Computer Science Department
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Data Structures

Chapter 5: Hash Table

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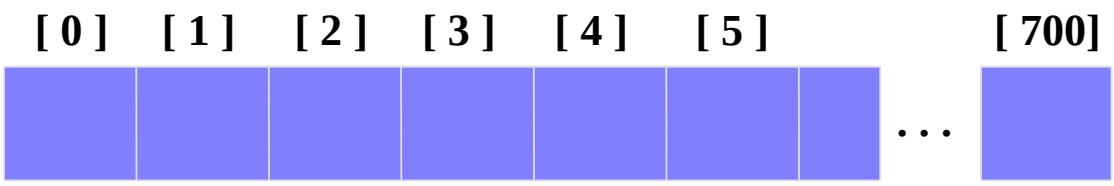
What is a Hash Table ?

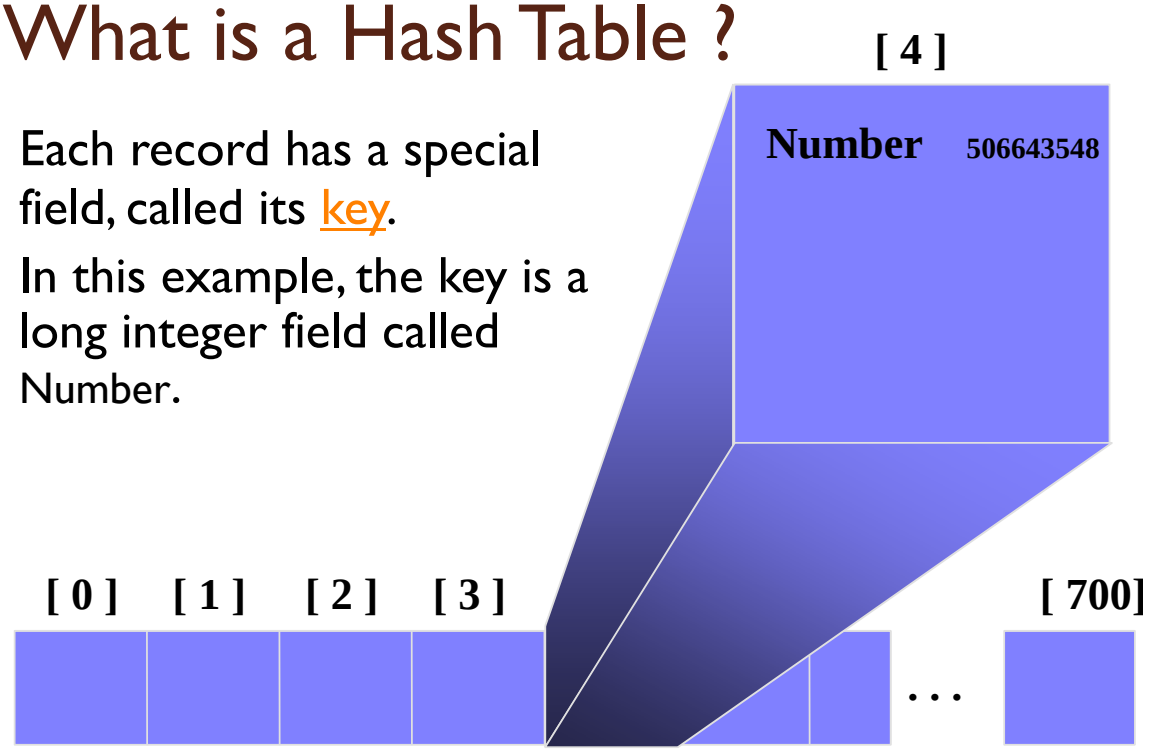
- The simplest kind of hash table is an array of records.
- This example has 701 records.



