Collision Resolution Technique - Part I

Course on C-Programming & Data Structures: GATE - 2024 & 2025

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Data Structure

Doubts

Hashing PYQs

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Question GATE-1989

A hash table with ten buckets with one slot per bucket is shown in the following figure. The symbols $S1$ to $S7$ initially entered using a hashing function with linear probing. The maximum number of comparisons needed in searching an item that is not present is

0	S7
1	S1
2	
3	S4
4	S2
5	
6	S5
7	
8	S6
9	S3

A. 4 B. 5 C. 6 D. 3

Question GATE-1996

An advantage of chained hash table (external hashing) over the open addressing scheme is

A. Worst case complexity of search operations is less

B. Space used is less

C. Deletion is easier

D. None of the above

Question GATE-1996

Insert the characters of the string $K\ R\ P\ C\ S\ N\ Y\ T\ J\ M$ into a hash table of size 10. Use the hash function

$$h(x) = (ord(x) - ord(\text{" } a \text{ "}) + 1) \mod 10$$

and linear probing to resolve collisions.

A. Which insertions cause collisions? J, M

B. Display the final hash table.

0	1	2	3	4	5	6	7	8	9
T	k	J	C	N	Y	P	M	R	S

Question GATE-2004

Given the following input $(4322, 1334, 1471, 9679, 1989, 6171, 6173, 4199)$ and the hash function x mod 10, which of the following statements are true?

I. $9679, 1989, 4199$ hash to the same value

II. $1471, 6171$ hash to the same value

III. All elements hash to the same value

IV. Each element hashes to a different value

A. I only

B. II only

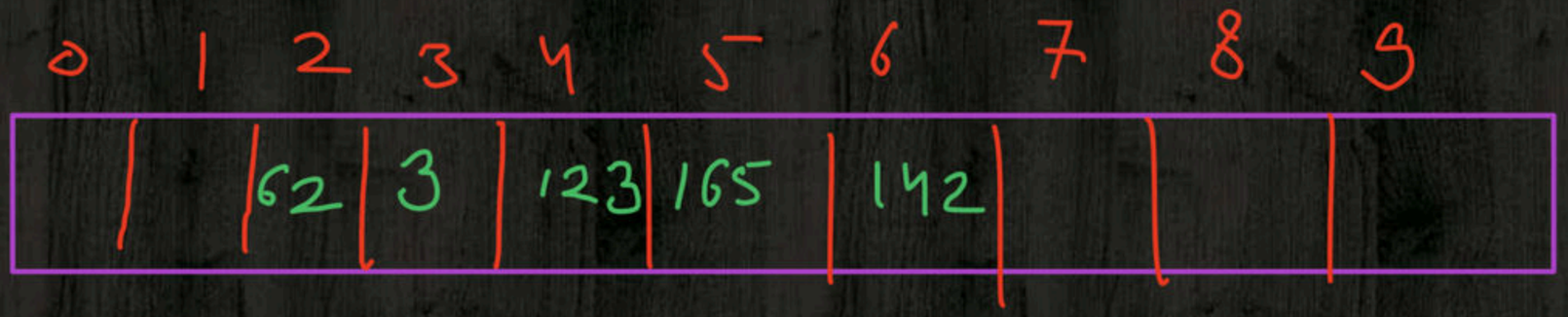
C. I and II only

D. III or IV

Question GATE-2005

A hash table contains 10 buckets and uses linear probing to resolve collisions. The key values are integers and the hash function used is key % 10. If the values $43, 165, 62, 123, 142$ are inserted in the table, in what location would the key value 142 be inserted?

A. 2 B. 3 C. 4 D. 6



Question GATE-2006

Which of the following statement(s) is TRUE?

I. A hash function takes a message of arbitrary length and generates a fixed length code.
II. A hash function takes a message of fixed length and generates a code of variable length.
III. A hash function may give the same hash value for distinct messages.

A. I only B. II and III only C. I and III only D. II only

Question GATE-2007

Consider a hash table of size seven, with starting index zero, and a hash function $(3x+4) \mod 7$. Assuming the hash table is initially empty, which of the following is the contents of the table when the sequence $1, 3, 8, 10$ is inserted into the table using closed hashing? Note that − denotes an empty location in the table.

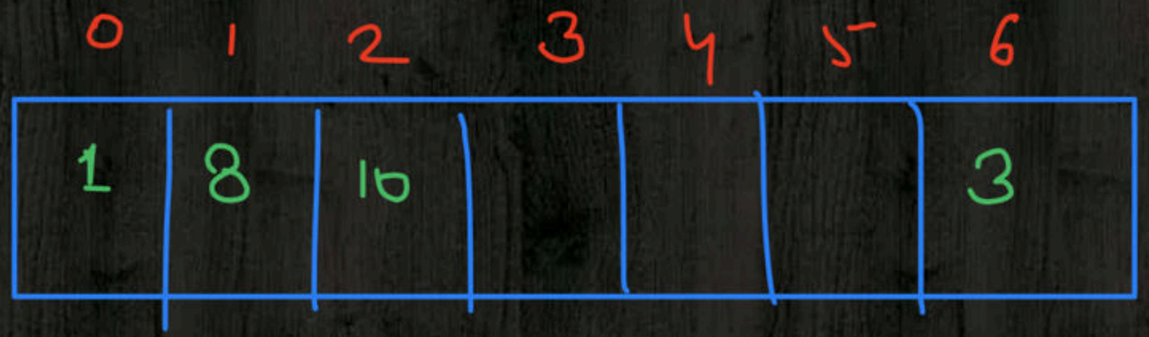
A. $8, -, -, -, -, -, 10$

B. $1, 8, 10, -, -, -, 3$

C. $1, -, -, -, -, -, 3$

D. $1, 10, 8, -, -, -, 3$

by default => linear probing



$H(1) = (3*1+4) \mod 7 = 0$

$H(3) = (3*3+4) \mod 7 = 6$

$H(8) = (8*3+4) \mod 7 = 0$

$\Rightarrow (0+1) = 1$

$H(10) = (10*3+4) \mod 7 = 6$

Question GATE-2007

Consider a hash function that distributes keys uniformly. The hash table size is 20. After hashing of how many keys will the probability that any new key hashed collides with an existing one exceed 0.5.

A. 5 B. 6 C. 7 D. 10

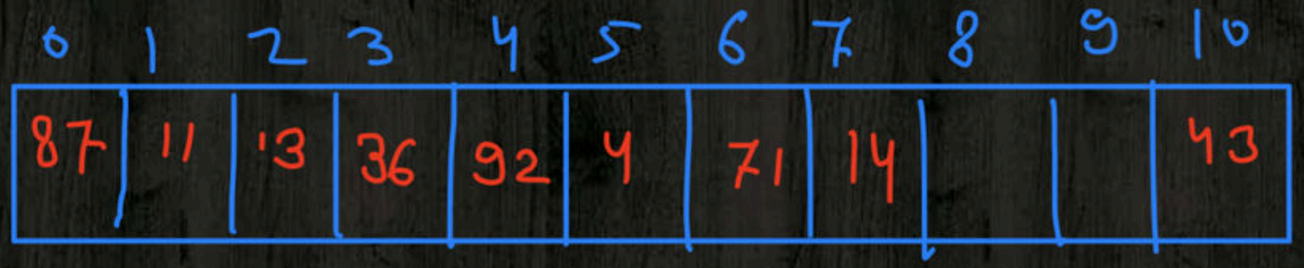
Question GATE-2008

Consider a hash table of size 11 that uses open addressing with linear probing. Let $h(k) = k \mod 11$ be the hash function used. A sequence of records with keys

43 36 92 87 11 4 71 13 14

is inserted into an initially empty hash table, the bins of which are indexed from zero to ten. What is the index of the bin into which the last record is inserted?

A. 3 B. 4 C. 6 D. 7



2+2+5+2+4 = 13 collisions

Question GATE-2009

The keys 12, 18, 13, 2, 3, 23, 5 and 15 are inserted into an initially empty hash table of length 10 using open addressing with hash function $h(k) = k \mod 10$ and linear probing. What is the resultant hash table?

A.

0	
1	
2	2
3	23
4	
5	15
6	
7	
8	18
9	

B.

