



FACULTY MENTOR

Yuanyuan Shi

PROJECT TITLE

Designing Learning Algorithms for Accelerated Control

PROJECT DESCRIPTION

To successfully deploy modern control systems such as energy systems, transportation, robotics, etc., we need algorithms that operate in real-time with stability and robustness guarantees. However, many of the algorithms in control theory require solving challenging differential and integral equations that take significant computational effort. This makes applying these algorithms in the real world challenging. Inspired by the explosion of deep learning, one can replace control algorithms with neural operators (<https://arxiv.org/pdf/2108.08481.pdf>) - neural networks that map from one function space to another. This enables us to significantly diminish the computation time of these challenging control algorithms while maintaining similar accuracy.

In this SRIP position, students will 1) develop neural operator-based control algorithms for a variety of dynamic systems. Additionally, they will 2) implement and test the performance of these neural operators for control systems. Thus, they will get experience both developing new learning algorithms and verifying their performance on a variety of dynamical systems.

This project will be in person.

INTERNS NEEDED

2 Students

PREREQUISITES

- Solid background in linear algebra and ODE; knowledge in PDE is preferred but not required
- Experience with machine learning and deep learning
- Proficiency with Python and Pytorch



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PROJECT TITLE

Reinforcement Learning under Large Dynamics Shift

PROJECT DESCRIPTION

Reinforcement learning (RL) can learn complex behavioral policies through trial-and-error interactions with real-world environments. However, many domains where we would like to learn policies are safety-critical and rather expensive to collect data from: from controlling a power grid to optimizing medical trials. In such applications, the desired property is to train the policy in a safer source domain, such as a simulator, and then convert the policy effectively into a target domain.

This project focuses on learning the optimal policy in the target domain using data mainly from a source domain where data collecting is fast and inexpensive. The main techniques used in this project would be offline reinforcement learning and imitation learning. The methods will be tested on a smart building simulator and OpenAI Gym (<https://gym.openai.com/>). Students in this project will be collaborating with other team members at Johns Hopkins University.

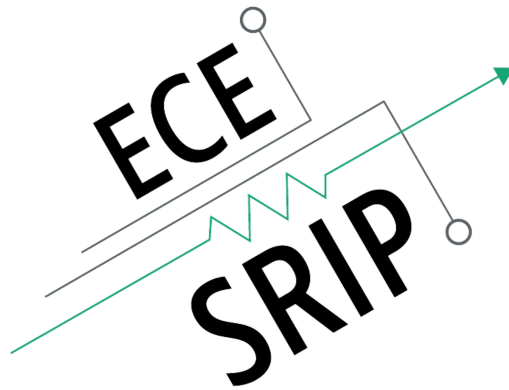
This project can accommodate both remote and in-person students.

INTERNS NEEDED

2 Students

PREREQUISITES

- Experience with machine learning and reinforcement learning is required.
- Proficiency with Python and Pytorch.
- Experience with OpenAI Gym (<https://gym.openai.com/>) is preferred but not required.



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PROJECT TITLE

Data-driven Smart Building Modeling

PROJECT DESCRIPTION

Recent advancements in learning and control have opened doors for researchers to operate and optimize building energy management systems autonomously. However, the lack of an easily configurable building dynamical model and energy management simulation and evaluation platform has arguably slowed the progress in developing advanced learning and control algorithms for building operation tasks.

In this SRIP position, students will develop data-driven building models using real-world building data from the UCSD campus. We aim to:

1. develop a holistic framework for processing and visualizing the individual building consumption data;
2. perform data analysis about the building's energy consumption and behavior patterns that may be exploited later for demand response programs;
3. incorporate the data-driven building models into BEAR - a physics-principled Building Environment for Control and Reinforcement Learning (our SRIP project last year and was recently accepted to ACM e-Energy) and then study multi-agent learning algorithms for multi-building coordination and control.

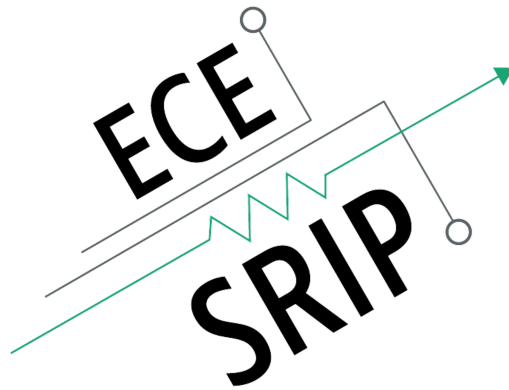
This project will be in person.

INTERNS NEEDED

2 Students

PREREQUISITES

- Experience with data analysis and machine learning; proficient in one programming language



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PROJECT TITLE

A Neural Network Solver for Combinatorial Optimization Problem

PROJECT DESCRIPTION

Combinatorial optimization problems are ubiquitous, from Traffic Assignment Problems in the transportation networks that are concerned with optimal routing choice of individual drivers to Unit Commitment problems in power systems for optimizing the power generators' schedule such that their operating cost is kept low, from playing the Go game that achieved super-human performance to optimizing compiler design.

In this project, we focus on solving combinatorial optimizations using recent advances in machine learning. We aim to:

1. perform a literature survey about recent advancements in machine learning methods for solving combinatorial optimizations;
2. design learning algorithms and structure to ensure the feasibility and (ideally) optimality of the solution;
3. fine-tune the learning algorithm performance with respect to specific application scenarios, e.g., the traffic assignment problem in EV charging and energy systems.

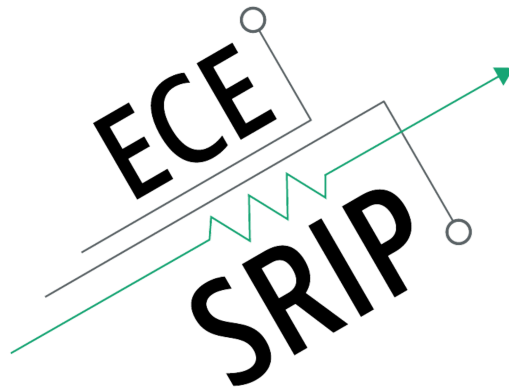
This project can accommodate both remote and in-person students.

INTERNS NEEDED

2 Students

PREREQUISITES

- Have taken at least one or more optimization and machine learning courses.
- Proficient in one programming language.



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PROJECT TITLE

Smart Forecast Catering to a Risk-aversion Decision-maker

PROJECT DESCRIPTION

In many real-world operation problems, a combination of both machine learning and optimization is used to make decisions. Specifically, a machine learning tool is used to generate a prediction model that predicts key unknown parameters of the subsequent optimization model for decision-making. For example, for the operation of a microgrid/virtual power plant, the future trend of renewable energy in it, such as wind or solar power, is needed to be forecasted.

In this project, by leveraging the historical data of renewable energy, we aim to smartly forecast its future trend catering to the decision-making objective of a risk-aversion operator. We aim to:

1. develop a method to measure the operator's aversion to risk;
2. use machine learning tools to learn the mapping between the contextual information and the forecast of renewable energy;
3. design a value-oriented loss function to smartly forecast catering to the objective of the risk-aversion operator.

This project can accommodate both remote and in-person students.

INTERNS NEEDED

2 Students

PREREQUISITES

- Have taken at least one or more optimization and machine learning courses.
- Proficient in one programming language.