An array of records

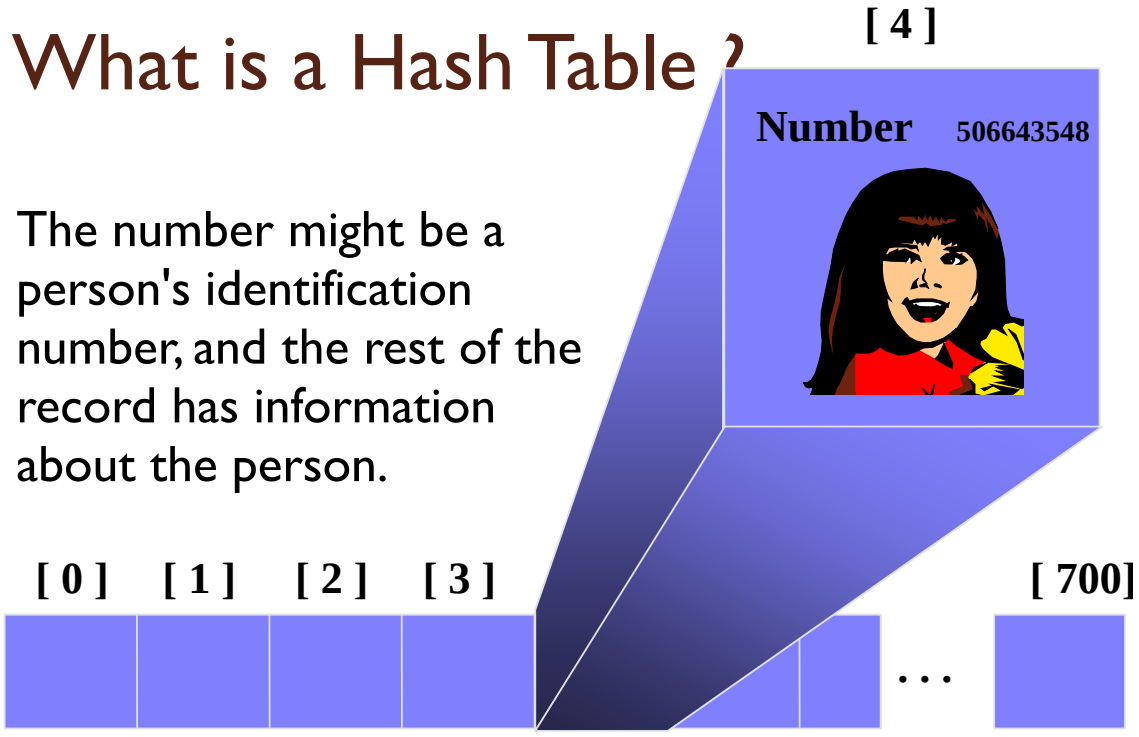
What is a Hash Table ?

- Each record has a special field, called its key.
- In this example, the key is a long integer field called Number.



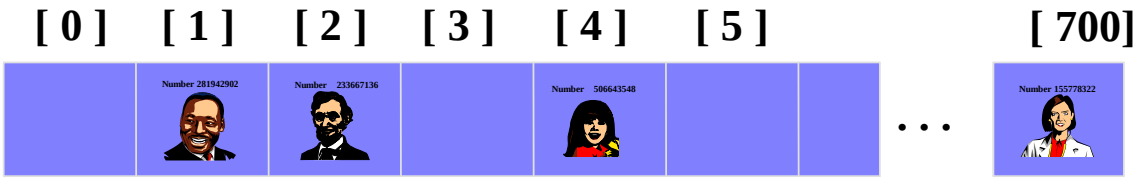
What is a Hash Table ?

- The number might be a person's identification number, and the rest of the record has information about the person.



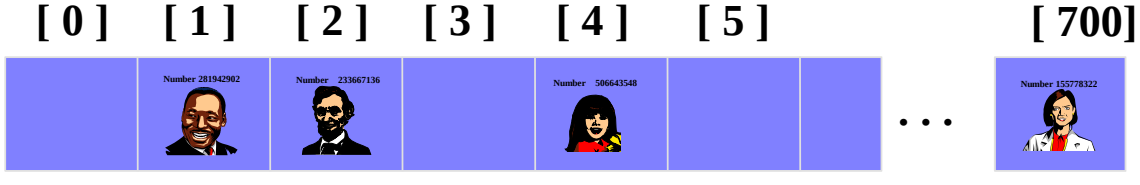
What is a Hash Table ?

- When a hash table is in use, some spots contain valid records, and other spots are "empty".



Inserting a New Record

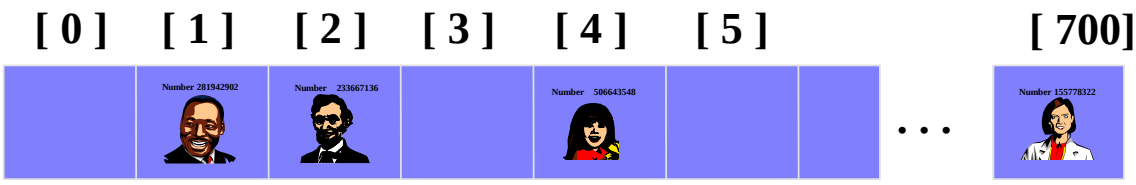
- In order to insert a new record, the **key** must somehow be **converted to** an array **index**.
- The index is called the **hash value** of the key.



Inserting a New Record

- Typical way create a hash value:

What is (580625685 mod 701) ?



