未来数理科学

Mathematical Sciences for the Future

Exploration of New Science Using Mathematics to Predict and Control the Future

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Research Supervisor **Zin Arai**

Professor, School of Computing, Institute of Science Tokyo

JST 科学技術振興機構

PRESTO sakigake

Strategic Objective

Scientific prediction and control as the foundation of a new society and industry

Overview

In order to realize Society 5.0 and to protect and nurture the Earth as the Global Commons as climate change and other threats grow more serious, accurately capturing and predicting important signs and the tipping point (point of no return) of social and global issues where complex factors are intertwined and building a new controllable social infrastructure are essential. To accurately capture and predict of these signs and the tipping point, it would be beneficial for fusing mathematical sciences with various fields and taking advantage of the strengths of mathematical sciences such as the abstractness. For this reason, looking towards to applications to the social infrastructures and industrial foundations of the next-generation, real-time data will be analyzed using advanced mathematical analysis and evaluation methods and new quantum computing algorithms, etc., through the fusion of mathematical science and other fields, to create the basic theory for prediction and control, and to construct fundamental technologies to realize such the theory with high reliability and efficiency. This will accelerate the resolution of issues in a complex and uncertain world.

Source : Ministry of Education, Culture, Sports, Science and Technology
https://www.mext.go.jp/b_menu/houdou/2023/mext_00007.html

Basic Policy

A virtual research institute for researchers

- PRESTO is basically conducted by individuals.
- The total research budget is generally within 30 million JPY, with a duration of 3.5 years.
- Researchers are expected to actively participate in outreach activities (see the next slide).

Comparison with CREST

- CREST takes a team-based approach, while PRESTO is more challenging and exploratory individual research.
- CREST emphasizes more direct approaches to social issues.
- PREST researchers are encouraged to strengthen approaches to social issues by collaborating with CREST

Activities

Conference

- 2 times par year, F2F or Online
- Usually, 2 or 3 days
- Progress report and discussion with advisors
- Joint hosting with CREST
  （under consideration）

Other activates

- Outreach activities such as
  - SUUGAKU Caravan
  - Young Mathematicians challenge
  - Workshop of Outstanding problem
- Groups research and meetings in the domain
- Final presentations　（at the end of research）

Advisers

Shingo Iwami	Professor, Graduate School of Science, Nagoya University
Takayuki Osogami	Senior Technical Staff Member, IBM Research - Tokyo, IBM Japan, Ltd.
Shizuo Kaji	Professor, Institute of Mathematics for Industry, Kyushu University
Yoshinobu Kawahara	Professor, Graduate School of Information Science and Technology, The University of Osaka
Hideyuki Suzuki	Professor, Graduate School of Information Science and Technology, The University of Osaka
Asuka Takatsu	Professor, School of Mathematical Sciences, The University of Tokyo
Masaki Tsukamoto	Professor, Graduate school of Science, Kyoto University
Katsuhiro Nishinari	Professor, School of Engineering, The University of Tokyo
Kazuhisa Makino	Professor, Research Institute for Mathematical Sciences, Kyoto University
Kaoru Yamamoto	Associate Professor, Faculty of Information Science and Electrical Engineering, Kyushu University

Examples of Research Plans

1. **Elucidate complex phenomena related to social issues and explore prediction and control methods via mathematical science**
   Analyze and elucidate data related to social issues using mathematics, AI, machine learning, and other techniques. Furthermore, by deriving causal relationships and parameters that are key factors, try to predict signs of change and turning points, leading to the presentation of control methods.

2. **Create new fundamental theories for predicting and controlling complex phenomena**
   Create new fundamental theories of prediction and control that can be applied and deployed to various social issues. Establish mathematical theories and fundamental technologies to evaluate the accuracy of prediction and control.

3. **Verify and demonstrate prediction and control theories to solve social issues**
   Toward concrete solutions to social issues, verify the accuracy of the theory and its social acceptability, and consider how to utilize it. Development of programs and software is also involved.

Keywords

Expected keywords

Causal inference, mathematical modeling, dynamical systems, optimization, optimal transport, nonlinear analysis, uncertainty quantification, probability theory (data assimilation, inverse problems, control, sampling), geometry, algebraic geometry, singularity theory, discrete mathematics, topological data analysis, mathematical fluid theory, network theory, graph theory, reinforcement learning, computational complexity, high-dimensional statistical analysis, machine learning models of non-equilibrium systems, quantum computing algorithms

Your “keyword” need not be listed on the list.

We believe it would be exciting if a “prediction and control” proposal emerges from an area not listed among the above keywords. (It will then be difficult for the supervisor and advisors to make a proper judgment on proposals from unfamiliar areas, but we will do our best.)

Social Issues

Expected Social Issues

- Global issues such as environmental, food, and natural disasters; social issues related to health, national resilience, finance, and the economy; issues to improve the well-being of humanity.
- Anything that contributes to achieving the Sustainable Development Goals. **In other words, any relevant topics are welcome!**

The extent to which your proposal engages with social issues is up to you

- While proposals that address specific social issues in depth are welcome, if you wish to propose a theoretical development on “prediction and control,” it is not necessary to specify particular social applications (you are encouraged to strengthen your connection with societal issues through PRESTO activities).
- “No interest in societal issues” will not be accepted.

