2.800781 -7.542969 -2.414063 -7.136719 -2.125 C -6.613281 -1.761719  
-5.644531 -1.582031 -4.234375 -1.582031 Z M -4.234375 -1.582031 "/> </symbol> <symbol  
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-1.117188 -0.628906 -1.5 -0.859375 -1.875 -1.179688 C -2.25 -1.492188 -2.683594 -1.953125  
-3.175781 -2.5625 C -3.941406 -3.492188 -4.546875 -4.125 -4.992188 -4.453125 C -5.4375  
-4.78125 -5.859375 -4.945313 -6.265625 -4.945313 C -6.679688 -4.945313 -7.03125 -4.792969  
-7.320313 -4.496094 C -7.601563 -4.191406 -7.746094 -3.804688 -7.75 -3.328125 C -7.746094  
-2.820313 -7.59375 -2.414063 -7.292969 -2.109375 C -6.984375 -1.804688 -6.5625 -1.648438  
-6.03125 -1.648438 L -6.140625 -0.5625 C -6.945313 -0.632813 -7.558594 -0.910156 -7.988281  
-1.398438 C -8.410156 -1.878906 -8.625 -2.53125 -8.625 -3.351563 C -8.625 -4.171875  
-8.394531 -4.824219 -7.9375 -5.308594 C -7.480469 -5.789063 -6.914063 -6.027344 -6.242188  
-6.03125 C -5.894531 -6.027344 -5.558594 -5.957031 -5.226563 -5.820313 C -4.890625  
-5.675781 -4.539063 -5.441406 -4.175781 -5.117188 C -3.804688 -4.789063 -3.300781 -4.25  
-2.664063 -3.492188 C -2.128906 -2.859375 -1.769531 -2.453125 -1.582031 -2.273438 C  
-1.394531 -2.09375 -1.203125 -1.945313 -1.015625 -1.828125 Z M -1.015625 -6.039063 "/>  
</symbol> <symbol overflow="visible" id="glyph2-5"> <path style="stroke:none;" d="M  
-2.265625 -0.503906 L -2.40625 -1.558594 C -1.808594 -1.679688 -1.378906 -1.882813  
-1.113281 -2.175781 C -0.847656 -2.464844 -0.714844 -2.820313 -0.71875 -3.242188 C  
-0.714844 -3.734375 -0.886719 -4.152344 -1.234375 -4.496094 C -1.574219 -4.832031 -2  
-5.003906 -2.515625 -5.007813 C -2.996094 -5.003906 -3.394531 -4.847656 -3.710938  
-4.535156 C -4.023438 -4.21875 -4.183594 -3.816406 -4.183594 -3.328125 C -4.183594  
-3.128906 -4.144531 -2.878906 -4.066406 -2.585938 L -4.992188 -2.703125 C -4.984375  
-2.765625 -4.980469 -2.824219 -4.980469 -2.871094 C -4.980469 -3.320313 -5.097656  
-3.722656 -5.332031 -4.085938 C -5.566406 -4.441406 -5.925781 -4.621094 -6.414063 -4.625 C  
-6.800781 -4.621094 -7.121094 -4.492188 -7.375 -4.230469 C -7.628906 -3.964844 -7.757813  
-3.625 -7.757813 -3.21875 C -7.757813 -2.804688 -7.628906 -2.464844 -7.371094 -2.191406 C  
-7.113281 -1.917969 -6.726563 -1.742188 -6.210938 -1.664063 L -6.398438 -0.609375 C  
-7.105469 -0.738281 -7.652344 -1.03125 -8.042969 -1.488281 C -8.429688 -1.941406 -8.625  
-2.507813 -8.625 -3.195313 C -8.625 -3.660156 -8.523438 -4.09375 -8.324219 -4.488281 C  
-8.121094 -4.878906 -7.847656 -5.179688 -7.5 -5.390625 C -7.148438 -5.601563 -6.777344  
-5.707031 -6.390625 -5.707031 C -6.019531 -5.707031 -5.683594 -5.605469 -5.378906 -5.40625  
C -5.074219 -5.207031 -4.832031 -4.914063 -4.652344 -4.523438 C -4.535156 -5.03125

