



***DIMACS Special Focus on  
Mechanisms and Algorithms to Augment Human Decision Making (2019-2022)***

At this point in our technological development, the convergence of humans and machines—through machine learning and increasingly intelligent (and autonomous) devices—promises a transformational impact on daily life. Already machines can outperform humans at certain tasks, but complete autonomy remains elusive, and predictions will continue to benefit from human wisdom for the foreseeable future. Beyond accurate predictions, decisions require insight into the preferences or utility functions of the people that they impact. Decision-support tools must go beyond observational data to actively elicit both information and preferences from stakeholders, to reward contributors appropriately, and to combine the inputs in a way that abides fairness constraints and practical limits on computational power.

The DIMACS Special Focus on Mechanisms and Algorithms to Augment Human Decision Making will launch in late 2019 and run through the end of 2022. The special focus aims to improve decision-support systems by leveraging both human and machine intelligence through study of tools to augment decision making in individuals and organizations. Available tools include (1) mechanisms to elicit complex probabilities and preferences from people, rewarding them appropriately (2) algorithms to combine human judgments and data-driven predictions, and (3) algorithms to aggregate potentially conflicting preferences under social-choice objectives. The special focus builds on recent advances in computational social choice, crowdsourced democracy, and crowdsourced forecasting, including prediction markets and scoring rules. Topics include eliciting probability distributions and statistics of distributions, decentralized elicitation using markets or blockchain, complexity of elicitation, participatory budgeting, fair division, incentivizing exploration, and digital democracy. Within each topic, we seek to characterize what is impossible, intractable, and tractable to compute either exactly or approximately.

Special focus workshops (listed below) will explore questions such as: which statistics of distributions can we compute by minimizing a loss (or maximizing a score) over elicited data with a limited number of responses; how can we characterize or design loss functions to expose desired statistics; and can we develop a more rigorous theory for how to combine potentially conflicting preferences reasonably and fairly. Workshops will investigate how organizations can reduce barriers by rewarding people in ways that enhance inputs to machine intelligence, improving the predictions and decisions that organizations make. Predictions are only one side of the decision-making coin. Good decisions also require accurate representations of individual preferences—which must be elicited—and algorithms to turn elicited votes into organization-level decisions that optimize an objective subject to fundamental axioms and efficient computation. Special focus events will investigate predictions and preferences, as well as the decision-making systems that bring it all together.

Approaches to eliciting information have been studied by various disciplines under a variety of names, notably scoring rules in statistics, prediction markets in economics, polls and surveys in

marketing, and peer prediction, crowdsourcing, combinatorial prediction markets, and incentivized exploration in computer and social sciences. The special focus aims to harness these multiple perspectives by bringing together theoretical computer scientists studying algorithmic game theory, machine learning theory, and NP-hard counting problems; AI computer scientists studying human computation, Bayesian inference, and satisfiability; statisticians studying scoring rules and belief aggregation; economists studying prediction markets, financial markets, and wagering mechanisms; marketing scientists studying surveys and polls; blockchain pioneers implementing decentralized prediction markets and other experimental market constructs; social and behavioral scientists studying human behavior modeling; and human-computer interaction researches designing interfaces to facilitate elicitation. Together researchers will explore how to use human-machine integration to modernize organizations, markets, and governments by improving how they collect and combine information to make decisions.

The special focus is led by incoming DIMACS Director *David Pennock (Microsoft Research)*.

**Special Focus Workshops:**

- ***DIMACS Workshop on Eliciting Complex Information***  
Organizers: Raf Frongillo (U. Colorado), David Pennock (Microsoft Research), and Bo Waggoner (U. Colorado)
- ***DIMACS Workshop on Algorithmic Social Choice***  
Organizer: Ashish Goel (Stanford)
- ***DIMACS Workshop on Eliciting Beyond Labels from the Crowd***  
Organizer: Yang Liu (UC Santa Cruz)
- ***DIMACS Workshop on Preference Aggregation***  
Organizers: Vasilis Gkatzelis (Drexel) and Alexis Tsoukias (U. Paris, Dauphine)
- ***DIMACS Workshop on Learning from Partially Reliable Data (or Learning from Real Data)***  
Organizers: Léa Deleris (BNP Paribas) and David Rios Insua (ICMAT Institute of Mathematical Sciences, and Royal Academy of Sciences, Madrid)

As the special focus progresses, we hope to add new events and activities that align with the theme.

DIMACS launches this special focus as it prepares to celebrate its 30<sup>th</sup> birthday. As a related historical reflection, we note that more than a decade ago the DIMACS Special Focus on Computation and the Socio-Economic Sciences held the first open gathering of researchers in prediction markets and helped establish prediction markets as an important academic and industry discipline. With the Special Focus on Mechanisms and Algorithms to Augment Human Decision Making, we will revisit this topic more broadly through the lens of AI and intelligent systems.

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