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Outreach Report: Algorithms

Oliver Gustafsson

Introduction

Algorithms are present everywhere in engineering and constituted an important part of my project. Therefore, the purpose of this outreach activity was to introduce the students to algorithms. The desired outcomes of the activity were the following:

- Define and explain what an algorithm is
- Illustrate that algorithms are present everywhere by discussing a wide range of examples of algorithms
- Introduce the idea of sorting algorithms and illustrate how they work through an interactive activity
- Highlight that many possible algorithms exist to solve the same problem

The activity was designed to achieve the aims described above. The next section will outline the chronology of the activity.

Outline of the Activity

In this section an outline of the activity will be described. PowerPoint slides were used to provide a framework for the session.

What is an algorithm?

Ask the students what they think an algorithm is and discuss their answers. An algorithm can be defined as: “a plan, a set of step-by-step instructions used to solve a problem.” [1]

Examples of Algorithms

Ask the students to name some examples of algorithms and discuss their answers. Some examples of algorithms are the following:

- Recipes
- Tying your shoelaces
- Solving a rubik's cube
- Algorithms used to tell computers what to do
- Google maps uses a clever algorithm to work out the best route to take between two locations

It is important to emphasise that algorithms are present everywhere, and not just in applications related to computers as the students may initially assume. Highlight that computers need to be given very precise instructions for them to be useful. Without good instructions, computers are useless.

Introduction to sorting algorithms

Introduce the students to sorting algorithms. Sorting algorithms can be used to sort various possible lists. For example a list of people's ages can be sorted from smallest to largest, or a list of names can be sorted alphabetically. [2]

Interactive Sorting Activity

At this point the students should have been sufficiently introduced to sorting algorithms to be ready for the interactive activity. Each student will be given a card with a number on it and the students will stand in a line holding up their cards in front of them to show the number. The cards are randomly generated numbers between 1 and 10,000. The students will implement various sorting algorithms by moving around and switching positions with each other.

First, ask for a volunteer. The job of the volunteer is to sort their fellow students from smallest to largest number. Challenge the volunteer to sort as fast as they can, and time how long it takes for them to complete the sorting with a stopwatch on the screen. Once they have sorted the numbers ask them to describe their sorting strategy. They will most likely have followed some sort of algorithm intuitively. Explain to them how what they have done constitutes an algorithm.

Now explain some different sorting algorithms to the students and get them to implement them by moving around. Challenge the students to implement them as quickly as possible and time how long it takes to sort the list with a stopwatch. One possible algorithm is **selection sort** which proceeds as follows:

1. Scan the list and find the smallest element.
2. Move the smallest element to the beginning of the list.
3. Repeat steps 1-2 with the remaining unsorted part of the list until the list is sorted.

Another algorithm is **bubble sort** which proceeds as follows [2]:

1. Start at the beginning of the list. Compare the first two elements. If the first element is larger than the second, switch their positions.
2. Consider the next pair of elements, if the former element is larger than the latter, switch their positions.
3. Repeat step 2 until you reach the end of the list.
4. Go to the beginning of the list.
5. Repeat steps 2-4 until the list is sorted.

Yet another algorithm is **bucket sort** [2]:

1. Split the numbers into "buckets", or sub-lists, where each bucket contains some sub-range of the numbers.
2. Sort each bucket using bubble sort.
3. Combine the sorted sub-lists from the buckets to form the overall sorted list.

Compare how long it took to sort the numbers with the different algorithms. Discuss with the students why they think a particular algorithm was the fastest. Bucket sort should be the fastest algorithm. However, this may not be the case depending on how the students implement it. Explain how these sorting algorithms are used by computers to sort lists.

Summary

This brings the activity to a conclusion. The key takeaways to highlight to the students are:

- What is an algorithm?
- What are the applications of algorithms?
- How can lists be sorted using algorithms?

Conclusion

Overall I believe this outreach activity was quite successful as the students seemed to grasp the inner workings of the sorting algorithms well. I think the main way it could be improved would be to add more of a “wow factor” to really inspire and intrigue the students. I think a good way to do this would be to add a live demonstration of an algorithm in action doing something visual and exciting. Perhaps a suitable example would be a live demonstration of face recognition.

References

[1] British Broadcasting Corporation. *Algorithms,* 2014. [online] Available at: https://www.bbc.co.uk/bitesize/guides/zpp49j6/revision/1 [Last accessed 15 June 2022].

[2] British Broadcasting Corporation. *Sorting,* 2014. [online] Available at: https://www.bbc.co.uk/bitesize/guides/z2m3b9q/revision/1 [Last accessed 15 June 2022].