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-4.289063 -5.425781 -3.921875 -5.707031 C -3.546875 -5.988281 -3.085938 -6.128906
-2.539063 -6.128906 C -1.785156 -6.128906 -1.148438 -5.855469 -0.628906 -5.308594 C
-0.105469 -4.761719 0.152344 -4.070313 0.152344 -3.234375 C 0.152344 -2.476563 -0.0703125
-1.847656 -0.519531 -1.355469 C -0.96875 -0.855469 -1.550781 -0.574219 -2.265625 -0.503906
Z M -2.265625 -0.503906 "/> </symbol> <symbol overflow="visible" id="glyph2-6"> <path
style="stroke:none;" d="M 2.398438 -0.742188 L 1.40625 -0.625 C 1.46875 -0.855469 1.5
-1.058594 1.5 -1.230469 C 1.5 -1.464844 1.460938 -1.652344 1.382813 -1.792969 C 1.304688
-1.933594 1.195313 -2.046875 1.054688 -2.140625 C 0.949219 -2.203125 0.6875 -2.3125
0.269531 -2.460938 C 0.207031 -2.480469 0.121094 -2.511719 0.0117188 -2.554688 L -6.222656
-0.195313 L -6.222656 -1.328125 L -2.617188 -2.625 C -2.160156 -2.789063 -1.679688 -2.9375
-1.179688 -3.078125 C -1.660156 -3.195313 -2.132813 -3.339844 -2.59375 -3.507813 L
-6.222656 -4.839844 L -6.222656 -5.894531 L 0.105469 -3.527344 C 0.789063 -3.273438
1.257813 -3.074219 1.515625 -2.9375 C 1.863281 -2.746094 2.117188 -2.53125 2.28125
-2.292969 C 2.4375 -2.046875 2.519531 -1.757813 2.523438 -1.421875 C 2.519531 -1.214844
2.476563 -0.988281 2.398438 -0.742188 Z M 2.398438 -0.742188 "/> </symbol> </g>
<clipPath id="clip1"> <path d="M 63 269 L 75 269 L 75 286.558594 L 63 286.558594 Z M 63
269 "/> </clipPath> <clipPath id="clip2"> <path d="M 314 59.039063 L 326 59.039063 L 326
77 L 314 77 Z M 314 59.039063 "/> </clipPath> </defs> <g id="surface6"> <rect x="0" y="0"
width="360" height="360" style="fill:rgb(100%,100%,100%);fill-opacity:1;stroke:none;"/> <g
clip-path="url(#clip1)" clip-rule="nonzero"> <g style="fill:rgb(100%,0%,0%);fill-opacity:1;"/>
<use xlink:href="#glyph0-1" x="62.394531" y="286.582031"/> </g> </g> <g
style="fill:rgb(100%,0%,0%);fill-opacity:1;"/> <use xlink:href="#glyph0-1" x="259.347656"
y="121.058594"/> </g> <g clip-path="url(#clip2)" clip-rule="nonzero"> <g
style="fill:rgb(100%,0%,0%);fill-opacity:1;"/> <use xlink:href="#glyph0-1" x="313.0625"
y="75.914063"/> </g> </g> <g style="fill:rgb(100%,0%,0%);fill-opacity:1;"/> <use
xlink:href="#glyph0-1" x="98.203125" y="256.488281"/> </g> <path style="fill:none;stroke-
width:0.75;stroke-linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-
opacity:1;stroke-miterlimit:10;" d="M 86.972656 286.558594 L 301.828125 286.558594 "/>
<path style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 86.972656
286.558594 L 86.972656 293.761719 "/> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"
d="M 122.78125 286.558594 L 122.78125 293.761719 "/> <path style="fill:none;stroke-
width:0.75;stroke-linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-
opacity:1;stroke-miterlimit:10;" d="M 158.589844 286.558594 L 158.589844 293.761719 "/>
<path style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 194.398438
286.558594 L 194.398438 293.761719 "/> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"
d="M 230.210938 286.558594 L 230.210938 293.761719 "/> <path style="fill:none;stroke-
width:0.75;stroke-linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-
opacity:1;stroke-miterlimit:10;" d="M 266.019531 286.558594 L 266.019531 293.761719 "/>
<path style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 301.828125
286.558594 L 301.828125 293.761719 "/> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"/> <use
xlink:href="#glyph1-1" x="83.636719" y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-
opacity:1;"/> <use xlink:href="#glyph1-2" x="119.445313" y="312.480469"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"/> <use xlink:href="#glyph1-3" x="155.253906"
y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"/> <use xlink:href="#glyph1-4"
x="191.0625" y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"/> <use
xlink:href="#glyph1-5" x="223.539063" y="312.480469"/> <use xlink:href="#glyph1-6"
x="230.212891" y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"/> <use
xlink:href="#glyph1-5" x="259.347656" y="312.480469"/> <use xlink:href="#glyph1-1"
x="266.021484" y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"/> <use
xlink:href="#glyph1-5" x="295.15625" y="312.480469"/> <use xlink:href="#glyph1-2"
x="301.830078" y="312.480469"/> </g> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"
d="M 59.039063 255.5625 L 59.039063 67.464844 "/> <path style="fill:none;stroke-

