

Lab 6 Report

Overall Organization

This experiment was organized very systematically. I used implementations from Lab 3 and Lab 4, removed all inconsequential methods and optimized them to accept long ints rather than just ints. I had to rename classes to distinguish from open and closed hashing classes. The experiment was pretty easy to run using for loops. An outer loop to increment the load factor, an inner to increment the seed amount, and two while loops to insert random values with both hashing methods, counting up to a predetermined number of values based on the prime and load factor.

Data Generation

Data was generated using the random number generator (rand()) and also srand(), which allowed us to test hashing methods with the same set of random numbers for each seed amount.

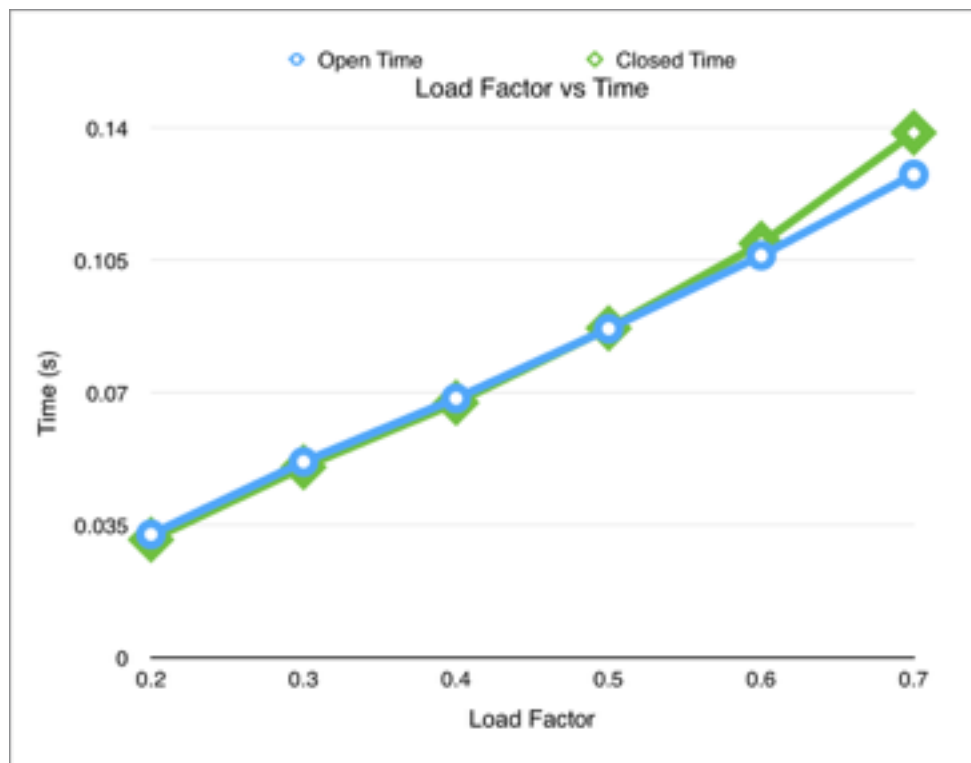
Summary of Results

Based on the average times, closed hashing completes faster for load factors < 0.5 . After that point, open hashing is faster, with a more drastic difference between the two. The results were as follows:

```
Load factor: 0.2  Seed: 1
Closed hashing completed in: 0.032514
Open hashing completed in: 0.034494
Load factor: 0.2  Seed: 6
Closed hashing completed in: 0.031158
Open hashing completed in: 0.032446
Load factor: 0.2  Seed: 11
Closed hashing completed in: 0.032534
Open hashing completed in: 0.03268
Load factor: 0.2  Seed: 16
Closed hashing completed in: 0.032107
Open hashing completed in: 0.032178
Load factor: 0.2  Seed: 21
Closed hashing completed in: 0.0293
Open hashing completed in: 0.030719
Load factor: 0.2  Seed: 26
Closed hashing completed in: 0.029491
Open hashing completed in: 0.032885
Average closed hashing time for load factor: 0.2: 0.031184
Average open hashing time for load factor: 0.2: 0.032567
Load factor: 0.3  Seed: 1
Closed hashing completed in: 0.051371
Open hashing completed in: 0.050864
Load factor: 0.3  Seed: 6
Closed hashing completed in: 0.049736
```

