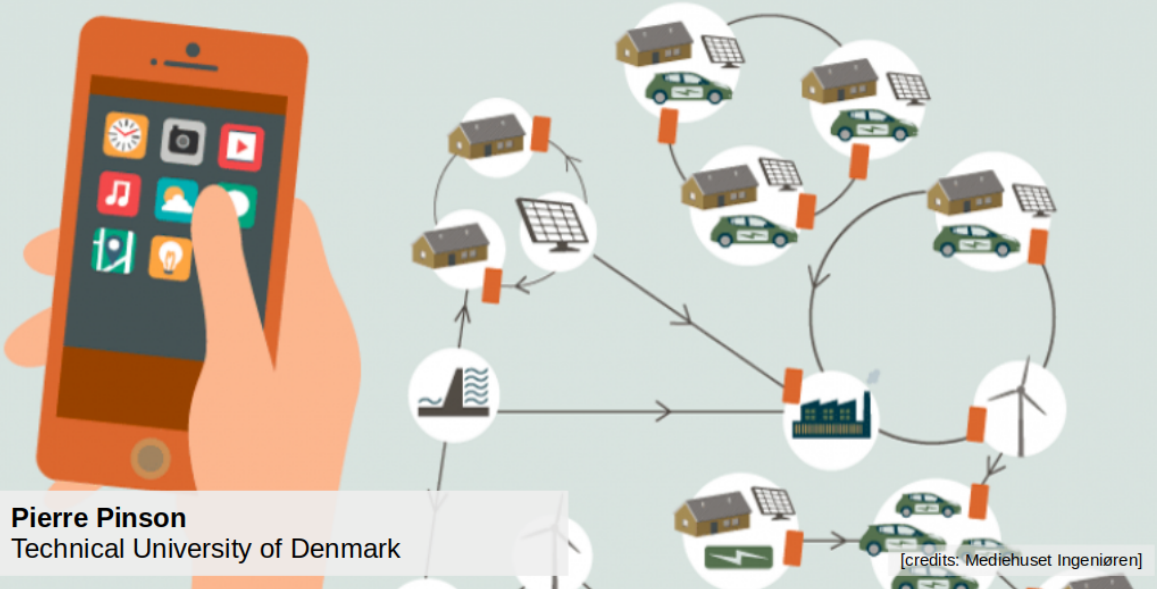
Module 10 – Renewable Energy Forecasting: Advanced Topics

Module introduction

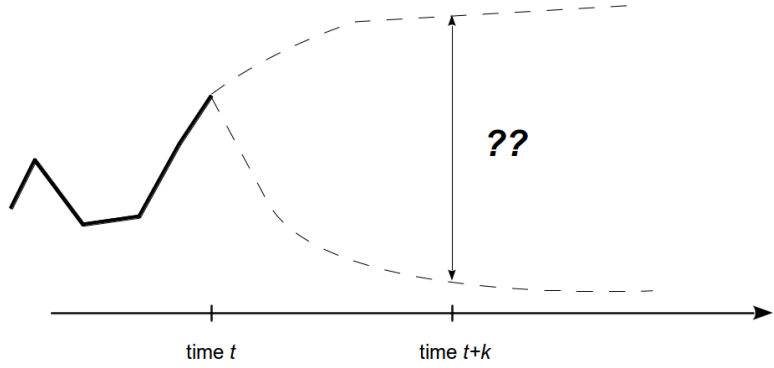


Pierre Pinson
Technical University of Denmark

[credits: Mediehuset Ingeniøren]

General considerations

- Forecasting is about the future! Lead times within 0-48 hours, in line with market-based operations
- When being at time t and aiming to generate a forecast for time $t + k$, **only knowledge available at time t can be used...**
  - observations up to time t: power generation, meteorological measurements, etc.
  - weather forecasts for the period of interest



- Since forecasts **will always have a part of error**, just accept, and *try to minimize it*

The essence of the forecasting problem

- Energy forecasting problems rely on some form of **regression** with a set of input-output ordered in time
- In practice this means that:
  - At time t_n, our dataset include a number of explanatory variable values $\{\mathbf{x}_{t+k}\}_{t<t_n-k}$ and response variable observations $\{y_{t+k}\}_{t<t_n-k}$.
    Ex: wind speed forecast and power production
  - We aim at finding a relationship between explanatory and response variables based on past data, i.e.

