ARTIFICIAL INTELLIGENCE

DM 351 PNRR - Machine Learning And Computational Fluid Dynamics For Diagnosing Complex Systems

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Context of the research activity
Computational Fluid Dynamics (CFD) provides accurate information on the flow fields in complex systems, but cannot predict their high-level functional properties. Machine Learning (ML) models have a huge potential in this regard, as they can exploit the wealth of information in a CFD to automatically solve inference problems. The PhD candidate will investigate a new methodology for training ML models solving inference problems on flow fields from CFD.

Objectives
This research follows a successful multidisciplinary research collaboration between DEIB (ICT departments) and DAER (Aerospace department) in Politecnico di Milano.

1. a new methodology for automatically extracting meaningful information from CFD flow fields, to be fed to a ML model.
2. new ML models and training procedure to enable inference on CFD simulations. In this regard, both techniques from ML and computational geometry will be used to augment training data.
3. Domain adaptation solution to adjust models trained on CFD simulations to operate equally well, given a sparse set of sensor measurements as input.

There are two key application scenarios the candidate will consider in their research. The first one concerns transportation and in particular Autonomous Platooning. Vehicle platoons are two or more vehicles driven at harmonised speed and at small inter-distances to reduce accidents, fuel consumption, pollution and congestion. Most of existing platooning systems and literature concern fleets of interconnected vehicles that are constantly transmitting information. The candidate will therefore work towards training ML models to enable the following vehicle to autonomously define the platooning strategy, without relying on communications or fleeting coordination. The second scenario concerns the automatic diagnosis of nasal and paranasal pathologies from CFD simulations executed over the CT scan of a subject.

This PhD grant is sponsored within the PNRR framework, please refer to the
related document for further information on the requirements and the conditions for this type of grant.

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<th>Skills and competencies for the development of the activity</th>
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<td>The PhD candidate will:</td>
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<td>- develop a solid background in ML models and in particular deep neural networks.</td>
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<td>- Investigate the literature on unsupervised domain adaptation and provide original contribution in this direction.</td>
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<td>- Become proficient in training deep learning models</td>
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<td>- Become acquainted with CFD simulations. Other techniques that will be investigated concerns the Computational Geometry and shape registration, which can be used either defining meaningful features or for data augmentation.</td>
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