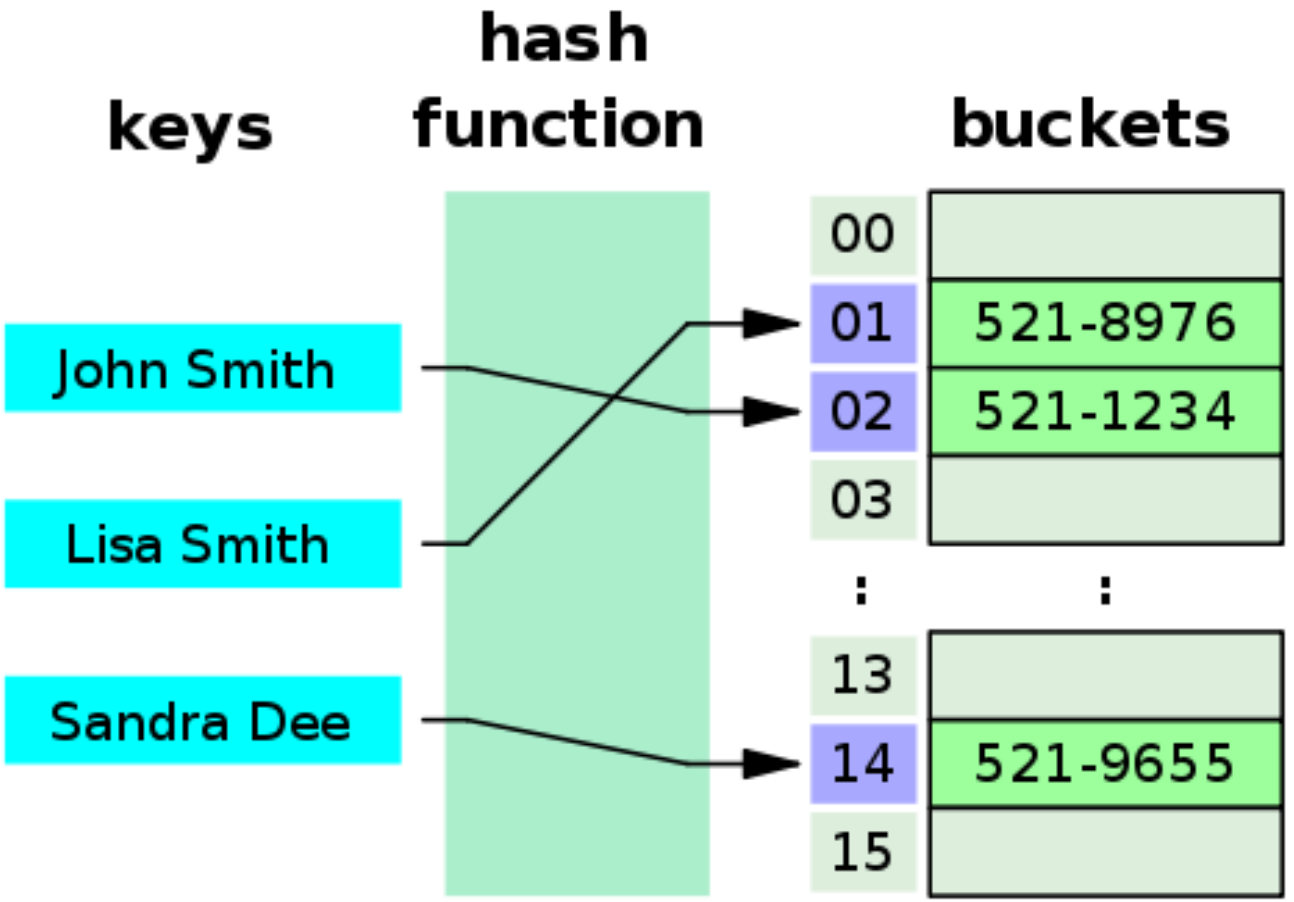
Hash table


keys
hash function
buckets
John Smith
Lisa Smith
Sandra Dee
00
01
02
03
13
14
15
521-8976
521-1234
521-9655

Hashing – principle

- Data is stored in an **array**
- The index **is calculated** based on a key.
  - **index = hash-function (key)**
- Insert
  - put(key, value)
- ”Search”
  - get (key)
- The **hash-function** must
  - return an integer (index < size of table)
  - be easy to calculate (why?)
  - Minimize the number of collisions
  - distribute data elements evenly across the table (why?)

