CIVIL-426

Machine learning for predictive maintenance applications

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Cursus	Sem.	Type
Civil Engineering	MA1, MA3	Opt.
Data and Internet of Things minor	H	Opt.
Robotics	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Withdrawal	Unauthorized
Session	Winter
Semester	Fall
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Lecture	2 weekly
Exercises	2 weekly
Number of positions	

Summary

The course aims at developing machine learning algorithms that are able to use condition monitoring data efficiently and detect occurring faults in complex industrial assets, isolate their root cause and ultimately predict the remaining useful lifetime.

Content

Early and reliable detection, isolation and prediction of faulty system conditions enables the operators to take recovery actions to prevent critical system failures and ensure a high level of availability and safety. This is particularly crucial for complex systems such as infrastructures, power plants and aircraft engines. Therefore, their system condition is increasingly tightly monitored by a large number of diverse condition monitoring sensors. With the increased availability of data on system condition on the one hand, and the increased complexity of explicit physics-based system models on the other hand, the application of data-driven approaches for predictive maintenance has been recently increasing.
This course provides insights and hands-on experience in selecting, designing, optimizing and evaluating machine learning algorithms to tackle the challenges faced by maintenance systems of complex engineered systems.
Specific topics include:
-Introduction to condition monitoring and predictive maintenance systems
-Feature extraction and selection methodology
-Machine learning algorithms for fault detection and fault diagnostics
-End-to-end learning architectures for fault detection and fault diagnostics
-Unsupervised and semi-supervised learning algorithms for predictive maintenance
-Deep learning algorithms for predicting the remaining useful lifetime
-Performance evaluation of the algorithms
-Predictive maintenance systems at fleet level
-Domain adaptation for fault diagnostics
-Explainable machine learning algorithms for predictive maintenance
-Introduction to decision support systems for maintenance applications
-Benefits and costs of predictive maintenance

Keywords

machine learning; predictive maintenance, fault detection, fault diagnostics, fault prognostics

Learning Prerequisites

Required courses

Mandatory pre-requisite course: Introduction to machine learning for engineers or other machine

learning courses

Recommended courses

Learning Outcomes

By the end of the course, the student must be able to:

- Define the learning problem in way that allows its solution based on existing constrains such as lack of fault samples
- Design data-driven predictive maintenance applications for complex engineered systems from raw condition monitoring data
- Assess / Evaluate the performance of the applied algorithms
- Choose machine learning algorithms for fault detection, diagnostics and prognostics
- Interpret the results of the algorithms

Teaching methods

Lectures, excercises, final project

Assessment methods

Performance will be assessed during the semester based on
-4 exercises, requiring the students to perform defined sub-tasks for designing a predictive maintenance system (70% of the final grade in total)
-Final project on a real case study (and real data) of designing a predictive maintenance system based on raw condition monitoring signals of a complex engineered system, requiring a report (including the implementation) and a presentation (30% of the final grade)

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

Resources

Moodle Link

- https://go.epfl.ch/CIVIL-426