120 km in distance

75 kgs in weight

55 cm in height

Writer: Seymour Lipschutz

- Collection of data are frequently organized into a
  - Hierarchy of fields
  - Records
  - Files

Entity?

An entity is something that has certain ATTRIBUTE or PROPERTIES which may be assigned **VALUES.**

may be numeric or non-numeric

ATTRIBUTE	NAME	Age	Sex	Height	NID
Values	Jhon	30	Male	65 cm	27642847

Entity Set?

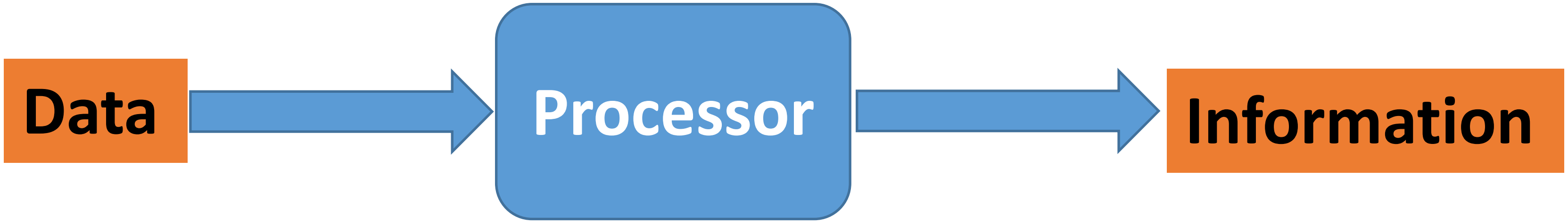
Entities with similar ATTRIBUTES form entity set.

Example:

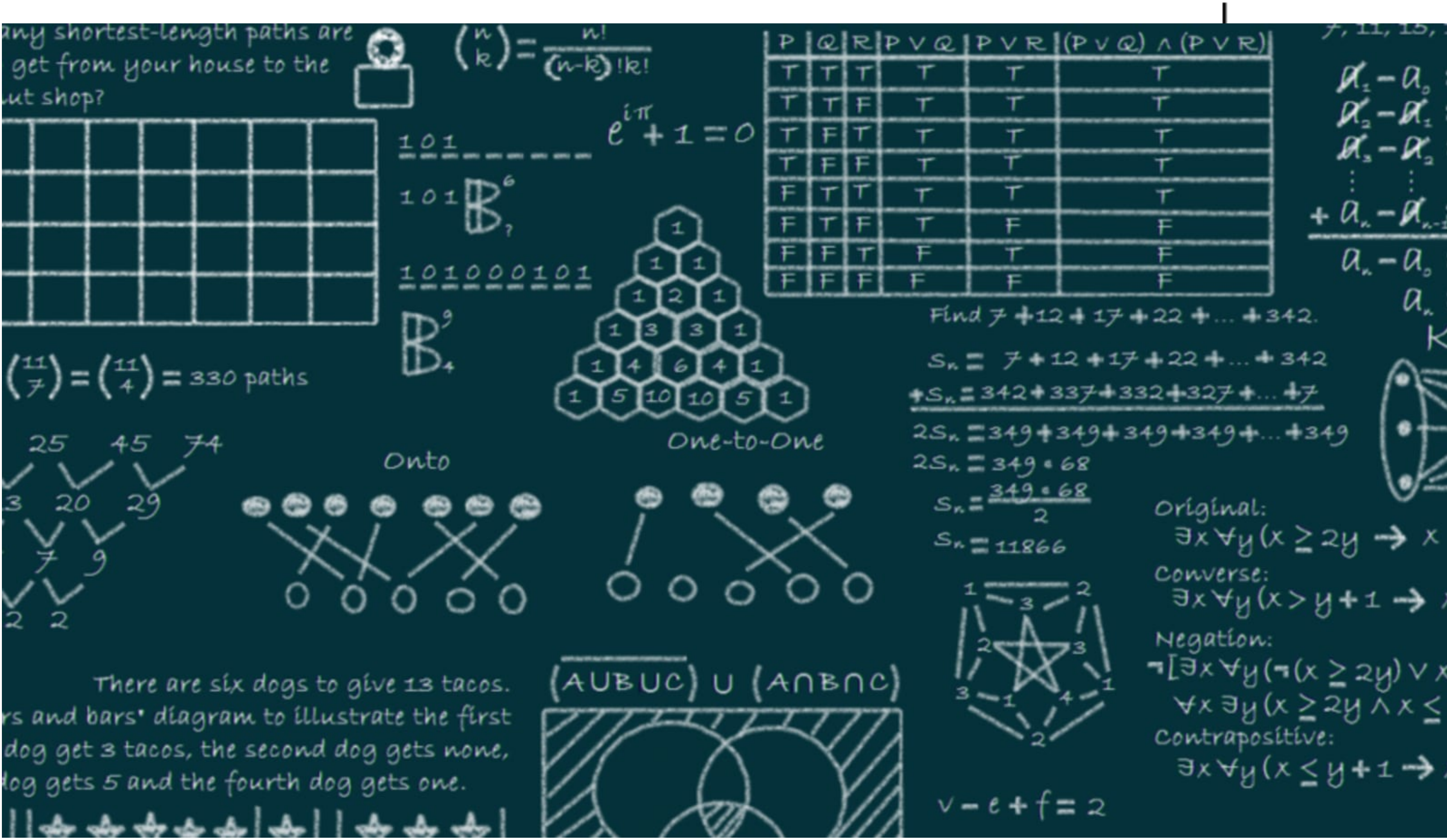
- All the employee in an organization
- All the students of any department.

