Data-Driven Predictive Maintenance of Rails

Who?
The PhD candidate specializes in applied mathematics in the context of predictive methods and optimization. The group of supervisors are specialized in mathematical modeling, the rail component of railway tracks, and vehicle track interaction. The mixture of specializations is intended to facilitate advanced model development oriented towards industrial application.

What?
Railway infrastructure faces a critical challenge posed by rail defects, presenting a threat to the environment and cost efficiency, while raising safety concerns for infrastructure managers. Performing maintenance operations prior to defect detection is emerging as a transformative approach in the railway industry with the potential of rectifying these critical challenges.

Where?
The bulk of the project is to be carried out partly at COWI headquarters and partly at the research facilities at The Technical University of Denmark. The project includes an exchange of 9 months at Simon Fraser University (Surrey, Canada) at the School of Sustainable Engineering.

When?
The industrial PhD ranges between the 1st of February 2024 and the 31st of January 2027.

How?
The project aims to optimize maintenance of rails using a mathematical modeling approach based on advanced data analysis in a predictive setting. We aim to do so, by:

i. Developing a prediction model for in-service defects in rails. This is relevant because accurate defect predictions improve the knowledge foundation for the maintenance decision-making which can, if performed prior to defect formation, increase the service time of the rails.
ii. Optimizing maintenance strategies for rails. This is relevant because the rail defect predictions should be utilized in a maintenance setting with limited resources to reduce life-cycle costs, carbon footprint, and operational disturbances optimally for the entire rail network.

Why?
Rail defects and subsequent replacements cause substantial greenhouse gas emissions and reduction of rail service life inducing safety risks and complications to railway operation. This decreases punctuality of trains which is a contributing factor to people choosing more pollutive alternatives to public transportation.

What then?
Implementation of the project results are tested with clients during the project and fully applied after project completion. For a successful implementation, two stages need to be completed:

i. *Verification.* Working with the railway manager to prove the effectiveness of the developed model under local operational settings.
ii. *Implementation*. Once proven effective, a full model implementation tailored to specific requirements of the individual railway manager is executed.