Learning To Run a Power Network Competition

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Abstract

We prsent the design of a new competition "Learning To Run a Power Network" to test the potential of Reinforcement Learning to solve a real world problem of great practical importance: controlling electricity transportation in smart grids while keeping people and equipment safe.

1 Context

Power grids transporting electricity across states, countries, or continents, are vital components of modern societies, playing a central economical and societal role, by supplying reliably power to industry, services, and consumers. Electricity blackouts may lead to significant losses and delay in public services and strategical industries, *de facto* freezing society. Grid operators are in charge of ensuring that a reliable supply of electricity is provided everywhere, at all times. However, their task is increasingly difficult in the digital era because they have to examine in real time massive amounts of data despite Artificial Intelligence's nascent developments. Power systems are in some sense archaic complex artificial (intelligent) systems currently in operation, in great need for innovation to cope with the increasingly complex task of satisfying electricity demand while using renewable energies and open market exchanges. Indeed, wind, solar, and the like, are not very dependable sources of energy (because they vary with the day/night cycle and weather conditions). Also, while providing opportunities, electricity markets may be plagued by speculations. This places new flexibility and reactivity requirements on the smart grids of the future.

Rather than using more hardware (e.g. more transportation lines), new software that could operate the grid with latest AI could be a game changer to optimize usage of existing assets [1]. In the community of power systems, optimal control methods [2] have been explored but have failed short until now, and humans are still in charge of operating the grid. With the latest breakthroughs from AlphaGo at go [3] and Libratus at poker [4], Reinforcement Learning (RL) seems a promising new avenue to develop an artificial agent able to operate a complex power system in real-time, assisted by high performance physical grid simulators. In line with recent work [5] using RL within the power system community, we propose a competition "Learning to run a Power Network" using a challenging game-like environment we have designed, to enable the RL community to join forces with the power system community in order to tackle this burning smart grid issue at larger scale.

2 Competition Protocol

This competition is inspired by the "Learning to run" competition at NIPS 2017[1], as could be guessed from its name "Learning to run a power network". By analogy, its goal is somewhat similar in nature: competitors will have to "run" (manage) a power grid as long as possible, before "falling" into a blackout (cascading failure). It will be also similar in terms of platform, since we are making available a virtual environment of a power grid that relies both on a "generator of scenarios", including inputs (so-called "injections", provided by power generators and consumers) and obstacles (broken transmission lines), and on a *physical grid simulator* computing power flows in every transmission line (the state of the system). This platform uses the opengym RL framework, developed by OpenAI[2] and the open source PyPower simulator[3]. Competitors will then have to create a proper controller in this environment, most likely (but not necessarily) using RL techniques. Aside from addressing a problem in a totally different application domain with a important economic impact, compared to the Learning to Run challenge, which inspired us, our setting has many novel and challenging features from the RL point of view :

- A state space described by both continuous variables (flows in lines) and discrete variables (line interconnection patterns).
- A discrete action space (change in line interconnection patterns).
- A stochastic component in the environments: "obstacles" present themselves to the agents as scheduled operations on the grid (maintenance), random variations in injections due e.g. to weather conditions (changing loads and productions) and unpredictable incidents (lines broken by a thunderstorm).
- Various reward models created to adjust the game difficulty level.

Hence, this competition offers novel aspects, which should attract RL researchers and ML people at large. The competition will take place in 2019.

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[1] `https://www.crowdai.org/challenges/nips-2017-learning-to-run`
[2] `https://gym.openai.com/`
[3] `https://pypi.org/project/PYPOWER/`

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