Search/Sort Writeup

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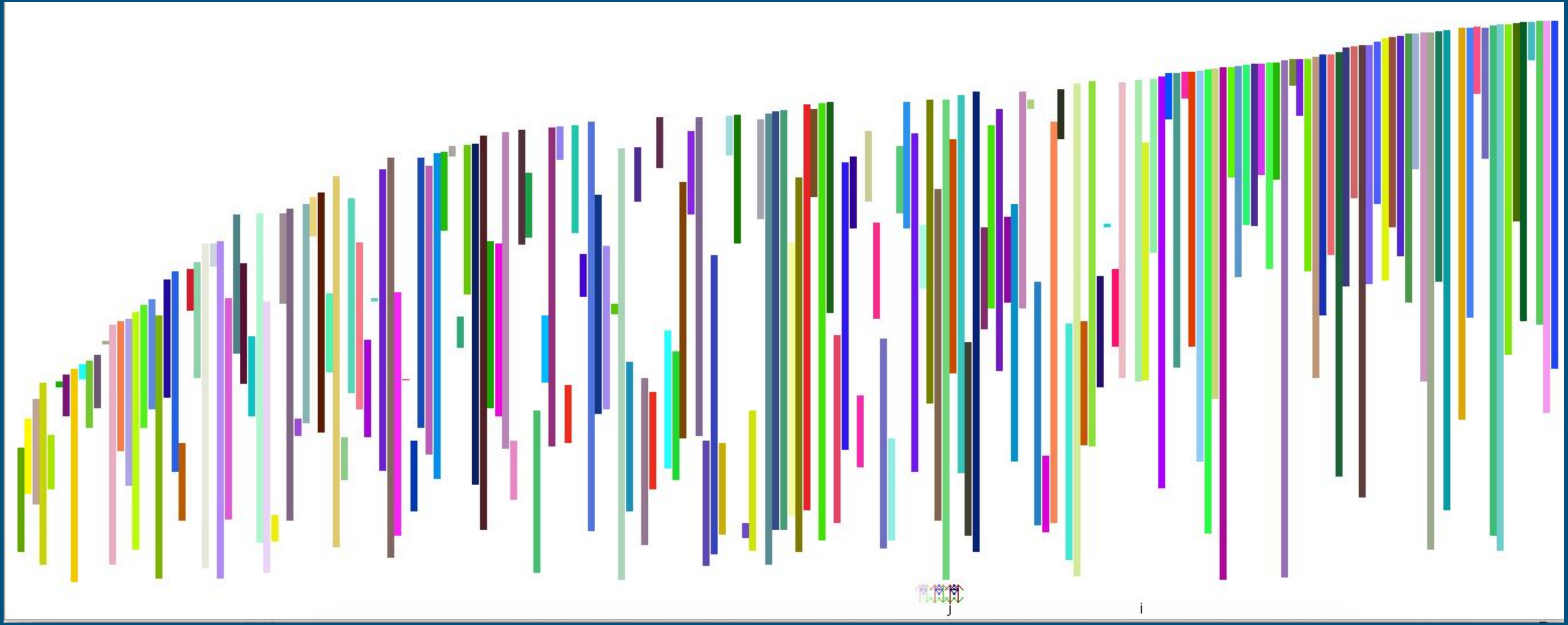
Bubble Sort - Overview

The Bubble sort works by comparing each bar with its neighbor and swapping them if they are out of order. One left-right pass of N cycles of this guarantees that the largest bar is at the far right. This bar is then considered to be in its final location and that position is no longer considered for the next pass.

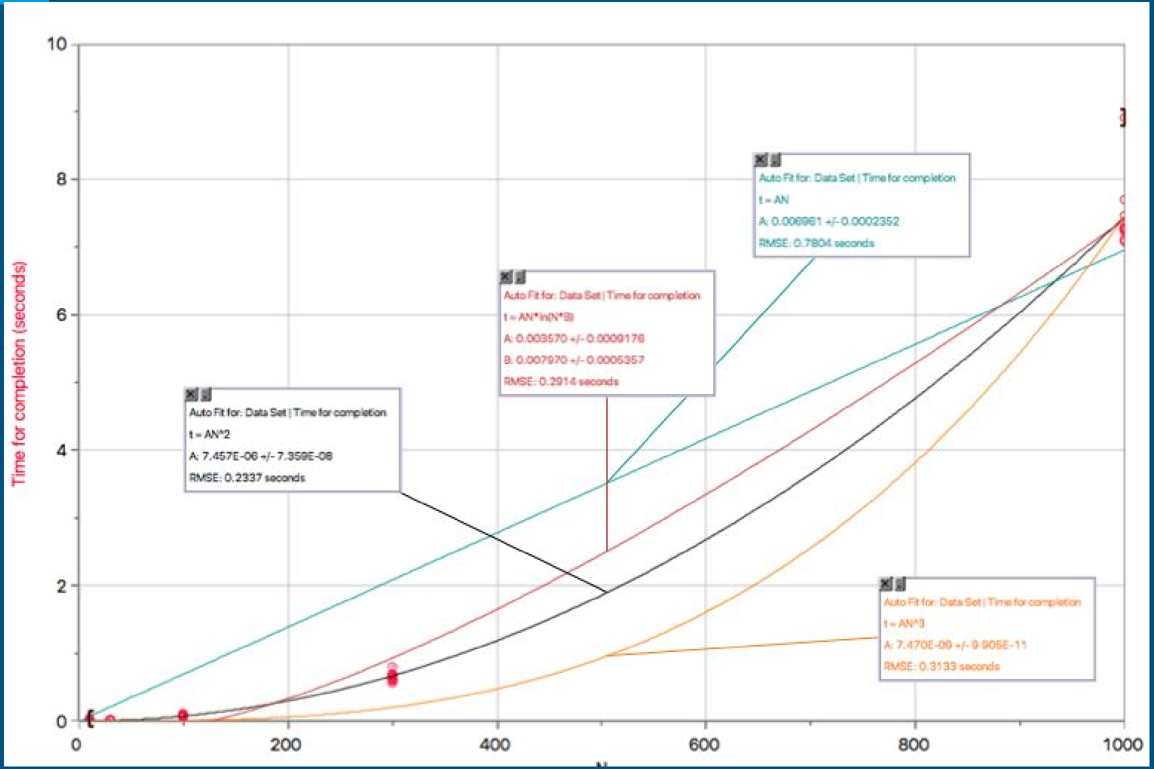
This "bubble" of finalized bars grows from right to left as the program progresses, until the entire list is in the bubble.

