List and Matrices

List

A **list** is a generic vector containing other objects.

Creating Lists

For example, the following variable x is a list containing copies of three vectors n, s, b, and a numeric value 3.

```
> n = c(2, 3, 5)
> s = c("aa", "bb", "cc", "dd", "ee")
> b = c(TRUE, FALSE, TRUE, FALSE, FALSE)
> x = list(n, s, b, 3)   # x contains copies of n, s, b
```

OR

```
x1 <- list ("Red", "Blue", c(42,36,01), FALSE, 73.91, 128.6)
print (x1)
```

Output:

```
[[1]]
[1] "Red"
[[2]]
[1] “Blue"
[[3]]
[1] 42 36 01
[[4]]
[1] FALSE
[[5]]
[1] 73.91
[[6]]
[1] 128.6
```

Naming List Elements

```
# Create a list containing a vector, a matrix and a list.
list_data <- list(c("Jan","Feb","Mar"), matrix(c(3,9,5,1,-2,8), nrow = 2), list("green",12.3))

 # Give names to the elements in the list.
names(list_data) <- c(“Month", "Matrix", "Inner list") # Show the list.
print(list_data)
```

Output:

```
$`Month`
[1] "Jan" "Feb" "Mar"
$Matrix
[,1] [,2] [,3]
[1,] 3 5 -2
[2,] 9 1 8
$Inner list
$Inner_list [[1]]
[1] "green“
 $Inner_list [[2]]
[1] 12.3
```

Accessing List Elements

```
# Create a list containing a vector, a matrix and a list.
list_data <- list(c("Jan","Feb","Mar"), matrix(c(3,9,5,1,-2,8), nrow = 2), list("green",12.3))

 # Give names to the elements in the list.
names(list_data) <- c(“Month", "Matrix", " Inner list")

 # Access the first element of the list.
print(list_data[1])

# Access the thrid element.
print(list_data[3])

# Access the list element using the name of the element.
 print(list_data$Matrix)
```

Output:

```
$`Month`
[1] "Jan" "Feb" "Mar"
$Inner list
$Inner list[[1]]
[1] "green"
$Inner list[[2]]
 [1] 12.3
```

```
     [,1] [,2] [,3]
[1,]    3    5   -2
[2,]    9    1    8
```

Manipulating List Elements

- We can **add, delete and update** list elements.
- We can **add and delete** elements only at the end of a list.
- we **can update any element**.

As in above example

```
# Add element at the end of the list.
list_data[4] <- "New element"
print(list_data[4])

# Remove the last element.
list_data[4] <- NULL

# Print the 4th Element.
print(list_data[4])

# Update the 3rd Element.
list_data[3] <- "updated element"
print(list_data[3])
```

Output:

```
[[1]]
[1] "New element"

$<NA> NULL

$`Inner list`
[1] "updated element"
```

Merging Lists

```
# Create two lists.
list1 <- list(1,2,3)
 list2 <- list("Sun","Mon","Tue")

# Merge the two lists.
merged.list <- c(list1,list2)

# Print the merged list.
print(merged.list)
```

Output:

```
[[1]]
[1] 1
[[2]]
[1] 2
[[3]]
[1] 3
[[4]]
[1] "Sun"
[[5]]
[1] "Mon"
[[6]]
[1] "Tue"
```

Converting List to Vector

unlist(): It takes the list as input and produces a vector.

```
# Create and print lists.
 list1 <- list(1:5)
print(list1)

list2 <-list(10:14)
 print(list2)

# Convert the lists to vectors.
v1 <- unlist(list1)
v2 <- unlist(list2)
print(v1)
print(v2)

# Now add the vectors
result <- v1+v2
print(result)
```

Output:

(Print list1)

```
[[1]]
[1] 1 2 3 4 5
```

(Print list2)

```
[[1]]
[1] 10 11 12 13 14
```

(Print v1)

```
[1] 1 2 3 4 5
```

(Print v2)

```
[1] 10 11 12 13 14
```

(Print result)

```
[1] 11 13 15 17 19
```

The *matrix* command

- A matrix is a 2-D array
- There is a fast method of creating a matrix

Syntax

The basic syntax for creating a matrix in R is –
matrix(data, nrow, ncol, byrow, dimnames)

Following is the description of the parameters used –
data is the input vector which becomes the data elements of the matrix.
nrow is the number of rows to be created.
ncol is the number of columns to be created.
byrow is a logical clue. If TRUE then the input vector elements are arranged by row.
dimname is the names assigned to the rows and columns.

