CS231: Project 7

Trees v. Hashing

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Abstract

In the project, a Hash Table has been created. A Hash Table is a data structure that uses a hash function (which is a formula) that computes an index position called hash code to store data into an array of buckets. This allows for a time complexity to access that is O(1) in the ideal case. In my implementation, if two elements get the same hash code, they are linked together using a Linked List. Once a certain number of elements are reached, the array is expanded and all elements are add to it again to keep time complexity close to O(1).

The purpose of doing it in this project is to compare times for reading the same files between a Binary Search Tree Map and a Hash Table (Hash Map).

Analysis

The following are the times that were obtained by analyzing all the reddit comment files. The ones highlighted in yellow were dropped from the robust average calculation.

	2008	2009	2010	2011	2012	2013	2014	2015
1	2270.19	5476.40	7963.05	6847.66	5953.64	5758.27	6086.68	12364.39
2	2204.96	5672.04	7406.91	6541.13	5952.92	5924.40	6845.69	13260.27
3	2252.93	5648.62	6872.01	7675.01	5768.88	5622.57	6007.36	13074.57
4	2111.92	5661.21	6755.47	6252.35	6439.31	6189.60	6427.00	12919.31
5	2188.05	5714.87	6907.88	6792.63	6197.47	5685.50	5927.56	12663.41
Robust average	2215.31	5660.62	7062.26	6727.14	6034.67	5789.39	6173.68	12885.76

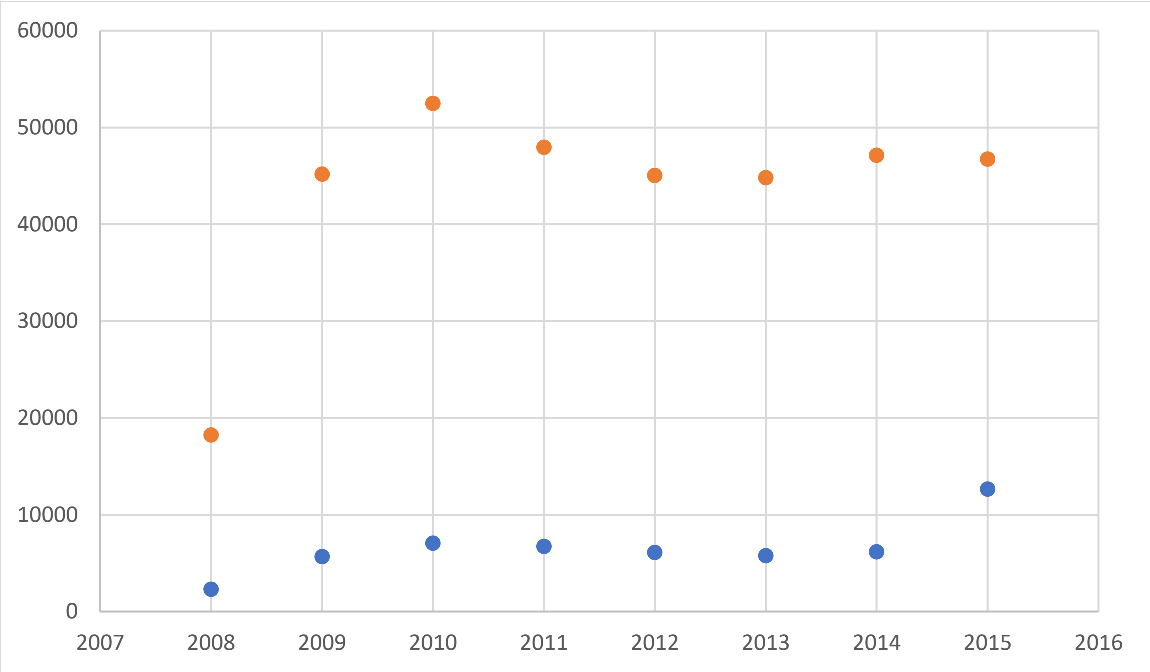
The following are the results obtained from running the analysis on the Binary Search Tree Map from last week:

	Run-Time	Total Words	Unique Words	Depth of Tree
2008	18240	16492769	191901	312
2009	45176	40263318	368559	500
2010	52505	46955203	428006	239
2011	47974	43372614	424995	303
2012	45075	40213302	431132	435
2013	44812	39236476	454010	288
2014	47132	41543298	491737	175
2015	46730	41151652	551608	156

On redoing the HashMap analysis, the following data was obtained:

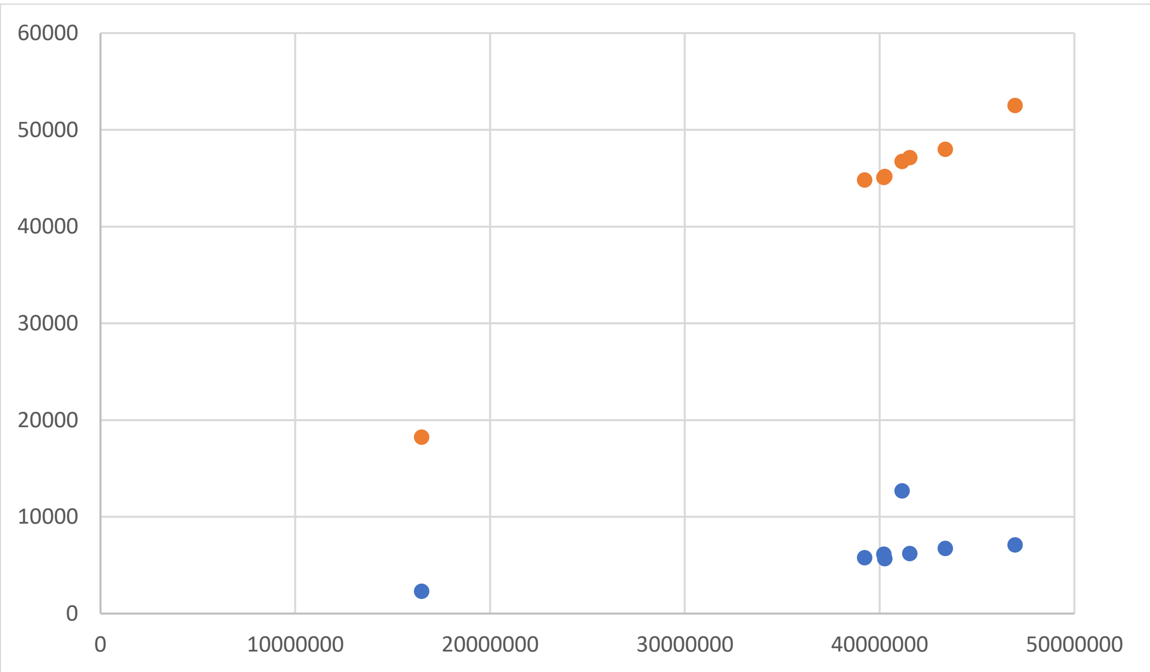
	Binary Search Tree				Hash Map	
	Run-Time	Total Words	Unique Words	Depth of Tree	Run-Time	Collisions
2008	18240	16492769	191901	312	2317.2	43709
2009	45176	40263318	368559	500	5677.3	82633
2010	52505	46955203	428006	239	7089.4	67961
2011	47974	43372614	424995	303	6729.3	67075
2012	45075	40213302	431132	435	6124.4	68852
2013	44812	39236476	454010	288	5788.9	75294
2014	47132	41543298	491737	175	6189.4	85917
2015	46730	41151652	551608	156	12667.3	103910

The first graph (Year versus run-time) is given below:



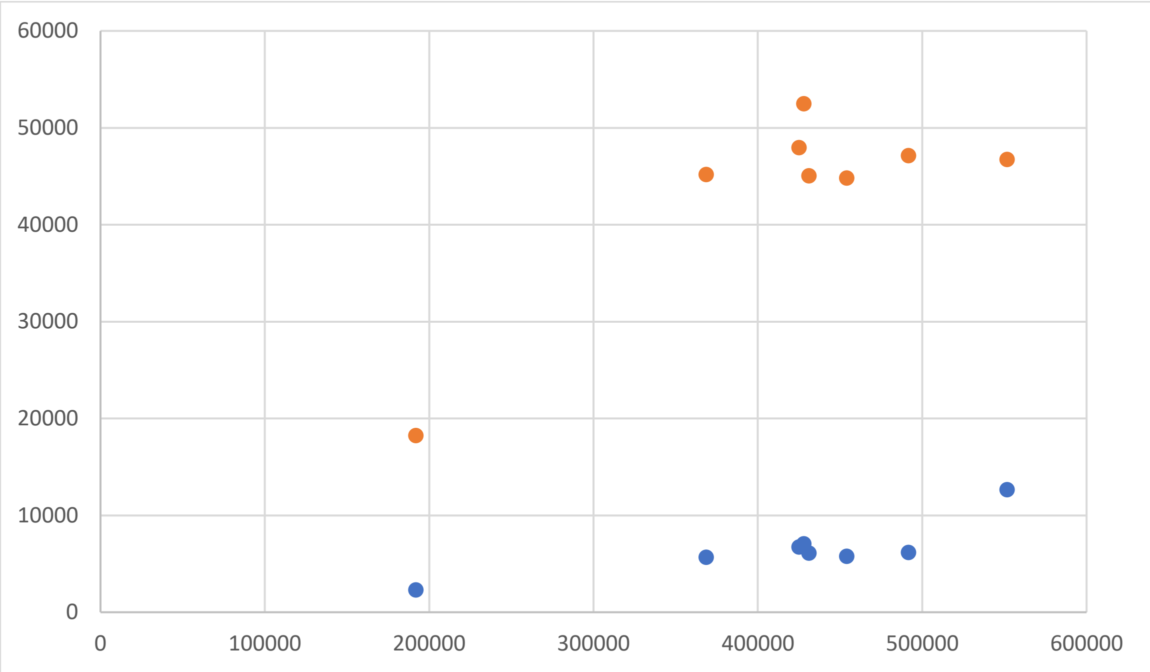
The run times for the Binary Search Tree are in orange while those for the HashMap are in blue. The run-time is on the Y axis while the years are on the X axis.

The next graph (Total number of words versus run-time) is:



Again, the run times for the Binary Search Tree are in orange while those for the HashMap are in blue. The run-time is on the Y axis while the total number of words are on the X axis.

The last graph (Unique words versus run-time) is as follows:



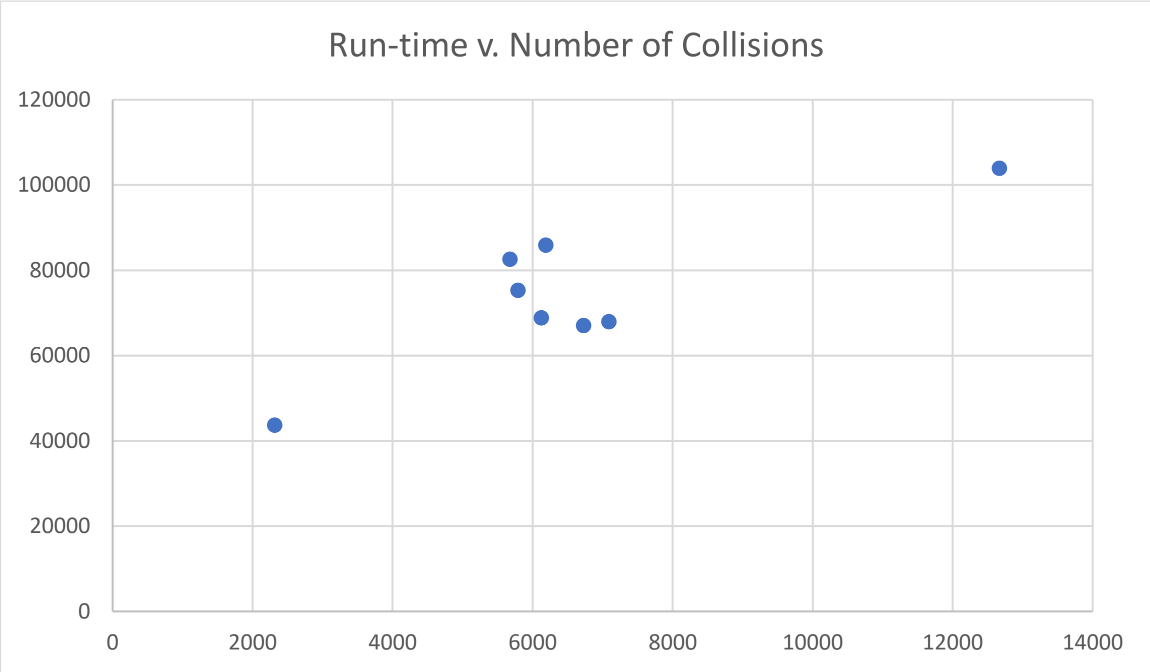
The run times for the Binary Search Tree are, again, in orange while those for the HashMap are in blue. The run-time is on the Y axis while the number of unique words are on the X axis.

