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Wednesday August, 19th 2020

Learning to Run a Power Network in a sustainable world – Part 2

02

L2RPN challenges

Useful material

Current competitions

Robustness

https://competitions.codalab.org/competitions/25426

Adaptability:

https://competitions.codalab.org/competitions/25427

Part 1 of this tutorial: https://youtu.be/1KCHoye8zq0

More information

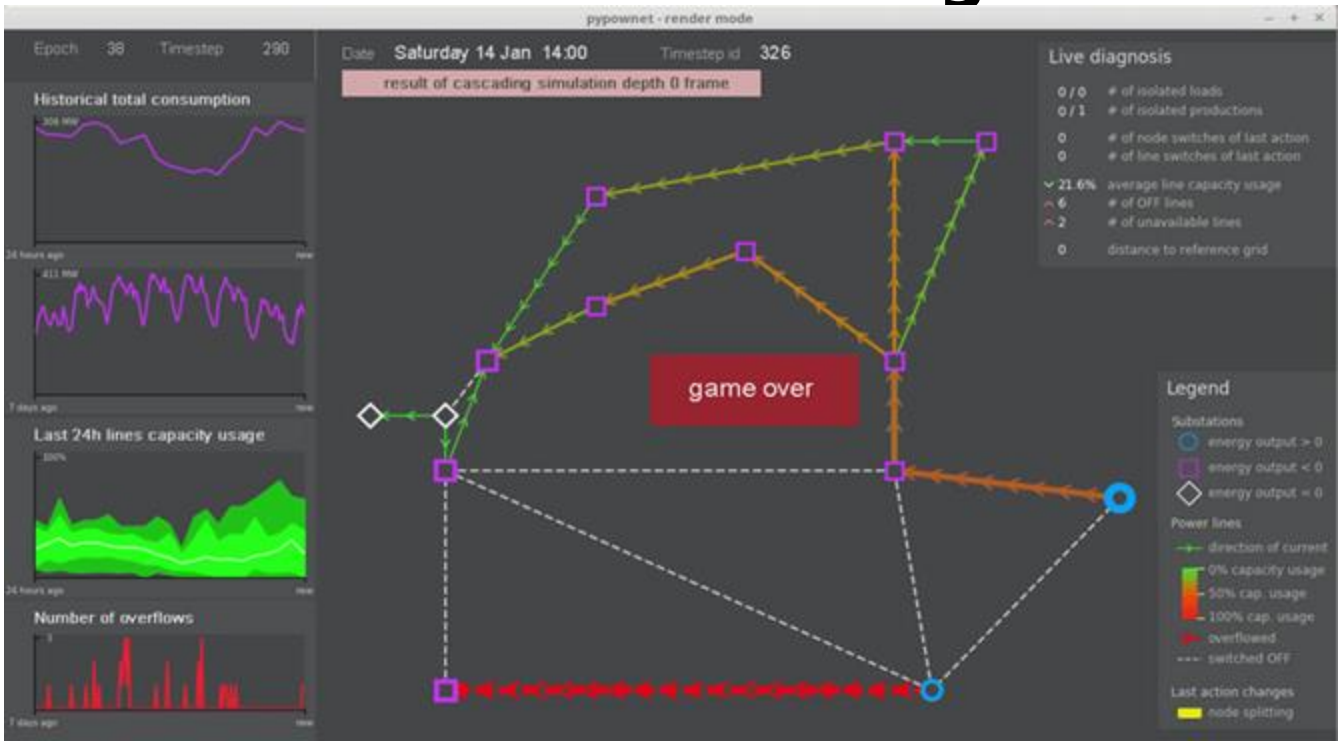
Website

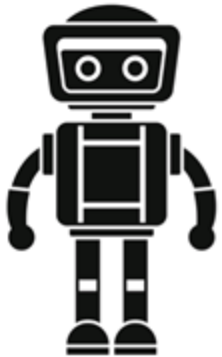
https://l2rpn.chalearn.org/

Discord server

https://discord.gg/cYsYrPT

« Learning To run a power network »
L2RPN Challenge





1) Test the potential of AI to robustly operate a power grid in real-time given operational constraints.

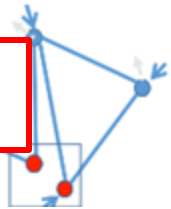
Different kind of flexibilities

On Grid Flexibilities

Topology:

Little research

- Node merging/splitting



Power devices:

Some research

- Phase shifter
- HVDC
- ...

