Chapter 12

Abstract Data Type

OBJECTIVES

After reading this chapter, the reader should be able to:

- Understand the concept of an abstract data type (ADT).
- Understand the concept of a linear list as well as its operations and applications.
- Understand the concept of a stack as well as its operations and applications.
- Understand the concept of a queue as well as its operations and applications.
- Understand the concept of a tree as well as its operations and applications.
- Understand the concept of a graph as well as its operations and applications.

12.1

BACKGROUND

Note:

The concept of abstraction means:
1. You know what a data type can do.
2. How it is done is hidden.

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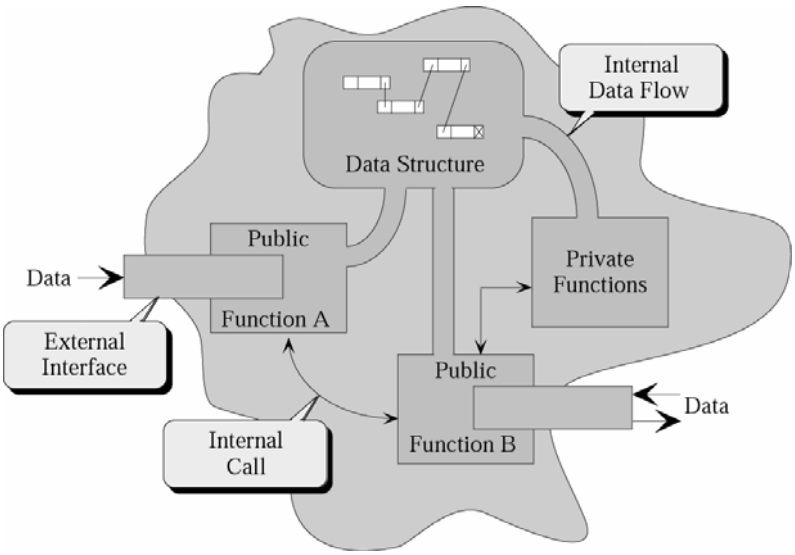
Abstract Data Type

1. ***Declaration of data***
2. ***Declaration of operations***
3. ***Encapsulation of data and operations***

