論文の内容の要旨

論文題目　Algorithms for Finding Disjoint Paths: Acceleration and Extension
（点素パス問題に対する算法：高速化と拡張）

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One of the central topics in graph theory is a characterization of graphs containing a certain structure such as a path, a cycle, a tree, a matching with some conditions. Since 1950s, the importance of finding such structures has been recognized also by computer scientists, because graphs appear in many practical situations. For example, graphs are abstractions of transportation networks, VLSI, social networks, protein interaction networks, web graphs, and so on. Today, there are many studies on efficient algorithms for finding such structures in graphs.

The central topic of this thesis is finding "disjoint paths" in a given graph efficiently. More precisely, when we are given a graph and pairs of vertices in the graph, we would like to decide whether or not the graph has paths such that they are mutually disjoint and each path connects given pairs of terminals. This problem has attracted attention in the contexts of transportation networks, VLSI-layout and virtual circuit routing in high-speed networks or Internet. A basic technical problem is to interconnect certain prescribed "channels" on the chip with wires, where wires belonging to different pins do not touch each other. In this simplest form, the problem amounts mathematically to finding disjoint trees or disjoint paths in a graph, each connecting a given set of vertices. The concept of disjoint paths, which is closely related to connectivity of a graph, is important also in graph theory.

The problem of finding disjoint paths has many variants depending on whether the input graph is directed or undirected, whether "disjoint" means vertex-disjoint or edge-disjoint,

whether the input graph is planar or not, and so on. The main aim of this thesis is to study computational complexities of these variants. In particular, we aim to give efficient algorithms for these variants. It is theoretically interesting that the computational complexities of these variants are completely different from one another, whereas the variants have similar forms. Besides the theoretical interest, efficient algorithms for the problems are useful in practice when they arise from practical situations.

In the field of theoretical computer science, an algorithm is considered to be "efficient," if its running time is proportional to a small-order polynomial of the input size such as the number of vertices of a graph. However, it is known that there exists a class of hard computational problems, which are called NP-hard problems. The concept of NP-hardness was developed in the early 1970s, and it is believed by most researchers today that there is no polynomial-time algorithm for NP-hard problems. With this background, for a problem of finding disjoint paths, our objectives are the following:

(1) Giving a polynomial-time algorithm for the problem or else showing the NP-hardness.
(2) Giving an efficient algorithm for the problem if it is polynomially solvable, i.e., giving an algorithm whose running time is a small-order polynomial of the input size.