Internship proposal

Machine learning energy measurement in a federated scenario

1 Context

In the context of global warming and the exponential growth of the IT sector's carbon footprint, the field of Frugal Artificial Intelligence (FAI) is becoming very important (Evchenko et al. 2021). In parallel, an emerging method for performing decentralized computation appeared, called Federated Learning (FL) (McMahan et al. 2017). This new method is beneficial not only in terms of saving energy (for example, the cost of transporting data over the network), but also in terms of privacy. However, energy consumption is often difficult to measure. Several tools exist, but they are often at the software level, and we would like to accurately measure the electricity consumption at the source, i.e. from the devices itself. On the one hand, based on connected plugs, we previously proposed a set of tools that measure the energy consumption of a device on a given task, on the other hand (Mary-Huet-de-Barochez 2024) built a simulator that determines the best topologies for a connected network of heterogeneous devices.

(Evchenko et al. 2021): Evchenko et al. (2021), *Frugal machine learning*

(McMahan et al. 2017): McMahan et al. (2017), *Communication-Efficient Learning of Deep Networks from Decentralized Data*

The goal of this internship is to build a benchmark platform to measure the energy consumption of a federated learning algorithm implemented on a network of heterogeneous devices. This benchmark will enable us to generalize the work of two previous internships to a heterogeneous distributed architecture. One goal is to mix the results obtained on using smart-plugs to measure energy and the existing Falafels simulator (Mary-Huet-de-Barochez 2024) built during this project. This will in the one hand generalizes the work done previously on measuring energy consumption on one single machine and also enable to calibrate (Mary-Huet-de-Barochez 2024) and verify the relevance of the results obtained on this simulator.

(Mary-Huet-de-Barochez 2024): Mary-Huet-de-Barochez (2024), *falafels : Federated Learning Frugality and Efficiency via Simulation*

2 Objectives and proposed work plan

The main objective of this internship is to build a platform to measure the actual energy consumption of a network of connected devices, from Rasberry Py to computer.

- Proposal of a solution for energy measurement of an interconnected network of several devices.
- Platform building and set up.
- Analysing the energy efficiency of this new platform by using the technology stack developed previously and falafels tool (Mary-Huet-de-Barochez 2024) to determine the best configuration for federated learning.
- writing a research article

(Mary-Huet-de-Barochez 2024): Mary-Huet-de-Barochez (2024), *falafels : Federated Learning Frugality and Efficiency via Simulation*

3 Profil

Master student with good coding skills in Python and bash scripting. A knowledge of docker containerisation technology is also appreciated. Knowledge in system and networking are expected to set up the different configuration of the devices. The candidate should have also good writing and oral communication skills

4 Scientific context

The internship will be held in LISTIC lab at Annecy for a duration of 4 to 6 months with the following supervision team :

- Ammar Mian, Associate Prof at LISTIC
- Stéphan Plassart, Associate Prof at LISTIC

5 How to Apply?

Send CV and motivation letter to `ammar.mian@univ-smb.fr` and `stephan.plassart@univ-smb.fr`.

Bibliography

Evchenko, Mikhail et al. (2021). « Frugal machine learning ». In : *arXiv preprint arXiv :2111.03731* (cf. p. 1).

Mary-Huet-de-Barochez, Andrew (2024). *falafels : Federated Learning Frugality and Efficiency via Simulation*. https://github.com/PhoqueEberlue/falafels (cf. p. 1).

McMahan, Brendan et al. (2017). « Communication-Efficient Learning of Deep Networks from Decentralized Data ». In : *Proceedings of the 20th International Conference on Artificial Intelligence and Statistics, AISTATS 2017, 20-22 April 2017, Fort Lauderdale, FL, USA*. Sous la dir. d'Aarti Singh et Xiaojin (Jerry) Zhu. T. 54. Proceedings of Machine Learning Research. PMLR, p. 1273-1282 (cf. p. 1).