✓**Each attribute of an entity set has a range of values**

Information?



Processed dare are usually called information



any shortest-length paths are
get from your house to the
ut shop?

$\binom{n}{k} = \frac{n!}{(n-k)!k!}$

$e^{i\pi} + 1 = 0$

$\binom{11}{7} = \binom{11}{4} = 330$ paths

P	Q	R	P ∨ Q	P ∨ R	(P ∨ Q) ∧ (P ∨ R)
T	T	T	T	T	T
T	T	F	T	T	T
T	F	T	T	T	T
T	F	F	T	T	T
F	T	T	T	T	T
F	T	F	T	F	F
F	F	T	F	T	F
F	F	F	F	F	F

Find 7 + 12 + 17 + 22 + … + 342.

$S_n = 7 + 12 + 17 + 22 + \ldots + 342$

$+ S_n = 342 + 337 + 332 + 327 + \ldots + 7$

$2S_n = 349 + 349 + 349 + 349 + \ldots + 349$

$2S_n = 349 \cdot 68$

$S_n = \frac{349 \cdot 68}{2}$

$S_n = 11866$

Original:
$\exists x \forall y (x \geq 2y \rightarrow x$

Converse:
$\exists x \forall y (x > y + 1 \rightarrow$

Negation:
$\neg[\exists x \forall y (\neg(x \geq 2y) \vee x$
$\forall x \exists y (x \geq 2y \wedge x \leq$

Contrapositive:
$\exists x \forall y (x \leq y + 1 \rightarrow$

$v - e + f = 2$

$(A \cup B \cup C) \cup (A \cap B \cap C)$

There are six dogs to give 13 tacos.
rs and bars' diagram to illustrate the first
dog get 3 tacos, the second dog gets none,
og gets 5 and the fourth dog gets one.

Data Structure?

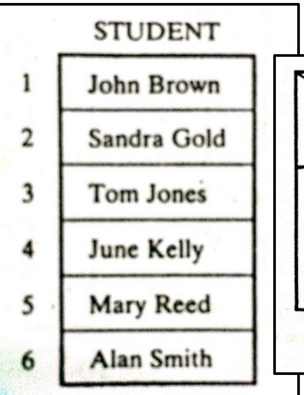
Data may be organized in many different ways.

The logical or mathematical model of a particular organization of data is called a data structure

✓ **Particular data model depends on TWO consideration**:

1. It must be rich enough in structure to mirror the actual relationships of the data in real world.
2. The structure should be simple enough that can be efficiently process the data when necessary.

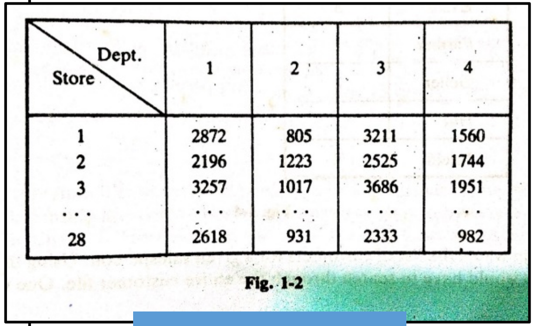
Some Data Structure



STUDENT

1	John Brown
2	Sandra Gold
3	Tom Jones
4	June Kelly
5	Mary Reed
6	Alan Smith

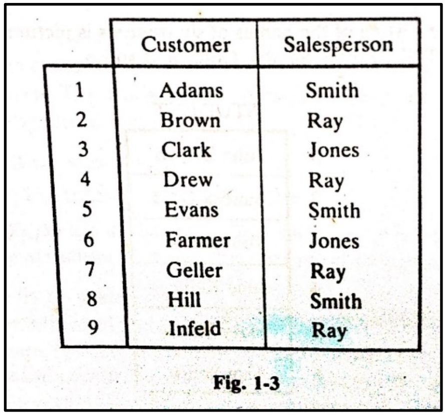
One D array



Store \ Dept.	1	2	3	4
1	2872	805	3211	1560
2	2196	1223	2525	1744
3	3257	1017	3686	1951
. . .	. . .	. . .	. . .	. . .
28	2618	931	2333	982