Figure 12-1

Model for ADT



12.2

LINEAR LISTS

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Figure 12-2

Linear list

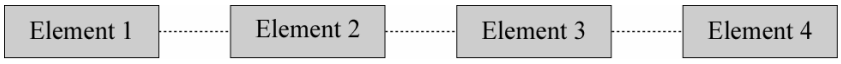

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Figure 12-3

Categories of linear lists

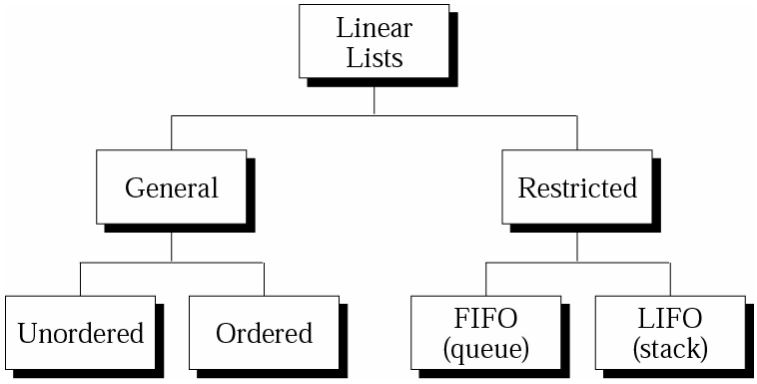

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Figure 12-5

Deletion from a linear list

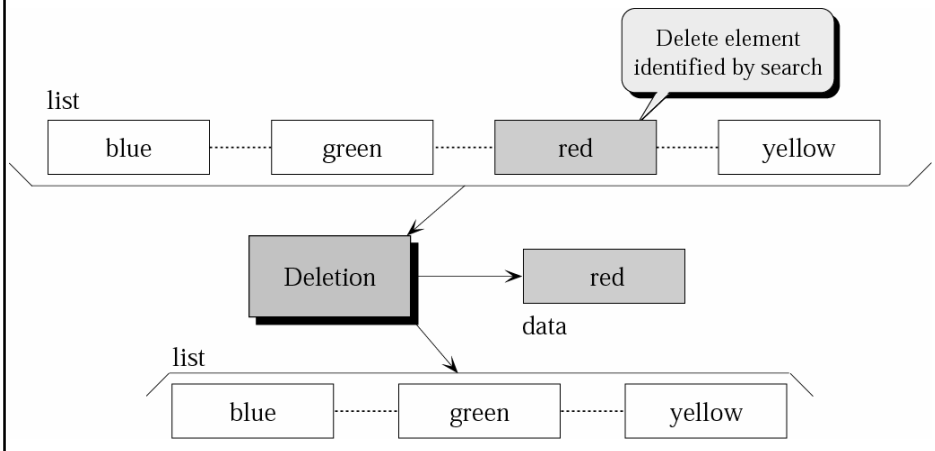

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Figure 12-6

Retrieval from a linear list

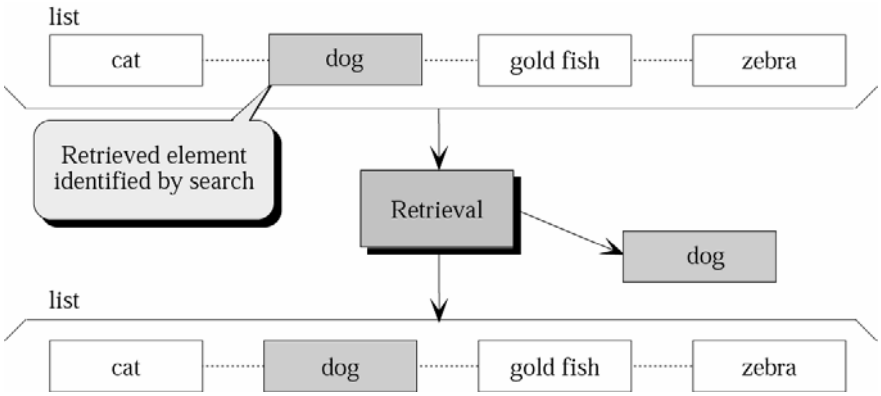

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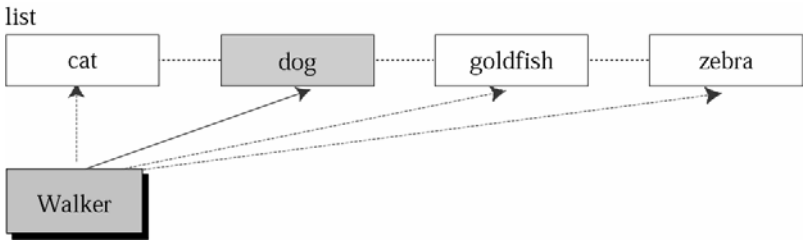
Figure 12-7

