Optimal control of complex, non-stationary Smart Buildings operating in dynamic environments using Continual Reinforcement Learning

Abstract:

This paper demonstrates that continual reinforcement learning can be used in connected smart buildings to ensure optimal building comfort conditions and energy performance even when conditions external and internal to the building follow non-stationary patterns. We created a data-driven "smart building environment", which simulates a commercial building on our university campus, using time series data obtained through the *Building Management System/BACnet*. The "smart building environment" models the effects of different variables inside and outside the building as well as the control action of the building *Heating Ventilation and Cooling system* (HVAC) on the overall comfort as well as heating and cooling energy consumption. In our experiments, we compared the comfort conditions and energy performance of the building when the HVAC is controlled by a static reinforcement learning controller versus a continually updating reinforcement learning controller. Our results suggest that the static controller performance diminishes significantly when either of the weather or internal building conditions change. But a relearning controller can quickly adjust to changing patterns and ensure optimal comfort and energy performance.

Abstract:

This paper demonstrates that continual reinforcement learning can be used in building *Heating Ventilation and Cooling system* (HVAC) systems to ensure optimal building comfort conditions and energy performance even when conditions external and internal to the building follow non-stationary patterns. We used a standard benchmark HVAC model developed by the DOE to demonstrate our approach. The environment models the effects of the outside weather as well as the heating and cooling controls of the HVAC on the overall comfort as well as heating and cooling energy consumption. In our experiments, we compared the comfort conditions and energy performance when the HVAC is controlled by a static reinforcement learning controller versus a continually updating reinforcement learning controller. Our results suggest that the static controller performance diminishes significantly when either of the weather or internal building conditions change. But a relearning controller can quickly adjust to changing patterns and ensure optimal comfort and energy performance.