Some versions of the bubble sort go the opposite direction, growing the bubble on the left (smaller) size.

Bubble Sort - in progress



Bubble Sort - Analysis



	Data Set N	Data Set t (seconds)
1	10	0.041
2	10	0.008
3	10	0.005
4	10	0.001
5	10	0.009
6	10	0.001
7	10	0.007
8	10	0.001
9	10	0.001
10	10	0.002
11	30	0.014
12	30	0.013
13	30	0.015
14	30	0.022
15	30	0.012
16	30	0.013
17	30	0.009
18	30	0.016
19	30	0.017
20	30	0.011
21	100	0.104
22	100	0.075
23	100	0.067
24	100	0.078
25	100	0.067

	Data Set N	Data Set t (seconds)
26	100	0.074
27	100	0.073
28	100	0.066
29	100	0.072
30	100	0.088
31	300	0.623
32	300	0.805
33	300	0.599
34	300	0.698
35	300	0.668
36	300	0.686
37	300	0.643
38	300	0.677
39	300	0.566
40	300	0.62
41	1000	8.911
42	1000	7.29
43	1000	7.269
44	1000	7.222
45	1000	7.256
46	1000	7.116
47	1000	7.708
48	1000	7.463
49	1000	7.261
50	1000	7.083

Bubble Sort - conclusions

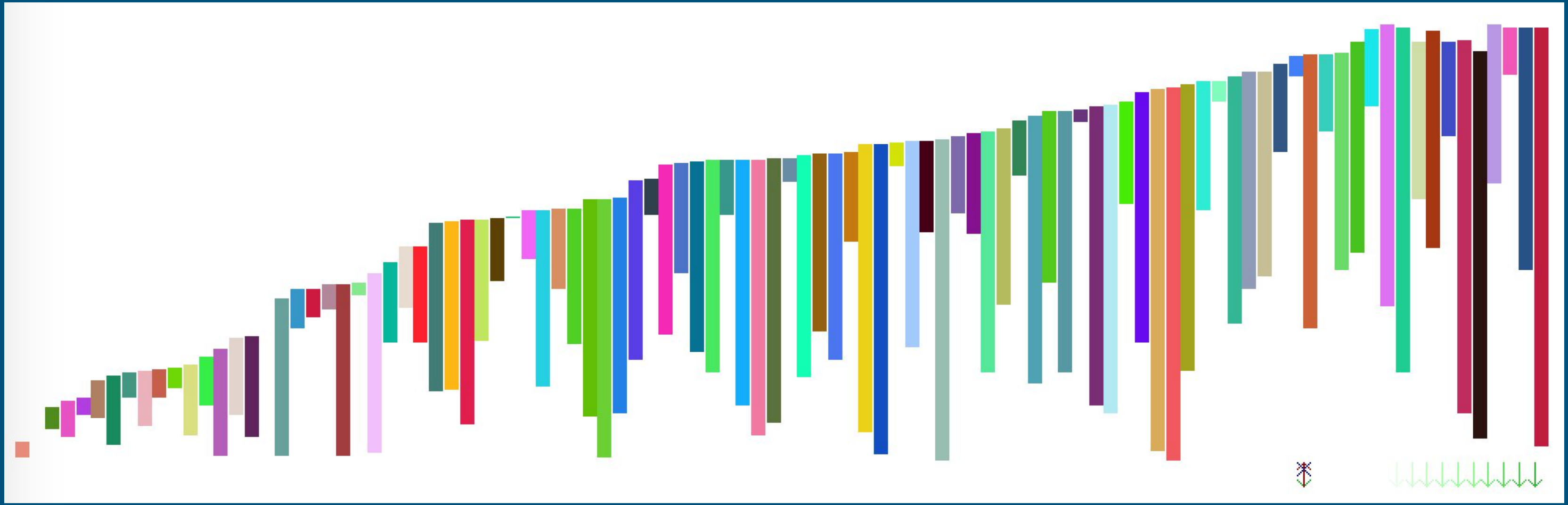
- Bubble sort is $O(N^2)$ - that had the best fit, and it matches theory, in that it functions like a set of nested loops over N and (on average) N/2.
- The strength of the Bubble Sort is that it is very easy to write.
- The weakness of the Bubble Sort is that it is slow and inefficient. Pieces get compared and moved many, many times before being "locked" in their final location.
- In the worst case, (an initially anti-ordered list), every bar will be moved (N-1) times before finding its final position.