Open hashing completed in: 0.05072
Load factor: 0.3 Seed: 11
Closed hashing completed in: 0.053217
Open hashing completed in: 0.052595
Load factor: 0.3 Seed: 16
Closed hashing completed in: 0.049925
Open hashing completed in: 0.053344
Load factor: 0.3 Seed: 21
Closed hashing completed in: 0.047545
Open hashing completed in: 0.050999
Load factor: 0.3 Seed: 26
Closed hashing completed in: 0.050353
Open hashing completed in: 0.051935
Average closed hashing time for load factor: 0.3: 0.0503578
Average open hashing time for load factor: 0.3: 0.0517428
Load factor: 0.4 Seed: 1
Closed hashing completed in: 0.070003
Open hashing completed in: 0.066631
Load factor: 0.4 Seed: 6
Closed hashing completed in: 0.063295
Open hashing completed in: 0.070542
Load factor: 0.4 Seed: 11
Closed hashing completed in: 0.065991
Open hashing completed in: 0.068295
Load factor: 0.4 Seed: 16
Closed hashing completed in: 0.068084
Open hashing completed in: 0.06777
Load factor: 0.4 Seed: 21
Closed hashing completed in: 0.06675
Open hashing completed in: 0.068815
Load factor: 0.4 Seed: 26
Closed hashing completed in: 0.070027
Open hashing completed in: 0.068966
Average closed hashing time for load factor: 0.4: 0.0673583
Average open hashing time for load factor: 0.4: 0.0685032
Load factor: 0.5 Seed: 1
Closed hashing completed in: 0.085991
Open hashing completed in: 0.084815
Load factor: 0.5 Seed: 6
Closed hashing completed in: 0.085831
Open hashing completed in: 0.088814
Load factor: 0.5 Seed: 11
Closed hashing completed in: 0.088125
Open hashing completed in: 0.086576
Load factor: 0.5 Seed: 16
Closed hashing completed in: 0.086212
Open hashing completed in: 0.086692
Load factor: 0.5 Seed: 21
Closed hashing completed in: 0.088479
Open hashing completed in: 0.086384
Load factor: 0.5 Seed: 26
Closed hashing completed in: 0.087603
Open hashing completed in: 0.088221
Average closed hashing time for load factor: 0.5: 0.0870402
Average open hashing time for load factor: 0.5: 0.086917
Load factor: 0.6 Seed: 1
Closed hashing completed in: 0.104307
Open hashing completed in: 0.102186
Load factor: 0.6 Seed: 6
Closed hashing completed in: 0.116995
Open hashing completed in: 0.106146
Load factor: 0.6 Seed: 11
Closed hashing completed in: 0.110383
Open hashing completed in: 0.105489

Load factor: 0.6 Seed: 16
 Closed hashing completed in: 0.104496
 Open hashing completed in: 0.11065
 Load factor: 0.6 Seed: 21
 Closed hashing completed in: 0.110715
 Open hashing completed in: 0.104905
 Load factor: 0.6 Seed: 26
 Closed hashing completed in: 0.109719
 Open hashing completed in: 0.108067
 Average closed hashing time for load factor: 0.6: 0.109436
 Average open hashing time for load factor: 0.6: 0.106241
 Load factor: 0.7 Seed: 1
 Closed hashing completed in: 0.136935
 Open hashing completed in: 0.128473
 Load factor: 0.7 Seed: 6
 Closed hashing completed in: 0.1442
 Open hashing completed in: 0.133394
 Load factor: 0.7 Seed: 11
 Closed hashing completed in: 0.144969
 Open hashing completed in: 0.128741
 Load factor: 0.7 Seed: 16
 Closed hashing completed in: 0.140403
 Open hashing completed in: 0.123668
 Load factor: 0.7 Seed: 21
 Closed hashing completed in: 0.131841
 Open hashing completed in: 0.128702
 Load factor: 0.7 Seed: 26
 Closed hashing completed in: 0.133924
 Open hashing completed in: 0.123073
 Average closed hashing time for load factor: 0.7: 0.138712
 Average open hashing time for load factor: 0.7: 0.127675



Observations and Conclusion

It is fairly easy to see the trend here. As amount of values in the hash table increases, closed hashing becomes less and less efficient compared to open hashing. This might change if we implemented quadratic probing, rather than linear as we use in this experiment. Also, if we continue to increase the load factor, though open hashing populates the table faster, it will have worse performance on removal of values and searching.