# Algorithm implementation

The time compare of the three algorithms for computing the convex hull are showing on the graph which shows below:

Firstly, the time complexity of Gift Wrap when the input is n that is O(*nh*). The n is number of input points, h is the number of convex hull. Therefore, if the amount of data is huge then Gift Wrap would take more and more time on computing. However, if the number of convex hull is really smaller such as log n, then the time of Gift Wrap would be fast, and the running time is O(nlogn) which is the best case. As the two compare graph showing that A group data which is less convex hull data is consume less time compare with B data which have more convex hull. At the meantime, the number of convex hull becomes more and more the disadvantage of Gift Wrap is more obvious as showing on graph of B data.

Secondly, the time complexity of Graham Scan is O(nlogn) so it is the faster than Gift wrap. According to the two compare graph when the number of convex hull be more and more, then the running time of Graham Scan are less and less such as in B data.

Thirdly, the Monotone Chain is a variant of Graham scan, so the complexity time of Monotone Chain on average case is O(nlogn) same as Graham Scan. According to the comparison of two group data graph, following the number of convex hull increasing, the time of the Monotone Chain computing convex hull are decreasing.

In conclusion, According to the A\_data graph, there is evidence shows that when the number of convex hull is small, Gift wrap, Graham scan, and Monotone chain are not significantly difference between each other. For example, the difference between Gift wrap and Graham scan are 23%, the difference between Monotone Chain and Gift wrap is similar with Graham scan which is 24%, and the difference between Graham scan and Monotone Chain is 1%. However, the information of B data graph is totally proof the theory. Because of the number of convex hull of B group is much more than A group, the advantage of Graham scan and Monotone chain are more obvious, because they running O(nlogn) for average case, Gift wrap cannot be O(nlogn) in large number of convex hull. The complexity time of Gift wrap is O(nh), it had big disadvantage of huge data convex hull computing.

# Algorithm analysis

The result of three different algorithms computing the two group data which shows below:

|  |  |  |
| --- | --- | --- |
| **Gift wrap** | | |
| Data: | Time of A Group Data: (s) | Time of B Group Data: (s) |
| 10 | 0.0007814905369917596 | 0.0016828156599957742 |
| 50 | 0.001767270801933613 | 0.004350753500287364 |
| 500 | 0.01865135631291698 | 0.0687233057170792 |
| 1000 | 0.038864147993197505 | 0.18028766121967416 |
| 3000 | 0.1128452470924195 | 0.6575639252321384 |
| 6000 | 0.22483522315475044 | 1.628354203103775 |
| 9000 | 0.33535645179389917 | 3.154729968089308 |
| 12000 | 0.4522077400323261 | 4.536461391286341 |

|  |  |  |
| --- | --- | --- |
| **Graham scan** | | |
| Data: | Time of A Group Data: (s) | Time of B Group Data: (s) |
| 10 | 0.0003196047936379116 | 0.0004023665066859851 |
| 50 | 0.0018965257025566724 | 0.001846116695342449 |
| 500 | 0.019276464728787468 | 0.019657701711491445 |
| 1000 | 0.03752573274170666 | 0.03824413655709499 |
| 3000 | 0.11158411059796552 | 0.11399589483534063 |
| 6000 | 0.2221935464396752 | 0.22723746566452355 |
| 9000 | 0.3339590690935434 | 0.3442026623200217 |
| 12000 | 0.4533348425850463 | 0.4591677986054514 |

|  |  |  |
| --- | --- | --- |
| **Andrew's monotone chain convex hull algorithm (amethod.py)** | | |
| Data: | Time of A Group Data: (s) | Time of B Group Data: (s) |
| 10 | 0. 0004640597071556953 | 0. 0004848292464873129 |
| 50 | 0. 0014671974575603912 | 0. 001438678090119961 |
| 500 | 0. 01728862653826338 | 0. 02209475993822457 |
| 1000 | 0. 03066420986782513 | 0. 03203003957372225 |
| 3000 | 0. 09283457092921679 | 0. 09254193741982802 |
| 6000 | 0. 18472180287041232 | 0. 18414025576912704 |
| 9000 | 0. 27555319823006325 | 0. 27626122252608437 |
| 12000 | 0. 3650361234987808 | 0. 3695099442694361 |

According to the data tables which show above, in A group data, the Gift wrap did not showing any huge difference compare with Graham scan algorithm and Monotone Chain algorithm even thought the amount of data increasing to 12000, since the amount of convex hull is small in A group data.

The fast algorithms are still Graham scan and Monotone chain. In B group data, we can clear to seen the computing time of B\_10.dat of Monotone Chain and Graham scan are 0. 0004848292464873129 and 0.0004023665066859851which are similar. However the computing time on gift wrap for B\_10.dat is 0. 0016828156599957742 which is quadruple running time compare with Graham scan, and Monotone chain algorithm. Following the size of data increasing the time changed dramatically in Gift wrap, For example it took 4.536461391286341 second to run the computing, but Graham scan and monotone chain only took around 0.45 second to complete the computing.

Significantly, there is a slightly difference between Graham scan and Monotone chain. The both algorithms are running O(n log n) for average case. The reasons for this is that since monotone chain is a variant of Graham scan, the way of the up hull of monotone chain runs from its rightmost position to the leftmost position in counter clockwise order, and down side hull is the remaining part of the convex hull. This will lead to the algorithm runs slightly more efficient compare Graham scan.

# Acknowledgment and references

**Pseudo Code of Andrew's** **monotone chain convex hull algorithm (**2011). Algorithmist. Retrieved May 10, 2013, from <http://www.algorithmist.com/index.php/Monotone_Chain_Convex_Hull>

**Convex Hull Algorithms (2013)** *Wikipedia***.** Retrieved May 21, 2013, from <http://en.wikipedia.org/wiki/Convex_hull_algorithms>