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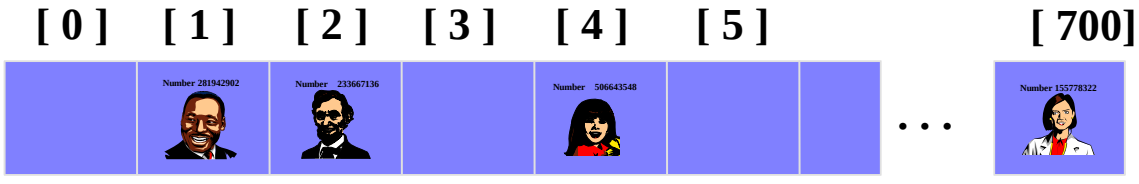
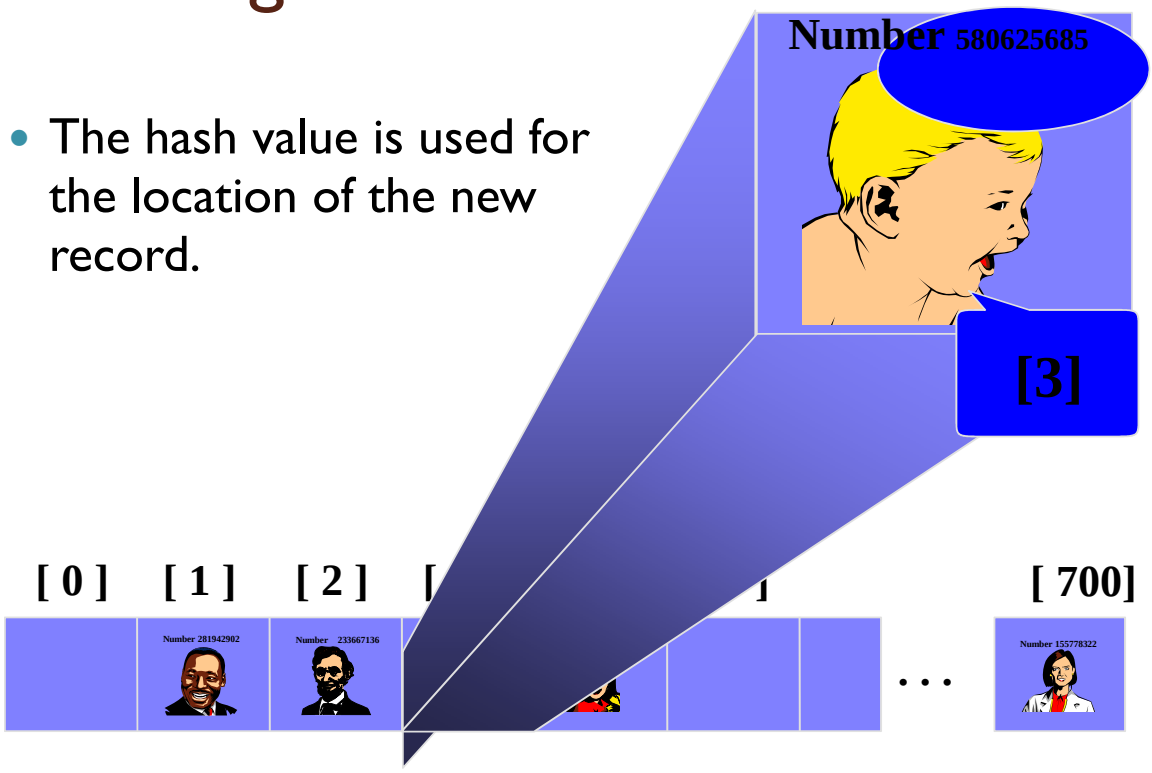


Inserting a New Record

- The hash value is used for the location of the new record.



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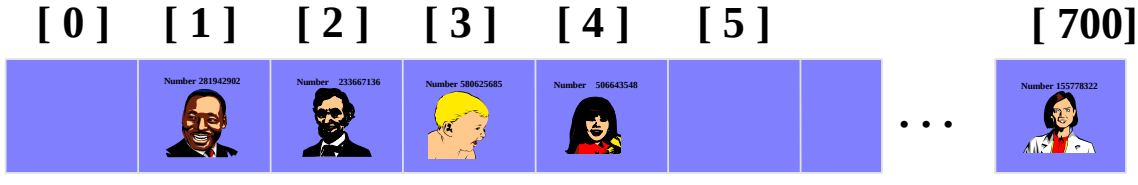
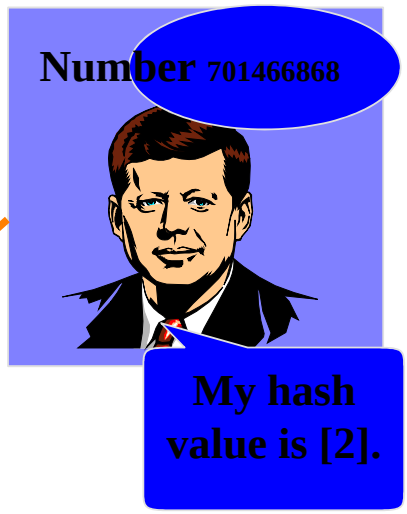
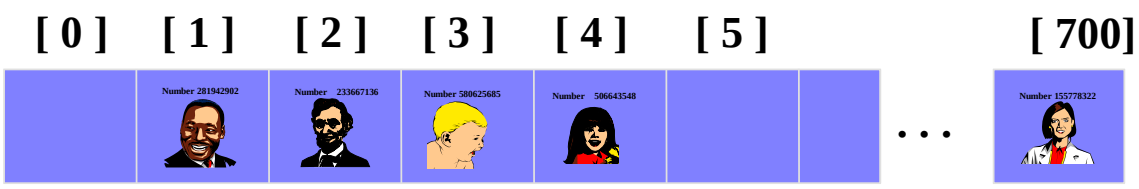


Collisions

- Here is another new record to insert, with a hash value of 2.