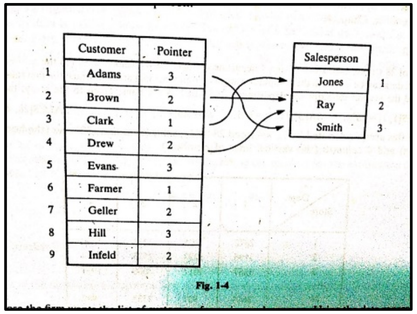
Fig. 1-2

Two D array



	Customer	Salesperson
1	Adams	Smith
2	Brown	Ray
3	Clark	Jones
4	Drew	Ray
5	Evans	Smith
6	Farmer	Jones
7	Geller	Ray
8	Hill	Smith
9	Infeld	Ray

Fig. 1-3

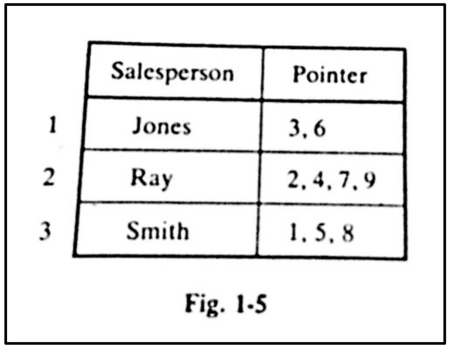


	Customer	Pointer
1	Adams	3
2	Brown	2
3	Clark	1
4	Drew	2
5	Evans	3
6	Farmer	1
7	Geller	2
8	Hill	3
9	Infeld	2

Salesperson	
Jones	1
Ray	2
Smith	3

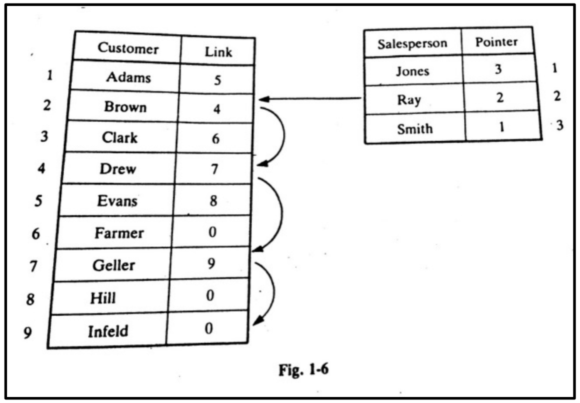
Fig. 1-4

Linked List



	Salesperson	Pointer
1	Jones	3, 6
2	Ray	2, 4, 7, 9
3	Smith	1, 5, 8

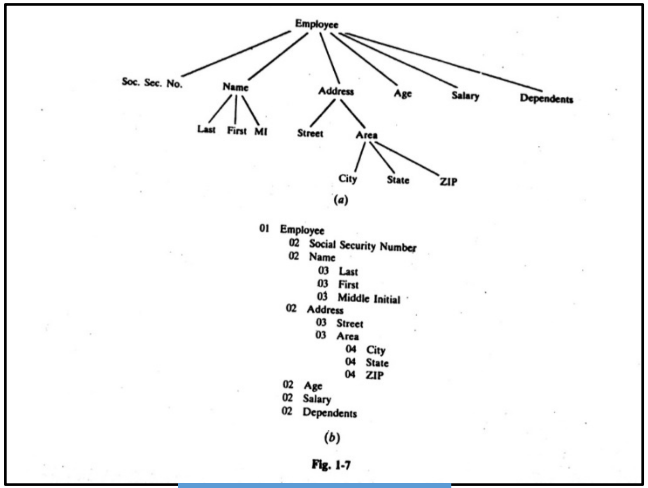
Fig. 1-5



	Customer	Link
1	Adams	5
2	Brown	4
3	Clark	6
4	Drew	7
5	Evans	8
6	Farmer	0
7	Geller	9
8	Hill	0
9	Infeld	0

Salesperson	Pointer	
Jones	3	1
Ray	2	2
Smith	1	3

Fig. 1-6



(a)

```
01  Employee
    02  Social Security Number
    02  Name
        03  Last
        03  First
        03  Middle Initial
    02  Address
        03  Street
        03  Area
            04  City
            04  State
            04  ZIP
    02  Age
    02  Salary
    02  Dependents
```

(b)

