Christopher Barclay
48254426 - crbarcla
CS 165
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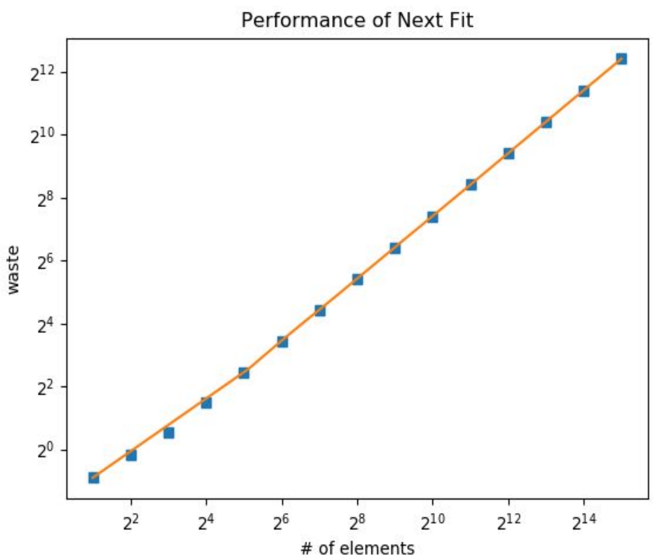
Project 2 Bin Packing Algorithms

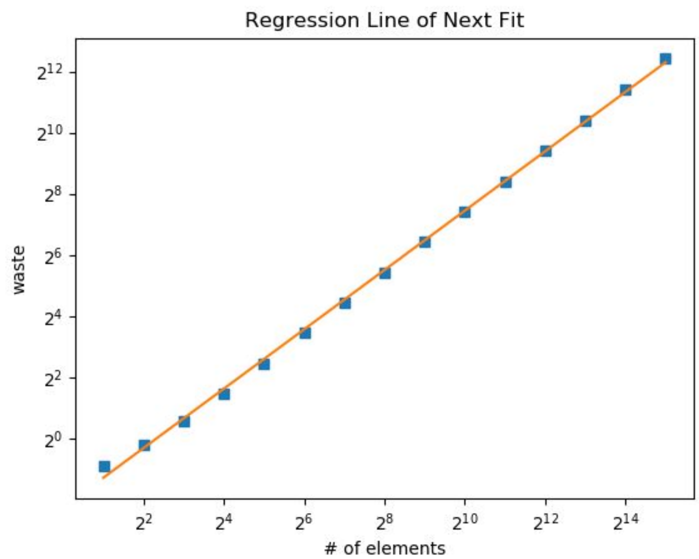
Introduction

This project focused on implementing bin packing algorithms. The purpose of bin packing is to efficiently pack weighted items into the smallest number of bins leaving minimal waste. These algorithms are used in a number of real word cases such as filling up many different types of containers, packing delivery trucks, job scheduling, etc... The algorithms of interest are next fit, first fit, first fit decreasing, best fit, and best fit decreasing. Each algorithm has been tested with 50 different randomly generated sequences of items for each n. The size for n is exponents of 2 starting from 2 up to 32768. The weight of each item is a uniform randomly generated double between 0 and 1 inclusively and the capacity of each bin is 1. The algorithm's waste is analyzed by using loglog plots and regression lines with slopes. The language used for this project was C++, specifically the 2011 standard.

Next Fit

Next Fit checks whether the current item fits in the last used bin and if not a new bin is created. It is a simple implementation of the bin packing problem considering you only need to check 1 bin for each item. Next fit has a slope of 0.97 which ranks worst of all the tested algorithms.





