Self-adaptive building energy control in smart grids

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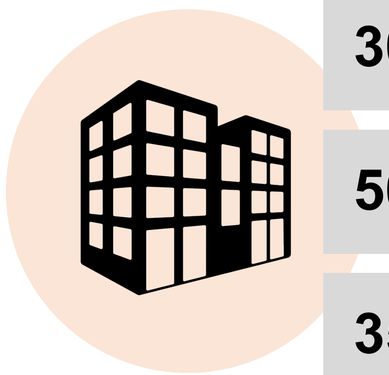
Motivation



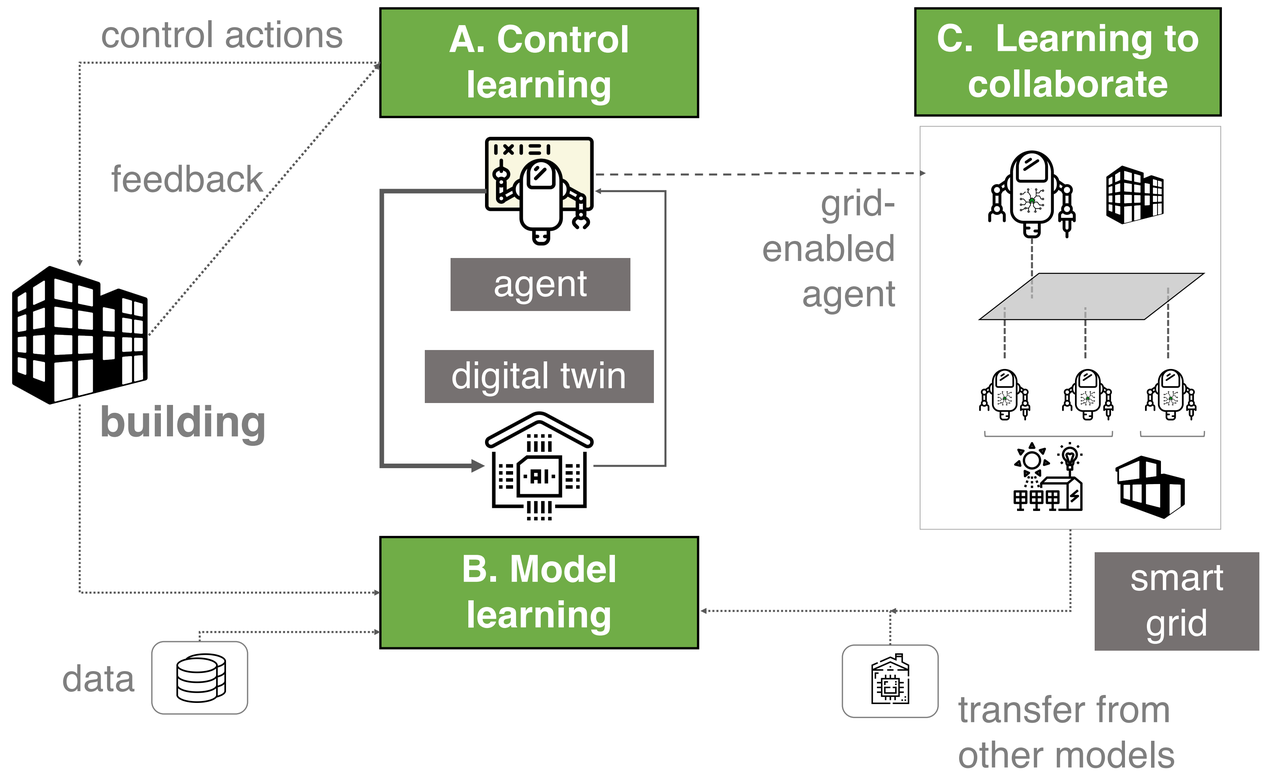
30% World energy demand

50% HVAC during lifecycle

35% Savings by optimal control

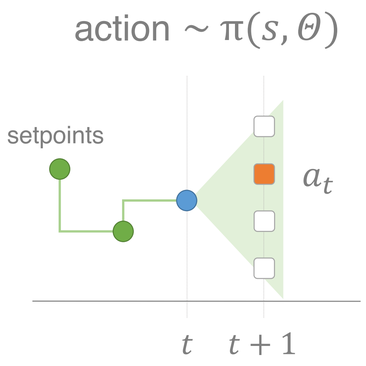
Create in 5 years the technologies to reduce energy consumption a 30% and increment a 30% the use of clean energies

