ICE-2231
(Data Structures and Algorithms)

Lecture on
Chapter-1: Introduction

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Course Details

Course Code: ICE 2231

Course Title: Data Structure and Algorithms

Total Credit:3 , Total Marks: 75

Total Lecture: 33 (Section A and B)

Exam Duration: 3 H

Section-A

Introduction: Data types and data structures, Data structure operations, Introduction to algorithms, Performance analysis.

Arrays, Records and Pointer: Linear arrays, Relationships of arrays, Operation on arrays, Multidimensional arrays, Pointer arrays, Record structures, Representation of records, Sparse matrices.

Stacks, Queues and Recursion: Fundamentals, Different types of stacks and queues: Circular, Dequeues, etc., Evaluation of expressions, Recursion, Direct and indirect recursion, Depth of recursion, Implementation of recursive procedures by stacks.

Linked List: Linked lists, Representation of linked list, Traversing and searching a linked list, Doubly linked list and dynamic storage management, Generalized list, Garbage collection and compaction.

Section-B

Trees and Graphs: Basic terminology, Binary trees, Binary tree representation, Tree traversal, Extended binary tree, Huffman codes/algorithm, Graphs, Graph representation, Shortest path and transitive closure, Traversing a graph.

Sorting and Searching: : Sorting, Insertion sort, Shell sort, Heap sort, Radix sort, The general method of divide and conquer method, Merge sort, Quick sort, Selection sort, Binary search.

Symbol Tables: Static tree tables, Dynamic tree tables, Hash tables overflow handling, Theoretical evaluation of overflow techniques.

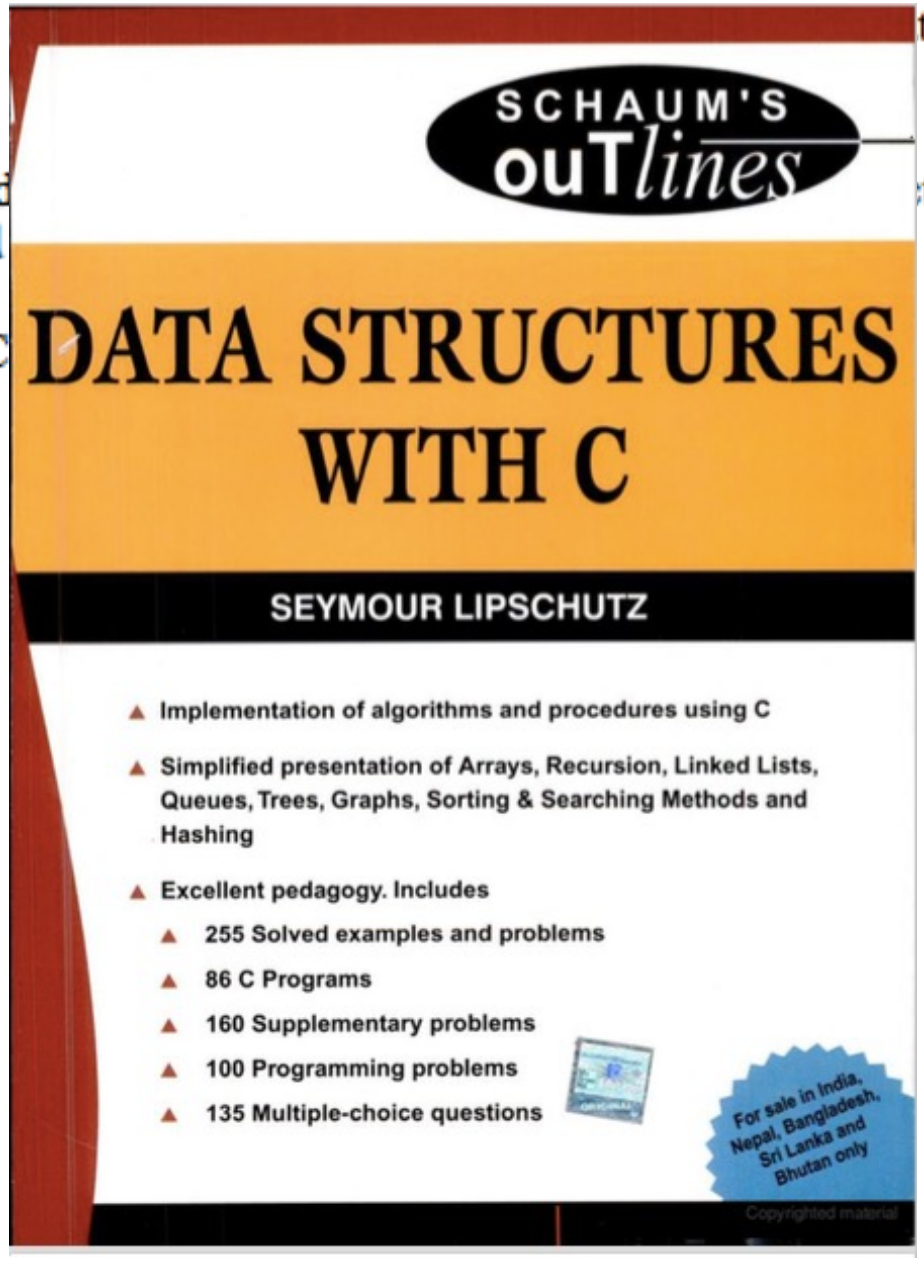
Dynamic Programming: The general method, multistage graphs, All pairs shortest paths, Single source shortest paths problems.

Text Books:

1. S Lipschutz ta Structures

Reference Books:

2. E. Horowitz and tures
3. E. Horowitz and
4. Reingold
5. T. H. Cormen, C



Section-A

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120

75

55

Seymour Lipschutz

- ✓ Data are simple values or set of values.
- ✓ Data item refers to a single unit of values
- ✓ Data items that are divided into sub-items are called group items.

For example:

An employee's name may be divided into three sub item…..

- ❖ First name
- ❖ Middle name
- ❖ Last Name

But, NID number would be normally be treated as a single item

120 km in distance

75 kgs in weight

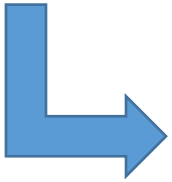
55 cm in height

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?

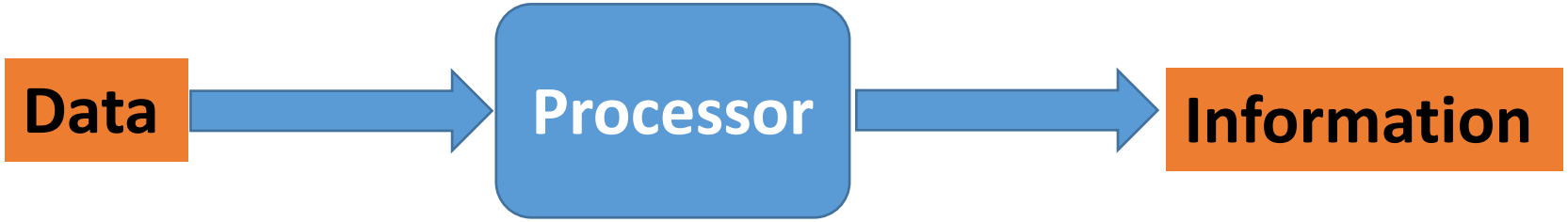
Entities with similar ATTRIBUTES form entity set.

Example:

