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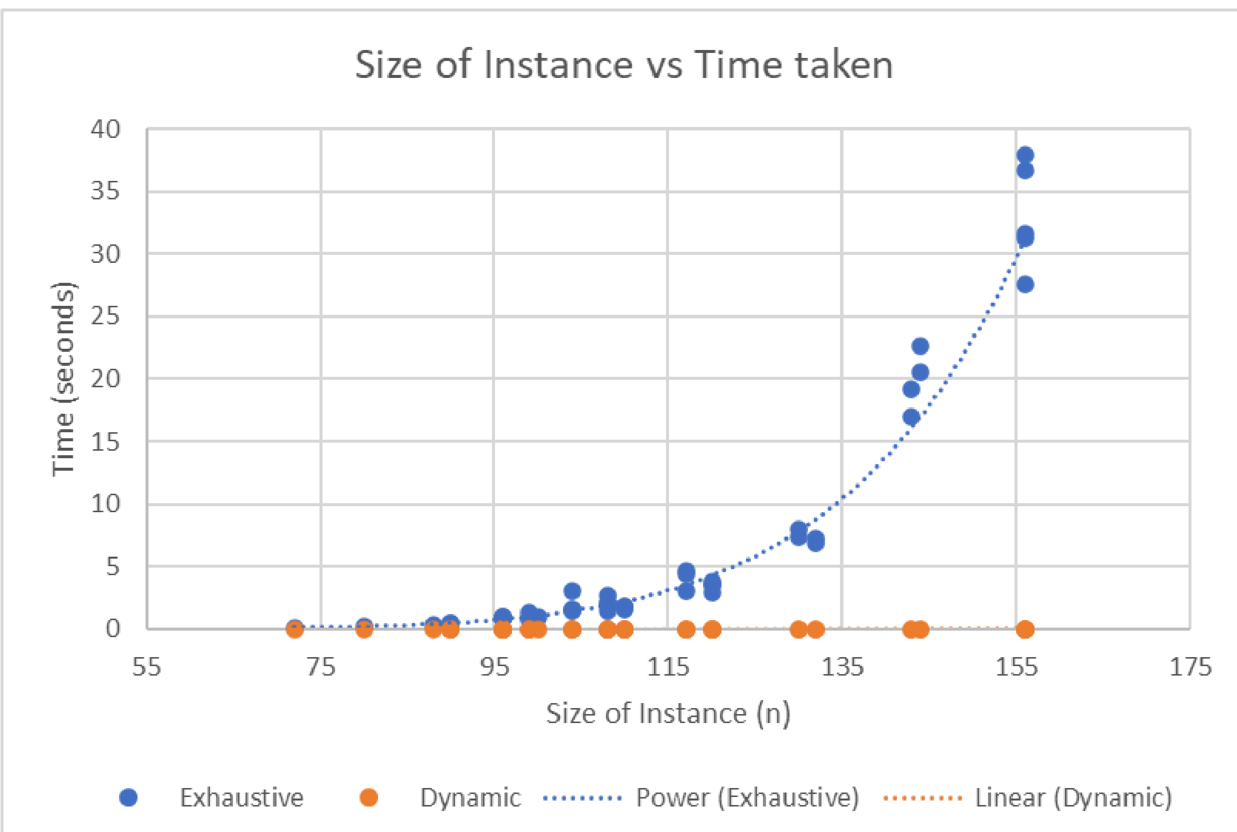
PROJECT 3

Hypothesis:

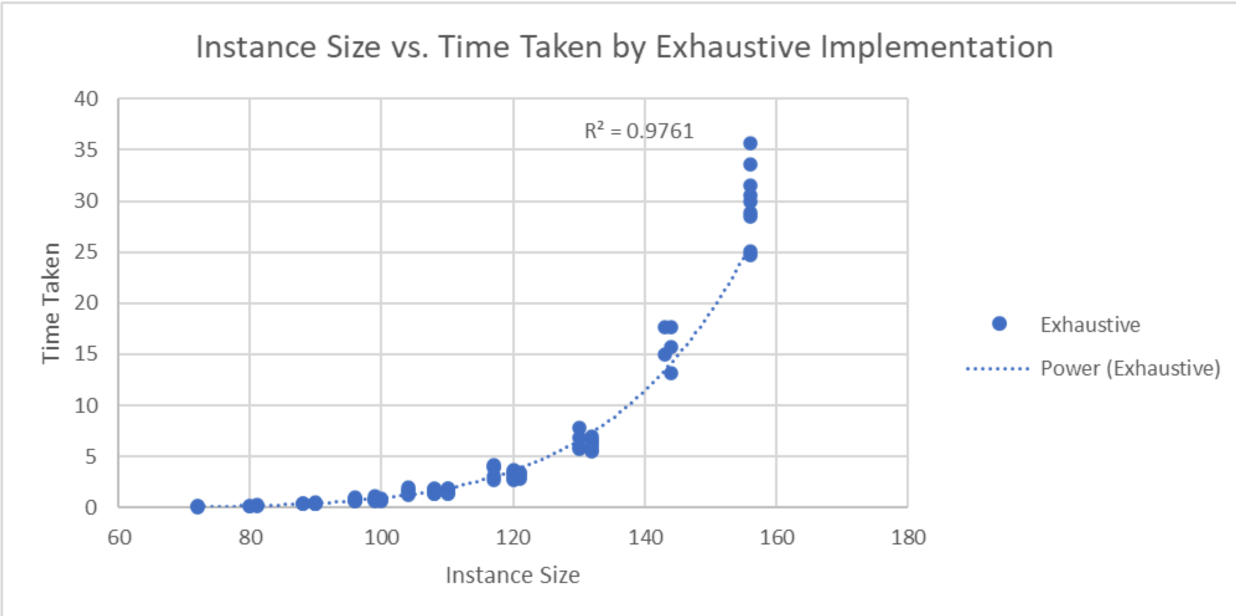
1. Exhaustive search algorithms can be implemented, and produce correct outputs.
2. Algorithms with exponential or factorial running times are extremely slow, probably too slow to be of practical use.

