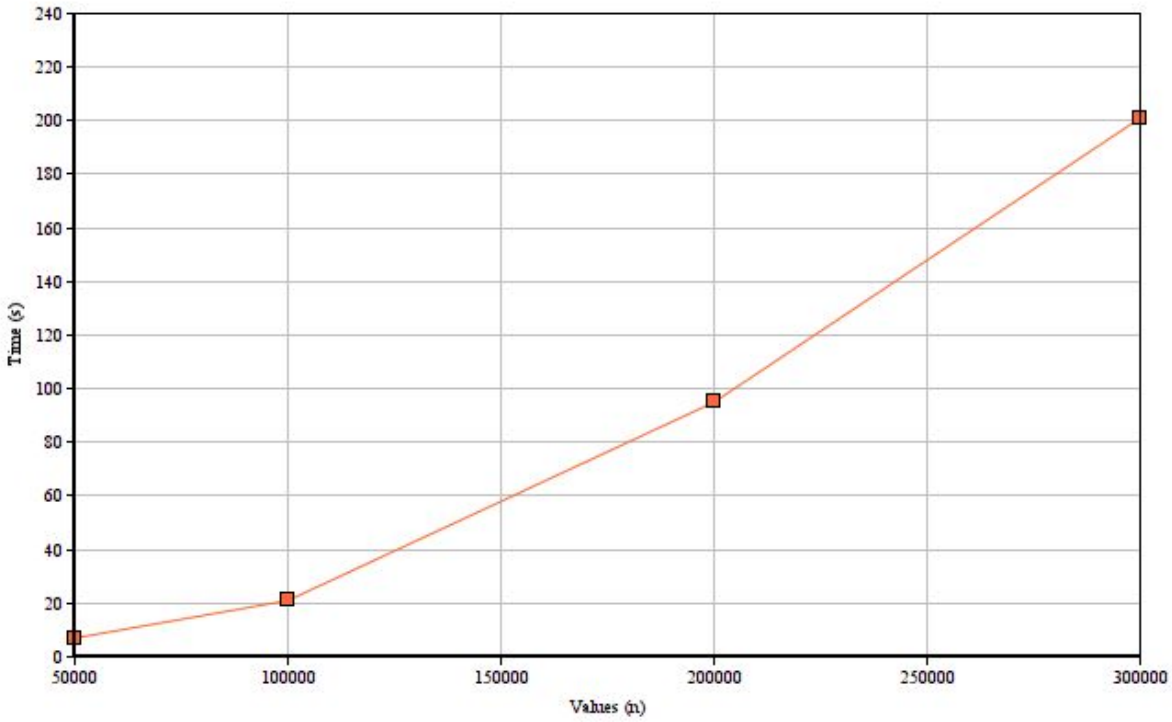
**CS 241 Report**

Note: Compiled and ran through a MacBook Pro, i5, 2.7 GHz. Speed of computer and computer efficiency may affect or alter results.