Hash function (ex):

key value modulo 11

(11 = size of table)

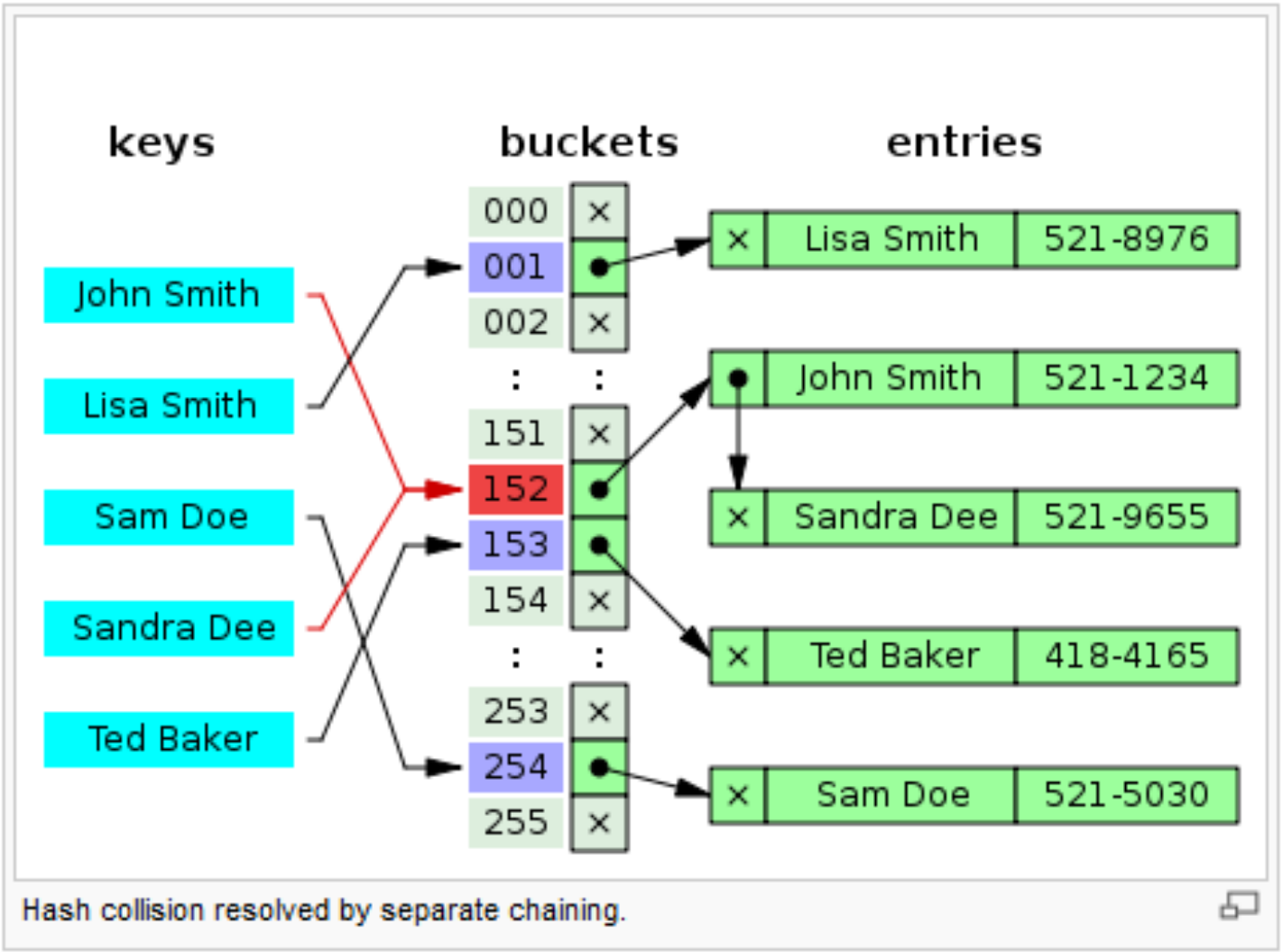
ex:

Key value: 13

hash (13) => 13 mod 11 => 2

0	11
1	1
2	13
3	
4	
5	
6	
7	
8	30
9	
10	10

Collisions, chaining



Hash collision resolved by separate chaining.

