DAA Assignment Report

Comparing results from the Jarvis March, Graham Scan, and Kirk Patrick Seidel algorithms.

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Testing Criteria

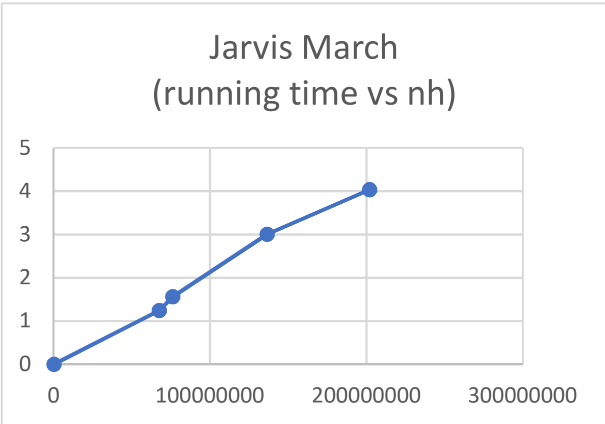
Keeping in mind that the running times of all three algorithms depend on the number of input points *(Jarvis March: O(nh), Graham Scan: O(nlogn), Kirk Patrick Seidel: O(nlogh)),* five test cases with 10000, 15000, 25000, 40000, and 55000 input points were designed.

Execution Time Observations

n	h	nh	nlogh	nlogn	Graham	Jarvis	KirkPatrick
10000	30	300000	49068.90596	132877.1238	0.009	0.003	0.045
15000	2708	67700000	171045.1804	208090.1232	0.012	1.241	0.499
25000	3052	76300000	289388.4812	365241.0119	0.023	1.562	0.780
40000	3416	136640000	469523.6904	611508.4952	0.035	3.004	1.155
55000	3676	202180000	651415.6578	866092.9199	0.048	4.036	1.595

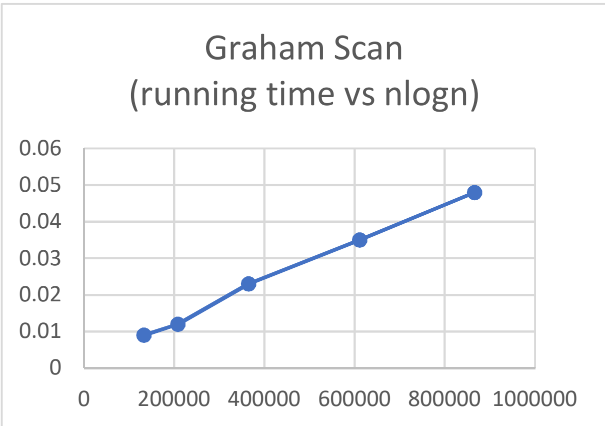
Jarvis March

In the Jarvis March method, every point on the hull entails an examination of all other points in the input to set to determine the next point. Due to this, the time complexity of this algorithm is *O(nh)*, where n is the number of input points and h the number of points on the convex hull of the polygon. In a worst-case scenario, where n = h, the time complexity worsens to *O(n^2)*, i.e. when all the input points make up the hull.



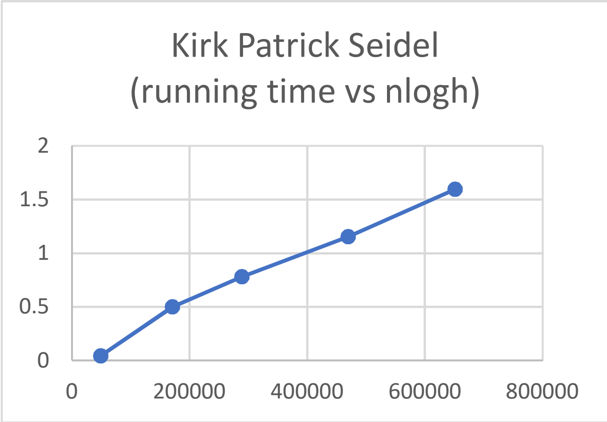
Graham Scan

If the input set constitutes *n* points, then the complexity of the algorithm is primarily dependent on the sorting algorithm used. So ideally, for a sorting algorithm that has a complexity of *O(nlogn)*, the complexity of the Graham Scan algorithm also becomes *O(nlogn)* (the other two steps that precede and supersede the sorting step are both of *O(n)* complexity).



Kirk Patrick Seidel

The Kirk Patrick Seidel algorithm, like the Jarvis March, is both input and output dependent. Hence the complexity *O(nlogh)*, where *n* is the number of input points and *h* the number of points on the convex hull of the two-dimensional polygon. Upper-Hull and Lower-Hull procedures take *O(nlogh)* time while both bridges take *O(n)* worst case time to compute.



Takeaways and Inferences

When only looking at complexities, the ideal algorithm to go to would be the Kirk Patrick Seidel algorithm, or the "Ultimate Convex Hull", as its authors like to call it. However, like how the running times data table suggests, it may not be the case always. In fact, for any moderately sized set of input points (by moderate, we mean even of the likes 50000 and 100000), the Ultimate Convex Hull algorithm should not be employed.

The Kirk Patrick algorithm becomes the ideal choice theoretically only when the number of input points exceed the likes of millions, when the algorithm's *constant* (when determining the complexity of an algorithm, we usually ignore the constant; however, this becomes significant when comparing *logn* and *logh* in the complexities of the two algorithms) and the *logh* values can actually do better than Graham Scan's *constant* and *logn*. For all other practical purposes, Graham's Scan is far superior than Kirk Patrick.

Jarvis March can potentially be a good choice when the number of hull points are far less than the number of input points, especially when the difference is in the order of 10^{10} points. At such scenarios, Graham Scan would theoretically perform far poorer than Jarvis March, and obviously even Kirk Patrick. The superiority of Kirk Patrick over Jarvis March in such a scenario is completely subjective to the value of *h*, depending on which it can be almost similar (small *h* values) vs far superior (very large *h* values, large enough for there to be a significant difference between *h* and *logh*).