CS 440 Theory of Algorithms

Fundamental Data Structures

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Fundamental Data Structures

- **Linear structures**
  - **Array**
  - **Linked list**
    - **Singly linked list**
    - **Doubly linked list**
  - **Stack**
  - **Queue**
- **Graph**
  - **Adjacency matrix**
  - **Adjacency list**
- **Trees**
  - **Binary trees**
  - **Binary search trees**

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Array and Linked List

FIGURE 1.3 Array of n elements

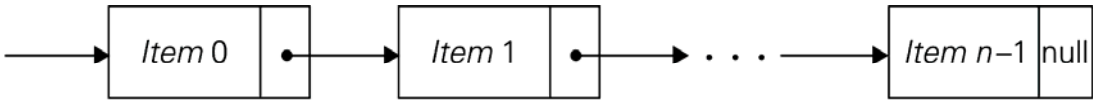

FIGURE 1.4 Singly linked list of n elements

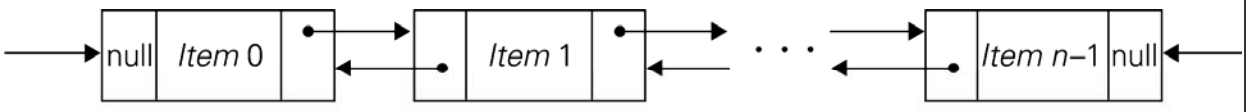

FIGURE 1.5 Doubly linked list of n elements

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Graph

FIGURE 1.6 (a) Undirected graph. (b) Digraph.

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Graph Representations

	a	b	c	d	e	f
a	0	0	1	1	0	0
b	0	0	1	0	0	1
c	1	1	0	0	1	0
d	1	0	0	0	1	0
e	0	0	1	1	0	1
f	0	1	0	0	1	0

(a)

a	→	c	→	d		
b	→	c	→	f		
c	→	a	→	b	→	e
d	→	a	→	e		
e	→	c	→	d	→	f
f	→	b	→	e		

(b)

FIGURE 1.7 (a) Adjacency matrix and (b) adjacency lists of the graph in Figure 1.6a

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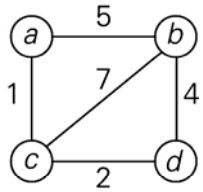
Graph Representations



(a)

	a	b	c	d
a	∞	5	1	∞
b	5	∞	7	4
c	1	7	∞	2
d	∞	4	2	∞

(b)

a	→ b, 5 → c, 1
b	→ a, 5 → c, 7 → d, 4
c	→ a, 1 → b, 7 → d, 2
d	→ b, 4 → c, 2

(c)

FIGURE 1.8 (a) Weighted graph. (b) Its weight matrix. (c) Its adjacency lists.