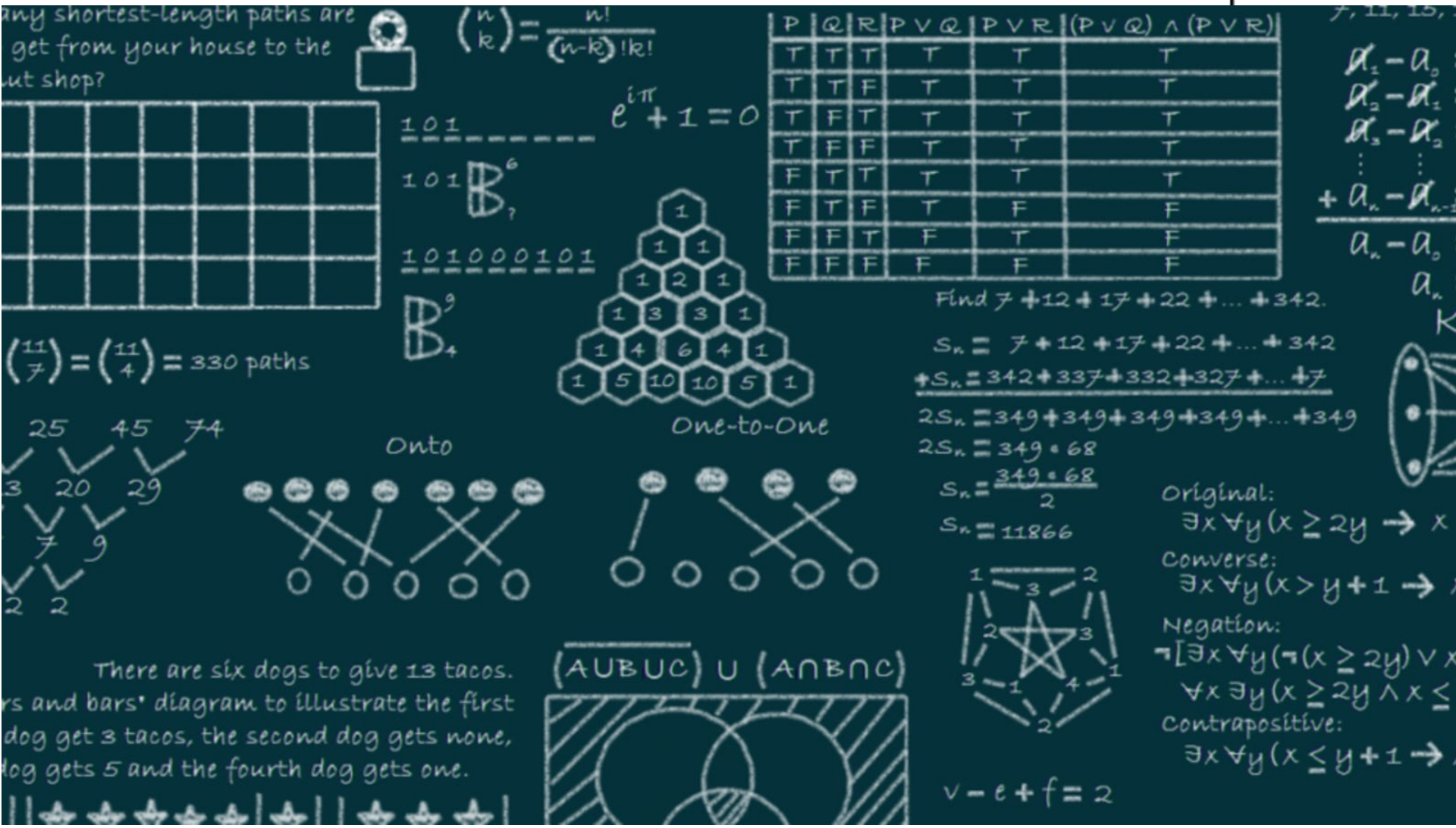
- All the employee in an organization
- All the students of any department.

✓**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?
$\binom{n}{k} = \frac{n!}{(n-k)!k!}$
$e^{i\pi} + 1 = 0$
101
101
1010000101
$\binom{11}{7} = \binom{11}{4} = 330$ 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 + ... + 342
+S_n = 342 + 337 + 332 + 327 + ... + 7
$2S_n$ = 349 + 349 + 349 + 349 + ... + 349
$2S_n$ = 349 • 68
$S_n = \frac{349 \cdot 68}{2}$
S_n = 11866
1 1 1 1 2 1 1 3 3 1 1 4 6 4 1 1 5 10 10 5 1
One-to-One
Onto
25 45 74
3 20 29
7 9
2 2
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,
dog gets 5 and the fourth dog gets one.
(AUBUC) U (A∩B∩C)
Original:
∃x∀y(x ≥ 2y → x
Converse:
∃x∀y(x > y+1 →
Negation:
¬[∃x∀y(¬(x ≥ 2y) ∨ x
∀x∃y(x ≥ 2y ∧ x ≤
Contrapositive:
∃x∀y(x ≤ y+1 →
v − e + f = 2

