2018-00528 - [CORDIS2018-ZENITH] Learning models parameters at scale

Level of qualifications required : Graduate degree or equivalent
Fonction : PhD Position

About the research centre or Inria department

The Inria Sophia Antipolis - Méditerranée center counts 37 research teams and 9 support departments. The center's staff (about 600 people including 400 Inria employees) is composed of scientists of different nationalities (250 foreigners of 50 nationalities), engineers, technicians and administrators. 1/3 of the staff are civil servants, the others are contractual. The majority of the research teams at the center are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Six teams are based in Montpellier and a team is hosted by the computer science department of the University of Bologna in Italy. The Center is a member of the University and Institution Community (ComUE) "Université Côte d'Azur (UCA)".

Context

The team and advisors

The Inria Zenith team is dedicated to large-scale scientic data management. The PhD will be supervised by Patrick Valduriez , a senior researcher at Inria working on distributed and parallel data management [9], and by Antoine Liutkus , a researcher at Inria working on machine learning and music signal processing [10, 11].

Insertion in the team

The defining objective of this PhD will be scaling up the estimation of probabilistic models thanks to the sketching methodology, applied to the management of massive scientic data, reflecting the team's specicities.

While music and audio heritage preservation is envisionned as the main application, the successful candidate will also apply his findings to the other applicative domains considered by the team, such as natural heritage preservation and indexing [12].

Collaborations

The PhD student will furthermore benefit from a dense network of scientic collaborators. In particular:

- The CREM (Centre de Recherches en Ethnomusicologie) is the UMR responsible for the Archives du CNRS Musée de l'Homme, that will be the main dataset considered for this Ph.D. It is a leading laboratory for the preservation of our immaterial audio heritage.
- The PANAMA team, lead by Rémi Gribonval, is a leading place for research on sketching approaches. The recruited Ph.D student will have exchange stays in this team.
- Telecom Paristech is a leading place for data science. As a renowed researcher for models parametrs estimation with MCMC, Umut Şimşekli is envisioned as a privilegied partner. As an internationally renowed specialist for audio processing, Roland Badeau is also envisioned as a close collaborator.

Assignment

Context

The activity of researchers often revolves around analyzing data to**learn model parameters** that are used by applications. However, the availability of **big data** requires a shift in the tools used for this purpose.

Deep learning [1] is emerging as an appropriate methodology to explore, analyze, and leverage big data. While initially framed as a sequential procedure, much research on deep learning is currently focusing on **parallel and distributed** architectures [2, 3] that allow scaling up to match the needs of scientists. This is first achieved by enabling asynchronous optimization strategies, which alleviate the sequential nature of training to some extent [4, 2], and also by distributing either the data or parts of the model to multiple nodes. In any case, these strategies clearly exhibit some shortcomings: the computing gain is rapidly mitigated by the communication cost between nodes. Parallelizing over more than a dozen nodes is **still a challenge** [5].

Assignments

This PhD project will investigate new ways of training model parameters in a distributed and parallel fashion, by exploiting the recently proposed **sketching methodology** [6, 7]. Its core idea is to drop the need to analyze the actual (massive) data, but rather focus on summary statistics computed beforehand. Recent research showed that effective sketching strategies allow for the provably correct estimation of model parameters in some cases and applied the method to various machine learning and
signal processing tasks [8, 7].

Here, we will investigate the impact of such a strategy on the large-scale learning of large data models, including but not limited to deep neural networks. The fundamental fact to be exploited is that **sketching and learning** can be performed in a parallel and totally asynchronous way.

Applications

General Information

- **Theme/Domain :** Data and Knowledge Representation and Processing Statistics (Big data) (BAP E)
- **Town/city :** Montpellier
- **Inria Center :** CRI Sophia Antipolis - Méditerranée
- **Starting date :** 2018-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2018-04-15

Contacts

- **Inria Team :** ZENITH
- **PhD Supervisor :**
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About Inria

Inria, the French national research institute for the digital sciences, promotes scientific excellence and technology transfer to maximise its impact. It employs 2,400 people. Its 200 agile project teams, generally with academic partners, involve more than 3,000 scientists in meeting the challenges of computer science and mathematics, often at the interface of other disciplines. Inria works with many companies and has assisted in the creation of over 160 startups. It strives to meet the challenges of the digital transformation of science, society and the economy.