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Graph – Disconnected Graph

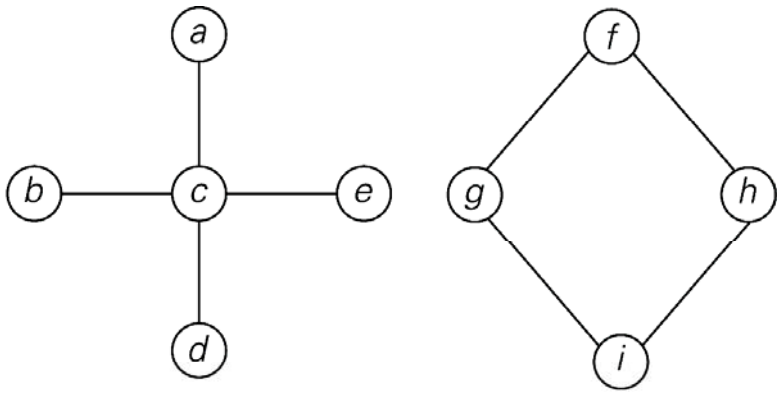

FIGURE 1.9 Graph that is not connected

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Tree

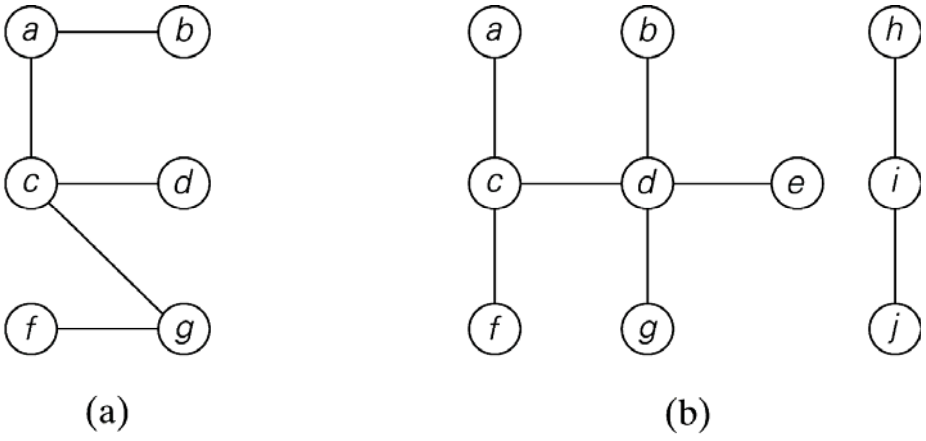

FIGURE 1.10 (a) Tree. (b) Forest.

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Rooted Tree

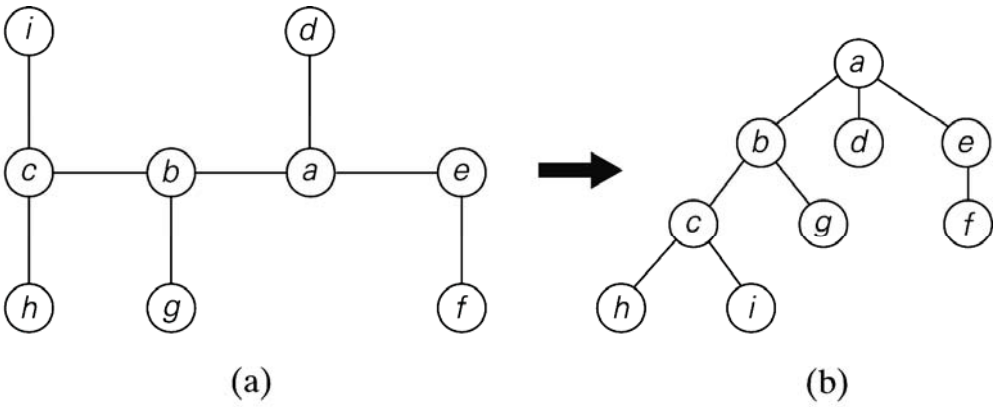

FIGURE 1.11 (a) Free tree. (b) Its transformation into a rooted tree.

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Binary Tree and Binary Search Tree

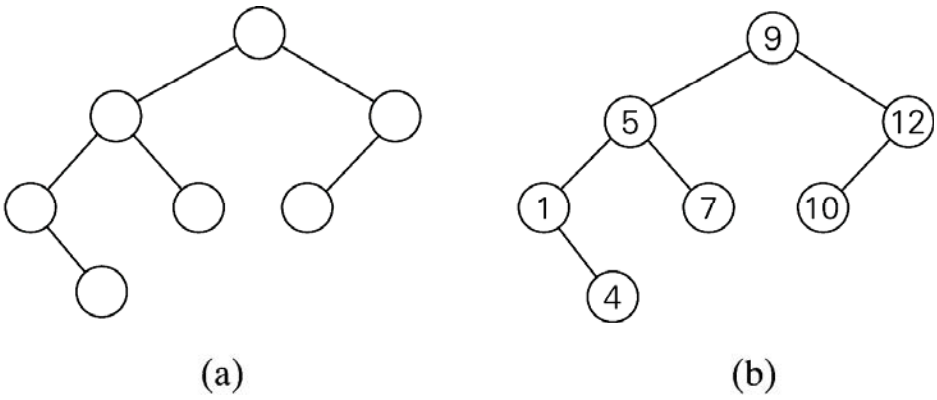

FIGURE 1.12 (a) Binary tree. (b) Binary search tree.

