Project 2 Report

Class:
CSE 5311 - 008

Students:
Name: Aadhitya Kumar Student ID: 1001918897
Name: Kenil Patel Student ID: 1002332816

Sources Used:

- Official Java Documentation: https://docs.oracle.com/javase/8/docs/api/
- CSE 5311 slides

Description:

Aadhitya Kumar has completed the Recursive top-down approach and Memoized approach coding part, and Kenil Patel has completed the Price Generation and Extended bottom-up approach coding part. The rest of the part is completed collectively.

Time complexity :

Extended bottom up approach : $\Theta(n^2)$

Memoized approach :$\Theta(n^2)$

Recursive top-down approach : $\Theta(2^n)$

Input for Experimental Results:

Seed used: 97
Length of 5 array used: 9 12 14 15 18
Length of 10 array used: 3 4 6 8 11 13 15 17 19 21
Length of 20 array used: 2 3 3 5 6 6 8 9 9 10 10 13 15 18 19 19 21 24 27 27
Length of 30 array used: 14 14 14 14 16 17 19 20 20 23 24 25 27 29 29 29 29 29 30 30 30 30 30 30 30 30 30 30 30 30

Experimental results for Recursive Top-Down approach:

File: price5.txt
Rod Length: 5
Maximum revenue: 45
Optimal cuts: 1 1 1 1 1
Execution time: 0.005 ms

File: price10.txt
Rod Length: 10
Maximum revenue: 30
Optimal cuts: 1 1 1 1 1 1 1 1 1 1
Execution time: 0.046 ms

File: price20.txt
Rod Length: 20
Maximum revenue: 40
Optimal cuts: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Execution time: 4.147 ms

File: price30.txt
Rod Length: 30
Maximum revenue: 420
Optimal cuts: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Execution time: 2594.560 ms

Experimental results for Memoized approach:

File: price5.txt
Rod Length: 5
Maximum revenue: 45
Optimal cuts: 1 1 1 1 1
Execution time: 0.007 ms

File: price10.txt
Rod Length: 10
Maximum revenue: 30
Optimal cuts: 1 1 1 1 1 1 1 1 1 1
Execution time: 0.003 ms

File: price20.txt
Rod Length: 20
Maximum revenue: 40
Optimal cuts: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Execution time: 0.010 ms

File: price30.txt
Rod Length: 30
Maximum revenue: 420
Optimal cuts: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Execution time: 0.044 ms

Experimental results for Extended-Bottom-Up approach:
File: price5.txt
Rod length: 5
Maximum revenue: 45
Optimal cuts: 1 1 1 1 1
Execution time: 0.003 ms

File: price10.txt
Rod length: 10
Maximum revenue: 30
Optimal cuts: 1 1 1 1 1 1 1 1 1 1
Execution time: 0.002 ms

File: price20.txt
Rod length: 20
Maximum revenue: 40
Optimal cuts: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Execution time: 0.004 ms

File: price30.txt
Rod length: 30
Maximum revenue: 420
Optimal cuts: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Execution time: 0.008 ms

Experimental and Theoretical Results:
The theoretical results give bounds on the running times of the algorithms, while the experimental results give us the real-world running time of each algorithm. The algorithms appear to be within the bounds given by the theoretical results. As expected, the running time of the recursive top-down approach is the longest and appears to grow exponentially while the running times of the memoized and extended-bottom-up approaches are similar and appear to grow polynomially.

Comparing and Contrasting the Three Algorithms:
On an input of length 5, extended-bottom-up was the fastest, followed by recursive top-down, with memoized coming in last. With small inputs, running time likely depends more on memory overhead as a pose to time-complexity. Extended-bottom-up uses the least memory, as it is not recursive. Recursive top-down uses more memory, but not as much as memoized, which is both recursive and stores inputs in an array. For inputs of size 10, 20, and 30, the results follow a similar pattern. Recursive comes in last, memoized approach in second, and extended-bottom-up if first. Recursive top-down comes in last due to having a much faster growing time complexity than the other two algorithms. Despite memoized and extended-bottom-up having the same time complexity, extended-bottom-up is always faster. This, again, is likely due to the extra memory that memoized uses.