<u>**Conclusions and Results**</u>

All three plots make sense. All three plots are a clear indication to the fact that the HashMap is faster. The second and third plots show that while a HashMap tracks somewhat with the trend of time taken vs total/unique words, it is much faster.

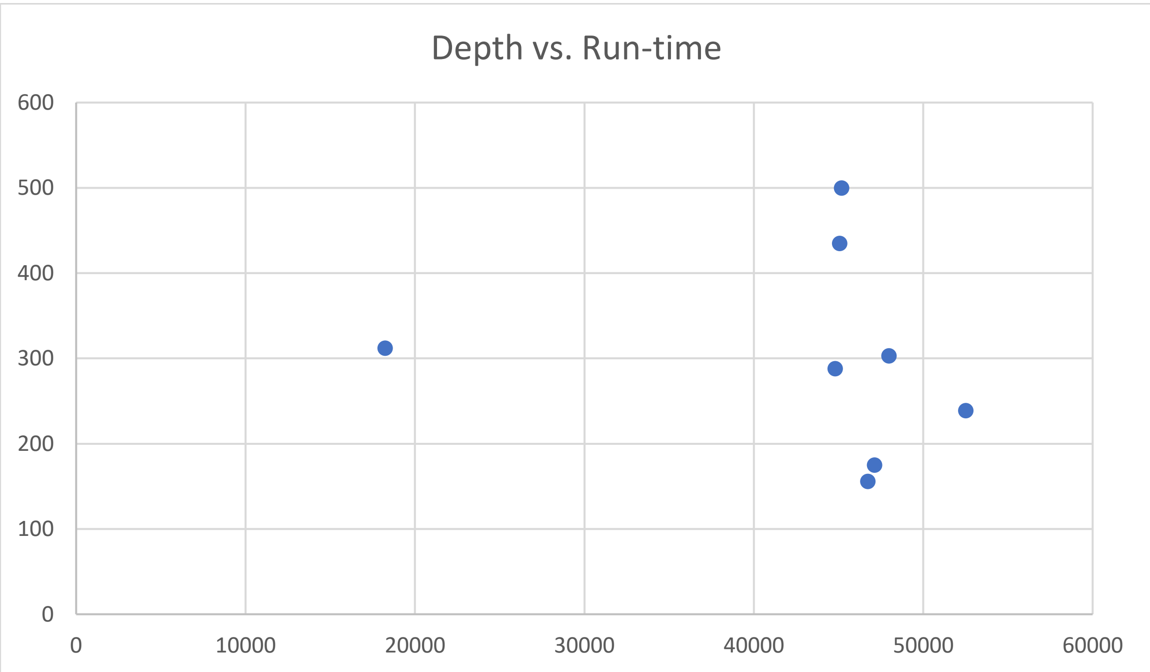
HashMap is probably faster because, as noted in the abstract, it has a time complexity of adding very close to O(1) i.e. constant time. (Clearly, from the graphs, it is not exactly O(1).) A Binary Search Tree, however, has an average time complexity of O(n*log(n)) which is much slower than the Hash Map.

The following graph shows a relationship between the run-time for the HashMap and number of collisions:



Clearly, as the number of collisions increases, the time increases too.

The next graph shows the relationship between the depth of the tree and run-time:



It is evident that while run-time does increase with depth, at some point the time becomes constant for depths.

Experimentation / Extension 0

In the main project, the HashMap expands in size when its size reaches 0.75 times the max-size. In this experiment, I have changed it to be so that it expands only when max-size is reached.

The run-times for the original condition have been copied from the analysis done above:

	Old condition	New Condition
2008	2317.2	1958.5
2009	5677.3	5505.8
2010	7089.4	5861.0
2011	6729.3	5193.6
2012	6124.4	4746.5
2013	5788.9	4849.6
2014	6189.4	5118.1
2015	12667.3	5198.7

Clearly, this condition is more efficient. This is most likely because in the old condition, the time to rehash the map was also being taken into account which was increasing execution time.