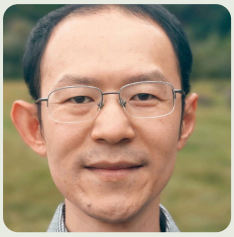
京都大学大学院情報学研究科 伊藤孝行研究室
Takayuki Ito Laboratory, Graduate School of Informatics, Kyoto University

# A Linear Theory of Multi-Winner Voting



**講師** Presenter — Professor Lirong Xia,
Professor of Computer Science, Rutgers University-New Brunswick. Deputy Director of DIMACS

**日時** Date & Time — September 18th, 2026. 13:00 - 15:00

**会場** Location — Lecture Room 2 (room 101) in Research Building 7

## 概要 Abstract

How should we choose a group of representatives rather than a single winner? This question arises in settings ranging from political representation to hiring and participatory budgeting. Many different voting rules have been proposed for this problem, together with different notions of what it means for the outcome to fairly represent the voters. At first glance, these rules and fairness requirements can look quite different. In this talk, I will describe a simple mathematical framework that puts many of them under the same roof. The key observation is that a surprisingly broad range of multi-winner voting rules and notions of proportional representation can be expressed using linear inequalities. This common structure lets us study seemingly different questions with the same set of tools. I will focus on two applications of the framework. First, how can we learn a voting rule or axiom based on feedback from the stakeholders? Specifically, how much data do we need to reliably design a rule, or to determine whether an outcome is approximately representative? The linear viewpoint gives general answers to these questions and, for several important families of voting rules, nearly tight bounds. Second, I will move beyond worst-case analysis and ask what typically happens when voters' preferences are drawn at random. Under a broad family of preference distributions, we find that several desirable properties that can fail in carefully constructed examples actually hold with high probability. For example, important families of voting rules typically select a unique outcome, and strong notions of proportional representation are typically achievable—and, in some cases, satisfied by these rules. More broadly, the goal of this work is to show that a simple linear perspective can reveal connections between voting rules, representation, learning, and average-case analysis, and provide a common toolkit for studying them.

The talk is based on https://arxiv.org/abs/2503.03082.

## 講師略歴 Biography

Lirong Xia is a Professor of Computer Science at Rutgers University - New Brunswick and the Deputy Director of DIMACS (the Center for Discrete Mathematics and Theoretical Computer Science). He was a faculty member at RPI, and was a CRCS fellow and NSF CI Fellow at the Center for Research on Computation and Society at Harvard University. He received his Ph.D. in Computer Science and M.A. in Economics from Duke University, and B.E. in Computer Science and Technology from Tsinghua University. His research focuses on the intersection of computer science and microeconomics. He is or has served in editorial board of Artificial Intelligence Journal (AIJ), Journal of Artificial Intelligence Research (JAIR), Transactions on Machine Learning Research (TMLR), IEEE Transactions on artificial intelligence (TAI), and Mathematical Social Sciences (MSS). He is the recipient of an NSF CAREER award, a Simons-Berkeley Research Fellowship, and was named as one of "AI's 10 to watch" by IEEE Intelligent Systems.