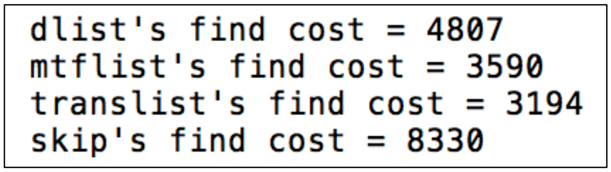
List Cost Analysis

Goal and Experiment

The purpose of program 4 was to compare the performance of skip list with doubly linked list, move-to-front list (MTF), and transpose list. I implemented a skip list using four sided nodes organized into 6 levels to form a grid, the level on the grid were filled with a 50% chance of success and ended after the first failure. This allowed the skip list to have a find functions whose average complexity is bound to O(logn).

Using a statistical program, I tested the cost of each list by filling it with 1,000 integers of random numbers. I then picked 10 of those integers and accessed each item with a probability of the number's index plus one divided by forty-five. Figure 1 shows the sample output from the statistics.cpp, these values are used to compare the cost of each list.



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dlist's find cost = 4807
mtflist's find cost = 3590
translist's find cost = 3194
skip's find cost = 8330
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Figure 1: Sample Results From Statistical Program

Results

Table 1 are the numerical cost for each list, the results are taken from the statistical driver. To better illustrate the change as size increases, the size of the list was increased by one hundred from one hundred to one thousand. The sample result from figure 1 is with a list size of ten.

Table 1: Numerical Cost Analysis

Size	Doubly Linked List Cost	MTF Cost	Transpose List Cost	Skip List Cost
100	42598	3983	15907	11850
200	109399	4407	59198	17029
300	128972	4771	84393	21362
400	255291	6179	197849	30037
500	170241	5605	111832	33755
600	271747	6519	66406	28022
700	281449	7094	229966	46648
800	249114	6475	191918	53704
900	387179	7900	333576	46856
1000	587934	9172	524082	75821

Table 2 illustrates the cost for each list starting at the size being squared after each iteration. Table 2 is included to better show the trends as size approaches infinity.

Table 2: Numerical Cost Approaching Larger Size

Size	Doubly Linked List Cost	MTF Cost	Transpose List Cost	Skip List Cost
10	4807	3590	3194	8330
20	12679	3598	3893	9691
40	25276	3769	5746	9354
80	27633	3784	6815	12971
160	60247	4171	27658	15084
320	118788	4814	66406	28022
640	356225	6690	293881	58737
1280	561521	8437	495587	116290
2560	1467763	18004	1401293	226399
5120	1880275	22321	1811494	636387

Analysis

Figure 2 illustrates the values from Table 1 to better understand the results from the statistical program statistics.cpp. Doubly linked list was the costliest, transpose list following closely behind. Skip list was significantly cheaper, however MTF list was even lower being the least costly list of the four.

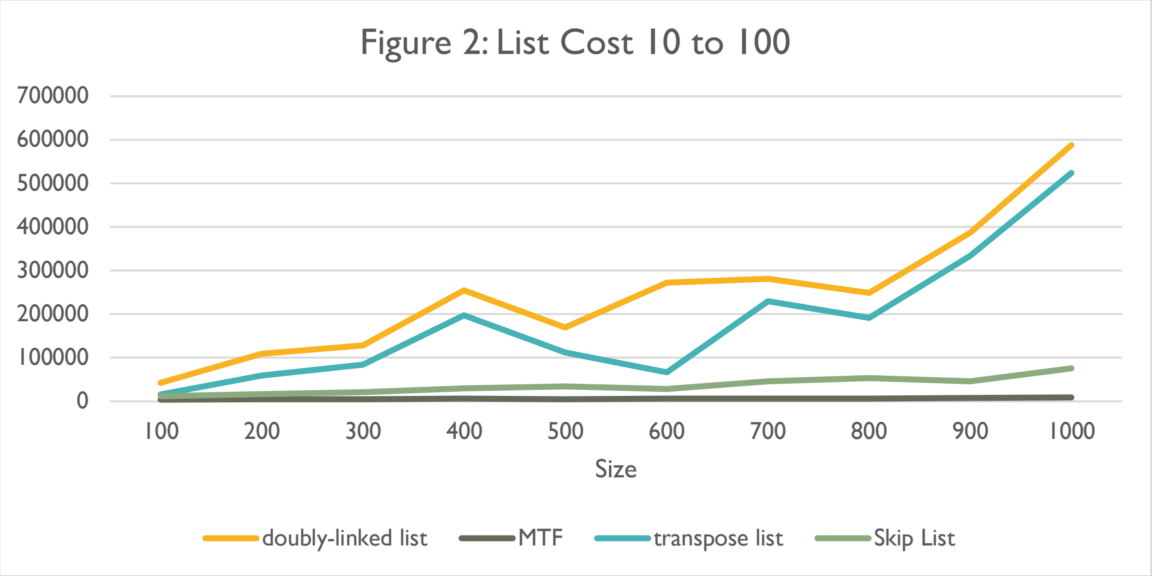


Figure 2: List Cost 10 to 100

To illustrate that this trend continues as the size increases figure 3 shows the costs from a list size 10 to 5120. It is difficult to see the beginning values, but easy to see that as size increased doubly linked list and transpose list's cost grows at a faster rate than skip list.

