Graduation/Internship Computer Science

Power Grid Network Layout Visualization

Background

The medium-voltage grid, which is almost 40,000 kilometers long, is an important part of Alliander's electricity grid. The pressure on this part of the grid is increasing uncontrollably, due to the increase in the amount of PVs, electric vehicles and heat pumps, amongst other things. A major challenge for Alliander is that very few measurements are available in this part of the grid, and the measurements that are present are usually only current measurements that cannot determine the direction of the energy flow. It is therefore often difficult to determine exactly how much room there is left for new customers at a certain spot.

To cope with this challenge, many analytical, statistical and machine learning methods are applied for power system analysis, which usually requires power system calculations (preferably in parallel) for a substantial number of simulation cases/scenarios. Hence, there is a critical requirement for a high-performance power system calculation library capable of efficiently executing a large volume of calculations. This library should be optimized for speed and accuracy, ensuring timely and reliable computational results for complex power system analyses. In this context, the LF Energy Power Grid Model project (https://github.com/PowerGridModel/power-grid-model) plays a key role. Power Grid Model is an open source, high-performance distribution grid calculation library written in Python/C++ with functionalities such as power flow, state estimation and short circuit calculations. Alliander initiated the development of the library and is now still actively contributing. Using efficient C++ implementations, the library provides a significant single-thread performance boost compared to

existing open-source solutions and proprietary services, let alone its native multi-threading support. It has already been successfully deployed in various Alliander in-house applications. Moreover, its adoption extends beyond Alliander, with other organizations beginning to utilize this library.

As an open-source library, Power Grid Model is accessible for widespread use across various domains, including industrial applications and academic research. Its open-source nature fosters the development of a community-driven ecosystem, encouraging rich collaboration and attracting numerous contributors. This approach not only broadens the library's applicability but also enhances its growth and innovation through diverse input and shared expertise.

Project description

As a member of LF Energy and contributor to the Power Grid Model project, Alliander helps promoting Power Grid Model to academic and industrial users and building a community. One of the important steps is to make Power Grid Model more user friendly. Being able to arrive at an electrically reasonable layout is essential for the grid visualization.

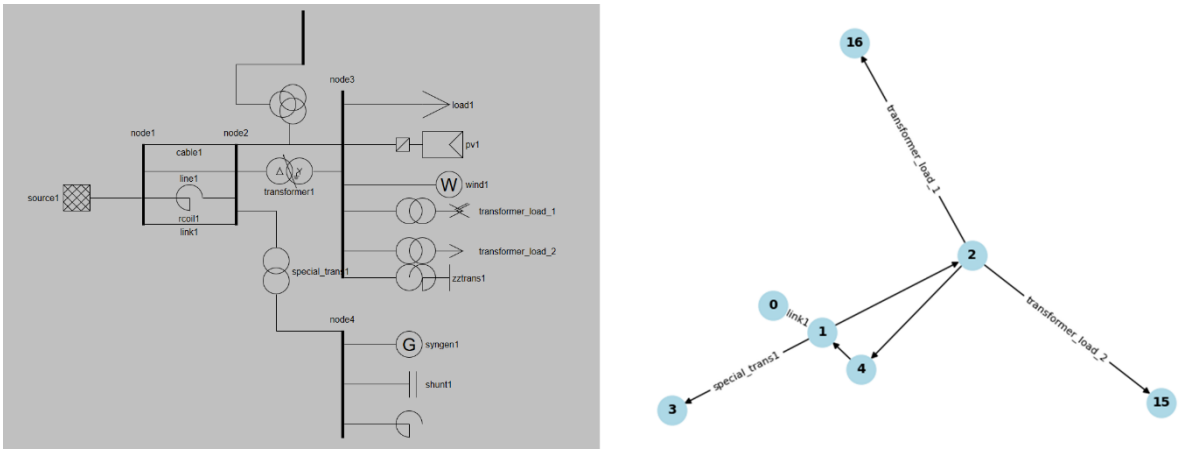

Figure 1 Left: Typical simple network created with eletrical information; Right: the direct graph visualization of the same network, removing all application specific layout information.

