Learning to optimize for urban energy systems

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Abstract:

Under the digitalization and low-carbon transition of urban energy systems, there is significant potential for flexible energy dispatch to promote efficient and economic system operation. In this process, learning-based technologies have been adopted to extract system operation characteristics from metered data, providing accurate operation boundaries for the optimization-based energy dispatch process. However, the learning and optimization processes are always conducted within independent sectors and are decoupled in practical application. The existing pattern always ignores the interactive relationship and results in untrustworthy learning and uneconomic optimization results. This presentation explores the deep coupling relationship between learning and optimization processes in urban energy systems. The talk begins with model predictive control in building energy systems, where learning-based thermal dynamics modeling is conducted as input constraints for optimization. Furthermore, this talk highlights the underlying influence of learning errors on downstream optimization problems under the same scenario and introduces a decision-oriented modeling method for building thermal dynamics. The purpose of this learning method is to minimize optimization costs instead of traditional accuracy metrics. The proposed decision-focused learning strategy is further extended into integrated energy systems, where the cross-sector (heating, cooling, and electric) load forecasting is coupled with the following central optimization task as the operation boundary conditions. The corresponding data value during the learning process is also evaluated.