



Course:

Data-driven digital twins for energy systems

Grey-box modelling and non-linear time series analysis

The evolution of energy systems into the era of digitalisation and the green transition calls for intensive use of data-driven modeling especially models combining physics and statistics.

Grey-box models are exactly the combination of physics and statistics and can be used for characterization, forecasting and control of dynamical systems based on measured data. In other words they can form the core of digital twins of energy systems.

The 4-days training course will give a hands-on introduction to non-linear time series modelling techniques. During the first day, some basics of non-linear statistical modelling will be given, e.g. kernel and splines methods, and through practical examples of model selection and validation the techniques will be exercised. Second and third day will offer grey-box modelling and forecasting, again through hands-on practical examples. The fourth day will be on flexibility functions and modelling techniques for flexible load integration in systems. Finally, the participants can choose to work on a small project, either brought by themselves or from a set of pre-defined challenges and datasets.

The statistical modelling software R will be used and run on the participants own laptops. The daily agenda will be a combination of lectures and exercises, such that the concepts are introduced hands on in small steps. For the exercises scripts and data will be given, together with step-by-step instructions.

Dette forløb er en del af indsatsen i projektet Kvalificeret arbejdskraft til Fyrtårn Syd; grøn energi og sektorkobling. Projektet er finansieret via regeringens udmøntning af REACT-EU-midler.

Projectsponsors:



Projectpartners:



A student who has met the learning objectives of the course will be able to:

- formulate and apply non-parametric models using kernel functions and splines
- achieve a thorough understanding of maximum likelihood estimation techniques
- application of statistical model selection techniques (AIC, BIC, likelihood-ratio tests, model validation)
- formulate and apply models for short-term forecasting in energy systems, e.g. for heat load in buildings, electrical power from PV and wind systems
- formulate and apply grey-box and digital twin models – model identification – tests for model order and model validation, and advanced non-linear models
- achieve an understanding of flexibility functions and indices, and their applications in energy systems.

Prerequisites for the course is an engineering background, primarily within energy systems and some basic knowledge of statistics and programming. Preparation material will be made available for self study in advance.

Dates (2x2 days):

28/02 - 01/03/2023

14/03 - 15/03/2023

The course is arranged by DTU and Center Denmark including the projects FED, ARV, syn.ikea, Elexia and IEA EBC Annexes 81, 82 and 83 and the project Kvalificeret Arbejdskraft til Fyrtårn Syd.

For more information:

Contact Henrik Madsen hmad@dtu.dk or Peder Bacher pbac@dtu.dk

See also this description DTU course 02960.

Practicalities:

Price : See next page

Place: Maskinmesterskolen and Center Denmark, Fredericia.

Sign up:

See next page

The course is held in English.



Henrik Madsen



Peder Bacher

Register by following the steps depending on your affiliation:



Master and PhD students from DTU:

Sign up via the studyplanner to the course 02960 in the spring 2023 period
Send a mail to pbac@dtu.dk informing that you signed up

PhD students, Postdoc or other university participants not from DTU:

Sign up for the spring school at <https://www.conferencemanager.dk/Spring2023>
Choose your affiliation
Follow all steps and pay with a credit card, a fee of appr. 135 Euros apply

Danish industry participants:

Sign up for the spring school through <https://www.conferencemanager.dk/Spring2023>
Choose: De minimis industry
Follow all steps

International industry participants:

Do the following two steps:
Sign up for the course at DTU: [Open university](#)
Fill only * marked fields
In "Type of course": Open University
In "I am signing up for courses in the following period": Doesn't matter, August is not even included.
In "Course number and title (1)": 02960 Time Series Analysis - with a focus on Modelling and Forecasting in Energy Systems
You will be charged an additional (appr.) 1000 Euros by DTU for the participation
Sign up for the summer school through <https://www.conferencemanager.dk/Spring2023>
Choose: Industry
Follow all steps and pay with a credit card, a fee of appr. 135 Euros apply

Master students from Danish and Non-Danish universities:

Send a mail to pbac@dtu.dk informing that you

DTU Compute

Department of Applied Mathematics
and Computer Science

