

Chapter 10

NP-hard Problems and Approximation Algorithms

10.1 What is the class NP?

The class P consists of all polynomial-time solvable decision problems. What is the class NP? There are two misunderstandings:

(1) NP is the class of problems which cannot be solved in polynomial-time.

(2) A decision problem belongs to the class NP if its answer can be checked in polynomial-time.

The misunderstanding (1) comes from misexplanation of the brief name NP for "Not Polynomial-time solvable". Actually, it is polynomial-time solvable, but in a wide sense of computation, nondeterministic computation, that is, **NP is the class of all nondeterministic polynomial-time solvable decision problems**. Thus, NP is the brief name of "Nondeterministic Polynomial-time".

In nondeterministic computation, there may contain some guess steps. Let us look at an example. Consider the HAMILTONIAN CYCLE problem: *Given a graph $G = (V, E)$, does G contain a Hamiltonian cycle?* Here, a Hamiltonian cycle is a cycle passing through each vertex exactly once. The following is a nondeterministic algorithm for the HAMILTONIAN CYCLE problem.

input a graph $G = (V, E)$.

step 1 guess a permutation of all vertices.

step 2 check if guessed permutation gives a Hamiltonian cycle.

Approximation Algorithms For Np Hard Problems

Alan Jay Wecker



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