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Using Bi-Objective Linear Programming and Reinforcement Learning to Conduct Electricity Supply Optimization

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Abstract

To balance the trade-offs between economic development and environmental sustainability, this research presents a novel framework to achieve the following goals: (1) linear programming (LP) is used to derive the optimal capacities of energy resources, (2) reinforcement learning (RL) considering environmental interactions is applied to compare to DLP , (3) the impacts of capacity expansion of nuclear power, wind energy, and solar power and decreasing installation costs are quantitatively assessed. Without loss of generality, installation costs and carbon costs are equally weighted. Meanwhile, three approaches, one-shot LP, dynamic LP, and RL, are quantitatively assessed. In terms of minimizing the objective value (weighted sum of installation costs and carbon costs), RL performs the best, followed by dynamic LP, and one-shot LP performs the worst. Experimental results show that RL outperforms one-shot LP by decreasing 15% installation costs, 40% carbon emissions, and 20% reduction of the objective value. In sensitivity analysis, decreasing installation costs of energy resources does not alter the original solution because of limited capacities. In contrast, capacity expansion of energy resources can effectively speed up the adoption of green energy. generally, RL tends to minimize the objective value while dynamic LP focuses on minimizing carbon emissions.

Keywords

Conflicting goals, linear programming, reinforcement learning, electricity.