Fig. 1-7

Hierarchical

$(2x+y)(a-7b)^3$

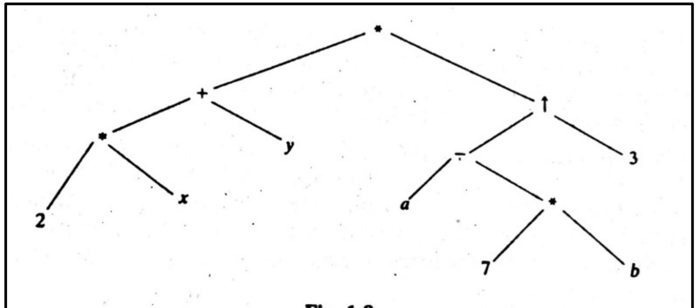
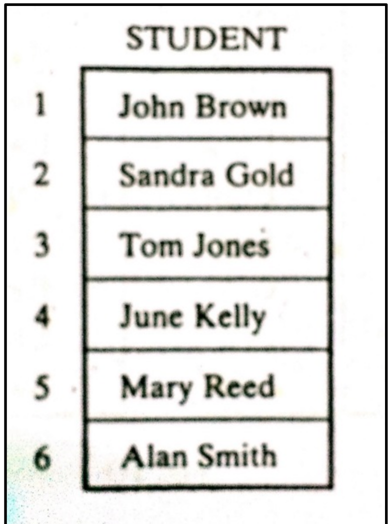


Fig. 1-8

Data Structure: Array

Simplest types of data structure

- One dimensional array /Linear

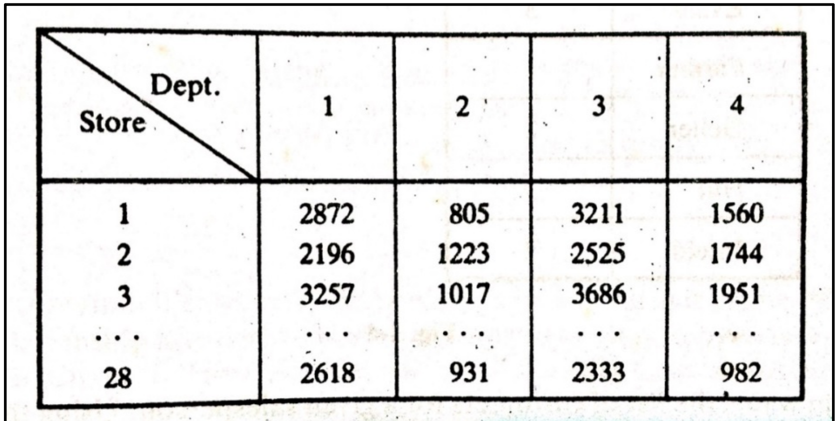


STUDENT

1	John Brown
2	Sandra Gold
3	Tom Jones
4	June Kelly
5	Mary Reed
6	Alan Smith

Fig. 1-1

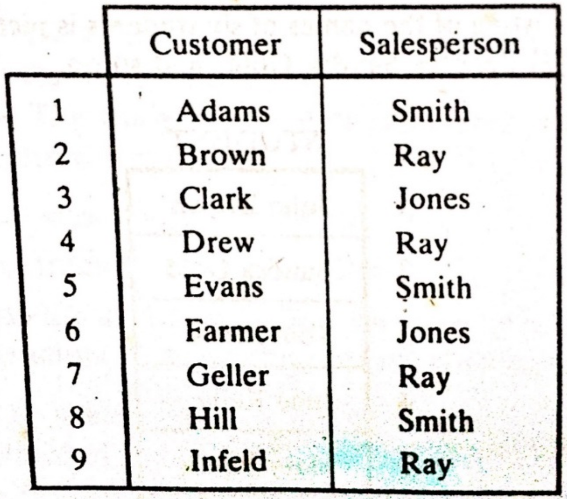
- Two dimensional Array



Dept. / Store	1	2	3	4
1	2872	805	3211	1560
2	2196	1223	2525	1744
3	3257	1017	3686	1951
. . .	. . .	. . .	. . .	. . .
28	2618	931	2333	982

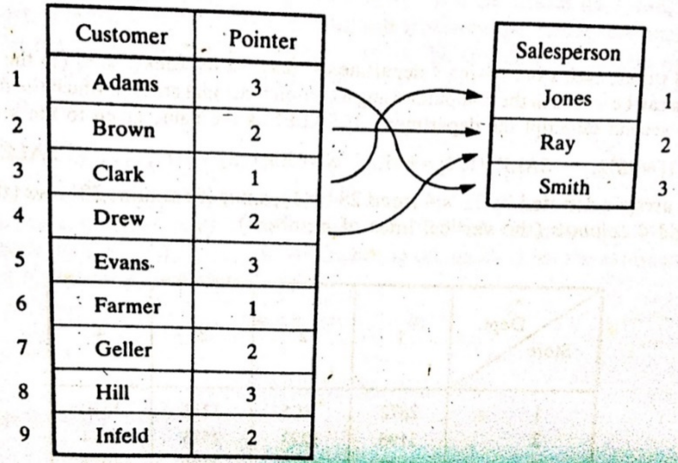
Fig. 1-2

Data Structure: Link List



	Customer	Salesperson
1	Adams	Smith
2	Brown	Ray
3	Clark	Jones
4	Drew	Ray
5	Evans	Smith
6	Farmer	Jones
7	Geller	Ray
8	Hill	Smith
9	Infeld	Ray