0	
1	
2	12
3	13
4	
5	5
6	
7	
8	18
9	

C.

0	
1	
2	12
3	13
4	2
5	3
6	23
7	5
8	18
9	15

D.

0	
1	
2	2, 12
3	13, 3, 23
4	
5	5, 15
6	
7	
8	18
9	

0 1 2 3 4 5 6 7 8 9

		12	13	2	3	23	5	18	15

Question GATE-2010

A hash table of length 10 uses open addressing with hash function $h(k) = k \mod 10$, and linear probing. After inserting 6 values into an empty hash table, the table is shown as below

0	
1	
2	42
3	23
4	34
5	52
6	46
7	33
8	
9	

A B C D

42 42 42 42

52 23 23 33

34 34 34

52 52

46 33 46

33

Which one of the following choices gives a possible order in which the key values could have been inserted in the table?

A. 46, 42, 34, 52, 23, 33

B. 34, 42, 23, 52, 33, 46

C. 46, 34, 42, 23, 52, 33

D. 42, 46, 33, 23, 34, 52

Question GATE-2010

A hash table of length 10 uses open addressing with hash function $h(k) = k \, mod \, 10$, and linear probing. After inserting 6 values into an empty hash table, the table is shown as below

0	
1	
2	42
3	23
4	34
5	52
6	46
7	33
8	
9	

How many different insertion sequences of the key values using the same hash function and linear probing will result in the hash table shown above?

A. 10 B. 20 C. 30 D. 40

52 should be inserted after 42, 23, 34

33 — 11 — 11 — 11 — 23, 34, 52, 46

$\frac{42, 23, 34, 46}{4!}$, 52, 33 = 24

+

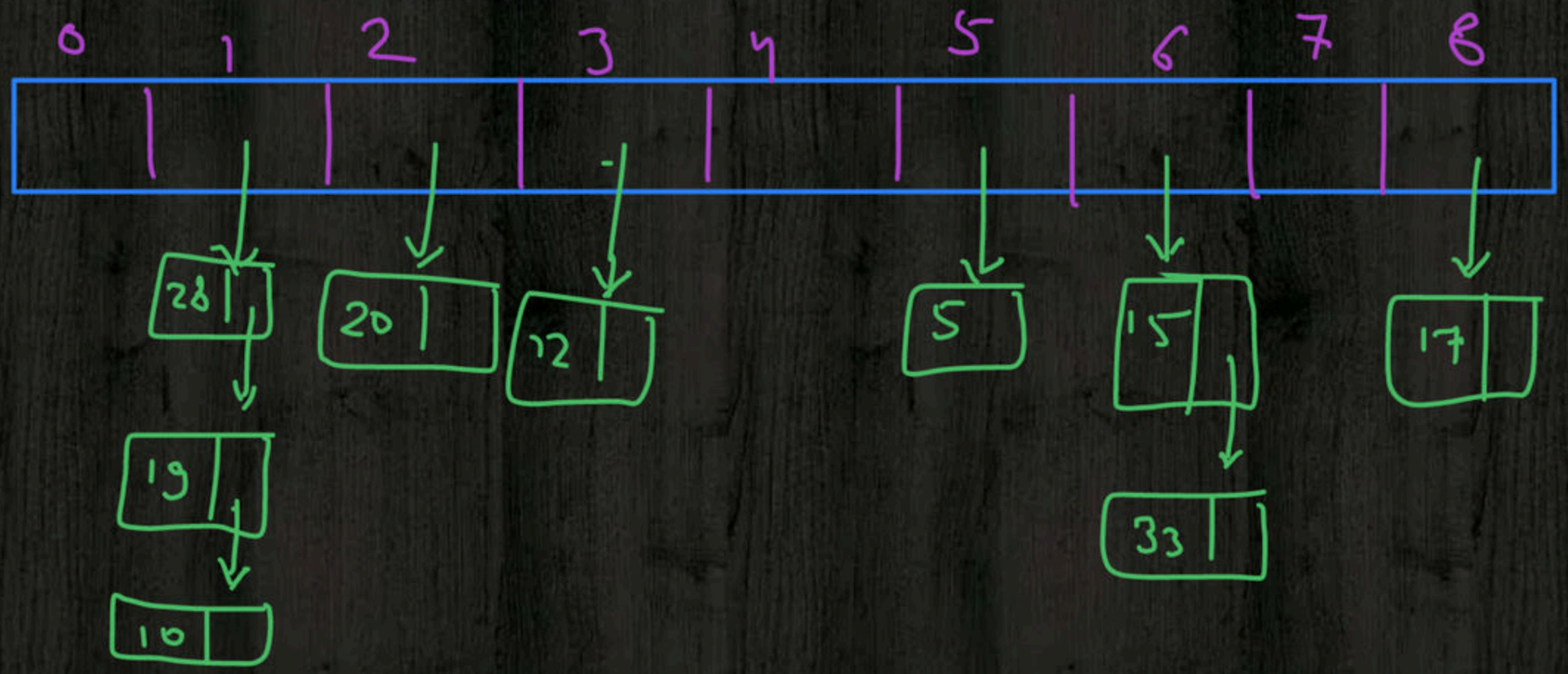
$\frac{42, 23, 34}{3!}$, 52, 46, 33 = 6

30

Question GATE-2014

Consider a hash table with 9 slots. The hash function is $h(k) = k \mod 9$. The collisions are resolved by chaining. The following 9 keys are inserted in the order: $5, 28, 19, 15, 20, 33, 12, 17, 10$. The maximum, minimum, and average chain lengths in the hash table, respectively, are

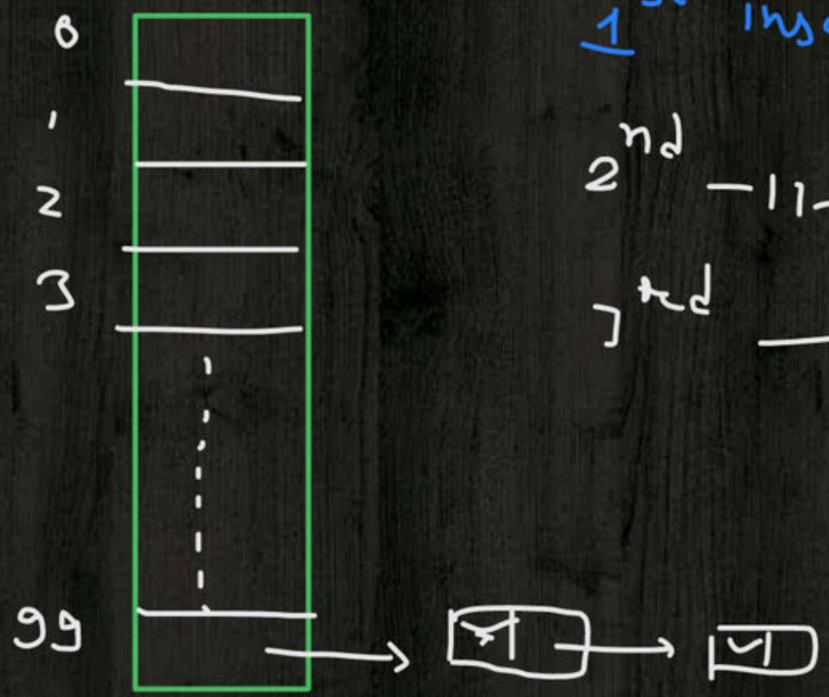
A. 3, 0, and 1 B. 3, 3, and 3 C. 4, 0, and 1 D. 3, 0, and 2



Question GATE-2014

Consider a hash table with 100 slots. Collisions are resolved using chaining. Assuming simple uniform hashing, what is the probability that the first 3 slots are unfilled after the first 3 insertions?

A. $(97 \times 97 \times 97)/100^3$
B. $(99 \times 98 \times 97)/100^3$
C. $(97 \times 96 \times 95)/100^3$
D. $(97 \times 96 \times 95/(3! \times 100^3)$



1st insertion → any of last 97 slots $\frac{97}{100}$

2nd —11— → $\frac{97}{100}$

3rd $\frac{97}{100}$

$$\frac{97}{100} * \frac{97}{100} * \frac{97}{100}$$

$$\frac{97 * 97 * 97}{100^3}$$

Question GATE-2015

Which one of the following hash functions on integers will distribute keys most uniformly over 10 buckets numbered 0 to 9 for i ranging from 0 to 2020?

A. $h(i) = i^2 \bmod 10$

B. $h(i) = i^3 \bmod 10$

C. $h(i) = (11 * i^2) \bmod 10$

D. $h(i) = (12 * i^2) \bmod 10$

Question GATE-2015

Given that hash table T with 25 slots that stores 2000 elements, the load factor a for T is _____.

$$\alpha = \frac{\text{no. of keys}}{\text{no. of slots}}$$

$$= \frac{2000}{25}$$

$$= 80$$

Ans = 80

Question GATE-2020

Consider a double hashing scheme in which the primary hash function is $h_1(k) = k \bmod 23$, and the secondary hash function is $h_2(k) = 1+(k \bmod 19)$. Assume that the table size is 23. Then the address returned by probe 1 in the probe sequence (assume that the probe sequence begins at probe 0) for key value $k = 90$ is

_____ .

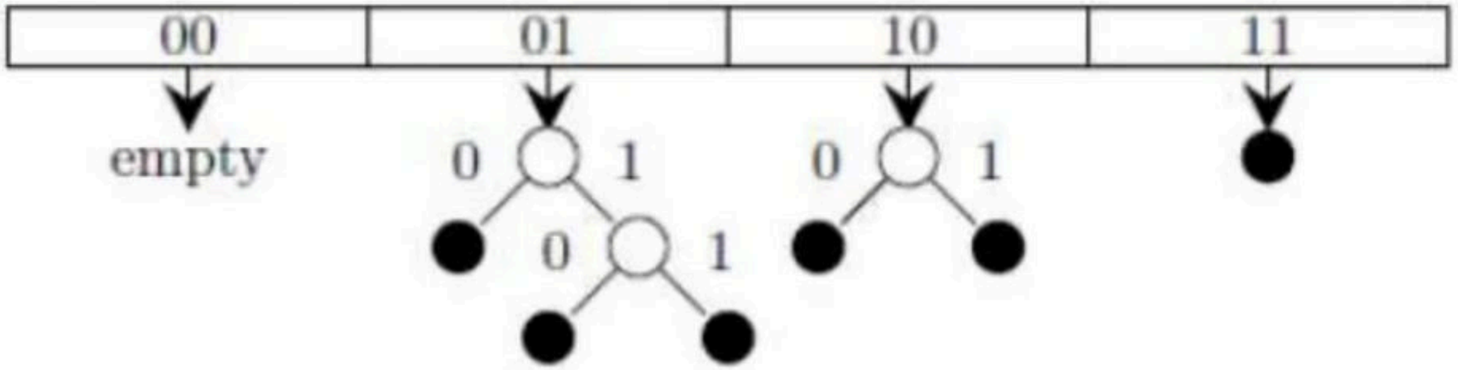
Question GATE-2021

Consider a *dynamic* hashing approach for 4-bit integer keys:

1. There is a main hash table of size 4.
2. The 2 least significant bits of a key is used to index into the main hash table.
3. Initially, the main hash table entries are empty.
4. Thereafter, when more keys are hashed into it, to resolve collisions, the set of all keys corresponding to a main hash table entry is organized as a binary tree that grows on demand.
5. First, the 3rd least significant bit is used to divide the keys into left and right subtrees.
6. To resolve more collisions, each node of the binary tree is further sub-divided into left and right subtrees based on the 4th least significant bit.
7. A split is done only if it is needed, i.e., only when there is a collision.

Consider the following state of the hash table.

Question GATE-2021



Which of the following sequences of key insertions can cause the above state of the hash table (assume the keys are in decimal notation)?

1. 10, 9, 6, 7, 5, 13
2. 9, 5, 13, 6, 10, 14
3. 9, 5, 10, 6, 7, 1
4. 5, 9, 4, 13, 10, 7

Happy Learning

Tomorrow

→ Hashing remaining questions (PYQ's)

→ Tree P.YQ's