Selection Sort - Overview

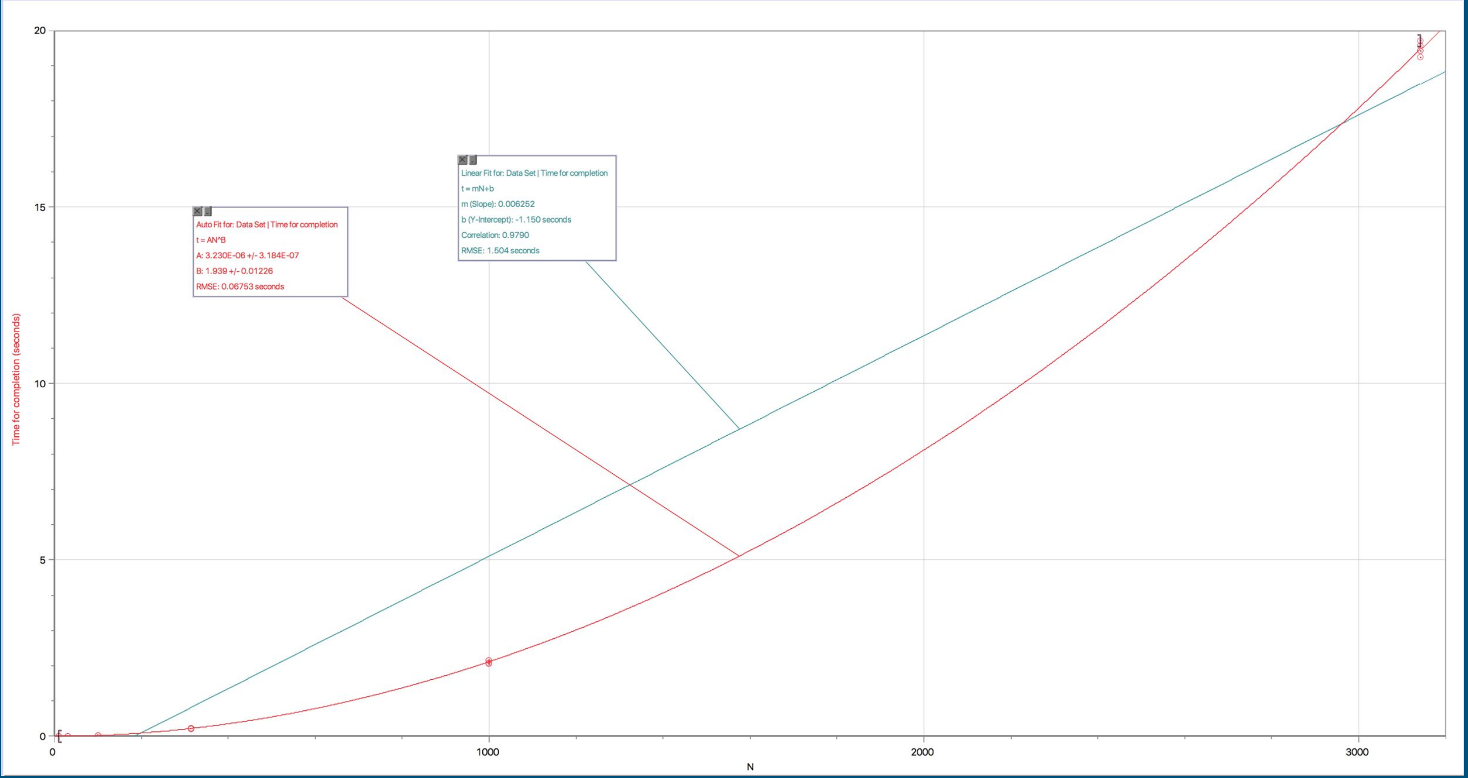
The Selection sort works by comparing the first value of a list to all others, until it finds one that is smaller. If it finds one that is smaller, it becomes the new value that is compared to the others. At the end, the smallest value takes the selected space and the program goes again for the next space. This value is considered to be in its final position and that position is no longer considered for the next passes.

This effectively acts as selecting a place and looking for a value that fits.

Selection Sort - in progress



Selection Sort - Analysis



	Data Set	
	N	t (seconds)
1	10	0
2	10	0.003
3	10	0
4	10	0.001
5	10	0.001
6	31	0.005
7	31	0.001
8	31	0.007
9	31	0.002
10	31	0.002
11	100	0.027
12	100	0.031
13	100	0.025
14	100	0.026
15	100	0.027
16	314	0.223
17	314	0.222
18	314	0.215
19	314	0.221
20	314	0.229
21	1000	2.143
22	1000	2.156
23	1000	2.14
24	1000	2.058
25	1000	2.084
26	3142	19.71
27	3142	19.562
28	3142	19.246
29	3142	19.421
30	3142	19.43

Selection Sort - conclusions

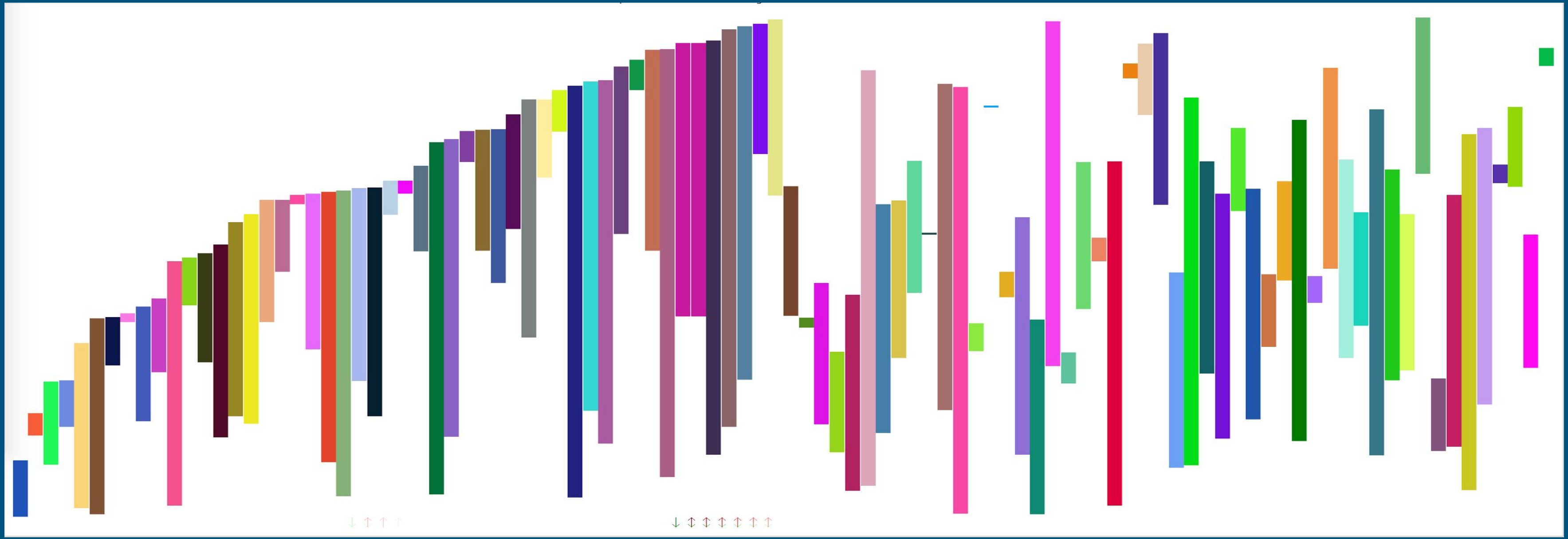
- Selection sort is $O(N^2)$ - that had the best fit, and matches theory, in that it functions like a set of nested loops over N
- The strength of Selection Sort is that it is easy to write, but faster than something like bubble sort
- The weakness of Selection Sort is that it is slow.
- There isn't a worst case or best case for this sort, as it will check every bar in the list that hasn't been sorted by the algorithm, even if it is already in it's final position before the sorting begins.

