【Grant-in-Aid for Transformative Research Areas（A）】

Section Ⅳ

# Title of Project： Creation and Organization of Innovative Algorithmic Foundations for Social Advancement

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## 【Purpose of the Research Project】

*Algorithms*, the theories, techniques and logical procedures of information processing, perform a key part of the recent sophisticated information society. Our project aims to develop and organize state-of-the-art techniques for algorithms. The results will be provided as open academic resources for many scientists and engineers in various fields, to be utilized for social advancement. Based on the recent drastic progress of computation power, upcoming innovative computation devices, and new concepts from social sense of values, we will reformulate and organize practical computation models to bridge theory and practice. We will also create and organize computational theories and state-of-the-art techniques for algorithms, such as discrete structure manipulation, constraint satisfaction problem solving, enumeration, discrete optimization, quantum computation theory, etc. Our results will be presented as the innovative *Algorithmic Foundations for Social Advancement* (AFSA).

## 【Content of the Research Project】

As shown in Fig 1, our AFSA-project consists of six research groups in two categories A and B. The groups in A (A01 and A02) investigate the interface layer to bridge theory and practice, and the groups in B (B01, B02, B03, and B04) investigate specific theories and techniques to support the interface layer. We also have a steering committee group and plan an open call for about 17 participants to work on additional related research topics. The contents of the six research groups are as shown below.

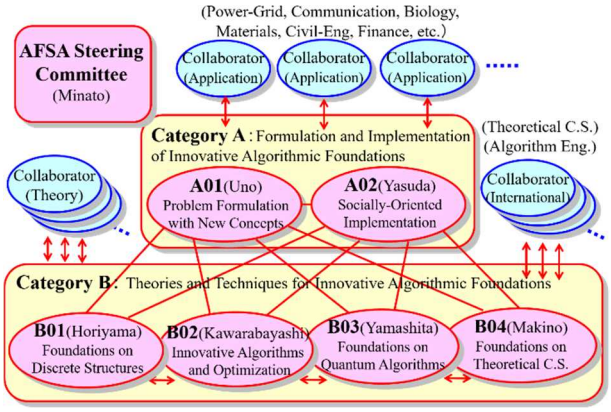


Fig. 1: Project Formation

**A01: New Problem Formulation on Next Generation Informatics and Researches on their Algorithms**

Collaborating with researchers in the application layer, this group discusses and formulates a set of new problems to be considered in the future society. We also design efficient algorithms based on a new approach.

**A02: Socially-Oriented Algorithm Implementation**

This group implements the algorithms proposed in our project and organizes the algorithmic foundations for social advancement. It provides an interface between theoretical researchers and application engineers.

**B01: Algorithmic Foundations Based on Large-Scale Discrete Structures**

By the collaboration of theoretical researchers and application engineers, this group tackles how to deal with exponentially large-scale discrete structures and develops new design methodologies of efficient algorithms.

**B02: New Computational Models for Algorithms and Discrete Optimization**

This group investigates basic research topics in the areas of discrete mathematics, combinatorial optimization, machine learning, etc. to develop efficient algorithms for solving very large-scale problems required in our society.

**B03: Creation of Innovative Foundations to Bridge Theory and Practice of Quantum Algorithms**

Combining the knowledge of classical computation and new quantum models, this group constructs useful algorithmic foundations to implement practically efficient quantum computers connected to conventional systems.

**B04: Exploration and Development of the Basic Theory of Algorithms**

This group investigates important problems in theoretical computer science, such as performance assurance, preserving fairness and stability, new computation models and design methodologies for social requirements.

## 【Expected Research Achievements and Scientific Significance】

This project will lead an active research community where theory and practice meet together. Our expected outputs are not only to produce top conference papers and journal publications, but also to contribute to real-life social problems by collaborating with application research engineers. These algorithmic foundations will be useful for various fields of science and technologies and aim to contribute to social advancement over the long-term.

## 【Key Words】

*Algorithms*: Techniques, procedures and strategies to produce valid and efficient computer programs.

**【Term of Project】** FY2020-2024

**【Budget Allocation】** 856,800 Thousand Yen

## 【Homepage Address and Other Contact Information】

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