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width:0.75;stroke-linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-
opacity:1;stroke-miterlimit:10;" d="M 59.039063 255.5625 L 51.839844 255.5625 "/> <path
style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 59.039063
217.941406 L 51.839844 217.941406 "/> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"
d="M 59.039063 180.324219 L 51.839844 180.324219 "/> <path style="fill:none;stroke-
width:0.75;stroke-linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-
opacity:1;stroke-miterlimit:10;" d="M 59.039063 142.703125 L 51.839844 142.703125 "/> <path
style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 59.039063
105.085938 L 51.839844 105.085938 "/> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"
d="M 59.039063 67.464844 L 51.839844 67.464844 "/> <g style="fill:rgb(0%,0%,0%);fill-
opacity:1;"> <use xlink:href="#glyph2-1" x="41.761719" y="258.898438"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-2" x="41.761719"
y="224.613281"/> <use xlink:href="#glyph2-3" x="41.761719" y="217.939453"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-2" x="41.761719"
y="186.996094"/> <use xlink:href="#glyph2-1" x="41.761719" y="180.322266"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-4" x="41.761719"
y="149.375"/> <use xlink:href="#glyph2-3" x="41.761719" y="142.701172"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-4" x="41.761719"
y="111.757813"/> <use xlink:href="#glyph2-1" x="41.761719" y="105.083984"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-5" x="41.761719"
y="74.136719"/> <use xlink:href="#glyph2-3" x="41.761719" y="67.462891"/> </g> <path
style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 59.039063
286.558594 L 329.761719 286.558594 L 329.761719 59.039063 L 59.039063 59.039063 Z M
59.039063 286.558594 "/> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use
xlink:href="#glyph1-7" x="191.398438" y="341.28125"/> </g> <g style="fill:rgb(0%,0%,0%);fill-
opacity:1;"> <use xlink:href="#glyph2-6" x="12.960938" y="175.800781"/> </g> </g> </svg>
```

Note that in R, most of the arguments to the functions have been given sensible defaults appropriate to most of the applications. Thus the ordinary user does not need to specify all of them, or to even be aware of their existence.

### args(fun.name)

Displays the arguments to an existing function specified by fun.name, e.g.:

In [28]: `args("my.plot")`

```
function (x, y, symb = "+", colour = "red", cex = 2)
NULL
```

## 3.4.2 Assignments in functions

Importantly, the variables used within a user-defined function (in the example of the function calculating a geometric mean these were `x` and `z`) are local (in R jargon, limited to the function's environment). This means that any assignments done within the function are temporary, being lost after the evaluation is done. Therefore, such assignments do not affect the value of the variable with the same name in the calling environment.

In [29]: `out<-12.5556`  
`my.plot <- function(x,y,symb="+",colour="red",cex=2){`

```
plot(x,y,pch=symb,col=colour,cex=cex)
  out<-"text assigned within the body of function definition"
}
my.plot(x.coord,y.coord,colour="blue")
out
```

12.5556