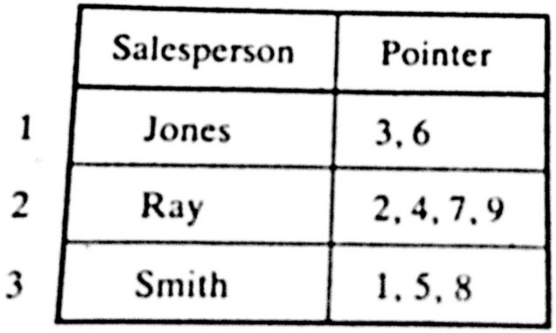
Fig. 1-3



	Customer	Pointer
1	Adams	3
2	Brown	2
3	Clark	1
4	Drew	2
5	Evans	3
6	Farmer	1
7	Geller	2
8	Hill	3
9	Infeld	2

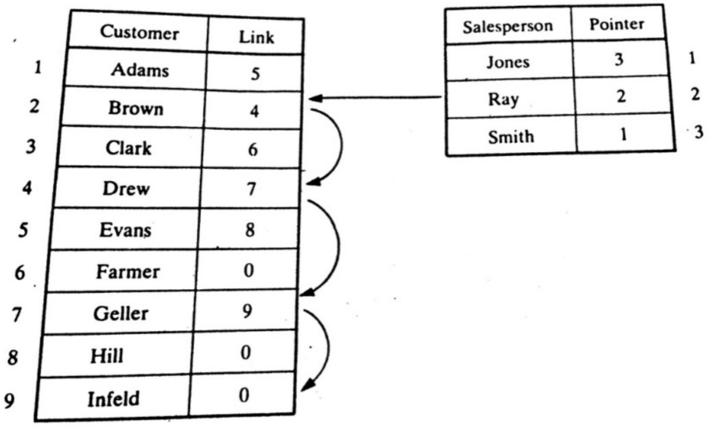
Salesperson	
Jones	1
Ray	2
Smith	3

Fig. 1-4



	Salesperson	Pointer
1	Jones	3, 6
2	Ray	2, 4, 7, 9
3	Smith	1, 5, 8

Fig. 1-5



	Customer	Link
1	Adams	5
2	Brown	4
3	Clark	6
4	Drew	7
5	Evans	8
6	Farmer	0
7	Geller	9
8	Hill	0
9	Infeld	0

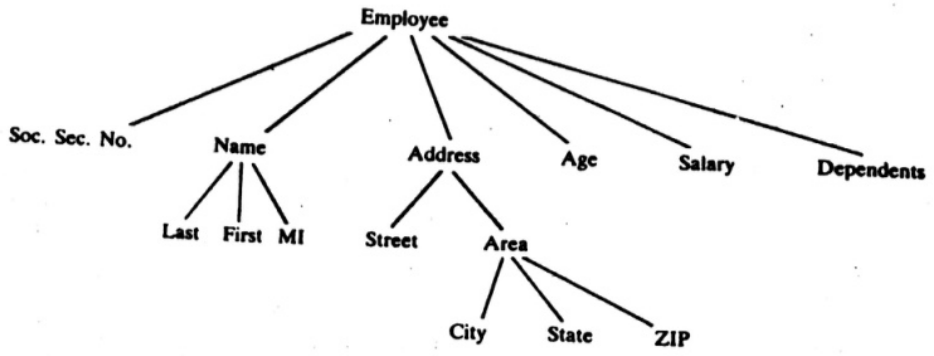
Salesperson	Pointer	
Jones	3	1
Ray	2	2
Smith	1	3

Fig. 1-6

Advantages: An integer used as a pointer requires less space than a name. Hence this representation saves spaces, if there are hundreds of customers for each salesman

Data Structure: Tree

Data frequently contain a hierarchical relationship between various elements. The data structure reflects this relationship is called a rooted tree graph or simply a tree



(*a*)

```
01  Employee
      02  Social Security Number
      02  Name
            03  Last
            03  First
            03  Middle Initial
      02  Address
            03  Street
            03  Area
                  04  City
                  04  State
                  04  ZIP
      02  Age
      02  Salary
      02  Dependents
```

(*b*)