Insertion Sort - Overview

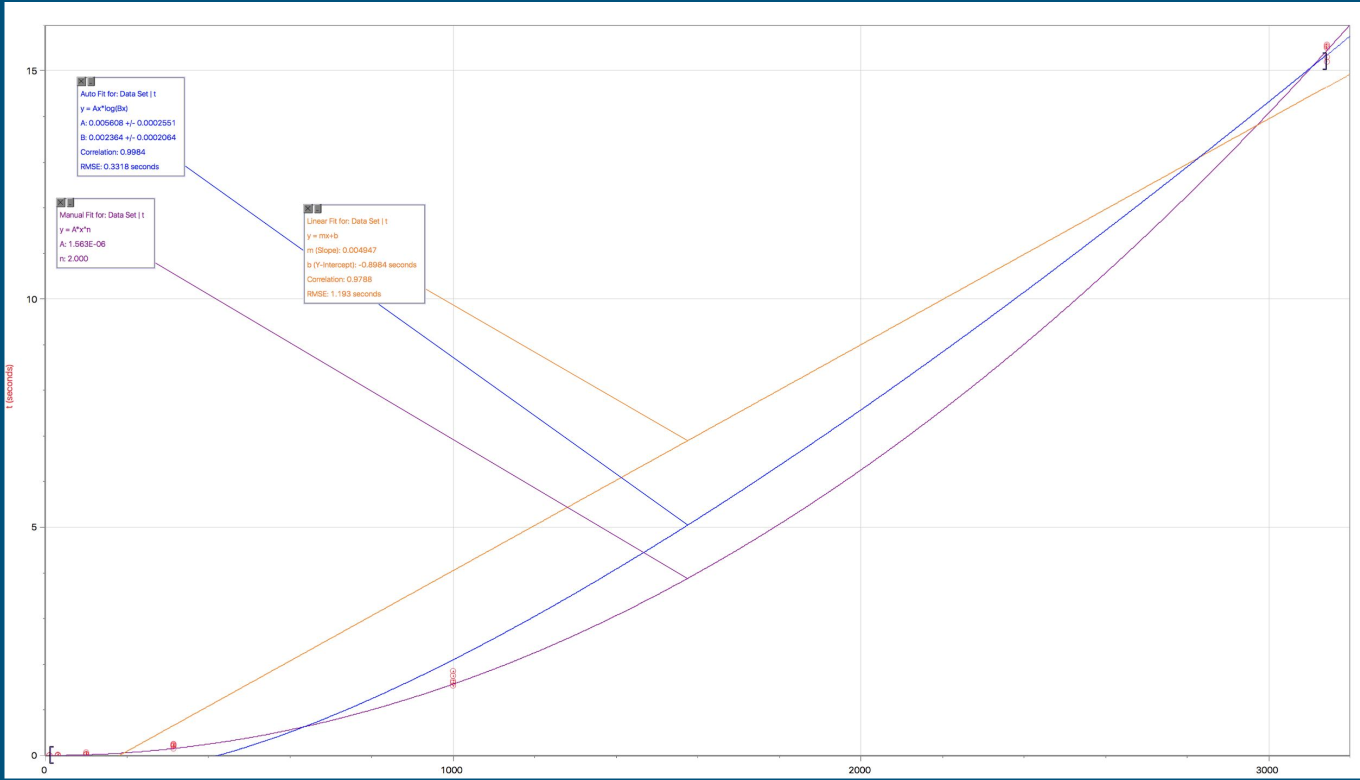
The insertion sort works by splitting the list into two sublists, with one being sorted and the other not. The program compares the value being sorted with the highest value, and keeps shifting lower until it finds a value lower than the value being sorted. This way, it knows everything to the left is lower, and to the right is higher.

Is effectively acts as selecting a value and looking for a place that fits. This is the way humans sort.

