

Polynomial optimization for sensor network placement

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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 8 and it will be in collaboration with work-package 3:

- 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.
- 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.

Goal of the Postdoctoral position: The postdoctoral research project will focus on problems related to optimal sensor placement on graphs. The task can be formulated as finding the global minimizer of a quartic polynomial. To address it, polynomial optimization techniques, based on sum of squares (SOS), can be applied to solve it [1]. However, the general SOS relaxations are too expensive to implement for large problems.

Exploiting the special features of this polynomial, a new structured SOS relaxation shall be proposed, improving upon [2].

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. 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.

Contact: Interested applicants please send your resume to

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

References

- [1] J.B. Lasserre (2001). Global optimization with polynomials and the problem of moments. *SIAM Journal on optimization*, 11(3), 796-817.
- [2] J. Nie (2009). Sum of Squares Method for Sensor Network Localization. *Computational Optimization and Applications*, 43(2), 151-179.