PhD Position: Towards a theory of deep learning

Main advisor: Pierre Nyquist.

Doctoral program: Applied and Computational Mathematics / WASP Graduate School.

KTH Royal Institute of Technology

KTH Royal Institute of Technology in Stockholm has grown to become one of Europe's leading technical and engineering universities, as well as a key center of intellectual talent and innovation. We are Sweden's largest technical research and learning institution and home to students, researchers and faculty from around the world. Our research and education covers a wide area including natural sciences and all branches of engineering, as well as in architecture, industrial management, urban planning, history and philosophy.

The School of Engineering Sciences carries out a wide range of research at the international frontline, from fundamental disciplines such as Physics and Mathematics, to Engineering Mechanics with applications such as Aeronautics and Vehicle Engineering. We also offer university degree programs in Engineering Physics, Vehicle Engineering, and 'Open entrance', as well as a number of international masters programs.

Job description

The goal of this project is to contribute to our understanding of the mathematical principles underlying modern methods for machine learning and artificial intelligence. Despite the enormous success of such methods in a wide range of application areas, a satisfying understanding of the underlying fundamental properties is still lacking. The successful candidate will pursue a PhD project at the intersection of probability theory, mathematical analysis, statistical physics and artificial intelligence. There are several possible directions for the project and this will be decided together with the student, with the overall aim to build towards a mathematical theory for deep learning and learning algorithms. Examples of topics include the recent development of using interacting particle systems to describe deep neural networks, the use of tools from optimal transport and gradient flows to explain the effectiveness of current stochastic techniques for solving non-convex optimisation tasks and the design and analysis of efficient Monte Carlo methods in the machine learning context.

A central theme of the project will be the interplay between probability theory, statistical physics and topics within mathematical analysis, such as partial differential equations and gradient flows. More generally we will investigate the role of stochastic control and stochastic calculus in the analysis of learning algorithms. Students interested in one or more fields related to the following are encouraged to apply: probability theory, artificial intelligence, machine learning, statistics, partial differential equations, interacting particle systems, statistical physics, stochastic analysis.

The position is a time-limited, full-time, five year position starting August 2020 or at an agreed upon date. The position is fully funded for four years and will be extended to five years by assigning teaching duties. It also includes generous travel support and possibilities for longer research visits abroad. The position is financed within the Wallenberg Autonomous Systems and Software Program (WASP), and the student will participate in the WASP graduate school. Through this program the student will have a wide variety of opportunities to interact with other researchers and industry collaborators in AI, ML, and statistics, including

events such as conferences and PhD courses; for more information about WASP see
`https://wasp-sweden.org/graduate-school/ai-graduate-school-courses/`.

Within the Department of Mathematics at KTH, the successful candidate will be part of vibrant and diverse groups in Probability and Mathematical Statistics and Mathematics for Data and AI. There will also be strong interactions with the "Brummer & Partners MathDataLab", a research lab in mathematics and applied mathematics, hosted at the Department of Mathematics, that aims at creating a hub for mathematical research in the analysis of complex data.

WASP

Wallenberg AI, Autonomous Systems and Software Program (WASP) is Sweden's largest individual research program ever, a major national initiative for strategically motivated basic research, education and faculty recruitment. The program addresses research on artificial intelligence and autonomous systems acting in collaboration with humans, adapting to their environment through sensors, information and knowledge, and forming intelligent systems-of-systems.

The vision of WASP is excellent research and competence in artificial intelligence, autonomous systems and software for the Swedish industry.

Read more: `https://wasp-sweden.org/`

Application

The official ad will be available early February 2020 via KTH's webpage. Interested students are encouraged to contact me at any time for an informal chat about the position.

Once the job is online, log into KTH's recruitment system in order to apply to the position. You are the main person responsible for ensuring that your application is complete according to this advertisement. Your complete application must be received by KTH no later than the stated application deadline **(March 8)**, midnight CET/CEST (Central European Time/Central European Summer Time). We expect a decision to be made by late March, early April at the latest. Note that interviews may start while the application period is still ongoing, however all submissions before the deadline will be given full consideration.

The application must include the following documents:

- CV including any relevant professional experience and knowledge.

- Cover letter (detailing your academic interests, your previous studies and scientific work experience and your interest in this position); maximum 2 pages long.

- Copy of the degree certificate(s) and transcripts of records from your previously attended university-level institutions. Translations into English or Swedish if the original documents are not issued in one of these languages.

- Desirable but not mandatory: Contact information (email, address, and phone number) for two references.

General information

Type of employment: Temporary position longer than 6 months.

Contract type: full-time.

First day of employment: 1 August 2020 or an agreed upon date.
Contact: Pierre Nyquist, Associate Professor, Email: pierren@kth.se

Application Submission Deadline: March 8, 2020.