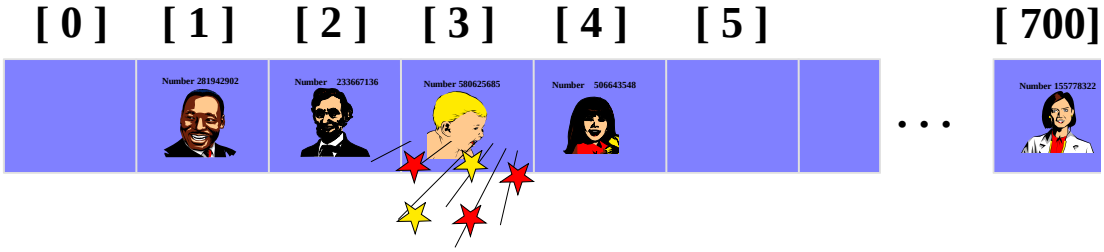




Collisions

- This is called a collision, because there is already another valid record at [2].

When a collision occurs, move forward until you find an empty spot.



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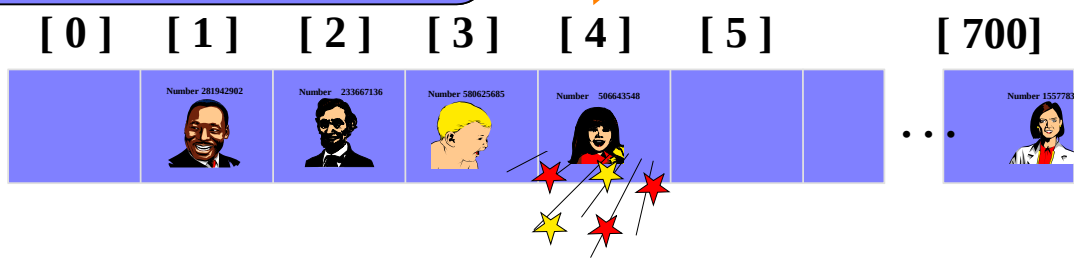

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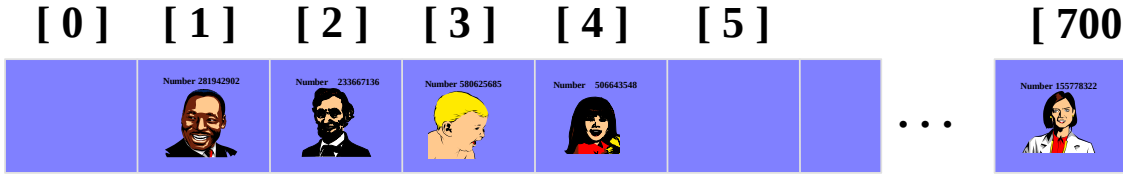
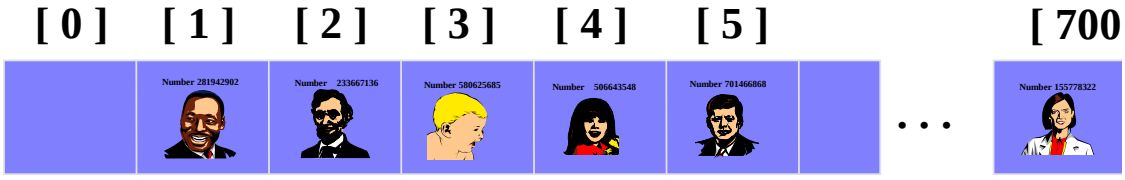


Collisions

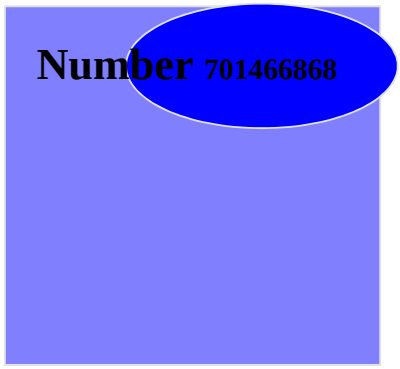
- This is called a **collision**, because there is already another valid record at [2].

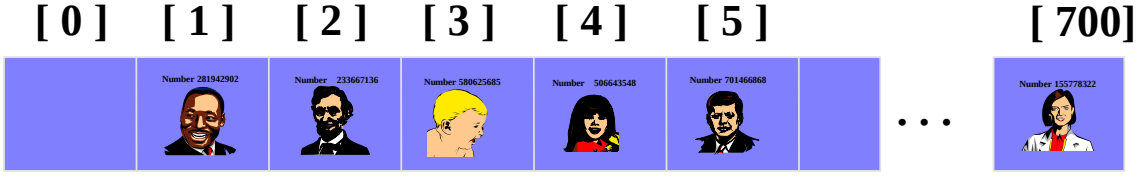
The new record goes in the empty spot.



