

THESIS TOPICS (08/06/2020)

Here is a list of topics, related to our current research that may be studied in your final thesis.

Please, contact me if you are interested in pursuing one of these works.

Impact of COVID-19 lockdown measures on air pollution. The study aims at comparing what happened in different European cities due to the adoption of activity reductions all over Europe. The difficulty of the study is that air quality concentrations are due both to, possibly reduced, emissions and to the meteorology that differs every year. Therefore, air quality and meteorological variables should be analyzed and compared. Most data are already available on <https://www.eea.europa.eu/themes/air/air-quality-and-covid19> and can be analysed with Excel or Matlab.

Similarity of meteorological conditions. The idea is to analyse the meteorological data provided by several measurement stations spread over the territory of a region to cluster them in a number of specific meteorological conditions. Data refer to different spatial positions and time instants. This kind of aggregation would allow the analysis of air pollution data separating them, as much as possible, from the effects of the meteorological conditions. Data for Lombardy region can be easily downloaded from www.arpalombardia.it and examined with Excel or Matlab.

Neural forecast of PM concentration. Recent studies have shown that the use of different architectures of neural networks can help forecasting the concentration of PM10 and PM2.5 in several locations in the world. The idea is to apply these techniques also in the Padana plain. Particulate matter shows a certain persistence in the atmosphere so, in principle, forecasting few days ahead is possible, provided there are no large changes in the atmospheric conditions. Thus, it will be probably necessary to add some meteorological variables to the input of the network.

Optimal planning of renewable energy measures in the building sector. The study is a follow-up of some previous work we have completed on the adoption of energy-saving measures in residential buildings of the Lombardy region and complements the original work by evaluating the possibility of shifting a part of the energy consumption to renewable sources. Data and algorithms are in Excel.

Evaluating actions to foster the adoption of energy efficiency measures. To reach an "optimal" solution at regional level, the authorities have to take a number of measures (subsidies, taxes) to incentivize private citizens to adopt measures that are efficient also from the regional viewpoint. The study is aimed at comparing the effect of possible actions on the individual citizen and compute what can be the result of all the individual decisions at regional level. It can be done in Excel or Matlab.

Centralized versus decentralized control of a multi-reservoir system. We have studied the synthesis of reservoir operating rule for the downstream portion of the Nile river basin and compared the effect of different information structures, e.g., each release is decided only on the basis of the corresponding reservoir storage or of all the reservoirs in the system. The rules are represented by neural networks. We would like to test the differences between this case and a centralized control, in which the neural operating rule determines all the releases from all the reservoirs at the same time. Matlab necessary.

Deep neural networks for the forecasting of environmental variables. We have already experimented the use of deep neural networks (more than one hidden layer) to forecast solar irradiance at an hourly time step, using only previous measurements of the irradiance itself. The study wants to evaluate this approach on other meteorological variables, e.g. wind, rainfall, and the role that other input, e.g., pressure, temperature, might have. Matlab or Python required.

Forecasting rainfall cells using GPS signals. The idea is to develop a forecasting model (possibly a deep neural network) to determine the location and intensity of rainfall cells few hours in advance. A relevant piece of information for this purpose may be the concentration of water vapor in the atmosphere, that can be assessed measuring the delays of the GPS signal. The application will be in Lombardy and Kenya. Matlab or Python required.