The University of Texas at Austin
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INTELLIGENT ENVIRONMENTS LABORATORY

CityLearn: A Tutorial on Reinforcement Learning Control for Grid-Interactive Efficient Buildings and Communities


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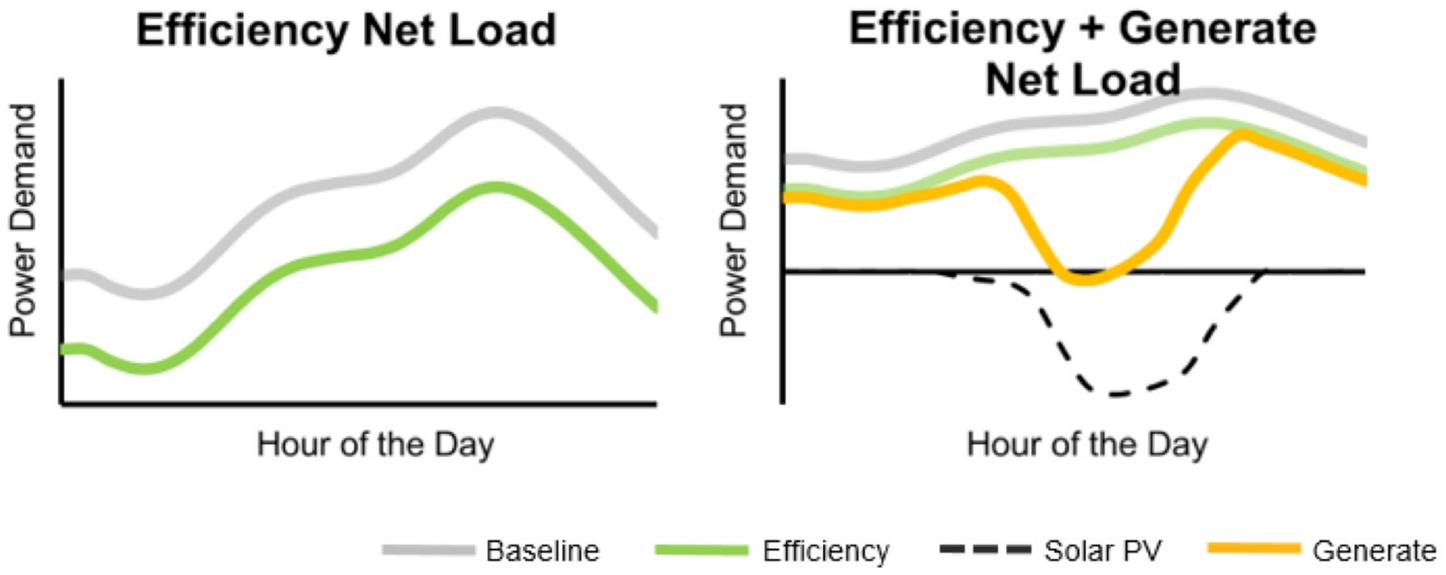
75%

of all U.S. electricity is consumed within **buildings**

US Energy Information Administration, 2018

Grid-interactive efficient buildings provide flexibility to solve power supply-demand mismatch