Searching for a Key

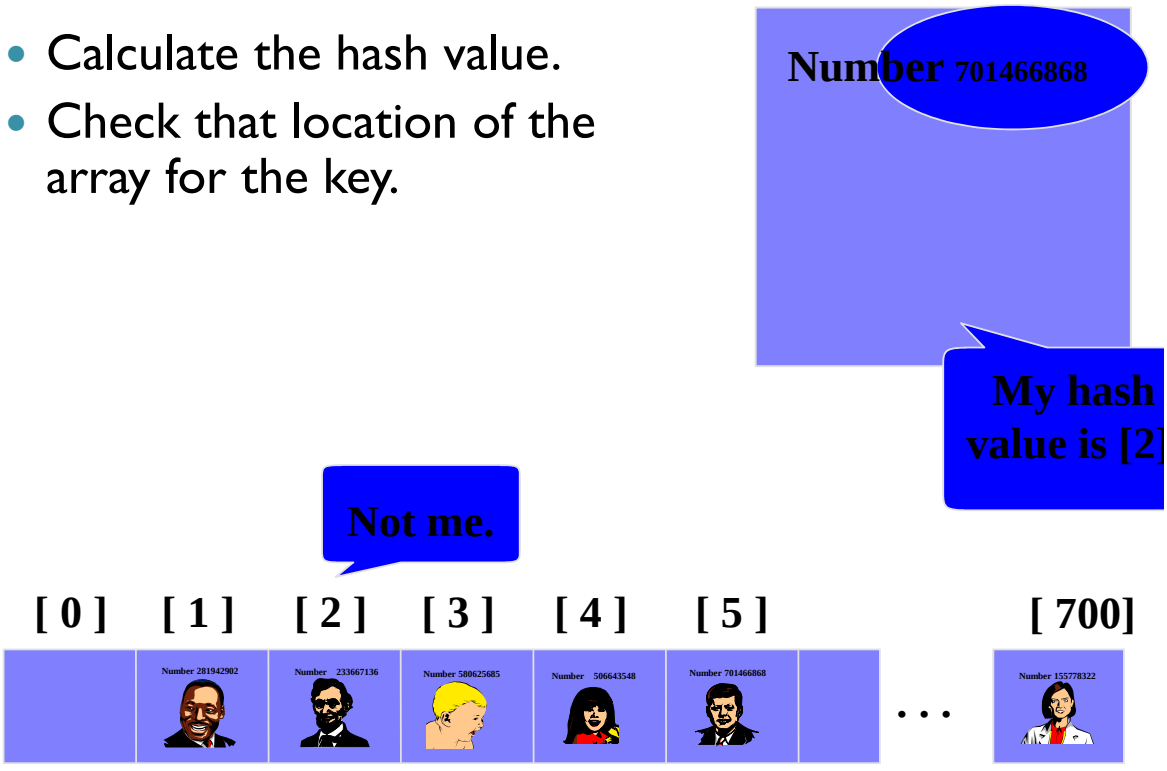
- The data that's attached to a key can be found fairly quickly.





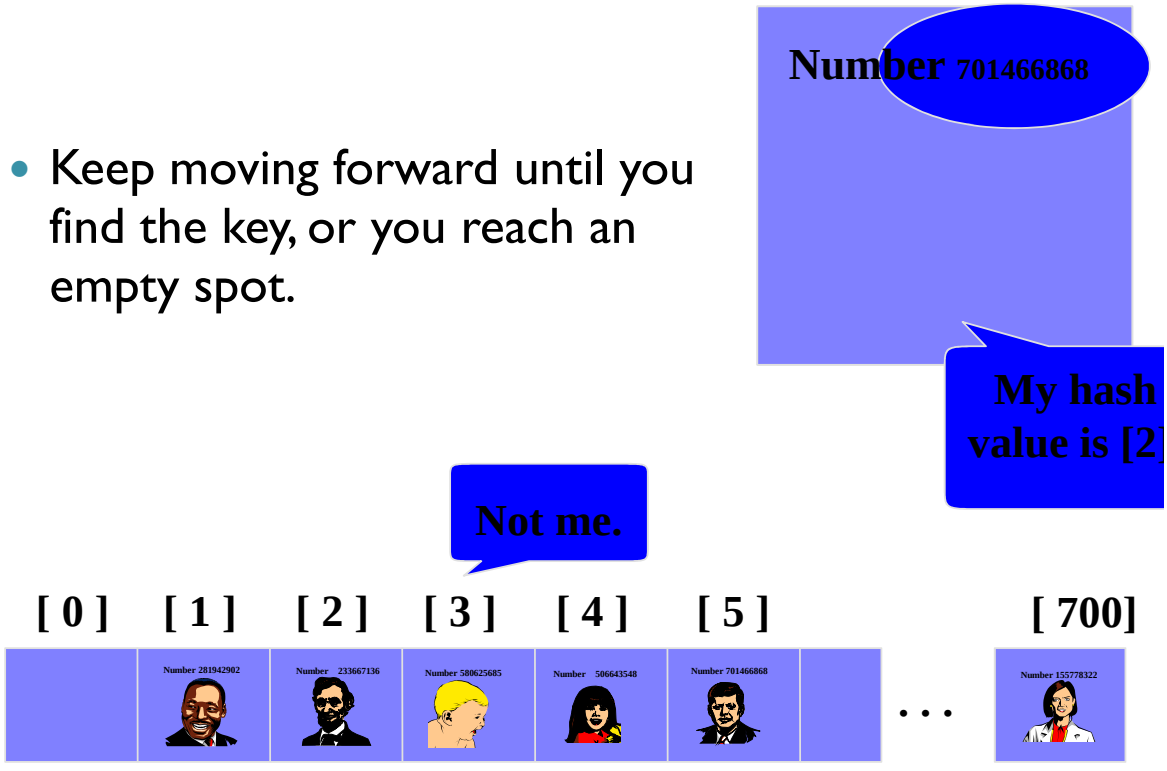
Searching for a Key

- Calculate the hash value.
- Check that location of the array for the key.



