
Experiment Organization

Experimentally, both black box hashing implementations are identical with object based hashing node implementations. Within the scope of organizational structure, after instantiation of a Hash model, load factor trials loop within the specified '*srand*' seed sequence. The motivation behind individual hashing trials resides mainly in the sake of simplicity, though mutual exclusivity in experimentation also increases timing accuracy.

Sequentially in order, we begin with the Initialize phase where a given hashing implementation builds up the chain of node for some specified number of bins (*m*). Secondly, we begin an '*srand*' loop for 5 different seeds, and within each of these seed iterations there is also a load factor '*for*' loop for each load factor value. The meat of the experimentation resides within the load factor iterations, mainly an insertion loop that injects values into the hash structure while the load factor condition isn't met (The '*while*' loop ceases for $n+1 > \text{load factor}$). After each load factor trial the hash is sterilized, and when an entire implementation test completes the hashing structure is removed from memory. This process repeats once for closed hashing, and then once for open hashing.

Data generation

The data generated from this experiment stems from carefully places timing statements according to the following:

- Individual Timing counts are isolated to a single while loop of random insertions
- This timing count includes random number generation
- Hashes are scrubbed between load iterations (counts toward total time, and not trial specific time)
- Initialization times are recorded (This is a function of the magnitude of '*m*')
- Total execution time is recorded (Mostly, for posterities sake)
- Computation environments were isolated during program execution for accuracy (meaning the only non-system process running was the experimentation code)

Summary of results (CPU timing)

Testing Environments:

Home Workstation	Work Desktop	Cycle Server
Intel 4 th Gen. i7-4690k @ 4.0GHz	Intel 2 nd Gen. i7-2600 @ 3.40GHz	Intel Xeon X5650 @ 2.67GHz
16 GB DDR3 – 2400MHz	8 GB DDR3 – 1333 MHz	~ 23 GB – (Unauthorized Info)
Windows 10 (Linux Mint VM)	Ubuntu 14.04 LTS	Fedora 22 (Server)
494.5286 Seconds Total	651.9222 Seconds Total	675.9946 Seconds Total

For collected data see '*Raw Data with Averages*'.

Both *Closed* and *Open* hashing exhibit pseudo linear behavior for low load factors. However, as the load factor approaches one, closed hashing starts to deviate from the linear trend presumably due to increasing collision rates. For low load factor values, the insertion times for closed hashing generally took no more than a second longer when compared to open hashing. One major drawback in implementation for closed hashing was its linked node structure, in an optimal closed hashing implementation with an array performance should have been much faster. Along the same lines, the open hashing implementation surely suffered from a linked node core mush in the same manner as the closed hashing implementation. Though, due to the nature of multiple list traversals on collision for closed hashing this inefficiency was exacerbated.

Raw Data with Averages

Closed Hashing – Machine 1

	Seed 1	Seed 2	Seed 3	Seed 4	Seed 5	Average
0.2	4.4312	4.4647	4.4058	4.4443	4.4383	4.4369
0.3	7.2088	7.1447	7.1387	7.2235	7.1865	7.1804
0.4	10.6046	10.4660	10.4400	10.4029	10.4214	10.4670
0.5	14.8087	14.8627	15.0178	14.8914	15.0364	14.9234
0.6	20.6590	21.0319	20.7356	20.6025	20.5547	20.7167
0.7	29.7807	29.8890	29.4457	30.5185	29.8390	29.8946

Open Hashing – Machine 1

	Seed 1	Seed 2	Seed 3	Seed 4	Seed 5	Average
0.2	3.3687	3.3788	3.3357	3.3759	3.3678	3.3654
0.3	5.4320	5.4170	5.4030	5.4703	5.4414	5.4327
0.4	7.9006	7.9010	7.8957	7.8600	7.8814	7.8877
0.5	11.1288	11.2351	11.9780	11.1198	11.3834	11.3690
0.6	15.5965	15.7927	16.1480	15.5279	15.6168	15.7364
0.7	22.5066	22.6257	22.3630	23.0830	22.5397	22.6236

Closed Hashing – Machine 2

	Seed 1	Seed 2	Seed 3	Seed 4	Seed 5	Average
0.2	3.6156	3.6482	3.7043	3.6516	3.6448	3.6529
0.3	5.4385	5.4724	5.5039	5.4740	5.4791	5.4736
0.4	7.2579	7.2802	7.2722	7.2109	7.2674	7.2577
0.5	8.9993	9.0426	9.1696	9.0729	9.0794	9.0728
0.6	10.9293	10.9349	10.9468	10.8572	10.9398	10.9216
0.7	12.7150	12.8045	12.6691	12.7660	12.7340	12.7377

Open Hashing – Machine 2

	Seed 1	Seed 2	Seed 3	Seed 4	Seed 5	Average
0.2	2.6906	2.7138	2.7198	2.7180	2.7048	2.7094
0.3	4.0365	4.0785	4.0535	4.0661	4.0744	4.0618
0.4	5.4167	5.4132	5.4236	5.3687	5.4149	5.4074
0.5	6.6857	6.7237	6.7908	6.7376	6.7249	6.7326
0.6	8.1548	8.1215	8.1272	8.0569	8.1156	8.1152
0.7	9.4404	9.5010	9.4023	9.5241	9.4322	9.4600

Graphical Results

