



Algorithm Design & Analysis
TCP2101
Fractional Knapsack Algorithm Analysis
TC02/TT05

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1 Fractional Knapsack Algorithm

1.1 Introduction

This report briefly discusses the fractional knapsack algorithm and shows an example of its implementation using c++. Then the output will be analysed through its output speed to measure efficiency. The analysis will provide examples of best case, worst case, and average case scenarios. Finally, the report will present a comparison of running time with input size to show how the algorithm deals with large inputs of data.

1.2 Fractional Knapsack Algorithm

The fractional knapsack algorithm was implemented in an attempt to solve the knapsack problem using a heap-based priority queue. Given a set of items, each with a weight, benefit and a value, determine the number of each item to include in a collection so that the total weight is less than or equal to a given limit and the total value is as large as possible. Also you are allowed to break any item into parts or fractions to optimize the use of the knapsack.

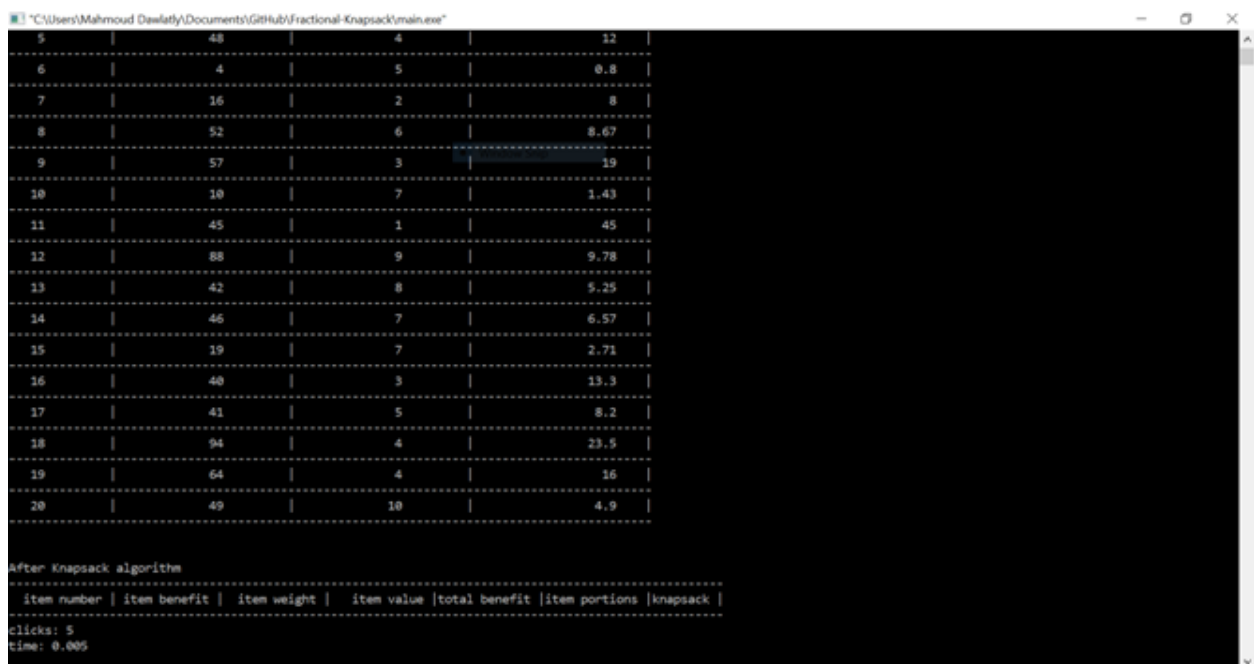
1.3 Best, Average and Worst case scenarios

We have implemented the fractional knapsack algorithm using C++. The program prompts the user to input the number of items, and the weight of the knapsack to be simulated. Then a table of results is displayed to the user showing the sequence of items being inserted into the knapsack. We will show the best, worst and average case scenarios of the algorithm.

1.3.1 Best case:

The best case scenario describes the priority queue when it doesn't need to pop anything from it to place it in the knapsack.

in the best case $T = O(1)$ case the size of knapsack is 0 and no items is going to be inserted to it that is going to take less time than the other .



5	48	4	12
6	4	5	0.8
7	16	2	8
8	52	6	8.67
9	57	3	19
10	10	7	1.43
11	45	1	45
12	88	9	9.78
13	42	8	5.25
14	46	7	6.57
15	19	7	2.71
16	40	3	13.3
17	41	5	8.2
18	94	4	23.5
19	64	4	16
20	49	10	4.9

item number	item benefit	item weight	item value	total benefit	item portions	knapsack
After Knapsack algorithm						
clicks: 5						
time: 0.005						

Figure 1.1: Best case scenario

1.3.2 Worst case:

On the other hand, the worst case scenario describes when all the items in the priority queue will be removed and placed in the knapsack. This is because it will take the longest time.

in the worst case the Knapsack size is very big to content the all items inside it and $T = O(n)$. it is going the largest amount of time case the Knapsack is going to visit all the items and insert it .

```

C:\Users\ahmad\Downloads\algorithm\assignment\algorithm\main.exe

20 | 25 | 10 | 2.5 |
-----
After Knapsack algorithm
item number | item benefit | item weight | item value | total benefit | item portions | knapsack |
-----
14 | 91 | 2 | 45.5 | 91 | | 498 |
9 | 43 | 2 | 21.5 | 134 | | 496 |
8 | 86 | 5 | 17.2 | 220 | | 491 |
2 | 91 | 6 | 15.2 | 311 | | 485 |
1 | 82 | 6 | 13.7 | 393 | | 479 |
4 | 63 | 5 | 12.6 | 456 | | 474 |
19 | 34 | 3 | 11.3 | 490 | | 471 |
3 | 70 | 0 | 8.75 | 560 | | 463 |
13 | 64 | 9 | 7.11 | 624 | | 454 |
10 | 50 | 8 | 6.25 | 674 | | 446 |
17 | 52 | 9 | 5.78 | 726 | | 437 |
11 | 40 | 7 | 5.71 | 766 | | 430 |
5 | 47 | 9 | 5.22 | 813 | | 421 |
7 | 32 | 7 | 4.57 | 845 | | 414 |
12 | 7 | 2 | 3.5 | 852 | | 412 |
6 | 10 | 3 | 3.33 | 862 | | 409 |
20 | 25 | 10 | 2.5 | 887 | | 399 |
16 | 10 | 9 | 1.11 | 897 | | 390 |
18 | 9 | 10 | 0.9 | 906 | | 380 |
15 | 1 | 5 | 0.2 | 907 | | 375 |
clicks: 137
time: 0.137

```

Figure 1.2: worst case scenario

1.3.3 Average case:

The average case scenario shows the cases in between the two extremes.

in the average case the knapsack is going to insert some items and get the portion of the items .

```

C:\Users\Mahmoud\Desktop\Documents\GitHub\fractional Knapsack\main.exe

12 | 13 | 5 | 2.6 |
-----
13 | 7 | 6 | 1.17 |
-----
14 | 24 | 5 | 4.8 |
-----
15 | 37 | 2 | 18.5 |
-----
16 | 39 | 6 | 6.5 |
-----
17 | 14 | 8 | 1.75 |
-----
18 | 85 | 6 | 14.2 |
-----
19 | 42 | 2 | 21 |
-----
20 | 74 | 2 | 37 |
-----
After Knapsack algorithm
item number | item benefit | item weight | item value | total benefit | item portions | knapsack |
-----
8 | 46 | 1 | 46 | 46 | | 9 |
3 | 85 | 2 | 42.5 | 131 | | 7 |
20 | 74 | 2 | 37 | 205 | | 5 |
19 | 42 | 2 | 21 | 247 | | 3 |
11 | 37 | 2 | 18.5 | 284 | | 1 |
11 | 37 | 2 | 18.5 | 302 | 0.5 | 0 |
clicks: 36
time: 0.036
Process returned 0 (0x0)   execution time : 2.300 s
Press any key to continue.

```

Figure 1.3: average case scenario

1.4 Experiment Results

This section will show the experiment results on the Knapsack code by running different items size and see the time as shown in the graph below.

and the table below explain clearly the number of items inserted and the time in seconds:

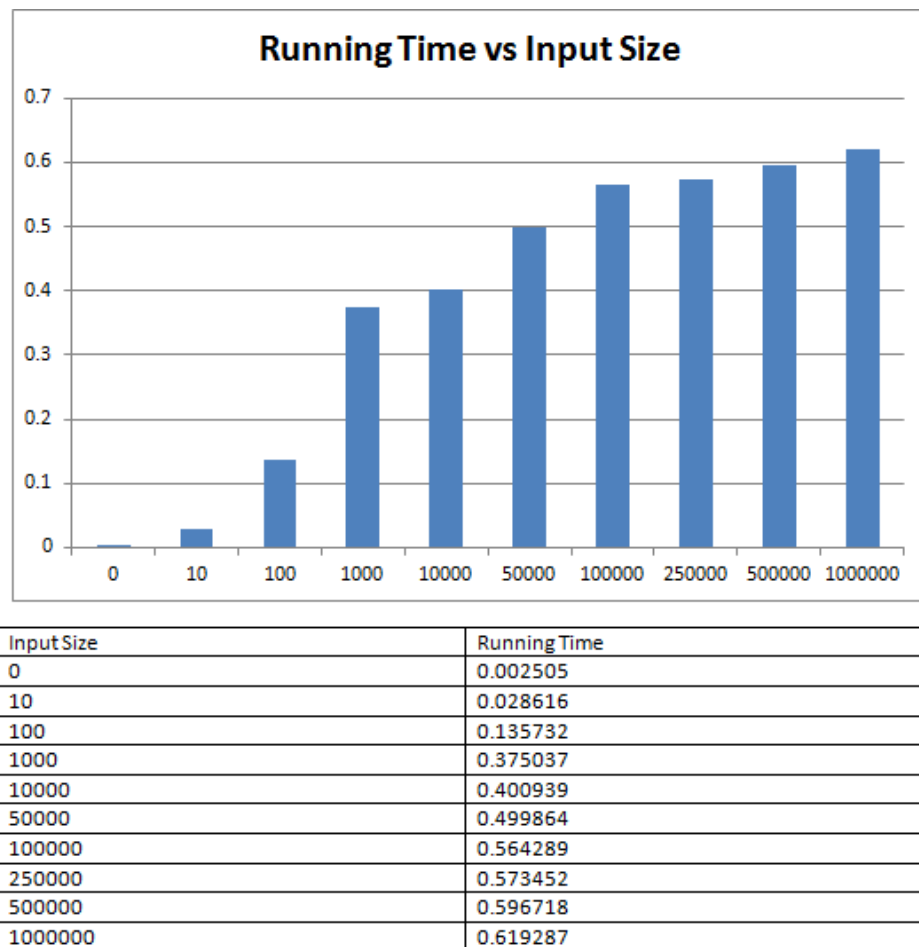


Figure 1.4: time and input size graph

the result approves that there is a relation between the input size and the time if the input size getting larger the time also is going to be larger.

1.5 conclusion

the code shows the 3 case senatrions in the Knapsack algorithm :Best, Worst and average and sgows the run time complicity for each one .

and shows also the time amount according to the input size, when the input size is getting larger the time also is getting lager.