Insertion Sort - in progress



Insertion Sort - Analysis



	Data Set	
	N	t (seconds)
1	10	0.008
2	10	0.003
3	10	0.001
4	10	0.001
5	10	0.003
6	31	0.021
7	31	0.003
8	31	0.003
9	31	0.006
10	31	0.001
11	100	0.072
12	100	0.041
13	100	0.021
14	100	0.023
15	100	0.02
16	314	0.253
17	314	0.219
18	314	0.235
19	314	0.159
20	314	0.202
21	1000	1.634
22	1000	1.529
23	1000	1.842
24	1000	1.747
25	1000	1.598
26	3142	15.205
27	3142	15.503
28	3142	15.571
29	3142	15.535
30	3142	15.299

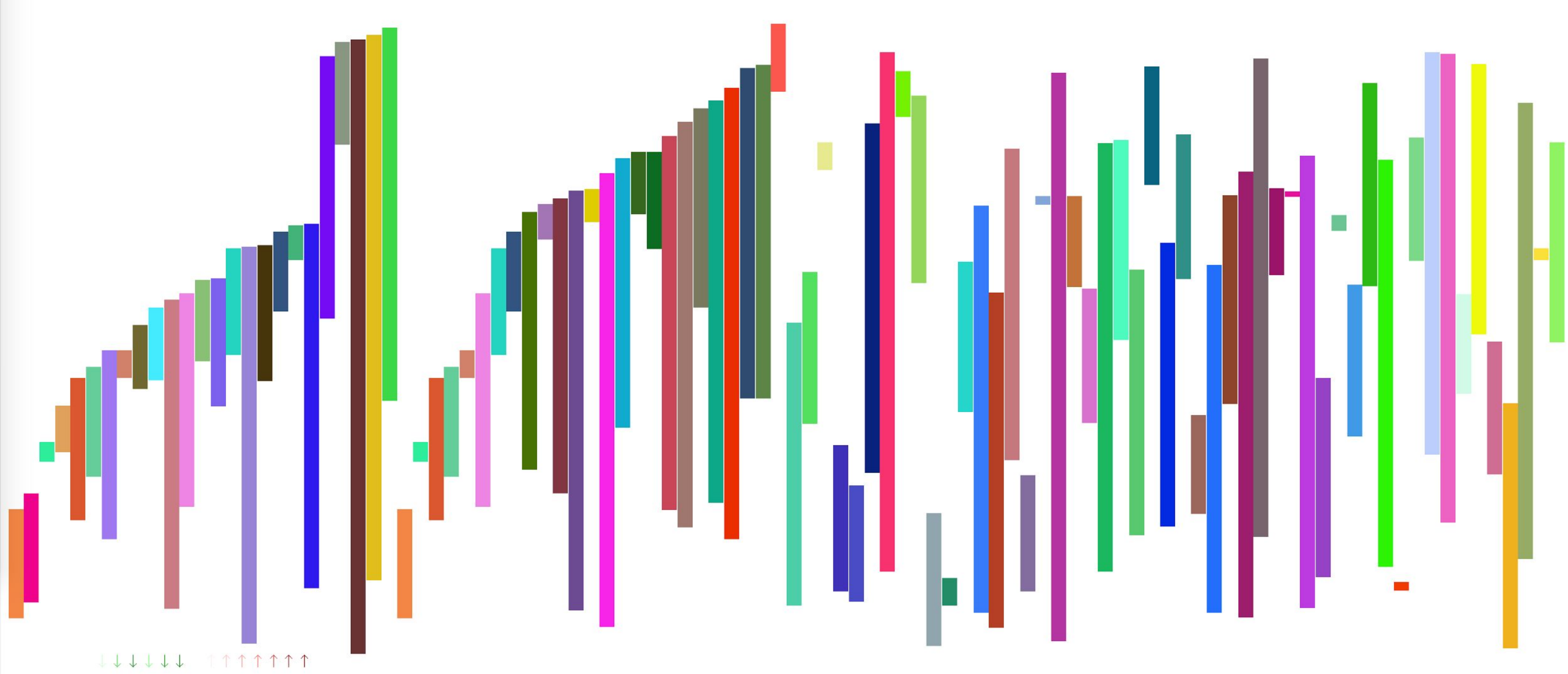
Insertion Sort - conclusions

- Insertion sort is $O(N^2)$ - that had the best fit, and matches the theory in that it functions like a set of nested loops over N
- The strength of Insertion Sort is that it is easy to write, but faster than something like bubble sort or selection sort.
- The weakness of Insertion Sort is that it's slow
- The worst case for this sort is $O(N^2)$ but the best is $O(N)$. This is because it only takes one step to realise if an item is already sorted relative to its neighbors. This means it will only take one pass to check a sorted list.