**Bubble Sort:**
**Worst: O($n^2$)**
**Average: $\theta$ ($n^2$)**

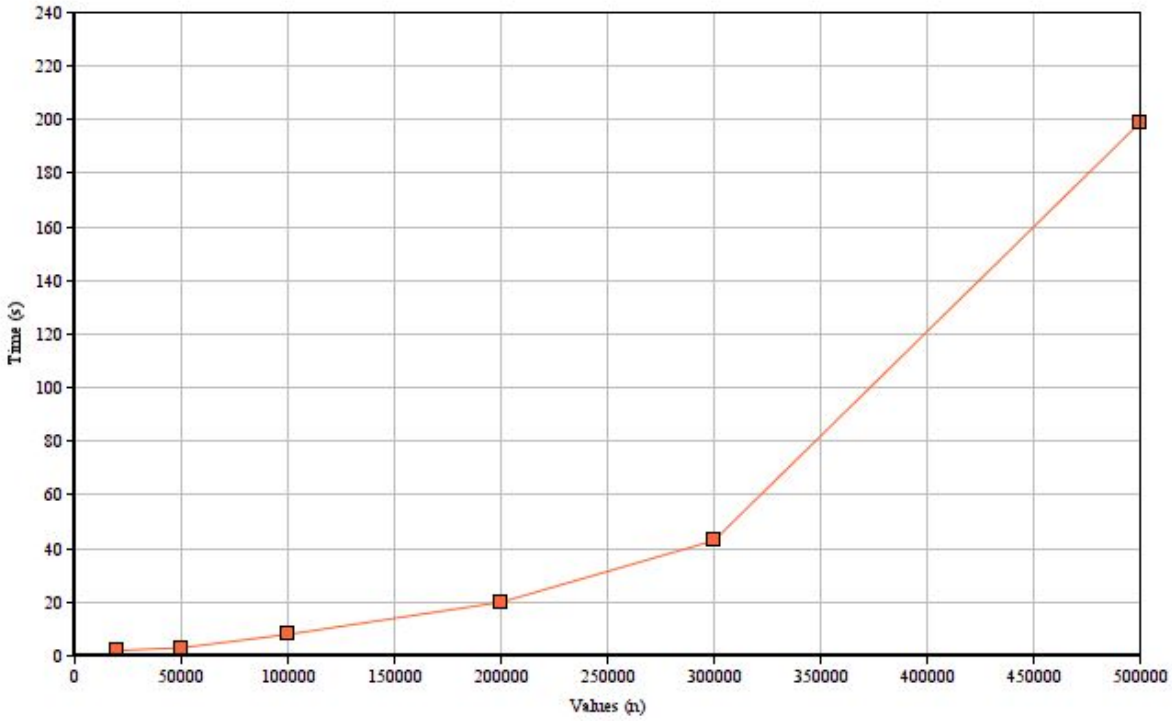
**<u>Time(s) vs values (n):</u>**
7 Seconds - 50,000
21 Seconds - 100,000
95 Seconds - 200,000
201 Seconds - 300,000




Graph does appear to be in an $x^2$ polynomial fashion. Supporting the empirical data.

**Selection Sort:**
**Worst: O($n^2$)**
**Average: $\theta$ ($n^2$)**

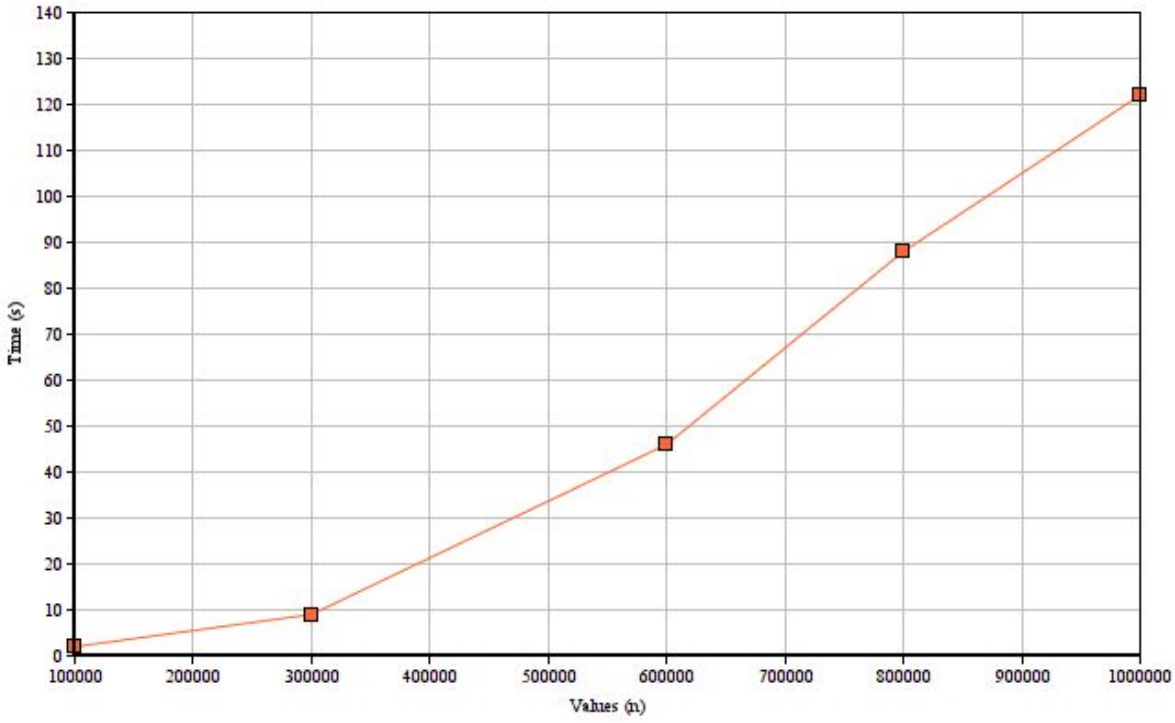
**<u>Time(s) vs values (n):</u>**
2 Seconds - 20,000
3 Seconds - 50,000
8 Seconds - 100,000
20 Seconds - 200,000
43 Seconds - 300,000
199 Seconds - 500,000