All over the grid & 0$!

Few & local & 0$

On Production and Load Balancing

Redispatching

Lots of research

Load shedding

Many over the grid & $$$

Many over the grid & $$$$$

2) Explore underutilized cheap topology controls with methods can deal with non-linear, non-convex and combinatorial complexity

Motivations for a challenge

Exhibit important real-world problems to the research community

Large Benchmark for Reproducible Science:

- Decouple the problem from its solution

Attract new communities, especially AI community, through an easy-to-use platform & a gameified problem

Modeling of power system operation world

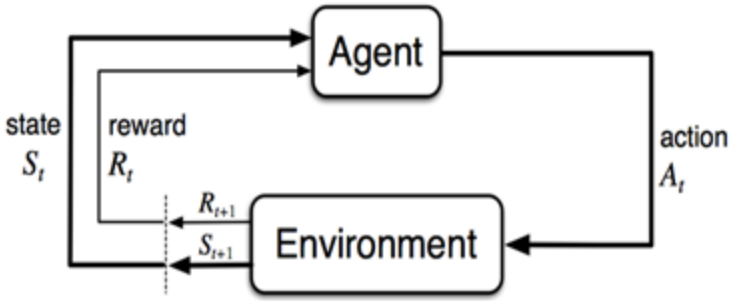


Fig. 1 - *Reinforcement Learning interaction loop*

Observation: flows, productions, consumptions, power grid topology, month, day, hour, etc

Action: connect/disconnect one transmission line **or** change the electrical configuration within a substation **or** adjust generation

Score: operational cost of the grid (losses + redispatching + penalty for blackout)

Maximize

$$\sum_{t=0}^{\infty} \gamma^t r(s_t, a_t)$$

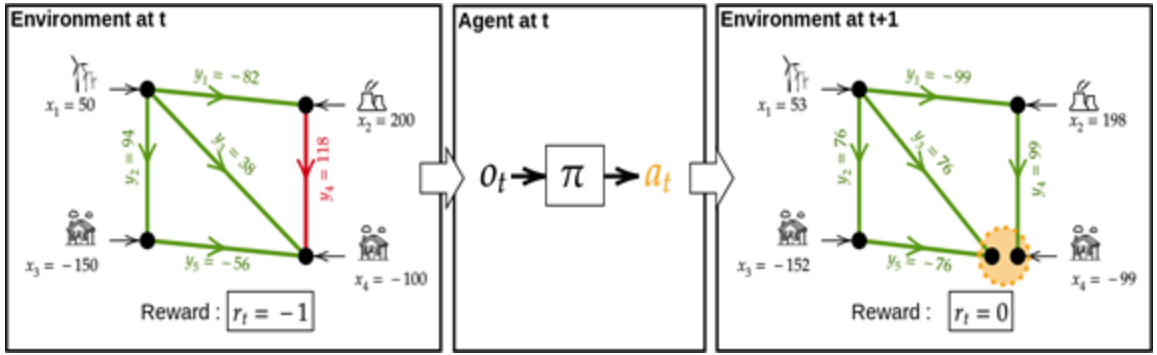


Fig. 2 - *Step-by-step evolution of the RL environment*

Focus on the score

What is an « efficient » grid [for this competition]?

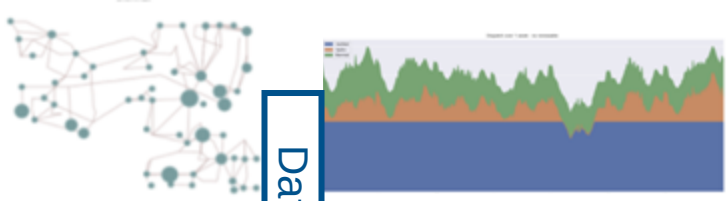
$$c(t) = c_{loss}(t) + c_{redispatch}(t) + c_{blackout}(t)$$

