

- industry cross-fertilisation
- technology transfer
- industry forum
- seminars
- consultancy and case studies
- training

Artificial Intelligence and Machine Learning for Machinery and Process Control Applications

Agenda

Artificial intelligence and machine learning has received a new impetus in recent years and offers new opportunities for services and potential products. This two-day course is concerned with the various methods that form the family of AI techniques and are particularly relevant to control engineering applications. Artificial intelligence can be utilised in control applications in two ways. The first involves the use of big data to inform control actions or initiatives. The second is more focused on the use of AI to provide improvements in control or signal processing systems at a local plant level. There is a large technical divide both in notation and understanding between the AI software communities and engineers in industry. The course will help bridge the divide, establish the links and explore the opportunities.

The focus is on the application of AI based modelling and identification and machine learning to industrial control problems. The influence of AI methods on system modelling and identification provides a different philosophical approach to aspects of control design. The AI methods include areas such as neural networks, fuzzy logic and control, and they utilise optimisation techniques such as genetic algorithms. The different topics will be overviewed and an engineering perspective on AI and machine learning will be provided. The way control algorithms can be improved using AI methods will be described such as introducing model knowledge in nonlinear and predictive control algorithms.

The course is intended as an introduction to the subject and the PowerPoint notes will therefore be provided in a tutorial manner. The morning will be more tutorial nature and the afternoon will include topics such as a review of current research and include material that is more advanced. It is not so suitable for engineers already using AI methods, although it will provide insights into the role they can play in advanced control applications.

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DAY 1: The Techniques of AI and Machine Learning

09.00 **Welcome and Introduction to the Course**

09.10 **Introduction to Intelligent Control and Machine Learning I** (*Introduction to Artificial Intelligence, Motivation and Terminology, Main ideas and techniques, possible application areas, benefits in control*).

10.00 *TEA/COFFEE*

10.15 **Introduction to Intelligent Control and Machine Learning II** (*Historical perspective, machine learning, reinforcement learning, neural networks, support vector machine; developments in AI*).

11.15 **Introduction to Neural Networks** (*Introduction to Neural Networks and exploitation in AI based systems, use in condition monitoring and fault detection*)

12.15 *LUNCH*

13.15 **Fuzzy Logic and Control: Relationship to AI Methods** (*Introduction to Fuzzy Control and links to AI, Neuro-fuzzy applications*)

14.00 **Support Vector Machine Approach to System Identification** (*Influence AI methods on modelling and system identification including LPV model identification for MPC*)

14.45 *TEA/COFFEE*

15.00 **Optimization and Optimal Control in AI Systems** (*Introducing AI methods into Nonlinear and Predictive Controls, Use of Genetic Algorithms, Use in industrial applications, Heat Exchanger*)

16.00 **State of the Art of Developments in AI for Control Applications** (*Overview of recent published results in AI/ML for industrial systems control, and applications in automotive, robotics, pharmaceuticals, chemicals, petrochemicals*)

17.00 *CLOSE*

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DAY 2: Design Issues in AI and Machine Learning

- 09.00 **Design of Tracking Control Systems** (*Lower level control using classical and optimal control approaches*)
- 10.00 *TEA/COFFEE*
- 10.15 **Linear and Nonlinear Model Predictive Control Methods** (*Introduction to most popular model predictive control methods*)
- 11.30 **Reference Governor and Hierarchical Control Design Methods**
- 12.30 *LUNCH*
- 13.30 **Control of Autonomous Vehicles** (*role of AI and combination with the above model based control methods*)
- 14.30 *TEA/COFFEE*
- 14.45 **Condition Monitoring and Fault Detection Methods** (*Using model based and AI approaches*)
- 15.30 **Software Demonstration of the Use of AI in Applications** (*AI based LPV model identification of Continuous stirred-tank reactor and Diesel/SI engine*)
- 16.15 **Review of most recent published works on Use of AI in Control** (*Review of recent works on Artificial Intelligence for automotive and AV*)
- 17.00 *CLOSE*