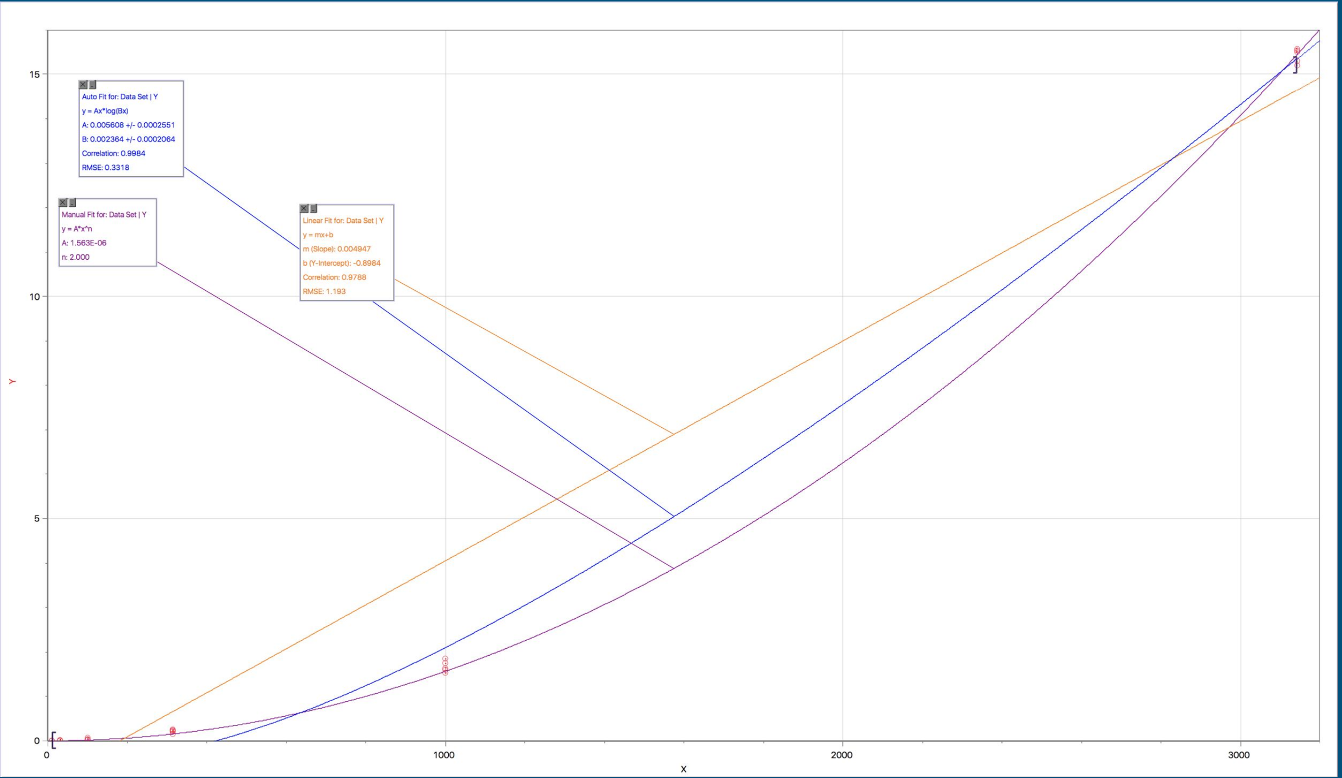
Merge Sort - Overview

The Merge Sort works by recursively breaking down a list at its center point until it has lists of one. Once this is done, it builds back up by comparing the first value of the smaller sorted lists into one bigger list over and over until it comes back to the top.

Merge Sort - in progress



Merge Sort - Analysis



	Data Set	
	N	t (seconds)
1	10	0.043
2	10	0.002
3	10	0.031
4	10	0.001
5	10	0.001
6	30	0.002
7	30	0.002
8	30	0.001
9	30	0.002
10	30	0.015
11	100	0.018
12	100	0.008
13	100	0.016
14	100	0.009
15	100	0.007
16	314	0.065
17	314	0.078
18	314	0.076
19	314	0.054
20	314	0.073
21	1000	0.207
22	1000	0.27
23	1000	0.311
24	1000	0.315
25	1000	0.153
26	3142	0.57
27	3142	0.549
28	3142	0.593
29	3142	0.47
30	3142	0.554
31	10000	1.868
32	10000	1.81
33	10000	1.924
34	10000	2.013
35	10000	2.036
36	31415	6.75
37	31415	7.001
38	31415	6.477
39	31415	6.554
40	31415	6.437
41	100000	27.453
42	100000	26.631
43	100000	28.868
44	100000	27.036
45	100000	26.713

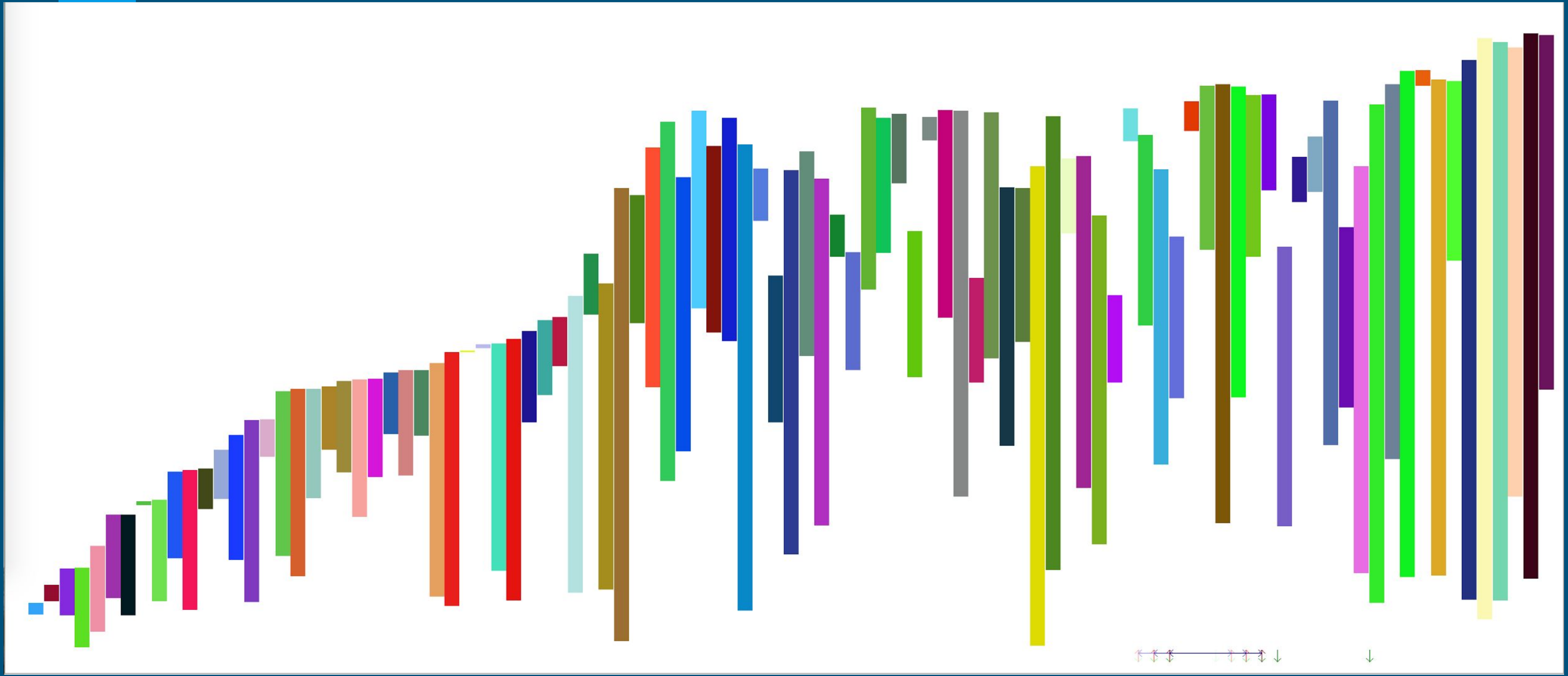
Merge Sort - conclusions

- Merge sort is O(nlogn) - that had the best fit, and it matches theory.
- The strength of merge sort is its speed.
- The weakness of merge sort is that it takes a lot of memory to run, as it recurses and keep making subsets of the previous set as the function breaks down.
- There is no best or worst case for this sort.

