§Introduction

Why should we study algorithms?

- Sorting algorithms

11, 7, 14, 1, 5, 9, 10
↓ sort
1, 5, 7, 9, 10, 11, 14

Insertion sort
Quick sort

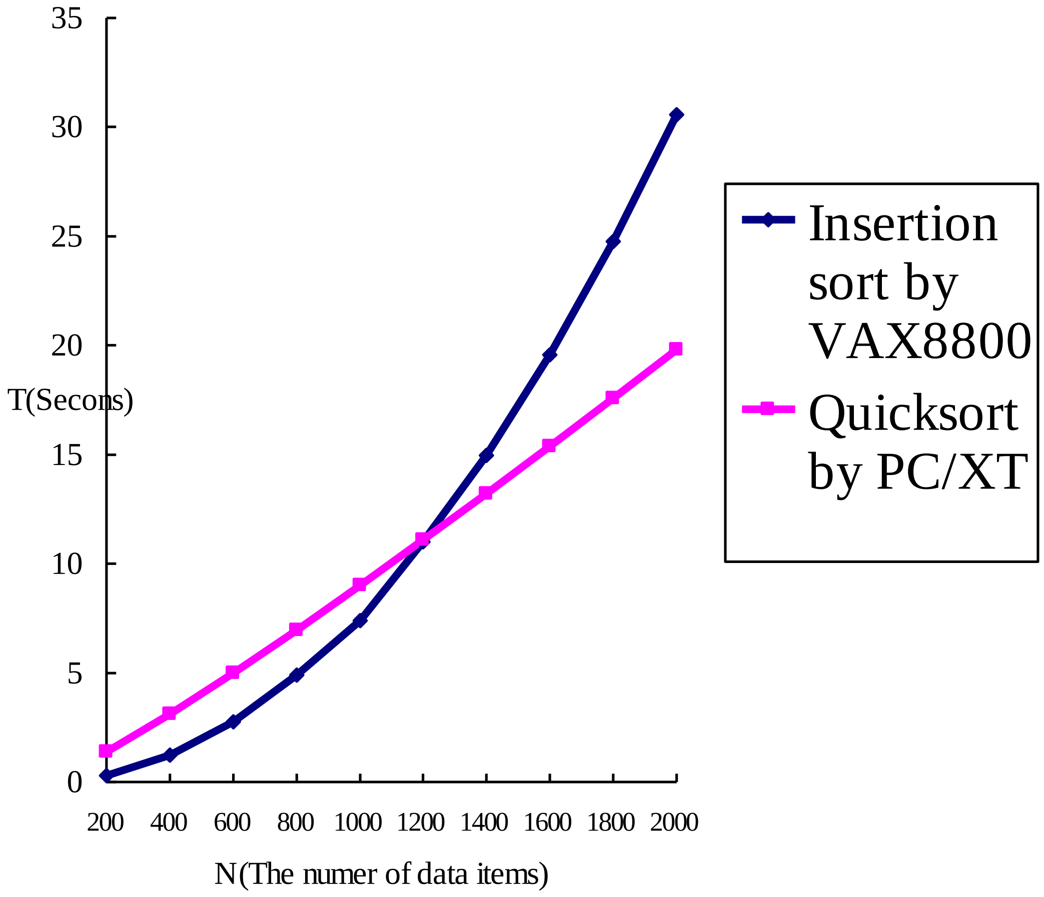


Fig 1-1. Comparison with Two Algorithms Implemented on Two Computers.

- Analysis of algorithms
  - Measure the goodness of algorithms efficiency?
    asymptotic notations: $O(n^2)$
    worst case
    average case
    amortized
  - Measure the difficulty of problems
    NP-complete
    undecidable
    lower bound
  - Is the algorithm optimal?

- Knapsack problem

	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8
Value	10	5	1	9	3	4	11	17
Weight	7	3	3	10	1	9	22	15

M(weight limit)=14
best solution: P_1, P_2, P_3, P_5(optimal)
This problem is NP-complete.

- Traveling salesperson problem

Given: A set of n planar points
Find: A closed tour which includes all points exactly once such that its total length is minimized.
This problem is NP-complete.

