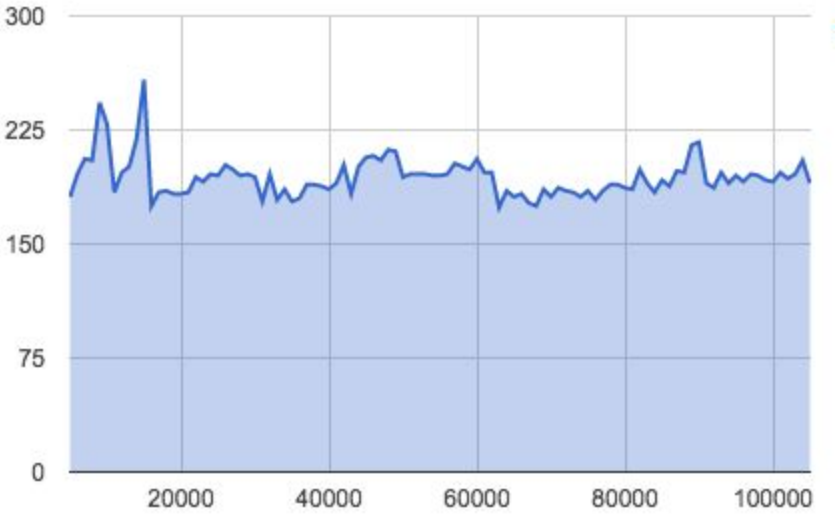
I. Bench Dict

A. Dictionary BST

Comment: We can see that the line is characteristic of a logarithmic function. What may have caused some of the spikes might be due to several processes running at the same time. The spike near the end may have been caused by the process stopping for a few nanoseconds to do something else and then coming back to finish the current task. However, the graph overall seems to be that of a log function.

B. DictionaryHashtable



Comment: I choose this type of graph since this is the one one that allows us to see the graph from a far point of view. From this, we can see the graph spike in the beginning and then level off. This is characteristic of a HashTable, because the worst case to find an element is O(1), which is presented by a horizontal line. The large spikes in the beginning may be due to some elements stored in disk versus the local memory. And when it is trying to look for the elements in the local memory, it sees that it's not there so it takes the elements stored in the disk to put back into local memory. As we keep adding more elements, they become more efficient with keeping the elements in local memory.

C. DictionaryTrie

Comment: The curve here also seems to be characteristic of a logarithmic function. If we ignore the spikes, the graph creeps up slowly and then levels off just like a log function. The spikes might be due to the height of the tree being different each time we step in a way that doesn't follow a log trend. For example, the heights might be 5000: 30, 6000: 35, 7000:36, 8000: 40. But also, it may be due to interferences with the program since the runs were done at a busy time in the labs. So, the program may have stopped for a while to finish other tasks before going back and finishing these ones.

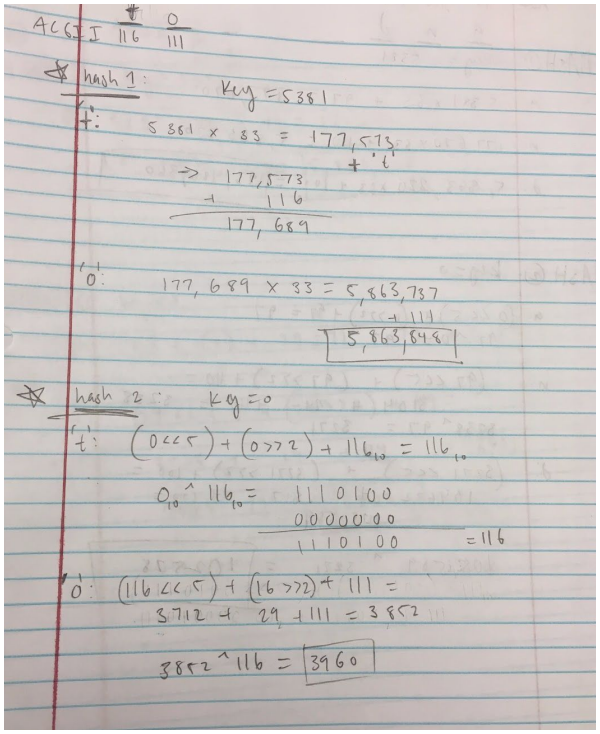
1. I implemented a TST so I expect a logarithmic running time, which did happen. So I am satisfied, because the graph makes its way up in the shape of a logarithmic function functions, although I am a little worried about the spikes. However, the TST still did find is what seems to be O(log(N)) running time where N is the number of elements