Power loss are low

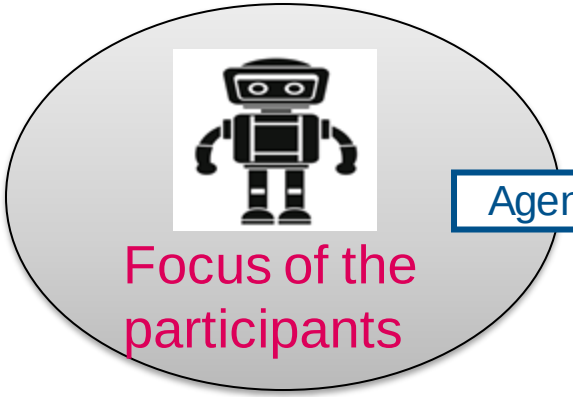
Generation cost is low

No blackout

L2RPN Environments



Data



Agent

Analysis

Solver

Pandapower	Lightsim2grid
(?) PSSE	(?) PowerFactory
(?) PSLF	(?) PowSyBl
(?) Powermodels	(?) GridPack

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L2RPN: competition series

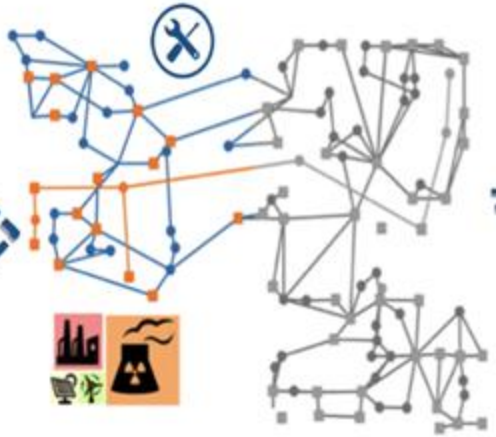
Ongoing L2RPN serie competitions

IJCNN Feasibility challenges

2019

Small Grid, no events,
Winter month,
only topology

Spring 2020



***Medium** Grid, **maintenance**,*
all year long, only topology

NeurIPS Sustainable World challenge

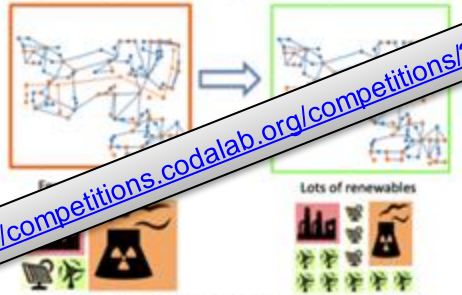
Robustness

Summer 2020

https://competitions.codalab.org/competitions/25426

*Medium Grid, **adverserial attacks**,*
*Topology & **redispatching** actions*

Adaptability



https://competitions.codalab.org/competitions/25427

***Large** Grid, **2 environments**,*
*Topology & **redispatching** actions*

Sponsors & Collaborators

Principal coordinators:

- Antoine Marot (RTE, France)
- Isabelle Guyon (U. Paris-Saclay; UPSud/INRIA, France and ChaLearn, USA)

Protocol and task design:

- Gabriel Dulac-Arnold (Google Research, France)
- Olivier Pietquin (Google Research, France)
- Isabelle Guyon (U. Paris-Saclay; UPSud/INRIA, France and ChaLearn, USA)
- Patrick Panciatici (RTE, France)
- Antoine Marot (RTE, France)
- Benjamin Donnot (RTE, France)
- Camilo Romero (RTE, France)
- Jan Viebahn (TenneT, Netherlands)
- Adrian Kelly (EPRI, Ireland)
- Mariette Awad (American University of Beirut, Lebanon)
- Yang Weng (Arizo State Univ., USA)

Data format, software interfaces, and metrics:

- Benjamin Donnot (RTE, France)
- Mario Jothy (Artelys, France)
- Gabriel Dulac-Arnold (Google Research, France)
- Aidan O'Sullivan (UCL/Turing Institute, UK)
- Zigfried Hampel-Arias (Lab 41, USA)
- Jean Grizet (EPITECH & RTE, France)

Environment preparation and formatting:

- Carlo Brancucci (Encoord, USA)
- Vincent Renault (Artelys, France)
- Camilo Romero (RTE, France)
- Bri-Mathias Hodge (NREL, USA)
- Florian Schäfer (Univ. Kassel/pandapower, Germany)
- Antoine Marot (RTE, France)
- Benjamin Donnot (RTE, France)

Baseline methods and beta-testing:

- Kishan Prudhvi Guddanti (Arizo State Univ., USA)
- Loïc Omnes (ENSAE & RTE, France)
- Jan Viebahn (TenneT, Netherlands)
- Medha Subramanian (TenneT & TU Delft, Netherlands)
- Benjamin Donnot (RTE, France)
- Jean Grizet (EPITECH & RTE, France)
- Patrick de Mars (UCL, UK)
- Lucas Tindall (Lab 41 & UCSD, USA)

