



Design and Analysis of Algorithms

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DESIGN AND ANALYSIS OF ALGORITHMS

Important Problem Types

Slides courtesy of **Anany Levitin**

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Important Problem Types



- sorting
- searching
- string processing
- graph problems
- combinatorial problems
- geometric problems
- numerical problems

- Rearrange the items of a given list in ascending order.
 - Input: A sequence of n numbers $\langle a_1, a_2, \dots, a_n \rangle$
 - Output: A reordering $\langle a'_1, a'_2, \dots, a'_n \rangle$ of the input sequence such that $a'_1 \leq a'_2 \leq \dots \leq a'_n$.
- Why sorting?
 - Help searching
 - Algorithms often use sorting as a key subroutine.
- Sorting key

A specially chosen piece of information used to guide sorting.
Example: sort student records by SRN.

- Rearrange the items of a given list in ascending order.
- Examples of sorting algorithms
 - Selection sort
 - Bubble sort
 - Insertion sort
 - Merge sort
 - Heap sort ...
- Evaluate sorting algorithm complexity: the number of key comparisons.
- Two properties
 - Stability: A sorting algorithm is called stable if it preserves the relative order of any two equal elements in its input.
 - In place : A sorting algorithm is in place if it does not require extra memory, except, possibly for a few memory units.

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Important Problem Types: Searching



Find a given value, called a **search key**, in a given set.

Examples of searching algorithms

- Sequential searching
- Binary searching...

A string is a sequence of characters from an alphabet.

Text strings: letters, numbers, and special characters.

String matching: searching for a given word/pattern in a text.

Text: I am a **computer** science graduate

Pattern: computer

Definition

Graph G is represented as a pair $G = (V, E)$,
where V is a finite set of vertices and E is a finite set of edges

Modeling real-life problems

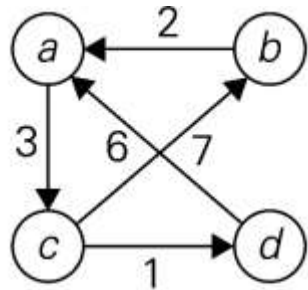
- Modeling WWW
- communication networks
- Project scheduling ...

Examples of graph algorithms

- Graph traversal algorithms
- Shortest-path algorithms
- Topological sorting

Shortest paths in a graph

To find the distances from each vertex to all other vertices.



(a)

$$W = \begin{matrix} & \begin{matrix} a & b & c & d \end{matrix} \\ \begin{matrix} a \\ b \\ c \\ d \end{matrix} & \begin{bmatrix} 0 & \infty & 3 & \infty \\ 2 & 0 & \infty & \infty \\ \infty & 7 & 0 & 1 \\ 6 & \infty & \infty & 0 \end{bmatrix} \end{matrix}$$

(b)

$$D = \begin{matrix} & \begin{matrix} a & b & c & d \end{matrix} \\ \begin{matrix} a \\ b \\ c \\ d \end{matrix} & \begin{bmatrix} 0 & 10 & 3 & 4 \\ 2 & 0 & 5 & 6 \\ 7 & 7 & 0 & 1 \\ 6 & 16 & 9 & 0 \end{bmatrix} \end{matrix}$$

(c)

FIGURE 8.5 (a) Digraph. (b) Its weight matrix. (c) Its distance matrix.

Minimum cost spanning tree

- A spanning tree of a connected graph is its connected acyclic sub graph (i.e. a tree).

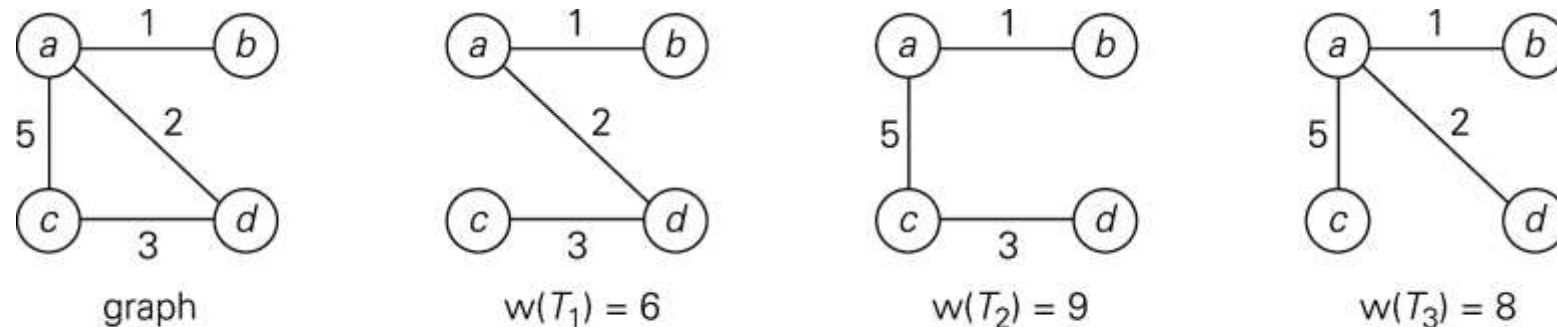
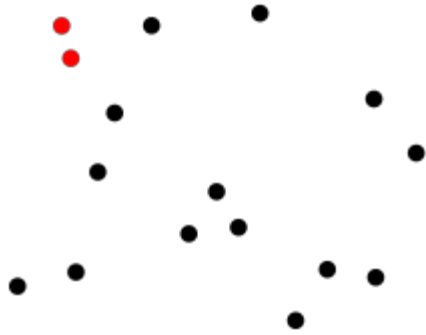
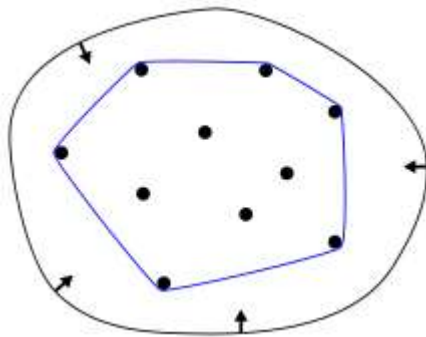


FIGURE 9.1 Graph and its spanning trees; T_1 is the minimum spanning tree

Closest Pair problem



Convex Hull Problem



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Important Problem Types: Numerical Problems

- Solving Equations
- Computing definite integrals
- Evaluating functions





THANK YOU

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