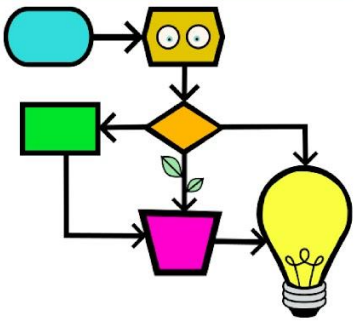
CTprimED

CT Foundations - Introduction to Decomposition



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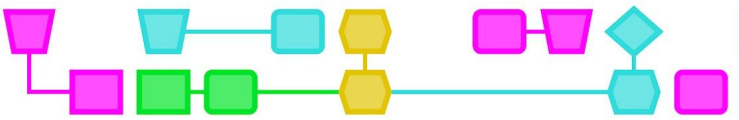


Summary
This activity explores the concept of Decomposition, which is one of the four foundations of Computational Thinking. Decomposition is the process of breaking down a problem into a number of smaller problems that can then more easily be understood and addressed.

Target group: Participants must understand the cards they are playing with (their values and how to order them) and know how to add.

Duration: 30-50 minutes

Learning goals: The objective is to learn, in a practical way, the concept of **Decomposition** used in Computer Science. It begins with an activity far removed from the computing field and then relates it to problem solving, computer programming or data structures.

Online/offline: offline

Computational Thinking:

- General skills: teamwork, logical thinking, problem solving, and decision making
- CT foundations: Decomposition

Materials:

- Two decks of cards for each group, typically poker cards (80-100 cards for each group)
- A stopwatch (typically a mobile phone timer)

Preparation:
Divide the class into groups of 4 to 8 students around a table.
Each group needs two decks of cards. You can also use the printable cards provided in appendix 1.

General introduction to the four CT foundation lessons

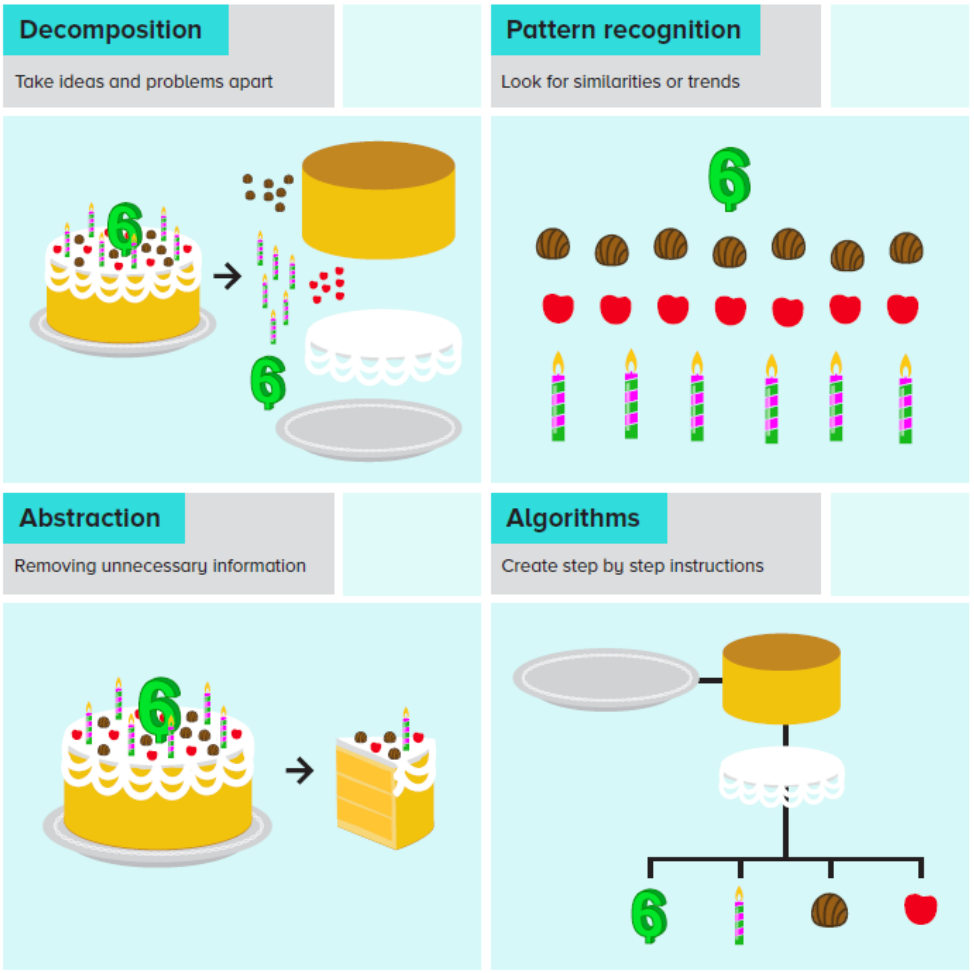
Ask the students:

- What do you know about how computers and telephones work?
- Can they think for themselves? (Why or why not?)
- Who controls what a computer does?

Explain to the students that they are going to work on Computational Thinking. Simply put, this involves learning how to get a computer to solve a problem for you. It is not merely programming, but also, for example, learning how to break down a problem into pieces, or recognizing patterns so you can better solve a problem. There are four main foundations of CT:

- Decomposition⟶ dividing a problem into small pieces.
- Pattern recognition ⟶ looking for similarities or patterns within those small pieces that can help yo
- u solve the problem.
- Abstraction ⟶ distinguishing between the main and secondary issues. What is really important to solve the problem?
- Algorithms ⟶ coming up with step-by-step instructions to solve the problem.

In this lesson you will be introduced to Decomposition.



Solve the challenges using the decks of cards

Introduction (5 min)
Explain the three different challenges to each group.

1) **Search**: the objective of this challenge is to find, as quickly as possible, the eight aces in the deck of cards. At the start of the challenge, the deck of cards should be properly shuffled and laid out face down on the table. The groups will have to start the timer immediately prior to attempting to solve the challenge and must do it as quickly as possible.

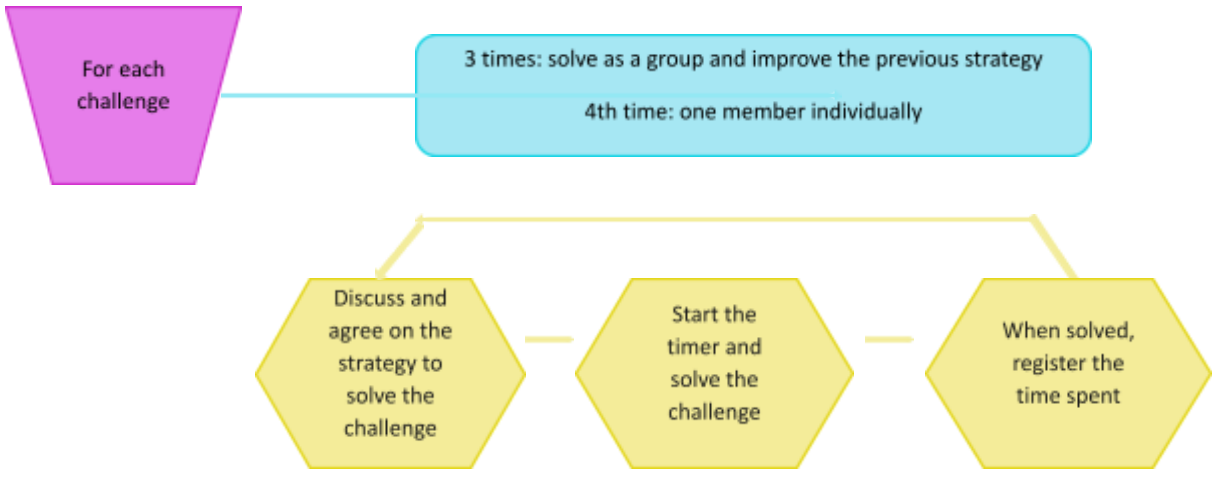
2) **Sorting**: the objective of this challenge is to sort the two decks of cards that make up the deck of cards provided to each group, from ace to king of clubs, diamonds, hearts, and spades. At the start of the challenge, the deck of cards should be properly shuffled and laid out face down on the table. The group will have to start the timer immediately prior to attempting to solve the challenge and must solve it as quickly as possible.