Traversal of a linear list



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12.3 STACKS

Figure 12-8

Three representations of a stack

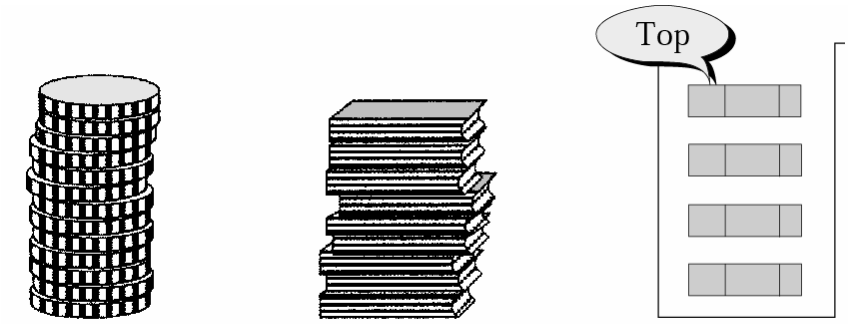

Figure 12-9

Push operation in a stack

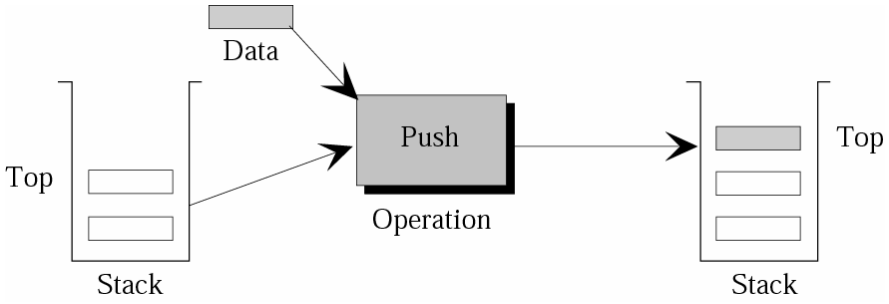

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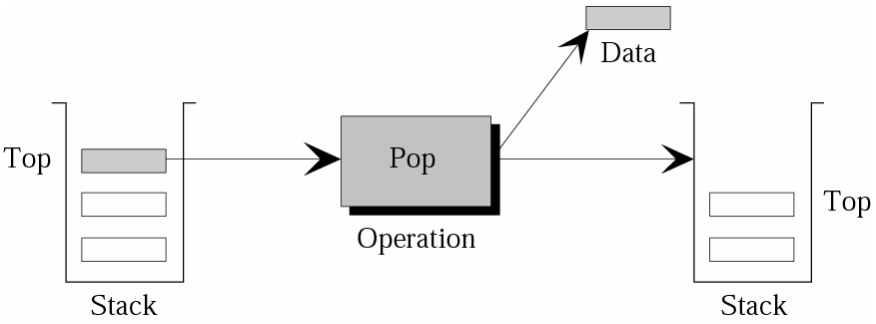
Figure 12-10

Pop operation in a stack



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Example 1

Show the result of the following operations on a stack S.

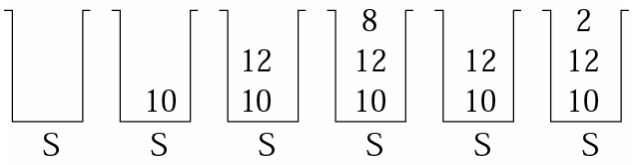
push (S , 10)
push (S , 12)
push (S , 8)
if not empty (S), then pop (S)
push (S , 2)

Solution

See Figure 12.11 (next slide).