Selection Policy

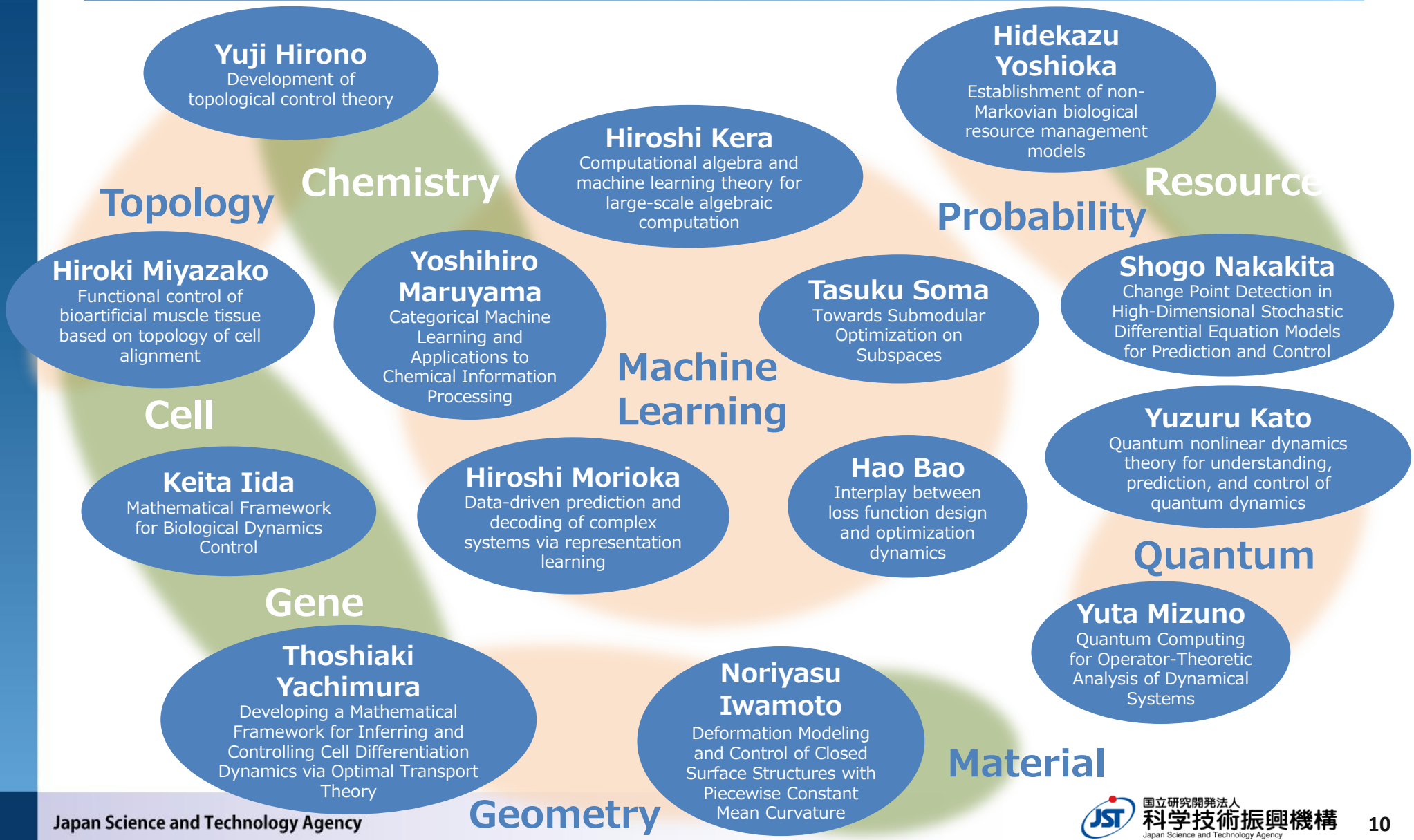
Requirement on the proposal

- We place great importance on originality. Proposals that appear to be subcontracted work for senior professors are not desirable.
- While you may freely choose your research topic, we emphasis on proposals that will contribute to our strategic goals.
- Please clearly state your own motivation for the research.

Unique situation of PRESTO

- As a "virtual research institute," the balance of research fields will be considered.
- While the amount of funding required does not affect the selection result, we check the appropriateness of your budget plan.
- We welcome proposals with strong ideas, even if your document or presentation is poorly polished. You can develop your writing and presentation skills through PRESTO activities.
- Even if you fail the first item, many people pass the second or third year, so please try again!

Portfolio of projects in FY2024



Conclusion

Message from the supervisor

In short, "PRESTO" is exciting, so please apply!

Schedule

Deadline for application	: May 27, 2025, at 12:00 noon（Japan time）
Interview-based review（ONLINE）	: July 22 to 25, 2025
Start of research	: Oct. 1, 2025　（plan）

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