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

Important Problem Types: Sorting

- Rearrange the items of a given list in ascending order.
  - Input: A sequence of n numbers <a1, a2, …, an>
  - Output: A reordering <a'_1, a'_2, …, a'_n> of the input sequence such that $a'_1 \leq a'_2 \leq \ldots \leq a'_n$.
- 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.

Important Problem Types: Sorting

- 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.

Important Problem Types: Searching

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

Examples of searching algorithms

- Sequential searching
- Binary searching…

Important Problem Types: String Processing

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

Important Problem Types: Graph Problems

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

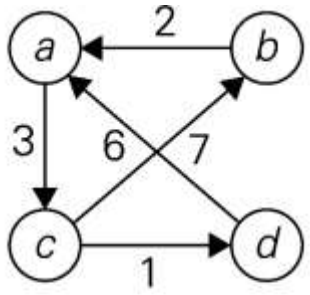
- Modeling WWW
- communication networks
- Project scheduling …

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)

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

(b)

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

(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).

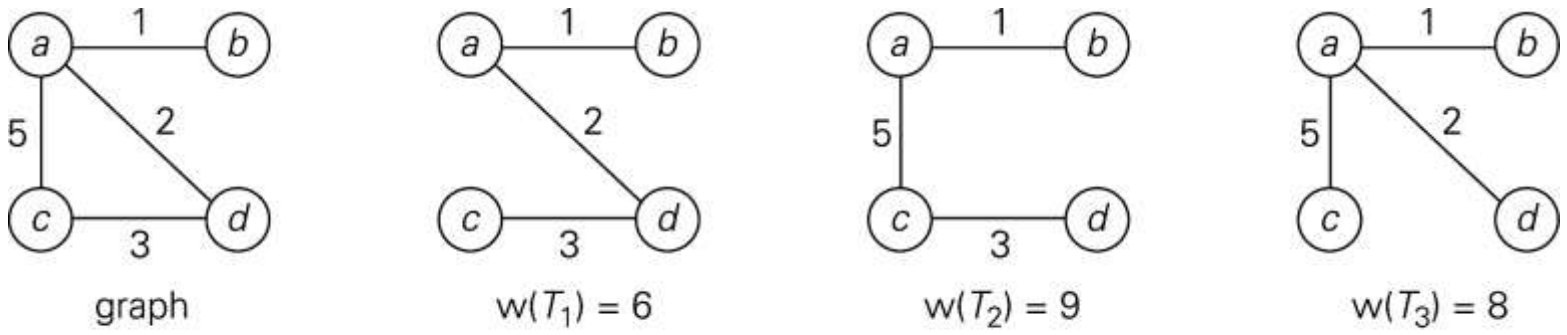


FIGURE 9.1 Graph and its spanning trees; T_1 is the minimum spanning tree

Important Problem Types: Geometric Problems

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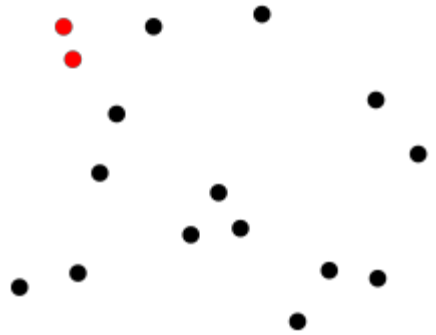
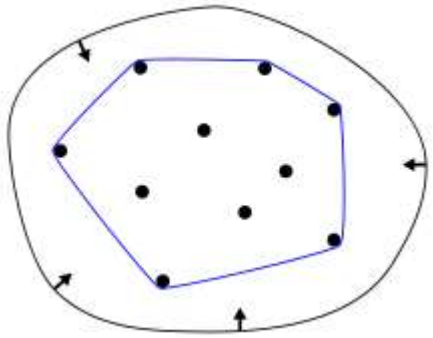
Closest Pair problem



Convex Hull Problem



Important Problem Types: Numerical Problems

- Solving Equations
- Computing definite integrals
- Evaluating functions

THANK YOU

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