```

<svg xmlns="http://www.w3.org/2000/svg" xmlns:xlink="http://www.w3.org/1999/xlink"
width="360pt" height="360pt" viewBox="0 0 360 360" version="1.1"> <defs> <g> <symbol
overflow="visible" id="glyph0-0"> <path style="stroke:none;" d="M 3 0 L 3 -15 L 15 -15 L 15 0
Z M 3.375 -0.375 L 14.625 -0.375 L 14.625 -14.625 L 3.375 -14.625 Z M 3.375 -0.375 "/>
</symbol> <symbol overflow="visible" id="glyph0-1"> <path style="stroke:none;" d="M
6.011719 -2.777344 L 6.011719 -7.488281 L 1.335938 -7.488281 L 1.335938 -9.457031 L
6.011719 -9.457031 L 6.011719 -14.132813 L 8.003906 -14.132813 L 8.003906 -9.457031 L
12.679688 -9.457031 L 12.679688 -7.488281 L 8.003906 -7.488281 L 8.003906 -2.777344 Z M
6.011719 -2.777344 "/> </symbol> <symbol overflow="visible" id="glyph1-0"> <path
style="stroke:none;" d="M 1.5 0 L 1.5 -7.5 L 7.5 -7.5 L 7.5 0 Z M 1.6875 -0.1875 L 7.3125 -0.1875
L 7.3125 -7.3125 L 1.6875 -7.3125 Z M 1.6875 -0.1875 "/> </symbol> <symbol
overflow="visible" id="glyph1-1"> <path style="stroke:none;" d="M 6.039063 -1.015625 L
6.039063 0 L 0.363281 0 C 0.355469 -0.253906 0.394531 -0.496094 0.484375 -0.734375 C
0.628906 -1.117188 0.859375 -1.5 1.179688 -1.875 C 1.492188 -2.25 1.953125 -2.683594 2.5625
-3.175781 C 3.492188 -3.941406 4.125 -4.546875 4.453125 -4.992188 C 4.78125 -5.4375
4.945313 -5.859375 4.945313 -6.265625 C 4.945313 -6.679688 4.792969 -7.03125 4.496094
-7.320313 C 4.191406 -7.601563 3.804688 -7.746094 3.328125 -7.75 C 2.820313 -7.746094
2.414063 -7.59375 2.109375 -7.292969 C 1.804688 -6.984375 1.648438 -6.5625 1.648438
-6.03125 L 0.5625 -6.140625 C 0.632813 -6.945313 0.910156 -7.558594 1.398438 -7.988281 C
1.878906 -8.410156 2.53125 -8.625 3.351563 -8.625 C 4.171875 -8.625 4.824219 -8.394531
5.308594 -7.9375 C 5.789063 -7.480469 6.027344 -6.914063 6.03125 -6.242188 C 6.027344
-5.894531 5.957031 -5.558594 5.820313 -5.226563 C 5.675781 -4.890625 5.441406 -4.539063
5.117188 -4.175781 C 4.789063 -3.804688 4.25 -3.300781 3.492188 -2.664063 C 2.859375
-2.128906 2.453125 -1.769531 2.273438 -1.582031 C 2.09375 -1.394531 1.945313 -1.203125
1.828125 -1.015625 Z M 6.039063 -1.015625 "/> </symbol> <symbol overflow="visible"
id="glyph1-2"> <path style="stroke:none;" d="M 3.878906 0 L 3.878906 -2.054688 L 0.152344
-2.054688 L 0.152344 -3.023438 L 4.070313 -8.589844 L 4.933594 -8.589844 L 4.933594
-3.023438 L 6.09375 -3.023438 L 6.09375 -2.054688 L 4.933594 -2.054688 L 4.933594 0 Z M
3.878906 -3.023438 L 3.878906 -6.898438 L 1.1875 -3.023438 Z M 3.878906 -3.023438 "/>
</symbol> <symbol overflow="visible" id="glyph1-3"> <path style="stroke:none;" d="M
5.96875 -6.484375 L 4.921875 -6.40625 C 4.828125 -6.8125 4.695313 -7.113281 4.523438
-7.304688 C 4.234375 -7.605469 3.882813 -7.757813 3.46875 -7.757813 C 3.132813 -7.757813
2.835938 -7.664063 2.585938 -7.476563 C 2.25 -7.234375 1.988281 -6.878906 1.796875
-6.414063 C 1.605469 -5.949219 1.507813 -5.289063 1.5 -4.429688 C 1.753906 -4.8125 2.0625
-5.097656 2.433594 -5.289063 C 2.796875 -5.472656 3.183594 -5.566406 3.585938 -5.570313 C
4.289063 -5.566406 4.886719 -5.308594 5.382813 -4.792969 C 5.875 -4.277344 6.121094
-3.609375 6.125 -2.789063 C 6.121094 -2.25 6.003906 -1.746094 5.773438 -1.285156 C 5.539063
-0.820313 5.222656 -0.46875 4.816406 -0.222656 C 4.410156 0.0234375 3.949219 0.144531
3.433594 0.148438 C 2.554688 0.144531 1.835938 -0.175781 1.285156 -0.820313 C 0.726563
-1.46875 0.449219 -2.535156 0.453125 -4.019531 C 0.449219 -5.675781 0.757813 -6.882813
1.371094 -7.640625 C 1.902344 -8.296875 2.621094 -8.625 3.53125 -8.625 C 4.207031 -8.625
4.761719 -8.433594 5.195313 -8.054688 C 5.625 -7.675781 5.882813 -7.152344 5.96875
-6.484375 Z M 1.664063 -2.78125 C 1.664063 -2.417969 1.738281 -2.070313 1.894531 -1.738281
C 2.042969 -1.40625 2.261719 -1.152344 2.542969 -0.980469 C 2.820313 -0.800781 3.109375
-0.714844 3.414063 -0.71875 C 3.859375 -0.714844 4.242188 -0.894531 4.566406 -1.257813 C
4.882813 -1.613281 5.042969 -2.101563 5.046875 -2.726563 C 5.042969 -3.316406 4.886719
-3.785156 4.570313 -4.128906 C 4.25 -4.46875 3.851563 -4.640625 3.375 -4.640625 C 2.898438
-4.640625 2.492188 -4.46875 2.160156 -4.128906 C 1.828125 -3.785156 1.664063 -3.335938
1.664063 -2.78125 Z M 1.664063 -2.78125 "/> </symbol> <symbol overflow="visible"
id="glyph1-4"> <path style="stroke:none;" d="M 2.121094 -4.65625 C 1.683594 -4.816406
1.359375 -5.046875 1.148438 -5.34375 C 0.9375 -5.640625 0.832031 -5.996094 0.832031
-6.410156 C 0.832031 -7.035156 1.054688 -7.558594 1.503906 -7.984375 C 1.953125 -8.410156
2.550781 -8.625 3.296875 -8.625 C 4.042969 -8.625 4.648438 -8.40625 5.109375 -7.972656 C
5.566406 -7.535156 5.792969 -7.003906 5.796875 -6.382813 C 5.792969 -5.976563 5.6875
-5.628906 5.480469 -5.339844 C 5.269531 -5.042969 4.953125 -4.816406 4.53125 -4.65625 C
5.054688 -4.480469 5.457031 -4.203125 5.734375 -3.824219 C 6.007813 -3.4375 6.144531
-2.980469 6.148438 -2.453125 C 6.144531 -1.714844 5.886719 -1.097656 5.367188 -0.601563 C
4.84375 -0.101563 4.160156 0.144531 3.316406 0.148438 C 2.46875 0.144531 1.785156

```