Figure 12-11

Example 1



12.4 QUEUES

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Figure 12-12

Queue representation

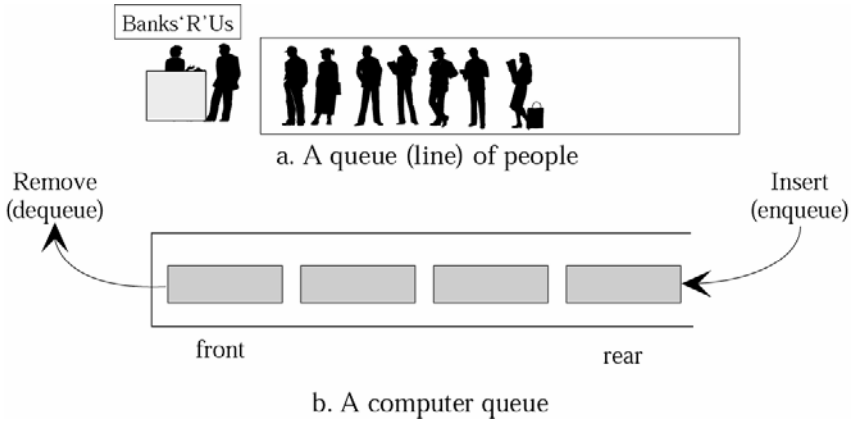

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Figure 12-13

Enqueue operation

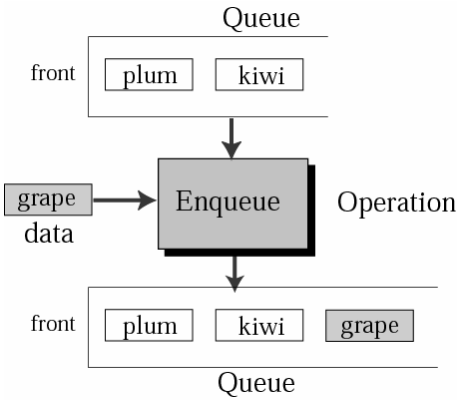

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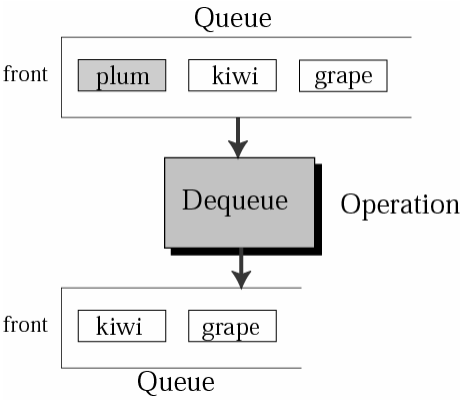
Figure 12-14

Dequeue operation



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Example 2

Show the result of the following operations on a queue Q.

enqueue (Q , 23)
if not empty (Q), dequeue (Q)
enqueue (Q , 20)
enqueue (Q , 19)
if not empty (Q), dequeue (Q)

Solution

See Figure 12.15 (next slide).

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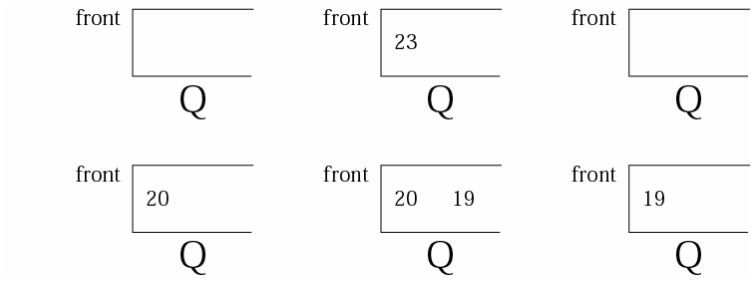
Figure 12-15

Example 2



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12.5 TREES

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Figure 12-16

Representation of a tree

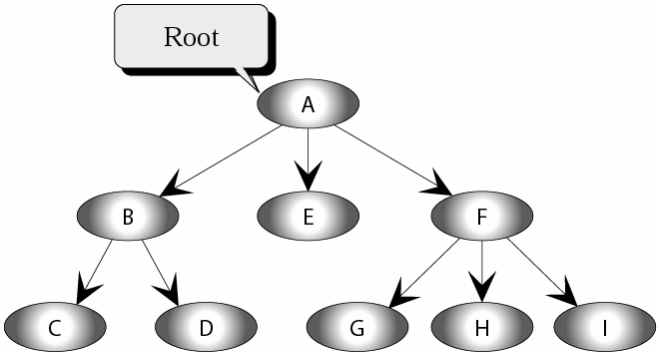

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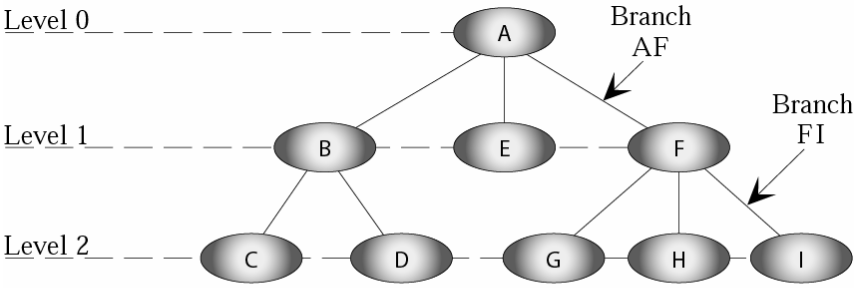
Figure 12-17

