Profile : Master degree
Duration : 6 to 9 months
Workplace : laboratoire de météorologie dynamique (LMD), Ecole Polytechnique, Palaiseau, 25km from Paris, France.

Solar energy production forecast using deep-learning techniques applied on meteorological satellite images

Context
Solar electricity production forecast enables a better integration of solar energy into the grid and then increases its share in the energy mix. Geostationary meteorological satellites, such as Meteosat, observe the cloud layer in real time by producing an image representing the same part of the Earth surface every 15 min. Proven forecast methods using image processing techniques are able to anticipate cloud motion and then deduce photovoltaic (PV) production forecast on a given location for the next hours. Despite of their limit to detect sudden cloud appearance/disappearance, these methods are generally more reliable than classical weather forecast models. Moreover, they require low computing costs and their operational implementation is straightforward.

Problematic
Recent deep-learning models, in particular convolutional neural networks (CNN) models encouraged researchers to develop precipitation forecast methods from radar images. Rainfall forecasts are known to be very complex and demanding in accuracy in order to prevent weather hazard consequences (floods, storm…). Despite of heavy computational costs, these techniques are advantageous compared to classical weather forecast models. These research demonstrate that solar energy forecast using satellite images have several reasons to use the CNN models. Indeed, more than 20 years of homogenous satellite data at high frequency (15 min.) are available for training models. Cloudiness and irradiance are bounded physical quantities that avoid inconsistent training. Finally, cloud evolution at fine spatiotemporal scale is a consequence of stochastic phenomenons that cannot be represented in the current physical models.

Objectives
The objective of the work consists in preparing the design of a new deep-learning model dedicated to PV production intraday forecast using visible channel of geostationary meteorological satellite. The main steps are :

- image classification in function of weather situation and/or forecast error generation with image processing techniques.
- Implementation of a CNN model already proven for precipitation forecast (e.g. U-net, convLSTM, …) on each weather situation classes
- Performance assessment on each classes and comparison with current techniques

This traineeship should be extended to a PhD work focused on physical interpretation of cloud forecast using deep-learning models, preparing a specific solar forecasting model using future satellites such as *Meteosat Third Generation*.

Required profile :

- Education : MSc in data analysis, data science, image processing or equivalent.
- Computer skills: Python, proven experience in deep learning model programming using Keras library with training on CPU and GPU.
- Strong interest in Earth observation, solar energy, meteorology
- Excellent written and communication skills

Contacts :

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