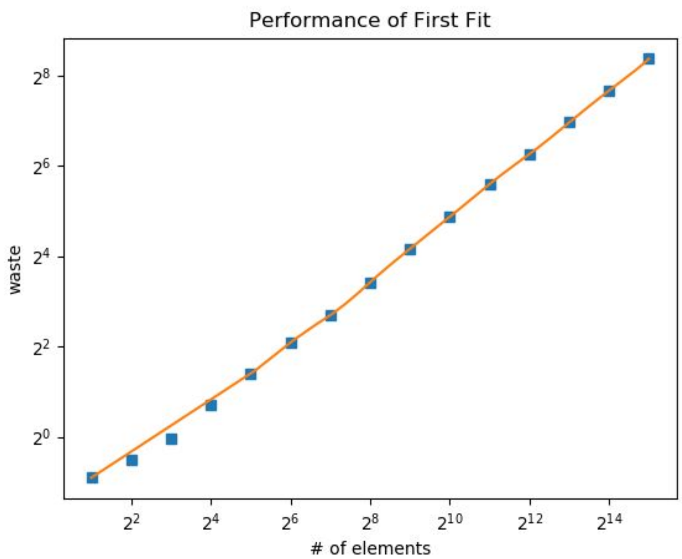
Waste

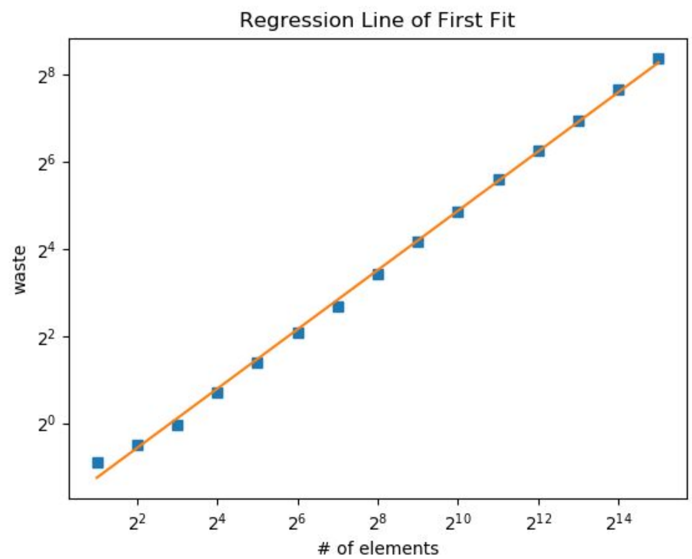
n	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768
W	0.5347	0.8759	1.470	2.781	5.398	10.95	21.64	42.96	85.89	170.4	340.9	681.9	1363	2732	5466

Slope: 0.97

First Fit

First Fit iterates through the bins starting at i = 0 until it finds a bin large enough to fit the item. If no bin can hold the item, then a new one is created. It is a more complex algorithm than next fit but is still a simple implementation of bin packing. First fit has a slope of 0.681 which ranks 4th among these 5 algorithms.