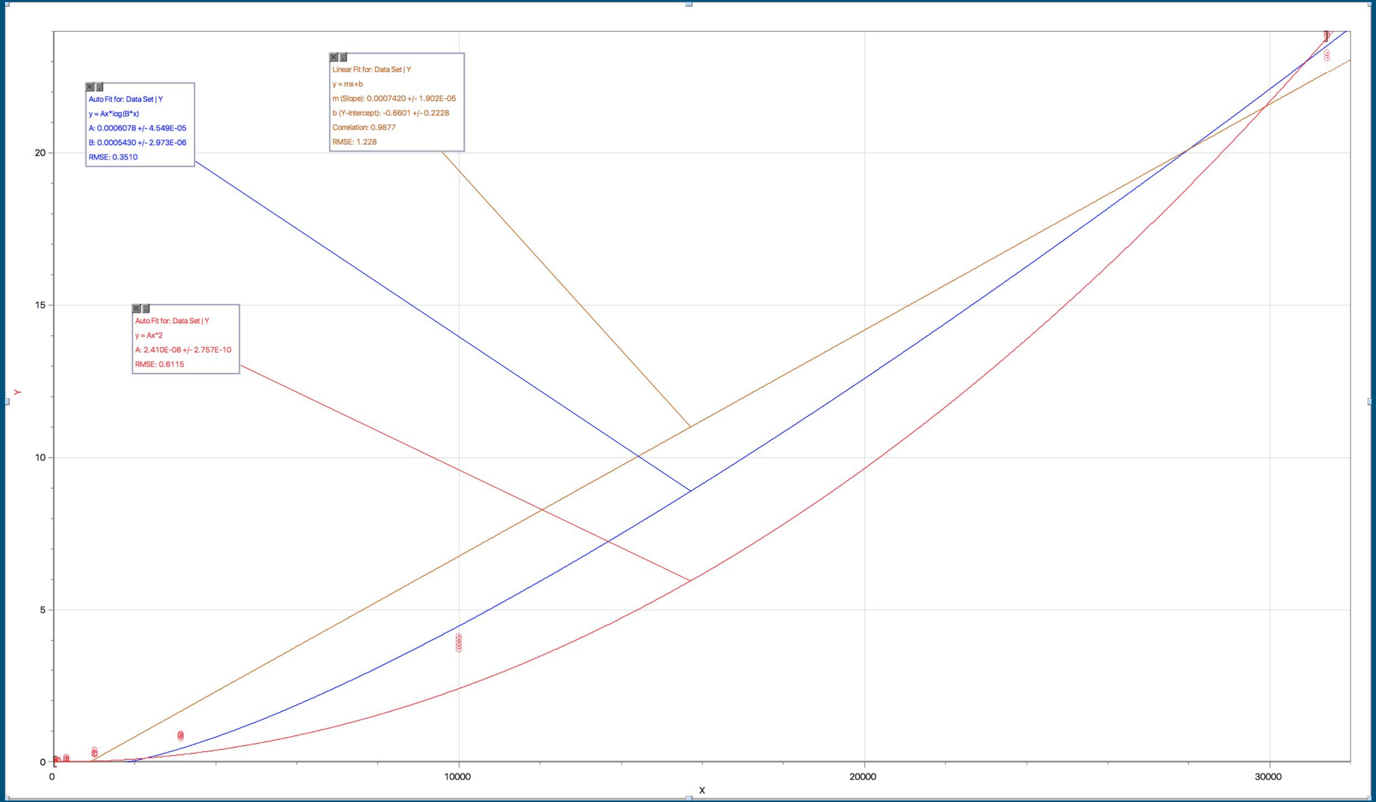
Quick Sort - Overview

The Quick sort works by taking the rightmost value, and calls it the pivot. Then, the algorithm as if there's an imaginary wall to the left of the first value. Now, by checking each value, the algorithm goes through and compares the value to the pivot. If the new value is less than the pivot, it goes to the left of the wall, switching places with the first value to the right of the wall, and by moving the wall up one place. If it's greater than the pivot, it stays in its place. At the very end, the pivot gets swapped with the value directly to the right of the wall. Now, everything to the left of the pivot is smaller than it and everything to the right of the pivot is larger than it. These two halves are then treated as new sortable lists and are then sorted the same way until the whole list is sorted.

Quick Sort - in progress



Quick Sort - Analysis



	Data Set	
	X	Y
1	10	0.009
2	10	0.003
3	10	0.005
4	10	0.001
5	10	0.005
6	30	0.005
7	30	0.006
8	30	0.009
9	30	0.093
10	30	0.005
11	100	0.012
12	100	0.058
13	100	0.052
14	100	0.068
15	100	0.009
16	314	0.054
17	314	0.107
18	314	0.167
19	314	0.125
20	314	0.044
21	1000	0.405
22	1000	0.249
23	1000	0.298
24	1000	0.264
25	1000	0.264
26	3142	0.922
27	3142	0.868
28	3142	0.759
29	3142	0.898
30	3142	0.856
31	10000	4.128
32	10000	3.906
33	10000	3.804
34	10000	3.702
35	10000	4.022
36	31415	23.83
37	31415	23.908
38	31415	23.273
39	31415	23.115
40	31415	23.978

Quick Sort - conclusions

- Quick sort works most like an O(nlogn) - that had the best fit. However, this can act like an $O(n^2)$ algorithm. It acts more like $O(n^2)$ the more the list is already sorted when the algorithm starts (worst case).
- The strength of Quick Sort is that it is faster than most other simple alternatives, while at the same time not taking any significant extra memory like Merge sort.
- The weakeness of quick sort is that it can potentially act as an $O(n^2)$ algorithm.