ScatterPlot 1: Exhaustive vs Dynamic comparison

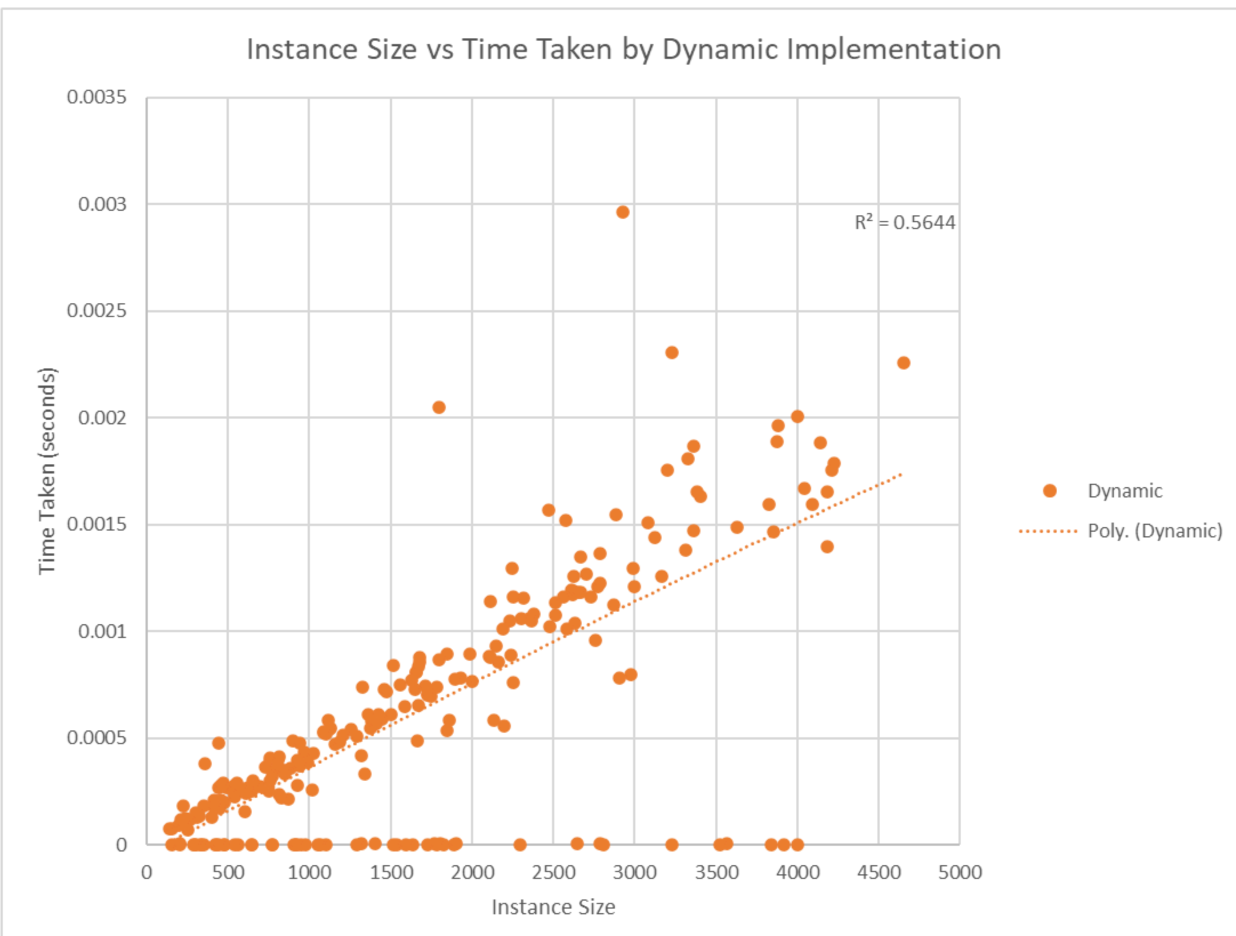
The plot points and line in blue represent the time taken by the exhaustive algorithm and the orange points and line represent time taken by the dynamic programming algorithm.



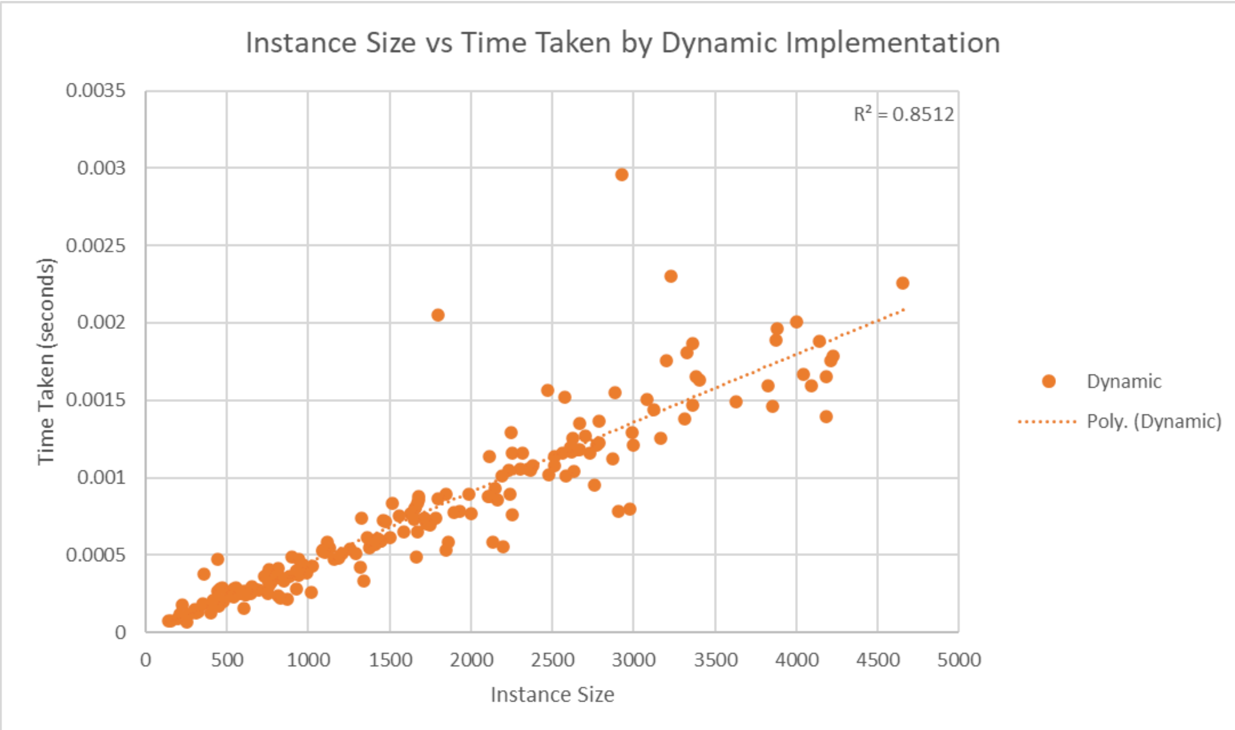
<u>ScatterPlot 2:</u> Exhaustive approach