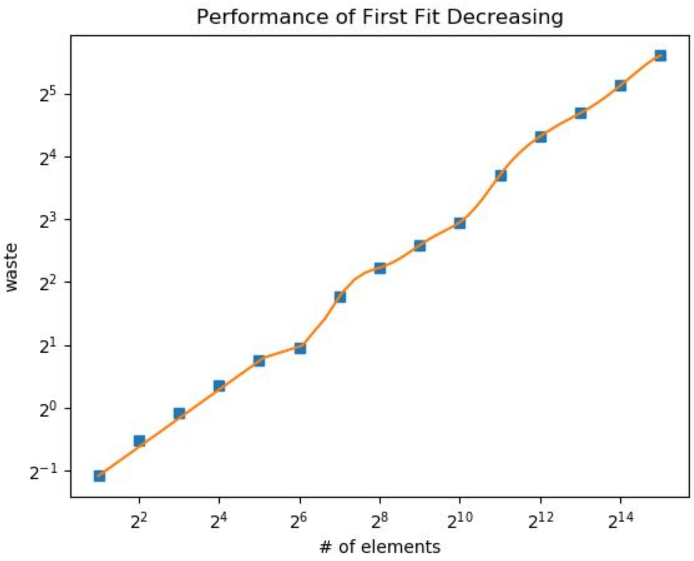
Waste

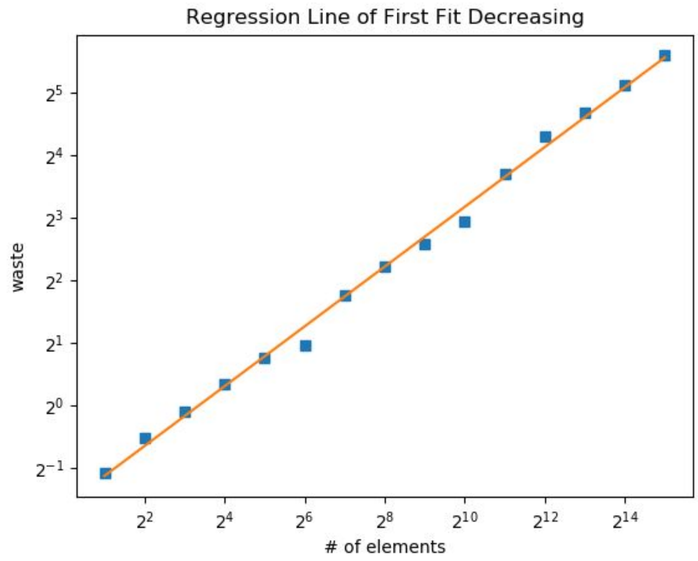
n	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768
W	0.5338	0.7061	0.9718	1.646	2.630	4.251	6.460	10.71	17.89	29.20	48.34	76.48	124.4	202.9	330.5

Slope: 0.681

First Fit Decreasing

First Fit Decreasing is the same bin packing algorithm as First Fit with the difference being the items are sorted from greatest to least before the bin packing algorithm operates. It has a slope of 0.4787 which ranks best among all the bin packing algorithms.





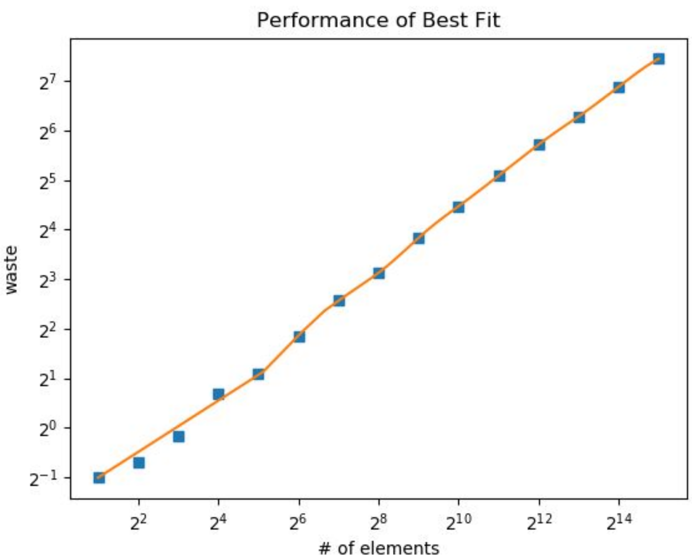
Waste

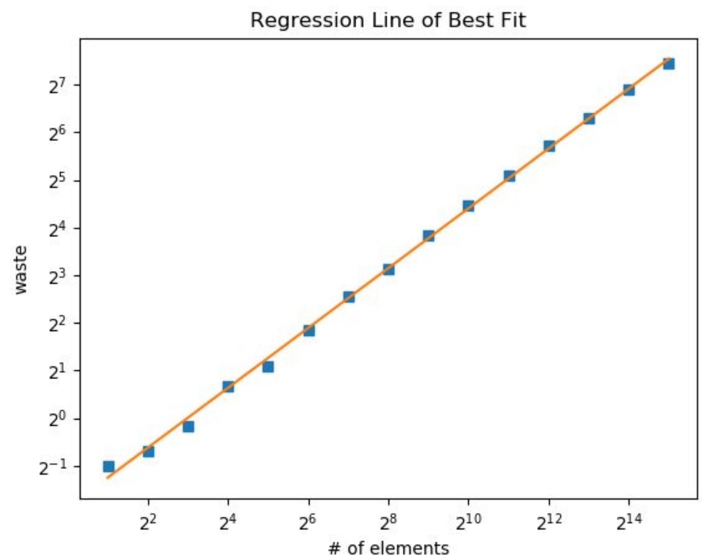
n	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768
W	0.4711	0.6975	0.9394	1.273	1.695	1.943	3.411	4.679	5.997	7.728	13.00	19.90	25.71	34.90	48.55

Slope: 0.4787

Best Fit

Best Fit operates by checking all the bins against the current item and finding the one that results in the least waste left over after adding the item to the bin. It is the least trivial algorithm in the group. Best fit has a slope of 0.62823 which ranks 3rd out of the 5 algorithms performance wise.