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

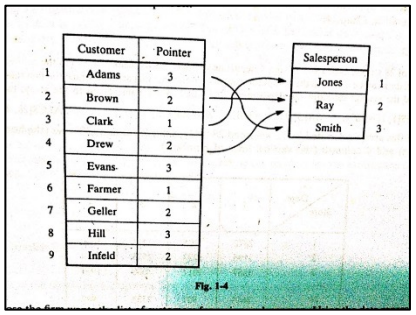


Fig. 1-4

Linked List

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

Fig. 1-5

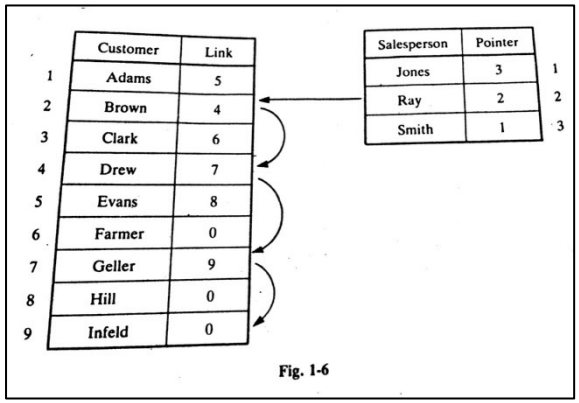


Fig. 1-6

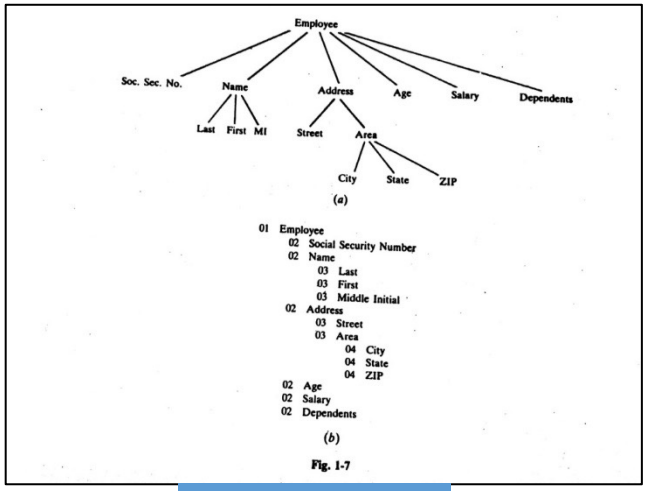


Fig. 1-7

Hierarchical

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

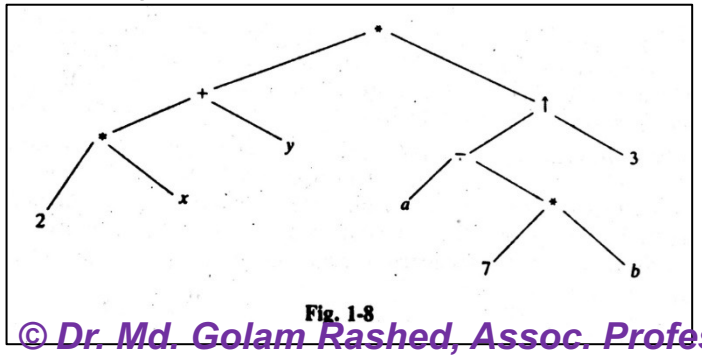