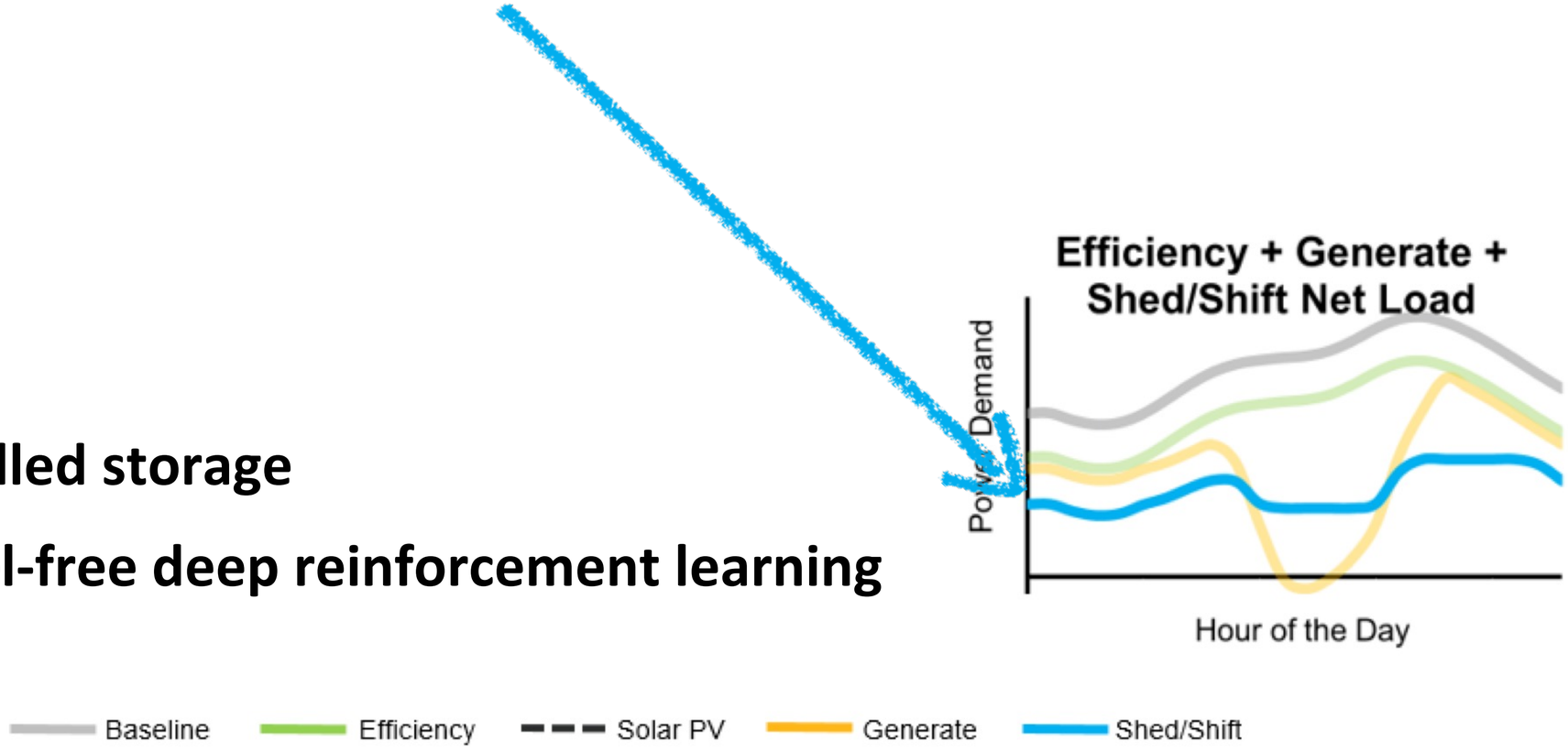


Neukomm et al., DOE, 2019

How do we get to here?