Tree terminology



Parents:	A, B, F	Leaves	C, D, E, G, H, I
Children:	B, E, F, C, D, G, H, I	Internal nodes	B, F
Siblings:	{B,E,F}, {C,D}, {G,H,I}		

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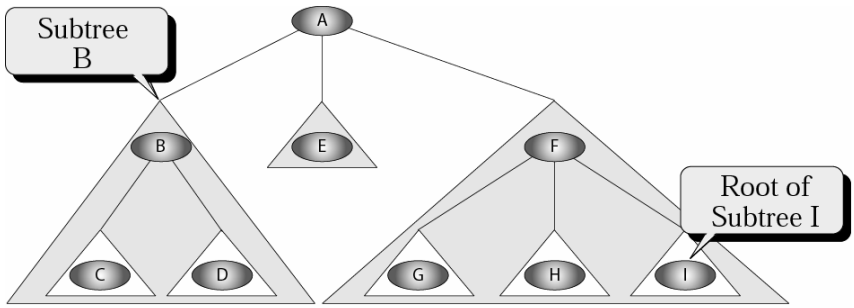
Figure 12-18

Subtrees



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12.6 BINARY TREES

Figure 12-19

Binary tree

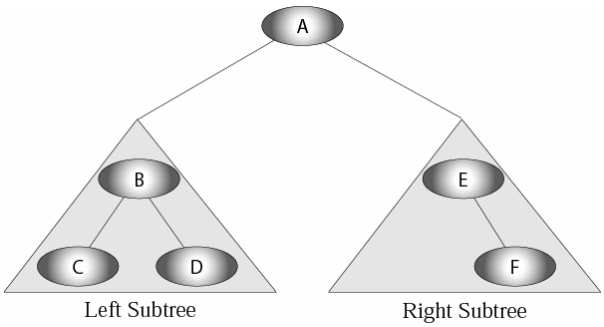

Figure 12-20

Examples of binary trees

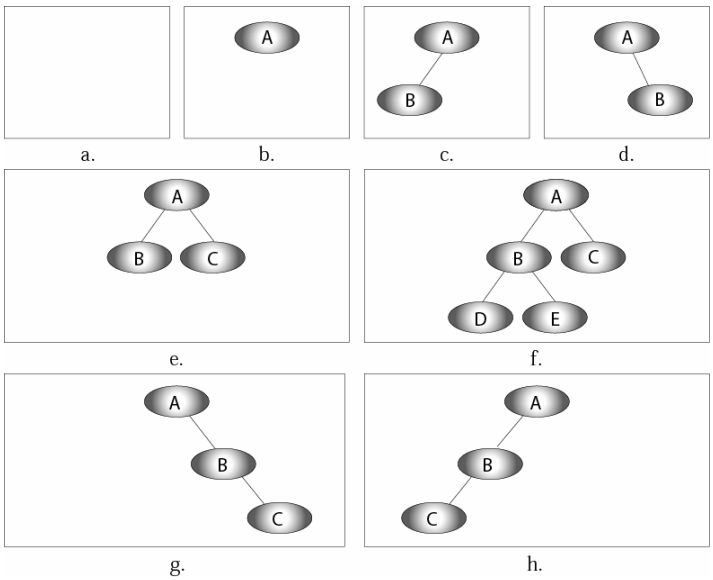

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Figure 12-21

