Exercises appear at the i1 homepage (http://algo.rwth-aachen.de/en/Lehre/SS17/Online.php) on Friday.

- You have seven days to create a solution and it must be done in a group of two or three students.
- Write the name, group number and enrollment number of each group member on every sheet that you hand in.
- To achieve the permission for the exam you must earn 50% of the sum of all points and present one of your solutions at least once.
- You can earn 50% bonus points by presenting your solution. At the beginning of every exercise session, you can mark the exercises that you want to present.
- If a student is not able to present a correct solution although he/she marked the exercise as presentable, he/she will lose all of his/her points on the exercise sheet.

Exercise 1 (6 points)
Recall Exercise 5 on sheet 2.

• Prove that doubling the distance each time is optimal.

• How does the competitive ratio change if a coin flip at the beginning determines the walking direction, e.g. to the left if the coin shows heads and to the right otherwise.

Hint: \( \sum_{i=0}^{k} m^i = \frac{m^{k+1}-1}{m-1} \)

Exercise 2 (6 points)
The friend of the cow suggests a new game, that he thought of. He gives the cow a set of equally long sticks which should be placed one after another and with the center point on a line with a 45° turn. The friend assigns to each stick a number as soon as they are placed. If a stick crosses another one the sticks are not allowed to have the same number. The cow knows that her friend will always choose the smallest possible number for the sticks.

So, from the viewpoint of the players which look at the line, the sticks are arranged from top left to bottom right or from bottom left to top right. Two arbitrary sticks are either parallel or orthogonal to each other. An example is presented in Figure Exercise 2.

The friend asks if the cow is able to place the sticks in a way such that the highest assigned number is \( \kappa \), which will be even. As a cow, she does the obvious: She counts the given sticks. Which number is necessary to win? Obviously this number should depend on \( \kappa \).

Figure 1: The dashed line is the center line. There are three sticks placed. Two of them are crossing such that one of them needs a different number.

Exercise 3 (4 points)
In the proof of the \( k \)-competitiveness of \( DCov \), we argued that when there are two servers \( s_{left} \) and \( s_{right} \) next to \( s \), one of them is matched to \( s \) after \( OPT \) made its move. Show that it matters which of the two is used. In particular, give an example where one of them is closer to \( s \), but a minimum-weight matching matches the other one to \( s \).