Searching for a Key

- Keep moving forward until you find the key, or you reach an empty spot.



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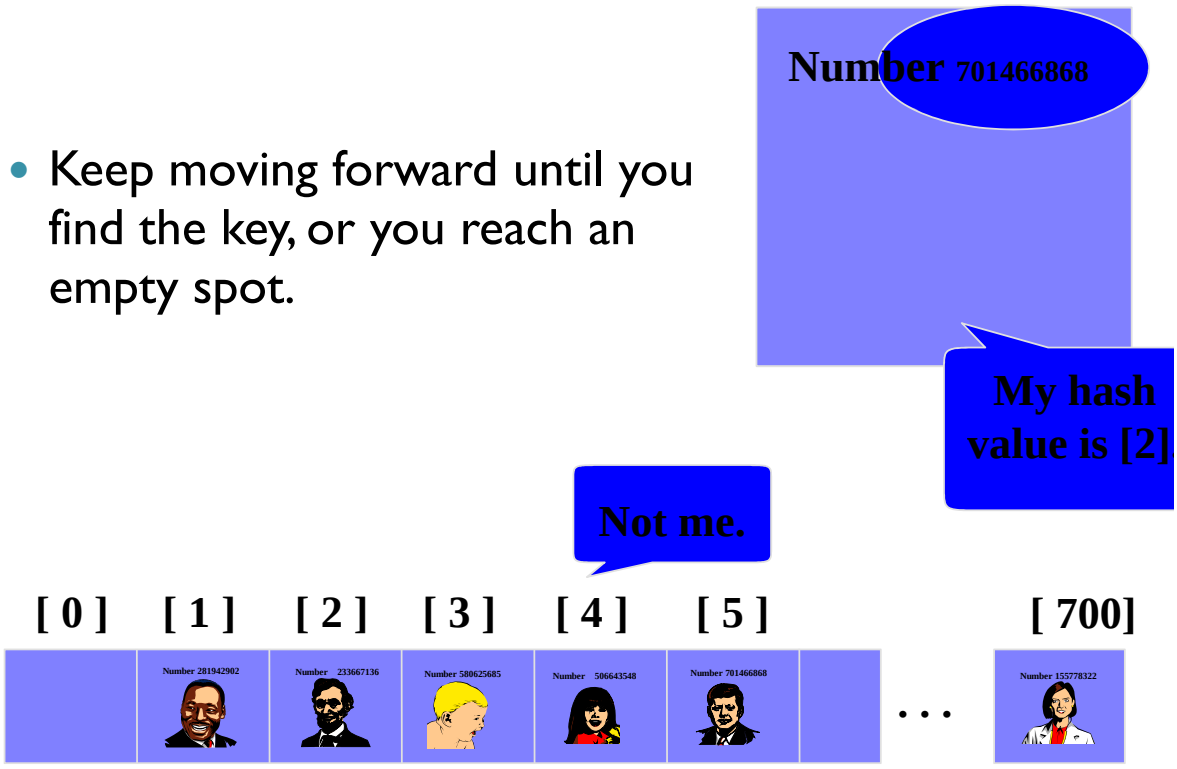

