WEEK-1

- **Exercise 1**

Let's create the following vectors:

u <- 4

v <- 8

Use the elementary arithmetic operators +, -, *, /, and ^ to:

add u and v

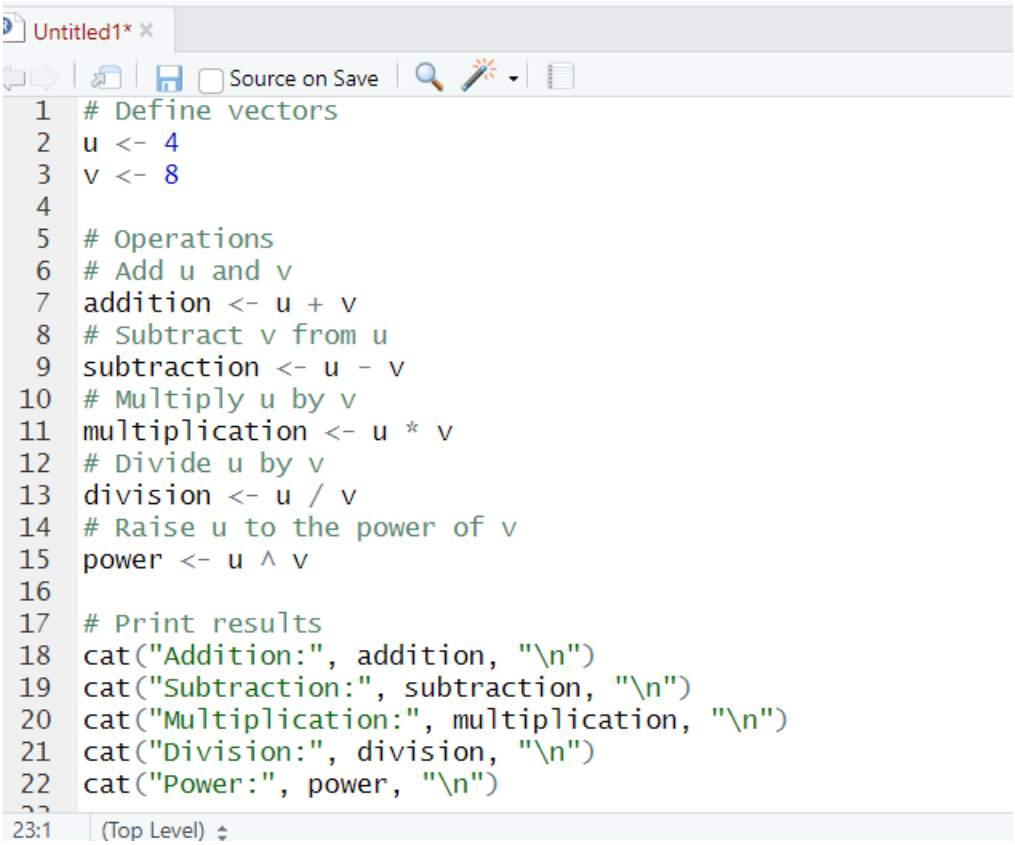
subtract v from u

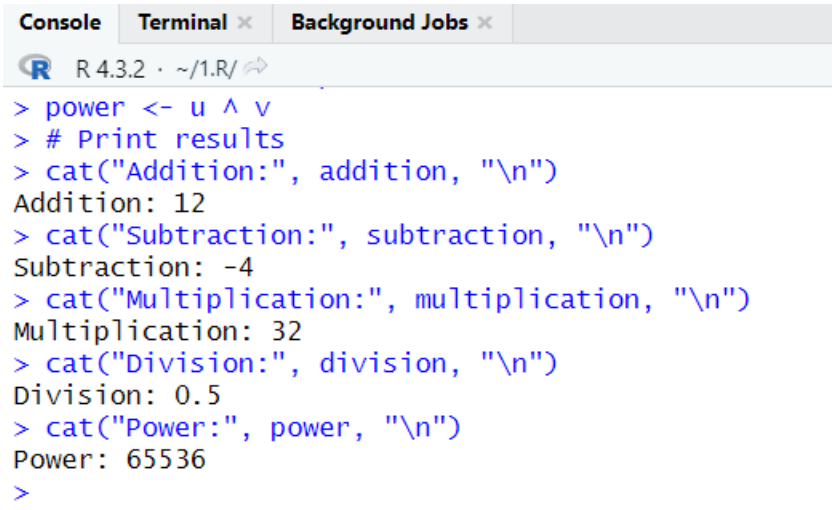
multiply u by v

divide u by v

raise u to the power of v

ANSWER:





- **Exercise 2**

Now, suppose u and v are not scalars, but vectors with multiple elements:

u <- c(4, 5, 6)

v <- c(1, 2, 3)

Without using R, write down what you expect as the result of the same operations as in the previous

exercise:

add u and v

subtract v from u

multiply u by v

divide u by v

raise u to the power of v

ANSWER

u <- c(4, 5, 6)

v <- c(1, 2, 3)

Addition: add u and v

Result: (4+1, 5+2, 6+3) = (5, 7, 9)

Subtraction: subtract v from u

Result: (4-1, 5-2, 6-3) = (3, 3, 3)

Multiplication: multiply u by v element-wise

Result: (41, 52, 6*3) = (4, 10, 18)

Division: divide u by v element-wise

Result: (4/1, 5/2, 6/3) = (4, 2.5, 2)

Power: raise u to the power of v element-wise

Result: (4^1, 5^2, 6^3) = (4, 25, 216)

- **Exercise 3**

When we want to carry out a series of arithmetic operations, we can either use a single expression, or a series of expressions. Consider two vectors u and v:

u <- c(8, 9, 10)

v <- c(1, 2, 3)

We can create a new vector w in a single line of code:

w <- (2 * u + v) / 10

or carry out each operation on a separate line:

```
w <- 2 * u
w <- w + v
w <- w / 10
```

Convert the following expressions to separate operations, and check that both approaches give the same

```
w <- (u + 0.5 * v) ^ 2
w <- (u + 2) * (u - 5) + v
w <- (u + 2) / ((u - 5) * v)
```

