CLRS

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1 The Role of Algorithms in Computing

This Chapter mostly focuses on the introduction of basic terms and familiarizes the reader with them.

1.1 Exercises

1.1.1

One of the real life problems that requires sorting could be managing books on the bookshelf in the lexicographic order.

The problem that would require solving the Shortest Path problem in real world could be finding the shortest path to the desired destination when travelling by foot or car.

1.1.2

Memory usage of the given algorithm might also be considered when devising the algorithm for a specific problem.

1.1.3

Data structure that I've seen and recently used could include a Linked-List.

Advantages include worst case $O(1)$ insertion and deletion of the particular node.

Disadvantages would include higher memory usage than regular array as we need to store additional pointer variable for each node, and also indexing takes more than in the regular arrays i.e. $O(n)$ in average case.

1.1.4

Shortest Path problem and Travelling Salesperson problem (TSP) are related to each other in a sense that both of them try to minimize the distance described by the problem. The difference is however in the definition of that distance, whereas Shortest Path problem aims to find the shortest path between two nodes in a graph, the Travelling Salesperson problem aims to minimize the distance between the set of nodes. Therefore the Travelling Salesperson problem can be somehow viewed as a Shortest path problem with additional constraint that all the specified nodes must be visited (usually ending at the starting node).

1.1.5

Problems in which only the best possible solution is anticipated could include: Medical equipment e.g. that analysis blood of the patient i.e. that is relied upon as the judgment of the medical staff depends on the accuracy of its working, therefore the results produced by such equipment shall be the most accurate.

Problems in which approximate solutions will do: Those could be problems that can trade off accuracy over time(money), as e.g. delivery company can find approximately good solution for TSP and not bother with the best solution as it could be computationally infeasible or extremely expensive to get better solution that would only slightly (in comparison to the resource thrown into solving the problem) improve the approximated one.

1.1.6

The type of problems that the input is present sometimes before and sometimes only during the solving of the problem could be the ones related to networks, where we can use an algorithm to devise the best possible paths in the network before the traffic flows through it and sometimes we would need an algorithm that could assess the best possible flow during the network usage as it might turn out that there is some increased traffic that have to be split efficiently in order not to ”clutter” the network.

1.2 Exercises

1.2.1

One of such applications that requires algorithmic content on the application level could be some form of map application where there is a possible option to find the shortest path between two points.

1.2.2

Insertion sort runs in: $8n^2$ steps
Merge Sort runs in: $64n \log_2 n$ steps

For which values of n Insertion Sort runs faster than Merge Sort, where is a natural number $n > 1$? (I excluded 1 as logarithm would be equal to zero per definition)
Therefore we need to find the biggest value of n for which equation:

$$8n^2 < 64n \log_2 n \tag{1}$$

which could be further transferred into:

$$8n^2 - 64n \log_2 n < 0 \tag{2}$$

Then the left hand side of the equation could be written as:

$$f(n) = 8n^2 - 64n \log_2 n \tag{3}$$

for which we should find a root(s) (I believe there is one root for the above function with the given constraints i.e. domain, though I lack mathematical rigor to prove this ;( )
(Another disclaimer: From what I have found, there is no "closed form" solution for this type of equations, but there is a Lambert W-function which could help me solve it, but as I am not that proficient in Calculus I will most likely proceed with the Newton-Raphson method)