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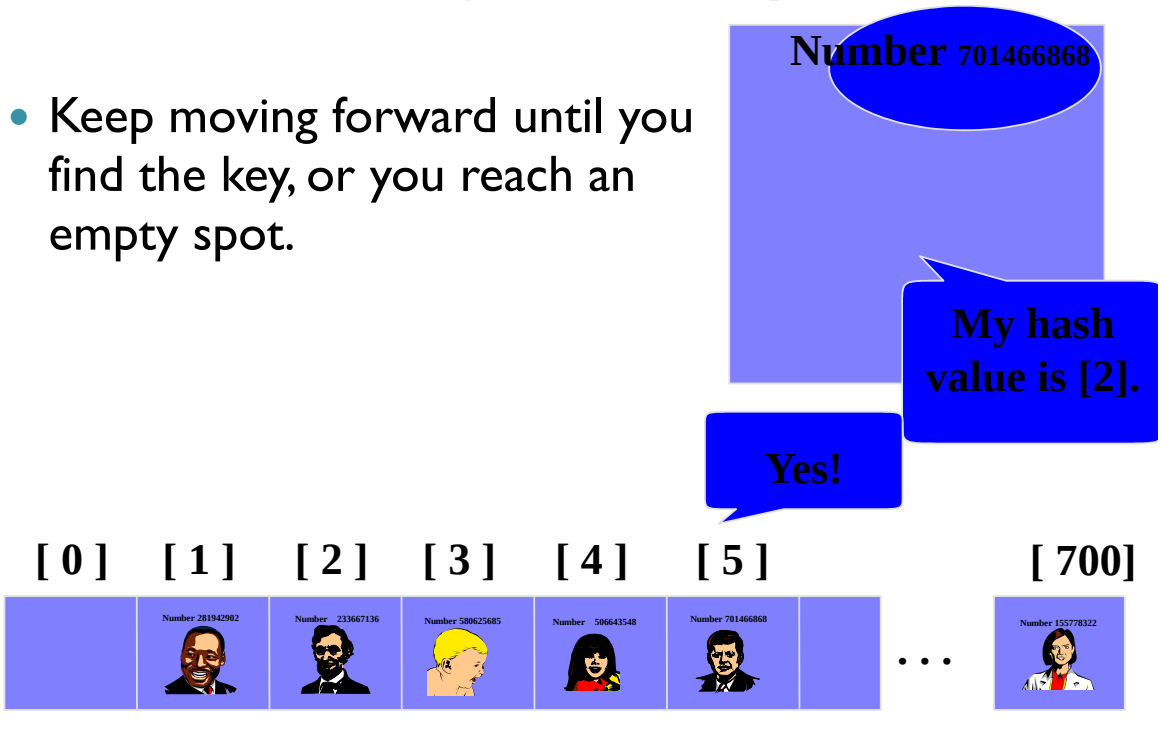
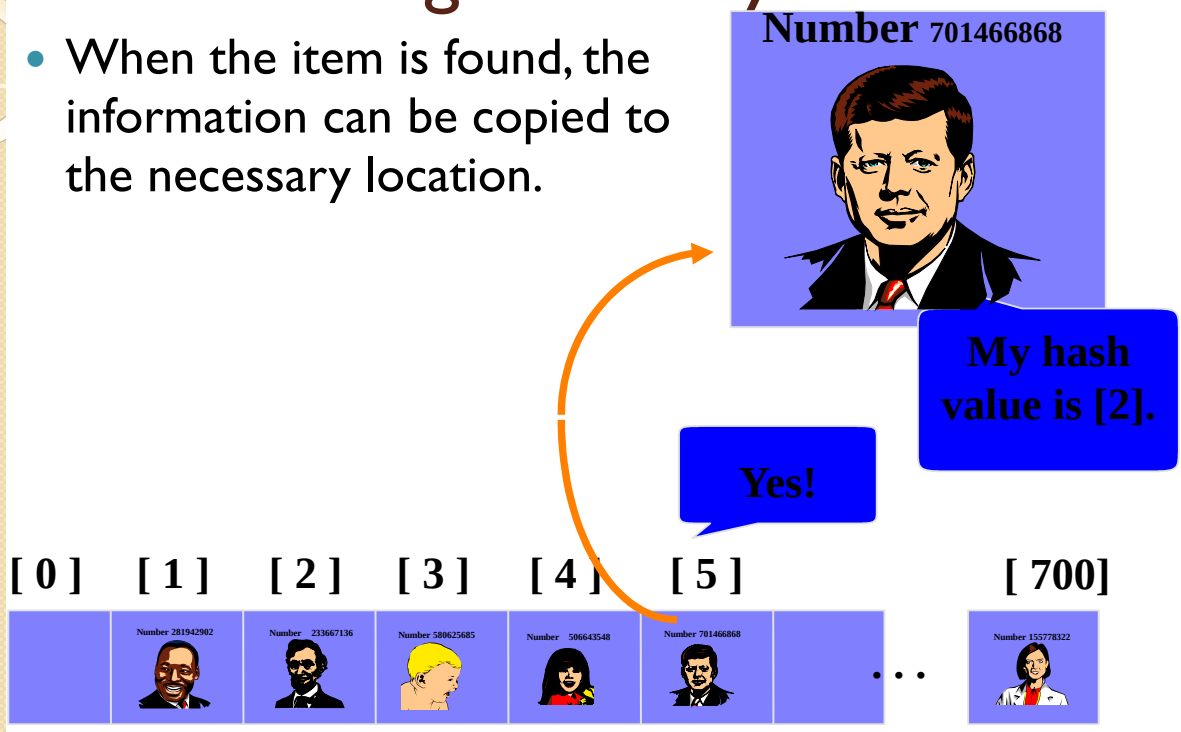