```

-0.101563 1.265625 -0.605469 C 0.742188 -1.105469 0.480469 -1.734375 0.484375 -2.484375 C
0.480469 -3.039063 0.621094 -3.503906 0.910156 -3.886719 C 1.191406 -4.261719 1.597656
-4.519531 2.121094 -4.65625 Z M 1.910156 -6.445313 C 1.910156 -6.039063 2.039063 -5.707031
2.300781 -5.449219 C 2.5625 -5.191406 2.902344 -5.0625 3.320313 -5.0625 C 3.722656 -5.0625
4.054688 -5.1875 4.320313 -5.445313 C 4.578125 -5.695313 4.710938 -6.011719 4.710938
-6.386719 C 4.710938 -6.773438 4.574219 -7.097656 4.308594 -7.363281 C 4.035156 -7.625
3.703125 -7.757813 3.3125 -7.757813 C 2.90625 -7.757813 2.574219 -7.628906 2.308594
-7.371094 C 2.042969 -7.113281 1.910156 -6.804688 1.910156 -6.445313 Z M 1.570313
-2.476563 C 1.570313 -2.175781 1.640625 -1.886719 1.785156 -1.605469 C 1.925781 -1.324219
2.136719 -1.105469 2.421875 -0.949219 C 2.699219 -0.792969 3.003906 -0.714844 3.328125
-0.71875 C 3.832031 -0.714844 4.246094 -0.878906 4.578125 -1.207031 C 4.902344 -1.53125
5.066406 -1.941406 5.070313 -2.445313 C 5.066406 -2.945313 4.898438 -3.367188 4.5625
-3.703125 C 4.222656 -4.035156 3.800781 -4.199219 3.292969 -4.203125 C 2.792969 -4.199219
2.378906 -4.035156 2.058594 -3.710938 C 1.730469 -3.378906 1.570313 -2.96875 1.570313
-2.476563 Z M 1.570313 -2.476563 "/> </symbol> <symbol overflow="visible" id="glyph1-5">
<path style="stroke:none;" d="M 4.46875 0 L 3.414063 0 L 3.414063 -6.71875 C 3.160156
-6.476563 2.828125 -6.234375 2.414063 -5.996094 C 2 -5.75 1.628906 -5.570313 1.304688
-5.449219 L 1.304688 -6.46875 C 1.894531 -6.742188 2.410156 -7.078125 2.851563 -7.476563 C
3.292969 -7.871094 3.605469 -8.253906 3.789063 -8.625 L 4.46875 -8.625 Z M 4.46875 0 "/>
</symbol> <symbol overflow="visible" id="glyph1-6"> <path style="stroke:none;" d="M 0.5
-4.234375 C 0.496094 -5.246094 0.601563 -6.0625 0.8125 -6.6875 C 1.019531 -7.304688
1.328125 -7.785156 1.742188 -8.121094 C 2.148438 -8.457031 2.667969 -8.625 3.296875 -8.625
C 3.757813 -8.625 4.164063 -8.53125 4.511719 -8.347656 C 4.855469 -8.160156 5.140625
-7.890625 5.371094 -7.542969 C 5.59375 -7.191406 5.773438 -6.765625 5.90625 -6.265625 C
6.035156 -5.761719 6.097656 -5.085938 6.101563 -4.234375 C 6.097656 -3.226563 5.996094
-2.414063 5.789063 -1.796875 C 5.578125 -1.175781 5.265625 -0.695313 4.859375 -0.359375 C
4.445313 -0.0195313 3.925781 0.144531 3.296875 0.148438 C 2.464844 0.144531 1.816406
-0.148438 1.347656 -0.742188 C 0.78125 -1.457031 0.496094 -2.621094 0.5 -4.234375 Z M
1.582031 -4.234375 C 1.582031 -2.824219 1.746094 -1.886719 2.074219 -1.417969 C 2.402344