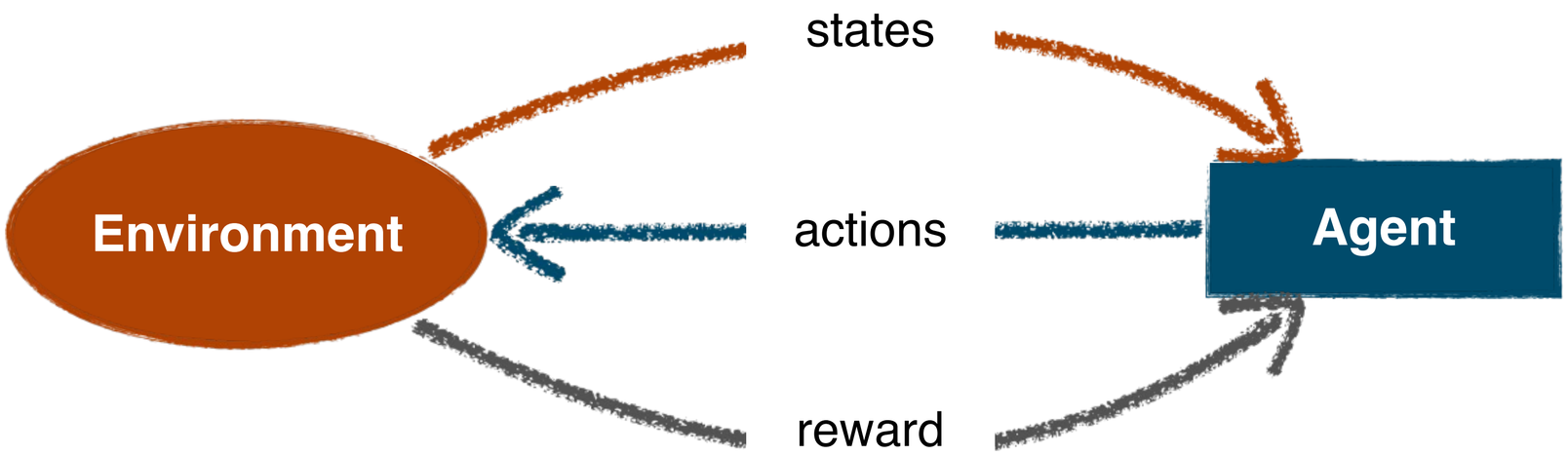
Controlled storage

> model-free deep reinforcement learning



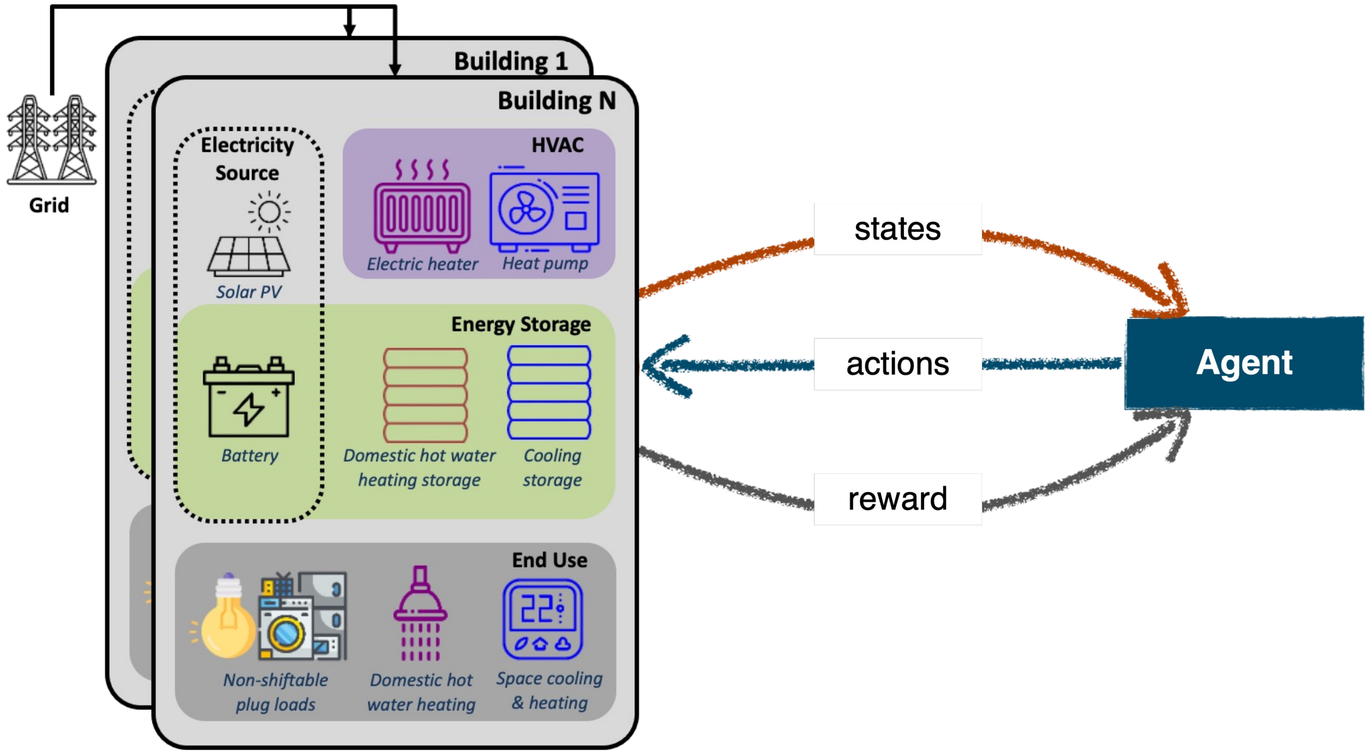
Neukomm et al., DOE, 2019

Simple systems with complex behavior: Reinforcement Learning



CityLearn: Control algorithm benchmarking in grid-interactive communities

- Open-source Gym environment to study neighborhood/community scale
- Buildings & systems are abstracted out in the library
  - Availability and size of systems can be configured
    (PV, thermal, electric storage)
  - Active energy storage control (load shifting)
  - Focus on control algorithms (RLC, MPC, RBC)