- Partition problem

  Given: A set of positive integers S

  Find: S_1 and S_2 such that $S_1 \cap S_2 = \varnothing$, $S_1 \cup S_2 = S$, $\sum_{i \in S_1} i = \sum_{i \in S_2} i$

  (partition into S_1 and S_2 such that the sum of S_1 is equal to S_2)

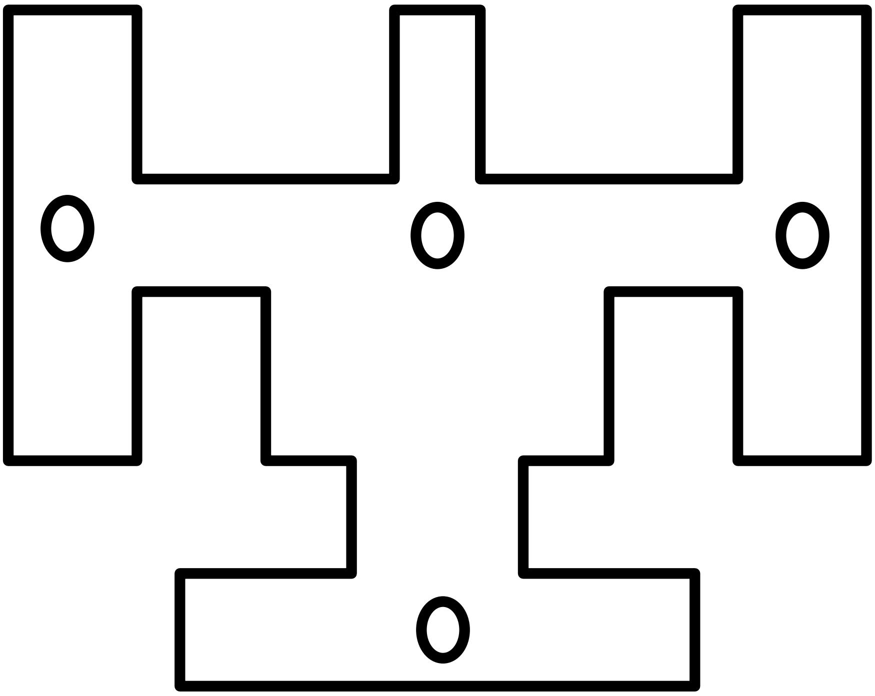
  e.g. S={1, 7, 10, 9, 5, 8, 3, 13}

  S_1={1, 10, 9, 8}

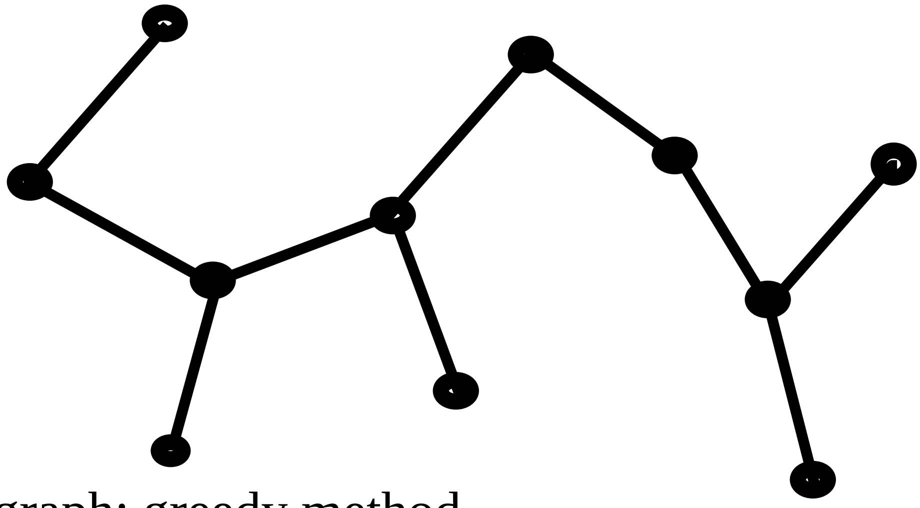
  S_2={7, 5, 3, 13}

  This problem is NP-complete.

