Overview of "Quantifying the quality of Smart Energy Solutions via testing"

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This document provides an overview of the Jupyter Notebooks on mosaik and design of experiments. These notebooks were used as part of the summer school "Quantifying the quality of Smart Energy Solutions via testing" held at the Technical University of Denmark on August 27-31st, 2018 as part of the ERIGrid H2020 project[1].

[1] www.erigrid.eu

Background

Electrical systems increasingly rely on distributed, stochastic and heterogenous resources for their operation and management, while at the same time facing increasing uncertainty due to variable renewable resources. In parallel, ownership of system resources is diversifying due to unbundling, and other domains[2] increasingly couple to and depend on electrical networks.

[2] e.g. heat, transportation, public communication networks

On this background, it is necessary to shift requirements in the electrical system from individual *components* to *systems*, potentially involving other domains. Two major challenges for this change are (1) the need to formulate and communicate requirements at multiple points in the system and subsystems, and (2) developing tests which ensure that the system fulfills these requirements in a robust manner.

The first of these challenges are addressed in the ERIGrid project by the definition of the Holistic Test Description methodology.[3] The second challenge is the focus of this set of notebooks. Here, we show how the second challenge can be addressed by application of Design of Experiment[4] methods.

[3] For an overview, see [SPAW+18]

[4] DoE = Design of Experiments

Materials overview

The notebooks are organized in two sets.

The first set[5] provides an overview of how systems are constructed in Mosaik, and constructs a simple electrical test system.

[5] in the folder scenario_build_up

The second set[6] then uses this system as a background for applying several DoE methods, showing how each allows to easily generate experiments which can be traced back to the requirements placed on the system.

[6] in the folder DoE-exercises

Suggested reading order

To get the most out of these notebooks, we suggest to read the associated documents in the order below:

1. Introduction to Mosaik[7]
2. Exercise on building up mosaik scenarios[8]
3. Lecture notes for DoE [9], switching to
4. Notebooks for DoE for each topic[10]

[7] Mosaik_Introduction.pdf

[8] Scenario_build_up/scenario_build_up.ipynb

[9] DoE-Exercises/doe_erigrid_dtu_summerschool_2018-08-28.pdf

[10] DoE-Exercises/*.ipynb

Notebook overview

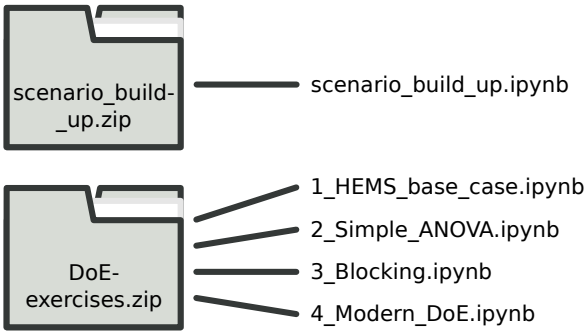

Figure 1: Available files and associated notebooks

A single notebook is provided for showing a build up of the simulation scenario:

scenario_build_up.ipynb Shows how mosaik scenarios can be built up from components

The notebooks available for Design of Experiments are:

1_HEMS_base_case.ipynb Introduction to the HEMS scenario, examples of running scenarios

2_Simple_ANOVA.ipynb Applying 2-factor ANOVA to the HEMS scenario

3_Blocking Applying Blocking to filter out confounding factors

4_Modern_DoE.ipynb Building metamodels using Kriging and Sobol sequences

Technical Notes

Requirements for these notebooks

The following are the python packages required for running the provided notebooks.

mosaik $\geq$ 2.5

matplotlib

pandas

Using Jupyter Notebooks

The associated notebooks can be viewed directly from this repository.

To use the notebooks interactively, see, e.g. `https://jupyter-notebook-beginner-guide.readthedocs.io/en/latest/` .

References

[SPAW+18] Thomas I. Strasser, F. Pröstl Andrén, E. Widl, G. Lauss, E. C. W. De Jong, M. Calin, M. Sosnina, A. Khavari, J. E. Rodriguez, P. Kotsampopoulos, M. Blank, C. Steinbrink, K. Mäki, A. Kulmala, A. van der Meer, R. Bhandia, R. Brandl, G. Arnold, C. Sandroni, D. Pala, D. E. Morales Bondy, K. Heussen, O. Gehrke, F. Coffele, Q.-T. Tran, E. Rikos, V. H. Nguyen, I. Orue, M. Z. Degefa, and S. Manikas. An integrated pan-european research infrastructure for validating smart grid systems. *e & i Elektrotechnik und Informationstechnik*, 135(8):616–622, Dec 2018.