PhD Course- CONTROL AND OPTIMIZATION IN SMART-GRIDS

Final exam

During the course we have covered three main topics: Random sources modelling, energy markets with renewables penetration and demand response. The aim of the exam is to apply some of the tools studied during the course to solve a problem of your interest. You can select one of the two proposed topics to develop your exam.

The exam should be presented in the form of a report with a length between 3 and 5 pages, including figures. The deadline to present the exam is June 15th.

1. Renewable generation models

Obtain a time series of a random source, such as wind or solar, from a thrusted supplier. At least one month of data should be used if hourly information is available.

1. Load the data set in a numerical processing software (e.g. Matlab, Julia, …).
2. Perform an initial analysis of the data
    a. What are the basic statistics?
    b. Do you identify outliers?
    c. Eliminate outliers ***without removing samples***.
    d. Obtain the signal autocorrelation function and analyze it.
3. Use the first 70% of data to build linear and non-linear models of the series. You can use the System Identification GUI (*systemIdentification*) in Matlab.
4. Use the remaining 30% of data to evaluate the performance of the derived models. Obtain the one step ahead prediction and FIT on the dataset.
5. Repeat the previous analysis for 12 and 24 hours ahead prediction horizon. How does the estimator behave as the horizon is increased?
6. Obtain the residues (estimation error) autocorrelation function. If the model properly explain data, the error should be white noise. Does the resulting error sequence have an autocorrelation function corresponding to a white noise signal?

2. Demand Response

Direct load management is one of the main strategies for implementing demand response programs. In the course we studied three examples of feasible direct load control methods.

For the exam you should select a type of load that can be managed directly by an aggregator to offer a demand response service to the grid. For this load you must do the following:

1. Explain the behavior of the load, how does it use and store energy?

2. Propose a strategy to modify the power consumption of the load. Would it be a deferrable or interruptible load?
3. What do you expect the time-response of the load to be? Could it offer regulation, reserve services or participate in the energy market?
4. Propose a framework where an aggregator controls a population of the selected loads to offer the service selected in the previous item. How would it operate?

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24/05/2018