

MSc in Data Science and Machine Learning

COURSE: Programming Tools and Technologies for Data Science INSTRACTOR: Dimitrios Fouskakis ACADEMIC YEAR: 2024-2025

Laboratory Exercise in R 11/12/2024 Programming using R

Exercise 1:

a) A prime number is a natural number (greater than 1) whose only divisors are 1 and itself. Write a function in R that takes a natural number $n \ge 2$ as an argument and checks (by returning TRUE or FALSE) whether it is a prime number or not. The function first checks if the number n is natural and greater than 1. If it is not, the function should return an error message and terminate.

b) Write a function in R that finds all possible triples (x, y, p) of natural numbers that satisfy the equation $x^2 + y^2 = p$, with the additional condition that p is a prime number. The function should return a matrix containing all possible triples in its rows, for each prime number p in the range $\{2, ..., n\}$, where n is a natural number. The value n is given as an argument to the function. If n is not a natural number (or it is less than 2), the function should return an error message and terminate.

Example: If the argument of the function is n = 8, the output should be a matrix with rows (1, 2, 5) and (2, 1, 5). Which of the two rows will be first and which will be second does not matter.

Hint: For each prime number p in the range $\{2, ..., n\}$ (use the function from **a**) to find it), check if the value $\sqrt{p - i^2}$ is a natural number, for each natural number i, such that $1 \le i \le \sqrt{p}$.

Exercise 2:

Consider a game played by two players (player A and player B), consisting of the following three phases:

Phase 1: A fair coin is tossed. If it lands on Tails, player A plays first; if it lands on Heads, player B plays first.

Phase 2: The player who goes first rolls a fair six-sided die. Depending on the outcome of the roll, he/she decides whether to end the game in this phase or to continue to the next phase. If he/she ends the game, he/she loses 1 euro.

Phase 3: If the game continues, then the other player (who did not played in Phase 2) rolls the fair six-sided die. If the outcome is a number greater than or equal to the one that player in Phase 2 got, the player that played first (in Phase 2) loses 3 euros; otherwise, he/she wins 2 euros.

Write a function in R, with no arguments, that simulates the game, with player A being a human and player B being the computer (PC). Follow the guidelines below:

- 1. If the human plays first in Phase 2: (a) display the human's roll result on the computer screen; (b) the function should ask the human to decide whether to continue to Phase 3 or not, and the human should respond to this question. If the answer is "Yes" Phase 3 is executed; otherwise, if the answer is "No" the game ends.
- 2. If the computer plays first in Phase 2, it will follow a strategy where it only continues to Phase 3 if the outcome of the die is 4 or higher; otherwise the game ends.

The output of the function should be the "profit" (positive or negative) of the human.

Hints:

(a) You can use the interactive command readline () to ask whether the human will continue or not in Phase 2. For example:

user_input <- readline(prompt = "Continue (Yes or No): ").
(b) To simulate the "values" of the coin and the die, you can use the
sample() command.</pre>