Postdoctoral Research at ILLS

Reinforcement Learning for Robust Decision-Making and Dispatcher Assistance in Power Grids

September 6, 2024

Project Overview

Context

The International Laboratory on Learning Systems (ILLS) is pleased to announce an exciting postdoctoral fellowship opportunity in collaboration with La Javaness and RTE (the transmission system operator) the support of Ile-de-France region. We are seeking a highly motivated and talented researcher to work on reinforcement learning (RL) techniques to the robust optimization of power grids.

The increasing complexity of modern power grids require advanced methods to ensure reliability and efficiency. We aim at developing novel reinforcement learning strategies tailored for power grid optimization. Addressing challenges related to robustness and reliability in power grid operations. Collaborating with interdisciplinary teams to integrate research outcomes into real-world applications,

primarily to assist dispatchers in making more informed decisions. In particular, this project is based on the Grid2Op framework and a series of L2RPN challenges that have been presented at major AI and RL conferences over the past five years, including WCCI, NeurIPS, and ICAPS. See Energy Transition Challenge for further details. This project aims to develop a real-world demonstrator.

Potential Obstacles to AI Adoption in Electric Grid Management

In addition to identifying the essential functionalities expected, it is crucial to examine the potential obstacles to the adoption of artificial intelligence (AI) in the context of electric grid management operations. Among these obstacles, it is necessary to understand how to ensure the reliability and robustness of AI tools in critical situations. Indeed, the operations of electric grids are of an extremely critical nature, and any malfunction or error in the decisions made by AI systems could have serious consequences. Therefore, it is essential to develop strategies to overcome these obstacles by ensuring that AI tools are reliable, robust, and capable of making informed decisions in real critical situations. Error detection from AI predictions (classification, regression, and estimation) is an important problem in machine learning, as it allows the identification of instances where model predictions are unreliable. However, conventional uncertainty measures, such as Shannon entropy, are insufficient for inferring the true uncertainty in AI predictions. Therefore, we will explore new measures that are better suited to characterizing confidence in decision-making and recommendations. These measures need to be able to highlight instances where AI decisions may not be fully reliable, allowing for human oversight and intervention.

Research Objectives

The successful candidate will join a dynamic research team at ILLS, working closely with La Javaness and RTE, two leading companies in the field of power grid management and optimization. The project aims to develop advanced reinforcement learning algorithms to enhance the robustness and efficiency of power grid operations. Key focus areas include:

1. **Ensuring confidence in AI decisions and recommendations.** We will focus on characterizing the confidence in decision-making and recommendations. This nuanced approach is vital because the reliability of AI decisions directly impacts critical operations (e.g., see [2, 4]). AI systems need to offer not only accurate predictions but also instill confidence in the decisions and recommendations they generate. For electric grid managers, the implications of AI decisions are far-reaching, and the potential for severe

consequences in case of errors is significant. Therefore, it is essential to develop methodologies that provide a clear characterization of the confidence associated with these AI-driven decisions and recommendations.

2. **Interpretation of decisions generated by AI.**. This is a crucial aspect to consider. A major challenge is to gain user trust in the algorithms underpinning this tool. To achieve this, it is essential to ensure the transparency and interpretability of decisions made by these algorithms, especially in critical situations. It is also important to identify the necessary features to enable users to make informed decisions. How to clearly and understandably present the recommendations generated by the tool and explain the choices made are crucial questions to resolve in this context.

3. **Dispatcher Assistance.** Create decision-support systems using RL to assist power grid dispatchers in managing grid operations. Develop algorithms to suggest optimal actions in response to detected anomalies or prediction errors. Enhance situational awareness for dispatchers by providing actionable insights and recommendations (e.g., [1, 3].

4. **Integration and Validation.** Test and validate the developed RL models on real-world power grid data provided by industry partners such as RTE. Conduct simulations to assess the impact of the proposed solutions on grid reliability and efficiency. Collaborate with power grid operators to refine and implement the solutions in practical settings.