-0.949219 2.808594 -0.714844 3.296875 -0.71875 C 3.777344 -0.714844 4.183594 -0.949219
4.519531 -1.421875 C 4.847656 -1.886719 5.015625 -2.824219 5.015625 -4.234375 C 5.015625
-5.648438 4.847656 -6.589844 4.519531 -7.054688 C 4.183594 -7.515625 3.773438 -7.746094
3.289063 -7.75 C 2.800781 -7.746094 2.414063 -7.542969 2.125 -7.136719 C 1.761719 -6.613281
1.582031 -5.644531 1.582031 -4.234375 Z M 1.582031 -4.234375 "/> </symbol> <symbol
overflow="visible" id="glyph1-7"> <path style="stroke:none;" d="M 0.0859375 0 L 2.359375
-3.234375 L 0.257813 -6.222656 L 1.578125 -6.222656 L 2.53125 -4.765625 C 2.710938
-4.484375 2.855469 -4.253906 2.964844 -4.066406 C 3.136719 -4.324219 3.292969 -4.550781
3.4375 -4.75 L 4.488281 -6.222656 L 5.75 -6.222656 L 3.597656 -3.292969 L 5.914063 0 L
4.617188 0 L 3.339844 -1.933594 L 3 -2.453125 L 1.367188 0 Z M 0.0859375 0 "/> </symbol>
<symbol overflow="visible" id="glyph2-0"> <path style="stroke:none;" d="M 0 -1.5 L -7.5 -1.5
L -7.5 -7.5 L 0 -7.5 Z M -0.1875 -1.6875 L -0.1875 -7.3125 L -7.3125 -7.3125 L -7.3125 -1.6875 Z
M -0.1875 -1.6875 "/> </symbol> <symbol overflow="visible" id="glyph2-1"> <path
style="stroke:none;" d="M -2.25 -0.5 L -2.34375 -1.605469 C -1.804688 -1.683594 -1.398438
-1.871094 -1.125 -2.175781 C -0.851563 -2.472656 -0.714844 -2.835938 -0.71875 -3.257813 C
-0.714844 -3.765625 -0.90625 -4.195313 -1.292969 -4.546875 C -1.671875 -4.898438 -2.179688
-5.074219 -2.820313 -5.074219 C -3.414063 -5.074219 -3.890625 -4.902344 -4.242188
-4.566406 C -4.589844 -4.226563 -4.761719 -3.785156 -4.765625 -3.242188 C -4.761719
-2.898438 -4.683594 -2.59375 -4.53125 -2.320313 C -4.375 -2.046875 -4.175781 -1.832031
-3.929688 -1.675781 L -4.0625 -0.6875 L -8.472656 -1.515625 L -8.472656 -5.789063 L
-7.464844 -5.789063 L -7.464844 -2.359375 L -5.15625 -1.898438 C -5.515625 -2.414063
-5.695313 -2.953125 -5.695313 -3.523438 C -5.695313 -4.269531 -5.433594 -4.902344
-4.914063 -5.421875 C -4.394531 -5.933594 -3.726563 -6.191406 -2.914063 -6.195313 C
-2.132813 -6.191406 -1.460938 -5.964844 -0.898438 -5.515625 C -0.199219 -4.960938 0.144531
-4.210938 0.148438 -3.257813 C 0.144531 -2.476563 -0.0703125 -1.835938 -0.507813 -1.34375
C -0.941406 -0.84375 -1.523438 -0.5625 -2.25 -0.5 Z M -2.25 -0.5 "/> </symbol> <symbol
overflow="visible" id="glyph2-2"> <path style="stroke:none;" d="M 0 -4.46875 L 0 -3.414063 L
-6.71875 -3.414063 C -6.476563 -3.160156 -6.234375 -2.828125 -5.996094 -2.414063 C -5.75 -2
-5.570313 -1.628906 -5.449219 -1.304688 L -6.46875 -1.304688 C -6.742188 -1.894531

```