$$y_{t+k} = f(\mathbf{x}_{t+k}; \theta) + \varepsilon_{t+k}, \;\; t < t_n - k$$

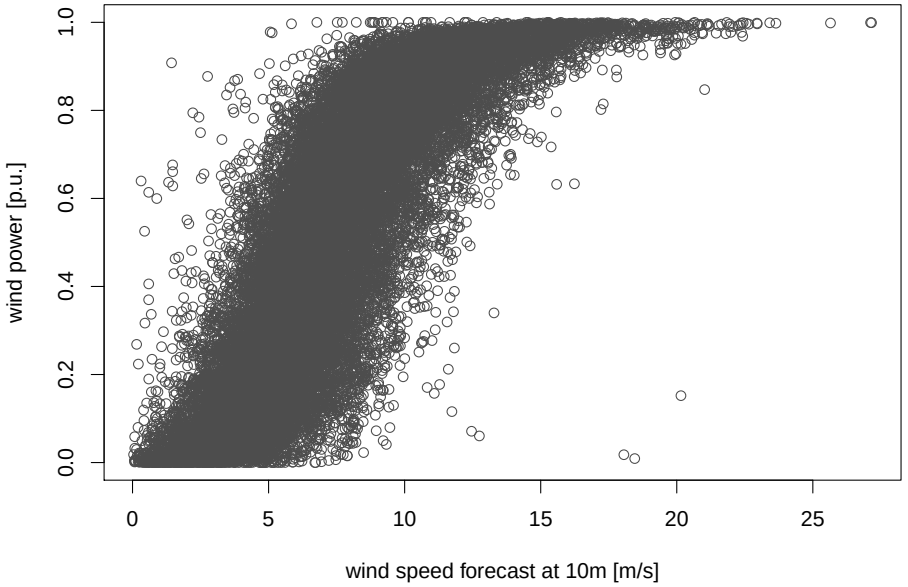
    where ε_{t+k} is a noise with 0 mean and finite variance, θ is a set of parameters that characterize f
  - The forecaster is to propose a way to stucture and learn f, and associated parameters.
    Ex: f is a linear function, 2 parameters are to be estimated
  - To issue forecasts using new values for explanatory variables,

$$\hat{y}_{t_n+k|t_n} = f(\mathbf{x}_{t_n+k}; \hat{\theta})$$

    where $\hat{\theta}$ are the parameters estimated
- Beyond this simple base case, decisions have to be make on how to **optimally use input data**, the **shape of** f, method for **parameter estimation**, etc.

Power curve modelling

This is snapshot of conversion from wind to power to be modelled



Learning objectives

Through this module, it is aimed for you to be able to:

1. Go **further than using linear regression techniques** in renewable energy forecasting
2. Have a basis for **making data-driven decisions** for improving models to be used for forecasting
3. Have an **understanding of nonstationarity** and ways to account for it when modelling

Module outline

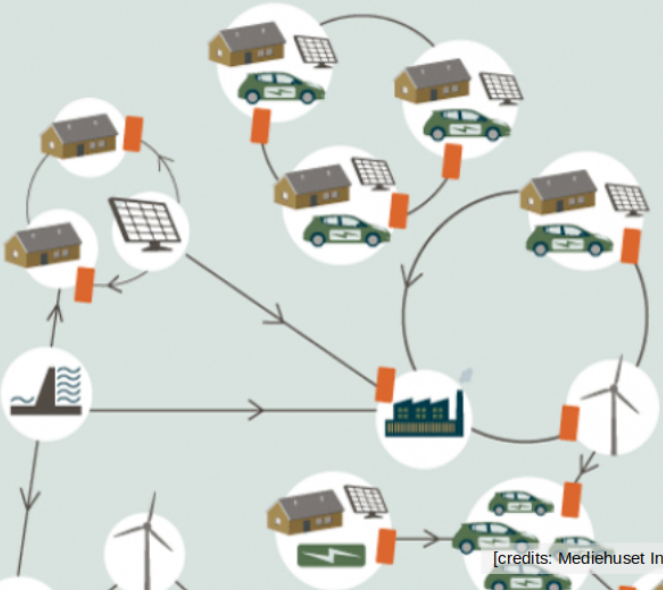
Module 10 is based on 3 video lectures and associated self-assessment quizzes:

10.1 From linear to nonlinear regression

10.2 Nonstationarity and time-adaptivity

10.3 Data-driven decisions

Good luck with Module 10!



[credits: Mediehuset Ingeniøren]