ANSWER

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Source on Save

```r
# Given vectors
u <- c(8, 9, 10)
v <- c(1, 2, 3)

w_single <- (u + 0.5 * v) ^ 2
w_single
w_single <- (u + 2) * (u - 5) + v
w_single
w_single <- (u + 2) / ((u - 5) * v)
w_single


w <- u + 0.5 * v
w <- w ^ 2
w


w <- u + 2
w <- w * (u - 5)
w <- w + v
w

w <- u + 2
w_denominator <- (u - 5) * v
w <- w / w_denominator
w
```

(Top Level)

OUTPUT:

Console | Terminal | Background Jobs

R 4.3.2 · ~/1.R/

```
> # Given vectors
> u <- c(8, 9, 10)
> v <- c(1, 2, 3)
> w_single <- (u + 0.5 * v) ^ 2
> w_single
[1]  72.25 100.00 132.25
> w_single <- (u + 2) * (u - 5) + v
> w_single
[1] 31 46 63
> w_single <- (u + 2) / ((u - 5) * v)
> w_single
[1] 3.333333 1.375000 0.800000
> w <- u + 0.5 * v
> w <- w ^ 2
> w
[1]  72.25 100.00 132.25
```

```
[1]  72.25 100.00 132.25
> w <- u + 2
> w <- w * (u - 5)
> w <- w + v
> w
[1] 31 46 63
> w <- u + 2
> w_denominator <- (u - 5) * v
> w <- w / w_denominator
> w
[1] 3.333333 1.375000 0.800000
>
>
```

Exercise 4

We can do the reverse as well. Convert the following multi-line operations to a single expression. Check that both approaches give the same result.

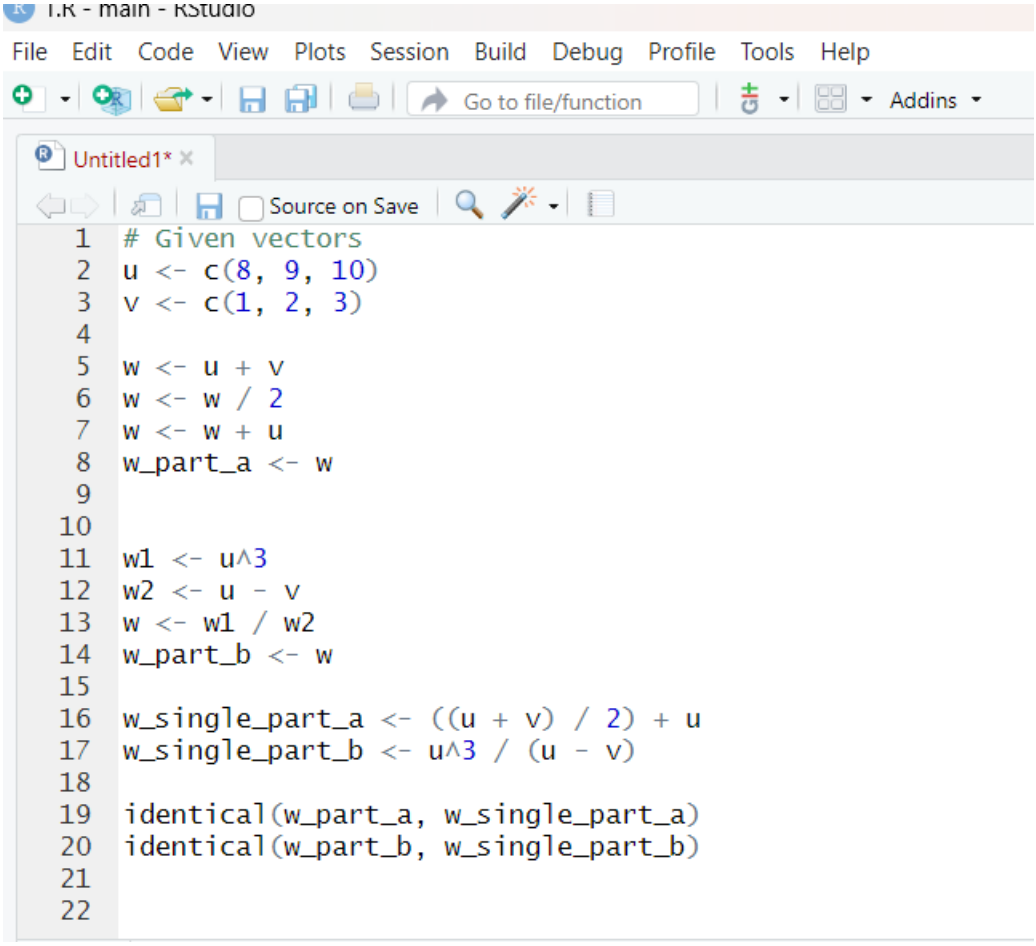
Part a:

w<- u + v
w <- w / 2
w <- w + u

Part b:

w1 <- u^3
w2 <- u - v
w <- w1 / w2

ANSWER



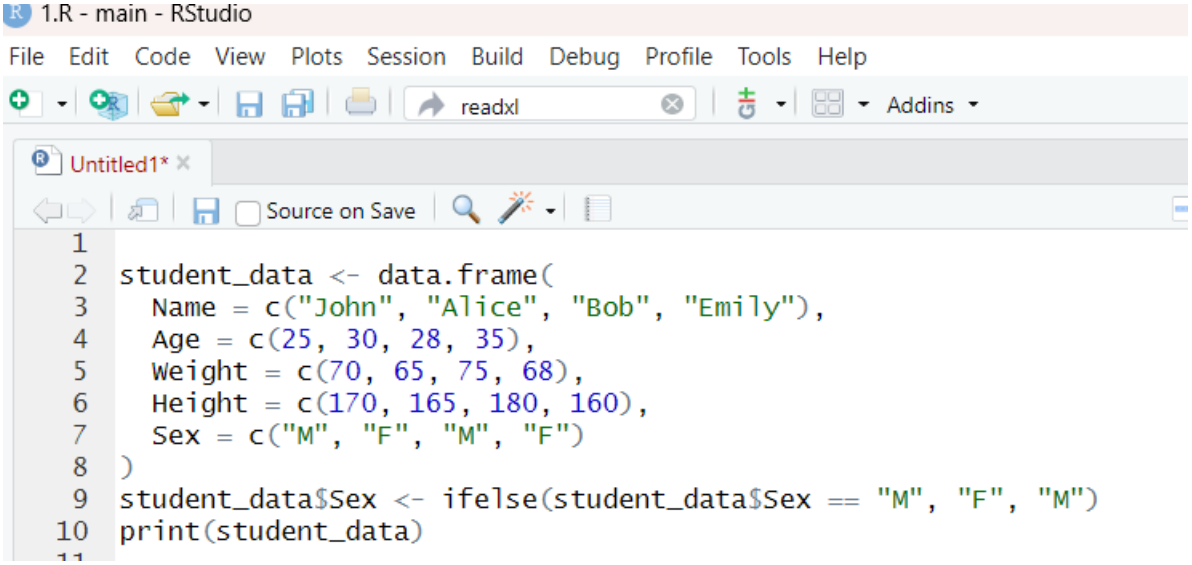
DATA FRAMES

In the exercises below we cover the basics of data frames. Before proceeding, first read the help pages for the cbind, dim, str, order and cut functions.

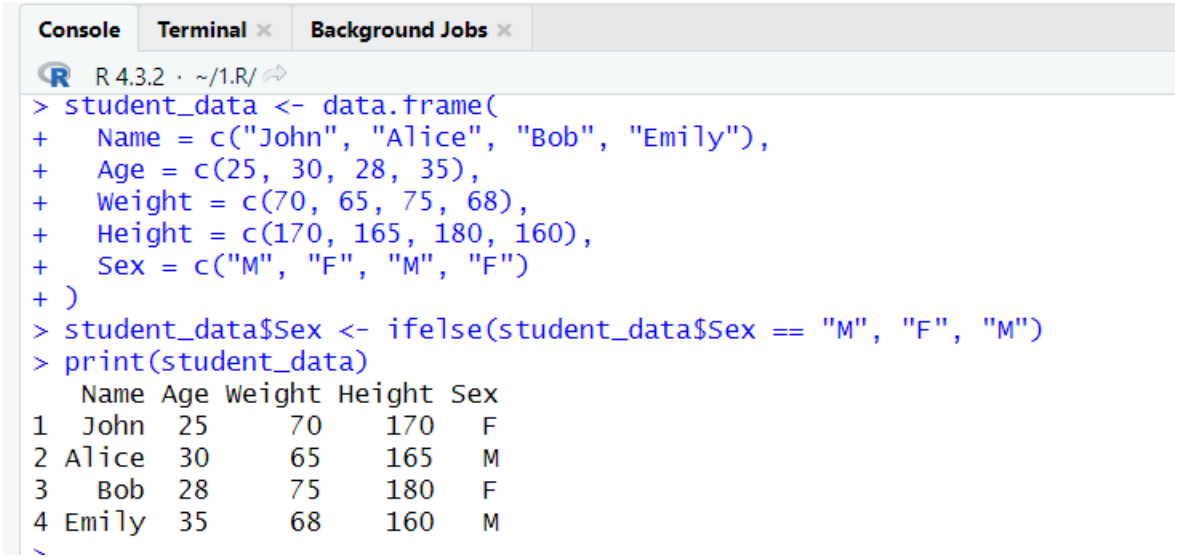
Exercise 1

Create the following data frame, afterwards invert Sex for all individuals.

Student Name vs Age vs weight vs height vs sex



OUTPUT:



Exercise 2

Create this data frame (make sure you import the variable Working as character and not factor).

Name vs working status (Yes or No)

Add this data frame column-wise to the previous one.

a) How many rows and columns does the new data frame have?

b) What class of data is in each column?

```
working_data <- data.frame(
  Name = c("John", "Alice", "Bob", "Emily"),
  Working = c("Yes", "No", "Yes", "No"),
  stringsAsFactors = FALSE  # Ensure "Working" is imported as character
)
combined_data <- cbind(student_data, working_data)
print(combined_data)
num_rows <- nrow(combined_data)
num_cols <- ncol(combined_data)
cat("\nNumber of rows:", num_rows, "\n")
cat("Number of columns:", num_cols, "\n")
column_classes <- sapply(combined_data, class)
print(column_classes)
```

OUTPUT:

```
> print(combined_data)
   Name Age Weight Height Sex  Name Working
1  John  25     70    170   F  John     Yes
2 Alice  30     65    165   M Alice      No
3   Bob  28     75    180   F   Bob     Yes
4 Emily  35     68    160   M Emily      No
> num_rows <- nrow(combined_data)
> num_cols <- ncol(combined_data)
> cat("\nNumber of rows:", num_rows, "\n")

Number of rows: 4
> cat("Number of columns:", num_cols, "\n")
Number of columns: 7

> column_classes <- sapply(combined_data, class)
> print(column_classes)
       Name         Age      Weight      Height         Sex        Name     Working
"character"   "numeric"   "numeric"   "numeric" "character" "character" "character"
>
```

Exercise 3

Check what class of data is the (built-in data set) state.center and convert it to data frame.