- Code & docs accessible through www.citylearn.net



Vazquez-Canteli et al., 2019

Tutorial summary

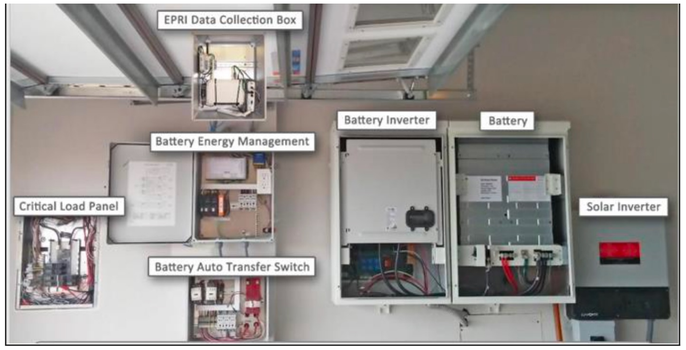
- **Learn** how to design a controller for **battery management** in a residential **neighborhood** for **load shifting** flexibility where each building has a photovoltaic system for **self-generation**.

- Learn the **benefits** and **shortcomings** of **3** control **algorithms.**

- **Evaluate** algorithm **performance** on **6** energy flexibility, environmental and economic **KPIs.**

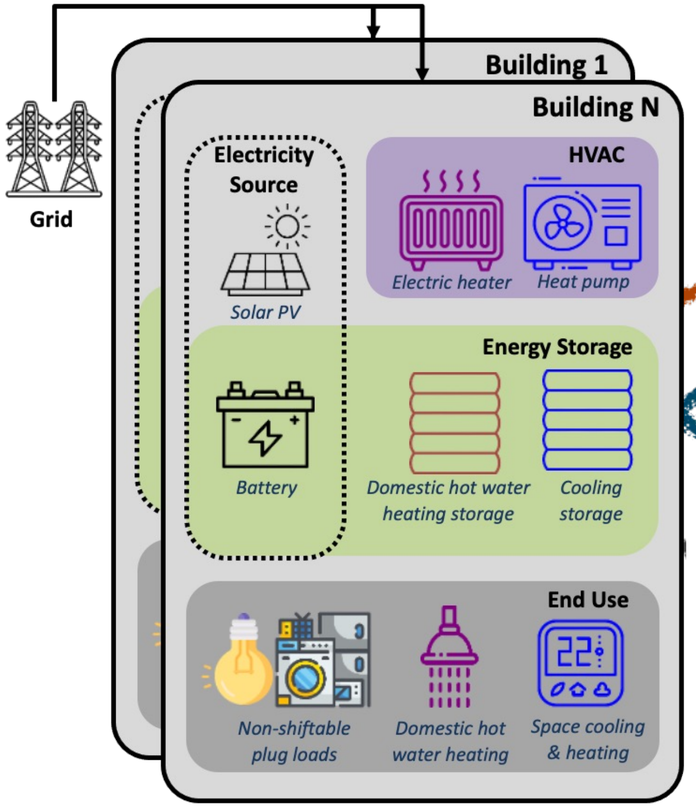
Transformed dataset from a real-world zero net energy residential neighborhood