Output of Memoized approach with given strings:

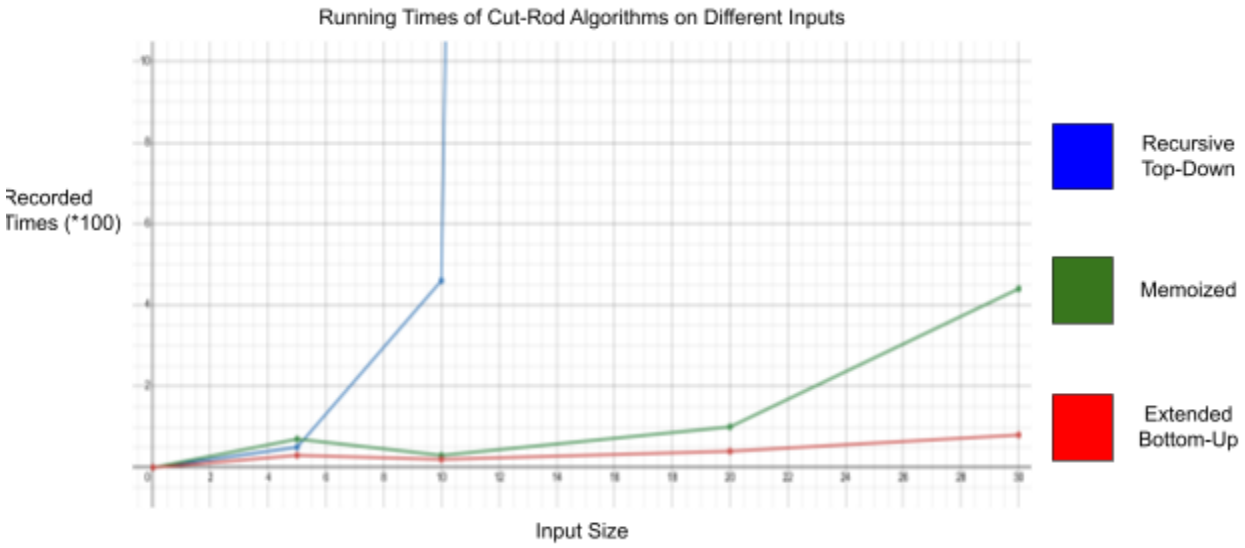
File: price5.txt
Rod Length: 5
Maximum revenue: 37
Optimal cuts: 1 2 2
Execution time: 0.004 ms

File: price10.txt
Rod Length: 10
Maximum revenue: 32
Optimal cuts: 4 6
Execution time: 0.005 ms

File: price20.txt
Rod Length: 20
Maximum revenue: 31
Optimal cuts: 9 11
Execution time: 0.010 ms

File: price30.txt
Rod Length: 30
Maximum revenue: 45
Optimal cuts: 6 6 6 6 6
Execution time: 0.026 ms

Length of Input	Recursive Top-Down	Memoized	Extended Bottom-Up	Explanation
N=5	0.005 ms	0.007 ms	0.003 ms	Memoized uses more memory so is slower than others. Extended bottom-up uses the least memory.
N = 10	0.046 ms	0.003 ms	0.002 ms	Recursive top-down time grows exponentially. Memoized and Extended bottom-up are faster, likely due to functions already being accessed by the program.
N = 20	4.147 ms	0.010 ms	0.004 ms	Recursive top-down time grows exponentially, while Memoized and Extended bottom-up grow polynomially.
N = 30	2594.560 ms	0.044 ms	0.008 ms	Recursive top-down time grows exponentially and blows up, while Memoized and Extended bottom-up grow polynomially.


