Discussions for the Buildings Reinforcement Learning implementation

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1 Variables Involved in the Building

Variable	**Remarks**
Outside air temperture	
Outside air relative humidity	
Global solar irradiation	collected from separate source
Air handling unit discharge temperature set point	
Chilled Water Energy	
Hot Water Energy	
Building Electrical Data	*have to separate out vrf energy signature; will use a bandpass to collect the vrf energy pattern*
VRF(on/off, heat/cool) status	

Table 1: Variables available for the buildings project

2 Building Modeling approach

Currently we are using an LSTM based energy model

3 RL approach

3.1 Choice of Algorithm-Policy or off Policy

N/A

3.2 Replay Buffer if used

The replay buffer will be used to store the experiences of the behavioral policy for an off policy algorithm. The way the experiences are sampled might lead to differences in the way the agent learns from its experiences.

- **Window: The time into the past until which the experiences are going to be stored into the buffer** This will be a important parameter to consider as the memory of the past experience will decide how quickly the controller adapts to new changes. A small memory would cause the agent to not care about older experiences which might not be always good. On the other hand a large window will cause the experience to use past experiences which might not be useful for changing dynamical system.
- **Sampling**: The way the experiences are sampled could have an impact on the way the controller learns the policy.

3.3 Choice of Reward Function

Based on the variables provided the following reward functions have been used to explore their applicability

The reward function should incorporate the objectives for the problem. A single component may implicitly help attain several objectives as will be pointed out later.

- **Energy reduction**: If E is the total energy consumed by the building in response to the control actions generated, then the reward is to be formulated as -E *i.e.* lower the energy consumption, higher the reward.
  - When the controller issues the reheat setpoint it notices that the energy consumption does not change when the reheat setpoint goes below a certain threshold: this implies that due to high outside air temperature, the air coming out of the recovery heat jacket heats it up already above the set point, so no additional heating is required at that point. The energy thus implicitly helps determine the lower limit of the energy consumption.
  - Also, the set point does not go to the lowest possible value (55^oF) under the above conditions because if it goes to a low set point, then the heating energy needed to reach higher set points in the future time steps, when air outside gets cooler, becomes comparatively higher. It is similar to cooling in a normal HVAC where instead of switching off the heating completely(by keeping set point at 55^oF, it keeps it at a slightly higher value to save energy in the future. This is backed by lower energy consumption when it is night time during summer and the environment starts cooling.)
- **Inversion wrt Outside Air temperature**: This is a part of the temperature safety requirement recommended by the building manager. Assuming that the temperature cycles every 24 hours, we are trying to set the set point for either the reheat or the preheat coil such that when the outside temperatures are higher, the set points are going to be typically low but within a safety bound. Conversely, if the outside temperatures are lower, the set point should ideally be in the higher range.

  The safety constraints put forth are: For temperature variation during winter would be safely above 62^oF, and for summer, the upper limit should be 72^oF.
- **VRF system information**: The effect of the discharge temperature, either preheat or reheat can be incorporated into the reward function. If the discharge temperature is higher, causing discomfort in the building, VRF system will turn on and work in cooling mode. The reverse will happen when the discharge temeprarture is too low. This can also be manifested as the increase in electrical energy.