- Sierra Crest Zero Net Energy community in Fontana, California
- 15 single-family homes
- 177m^2 – 269m^2 floor area
- Constructed mid – late 2010s
- 6.5 kWh battery in each building
- 4 – 5 kW PV capacity in each building
- Dataset spans August 1, 2016 – July 31, 2017



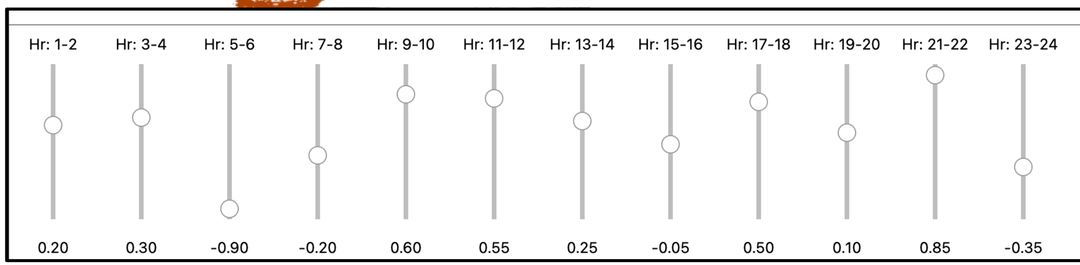
Narayanamurthy, 2017