Example: (Create a matrix)

```
# Elements are arranged sequentially by row.
 M <- matrix(c(3:14), nrow = 4, byrow = TRUE)
print(M)

 # Elements are arranged sequentially by column.
 N <- matrix(c(3:14), nrow = 4, byrow = FALSE)
print(N)

# Define the column and row names.
rownames = c("row1", "row2", "row3", "row4")
colnames = c("col1", "col2", "col3")

P <- matrix(c(3:14), nrow = 4, byrow = TRUE, dimnames = list(rownames, colnames))
 print(P)
```

Print(M)

```
[,1] [,2] [,3]
[1,] 3 4 5
[2,] 6 7 8
[3,] 9 10 11
[4,] 12 13 14
```

print(N)

```
[,1] [,2] [,3]
[1,] 3 7 11
[2,] 4 8 12
[3,] 5 9 13
[4,] 6 10 14
```

print(P)

```
col1 col2 col3
row1 3 4 5
row2 6 7 8
row3 9 10 11
row4 12 13 14
```

Accessing Elements of a Matrix

- **by using the column and row index**

```
# Access the element at 3rd column and 1st row. (Byrow=true)
print(P[1,3])

# Access the element at 2nd column and 4th row.
print(P[4,2])

# Access only the 2nd row.
print(P[2,])

# Access only the 3rd column.
print(P[,3])
```

Output:

```
[1] 5

[1] 13

col1 col2 col3
6 7 8

row1 row2 row3 row4
5 8 11 14
```

Matrix Addition & Subtraction

```
# Create two 2x3 matrices.
matrix1 <- matrix(c(3, 9, -1, 4, 2, 6), nrow = 2)
print(matrix1)

matrix2 <- matrix(c(5, 2, 0, 9, 3, 4), nrow = 2)
print(matrix2)

# Add the matrices.
result <- matrix1 + matrix2
cat("Result of addition","\n")
print(result)

# Subtract the matrices
result <- matrix1 - matrix2
cat("Result of subtraction","\n")
print(result)
```

Output:

```
     [,1] [,2] [,3]
[1,]    3   -1    2
[2,]    9    4    6

     [,1] [,2] [,3]
[1,]    5    0    3
[2,]    2    9    4

Result of addition
     [,1] [,2] [,3]
[1,]    8   -1    5
[2,]   11   13   10

Result of subtraction
     [,1] [,2] [,3]
[1,]   -2   -1   -1
[2,]    7   -5    2
```

Matrix Multiplicaton & Division

```
# Create two 2x3 matrices.
matrix1 <- matrix(c(3, 9, -1, 4, 2, 6), nrow = 2)
print(matrix1)

matrix2 <- matrix(c(5, 2, 0, 9, 3, 4), nrow = 2)
print(matrix2)

# Add the matrices.
result <- matrix1 * matrix2
cat("Result of addition","\n")
print(result)

# Subtract the matrices
result <- matrix1 / matrix2
cat("Result of subtraction","\n")
print(result)
```

Output:

```
[,1] [,2] [,3]
[1,] 3 -1 2
[2,] 9 4 6

[,1] [,2] [,3]
[1,] 5 0 3
[2,] 2 9 4
Result of multiplication
[,1] [,2] [,3]
[1,] 15 0 6
[2,] 18 36 24

Result of division
[,1] [,2] [,3]
[1,] 0.6 -Inf 0.6666667
[2,] 4.5 0.4444444 1.5000000
```

Note: Element by element multiplication and division Solution(%*%) and multiplication condition must satisfied

Example:

```
matrix1 <- matrix(c(3, 9, -1, 4, 2, 6, 5, 4, 3), nrow = 3)
print(matrix1)

res= matrix1 * matrix1

res1=matrix1 %*% matrix1

print(res)

print(res1)
```

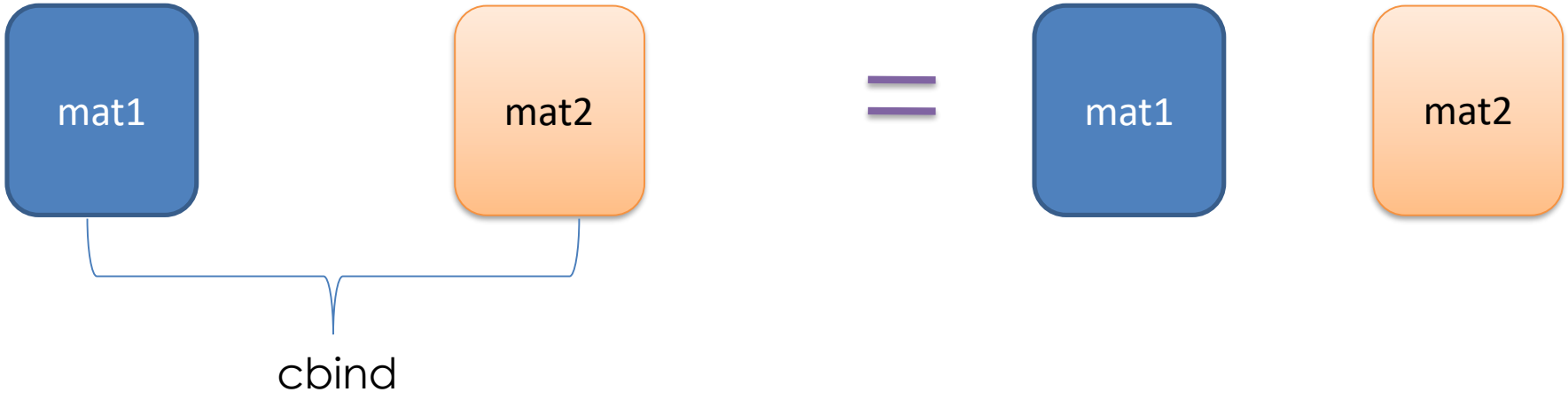
Output:

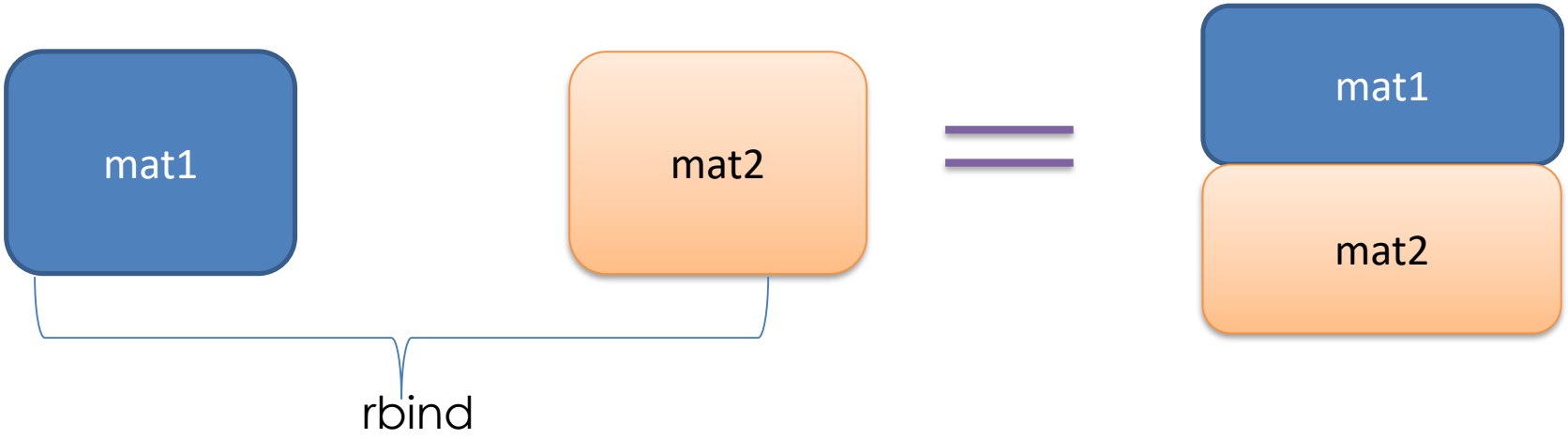
```
>print(matrix1)
     [,1] [,2] [,3]
[1,]    3    4    5
[2,]    9    2    4
[3,]   -1    6    3

> print(res)
     [,1] [,2] [,3]
[1,]    9   16   25
[2,]   81    4   16
[3,]    1   36    9

> print(res1)
     [,1] [,2] [,3]
[1,]   40   50   46
[2,]   41   64   65
[3,]   48   26   28
```

cbind and rbind





Example:(cbind and rbind)

```
# Create two matrices
m1 <- matrix(c(3, 9, -1, 4, 2, 6), nrow = 2)
m2 <-matrix(c(1, 2, 4, 3, 5, 7), nrow=2)

# Print m1 and m2
print(m1)
print(m2)

# apply cbind and rbind
mcb=cbind(m1[1:2], m2[1:2])
mrb=rbind(m1[1], m2[1])

# print mca and mrb
print(mcb)
print(mrb)

#Print mcb1
mcb1=cbind(m1[1:2,1:2], m2[1:2,1:2])
```

Output:

```
> print(m1)
     [,1] [,2] [,3]
[1,]    3   -1    2
[2,]    9    4    6

> print(m2)
     [,1] [,2] [,3]
[1,]    1    4    5
[2,]    2    3    7

> print(mcb)
     [,1] [,2]
[1,]    3    1
[2,]    9    2

> print(mrb)
     [,1]
[1,]    3
[2,]    1

> mcb1
     [,1] [,2] [,3] [,4]
[1,]    3   -1    1    4
[2,]    9    4    2    3
```