Programming for E&BI 2025 Resit Solutions

Short-Answer Questions (4 points)

Question 1 (2 points)

Write an R command that calculates the following:

$$\frac{\frac{3}{4} + \log_2(12)}{\sqrt{10}}$$

Provide both the numerical answer and the R command.

Answer:

```
((3/4) + log(12, base = 2))/sqrt(10)
```

```
[1] 1.370836
```

Question 2 (1 point)

Write an R command in the box below that generates a sequence of 20 evenly-spaced values starting from 0 and ending in 1.

The first two elements of your sequence should be `0.00000000` and `0.05263158`.

Your answer must use a sequence-generating function. It is not permitted to write out the full vector manually.

Answer:

```
seq(from = 0, to = 1, length.out = 20)
```

```
 [1] 0.00000000 0.05263158 0.10526316 0.15789474 0.21052632 0.26315789
 [7] 0.31578947 0.36842105 0.42105263 0.47368421 0.52631579 0.57894737
[13] 0.63157895 0.68421053 0.73684211 0.78947368 0.84210526 0.89473684
[19] 0.94736842 1.00000000
```

Question 3 (1 point)

Consider the following 2 vectors:

```
cities <- c("Amsterdam", "Brussels", "Paris", "Rotterdam")
dutch_cities <- c("Amsterdam", "Den Haag", "Rotterdam", "Utrecht")
```

Write an R command using the `%in%` operator that returns the elements of `cities` that are contained in the vector `dutch_cities`. The code you provide in your answer does not need to include these above 2 lines .

The output of your command should be `[1] "Amsterdam" "Rotterdam"`

Answer:

```
cities[cities %in% dutch_cities]
```

```
[1] "Amsterdam" "Rotterdam"
```

Question 4 (1 point)

Define `x` as follows:

```
x <- c(1, -7, 3, -4)
```

Writing an R command in the box below using the `ifelse()` function that takes `x` as input and returns a character vector with `"positive"` whenever `x` is positive and `"not positive"` whenever `x` is not positive.

The output of your command should be `[1] "positive"     "not positive" "positive"     "not positive"`.

```
ifelse(x > 0, "positive", "not positive")
```

```
[1] "positive"     "not positive" "positive"     "not positive"
```

Data Analysis (5 points)

Download the dataset sales-data-dec-2025.csv. The dataset contains information on the total sales of a firm for different furniture products in different cities where it has stores in December 2025. The variable descriptions are:

- `product`: The product (`Sofa`, `Chair` or `Table`).
- `city`: The city where the store is (`Tilburg`, `Breda`, `Eindhoven` or `'s-Hertogenbosch`).
- `price`: The selling price of the product.
- `sales`: The total number of units sold of that product in that city in December 2025.

When reading the dataset into R, assign it to `df`.

Question 5 (1 point)

What is the mean of the variable `sales`?

Provide both the numerical answer and the R command required to obtain the answer (if the dataframe is assigned to `df`).

Answer:

```
df <- read.csv("sales-data-dec-2025.csv")
mean(df$sales)
```

```
[1] 140.5
```

Question 6 (2 points)

Part (a): Write an R command in the box below that creates a new variable in `df` called `revenue`, which is price multiplied by sales.

Answer:

```
df$revenue <- df$price * df$sales
```

Part (b): Write an R command in the box below that returns the total revenue from chair sales across the 4 cities.

Answer:

```
sum(df$revenue[df$product == "Chair"])
```

```
[1] 485749
```

Question 7 (1 point)

Write an R command in the box below using the `aggregate()` function that returns the total number of units sold for each product.

Answer:

```
aggregate(sales ~ product, data = df, FUN = sum)
```

```
  product sales
1   Chair  1104
2    Sofa   292
3   Table   290
```

Question 8 (1 point)

Using an appropriate function from the `reshape2` package, write an R command in the box below to reshape the data such that there are 4 rows, one for each city, and the columns are:

- The city.
- The sales of chairs in each city.
- The sales of sofas in each city.
- The sales of tables in each city.

The output should be the following:

```
               city Chair Sofa Table
1 's-Hertogenbosch   286  147   113
2             Breda   240   41    72
3         Eindhoven   285   63    45
4           Tilburg   293   41    60
```

Hint: Load the `reshape2` package using the command `library(reshape2)`. You do not need to include loading this package in your answer.

