Moment Methods for Fokker-Planck Equations

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Context: DesCartes Program is looking for a 1 year position in Optimization-driven hybrid AI. The DesCartes programme is developing a hybrid AI framework, combining Learning, Knowledge and Reasoning, which has good properties (need for less resources and data, security, robustness, fairness, respect for privacy, ethics), and demonstrated on industrial applications of the smart city (digital energy, monitoring of structures, air traffic control). The program brings together 80 permanent researchers (half from France, half from Singapore), with the support of large industrial groups (Thales SG, EDF SG, ESI group, CETIM Matcor, ARIA etc.).

The research will take place mainly in Singapore, at the premises of CNRS@CREATE, with a competitive salary and generous funding for missions. Read more about the DesCartes program here. The position will be attached to work-package 3 but it will be in close collaboration with work-package 8, which is focusing on hybrid engineering, in the sense of combining physics-based and data-based approaches:

- Work-package 3 aims at supporting the whole Descartes program in order to develop advanced optimization-based solutions in the context of hybrid AI. Any AI system or machine learning algorithm ultimately involves a formulation with an objective or loss function to be minimized. The modelling of the problem as well as the chosen objective function optimization algorithm is crucial to the success of the overall AI task. This is all the more crucial in the context of hybrid AI, which seeks to integrate physics-inspired models with machine learning algorithms. We address this problem from two complementary angles, namely optimization-based methods and machine learning-based methods.

- Work-package 8 aims at producing general methods on decision making frameworks based on Hybrid AI. Topics of interest cover smart sensing, understood in the sense of optimal generation of data from sensors, as well as interactions between data and physics-based models.

Goal of the Postdoctoral position: Fokker-Planck equations arise in several forms in forward and inverse problems. Its numerical solution is particularly challenging for classical numerical solvers when the equation has nonlinearities and it is posed in a high-dimensional space. The postdoctoral candidate will engage in a collaborative effort to develop novel methods based in viewing the Fokker-Planck solution as a moment problem optimization method (based on sums of squares – SOS). This approach has potential to

address the above bottlenecks since polynomial nonlinearities are automatically treated as unknown moments of the solution, and there is room to incorporate low rank feature in the solution search in order to fight against the curse of dimensionality.

Requirements: A successful candidate will have a PhD degree in applied mathematics or computer science, having a good knowledge of probability and statistics as well as a working knowledge of convex optimization, real analysis and basic measure theory. Knowledge in numerical methods for PDEs is a plus. The candidate is expected to have strong programming skills, be highly motivated and creative.

Funding: This Postdoc will be funded by DesCartes (A CREATE Programme on AI-based Decision making in Critical Urban Systems), a hybrid AI project between CNRS and Singapore. It will be co-supervised between researchers from Nanyang Technological University (NTU), the National University of Singapore (NUS), TU Eindhoven and LAAS CNRS.

Salary range: 70K to 85K SGD, depending on suitability and experience.

Workplace address: CREATE Campus, CREATE Tower, 1 Create Way #08-01 Singapore 138602.

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Please attach your full CV, with the names and contacts (including email addresses) of two character referees.

References

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[2] J. Nie (2009). Sum of Squares Method for Sensor Network Localization. Computational Optimization and Applications, 43(2), 151-179.

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