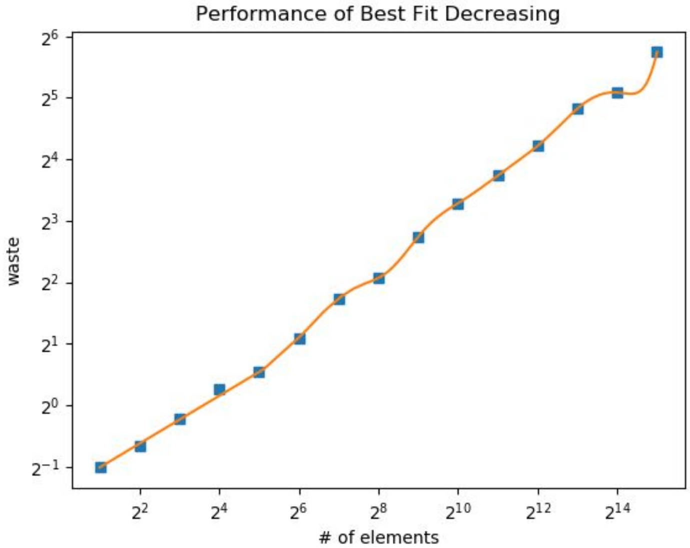
Waste

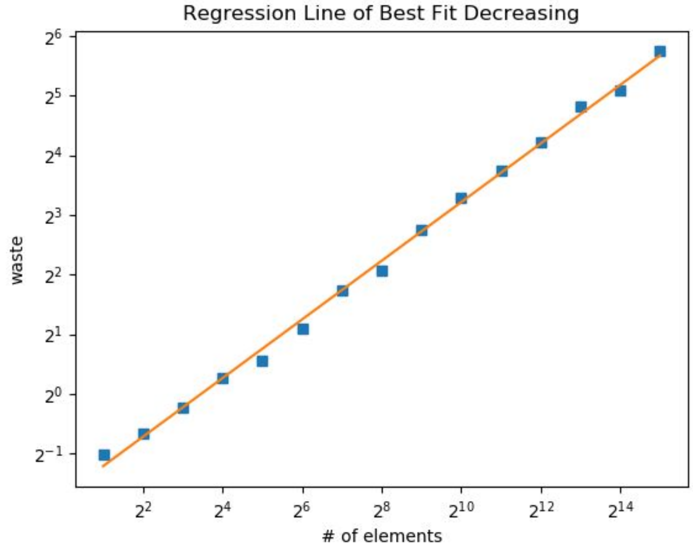
n	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768
W	0.4954	0.6139	0.888	1.595	2.111	3.605	5.915	8.736	14.26	22.22	34.07	52.77	78.24	118.8	175.3

Slope: 0.62823

Best Fit Decreasing

Best Fit Decreasing is the same bin packing algorithm as Best Fit with the difference being the items are sorted from greatest to least before the bin packing algorithm operates. It has a slope of 0.492 which ranks 2nd among all the bin packing algorithms.





Waste

n	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768
W	0.4962	0.6313	0.8563	1.208	1.467	2.130	3.332	4.195	6.690	9.749	13.32	18.62	28.36	33.98	53.64

Slope: 0.492

Conclusion

Using the results above it can be concluded that First Fit Decreasing minimized waste the most between all five implementations. The order of the items makes a difference as can be seen from the slopes. First fit decreasing and best fit decreasing both out performed any of the other algorithms. If the items are in descending order then first fit should be used. If items are randomly sorted the best fit is the best implementation to use. All of this can be concluded from looking at the regression slopes calculated by the waste at each n.