Hashing Exercises

1. Insert the following sequence of integers into a hash table with m = 9 slots and with open addressing:

[31, 45, 15, 99, 9084, 45, −3, 28]

Assume that the hash table is empty and initialized in the beginning and assume indexing starts at 0. Use $h_{base}(k) = k \bmod 9$ as hash function and apply linear probing with a step size of c = 1 as a collision resolution strategy.

a) Write down the resulting extended hash function h(k, i), where i is the probe number (starting from 0).

h(k, i) =

b) In the template below, show the final state of the hash table after inserting the given keys. Use the rightmost column to write down the calls of the hash functions applied during probing. As status indicators, use the following abbreviations: EMP = empty, OCC = occupied and DEL = deleted.

index	*key*	*status*	*applied hash function(s)*
0		EMP	
1		EMP	
2		EMP	
3		EMP	
4		EMP	
5		EMP	
6		EMP	
7		EMP	
8		EMP	

c) How many collisions did occur while inserting the given keys?

d) Is the applied hash function a good choice? Explain your answer.

2. Solve task 1 again but this time apply quadratic probing with constants $c_1 = 0$ and $c_2 = 1$. In the end, examine this choice of the constants c_1 and c_2. In particular, how do they perform when compared to the choice $c_1 = c_2 = 0.5$?

Sequence of keys to be inserted: [31, 45, 15, 99, 9084, 45, −3, 28]

Extended hash function:

h(k, i) =

Resulting hash table:

index	*key*	*status*	*applied hash function(s)*
0		EMP	
1		EMP	
2		EMP	
3		EMP	
4		EMP	
5		EMP	
6		EMP	
7		EMP	
8		EMP	

Number of collisions:

3. Repeat task 1 again, this time by applying double hashing where $h_1(k) = k \bmod 9$ and $h_2(k) = 1 + (k \bmod 7)$.

Sequence of keys to be inserted: [31, 45, 15, 99, 9084, 45, −3, 28]

Extended hash function:

h(k, i) =

Resulting hash table:

index	*key*	*status*	*applied hash function(s)*
0		EMP	
1		EMP	
2		EMP	
3		EMP	
4		EMP	
5		EMP	
6		EMP	
7		EMP	
8		EMP	

Number of collisions:

4. Using the hash function h(k) = (k + 3) mod 7 apply the following operations on an initially empty hash table:

insert(31)
insert(15)
insert(−1)
insert(705)
insert(26)
search(31)
search(2)
search(5)
delete(−1)
delete(15)
search(7)

Resulting hash table:

index	*key*	*status*	*applied hash function(s)*
0		EMP	
1		EMP	
2		EMP	
3		EMP	
4		EMP	
5		EMP	
6		EMP	

Number of collisions: