Department of Computer Science,
Data Structures (CSC212),
Tutorial 9
Autumn Semester 1427-28

Question 1.
Use the hash function **H**(key) = key mod 11 to store the sequence of integers: 82, 31, 28, 4, 45, 27, 59, 79, 35 in the hash table of TableSize = 11. (a) Use linear rehashing (b) Use external chaining (c) Use coalesced chaining with a cellar size of four and the hash function H(key) = key mod 7.
For each of the collision resolution strategies determine (after the values have been inserted into the table) the following:
(d) The load factor (e) The average number of probes needed to find a value that is in the table (f) The average number of probes needed to find a value that is not in the table.

Question 2.
Develop a hashing function to store student's records, with ID # as their key, into a hash table of a suitable size. Assume that the number of students is about 1000. Use a suitable collision resolution strategy.

Question 3.
Develop a hashing function to convert a character key of 15 characters into integers in the range of 0 to 999.

Question 4.
Assuming the keys are integers, denoted by $d_n d_{n-1} \ldots d_k \ldots d_2 d_1$ where d_i is the i-th decimal digit in the key, d_n being the leftmost decimal digit. The hash function *H(key)* is given by:

$$H(key) = (d_1 d_2 + d_{n-1} d_n + d_k) \bmod 11$$

where $d_1 d_2$ is a two digit number (composed by swapping the rightmost two digits), $d_{n-1} d_n$ is also a two digit number (composed by swapping the leftmost two digits), and $k = \lceil n/2 \rceil$. For example:

$$H(70934) = (43 + 07 + 9) \bmod 11 = 59 \bmod 11 = 4 .$$

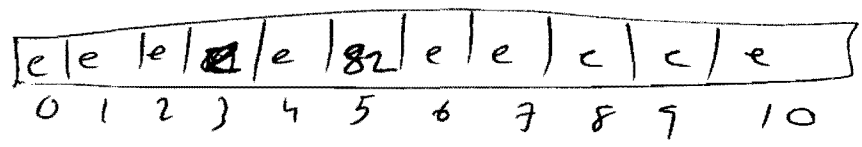
Assume the keys are: 1234, 519, 911, 7346, 0, 999, 99834, 54 and 40015.

(a) Compute *H(key)* for each of the above keys.
(b) Insert the above keys (in exactly the same order) in a hash table with open addressing (linear rehashing).
(c) Find the number of probes required to search for keys 54 and 11 in the above hash table.
(d) Repeat part (b) using an external chaining hash table.

Q1

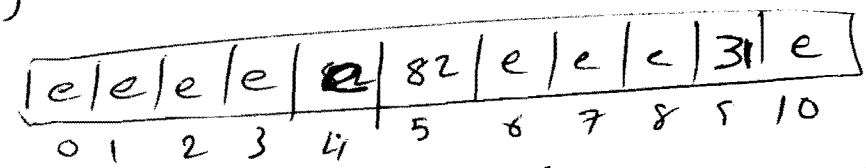
$H(key) = key \bmod 11$.

