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This experiment needed to use the hash tables I created in lab 2 and lab 3. It used a pseudo random numbers using the srand and rand C++ functions. These numbers were inserted into the closed and open hash tables. A timer class was given to calculate the execution time of the insertion. It was important to place the timer in the correct location to make sure the timer is only calculating the insertion time and not the data generation.

Data was generated in three main loops. The outer loop generated looped five times with the load factor of 0.2, 0.3, 0.4, 0.5, and 0.6. The next inner loop generated a seed to be used for the pseudo random number. The seeds for 1 to 5 for my experiment. The final loop generated the pseudo random number based on the load factor and seed, and placed it in an array. A timer was then started while data was inserted into an open hash table. It stop and printed out the execution time when it finished. The same process was done for the closed hash table. The final results were put into an Excel spreadsheet to generate the graphs below comparing the execution times vs load factor.

The results were as expected based on the theory we have learned in class. The open hash table took longer to insert than the closed hash table for every load factor. The execution time for both tables generally took longer as the load factor increased. The closed hash table took a shorter amount of time because it does not have to follow all of the pointers. The closed hash table also uses quadratic probing to reduce collisions. The open hash table stores all objects with the same hash at the same location which can decay to $O(n)$. All of the execution times for each seed and average execution time are in the tables below.

Load	Open Hashing Average (s)	Closed Hashing Average (s)
0.2	0.0405326	0.040937
0.3	0.045536	0.0437872
0.4	0.0506082	0.044897
0.5	0.0524234	0.0428038
0.6	0.0574448	0.04405

Open Hashing Seed	Load 0.2 Execution Time (s)	Load 0.3 Execution Time (s)	Load 0.4 Execution Time (s)	Load 0.5 Execution Time (s)	Load 0.6 Execution Time (s)
1	0.041991	0.046532	0.052332	0.052831	0.057761
2	0.041455	0.045295	0.05138	0.052146	0.0575
3	0.039762	0.045269	0.051407	0.052857	0.05723
4	0.039723	0.045349	0.051406	0.052153	0.057361
5	0.039732	0.045235	0.046516	0.05213	0.057372

Closed Hashing Seed	Load 0.2 Execution Time (s)	Load 0.3 Execution Time (s)	Load 0.4 Execution Time (s)	Load 0.5 Execution Time (s)	Load 0.6 Execution Time (s)
1	0.040698	0.043826	0.046407	0.042811	0.043976
2	0.041008	0.043801	0.04623	0.042819	0.044054
3	0.040989	0.043821	0.046224	0.042759	0.043946
4	0.041005	0.043779	0.044363	0.042827	0.044006
5	0.040985	0.043709	0.041261	0.042803	0.044268

The chart below represent the average execution times for open and closed hashing as discussed above.