1.R - main - RStudio

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readxl Addins

Untitled1*

Source on Save

```
1
2  class_of_data <- class(state.center)
3  print(class_of_data)
4  state_center_df <- as.data.frame(state.center)
5  class_of_data_frame <- class(state_center_df)
6  print(class_of_data_frame)
7
8
```

OUTPUT:

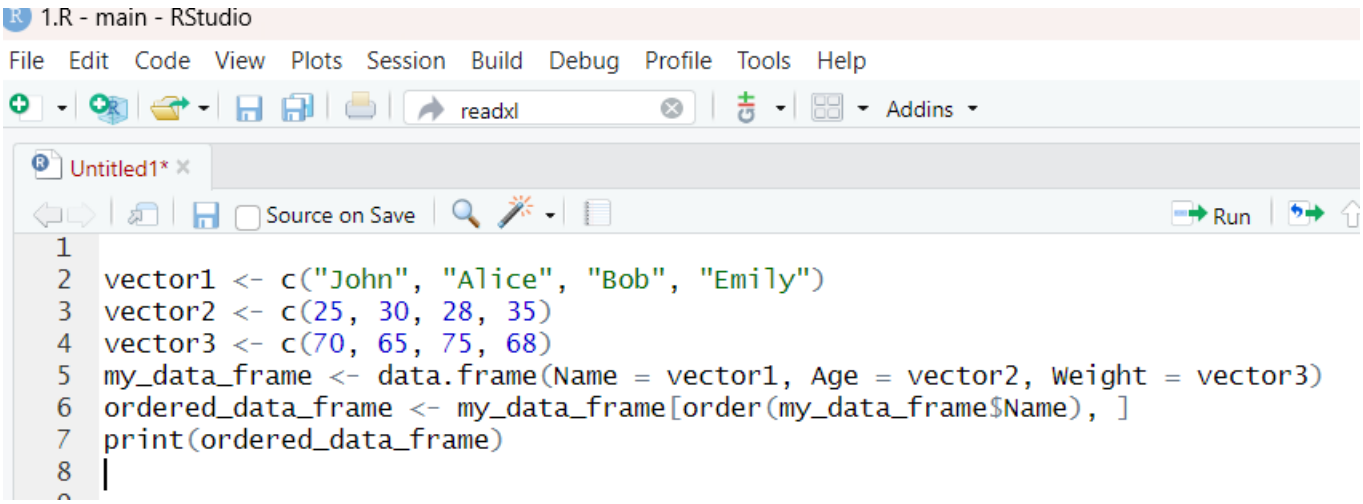
Console Terminal Background Jobs

R 4.3.2 · ~/1.R/

```
> class_of_data <- class(state.center)
> print(class_of_data)
[1] "list"
> state_center_df <- as.data.frame(state.center)
> class_of_data_frame <- class(state_center_df)
> print(class_of_data_frame)
[1] "data.frame"
>
>
```

Exercise 4

Create a simple data frame from 3 vectors. Order the entire data frame by the first column..

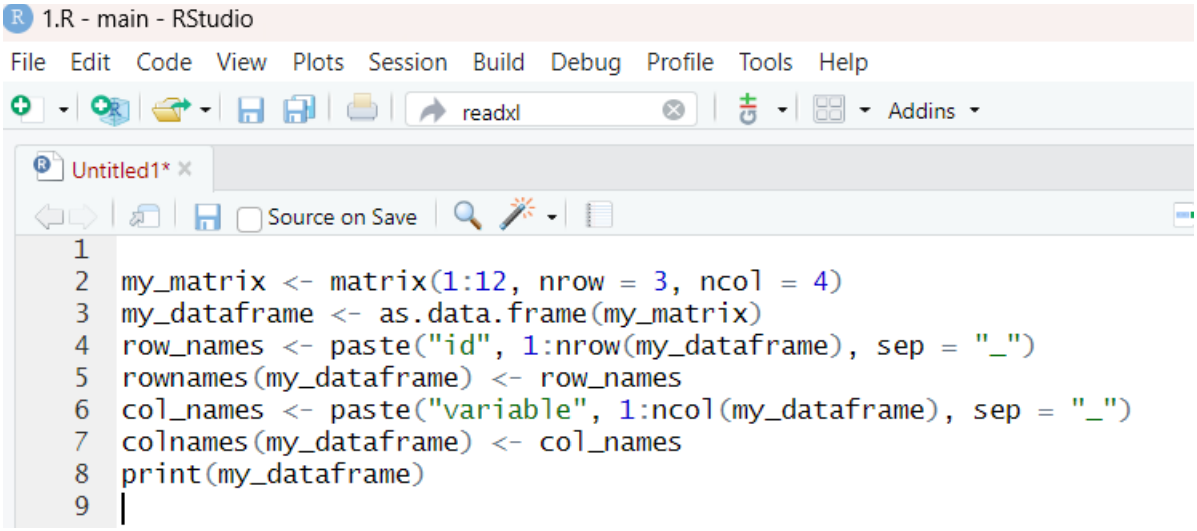


OUTPUT:

```
Console  Terminal  Background Jobs
R 4.3.2 · ~/1.R/
> vector1 <- c("John", "Alice", "Bob", "Emily")
> vector2 <- c(25, 30, 28, 35)
> vector3 <- c(70, 65, 75, 68)
> my_data_frame <- data.frame(Name = vector1, Age = vector2, Weight = vector3)
> ordered_data_frame <- my_data_frame[order(my_data_frame$Name), ]
> print(ordered_data_frame)
   Name Age Weight
2 Alice  30     65
3   Bob  28     75
4 Emily  35     68
1  John  25     70
>
```

Exercise 5

Create a data frame from a matrix of your choice, change the row names so every row says id_i (where i is the row number) and change the column names to variable_i (where i is the column number). I.e., for column 1 it will say variable_1, and for row 2 will say id_2 and so on.



