Research Internship
Symmetric Neural Networks for Symmetric Problems

Topic profile

theory/math

coding

Tags

#AI

#neural networks

#formal methods

#interdisciplinary research

Supervision

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Why symmetry?

Many problems that neural networks are being used for display some inherent symmetry. A toy example is the computation of the maximum of a set of numbers. We know *a priori* that the maximum cannot change if we change the order of the numbers. Likewise, if the task is to find the argmax, *i.e.*, the index of the maximum input value, then a permutation applied to change the order of the input values should result in the same permutation applied to the order of the output values.

What we are looking for

We value a curious and driven attitude. An ideal candidate is inclined to artificial intelligence, mathematical analysis, and coding (in Python).

The team

You will be part of an interdisciplinary research team at ENS Paris-Saclay near Paris, working on different aspects of synthetic biology, distributed computing, and circuit design.

Research

The goal of this internship is to find rules and heuristics that make neural networks have a given set of symmetry properties by design. A possible sequence of research goals is:

- Generalize the DeepSet framework [1] from permutation equivariance for a single layer to the whole network. In DeepSet, every single layer has to have the exact number of nodes. In particular, it does not allow for layers that compare the inputs in a pairwise fashion.
- Implement the generalized framework in PyTorch and apply it to the toy problem of the argmax calculation and to the multi-armed bandit problem to develop heuristics for the structure of the network to efficiently learn the desired behavior.
- Showcase the quality of the heuristics on a more intricate problem, such as the anomaly detection problem in a set of images.

References

[1] Zaheer et al. Deep sets. *NIPS'17*, 2017. URL

You are interested or would like to join us?

Please send us your questions or, in case you would like to apply, a short statement of interest and a CV, to Matthias Fuegger (mfuegger@lmf.cnrs.fr) and Thomas Nowak (thomas@thomasnowak.net). Applications received until December 15, 2023 will receive full consideration. The start date of the internship is flexible, but the goal is to start in spring or summer 2024.