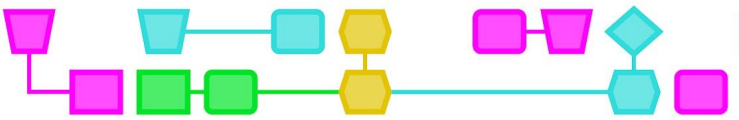
3) **Addition**: the objective of this challenge is to add up the numerical value of all the cards that make up the deck of cards that has been provided to each group. At the end of the activity, the total sum must be written down. At the beginning of the challenge, the deck of cards must be conveniently shuffled and placed face down on the table. The first 20 cards are drawn from this deck and placed out of the group's reach. In this way, the group does not know the value of the total sum because it cannot deduce it mathematically. Subsequently, the 20 cards that have been set aside will be added together and the initial sum will be checked to see if it was correct. The group will then have to start the timer immediately prior to attempting to solve the challenge and then must solve it as quickly as possible.

Description of the lesson (15-45 minutes for each challenge)
The students must solve each challenge in the shortest time possible using different strategies. In each round, they must shuffle the cards and leave the deck with the cards face down.

Prior to trying to solve each challenge, the group will agree on a strategy to decompose the problem into different parts and try to take advantage of the size of the group (i.e., if there are four people, then how should the work be allocated between the four people to minimize the time needed to solve the challenge).

Each challenge will be solved four times: three times as a group (you can try new strategies or try to refine the ones already used) and once individually by a member of the group. In all cases, the time in seconds will be recorded in order to see the improvement derived from decomposing the problem and comparing strategies. To solve the challenges, groups can talk or use the table to arrange the cards.





Conclusion (15-25 min)
Reflect with the students upon the concept of Decomposition.

Discuss with the students that Decomposition involves breaking down a problem into smaller and simpler parts, taking advantage of the capacity of several agents (processors) solving it. The challenges in this activity are of an increased complexity that aims to demonstrate when decomposing a problem into subproblems is advantageous and when it is not. This is a fundamental competency in trying to solve problems through CT.

In the first challenge, comparisons between the time required to solve the challenge in a group or individually are often inconclusive: in some instances it is almost as fast to solve the challenge individually as it is in a group. It is such a simple challenge that the time gained by dividing up the work does not always compensate for the time lost dividing up the work.

In the second challenge, the advantages of having several people in the group are more noticeable. This is where richer and more varied strategies emerge amongst different groups that give rise to further discussion of their respective advantages and disadvantages. It is relatively common for many groups to turn this sorting challenge into a two-stage challenge: sorting and subsequent sorting. It is also interesting to note how groups that do not have a multiple or submultiple of four members have to devise less obvious strategies to exploit their full potential since the decks have four suits.

The third challenge can only be done once and in a group. It is so tedious that any breakdown and sharing of the work is very welcome by the groups. Interestingly, it is a very error prone task, and few groups get the sum correct.

Explain to the students that in Computer Science there is very often a need to decompose a problem into smaller parts, solve them separately and integrate them. In this way, their analysis, design, programming, and testing becomes easier and more efficient. The same is true for complex data and data structures, insofar as decomposing them and analysing the parts is easier, as is maintenance and debugging.

Discuss different examples from their daily life of when they use Decomposition to deal with any medium-sized or major challenge, such as:

- When you do a large task (e.g., a complex cooking recipe, an experiment, a theatre play, group work, etc.), they divide the task into smaller parts, distribute it (if it is in a group) and, once the parts are finished, integrate them to achieve the overall solution.
- When you organize a party or celebration, tasks are distributed amongst the attendees so that everything runs smoothly: buying the drinks and food, cooking the different dishes, preparing the table, choosing the music and buying the decorations, etc.
- Housework is distributed to have all the people living in the house contribute, to the extent of their abilities.

Extra activity: Pose other challenges to the students about Decomposition, so that it could be solved by a processor (human or machine). For example: go from point A to point B of the city. They can spend a few minutes thinking about it individually, then discuss and agree upon it in small groups, before finally sharing it in the large group (no discussion or agreement is required).

Colophon

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