OUTPUT:

```
Console  Terminal  Background Jobs
R 4.3.2 · ~/1.R/
> my_matrix <- matrix(1:12, nrow = 3, ncol = 4)
> my_dataframe <- as.data.frame(my_matrix)
> row_names <- paste("id", 1:nrow(my_dataframe), sep = "_")
> rownames(my_dataframe) <- row_names
> col_names <- paste("variable", 1:ncol(my_dataframe), sep = "_")
> colnames(my_dataframe) <- col_names
> print(my_dataframe)
     variable_1 variable_2 variable_3 variable_4
id_1          1          4          7         10
id_2          2          5          8         11
id_3          3          6          9         12
>
>
```

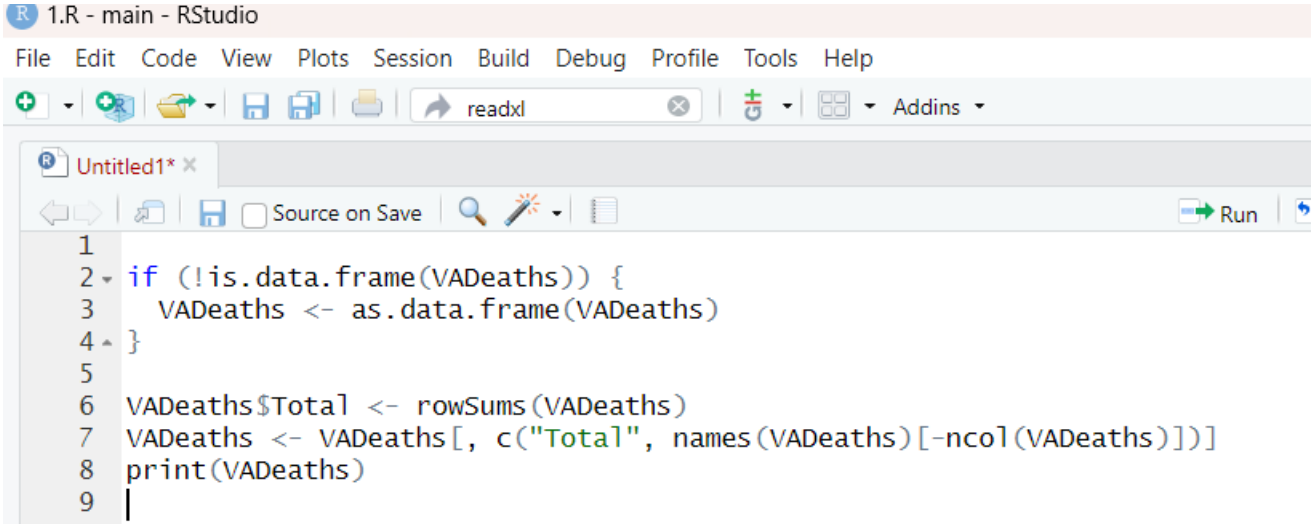
Exercise 6

For this exercise, we'll use the (built-in) dataset VADeaths.

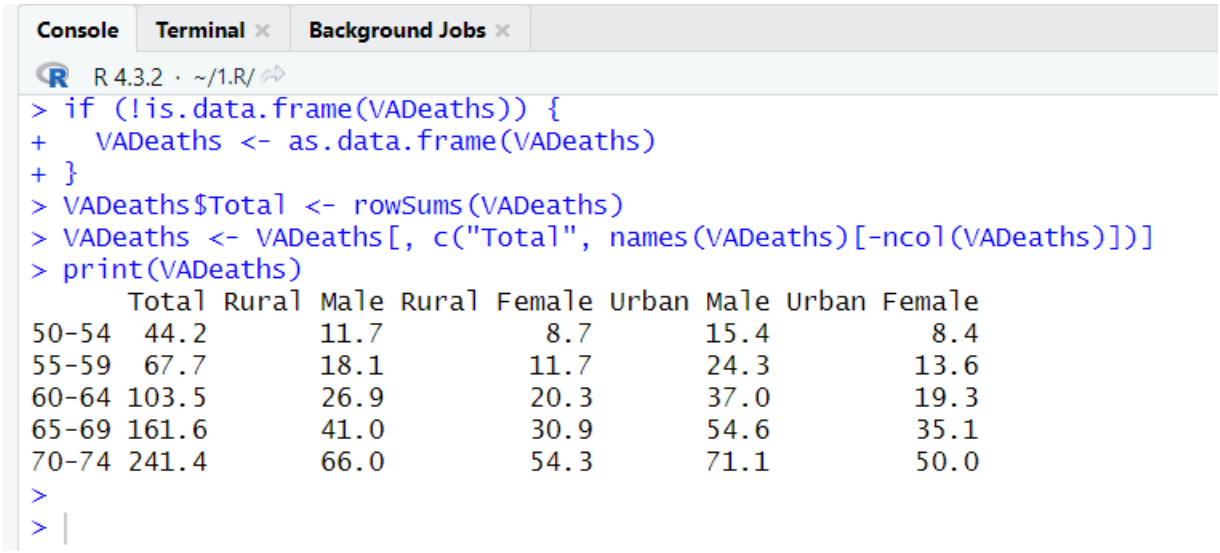
a) Make sure the object is a data frame, if not change it to a data frame.

b) Create a new variable, named Total, which is the sum of each row.

c) Change the order of the columns so total is the first variable.



OUTPUT:



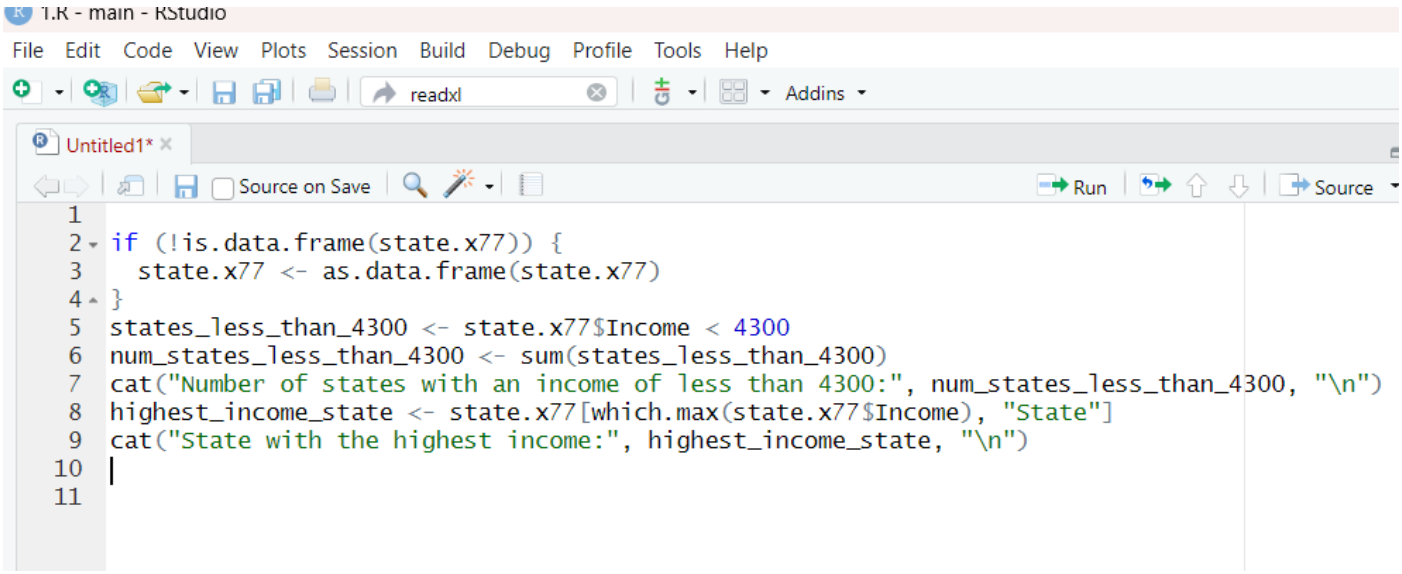
Exercise 7

For this exercise we'll use the (built-in) dataset state.x77.

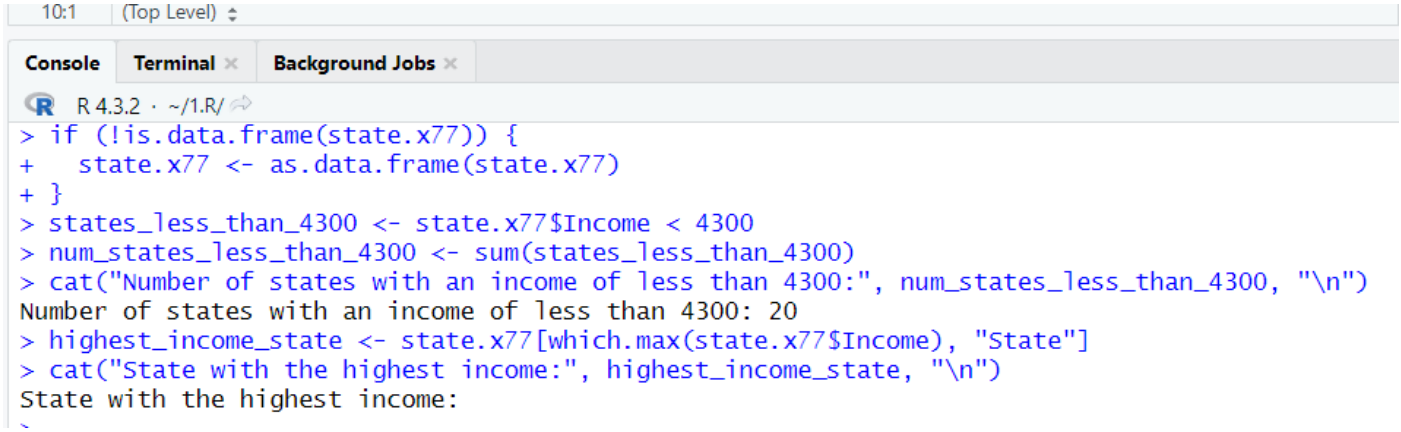
a) Make sure the object is a data frame, if not change it to a data frame.

b) Find out how many states have an income of less than 4300.

c) Find out which is the state with the highest income.



OUTPUT:



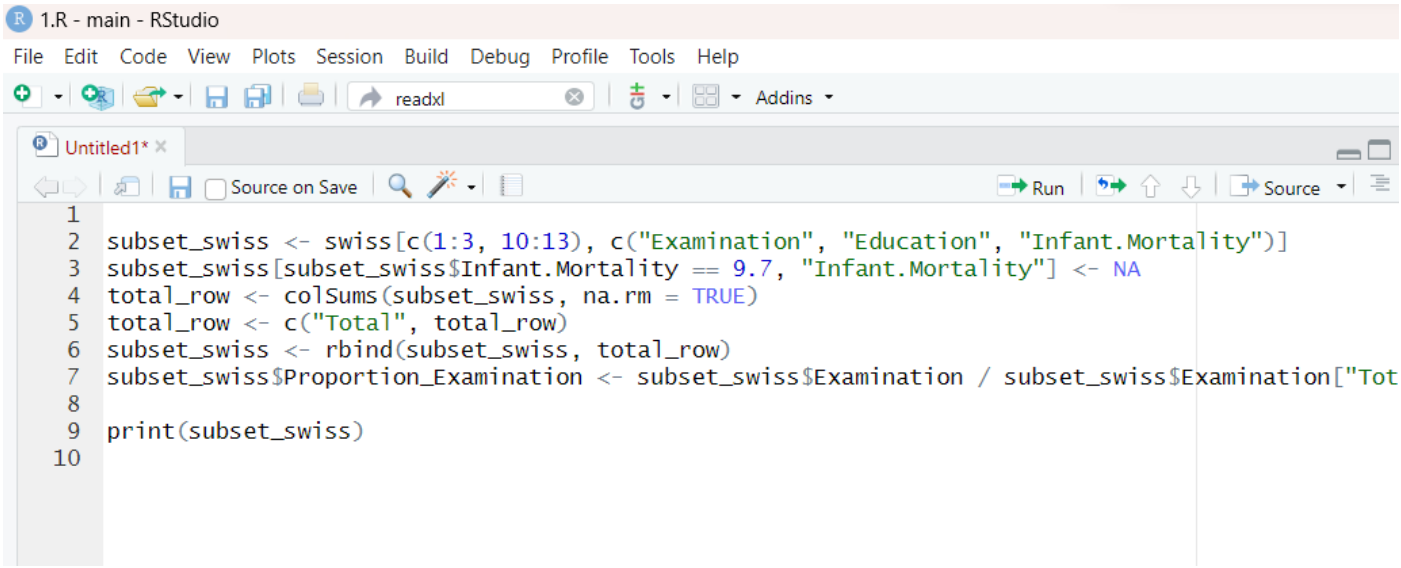
Exercise 8

With the dataset swiss, create a data frame of only the rows 1, 2, 3, 10, 11, 12 and 13, and only the variables Examination, Education and Infant.Mortality.