Appears to be much faster than Bubble Sort, even though both have O($n^2$).

**Insertion Sort:**
**Worst: $O(n^2)$**
**Average: $\theta(n^2)$**

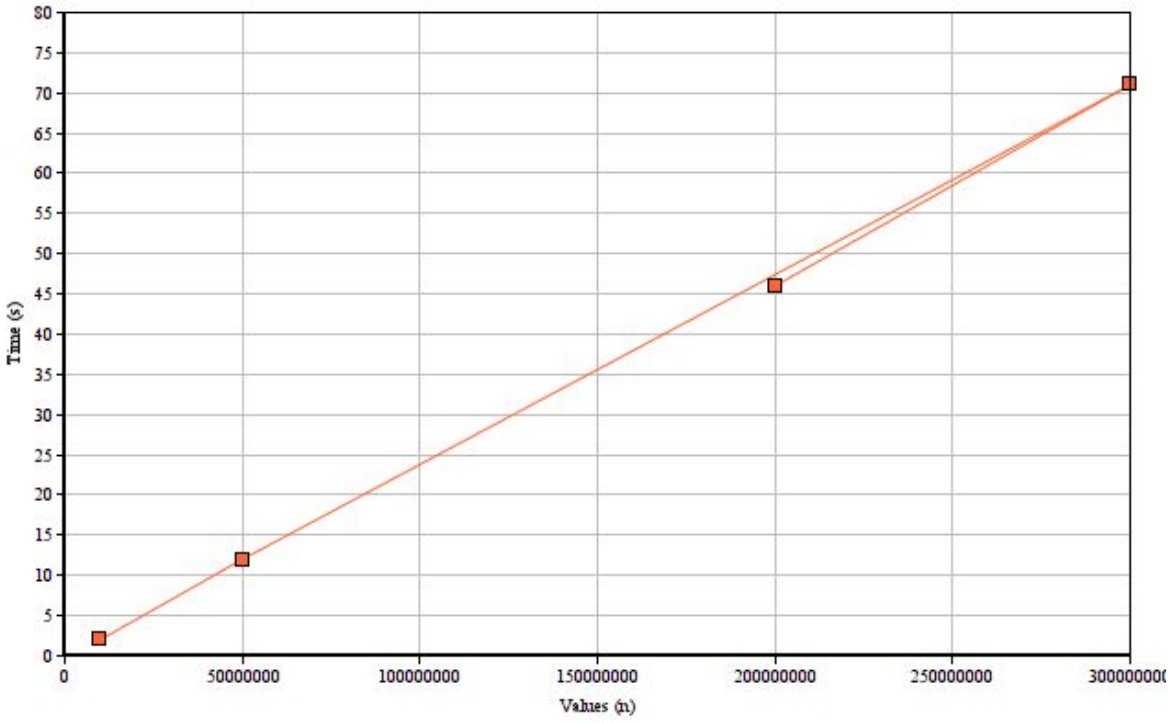
**<u>Time(s) vs values (n):</u>**
2 Seconds - 100,000
9 Seconds - 300,000
46 Seconds - 600,000
88 Seconds - 800,000
122 Seconds - 1,000,000




Appears to be way faster than Selection Sort and thus Bubble Sort. Still follows $O(n^2)$ but in a drastically different way.

