



Data Structure

Lab Session #11: Searching 2

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Goals

- Implement **both Open and Closed Hash Table**
 - Fill in the following methods in HashTable.java.
 - `public void hashInsert(Key k, E r);`
 - `public E hashSearch(Key k);`
 - `public E hashRemove(Key k);`
 - `public void changeToClosed();`
 - `public void hashPrint();`
 - Use the implemented interface and classes.
 - Dictionary, HashDictionary, and KVpair.
- Print the sample output corresponding to the sample input.



Notice

- After implementing “HashTable”, check if your program works well.
 - Check sample input and output files from the ‘testcase’ folder.
 - Test your program by using it.
- When you finish implementing the program, you can leave.
 - But, you need to stay for at least an hour.
- Check your attendance.



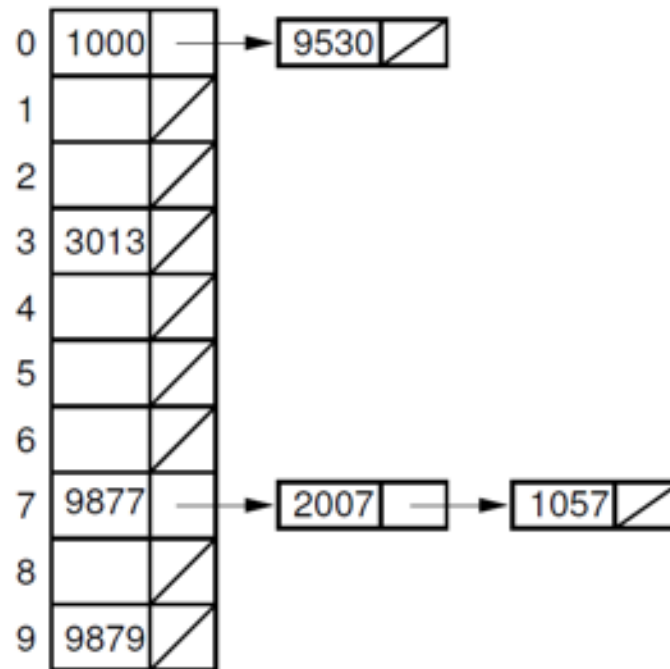
Build a project

- Download the project for this lab from eTL.
- Extract the project, and open it in IntelliJ.
 - See the slide of 1st lab session to check how to open the project in IntelliJ.



Open Hashing

- Review Lectures 21 & 22
- Open hashing (also called ‘separate chaining’)
 - Collisions are stored outside the table
 - Limitation: some slots in the table may not be used





Closed Hashing

- Review Lecture 21 & 22
- Closed hashing with linear probing
 - Collisions are stored inside the table
 - Linear probing: insert a colliding value into the next available slot in the table

0	9050
1	1001
2	
3	
4	
5	
6	
7	9877
8	2037
9	

Insertion order:
1001, 9050, 9877, 2037

“Linearly probed”



I/O Specification (1)

■ `public void hashInsert(Key k, E r);`

Input form	Output form
<code>insert (key) (value)</code>	-
Description	
<ul style="list-style-type: none">• Inserts a record of ((key), (value)).• (key) is an integer and (value) is a string not containing spaces.• Assumes there is no insertion of records with duplicate keys.	
Sample Input	Sample Output
<code>insert 1 apple1</code>	-



I/O Specification (2)

■ public E hashSearch(Key k);

Input form	Output form
find (key)	FIND: ((key), (value))
Description	
<ul style="list-style-type: none">• Finds a record with (key).• Does not change the table.• Assumes there is no query for a non-existing key.	
Sample Input	Sample Output
find 1	FIND: (1, apple1)



I/O Specification (3)

■ public E hashRemove(Key k);

Input form	Output form
remove (key)	REMOVE: ((key), (value))
Description	
<ul style="list-style-type: none">• Removes a record with (key).• Assumes there is no query for a non-existing key.	
Sample Input	Sample Output
remove 1	REMOVED: (1, apple1)



I/O Specification (3)

■ `public void changeToClosed();`

Input form	Output form
change	-

Description

- **Changes open hashing formatted table to closed hashing table.**
- *** Check sample output (page 11) to see how it should be changed.**
- **Hint: use `hashRemove()`**

Sample Input	Sample Output
change	-



I/O Specification (3)

■ `public void print();`

Input form	Output form
<code>print</code>	<code>PRINT HASH: ((key), (value))...</code>
Description	
<ul style="list-style-type: none">Prints elements in hash table with keys and values in orderIt should be able to print both open and closed hashing table	
Sample Input	Sample Output
<code>print</code>	<div>PRINT HASH: (1, apple1) (111, apple3) (2, banana1) (22, banana2)</div> <div>PRINT HASH: (1, apple1) (2, banana1) (111, apple3) (22, banana2)</div>



Sample Input & Sample Output

<Sample Input>

- insert 1 apple1
- insert 11 apple2
- insert 111 apple3
- insert 2 banana1
- insert 22 banana2
- print
- find 11
- find 2
- remove 11
- remove 2
- find 111
- find 22
- print
- change
- print
- quit

<Sample Output>

- PRINT HASH:
(1, apple1), (11, apple2) (111, apple3)
(2, banana1) (22, banana2)
- FIND: (11, apple2)
- FIND: (2, banana1)
- REMOVE: (11, apple2)
- REMOVE: (2, banana1)
- FIND: (111, apple3)
- FIND: (22, banana2)
- PRINT HASH:
(1, apple1) (111, apple3)
(2, banana1) (22, banana2)
- PRINT HASH:
(1, apple1)
(2, banana1)
(111, apple3)
(22, banana2)



Questions?