Materials available

- Visit our **website** https://l2rpn.chalearn.org/ for an interactive introduction to power grid operations
- Reading the companion white paper as well as the description of the competition, and also our L2RPN 2019 paper should help you understand the problem deeper.
- Visit the **Instructions** subsection to get started with the competition
- Understand the rules of the **game** and the evaluation of your submission in the related subsection
- Review the **terms and conditions** that you will have to accept to make your first submission.
- Dive into the **starting kit** for a guided tour and tutorial to get all set for the competition and start make submissions. It helps you **TROUBLESHOOT** your submission if you are having troubles
- Take a look at the Grid2op documentation

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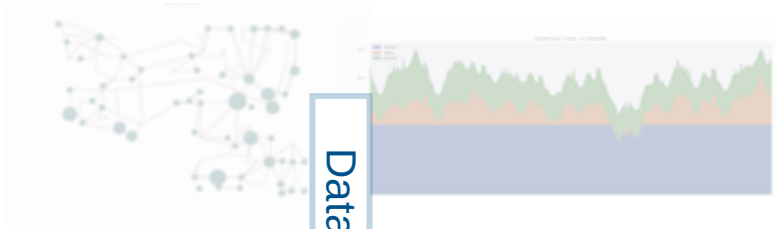
Let’s dive in!

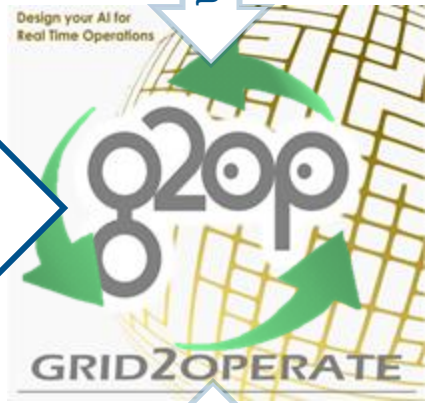
Live Demo 1: how to perform actions



Data

Focus of the participants

Agent



Analysis

Solver

Pandapower	Lightsim2grid
(?) PSSE	(?) PowerFactory
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Possible actions: sum up

1. **Powerline status**
   - Low cost (0)
   - Can endanger the grid
   - One line at a time
2. **Substation configuration**
   - Low cost
   - Highly non linear impact, everywhere on the grid
   - One substation at a time
3. **Redispatching**
   1. High cost (proportional to amount of dispatch performed)
   2. Localized impact
   3. As many generator at a time, be carefull with the ramps

Notebooks can be run interactively at:

https://mybinder.org/v2/gh/rte-france/Grid2Op/master

Or downloaded from:

https://github.com/BDonnot/Grid2Op/tree/master/getting_started

(IEEE BDA Tutorial Series.ipynb)

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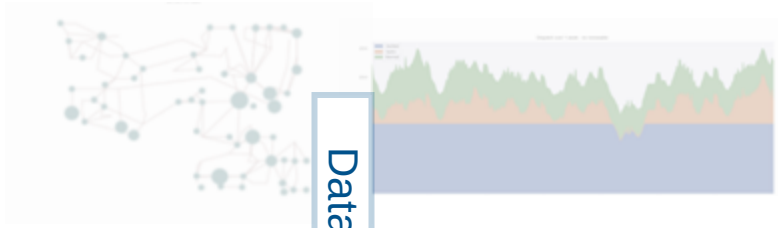
How to get started

Live Demo 2: how to make an agent



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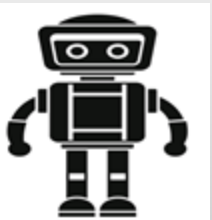
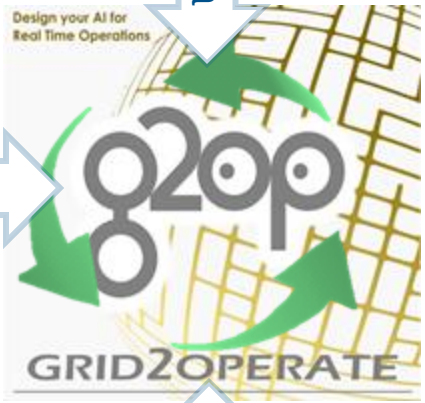


Focus of the participants

Agent



Solver

Analysis

Pandapower	Lightsim2grid
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Workflow

- **Define an agent**
- **Evaluate its performance**
- **Submit it**

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