SPARCL
post-doc

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Structure-preserving reduced order models for conservation laws

Context

Numerical simulation of **partial differential equations** plays a crucial role in understanding and predicting the behaviour of complex physical phenomena. High-fidelity (HF) numerical methods have been developed over the years, such as finite element method, finite volume method, and spectral methods. These methods, although very accurate, can be prohibitively expensive to simulate parametrised PDEs in multi-query contexts. In the last few decades, extensive research studies have been carried out on **reduced order models** (ROMs) [HPR22]. The main aim of ROMs is to reduce the computational cost while maintaining an acceptable level of accuracy, by reducing the dimensionality of the problem compared to HF methods.

In this project, we focus on the specific case of **conservation laws** [Tor13], which model advection-dominated problems and physical phenomena characterised by no dissipation. Classical ROMs are known to fail in this scenario. The main objective of this project is to advance the field of ROMs of conservation laws by conveying the structure-preserving capabilities of HF methods to ROMs, while retaining computational efficiency.

This post-doc will be part of the ANR-funded project SPARCL (Structure-Preserving Approach for Reduced order models of Conservation Laws).

Post-doc description

The position will primarily focus on **error estimation** and **uncertainty quantification** (UQ) for ROM. The hired post-doc will develop a posteriori error estimators to assess the accuracy of reduced models with respect to high-fidelity simulations, with a focus on hyperbolic conservation laws. Both theoretical and empirical approaches will be considered, depending on the candidate's profile. In parallel, the post-doc will investigate how uncertainties in input parameters propagate through reduced models. This includes the use of **sensitivity analysis** to estimate statistical moments of the solution and to derive confidence intervals for quantities of interest.

Finally, the post-doc will contribute to a global analysis of the interaction between different sources of error—spatial discretisation, model reduction, and parametric uncertainty—with the aim of identifying optimal computational strategies under resource constraints.

The work will involve the design and implementation of advanced numerical methods, as well as their validation on a hierarchy of test cases, ranging from academic benchmarks to more realistic configurations, including problems with parametric geometries.

Required skills

The candidate should hold a PhD in applied mathematics, scientific computing, computer science or equivalent.

The ideal candidate has a good knowledge of either **reduced order modelling** or **numerical methods for hyperbolic PDEs** and at least one **programming language**.

Location and duration

This position is for a **18-month post-doc**, with a flexible **starting date between November 2026 and April 2027**.

The post-doc will take place at the Conservatoire National des Arts et Métiers (CNAM), situated in Paris (2, rue Conté, 75003).

The post-doc will be part of the mathematical and numerical modelling (M2N) laboratory.

How to apply

Please, send your application (CV and a short motivation letter) to camilla.fiorini@lecnam.net **before the end of May**.

Contacts

Camilla FIORINI
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References

[HPR22] Hesthaven, J. S., Pagliantini, C., & Rozza, G. (2022). Reduced basis methods for time-dependent problems. *Acta Numerica*, 31, 265-345.

[Tor13] Toro, E. F. (2013). Riemann solvers and numerical methods for fluid dynamics: a practical introduction. Springer Science & Business Media.