a) The infant mortality of Sarine is wrong, it should be a NA, change it.

b) Create a row that will be the total sum of the column, name it Total.

c) Create a new variable that will be the proportion of Examination (Examination / Total)



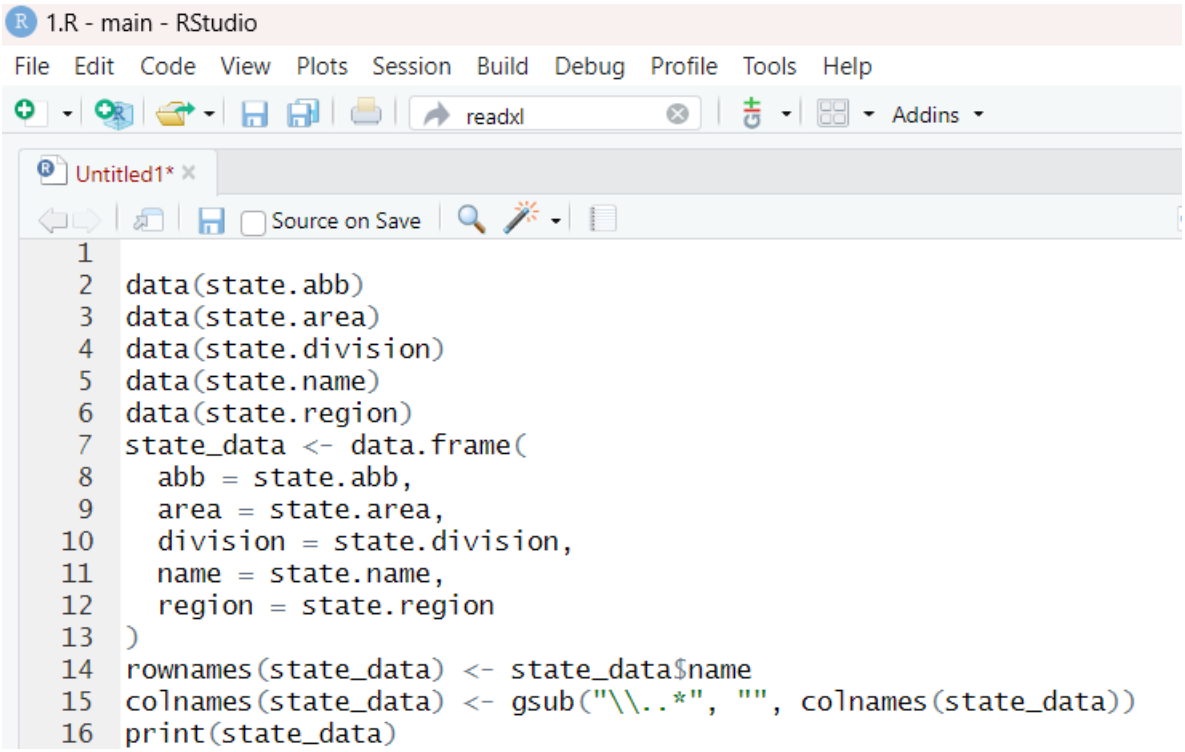
OUTPUT:

```
> print(subset_swiss)
             Examination Education Infant.Mortality
Courtelary            15        12             22.2
Delemont               6         9             22.2
Franches-Mnt           5         5             20.2
Sarine                16        13             24.4
Veveyse               14         6             24.5
Aigle                 21        12             16.5
Aubonne               14         7             19.1
8                  Total        91               64
> 
```

Exercise 9

Create a data frame with the datasets state.abb, state.area, state.division, state.name, state.region. The row names should be the names of the states.

a) Rename the column names so only the first 3 letters after the full stop appear (e.g. States.abb will be abb).




```
1
2  data(state.abb)
3  data(state.area)
4  data(state.division)
5  data(state.name)
6  data(state.region)
7  state_data <- data.frame(
8    abb = state.abb,
9    area = state.area,
10   division = state.division,
11   name = state.name,
12   region = state.region
13 )
14 rownames(state_data) <- state_data$name
15 colnames(state_data) <- gsub("\\..*", "", colnames(state_data))
16 print(state_data)
```

OUTPUT:

Console Terminal Background Jobs

R 4.3.2 · ~/1.R/

	abb	area	division	name	region
Alabama	AL	51609	East South Central	Alabama	South
Alaska	AK	589757	Pacific	Alaska	West
Arizona	AZ	113909	Mountain	Arizona	West
Arkansas	AR	53104	West South Central	Arkansas	South
California	CA	158693	Pacific	California	West
Colorado	CO	104247	Mountain	Colorado	West
Connecticut	CT	5009	New England	Connecticut	Northeast
Delaware	DE	2057	South Atlantic	Delaware	South
Florida	FL	58560	South Atlantic	Florida	South
Georgia	GA	58876	South Atlantic	Georgia	South
Hawaii	HI	6450	Pacific	Hawaii	West
Idaho	ID	83557	Mountain	Idaho	West
Illinois	IL	56400	East North Central	Illinois	North Central
Indiana	IN	36291	East North Central	Indiana	North Central
Iowa	IA	56290	West North Central	Iowa	North Central
Kansas	KS	82264	West North Central	Kansas	North Central
Kentucky	KY	40395	East South Central	Kentucky	South
Louisiana	LA	48523	West South Central	Louisiana	South
Maine	ME	33215	New England	Maine	Northeast
Maryland	MD	10577	South Atlantic	Maryland	South
Massachusetts	MA	8257	New England	Massachusetts	Northeast
Michigan	MI	58216	East North Central	Michigan	North Central
Minnesota	MN	84068	West North Central	Minnesota	North Central
Mississippi	MS	47716	East South Central	Mississippi	South
Missouri	MO	69686	West North Central	Missouri	North Central
Montana	MT	147138	Mountain	Montana	West
Nebraska	NE	77227	West North Central	Nebraska	North Central
Nevada	NV	110540	Mountain	Nevada	West
New Hampshire	NH	9304	New England	New Hampshire	Northeast
New Jersey	NJ	7836	Middle Atlantic	New Jersey	Northeast
New Mexico	NM	121666	Mountain	New Mexico	West

