Lesson 3.4: Sorting Algorithms

Objectives

In this lesson, students will:

- ❖ Experience using two sorting algorithms to sort a set of objects by weight
- ❖ Recognize comparing two algorithms to decide which is faster
- ❖ Work as a team to complete a task and keep records

Agenda

1. Overview	
2. Selection Sort	10 mins
3. Student Activity: Sorting Weights	15 mins
4. Student Activity: Quicksort	15 mins
5. Wrap Up and Reflections	10 mins

Preparation

- ❑ This lesson requires 2 or more balance scales. If these are not available for your classroom, there are several videos and instructions online on how to build one.
- ❑ Each group of children will need:
- ➔ 8 containers of the same size but different weights (e.g. milk cartons or film canisters filled with sand or pennies)
- ➔ Balance scale
- ➔ Activity Worksheet

Resources & Links

- ❑ Lesson adapted from the following CSunplugged.org activity: https://tinyurl.com/y5unh5z3
- ❑ Video on how to sort using the scale: **https://tinyurl.com/y3twxg9g**
- ❑ How to make a very simple balance scale: https://tinyurl.com/y4cxufjl

1. Overview

Computers are often used to put lists into some sort of order, for example names into alphabetical order, appointments or e-mail by date, or items in numerical order. Sorting lists helps us find things quickly, and also makes extreme values easy to see. If you sort the marks for a class test into numeric order, the lowest and highest marks become obvious. If you use the wrong method, it can take a long time to sort a large list into order, even on a fast computer. Fortunately, several fast methods are known for sorting. In this activity students will discover different methods for sorting, and see how a clever method can perform the task much more quickly than a simple one.

Credit: This lesson was adapted from *Sorting Algorithms* at classic.csunplugged.org .

2. Selection Sort

Demonstrate and instruct students how to do a selection sort. Use the scale and encourage student participation. You can additionally opt to show the video which showcases both sorting algorithms used in both activities.

One method a computer might use is called selection sort. This is how selection sort works:

First find the lightest weight in the set and put it to one side. The best way to find the lightest weight is to go through each object in turn, keeping track of the lightest one so far. That is, compare two objects, and keep the lighter one. Now compare that with another, keeping the lighter from the comparison. Repeat until all the objects have been used.
Next, find the lightest of the weights that are left, and remove it. Repeat this until all the weights have been removed. Count how many comparisons you made.

3. Student Activity: Sorting Weights with Selection Sort

In this activity students are instructed to use **selection sort** to sort the weights and write down the number of comparisons they made.

Description:

1. Divide students into 2 or more groups (the number of scales might determine the number of groups).
2. Each group will need a copy of the activity worksheet and its own weights and

Scales.

3. Students are only allowed to use the scale to find out how heavy each container is.
4. Distribute the activity worksheet. Have students do the activity, then discuss the results.

Prompt students for their comparison numbers and to share their experience.

4. Student Activity: Sorting Weights with Quicksort

Demonstrate and instruct students how to do a quicksort. Use about 4 objects to do a quick demonstration. Use the activity worksheet instructions on how to do a quicksort.

Quicksort is a lot faster than selection sort, particularly for larger lists. In fact, it is one of the best methods known.

Distribute the activity worksheet and have students sort the objects using quicksort. Students can work on the same teams. Regroup after the activity to discuss the results.

Prompt students for their comparison numbers and to share their experience.

5. Wrap Up and Reflections

Reflection Points:

- Which sorting algorithm is faster?
- What was challenging about today's activity?
- Why is it useful to know about multiple algorithms to do a task?

Helpful Reference Material: What's it all about?

Information is much easier to find in a sorted list. Telephone directories, dictionaries and book indexes all use alphabetical order, and life would be far more difficult if they didn't. If a list of numbers (such as a list of expenses) is sorted into order, the extreme cases are easy to see because they are at the beginning and end of the list. Duplicates are also easy to find, because they end up together. Computers spend a lot of their time sorting things into order, so computer scientists have to find fast and efficient ways of doing this. Some of the slower methods such as insertion sort, selection sort and bubble sort can be useful in special situations, but the fast ones such as quicksort are usually used. Quicksort uses a concept called recursion. This means you keep dividing a list into smaller parts, and then performing the same kind of sort on each of the parts. This particular approach is called divide and conquer. The list is divided repeatedly until it is small enough to conquer. For quicksort, the lists are divided until they contain only one item. It is trivial to sort one item into order! Although this seems very involved, in practice it is dramatically faster than other methods.

Student Activity: Sorting Weights with Selection Sort

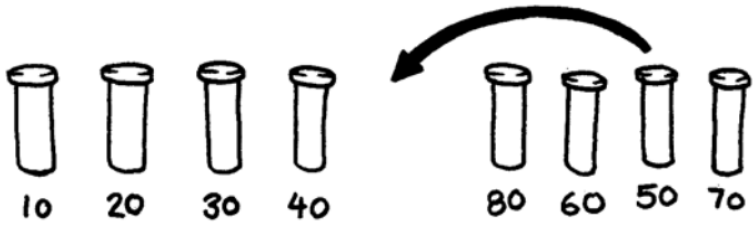
What to do:

- ❑ Sort all of the objects into order from lightest to heaviest.
- ❑ You can only use the scale to find out how heavy each container is.
- ❑ A person in the group should keep track of the number of comparisons.
- ❑ If you need a reminder of how to sort using selection sort, follow these instructions:

  First find the lightest weight in the set and put it to one side. The best way to find the lightest weight is to go through each object in turn, keeping track of the lightest one so far. That is, compare two objects, and keep the lighter one.

  Now compare that with another, keeping the lighter from the comparison. Repeat until all the objects have been used.

  Next, find the lightest of the weights that are left, and remove it. Repeat this until all the weights have been removed.



Count how many comparisons you made.

Student Activity: Sorting Weights with Quicksort

What to do:

- ❏ Sort all of the objects into order from lightest to heaviest using quicksort
- ❏ Assign a team member to count how many comparisons you made.
- ❏ It is helpful if one team member reads the instructions, and others help perform the comparisons.

<u>This is how quicksort works:</u>

Choose one of the objects at random, and place it on one side of the balance scales.

Now compare each of the remaining objects with it. Put those that are lighter on the left, the chosen object in the middle, and the heavier ones on the right. (By chance you may end up with many more objects on one side than on the other.)

Choose one of the groups and repeat this procedure. Do the same for the other group. Remember to keep the one you know in the center.

Keep repeating this procedure on the remaining groups until no group has more than one object in it. Once all the groups have been divided down to single objects, the objects will be in order from lightest to heaviest.