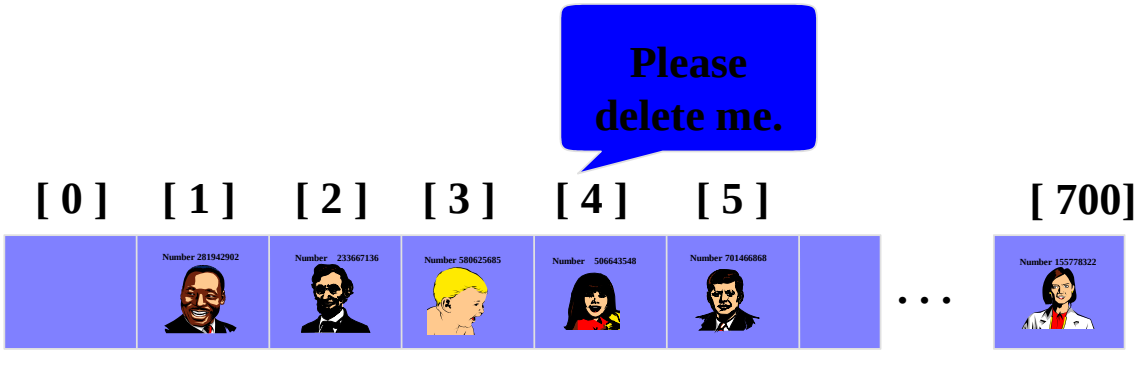
Searching for a Key

- When the item is found, the information can be copied to the necessary location.



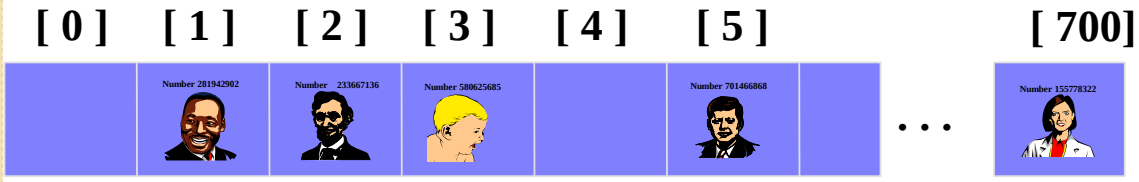
Deleting a Record

- Records may also be deleted from a hash table.



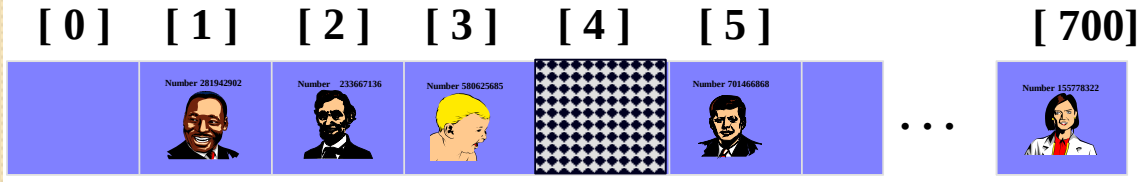
Deleting a Record

- Records may also be deleted from a hash table.
- But the location must not be left as an ordinary "empty spot" since that could interfere with searches.



Deleting a Record

- Records may also be deleted from a hash table.
- But the location must not be left as an ordinary "empty spot" since that could interfere with searches.
- The location must be marked in some special way so that a search can tell that the spot used to have something in it.



Exercise

- For the following two questions, use the following values:

67 46 88 91 123 141 152 155 178 288 390 399 465 572 621 734

Question1

1 Draw a diagram to show how the values are inserted into a hash table with 20 positions. Use the division method of hashing and the linear probing method of resolving collisions.

Solution Quetion1

Step 1: Apply the Division Method to Get the Index

67 % 20 = 7

46 % 20 = 6

88 % 20 = 8

91 % 20 = 11

. . .

734 % 20 = 14

Step 2: Create Table Using Linear Probing Method

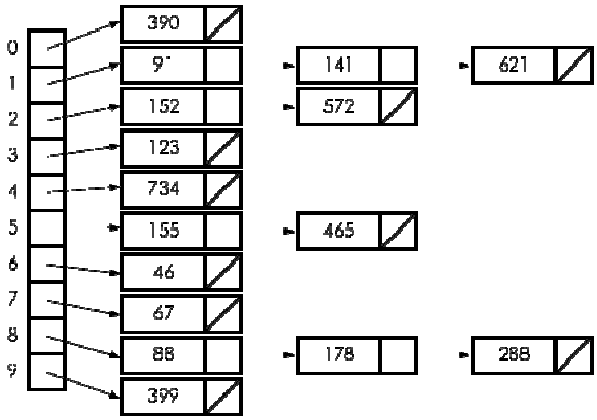
0	
1	141
2	621
3	123
4	
5	465
6	46
7	67
8	88
9	288
10	390
11	91
12	152
13	572
14	734
15	155
16	
17	
18	178
19	399

Question2

- Draw a diagram to show how the values are inserted into a hash table that uses the hash function key % 10 to determine into which of ten chains to put the value.

Solution Question2

Step 1: Apply the Division Method to Get the Index
67 % 10 = 7
46 % 10 = 6
88 % 10 = 8
91 % 10 = 1
. . .
734 % 10 = 4
Step 2: Create Table Using Chaining Method



Summary

- **Hash tables store a collection of records with keys.**
- **The location of a record depends on the hash value of the record's key.**
- **When a collision occurs, the next available location is used.**
- **Searching for a particular key is generally quick.**
- **When an item is deleted, the location must be marked in a special way, so that the searches know that the spot used to be used.**