Activity 7

Lightest and heaviest—*Sorting algorithms*

Age group	Early elementary and up.
Abilities assumed	Using balance scales, ordering.
Time	10 to 40 minutes.
Size of group	From individuals to the whole classroom.

Focus

Comparing.

Ordering.

Inequalities.

Summary

Computers are often used to put lists into some order, whether alphabetic, numeric, or by date. 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 children will encounter different methods for sorting, and see how a clever method can perform the task much more quickly than a simple one.

Technical terms

Sorting algorithms; insertion sort; selection sort; quicksort; recursion; divide and conquer; merging; mergesort; insertion sort; bubble sort.

Materials

Each child or group of children will need:

a set of about eight containers of the same size but different weights (e.g. milk cartons or film canisters filled with sand), and

balance scales.

What to do

In computer science, the term *sorting* usually refers to putting a list into alphabetical or numeric order. This is different from the common meaning in schools, where sorting involves placing objects into categories, or grouping identical objects together.

1. Discuss the computer science meaning of sorting, and see if the children can think of places where putting things into order is important (such as names in the telephone book, entries in a dictionary, the index of a book, the books on the shelves in a library, the letters in a postal worker's bag, a class roll, names in an address book, a list of files on a computer). Have the children think about the consequences if these things were not in order (usually the problem is that it takes a long time to locate an object in an unsorted list).

   Point out that 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 order, the lowest and highest marks become obvious.

2. The children will be using balance scales with a set of about eight containers that are of different weights, but look identical. Having identical containers ensures that they must compare the weights using the scales instead of visually. If the weights can be compared simply by picking them up, assign a person for each balance scale to handle the weights under the direction of the children who are making the decisions. The only clues available to the children should arise from comparisons between pairs of weights on the scales.

   It can be helpful for the teacher to keep track of the order of the weights by writing a code on each one that the children won't be able to interpret. For example, if you know the letters of the Greek alphabet you could label the containers from lightest to heaviest with , β, etc.

   Check that the children can use the balance scales to find the lightest and heaviest of two objects.

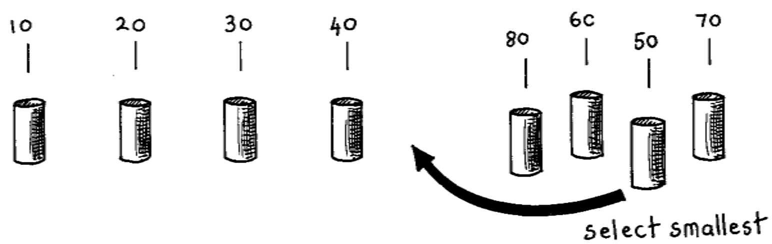

Figure 7.1: Sorting weights using the selection sort method

3. Have the children find the lightest of the eight or so weights they have been given, using only the balance scales. (The best way to do this 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.)

4. Discuss how you would check whether the weights are sorted into ascending order. (Check that the first object is lighter than the second, the second is lighter than the third, and so on. If each pair is in order then the whole list must be in order.)

5. Have the children sort three containers into ascending order of weight, using only comparisons on the balance scales. This can easily be done with three comparisons, and sometimes just two will suffice—if the children realize that the comparison operator is transitive (that is, if A is lighter than B and B is lighter than C, then A must be lighter than C).

6. Have the children sort all of the objects (about eight) into ascending order, using whatever strategy they wish. This might be very time consuming. When they think they have finished, check their ordering by comparing each adjacent pair of objects on the balance scales.

7. Have the children sort their weights into order using the following method, which is called *selection sort*. They should count how many comparisons they make to sort the objects.

   This is how selection sort works. Find the lightest weight in the set using the method described above, and put it to one side. Next, find the lightest of the remaining weights, which belongs next in ascending order of weight, and remove it. Repeat this until all the weights have been removed. Figure 7.1 shows the fifth weight being selected and added to the end of the sorted list.