Depth-first traversal of a binary tree

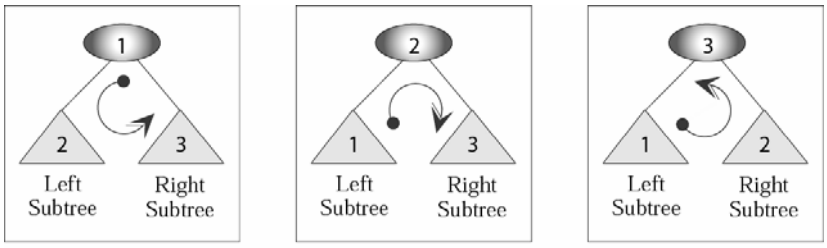

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Figure 12-22

Preorder traversal of a binary tree

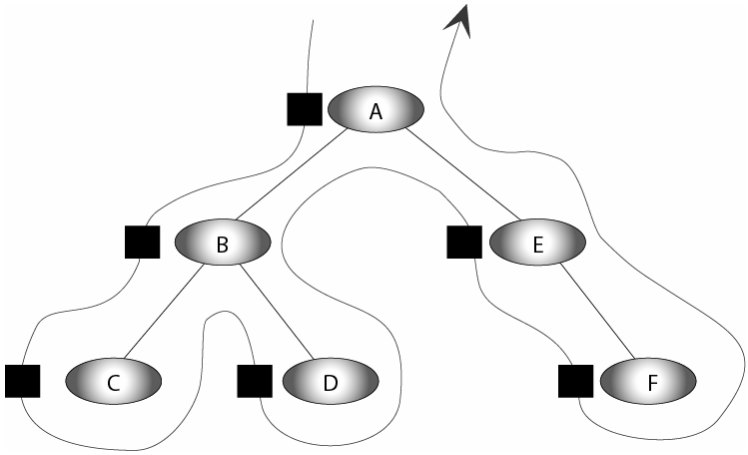

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Figure 12-23

Inorder traversal of a binary tree

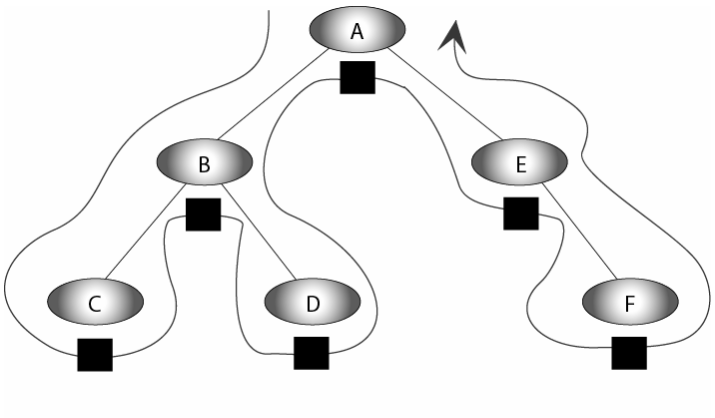

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Figure 12-24

Postorder traversal of a binary tree

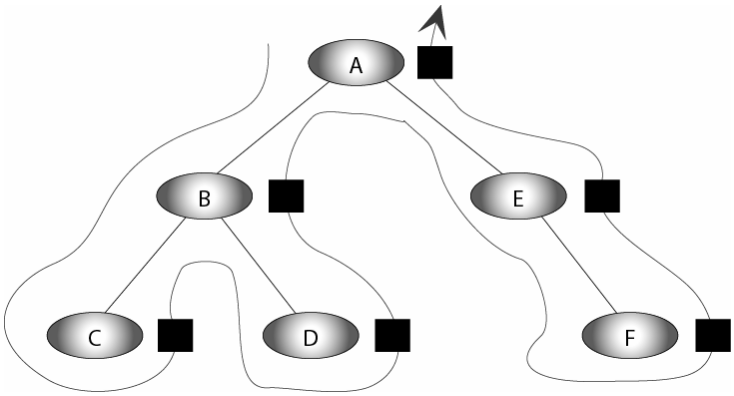