Fig. 1-8

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

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

Data Structure: Link List

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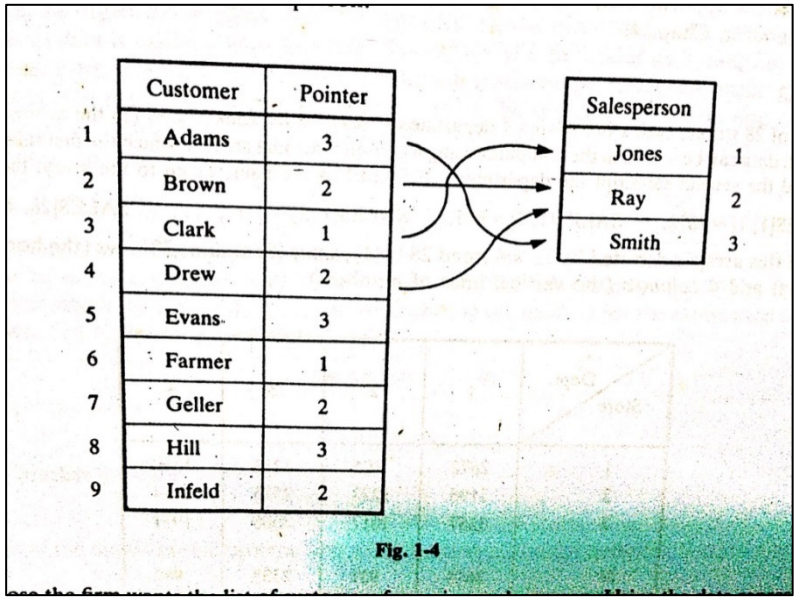
Fig. 1-3



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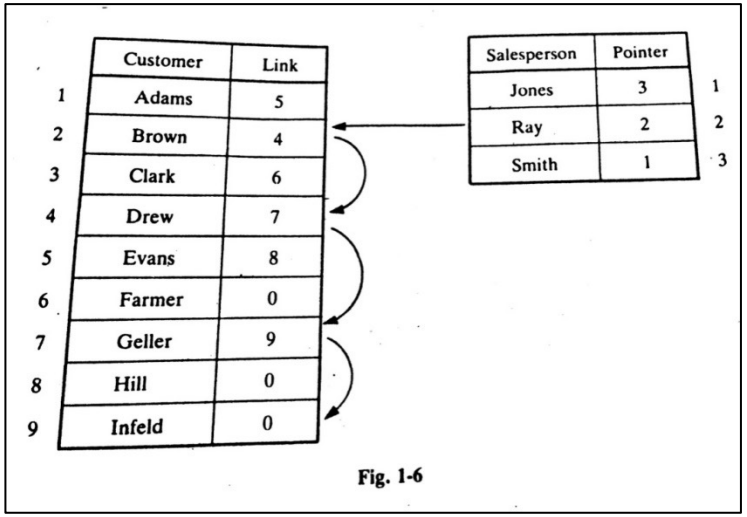
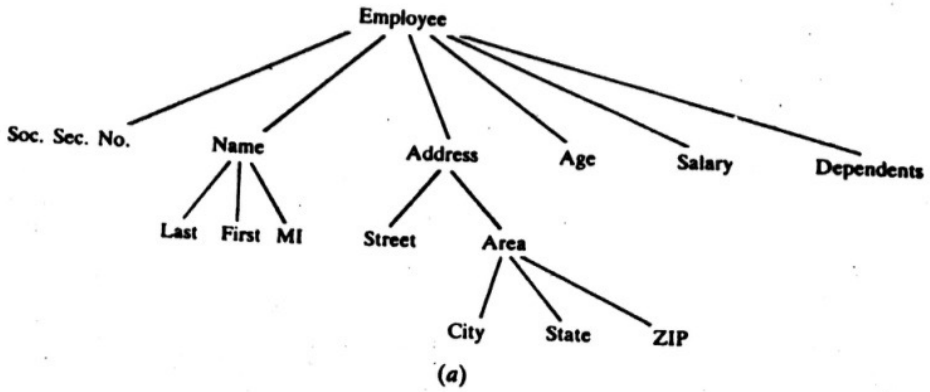