This project is focused on the layout algorithms that transforms a layout-less grid topology into an electrically reasonable network layout (i.e. graphical schematic representation), forming one of the basis of the visualization debug tool for Power Grid Model library. As a pure computation library, the interface for users is largely hidden behind applications. However, users would like to have a quick view of the grid, including topological layout and state of the grid. This is especially helpful when users run into issues and would like to quickly locate the root cause.

Since majority of the production data contains no information regarding the layout of the grid, a naïve approach would lead to simple tree like structure that carries no meaning in the domain (see Figure 1). A debug tool with state-of-the-art visualization for power grid systems would come in handy in this case. In an ideal scenario, this method in speak would take plain graph information as input and output a layout that is useful and can help user understand the state of the grid.

The research question follows naturally then: how can we generate a (physical) electrical network diagram from only the topological information of a power grid using visualization, classification and power analysis techniques?

The goal of the project is to develop a layout algorithm that can visualize the simulation of a logical network in the Power Grid Model into an physical electrical diagram that users with an Electrical Engineering background can interpret.

Current methodologies first generate a logical network after which, in a post-processing, steps users have to transform this diagram with concepts about certain nodes being transformers, switch boxes, sinks, sources etc. However, we believe that this information can be automatically derived from the logical model by studying the power flow inside the logical network.

The challenge is two-fold, namely:

- Developing a layout algorithm that minimizes the amount of crossings;
- Grouping and classifying the logical nodes and edges into physical entities of the original network.

The project could include, but not limited to, the following subtasks:

- Get familiar with the library interface of Power Grid Model and Power Grid Model - IO
- Get familiar with the way of working of Power Grid Model users
- Study state-of-the-art way of grid visualization
- Study human-machine interaction among PGM users
- Implement the tool.
- Write relevant documentations and academic reports.
- Write relevant tests, make pull requests.
- Make a simple benchmark to demonstrate the use case.
- Communicate stakeholders for revisions and suggestions.

Requirements

You are a master student with a Computer Science or Software Engineering background. You are enthusiastic about making contributions to open-source projects. You are looking for an internship/graduation project for at least 6 months.

You also have:

- Solid programming experience in modern programming languages
- Solid knowledge about software engineering (e.g. Git, version control, unit test, etc.)
- Strong communication skills in team environment

Nice to have:

- Experience with GUI design using common GUI languages
- Experience in (modern) C++

Willing to learn:

- Basic knowledge of power system analysis

What do we offer you?

Alliander is at the forefront when it comes to applying computer/data science and software engineering in a technical environment. We also offer you a good compensation, and we support you with all other means necessary to be successful.

Where will you work?

You will be part of the IT Chapter Advanced Data Professionals 1 with over 40 Data Scientists and Data Engineers. People in this chapter are spread out in different multidisciplinary scrum teams and they work on challenges like:

- Where is the greatest chance of a power failure?
- Which households will probably be placing solar panels on their roof in the coming years?
- Can we estimate the difficulty of a task for a contractor from a photo of the customer’s meter cabinet with image recognition?

We offer you the experience to be part of one of these scrum-teams at least part-time. It's also fine to work more independently in close relation with your internship supervisor.

About Alliander

Alliander is a large Dutch distribution system operator (DSO) that ensures that millions of customers have access to electricity and gas every day for living, working, transport and recreation. We stand for an energy supply that gives everyone access to reliable, affordable and sustainable energy under the same conditions. Now and in the future. That is what we work on together every day. We offer our professionals an environment for innovative and smart ideas. An environment for your energy.

Screening policy

Alliander screens all applicants. Depending on the position, the screening consists of the following steps: checking references, checking the authenticity of identity papers and diplomas, an integrity check and requesting a certificate of conduct (VOG).