1. Let us consider a quantum analog of the function that subtracts two 3-digit binary numbers. In this case, the difference may contain 3 binary digits. What will this quantum analog produce if we take \( x_1 = 101 \) and \( x_2 = 010 \), and we take \( y_1 = y_2 = 1 \) and \( y_3 = 0 \)?

2. Suppose that all the numbers in an array are located in an interval \([5, 13]\), and we need to find the largest element with accuracy \( \varepsilon = 0.5 \). How many iterations will you need if we use the quantum optimization algorithm? How many times do we need to apply Grover’s algorithm? Trace the quantum optimization algorithm for the case when the actual largest element is \( a_4 = 7.8 \).

3–4. Trace how quantum cryptography will work if \( n = 4 \), and random bits corresponding to the preliminary steps are:

- the bits describing the signal sent by Alice are
  \[
  b_1 = 0, \quad b_2 = 1, \quad b_3 = 0, \quad b_4 = 1;
  \]

- the bits describing the orientation of Alice’s preliminary message are
  \[
  r_1 = 0, \quad r_2 = 1, \quad r_3 = 1, \quad r_4 = 0;
  \]

- the bits describing orientations of Bob’s measurements are
  \[
  s_1 = 1, \quad s_2 = 1, \quad s_3 = 0, \quad s_4 = 0.
  \]

As a message, Alice wants to send as many first bits as possible from the string 0101, i.e.:

- if possible, the whole string,
- if not possible to send the whole string, the first three bits 010;
• if this is also not possible, the first two bits 01, etc.

5. What is Kolmogorov complexity?

6. What can you say about the Kolmogorov complexity of a string 101101...101 (101 repeated 500 times). Is it $C$-random for $C = 10$? Explain your answer.

7. Explain how Kolmogorov complexity can be used in computations.