Fig. 1-6

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

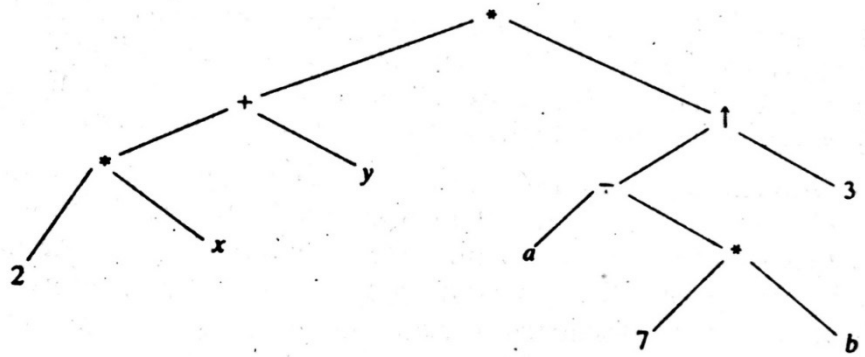
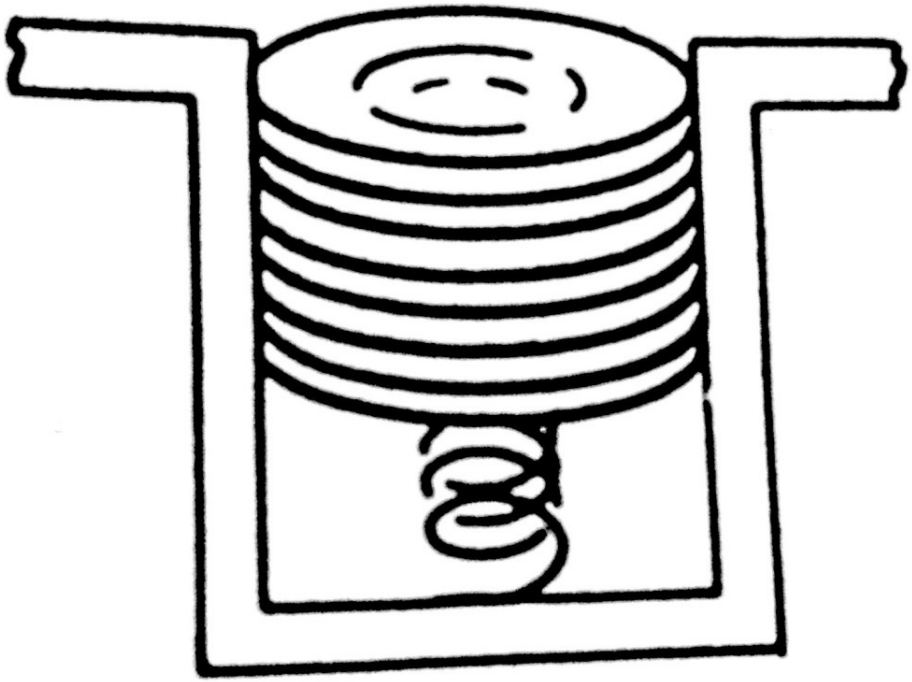


Fig. 1-8

Data Structure: Stack



(a) Stack of dishes.

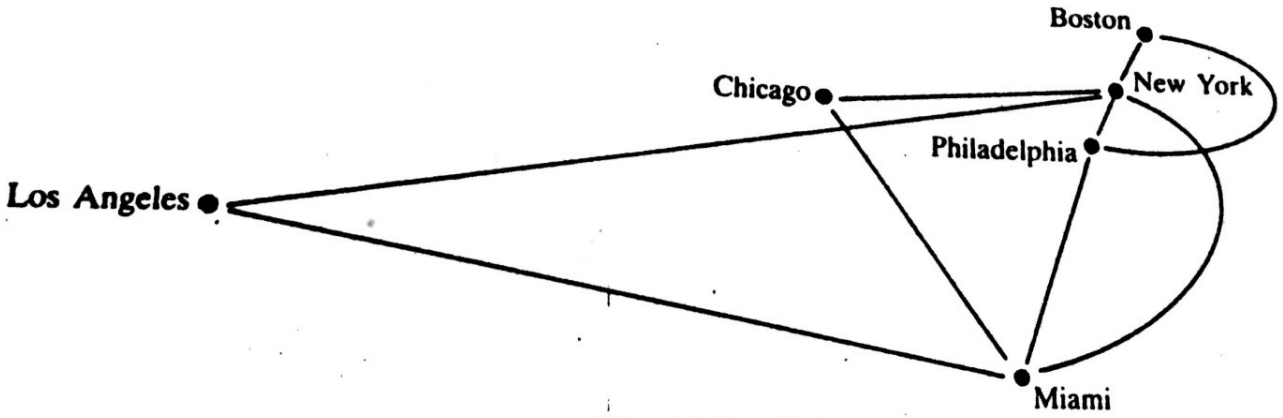
LIFO

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.**

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  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.

