Chapter 12 discusses several ways of storing information in an array, and later searching for the information.

Hash tables are a common approach to the storing/searching problem.

This presentation introduces hash tables.

### What is a Hash Table?

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

```
[0] [1] [2] [3] [4] [5] ...
```

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`.

```
Number 506643548
Number 233667136
Number 281942902
Number 155778322
```

### 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.

```
Number 506643548
```

### What is a Hash Table?

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

```
[0] [1] [2] [3] [4] [5] ...
```

### 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.

```
Number 580625685
```

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

```
[0] [1] [2] [3] [4] [5] ...
```

An array of records
Inserting a New Record

Typical way to create a hash value:

(Number mod 701)

What is \(580625685 \mod 701\) ?

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

Collisions

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

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.
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.

The new record goes in the empty spot.

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

Calculate the hash value.

Check that location of the array for the key.

Where would you be placed in this table if there is no collision? Use your social security number or some other favorite number.
### Searching for a Key

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

  - My hash value is [2].
  - Not me.

### Deleting a Record

- Records may also be deleted from a hash table.

  - Please delete me.
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.

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.

Summary

Kathy Martin
817339024
Took Data Structures in Fall 1993.
Grade A.
Hard worker. Always gets things done on time.
Currently working for Hewlett-Packard in Fort Collins.

Will Smith
506643973
Took Data Structures in Fall 1995.
Grade A.
A bit of a goof-off, but he comes through in a pinch.
Currently saving the world from alien invasion.

William “Bill” Clinton
330220393
Took Data Structures in Fall 1995.
Grade B-.
Gets along with most people well.
Currently working for federal government.

Elizabeth Windsor
092223340
Took Data Structures in Fall 1995.
Grade B-.
Prefers to be called “Elizabeth II” or “Her Majesty.” Has some family problems.
Currently working in public relations near London.
Took CSCI 2270 in Fall 1995.
Grade F.

In spite of poor grade, I think there is good academic ability in Al.
Currently a well-known advocate for peace.