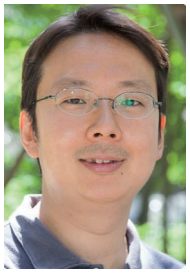
【Grant-in-Aid for Scientific Research (S)】

Broad Section J



Title of Project : Large Graphs: Theory and Algorithms

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Research Project Number : 18H05291 Researcher Number : 40361159
Keyword : Graph, Algorithm, Combinatorial Optimization, Theoretical Computer Science

【Purpose and Background of the Research】

Algorithms based on mathematical theory have created progress for human civilization. At present, algorithmic innovations, information searches, and genome information processing are connected to the creation of large business on a national scale. In the 21st century, it is expected that developments in advanced computer science will solve mankind's various problems, but many of these are difficult problems which cannot be solved even if a supercomputer is used. In order to solve these problems, new innovations in algorithms are needed, and new algorithmic technologies which are based on mathematical science have top-priority significance. In particular, the high-speed implementation for large networks and data on the scale of billions of units shall be raised, and will be applied to a wide range of fields, such as transportation, Web analysis and biotechnology. Theoretical research in this proposal could be a breakthrough for solving these global problems.

【Research Methods】

We plan to work on the following three projects.

1. Submodular function appears everywhere in optimization problems and machine learning problems. In this proposal, we attempt to consider the online setting, the adaptive setting, and some robust algorithms.

2. Graph minor theory, by Robertson and Seymour, is perhaps the deepest theory in all of Discrete Mathematics, and it also creates the deepest discrete algorithms. But this theory applies only for undirected graphs. In this proposal, we will extend graph minor theory to digraphs.

3. Graph Coloring is one of the fundamental problems in graph theory and algorithms. In this proposal, we will work on graph coloring problems for planar graphs (i.e., the four color theorem), and graphs on a surface. Our special focus would be to obtain a faster algorithm for these problems.

【Expected Research Achievements and Scientific Significance】

The main point of this proposal is to invent theory-based algorithms for large graphs. In the future, the following academic and technical contributions can be expected from this research proposal.

- With an innovative algorithm based on mathematical analysis, it is possible to solve large-scale graph problems, which is current not possible
- A joint research base of researchers in discrete mathematics, theoretical computer science, probability, combinatorial optimization for solving practical problems through mathematical modeling, can be formulated.

【Publications Relevant to the Project】

K. Kawarabayashi, M. Thorup: Coloring 3-colorable graphs with o(n^{1/5}) colors, Journal of the ACM, 64 Issue 1, Article No 4

K. Kawarabayashi, S. Kreutzer: The Directed Grid Theorem. STOC 2015, 655-664.

【Term of Project】 FY2018-2022

【Budget Allocation】 148,500 Thousand Yen

【Homepage Address and Other Contact Information】

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