**Merge Sort:**
**Worst: O(n*log(n))**
**Average: $\theta$ (n*log(n))**

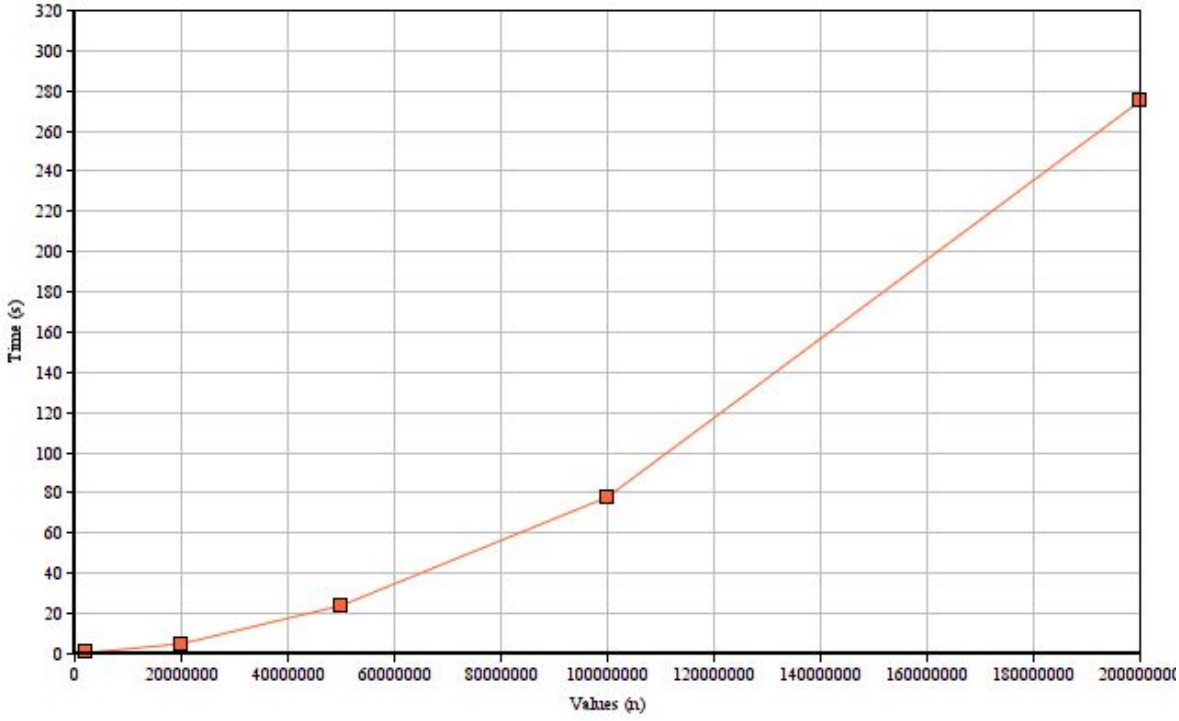
**<u>Time(s) vs values (n):</u>**
0.5 Seconds - 1,500,000
2 Seconds - 10,000,000
12 Seconds - 50,000,000
46 Seconds - 200,000,000
70+ Seconds - 300,000,000 (Out of Memory Error)




The most powerful and fastest one. Performed consistently and does appear to be in a somewhat **$\theta$ (n*log(n))** situation. (Constant Linear Function)

**Quick Sort:**
**Worst: $O(n^2)$**
**Average: $\theta$ (n*log(n))**

**<u>Time(s) vs values (n):</u>**
0.5 Seconds - 2,000,000
5 Seconds - 20,000,000
24 Seconds - 50,000,000
78 Seconds - 100,000,000
275 Seconds - 200,000,000




Not as efficient as Merge Sort but greatly outperforms the rest. Seems to mix in between **$\theta$ (n*log(n)) and $O(n^2)$.** However the graph can be misleading as the values are vastly different compared to the rest of the sorting algorithms. Still super effective.