

Lesson 12 – Introduction to Sorting

Introduction

Sorting is one of the most common ingredients of programming systems. It has been used widely for daily task. In this lesson, we discuss what is sorting and its importance. Moreover, we will look at how sorting has been put into practice.

Learning outcome

On successful completion of this lesson, you would be able to describe what sorting is and few of its applications. Thus you should be able to,

- ③ Define sorting
- ③ Identify applications where sorting can be applied

12.1 Introduction to Sorting

The concept of an ordered set of elements is one that has considerable impact on our daily lives. Consider, for example, the process of finding a telephone number in a telephone directory. This process, called a search, is simplified considerably by the fact that the names in the directory are listed in alphabetical order. Consider the trouble you might have in attempting to locate a telephone number if the names were listed in the order in which the customers placed their phone orders with the telephone company. In such a case, the names might as well have been entered in random order. If the entries are sorted in alphabetical rather than in chronological order, the process of searching is simplified. Or consider the case of someone searching for a book in a library. Because the books are shelved in a specific order, each book is assigned a specific position relative to the others and can be retrieved in a reasonable amount of time (if it is there). Or consider a set of numbers sorted sequentially in a computer's memory. As we shall see later it is usually easier to find a particular element of such a set if the numbers are maintained in sorted order.



Sorting is, without doubt, the most fundamental algorithmic problem that was faced in the early days on computing. Because sorting is so important and potentially so time-consuming, it has been the subject of extensive research in computer science, and some very sophisticated methods have been developed. Further a sort can be classified as being *internal* if the records that is sorting are in main memory, or *external* if some of the records that is sorting are in auxiliary storage. We restrict our attention to internal sort only.

In fact, most of the computer science research was centered on finding a best way to sort a set of data. There is probably a good reason to make sorting that important.

1. Supposedly, 25% of all CPU cycles are spent sorting
2. Sorting is fundamental to most other algorithmic problems, for example binary search.
3. *Many* different approaches lead to useful sorting algorithms, and these ideas can be used to solve many other problems.

There are many issues that need to be considered when sorting a list. We need to consider whether we need to sort the list in increasing or decreasing order. Clearly we can use the same algorithm in both cases. All we need to do is to change the comparison criteria from $>$ to $<$ or vice versa. What about equal keys? Do we change their order or leave them wherever they are? How about non-numerical keys such as Strings? How do we sort them? What if we want to sort a list of names by two criteria's? First by last name, then by first name?

There is one thing that we assume for any list that needs to be sorted. We assume that keys in the list can be “compared” by some criteria. In Java sense, we assume that interface Comparable is implemented for the objects we are trying to compare.

12.2 Application of Sorting

There are many applications of sorting. Once a list is sorted many questions about the list can be answered easily. We can efficiently find an element in a sorted list using Binary Search. Binary search requires only $O(\log n)$ operations in finding an element. We can also determine in $O(n)$ if a sorted list has duplicates. We can construct a frequency distribution of the list if the list is sorted, or find the median and mode of the list in $O(1)$ and $O(n)$ respectively. We can find the k^{th} largest element in a list in $O(1)$ time.

In practice we can find sorting application everywhere. In the following video we can see that, how an automatic peach nectarine sorting machine works. It basically sort the fruit peach based on their weight.



Source : <https://www.youtube.com/watch?v=DtNwJ-Jqbz0>

In the following video we can see that how potatoes are sorted based on their sizes and shapes.



Sources https://www.youtube.com/watch?v=LhzL6Fg_ZkU

Summary

In this lesson you have learnt about what is sorting and their application in practice. In the next lesson you will learn about several algorithms including selection sort, bubble sort, insertion sort used for sorting and finally get a sorted list of items.