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Efficient Chiller Plant Control Using Modern Reinforcement Learning

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Abstract : The need of optimizing air conditioning systems for existing buildings calls for control methods designed with energy-efficiency as a primary goal. The majority of current control methods boil down to two categories: empirical and model-based. To be effective, the former heavily relies on engineering expertise and the latter requires extensive historical data. Reinforcement Learning (RL), on the other hand, is a model-free approach that explores the environment to obtain an optimal control strategy often referred to as “policy”. This research adopts Proximal Policy Optimization (PPO) to improve chiller plant control, and enable the RL agent to collaborate with experienced engineers. It exploits the fact that while the industry lacks historical data, abundant operational data is available and allows the agent to learn and evolve safely under human supervision. Thanks to the development of language models, renewed interest in RL has led to modern, online, policy-based RL algorithms such as the PPO. This research took inspiration from “alignment”, a process that utilizes human feedback to finetune the pretrained model in case of unsafe content. The methodology can be summarized into three steps. First, an initial policy model is generated based on minimal prior knowledge. Next, the prepared PPO agent is deployed so feedback from both critic model and human experts can be collected for future finetuning. Finally, the agent learns and adapts itself to the specific chiller plant, updates the policy model and is ready for the next iteration. Besides the proposed approach, this study also used traditional RL methods to optimize the same simulated chiller plants for comparison, and it turns out that the proposed method is safe and effective at the same time and needs less to no historical data to start up.

Keywords : chiller plant, control methods, energy efficiency, proximal policy optimization, reinforcement learning
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