- Art gallery problem

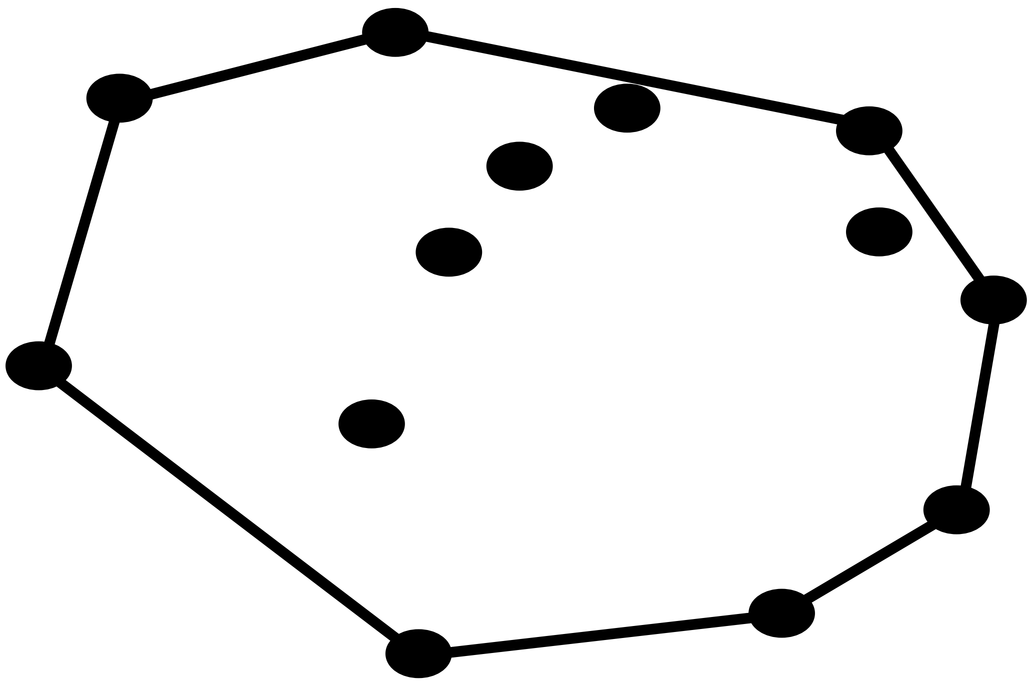


- Minimum spanning tree



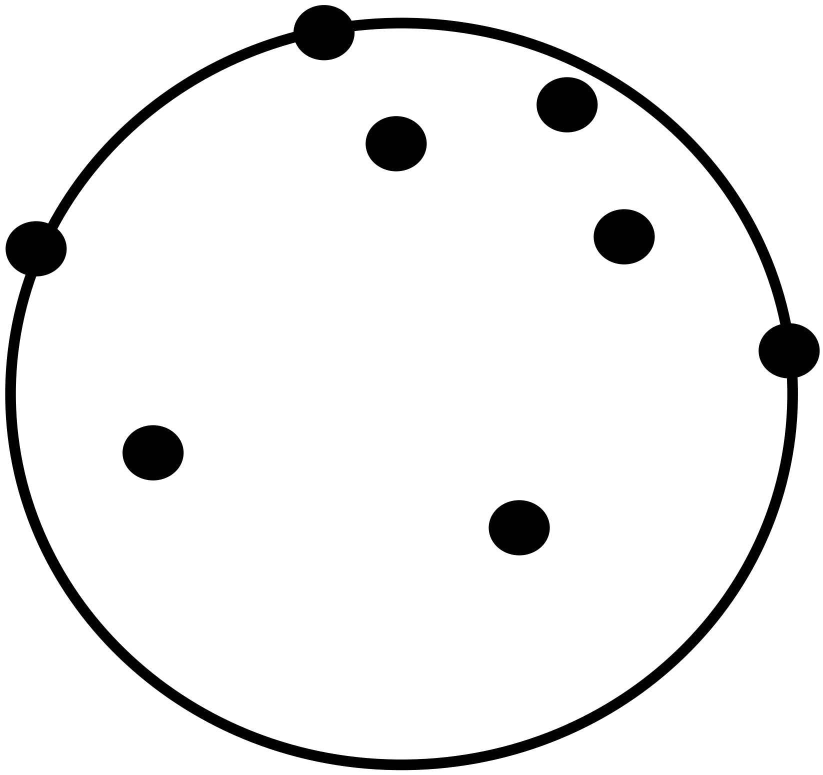
graph: greedy method
geometry(on a plane): divide-and-conquer
# of possible spanning trees for n points: n^{n-2}
$n=10 \rightarrow 10^8$, $n=100 \rightarrow 10^{196}$

- Convex hull



It is not obvious to find a convex hull by examining all possible solutions
divide-and-conquer

- One-center problem



prune-and-search