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Figure 12-25

Breadth-first traversal & Depth-first traversal of a binary tree

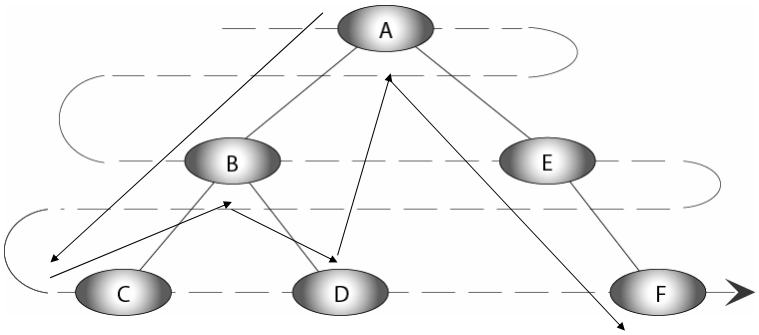

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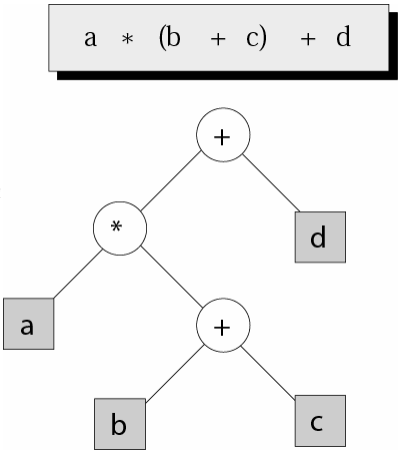
Figure 12-26

Expression tree

Leaf node: operand
Internal: operators
Subtree: subexpression
Use inorder traversal



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12.7 GRAPHS

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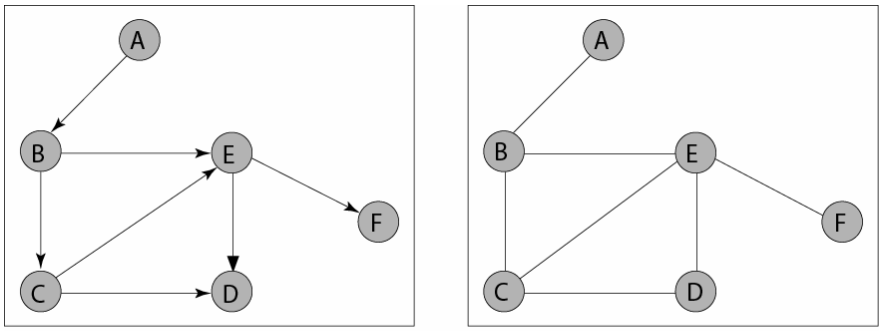
Figure 12-27

