**Challenge problems from AVL for ITT10**

**1) City emission modelling**

Can smart “fleet management” reduce air pollution in cities? The challenge is to first integrate data from multiple sources (street-level sensors, meteorological models, vehicle movement data, etc.) to make a statistical inference of predicted air quality. Second, this information must then be used to adaptively manage vehicle routing (possibly in a non-centralised way) to improve air quality.

**2) Data-driven model for SCR (Selective Catalytic Reduction)**

Harmful NOx in exhaust gasses is reduced using ammonia in a catalyst. This process is controlled by an on-board computer and needs to adapt to operating conditions. The present state-of-the art involves a complicated physical model with many degrees of freedom and empirically-determined parameters. Can this be improved upon (or better, replaced) using data-integrative approaches?

**3) Anomaly detection in test beds**

Engine test beds are expensive to build and operate. A typical rig has over 500 measurement channels, and the data traces are chaotic and/or noisy. Measurement anomalies can arise due to faults or unpredicted behaviour in the measurement devices and/or in the testing environment. A trained engineer can spot anomalies when, for example, traces from different sensors are incompatible or imply something the engineer knows to be impossible. Sometimes the engineer cannot easily spot anomalies if they are of similar magnitude to the expected system response. Can we develop principled mathematical approach to anomaly detection that could be automated, ideally to run in real time?

**4) Predictive battery maintenance**

Batteries in electric vehicles are under significant stress, particularly when charging. Unobservable micro-level damage accumulates in the batteries that eventually leads to a fault developing, and the battery requiring maintenance or replacement. Complex physical models exist for predicting battery behaviour, but these are very high-dimensional and expensive to solve. Can we take another approach to make a real-time probabilistic calculation to predict when a fault may occur in the future?