Control Algorithm 1: Simple but inefficient rule-based control

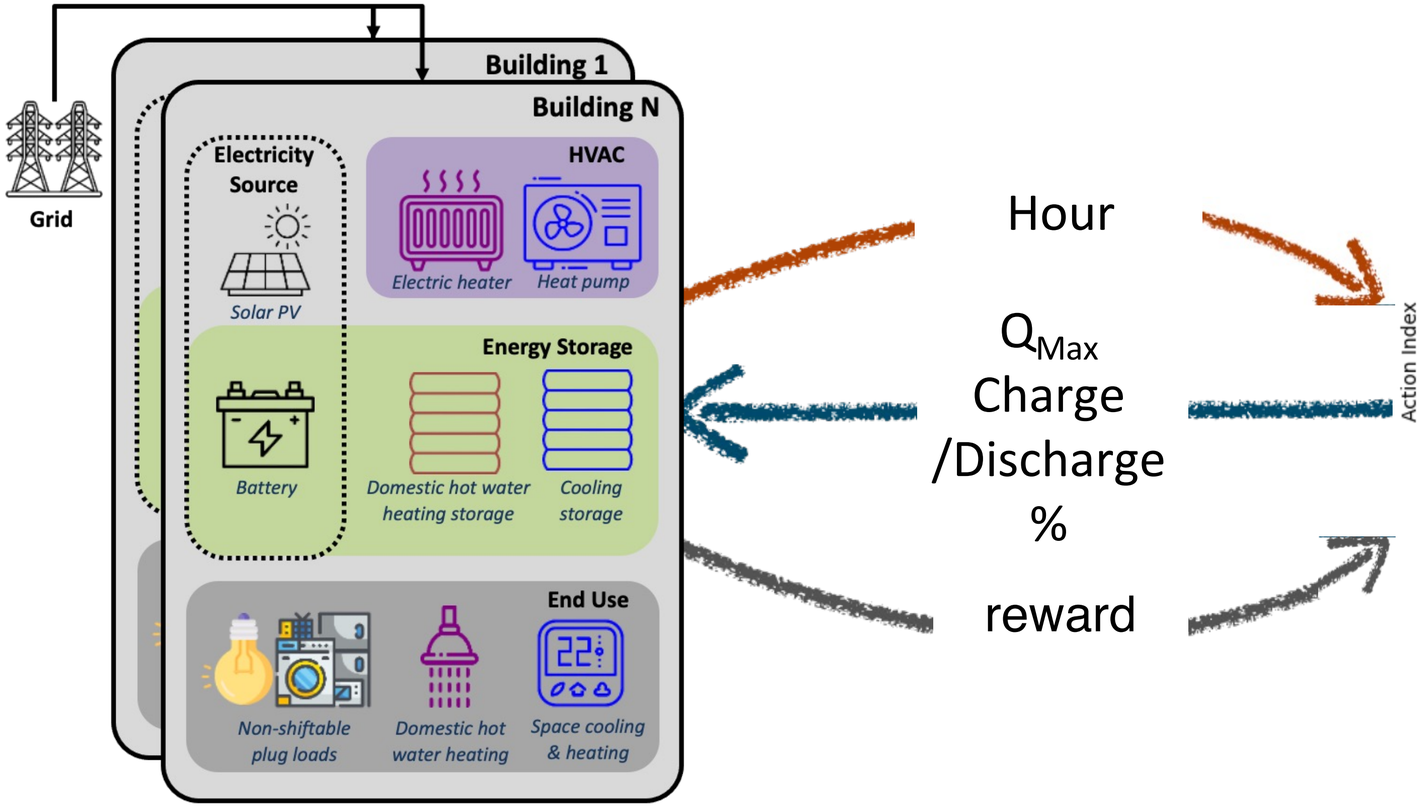


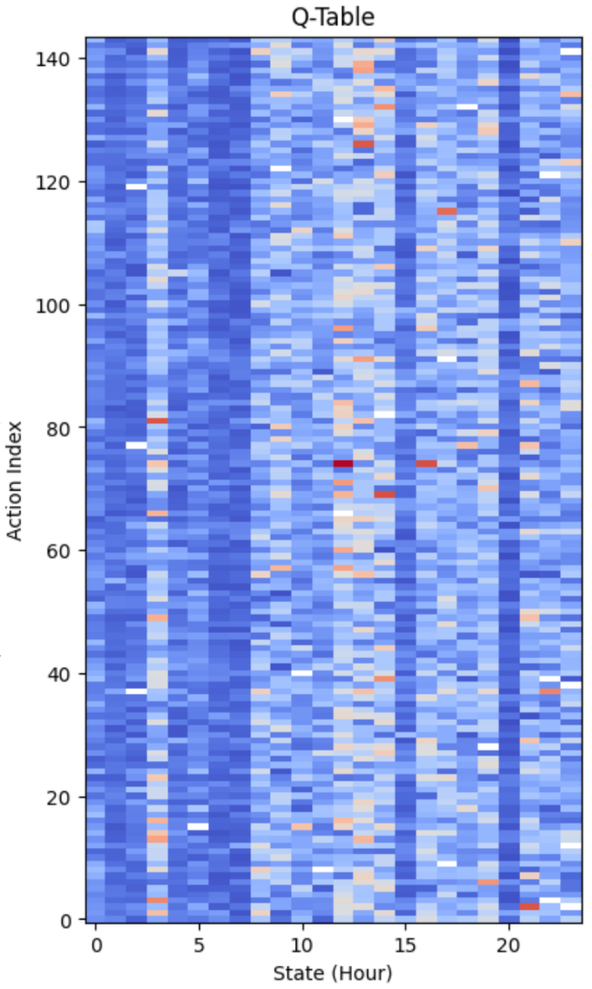
Hour

Charge /Discharge %



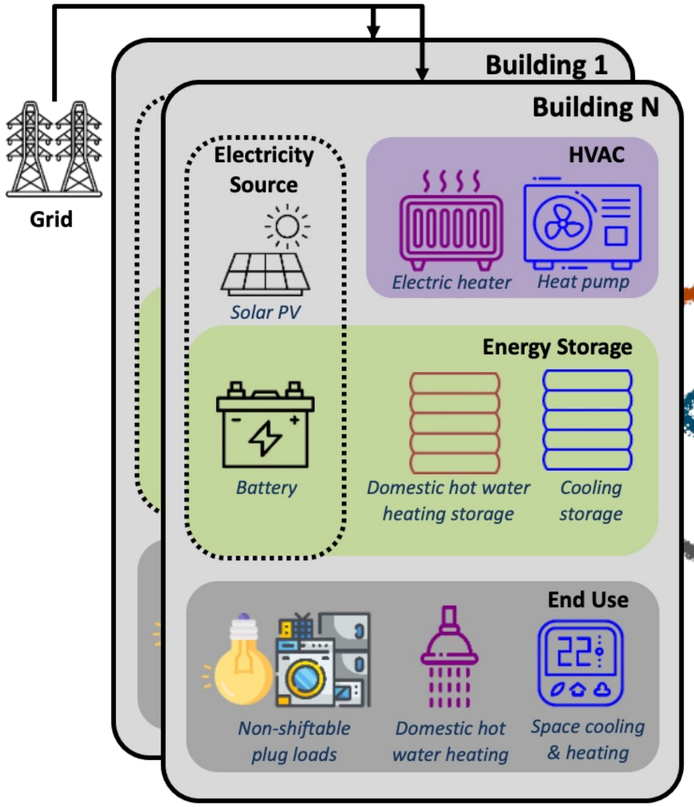
Control Algorithm 2: Adaptive Tabular Q-Learning and the Curse of Dimensionality

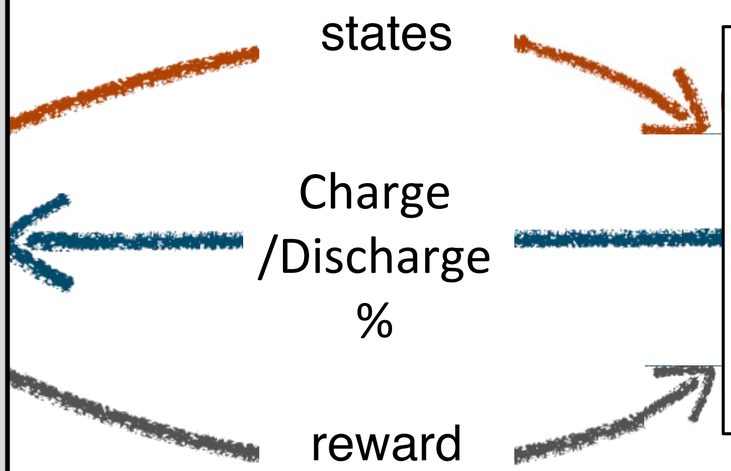


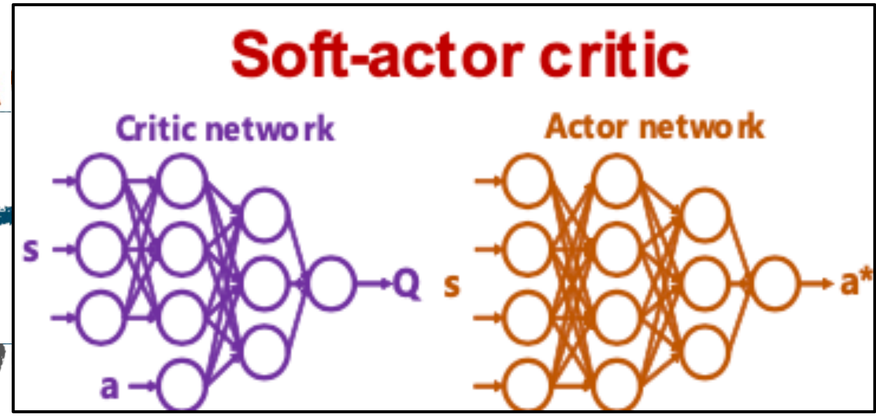


Watkins et al., 1992

Control Algorithm 3: Advanced soft-actor critic algorithm for high-dimensional spaces







Haarnoja et al., 2018

Thank You!

Web: *https://www.ie-lab.org*
YouTube: *UT Intelligent Environments Lab*
GitHub: *https://github.com/intelligent-environments-lab*

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