```
-7.078125 -2.410156 -7.476563 -2.851563 C -7.871094 -3.292969 -8.253906 -3.605469 -8.625
-3.789063 L -8.625 -4.46875 Z M 0 -4.46875 "/> </symbol> <symbol overflow="visible"
id="glyph2-3"> <path style="stroke:none;" d="M -4.234375 -0.5 C -5.246094 -0.496094 -6.0625
-0.601563 -6.6875 -0.8125 C -7.304688 -1.019531 -7.785156 -1.328125 -8.121094 -1.742188 C
-8.457031 -2.148438 -8.625 -2.667969 -8.625 -3.296875 C -8.625 -3.757813 -8.53125 -4.164063
-8.347656 -4.511719 C -8.160156 -4.855469 -7.890625 -5.140625 -7.542969 -5.371094 C
-7.191406 -5.59375 -6.765625 -5.773438 -6.265625 -5.90625 C -5.761719 -6.035156 -5.085938
-6.097656 -4.234375 -6.101563 C -3.226563 -6.097656 -2.414063 -5.996094 -1.796875
-5.789063 C -1.175781 -5.578125 -0.695313 -5.265625 -0.359375 -4.859375 C -0.0195313
-4.445313 0.144531 -3.925781 0.148438 -3.296875 C 0.144531 -2.464844 -0.148438 -1.816406
-0.742188 -1.347656 C -1.457031 -0.78125 -2.621094 -0.496094 -4.234375 -0.5 Z M -4.234375
-1.582031 C -2.824219 -1.582031 -1.886719 -1.746094 -1.417969 -2.074219 C -0.949219
-2.402344 -0.714844 -2.808594 -0.71875 -3.296875 C -0.714844 -3.777344 -0.949219 -4.183594
-1.421875 -4.519531 C -1.886719 -4.847656 -2.824219 -5.015625 -4.234375 -5.015625 C
-5.648438 -5.015625 -6.589844 -4.847656 -7.054688 -4.519531 C -7.515625 -4.183594
-7.746094 -3.773438 -7.75 -3.289063 C -7.746094 -2.800781 -7.542969 -2.414063 -7.136719
-2.125 C -6.613281 -1.761719 -5.644531 -1.582031 -4.234375 -1.582031 Z M -4.234375
-1.582031 "/> </symbol> <symbol overflow="visible" id="glyph2-4"> <path
style="stroke:none;" d="M -1.015625 -6.039063 L 0 -6.039063 L 0 -0.363281 C -0.253906
-0.355469 -0.496094 -0.394531 -0.734375 -0.484375 C -1.117188 -0.628906 -1.5 -0.859375
-1.875 -1.179688 C -2.25 -1.492188 -2.683594 -1.953125 -3.175781 -2.5625 C -3.941406
-3.492188 -4.546875 -4.125 -4.992188 -4.453125 C -5.4375 -4.78125 -5.859375 -4.945313
-6.265625 -4.945313 C -6.679688 -4.945313 -7.03125 -4.792969 -7.320313 -4.496094 C
-7.601563 -4.191406 -7.746094 -3.804688 -7.75 -3.328125 C -7.746094 -2.820313 -7.59375
-2.414063 -7.292969 -2.109375 C -6.984375 -1.804688 -6.5625 -1.648438 -6.03125 -1.648438 L
-6.140625 -0.5625 C -6.945313 -0.632813 -7.558594 -0.910156 -7.988281 -1.398438 C -8.410156
-1.878906 -8.625 -2.53125 -8.625 -3.351563 C -8.625 -4.171875 -8.394531 -4.824219 -7.9375
-5.308594 C -7.480469 -5.789063 -6.914063 -6.027344 -6.242188 -6.03125 C -5.894531
-6.027344 -5.558594 -5.957031 -5.226563 -5.820313 C -4.890625 -5.675781 -4.539063
-5.441406 -4.175781 -5.117188 C -3.804688 -4.789063 -3.300781 -4.25 -2.664063 -3.492188 C
-2.128906 -2.859375 -1.769531 -2.453125 -1.582031 -2.273438 C -1.394531 -2.09375 -1.203125
-1.945313 -1.015625 -1.828125 Z M -1.015625 -6.039063 "/> </symbol> <symbol
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-2.40625 -1.558594 C -1.808594 -1.679688 -1.378906 -1.882813 -1.113281 -2.175781 C
-0.847656 -2.464844 -0.714844 -2.820313 -0.71875 -3.242188 C -0.714844 -3.734375 -0.886719
-4.152344 -1.234375 -4.496094 C -1.574219 -4.832031 -2 -5.003906 -2.515625 -5.007813 C
-2.996094 -5.003906 -3.394531 -4.847656 -3.710938 -4.535156 C -4.023438 -4.21875 -4.183594
-3.816406 -4.183594 -3.328125 C -4.183594 -3.128906 -4.144531 -2.878906 -4.066406
-2.585938 L -4.992188 -2.703125 C -4.984375 -2.765625 -4.980469 -2.824219 -4.980469
-2.871094 C -4.980469 -3.320313 -5.097656 -3.722656 -5.332031 -4.085938 C -5.566406
-4.441406 -5.925781 -4.621094 -6.414063 -4.625 C -6.800781 -4.621094 -7.121094 -4.492188
-7.375 -4.230469 C -7.628906 -3.964844 -7.757813 -3.625 -7.757813 -3.21875 C -7.757813
-2.804688 -7.628906 -2.464844 -7.371094 -2.191406 C -7.113281 -1.917969 -6.726563
-1.742188 -6.210938 -1.664063 L -6.398438 -0.609375 C -7.105469 -0.738281 -7.652344
-1.03125 -8.042969 -1.488281 C -8.429688 -1.941406 -8.625 -2.507813 -8.625 -3.195313 C
-8.625 -3.660156 -8.523438 -4.09375 -8.324219 -4.488281 C -8.121094 -4.878906 -7.847656
-5.179688 -7.5 -5.390625 C -7.148438 -5.601563 -6.777344 -5.707031 -6.390625 -5.707031 C
-6.019531 -5.707031 -5.683594 -5.605469 -5.378906 -5.40625 C -5.074219 -5.207031 -4.832031
-4.914063 -4.652344 -4.523438 C -4.535156 -5.03125 -4.289063 -5.425781 -3.921875 -5.707031
C -3.546875 -5.988281 -3.085938 -6.128906 -2.539063 -6.128906 C -1.785156 -6.128906
-1.148438 -5.855469 -0.628906 -5.308594 C -0.105469 -4.761719 0.152344 -4.070313 0.152344
-3.234375 C 0.152344 -2.476563 -0.0703125 -1.847656 -0.519531 -1.355469 C -0.96875
-0.855469 -1.550781 -0.574219 -2.265625 -0.503906 Z M -2.265625 -0.503906 "/> </symbol>
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1.460938 -1.652344 1.382813 -1.792969 C 1.304688 -1.933594 1.195313 -2.046875 1.054688
-2.140625 C 0.949219 -2.203125 0.6875 -2.3125 0.269531 -2.460938 C 0.207031 -2.480469
0.121094 -2.511719 0.0117188 -2.554688 L -6.222656 -0.195313 L -6.222656 -1.328125 L
```