Position Overview

- Title: Postdoctoral Fellow
- Laboratory: ILLS is located in Montreal (QC, Canada), and La Javaness and RTE located in Paris (France)
- Duration: 12 - 18 months
- Competitive salary (determined based on the candidate's experience and qualifications)
- Start Date: As soon as possible

Key Responsibilities

- Conduct cutting-edge research on reinforcement learning and its applications to power grid optimization.

- Design, implement, and evaluate novel algorithms for robust optimization.
- Publish research findings in top-tier conferences and journals (NeurIPS, ICML, ICLR, AAAI,...).
- Collaborate with engineers of the R&D from La Javaness, RTE, and researchers from ILLS to ensure successful project outcomes.
- Possibility to collaborate with graduate students and contribute to the academic community at ILLS.

Qualifications

- Ph.D. in Computer Science, Electrical Engineering, or a related field.
- Strong background in reinforcement learning, machine learning, and optimization techniques.
- Some knowledge of power systems and grid management is desirable.
- Proven track record of research excellence, including publications in top-tier venues.
- Excellent programming skills and experience with relevant software and tools.
- Strong analytical, problem-solving, and communication skills.

Application Process

Interested candidates should submit the following documents:

- A cover letter detailing your research interests and how they align with the project.
- A curriculum vitae (CV) including a list of publications.
- Contact information for at least three references.
- Application Deadline: September 20th , 2024, though, applications will be welcome until the position is filled.

For any inquiries regarding the position, please contact: Prof. Pablo Piantanida, Director of ILLS, CNRS CentraleSupelec, ILLS.

In the application, please send a resume, a motivation letter and a link to relevant publications to Pablo Piantanida, firstname.lastname@mila-quebec. At least one reference letter will be asked in a second step.

An International and Stimulating Environment for Research

The International Laboratory on Learning Systems (ILLS) gathers 19 permanent faculties (McGill University and ETS) and CNRS researchers covering a wide variety of research topics including Statistics, Probabilistic modeling, Machine learning, Computer Sciences, Natural Language and Speech Processing, and Statistical Signal processing. On the overall, ILLS research counts up to 100 PhD students and postdoctoral researchers and covers various domains in computer science and networks, applied mathematics. It has been founded by six prestigious French engineering schools and research institutions: the CNRS, McGill University, École de Technologie Supérieure (ÉTS), Université Paris-Saclay, CentraleSupelec and MILA - Quebec AI Institute, which are all major players in AI at the international. ILLS will promote international mobility between Canada and France, to facilitate collaborations with other partners La Javaness and RTE.

Join us at ILLS to advance the frontier of reinforcement learning and power grid optimization in collaboration with industry leaders La Javaness and RTE. We look forward to receiving your application!

References

[1] Tuomas Haarnoja et al. "Soft Actor-Critic: Off-Policy Maximum Entropy Deep Reinforcement Learning with a Stochastic Actor". In: *Proceedings of the 35th International Conference on Machine Learning*. Ed. by Jennifer Dy and Andreas Krause. Vol. 80. Proceedings of Machine Learning Research. PMLR, Oct. 2018, pp. 1861–1870. URL: https://proceedings.mlr.press/v80/haarnoja18b.html.

[2] Federica Granese et al. "DOCTOR: A Simple Method for Detecting Misclassification Errors". In: *Advances in Neural Information Processing Systems 34: Annual Conference on Neural Information Processing Systems 2021, NeurIPS 2021, December 6-14, 2021, virtual (accepted as a spotlight)*. Ed. by Marc'Aurelio Ranzato et al. 2021, pp. 5669–5681. URL: https://proceedings.neurips.cc/paper/2021/hash/2cb6b10338a7fc4117a80da24b582060-Abstract.html.

[3] Andres Altieri et al. "Beyond the Norms: Detecting Prediction Errors in Regression Models". In: *Forty-first International Conference on Machine Learning (accepted as a spotlight)*. 2024. URL: https://openreview.net/forum?id=YqIIhl2ToH.

[4] Eduardo Dadalto Câmara Gomes et al. "A Data-Driven Measure of Relative Uncertainty for Misclassification Detection". In: *The Twelfth International Conference on Learning Representations*. 2024. URL: https://openreview.net/forum?id=ruGY8v10mK.