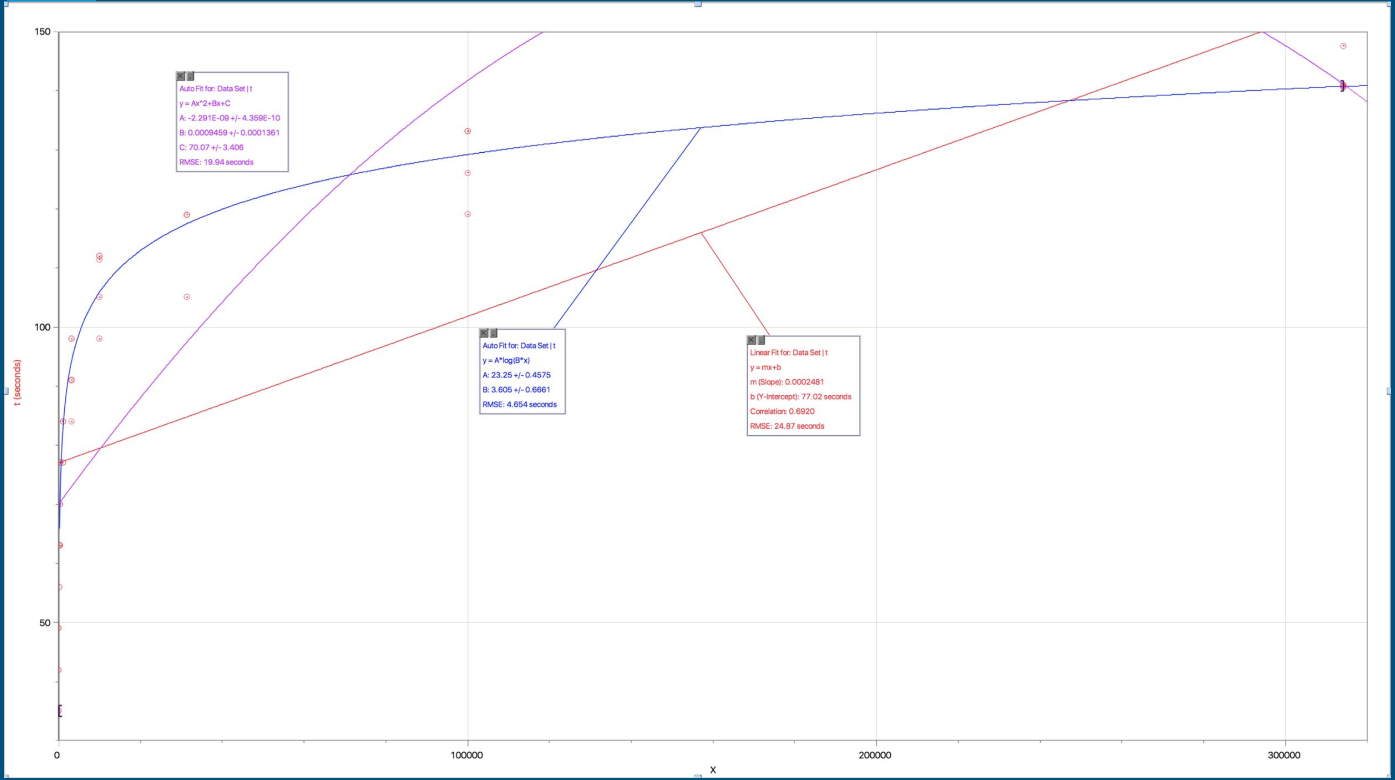
Binary Search - Overview

The binary search works by taking advantage of the nature of ordered lists. It starts in the middle, and checks if the value being searched for is less than or greater than the middle value. The algorithm then goes to the middle of the edge and middle and checks again. This happens over and over until there is only one value left. If the values match, it confirms that the value exists. If the values don't match, the value is not in the list.

Binary Search - in progress

There’s not really a visual way to represent this :/

Binary Search - Analysis



	Data Set	
	X	t (seconds)
1	10	35.012
2	10	35.004
3	10	35.006
4	10	35.019
5	10	42.008
6	30	49.012
7	30	42.009
8	30	49.013
9	30	49.009
10	30	49.011
11	100	56.011
12	100	63.018
13	100	56.012
14	100	63.015
15	100	63.008
16	314	70.027
17	314	77.027
18	314	63.016
19	314	70.027
20	314	77.018
21	1000	77.016
22	1000	84.031
23	1000	84.031
24	1000	77.022
25	1000	84.031
26	3142	98.026
27	3142	91.027
28	3142	98.033
29	3142	84.019
30	3142	91.016
31	10000	105.046
32	10000	112.036
33	10000	98.026
34	10000	112.003
35	10000	111.451
36	31415	119.052
37	31415	119.051
38	31415	119.055
39	31415	119.045
40	31415	105.055
41	100000	126.129
42	100000	133.127
43	100000	133.08
44	100000	133.167
45	100000	119.117
46	314159	140.841
47	314159	140.659
48	314159	147.597
49	314159	140.749
50	314159	140.968

Binary Search - conclusions

- Binary Search is O(logn) - that had the best fit, and it matches theory.
- The strength of Binary search is that it’s easy to code and *really* fast.
- There really isn’t a weakness to this algorithm that I can think of.
- The O(logn) is the worst case, but the best case is potentially O(1).