New York	NY	49576	Middle Atlantic	New York	Northeast
North Carolina	NC	52586	South Atlantic	North Carolina	South
North Dakota	ND	70665	West North Central	North Dakota	North Central
Ohio	OH	41222	East North Central	Ohio	North Central
Oklahoma	OK	69919	West South Central	Oklahoma	South
Oregon	OR	96981	Pacific	Oregon	West
Pennsylvania	PA	45333	Middle Atlantic	Pennsylvania	Northeast
Rhode Island	RI	1214	New England	Rhode Island	Northeast
South Carolina	SC	31055	South Atlantic	South Carolina	South
South Dakota	SD	77047	West North Central	South Dakota	North Central
Tennessee	TN	42244	East South Central	Tennessee	South
Texas	TX	267339	West South Central	Texas	South
Utah	UT	84916	Mountain	Utah	West
Vermont	VT	9609	New England	Vermont	Northeast
Virginia	VA	40815	South Atlantic	Virginia	South
Washington	WA	68192	Pacific	Washington	West
West Virginia	WV	24181	South Atlantic	West Virginia	South
Wisconsin	WI	56154	East North Central	Wisconsin	North Central
Wyoming	WY	97914	Mountain	Wyoming	West

>

Exercise 10

Add the previous data frame column-wise to state.x77

a) Remove the variable div.

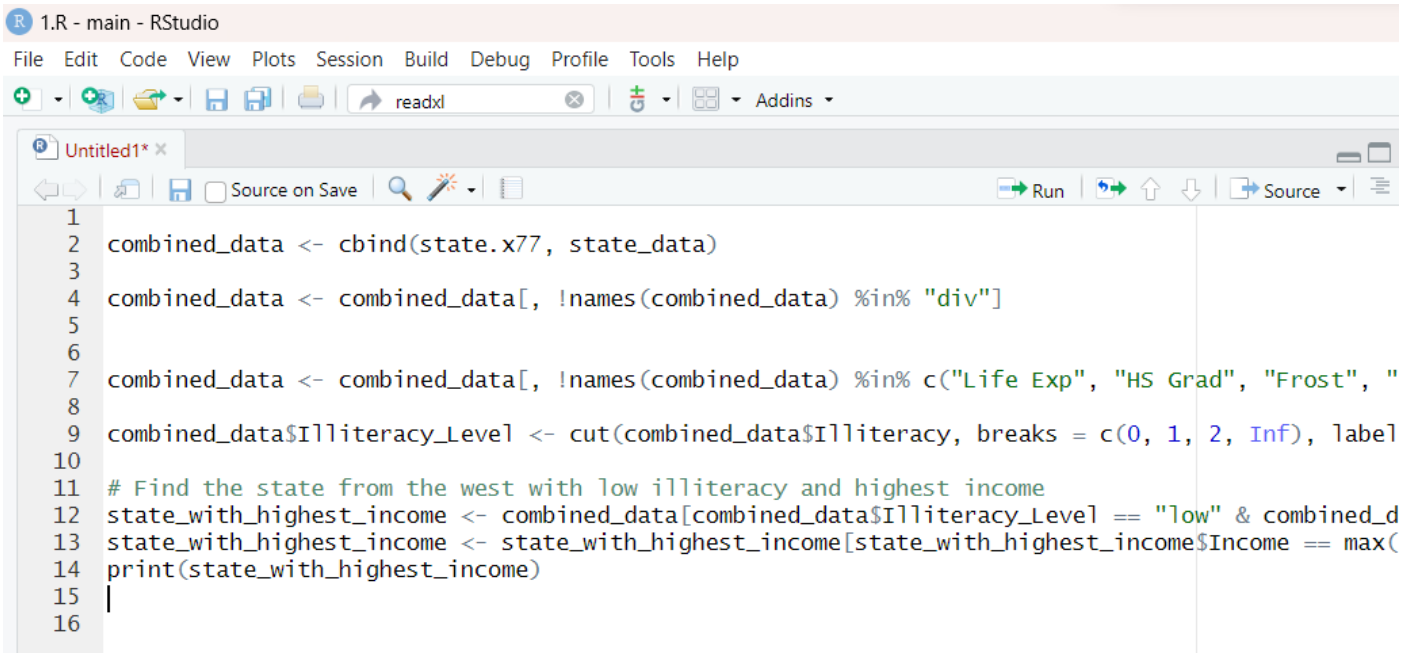
b) Also remove the variables Life Exp, HS Grad, Frost, abb, and are.

c) Add a variable to the data frame which should categorize the level of illiteracy:

[0,1) is low, [1,2) is some, [2, inf) is high.

d) Find out which state from the west, with low illiteracy, has the highest income, and what that income is

```
combined_data <- cbind(state.x77, state_data)

combined_data <- combined_data[, !names(combined_data) %in% "div"]

combined_data <- combined_data[, !names(combined_data) %in% c("Life Exp", "HS Grad", "Frost", "abb", "area")]


combined_data$Illiteracy_Level <- cut(combined_data$Illiteracy, breaks = c(0, 1, 2, Inf), labels = c("low", "some", "high"), right = FALSE)


state_with_highest_income <- combined_data[combined_data$Illiteracy_Level == "low" & combined_data$Region == "West", ]

state_with_highest_income <- state_with_highest_income[state_with_highest_income$Income == max(state_with_highest_income$Income), c("State", "Income")]

print(state_with_highest_income)
```



OUTPUT:

```
> print(state_with_highest_income)
[1] Population       Income           Illiteracy       Murder           Area
[6] division         name             region           Illiteracy_Level
<0 rows> (or 0-length row.names)
>
```