Efficiency and hash table

- Insert, delete and search is (nearly) independent of the number of elements (n)
  - O(1)
  - Load factor
- Table size << number of possible different key values
- Preferred when you require fast
  - search
  - Insert

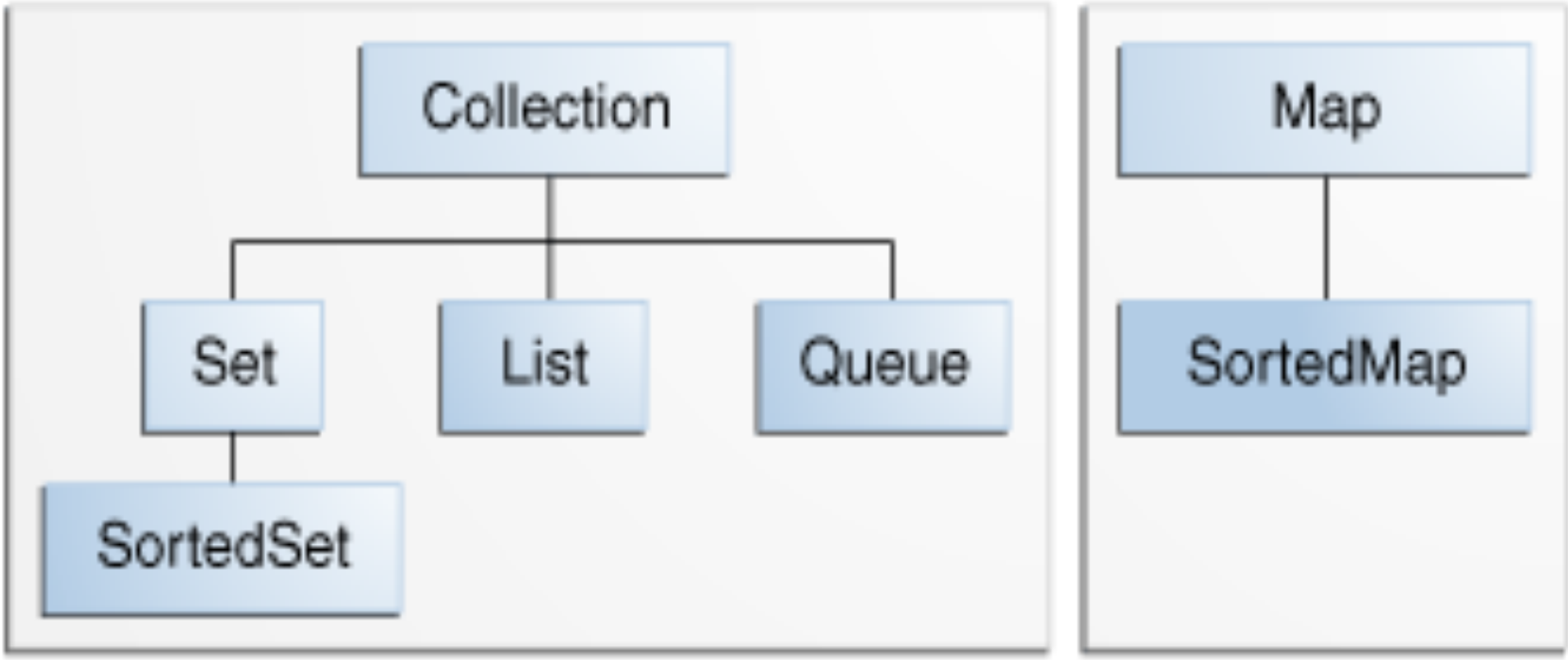
  but not fast
  - Iterate sorted
  - Location of max /min

Java Collections Framework

- Include
  - **interfaces**
  - **implementations**
  - **methods**, that manipulates collections

- Interfaces:
  - Collection // a group of elements
  - Set // no dublicates (~ mathematical set concept)
  - List // ordered Collection, each element has a position
  - Queue // ordered Collection with special operations (ex: FIFO)
  - SortedSet // ordered by the natural ordering of the elements // (Comparable)
  - Map // ~ table of (key,value)- pairs. No dublicate keys
  - SortedMap // ordered according to the natural order of the key //(Comparable)

Interfaces in JCF



Implementations of interfaces

General-purpose Implementations			(SortedSet and Sorted Map) ↓		
Interfaces	**Hash table Implementations**	**Resizable array Implementations**	**Tree Implementations**	**Linked list Implementations**	**Hash table + Linked list Implementations**
Set	**HashSet**		TreeSet		LinkedHashSet
List		**ArrayList**		LinkedList	
Queue				(LinkedList)	
Map	**HashMap**		TreeMap		LinkedHashMap

Methods (algorithms)

- The Collections class
  - sorting
  - shuffling
  - rutine data manipulation (List)
  - searching

Efficiency of data structure

	array Eg. int[]	ArrayList	Linked list	Hash map	**BST (Binary search tree**
insert first insert last insert middle					
erase first erase last erase middle					
find					
iteration					
Sorted iteration					