CIVIL-426

# Machine learning for predictive maintenance applications

Fink Olga

| Cursus | Sem. | Type |
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| Civil Engineering | MA1, MA3 | Opt. |

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| Language of teaching | English |
| Credits | 4 |
| Session | Winter |
| Semester | Fall |
| Exam | During the semester |
| Workload | 120h |
| Weeks | 14 |
| **Hours** | **4 weekly** |
| Courses | 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 system physics-based 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 isolation
-End-to-end learning architectures (including feature learning) for fault detection and fault isolation
-Unsupervised and semi-supervised learning algorithms for predictive maintenance
-Machine learning algorithms for prediction of the remaining useful life
-Performance evaluation
-Predictive maintenance systems at fleet level
-Domain adaptation for fault diagnostics
-Introduction to decision support systems for maintenance applications

## 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)
-Report (including the implementation) and presentation of a real case study of designing a predictive maintenance system based on raw condition monitoring signals of a complex engineered system (30%)

## Supervision

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| Office hours | Yes |
| Assistants | Yes |
| Forum | Yes |

## Resources

### Moodle Link

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