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Multilevel Conditional Compositional Estimation and Optimization

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We introduce Multilevel Conditional Compositional Optimization (MCCO) as a new framework for decision-making under uncertainty that combines aspects of multistage stochastic programming and conditional stochastic optimization. MCCO minimizes a nest of conditional expectations and nonlinear cost functions. It finds wide applications in optimal stopping, credit valuation adjustments, distributionally robust contextual bandits, and nested risk minimization. The naive nested sampling approach for MCCO suffers from the curse of dimensionality familiar from scenario tree-based multistage stochastic programming, that is, its sample complexity grows exponentially with the number of nests. We develop new multilevel Monte Carlo techniques for MCCO whose sample complexity grows only polynomially with the desired accuracy.

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