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Ph.D. DISSERTATION DEFENSE

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Date:	Thursday, April 25th, 2024
Time/Location:	10:30, Howe Center 303
Title:	Risk of Distributed Systems in Sequential Decision Problems
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ABSTRACT

The main objective of this work is to address the evaluation and optimal control of risk of distributed systems. Our motivation stems from problems arising in robotics, where a team of robots cooperates to complete a common task in an unknown environment. In these types of problems, the risk may be associated with systemic features pertaining to the whole system as well as with features related to the local operation of individual agents. The goal is to devise methods for evaluating and optimizing the total risk by integrating both systemic and local features while allowing independent operation of agents within the system under limited information exchange.

To address these issues, we propose a minimal set of axioms for risk functionals on multi-dimensional risk sources. We construct several classes of non-trivial risk evaluation methods that align with the postulated properties and provide novel ways of aggregating risk. The proposed risk evaluation methods are compared theoretically and numerically to other systemic risk measurements in the existing literature. New risk-averse two-stage stochastic programming problems are formulated using the proposed risk measures. We devise new numerical methods to solve those problems in a decentralized manner, in which the global optimization problem is decomposed into subproblems of individual agents who collaborate in optimizing the total risk of the system. We distribute the systemic features among the agents and show that the optimal solution is obtained with limited information exchange only among directly connected agents within the system. The convergence of the numerical methods to the solution of the centralized optimization problem is established. The methods are applied to specific problems such as wireless information exchange in a network. The proposed framework facilitates risk-averse sequential decision-making for distributed systems.