Fig. 1-7

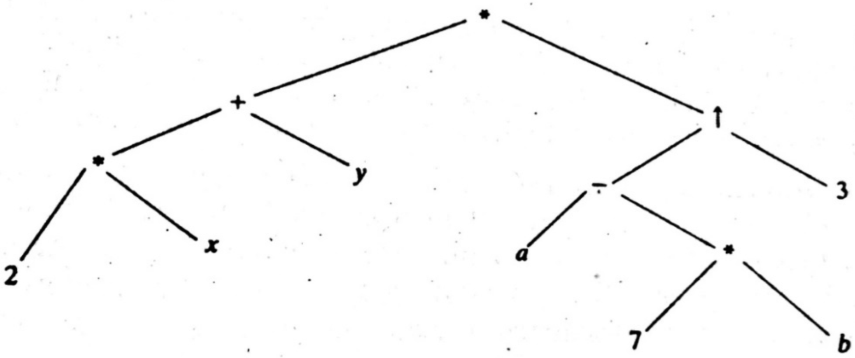
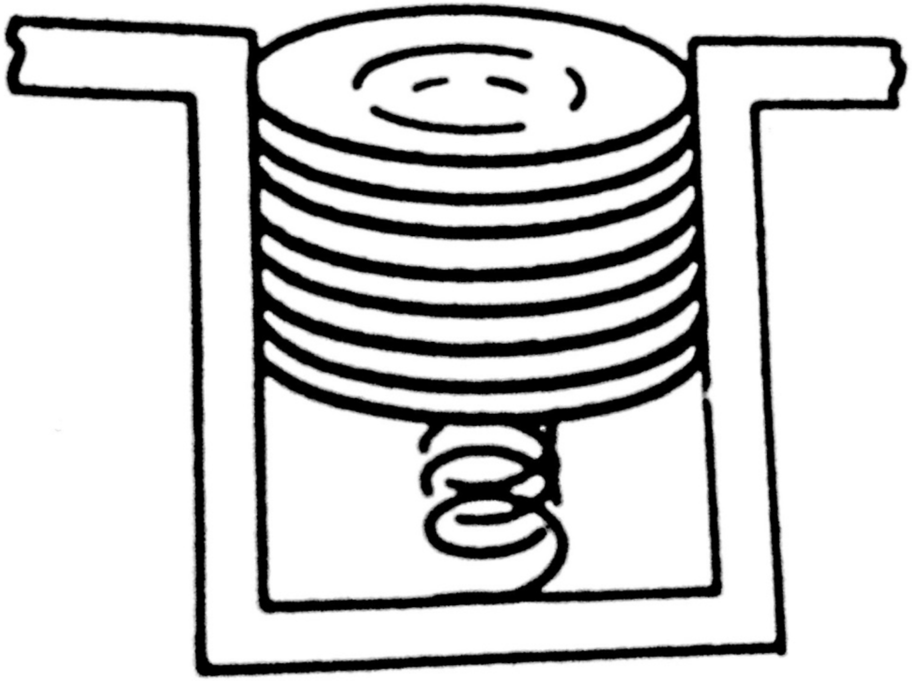


Fig. 1-8

Data Structure: Stack



(a) Stack of dishes.

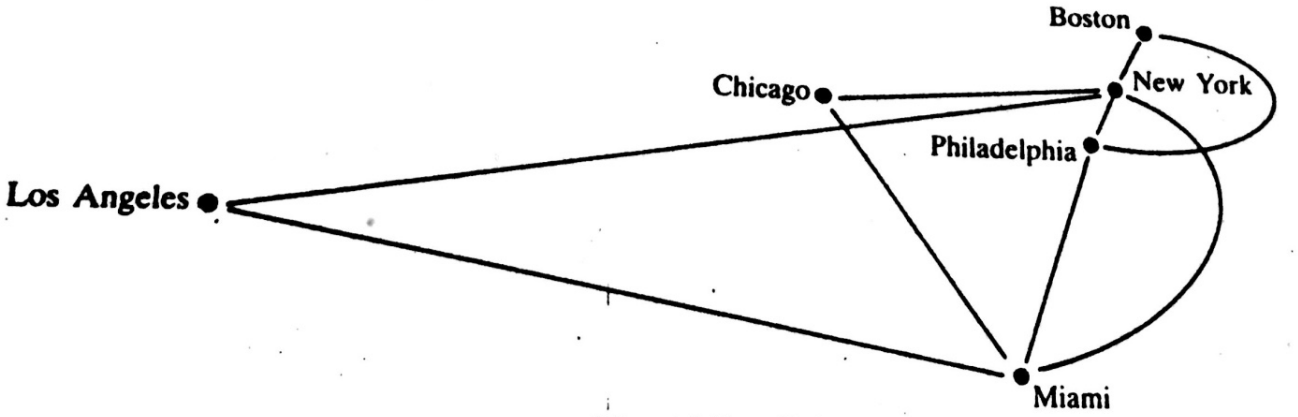
LIFO

Data Structure: Queue

(*b*) Queue waiting for a bus.

FIFO

Data Structure: Graph



(c) Airline flights.

Data Structure Operations

The data appearing in our data structure are processed by mean of certain operations.

The most frequently used of these operation are:

1. Traversing
2. Searching
3. Inserting
4. Deleting
5. Update
6. Sorting
7. Merging

Data Structure Operations

Accessing each record once so that certain items in the record may be processed (Visit).

Example:

An organization contains a membership file in which each record contains data for a given member:

Name Address Tel. Number Age Sex

(a) Suppose the organization wants to announce through a mailing.

(b) Suppose one wants to find the name of all members in a certain area.

Operation: Traversing

Data Structure Operations

Finding the location of the record with a given key value, or finding the locations of all records which satisfy one or more condition.