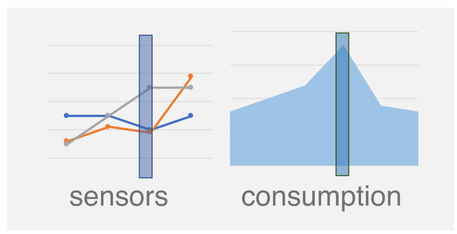
Concept



Approach

A. Building control optimization by Deep Reinforcement Learning

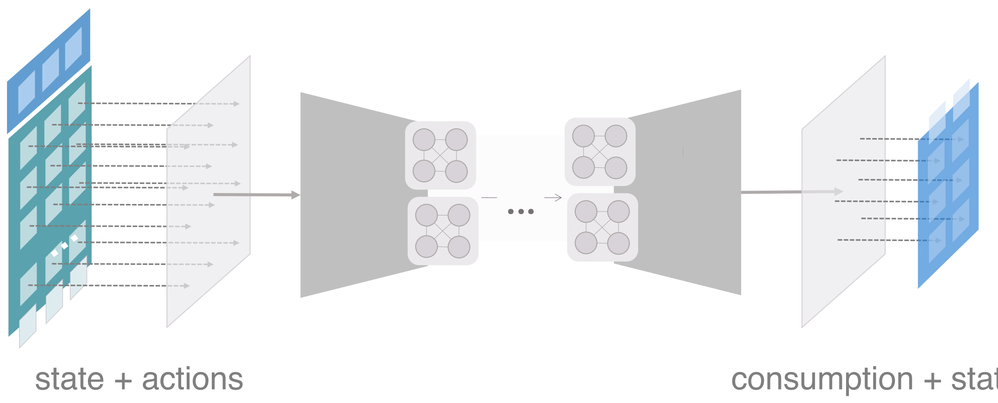




From the game board to the Building Management System

Building control is formulated as a DRL problem: (a) the board (i.e. the state) is the building; (b) the game moves (actions) are the equipment setpoint changes; (c) winning (reward) is quantified as the negative of the energy cost plus a penalty for deviating from the comfort requirements; (d) a game (episode) is a control plan for a medium-term horizon, e.g. one day.

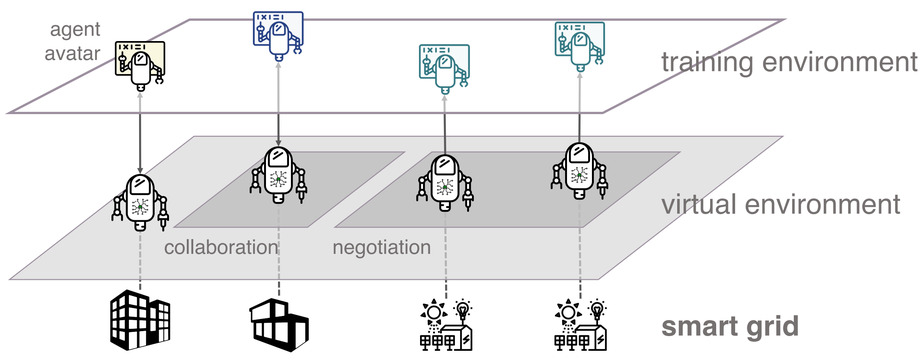
B. Learning and predicting the building behavior with Recurrent Neural Networks



Deep Neural Simulation Model

A Deep Neural Simulation Model (DNSM) uses Recurrent Neural Networks to model long-term thermal behavior of larger sections of a building. Specifically, given a set of inputs –indoor sensor measurements, external conditions and control instructions–, a DNSM calculates the simulation outputs –comfort, consumption, etc.– for a long period of time –e.g. one day.

C. Grid-level optimization through Multi-Agent Deep Reinforcement Learning



Leveraging agent cliques to federations

Agents are trained to interact to other agents of the smart grid on a virtual environment to automatically learn themselves how to cooperate and/or negotiate to minimize energy consumption and maximize clean energy usage. Agents publish a description of their capabilities from which avatars are created and trained by repeated simulation of interactions.

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