① $H(82) = 82 \bmod 11 = 3$ LF 1/11



1 prob

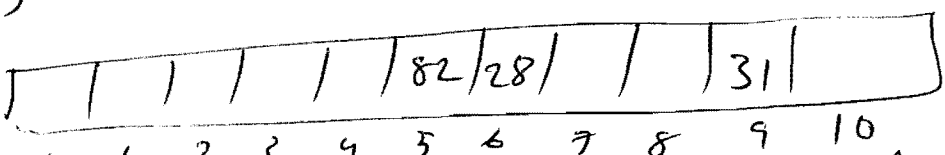
② $H(31) = 31 \bmod 11 = 9$



LF 2/11

1 prob

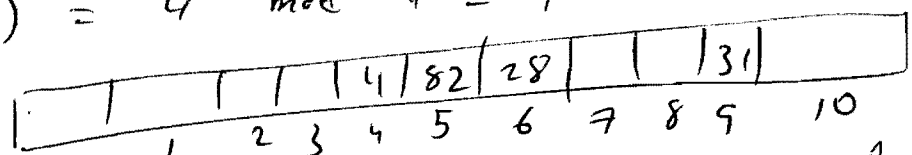
③ $H(28) = 28 \bmod 11 = 6$



LF 3/11

1 prob

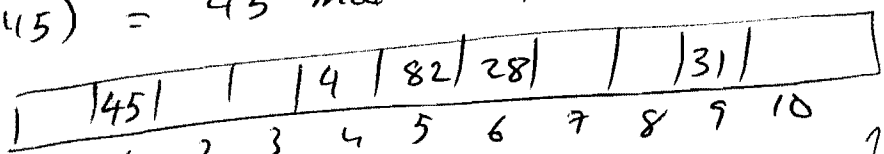
④ $H(4) = 4 \bmod 4 = 4$



LF 4/11

1 prob

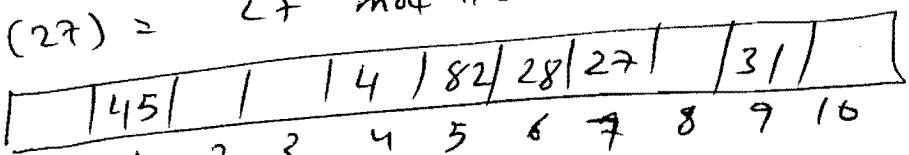
⑤ $H(45) = 45 \bmod 11 = 1$



LF 5/11

1 prob

⑥ $H(27) = 27 \bmod 11 = 5$



LF 6/11

~~rehash = 5 mod 7 = 5~~

~~6 mod 7 = 6~~

3 probs

rehash = $5 + 1 \bmod 11 = 6$

$= 6 + 1 \bmod 11 = 7$

⑦ $H(59) = 59 \bmod 11 = 4$

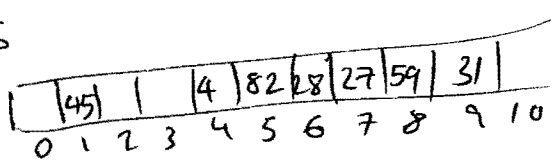
rehash = $4 + 1 \bmod 11 = 5$

$5 + 1 \bmod 11 = 6$

$6 + 1 \bmod 11 = 7$

$7 + 1 \bmod 11 = 8$

5 probs LF 7/11



T9/1

$H(79) = 79 \bmod 11 = 2$

		45	79		4	82	28	27	59	31	
0	1	2	3	4	5	6	7	8	9	10	

LF 8/11

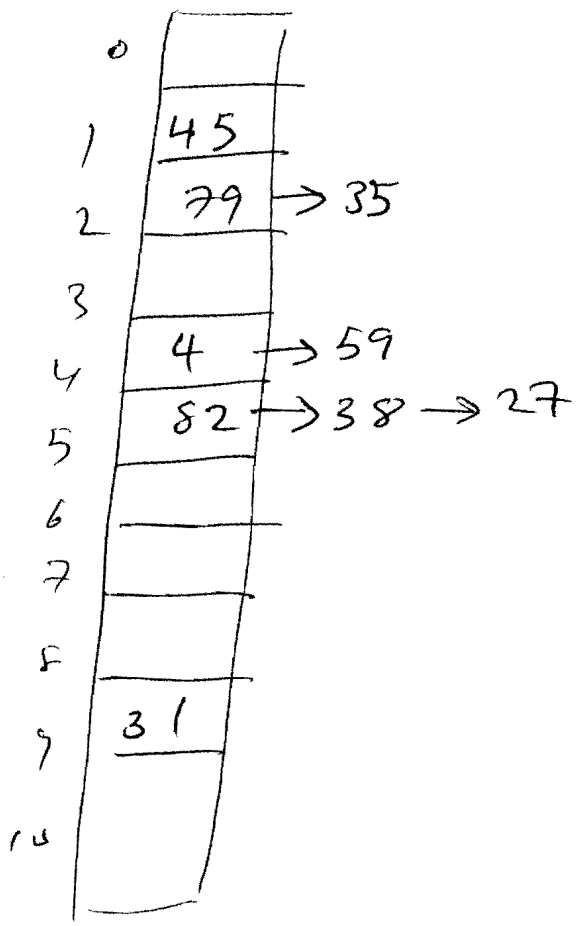
$H(35) = 35 \bmod 11 = 2$

		45	79	35	4	82	28	27	59	31	
0	1	2	3	4	5	6	7	8	9	10	

LF 9/11

rehash = $2 + 1 \bmod 11 = 3$ — 2 probs

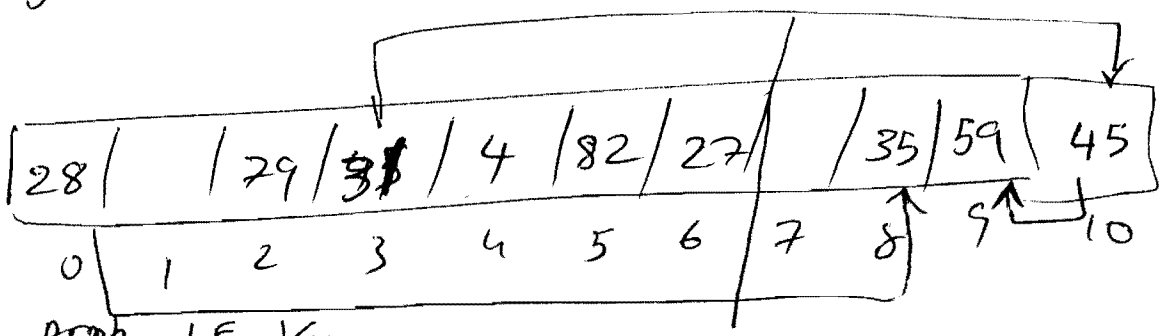
(b) External chaining — all 1 prob.



LF 1/11
2/11
3/11
4/11
5/11

(c) Coalesced

$h(key) = key \bmod 7$



82	1	prob.	LF	1/11
31	1	=		2/11
28	1	=		3/11
4	1	=		4/11
45	2	=		5/11
27	1	=		1
59	3	=		1
79	1	=		1
35	2	=		

(d) load factor = n/s when n is the stored entry. s is the Array size.

- Linear rehashing = 7/11
- External = 5/11
- Coalesced = 9/11

} Final

(e) avg probs:

- Open : 17/9
- External : 9/9
- Coalesced : 13/9.

(f) avg probs not found: +1

T9/2

Q2

Key ⇒ I D No.

no of student 1000.

Digit selection.

H(key) = key mod 1000.

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Collision : External or open.

Q3

Key 15 character ⇒ Int range 0-999.

Q4

$$H(key) = (d_1 d_2 + d_{n-1} d_n + d_k) \bmod 11.$$

Example

$$H(70934) = 43 + 07 + 9$$

d_n d_{n-1} d_2 d_1 — d_2 d_1 $n-1$ n $n/2$, $5/2 = 3$

$$= 59 \bmod 11 = 4$$

$H(1234) = 43 + 21 + 3 = 67 \bmod 11 = 1$

$H(519) = 91 + 15 + 1 = 107 \bmod 11 = 8$

$H(911) = 11 + 19 + 1 = 31 \bmod 11 = 9$

⋮

$H(40015) = 51 + 04 + 0 = 55 \bmod 11 = 0.$