Example:

An organization contains a membership file in which each record contains data for a given member:

Name   Address   Tel. Number   Age   Sex

(a) Suppose one wants to obtain address for a given name.

Operation: Searching

Data Structure Operations

Adding a new record to the structure

Example:

An organization contains a membership file in which each record contains data for a given member:

Name Address Tel. Number Age Sex

(a) Suppose a new person joins the organization.

Operation: Inserting

Data Structure Operations

Removing a record from the structure

Example:

An organization contains a membership file in which each record contains data for a given member:

Name Address Tel. Number Age Sex

(a) Suppose a Member dies.

Operation: Deleting

Data Structure Operations

Changing items in the record with the new data

Example:

An organization contains a membership file in which each record contains data for a given member:

Name Address Tel. Number Age Sex

(a) Suppose a member has moved and has a new address and telephone number.

Operation: Updating

Data Structure Operations

Arranging the record in some logical order (e.g. alphabetically according to some NAME key)

Example:

An organization contains a membership file in which each record contains data for a given member:

NAME	**Address**	**Tel. Number**	**Age**	**Sex**

(a) Suppose One wants to obtain all the members list according to alphabetical order of their family name.

Operation: Sorting

Data Structure Operations

Combining the records in two different sorted files into a single sorted file.

Example: Exam Answer Script

Operation: Merging

Algorithms ?

An algorithm is a well-defined list of step for solving problem.

The efficiency of an algorithm is obtained by measuring the TIME and SPACE it uses.

Algorithms Notation

(Largest Element in Array) A nonempty array **DATA** with **N** numerical values is given. This algorithm finds the location **LOC** and the value **MAX** of the largest element of **DATA**. The variable **K** is used as counter.

```
• Step 1.   [Initialize] Set K:=1, LOC:=1 and MAX := DATA[1].

• Step 2.   [Increment counter.] Set K:=K+1.

• Step 3.   [Test counter.] If K>N, then:

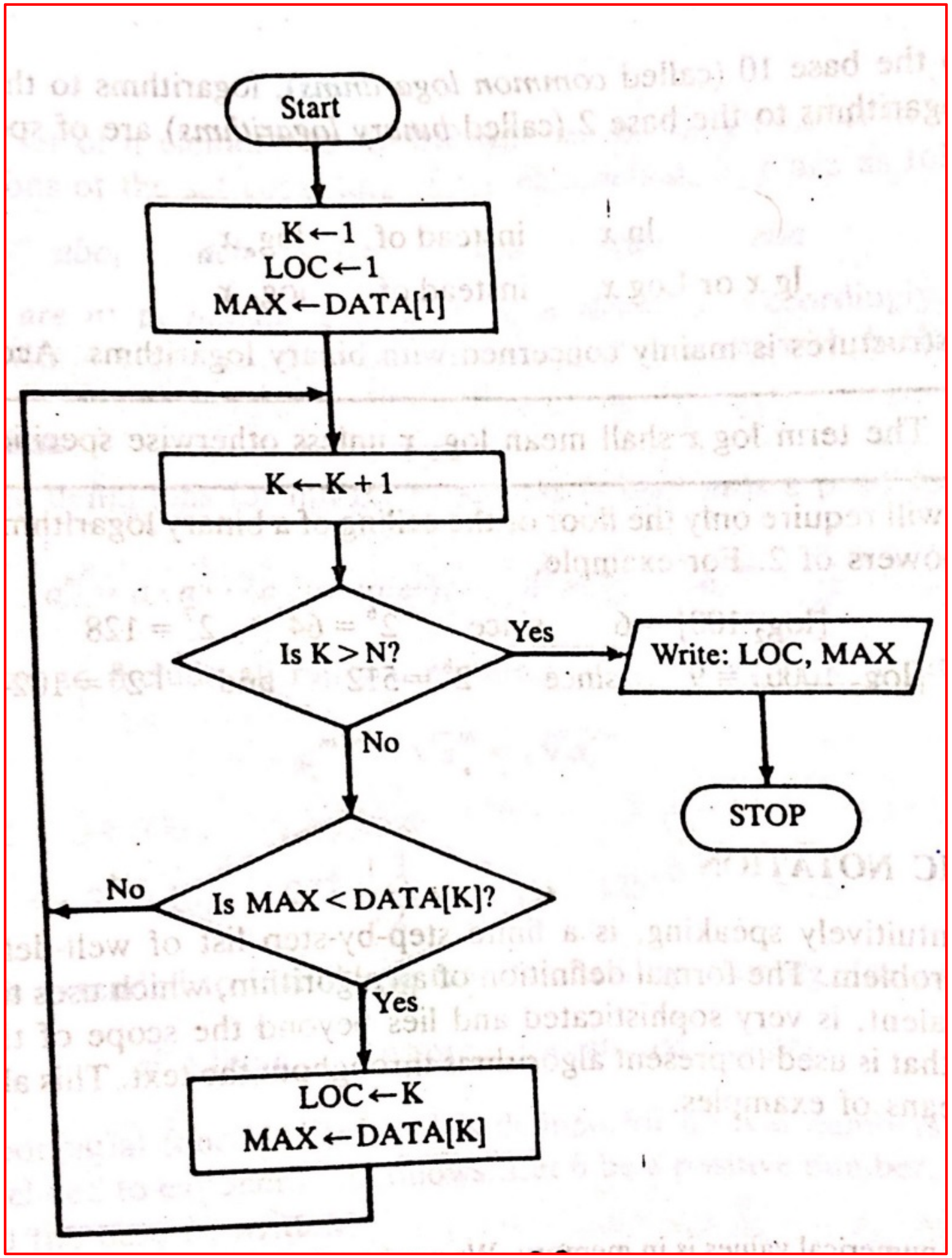
                Write: LOC, MAX, and Exit.

• Step 4. [Compare and update.] If MAX<DATA[K], then:

                Set LOC:=K and MAX := DATA[K].

• Step 5. [Repeat loop.] Go to Step 2.
```