```

-2.617188 -2.625 C -2.160156 -2.789063 -1.679688 -2.9375 -1.179688 -3.078125 C -1.660156
-3.195313 -2.132813 -3.339844 -2.59375 -3.507813 L -6.222656 -4.839844 L -6.222656
-5.894531 L 0.105469 -3.527344 C 0.789063 -3.273438 1.257813 -3.074219 1.515625 -2.9375 C
1.863281 -2.746094 2.117188 -2.53125 2.28125 -2.292969 C 2.4375 -2.046875 2.519531
-1.757813 2.523438 -1.421875 C 2.519531 -1.214844 2.476563 -0.988281 2.398438 -0.742188 Z
M 2.398438 -0.742188 "/> </symbol> </g> </defs> <g id="surface11"> <rect x="0" y="0"
width="360" height="360" style="fill:rgb(100%,100%,100%);fill-opacity:1;stroke:none;"/> <g
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y="286.589844"/> </g> <g style="fill:rgb(0%,0%,100%);fill-opacity:1;"> <use
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style="fill:rgb(0%,0%,100%);fill-opacity:1;"> <use xlink:href="#glyph0-1" x="312.726563"
y="75.921875"/> </g> <g style="fill:rgb(0%,0%,100%);fill-opacity:1;"> <use
xlink:href="#glyph0-1" x="97.867188" y="256.492188"/> </g> <path style="fill:none;stroke-
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opacity:1;stroke-miterlimit:10;" d="M 86.972656 286.558594 L 301.828125 286.558594 "/>
<path style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
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286.558594 L 86.972656 293.761719 "/> <path style="fill:none;stroke-width:0.75;stroke-
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d="M 122.78125 286.558594 L 122.78125 293.761719 "/> <path style="fill:none;stroke-
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opacity:1;stroke-miterlimit:10;" d="M 158.589844 286.558594 L 158.589844 293.761719 "/>
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linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 194.398438
286.558594 L 194.398438 293.761719 "/> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"
d="M 230.210938 286.558594 L 230.210938 293.761719 "/> <path style="fill:none;stroke-
width:0.75;stroke-linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-
opacity:1;stroke-miterlimit:10;" d="M 266.019531 286.558594 L 266.019531 293.761719 "/>
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286.558594 L 301.828125 293.761719 "/> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use
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opacity:1;"> <use xlink:href="#glyph1-2" x="119.445313" y="312.480469"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph1-3" x="155.253906"
y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph1-
4" x="191.0625" y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use
xlink:href="#glyph1-5" x="223.539063" y="312.480469"/> <use xlink:href="#glyph1-6"
x="230.212891" y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use
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x="266.021484" y="312.480469"/> </g> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use
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x="301.830078" y="312.480469"/> </g> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"
d="M 59.039063 255.5625 L 59.039063 67.464844 "/> <path style="fill:none;stroke-
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opacity:1;stroke-miterlimit:10;" d="M 59.039063 255.5625 L 51.839844 255.5625 "/> <path
style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 59.039063
217.941406 L 51.839844 217.941406 "/> <path style="fill:none;stroke-width:0.75;stroke-
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d="M 59.039063 180.324219 L 51.839844 180.324219 "/> <path style="fill:none;stroke-
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opacity:1;stroke-miterlimit:10;" d="M 59.039063 142.703125 L 51.839844 142.703125 "/> <path
style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 59.039063
105.085938 L 51.839844 105.085938 "/> <path style="fill:none;stroke-width:0.75;stroke-
linecap:round;stroke-linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;"

```

```
d="M 59.039063 67.464844 L 51.839844 67.464844 "/> <g style="fill:rgb(0%,0%,0%);fill-
opacity:1;"> <use xlink:href="#glyph2-1" x="41.761719" y="258.898438"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-2" x="41.761719"
y="224.613281"/> <use xlink:href="#glyph2-3" x="41.761719" y="217.939453"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-2" x="41.761719"
y="186.996094"/> <use xlink:href="#glyph2-1" x="41.761719" y="180.322266"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-4" x="41.761719"
y="149.375"/> <use xlink:href="#glyph2-3" x="41.761719" y="142.701172"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-4" x="41.761719"
y="111.757813"/> <use xlink:href="#glyph2-1" x="41.761719" y="105.083984"/> </g> <g
style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use xlink:href="#glyph2-5" x="41.761719"
y="74.136719"/> <use xlink:href="#glyph2-3" x="41.761719" y="67.462891"/> </g> <path
style="fill:none;stroke-width:0.75;stroke-linecap:round;stroke-
linejoin:round;stroke:rgb(0%,0%,0%);stroke-opacity:1;stroke-miterlimit:10;" d="M 59.039063
286.558594 L 329.761719 286.558594 L 329.761719 59.039063 L 59.039063 59.039063 Z M
59.039063 286.558594 "/> <g style="fill:rgb(0%,0%,0%);fill-opacity:1;"> <use
xlink:href="#glyph1-7" x="191.398438" y="341.28125"/> </g> <g style="fill:rgb(0%,0%,0%);fill-
opacity:1;"> <use xlink:href="#glyph2-6" x="12.960938" y="175.800781"/> </g> </g> </svg>
```

In (rare) cases when it is desirable to alter the value of a variable globally (in the `.GlobalEnv` environment), this can be done with the “super assignment”:

```
x <- "Hello"
```

## 3.5 An alternative to loops – *sapply*

If loop-like execution of code seems unavoidable, often a most time-efficient solution can be made using functions such as `apply`, `tapply` or `sapply`.

### `sapply(x, FUN)`

Applies a function `FUN` over a vector `x`. This means, that the function is run once for each of the values in the vector `x`. An example (the same as given for for loops, but quicker and more compact):

```
In [30]: i <- seq(1,10,by=2)
ee <- sapply(i,sqrt)
print(paste("Square root of ",i," is ",round(ee,6)))

[1] "Square root of 1 is 1" "Square root of 3 is 1.732051"
[3] "Square root of 5 is 2.236068" "Square root of 7 is 2.645751"
[5] "Square root of 9 is 3"
```

Of course, the function `FUN` can also be a user-defined one.

## Anonymous functions

A strategy, often employed in R, is to use an anonymous function. So called, as it is not named and not visible outside the `sapply` statement:

```
In [31]: ee <- sapply(seq(1,10,by=2),function(j){
  z <- paste("Square root of ",j," is ",round(sqrt(j),6))
  return(z)
})
print(ee)
```

```
[1] "Square root of 1 is 1"          "Square root of 3 is 1.732051"
[3] "Square root of 5 is 2.236068"  "Square root of 7 is 2.645751"
[5] "Square root of 9 is 3"
```