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- 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).

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  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.

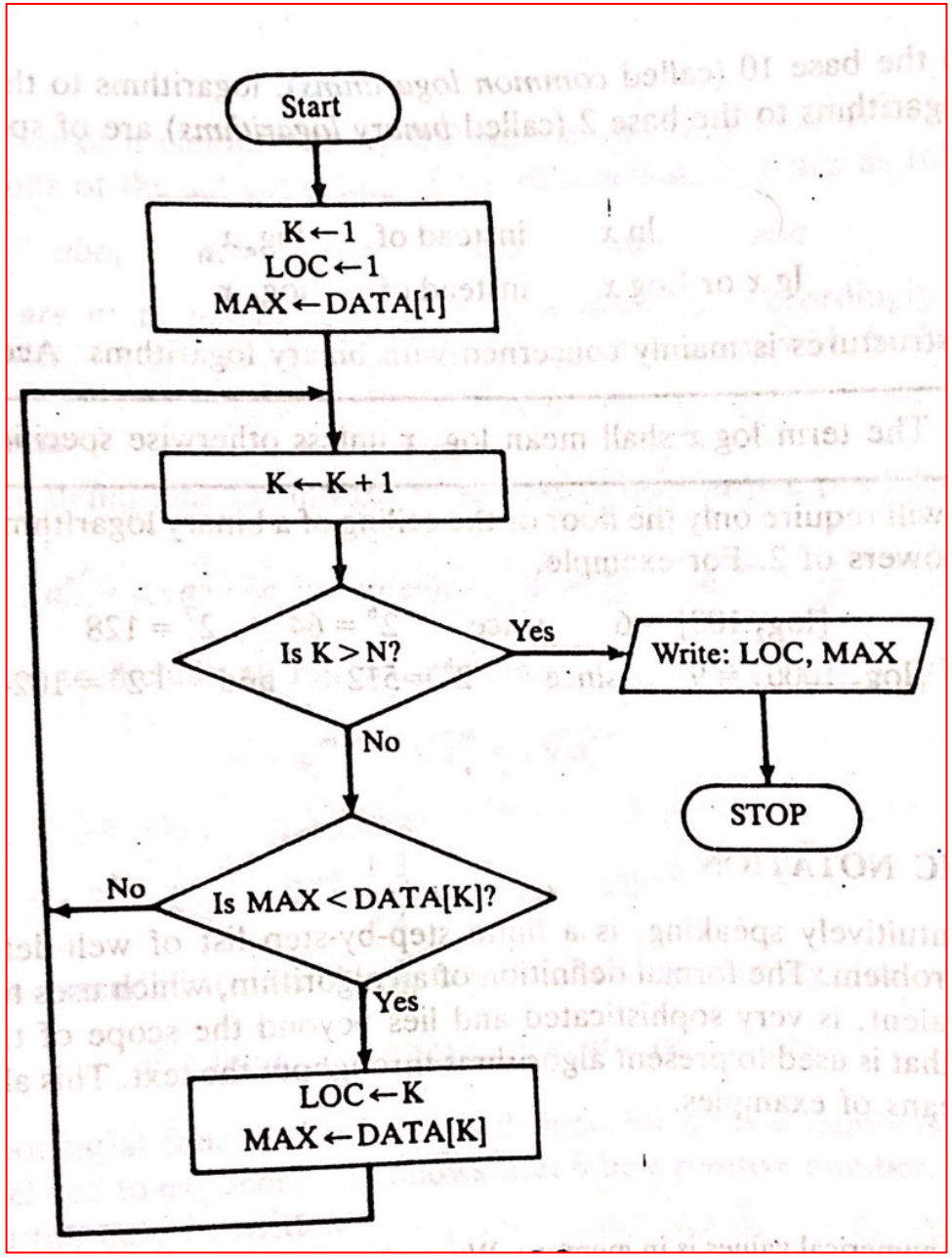
Suppose ***M*** is an algorithm, and suppose ***n*** is the size of the input data.

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

Flowcharts


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