II. BenchHash

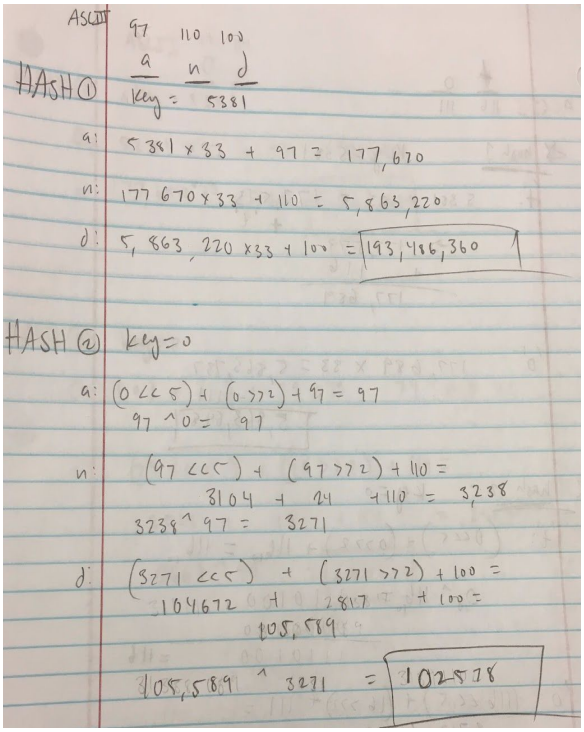
a. The first hash function works by multiplying the hash value at the previous index of the string by 33. The it adds that to the value at the current index of the string to the result(hash*33+c). This happens for every letter of the string. Before all of this happens, the key will first be initialized to 5381 which is a prime number. After going through all the letters, we mod the key to the size of the table.
   The second hash function, for every letter in the string, it will first shift the previous hash value left 5 times. Then that will be added it to the result of the previous hash value shifted right 2 times. That will be added to the ASCII value of the current letter in the index. The result will be XOR with the previous hashvalue. After that, like the first hash function, we mod it with the size of the table.

b. I verified the correctness by printing out the results of the key with some arbitrary strings. Then, I did the functions by hand and checked to see if the answers I got matched the ones that were printed out. All of my tests passed

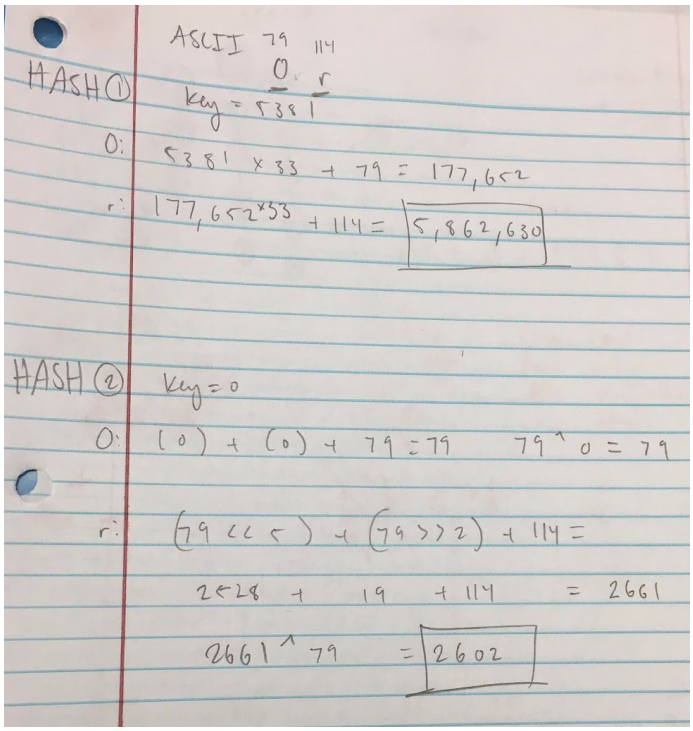
to:



and:



Or:



c. Results

Hashfunction 1

Shuffled_freq_dict with 1000 words

#hits	#slots receiving #hits
0	1209
1	611
2	155
3	21
4	4

Average steps: 1.242

freq_dict with 1000 words

#hits	#slots receiving #hits
0	1209
1	611
2	155
3	21
4	4

Average steps: 1.26

freq1 with 1000 words

#hits	#slots receiving #hits
0	1215
1	608
2	145
3	26
4	6

Average steps: 1.259

freq3 with 1000 words

#hits	#slots receiving #hits
0	12016
1	610
2	135
3	36
4	3

Average steps: 1.261

freq3 with 1000 words

#hits	#slots receiving #hits
0	1204
1	625
2	141
3	27
4	3

Average steps: 1.24

Hashfunction 2

Shuffled_freq_dict with 1000 words

#hits	#slots receiving #hits
0	1218
1	594
2	161
3	24
4	3

Average steps: 1.251

freq_dict with 1000 words

#hits	#slots receiving #hits
0	1204
1	621
2	150
3	22
4	2
5	1

Average steps: 1.238

freq1 with 1000 words

#hits	#slots receiving #hits
0	1203
1	628
2	137
3	30
4	2

Average steps: 1.239

freq2 with 1000 words

#hits	#slots receiving #hits
0	1214
1	604
2	155
3	23
4	3
5	1

Average steps: 1.252

freq3 with 1000 words

#hits	#slots receiving #hits
0	1203
1	594
2	144
3	31
4	5
5	1

Average steps: 1.277

d. Based on the outputs, the second hash function seems to be a better function for resolving collisions, because comparing the first to the second hashfunction results, the second one has a better step averages. We can see that this is not true for freq3.txt, which is a little disappointing but since the second hash function was a little more complex, it did better as expected.