Answer:

```r
library(reshape2)
dcast(df, city ~ product, value.var = "sales")
```

```
               city Chair Sofa Table
1 's-Hertogenbosch   286  147   113
2             Breda   240   41    72
3         Eindhoven   285   63    45
4           Tilburg   293   41    60
```

Data Cleaning and Analysis (9 points)

Download the following two datasets:

- ice-cream-sales-2025.csv
- temperature-2025.csv

The first dataset contains the total number of ice cream scoops sold by an ice cream salesman in Tilburg in the summer of 2025 (May 1 to September 30). This salesman takes Mondays off every week, so it says `"Day off"` for the `sales` variable on Mondays.

The second dataset contains the daily high temperature in Tilburg on each date from May-September 2025.

When reading the datasets into R, assign `ice-cream-sales-2025.csv` to `df1` and `temperature-2025.csv` to `df2`.

The next question will involve some data cleaning steps. If you perform these steps correctly, your final dataset should match the following file: temperature-sales-2025.csv If it does not, you can use this file to answer the analysis questions that follow.

Question 9 (6 points)

Perform the following cleaning steps:

Part (a): Write an R command in the box below using the `as.Date()` function that will correctly format the `date` variable in `df1` to an R date.

Answer:

```r
df1 <- read.csv("ice-cream-sales-2025.csv")
df1$date <- as.Date(df1$date, format = "%d/%m/%y")
```

Part (b): Write an R command in the box below that will drop all Mondays from `df1`. After this command `df1` should have 131 rows.

Answer:

```r
df1 <- df1[df1$day_of_week != "Mon", ]
```

Part (c): Write an R command in the box below that will convert the `sales` variable in `df1` to numeric.

Answer:

```r
df1$sales <- as.numeric(df1$sales)
```

Part (d): Write an R command in the box below that will create a variable called `weekend` that is `TRUE` if the day of the week is Saturday or Sunday and `FALSE` otherwise.

Answer:

```r
df1$weekend <- df1$day_of_week %in% c("Sat", "Sun")
```

Part (e): Write an R command in the box below that will convert the `date` variable in `df2` to an R date.

Answer:

```r
df2 <- read.csv("temperature-2025.csv")
df2$date <- as.Date(df2$date, format = "%Y-%m-%d")
```

Part (f): Write an R command in the box below that will merge `df1` and `df2` by the `date` variable. Assign the output of this command to `df`.

Answer:

```r
df <- merge(df1, df2, by = "date")
```

Question 10 (1 point)

Using your cleaned dataset (or the cleaned version of the data provided in the block introduction), calculate the average sales on days that were *both* on the weekend *and* had a temperature of at least 30 degrees.

Answer:

```r
mean(df$sales[df$weekend & df$temp >= 30])
```

```
[1] 524.25
```

Question 11 (2 points)

Using your cleaned dataset (or the cleaned version of the data provided in the block introduction), plot temperature on the horizontal axis and sales on the vertical axis. Make the color of the points represent the value of the `weekend` variable.

Use this plot to answer the following two questions.

Part (a): Choose the correct option from the following.

- Warmer days on average have higher sales compared to cooler days.
- Warmer days on average have fewer sales compared to cooler days.
- The temperature that sells the most ice cream is about 25C.
- There is no clear relationship between temperature and sales in these data.

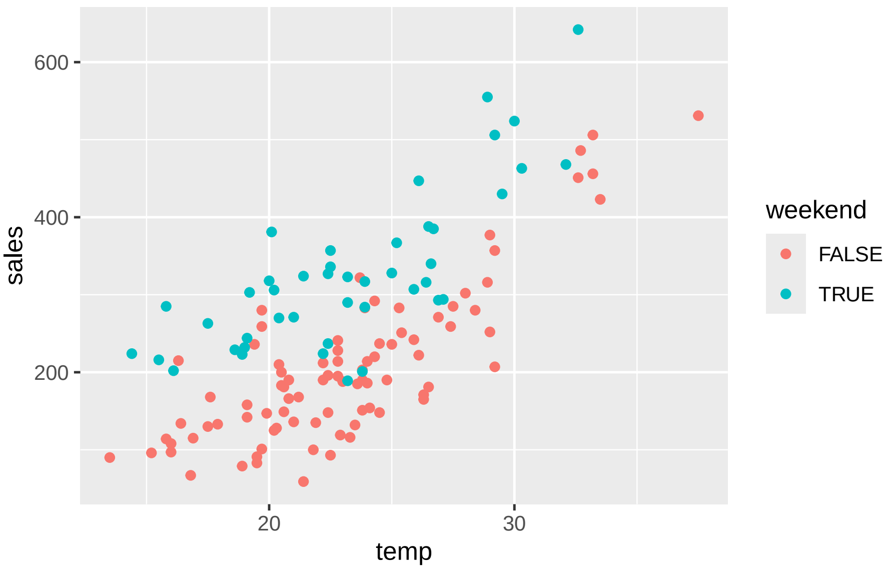
Part (b): Choose the correct option from the following.