Running Times of Cut-Rod Algorithms on Different Inputs
Recorded Times (*100)
Input Size
Recursive Top-Down
Memoized
Extended Bottom-Up

⇒ 5311 - Design and Analysis of Algorithms

⇒ Project-2

Name : Kenil Patel
Student ID : 1002332816

⇒ Honor Code :

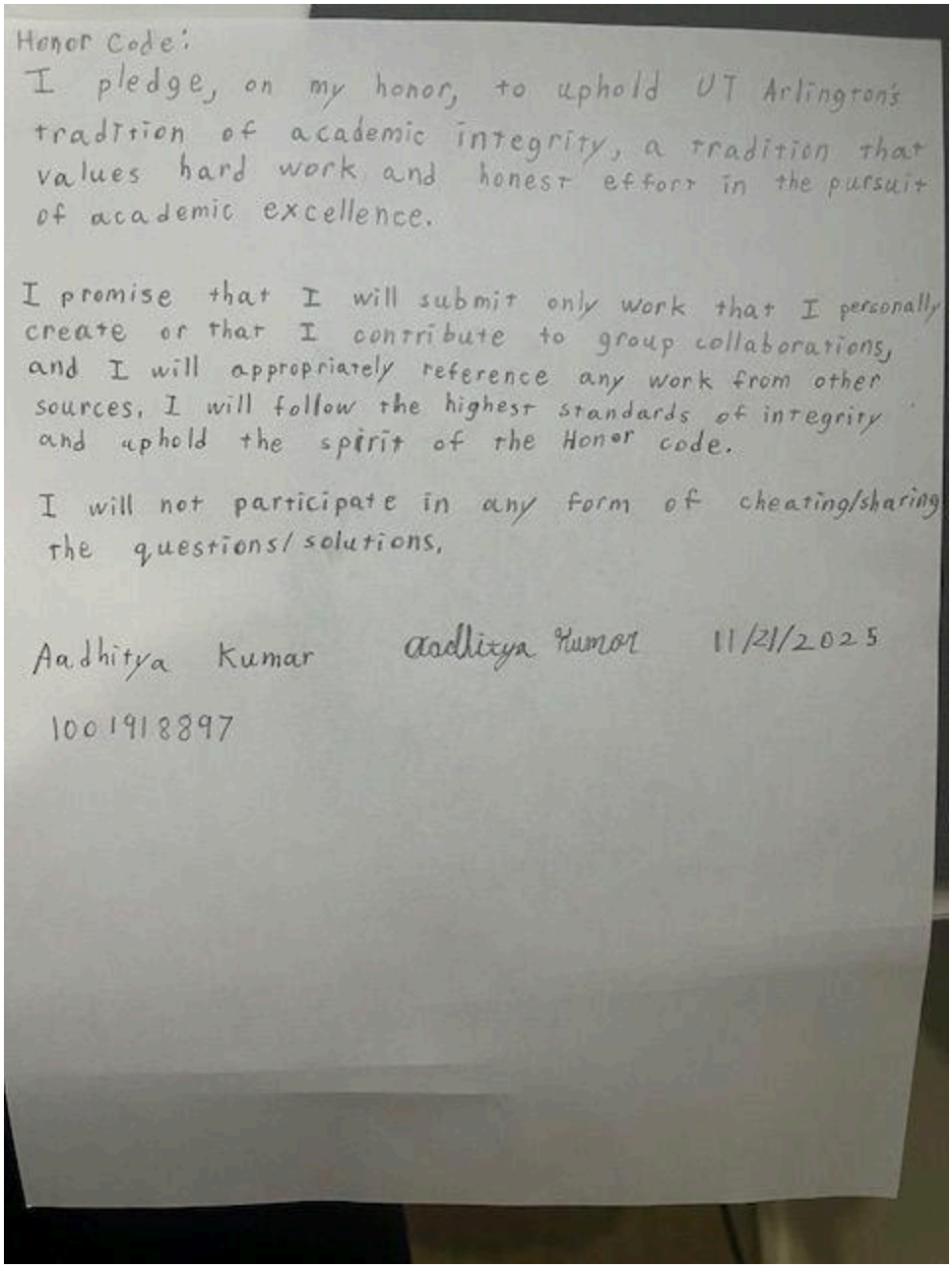
I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the persuit of academic excellence.

I promise that I will submit only work that I personally create or that I contribute to group collaborations and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and upload the spirit of the honor code.

I will not participate in any form of cheating/ sharing the questions/solutions.

Date : 11/21/2025

Signature : Kpatel



Honor Code:

I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.

I promise that I will submit only work that I personally create or that I contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor code.

I will not participate in any form of cheating/sharing the questions/solutions.

Aadhitya Kumar Aadhitya Kumar 11/21/2025

1001918897