The keys to success

The applicant should have at least:

- A master degree in one of the following areas: computer science, applied mathematics, applied statistics, signal processing, machine learning.
- A good practice of English (spoken and written).
- A strong interest in programming.

Instruction to apply

Defence Security :
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :
As part of its diversity policy, all Inria positions are accessible to people with disabilities.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

This PhD will use large-scale learning for the automatic restoration and browsing of **audio ethnomusicological archives** . This topic is at the crossroads of cultural heritage preservation, large-scale learning, audio and music signal processing and probability theory.

Through previous fundings, the Zenith team is developing cutting-edge audio restoration techniques and making them available for research purpose in an open-source environment embedded in real-world historical sound archives.
The Ph.D candidate will go further into bridging the gap between research in computer science and digital humanities, striving for the preservation of our immaterial heritage. The intended outcome are **audio analysis and processing tools** designed through systematic training on the 50k items of the CNRS-Musée de l'Homme archives.

The successful candidate will conduct theoretical and applied research , with an expected impact on both the machine learning and the digital humanities communities.

References

[1] I. Goodfellow, Y. Bengio, and A. Courville, Deep learning. MIT press Cambridge, 2017.

[2] J. Dean, G. Corrado, R. Monga, K. Chen, M. Devin, M. Mao, A. Senior, P. Tucker, K. Yang, and Q. Le, Large scale distributed deep networks, in Advances in neural information processing systems, pp. 12231231, 2012.

[3] S.Sridharan, K. Vaidyanathan, D. Kalamkar, D. Das, M. Smorkalov, M. Shiryaev, D. Mudigere, N. Mellempudi, S. Avancha, and B. Kaul, On scale-out deep learning training for cloud and hpc, arXiv preprint arXiv:1801.08030, 2018.

[4] B. Recht, C. Re, S. Wright, and F. Niu, Hogwild: A lock-free approach to parallelizing stochastic gradient descent, in Advances in neural information processing systems, pp. 693701, 2011.

[5] J. Keuper and F.-J. Preundt, Distributed training of deep neural networks: theoretical and practical limits of parallel scalability, in Proceedings of the Workshop on Machine Learning in High Performance Computing Environments, pp. 1926, IEEE Press, 2016.

[6] R. Gribonval, G. Blanchard, N. Keriven, and Y. Traonmilin, Compressive statistical learning with random feature moments, arXiv preprint arXiv:1706.07180, 2017.

[7] A. Chatalic, R. Gribonval, and N. Keriven, Large-scale high-dimensional clustering with fast sketching, in IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 2018.

[8] M. Fontaine, C. Vanwynsberghe, A. Liutkus, and R. Badeau, Sketching for neareld acoustic imaging of heavytailed sources, in International Conference on Latent Variable Analysis and Signal Separation, pp. 8088, Springer, 2017.

[9] M. Özsu and P. Valduriez, Principles of distributed database systems. Springer Science & Business Media, 2011.

[10] A. Liutkus, F.-R. Stöter, Z. Rai, D. Kitamura, B. Rivet, N. Ito, N. Ono, and J. Fontecave, The 2016 signal separation evaluation campaign, in International Conference on Latent Variable Analysis and Signal Separation, pp. 323332, Springer, 2017.

[11] A. Nugraha, A. Liutkus, and E. Vincent, Deep neural network based multichannel audio source separation, in Audio Source Separation, Springer, 2017.

[12] A. Joly, H. Goëau, H. Glotin, C. Spampinato, P. Bonnet, W.-P. Vellinga, J.-C. Lombardo, R. Planque, S. Palazzo, and H. Müller, Lifeclef 2017 lab overview: multimedia species identication challenges, in International Conference of the Cross-Language Evaluation Forum for European Languages, pp. 255274, Springer, 2017.

Main activities

The tasks to be realized by the PhD student will be to:

1. Investigate the state-of-the-art approaches in parallel deep learning
2. Propose novel, ecient parallel techniques based on the sketching methodology
3. Validate the techniques by building a prototype on a parallel platform and performing experiments on big datasets

Skills

Additional, useful elements are:

- Programming experience with Hadoop or any software framework for distributed computing like Spark and Scala.
- Programming experience with Python and using GPU.
- Notions of signal processing and machine learning.
- A strong interest in music and cultural heritage preservation

Benefits package

- Subsidised catering service

- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours

Remuneration

Duration: 36 months
Location: Sophia Antipolis, France
Gross Salary per month: 1982€brut per month (year 1 & 2) and 2085€ brut/month (year 3)