Flowcharts


Start
K←1
LOC←1
MAX←DATA[1]
K←K+1
Is K>N?
Yes
Write: LOC, MAX
STOP
No
Is MAX<DATA[K]?
No
Yes
LOC←K
MAX←DATA[K]

Algorithms Notation

(Largest Element in Array) A nonempty array **DATA** with **N** numerical values is given. This algorithm finds the location **LOC** and the value **MAX** of the largest element of **DATA**. The variable **K** is used as counter.

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• Step 1.   [Initialize] Set K:=1, LOC:=1 and MAX := DATA[1].
• Step 2.   [Increment counter.] Set K:=K+1.
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                 Write: LOC, MAX, and Exit.
• Step 4. [Compare and update.] If MAX<DATA[K], then:
                 Set LOC:=K and MAX := DATA[K].
• Step5. [Repeat loop.] Go to Step 2.
```

✓ The Steps of the algorithm are executed one after the other, beginning with **Step 1**

✓ Control may be transferred to **Step n** of the algorithm by the statement "***Go to Step n***"

✓ If several statements appear in the same step, e.g.,

Set K:=1, LOC:=1 and MAX := DATA[1].

then they are executed from **LEFT TO RIGHT**

✓ The algorithm is completed when the statement

Exit. Is encountered.

Algorithms Notation

(Largest Element in Array) A nonempty array **DATA** with **N** numerical values is given. This algorithm finds the location **LOC** and the value **MAX** of the largest element of **DATA**. The variable **K** is used as counter.

```
• Step 1.  [Initialize] Set K:=1, LOC:=1 and MAX := DATA[1].
• Step 2.  [Increment counter.] Set K:=K+1.
• Step 3.  [Test counter.] If K>N, then:
               Write: LOC, MAX, and Exit.
• Step 4. [Compare and update.] If MAX<DATA[K], then:
               Set LOC:=K and MAX := DATA[K].
• Step5. [Repeat loop.] Go to Step 2.
```

✓ The [comment] will usually appear at the beginning or the end of the step.

✓ Variable names will use capital letters as in MAX and DATA.

- ➢ Single-letter names of variables used as counters or subscripts will also be capitalized in the algorithms (K and N, for example).

Algorithms Notation

(Largest Element in Array) A nonempty array **DATA** with **N** numerical values is given. This algorithm finds the location **LOC** and the value **MAX** of the largest element of **DATA**. The variable **K** is used as counter.

```
•  Step 1.  [Initialize] Set K:=1, LOC:=1 and MAX := DATA[1].
•  Step 2.  [Increment counter.] Set K:=K+1.
•  Step 3.  [Test counter.] If K>N, then:
                Write: LOC, MAX, and Exit.
•  Step 4. [Compare and update.] If MAX<DATA[K], then:
                Set LOC:=K and MAX := DATA[K].
•  Step5. [Repeat loop.] Go to Step 2.
```

✓ Assignment statements will use the dots-equal notation (:=).
For example, MAX := DATA[1]. (Some time ← or = is used for this operation

✓ Data may be input and assigned to variables by means of a Read statement
For example, Read: Variable names

✓ Similarly, data in variable may be output by mean of a **Write** or **Print** statement
For example, Write: Message and / or variable names.

Complexity of Algorithms

The complexity of an algorithm is the function which gives the running time and/or space in terms of the input size.

In order to compare algorithms, we must have some criteria to measure the efficiency of a algorithm.

Suppose ***M*** is an algorithm, and suppose ***n*** is the size of the input data.

The *TIME* and *SPACE* used by the algorithm M are the two main measures for the efficiency of *M.*

The TIME is measured by counting the number of key operation-in sorting and searching algorithms. (the # of comparison)

The SPACE is measured by counting the maximum of memory needed by the algorithm