Based on the colors of the points:

- Given the temperature, there are more sales on the weekend compared to during the week.
- Given the temperature, there are less sales on the weekend compared to during the week.
- Given the temperature, the sales on the weekend are similar to the sales during the week.
- Warmer days are more likely on the weekend.
- Warmer days are less likely on the weekend.

Answer:

```r
library(ggplot2)
ggplot(df, aes(temp, sales, color = weekend)) + geom_point()
```



```
# (a) Warmer days on average have higher sales compared to cooler days.
# (b) Given the temperature, there are more sales on the weekend compared to
# during the week.
```

Optimization (2 points)

The following 3 questions will involve working with the following mathematical function defined over all real numbers x:

$$f(x) = 20 + 8x - 2x^2$$

Question 12 (1 point)

Plot the function between the x values -1 and $+5$. Add the correct options in the boxes below that best describe the plot.

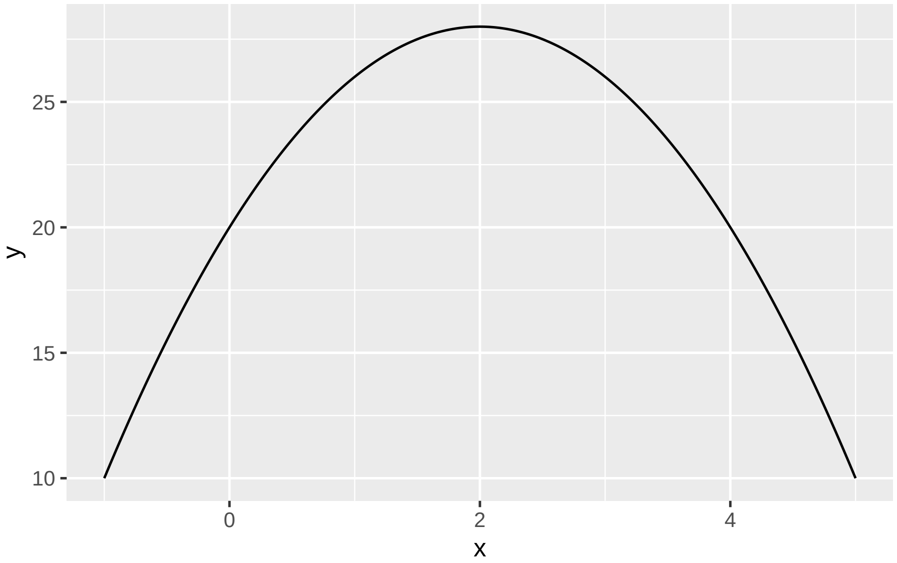
Part (a): The shape of the function is *a straight line / flat / U-shaped / inverse U-shaped*.

Part (b): When $f(x) = 20$, the corresponding values of x are _____ and _____.

Part (c): At $x = 3$, the function is *downward-sloping / flat / upward-sloping / vertical*.

Answer:

```
f <- function(x) {
  y <- 20 + 8*x - 2 * x^2
  return(y)
}
library(ggplot2)
x <- seq(-1, 5, length.out = 2000)
y <- f(x)
df <- data.frame(x, y)
ggplot(df, aes(x, y)) + geom_line()
```



```
# Part (a) The shape of the function is inverse U-shaped.
# Part (b) The values of x when f(x)=20 are 0 and 4.
# Part (c) At x=3, the function is downward-sloping.
```

Question 13 (1 point)

Use R to find the value of x at an extreme point of this function.

Part (a): Type this value of x in the box below.

Answer:

```
f_max <- optimize(f, c(-100, 100), maximum = TRUE)
f_max$maximum
```

```
[1] 2
```

Part (b) What value does the function take at the extreme point?

Answer:

```
f_max$objective
```

```
[1] 28
```

```
# or alternatively:
f(f_max$maximum)
```

```
[1] 28
```