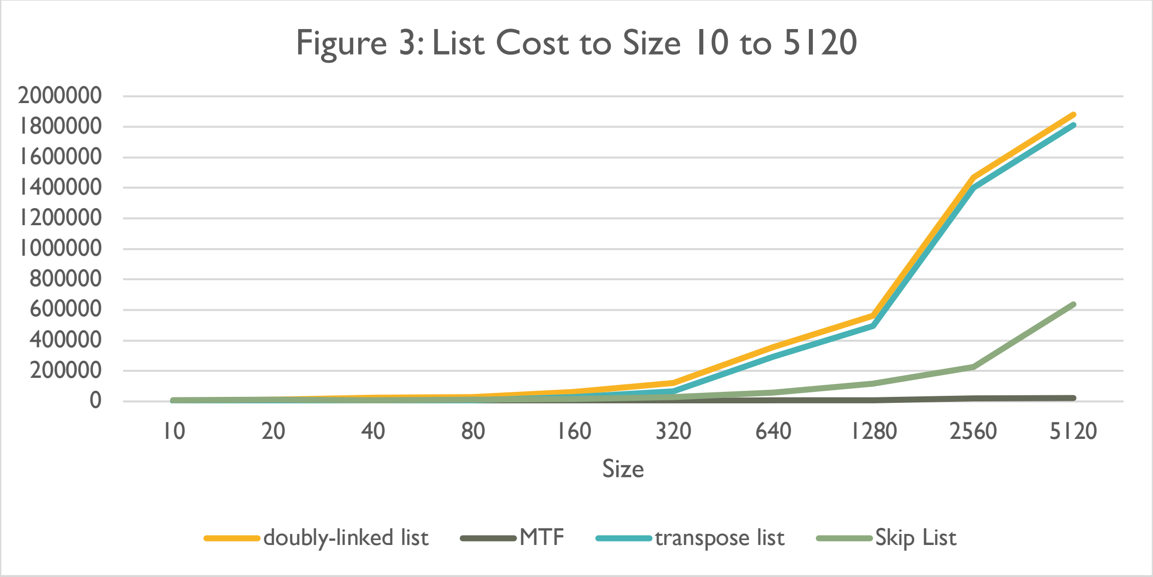
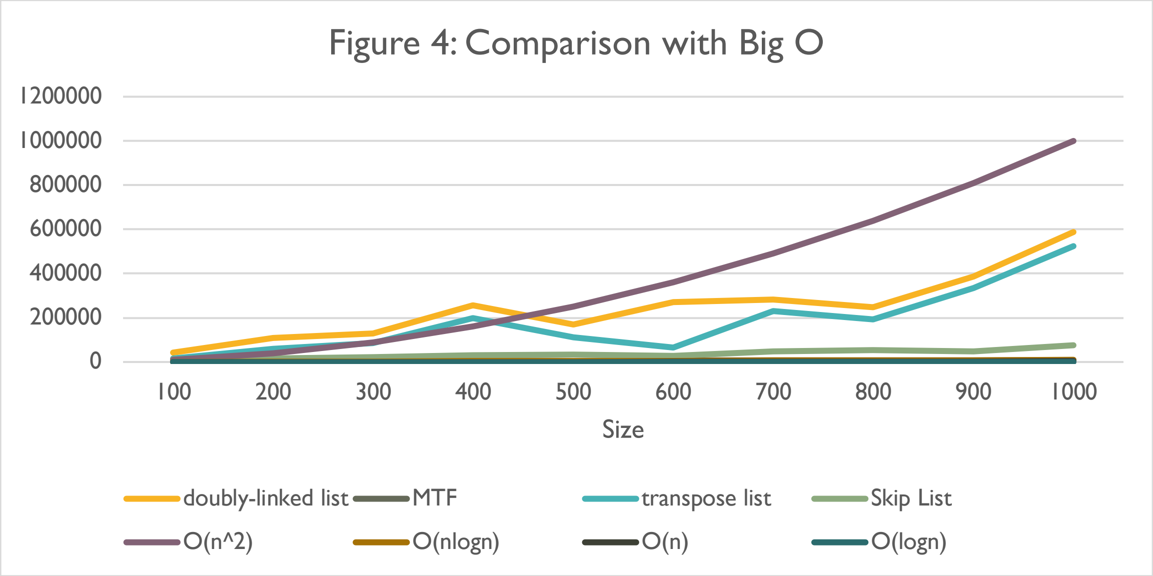


Figure 4 illustrates the comparisons from Figure 2 along with the values of the Big O notation. This is used to help understand how the costs compare in practice to the Big O notation. While it is difficult to see the smaller values the figure still illustrates the major trends.



Conclusion

Skip list performed much better than doubly linked list and transposed list but was still slower than MTF list. Skip List's use of levels significantly helped increase the cost of finding a value compared to the simpler version doubly linked list. Logically, skip list and doubly linked list still shares a worst case of O(n); however, in practice skip list on average performs much better than doubly-linked list.