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Decomposition Strategies for Multi-Timescale Stochastic Optimization in Power System Applications

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We propose decomposition algorithms to solve computationally challenging multi-timescale mixed-integer stochastic optimization problems in power system operation, where decisions across different time horizons are coordinated using aggregate state variables. Three distinct decomposition strategies are presented based on the stochastic model: (1) Price-directive decomposition for multi-horizon scenario trees; (2) Resource-directive decomposition for Markovian processes; and (3) A hybrid approach combining both price-directive and resource-directive decomposition. These methods allow coordination across timescales, improving system reliability and economic performance in applications like unit commitment. Furthermore, acknowledging that practical applications often involve solving sequences of similar problems, where achieving optimality for each instance is challenging, we introduce techniques that leverage computations from previous instances to progressively improve solution quality.

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