<u>ScatterPlot 3:</u> Dynamic Approach 1



Scatterplot 4: Dynamic Approach 2



Research Questions

1. Is there a noticeable difference in the performance of the two algorithms?
    a. Yes there is a noticeable difference between the performance of the two algorithms.
2. According to your experimental observation, which of the implementations is faster, and by how much?
    a. The implementation of the dynamic programming algorithm is much faster but the difference between time taken varies with instance size (n). According to scatterplot 1, the difference between the two implementations grows exponentially as n increases.
3. Are your empirical analyses consistent with the predicted big-O efficiency class for each algorithm? Justify your answer.
    a. Yes, the analysis is consistent with the predicted big-O efficiency class for each algorithm. The results of the exhaustive approach can be seen in scatterplot 2. The graph's best fit line is exponential which matches the expected $O(n*2^n)$ run time.

       The results of the dynamic approach can be seen in scatterplot 3 and scatterplot 4. Although the graphs seem to show a linear trend, the best fit line is actually a polynomial of order 2, which matches with the expected $O(n^2)$ runtime. In scatterplot 3, the best fit line results in a r^2 value of 0.5644, meaning that the line accounts for 56.44% of all data points on the graph. In scatterplot 4, we

dropped the test cases in which the starting position is blocked for a clearer view on time taken. This is because the algorithm will always run O(1) when the starting position is blocked. In this case, the best fit line results in a r2 value of 0.8512, meaning that the line accounts for 85.12% of all data points on the graph.

4. Is this evidence consistent or inconsistent with hypothesis 1? Justify your answer. Hypothesis 1: Exhaustive search algorithms can be implemented, and produce correct outputs.
    a. Yes, exhaustive search algorithms which produce correct outputs can be implemented. Although the exhaustive search algorithms take much longer than dynamic programming implementations, they still produce the same, correct result.
5. Is this evidence consistent or inconsistent with hypothesis 2? Justify your answer. Hypothesis 2: Algorithms with exponential or factorial running times are extremely slow, probably too slow to be of practical use.
    a. The evidence is consistent with hypothesis 2. Looking at scatterplot 2, we can reasonably assume that if we continue to increase n, the time taken will exponentially increase. Although this is still acceptable for smaller cases of n, eventually the time taken will be too slow to be of practical use. This can be seen when comparing the two algorithms in scatterplot 1. For example, a dynamic approach at n = 155 will take less than 1 seconds, while the exhaustive approach will take around 30 seconds.