Directed and undirected graphs

Graph: G={V,E} V: vertices, E: edges



a. Directed Graph b. Undirected Graph

Figure 12-33

Depth-first traversal of a graph

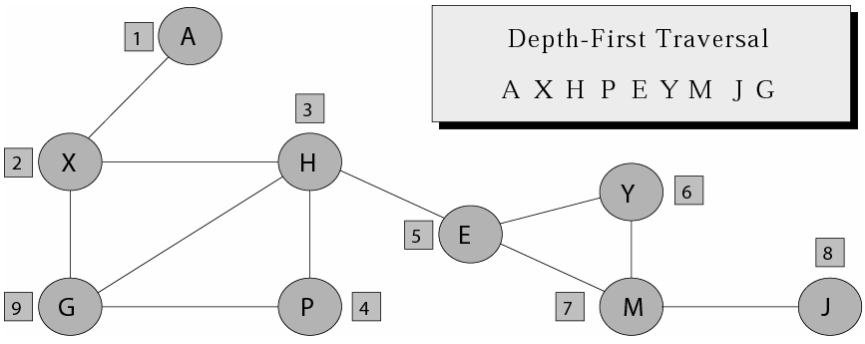


Figure 12-34

Breadth-first traversal of a graph

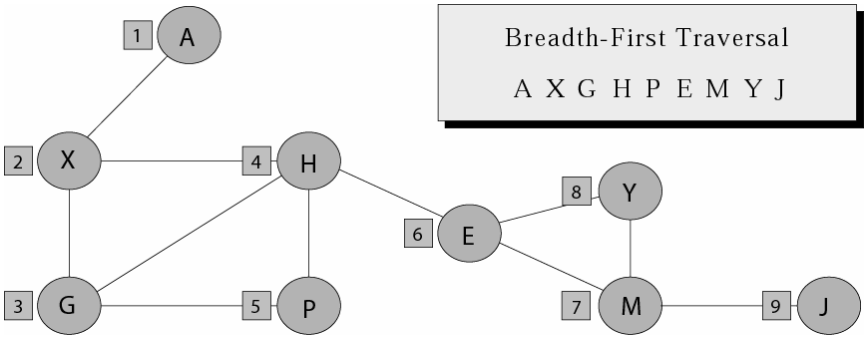


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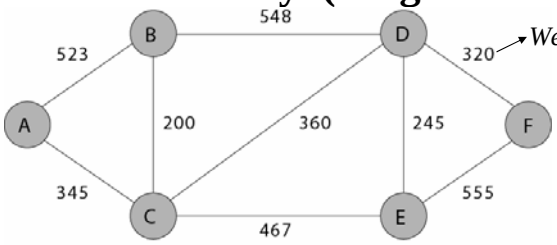
Figure 12-35: Part I

Graph implementations
Use array (#edges is large)



	A	B	C	D	E	F
A	0	523	345	0	0	0
B	523	0	200	548	0	0
C	345	200	0	360	467	0
D	0	548	360	0	245	320
E	0	0	467	245	0	555
F	0	0	0	320	555	0

Vertex Array

Adjacency Matrix

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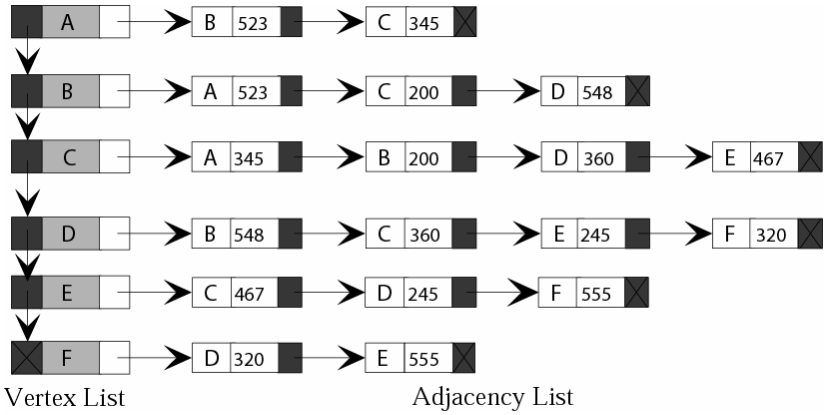
Figure 12-35: Part 2

Graph implementations
Link list (#edges is large)



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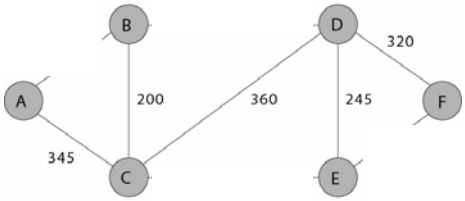
Minimum Spanning Tree



Spanning tree: A tree that contains all the vertices in the graph.
Min. spanning tree: A spanning tree with min. weight.
Applications:
Example:The shortest length of cable to connect all computers.

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