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Binary Search Tree

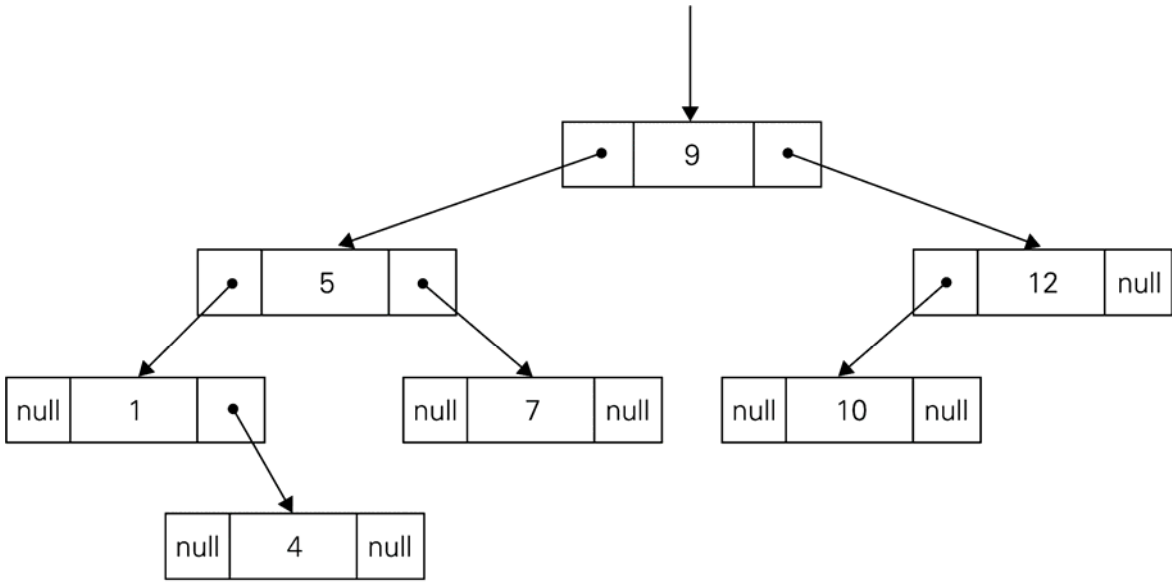

FIGURE 1.13 Standard implementation of the binary search tree in Figure 1.12b

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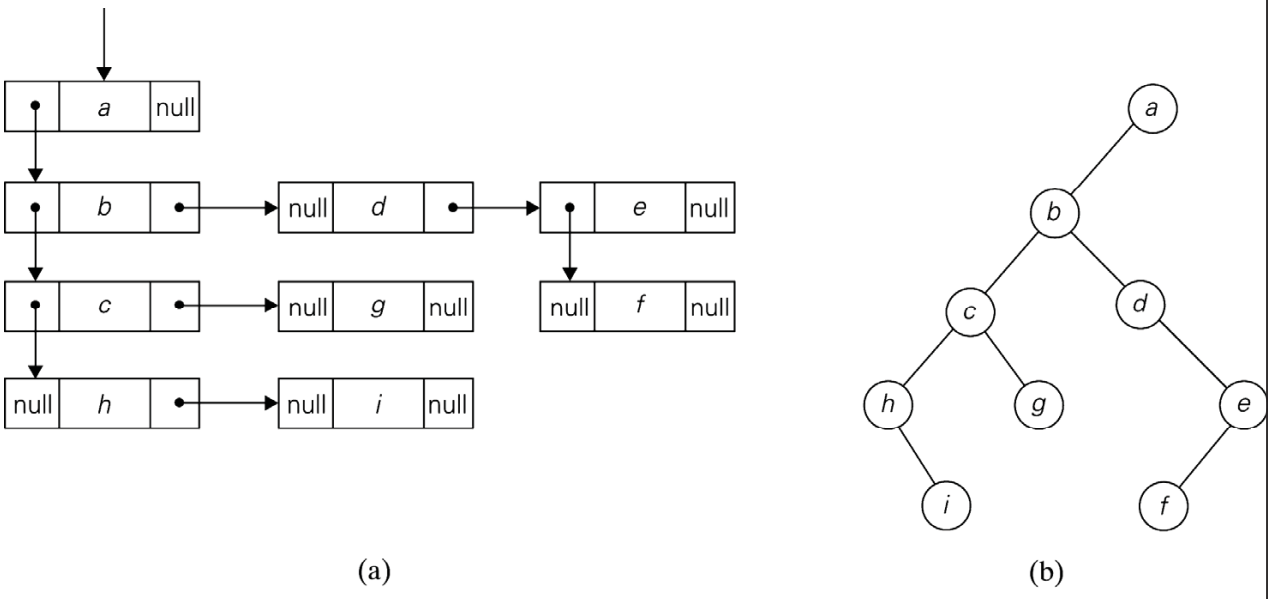
General Tree Representation



(a) (b)

FIGURE 1.14 (a) First child–next sibling representation of the graph in Figure 1.11b. (b) Its binary tree representation.

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