by intermediate storage. We worked with fluid simulations and managed to have a NN learn simple
executed provide the data to train the network on-line, without the performance bottleneck caused
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Expansions. But DNN could be used to learn a model of a simulation simply by training it to reproduce
train a DNN (with the proper parallelization solutions to process the incoming flow of data). We will
Melissa
Deep Neural Networks (DNN) are inherently on-line data processing machines that easily fit into the
The objective of this PhD thesis is to extend this approach to on-line deep learning from simulations.
these numerical simulations, usually called an ensemble run. Having a large sample of executions is
very challenging. Deep learning is emerging as a potentially disruptive approach to address some of these issues. The goal of this PhD is to
investigate such approaches in the specific context of on-line learning from ensemble runs.
numerical simulations, usually called an ensemble run. Having a large sample of executions is
classically used for statistical evaluation of the simulation quality, called a sensitivity analysis. But
ensemble runs can also be used to support learning processes.
But storing the results of a large ensemble runs is becoming a strong bottleneck on supercomputers,
requiring to look for on-line, also called in transit, data processing solutions. EDF and INRIA developed
an original solution for computing on-line statistics for sensibility analysis from ensemble runs. The
framework, called Melissa, is elastic and fault tolerant leading to a very efficient use of
supercomputers. Because the data are processed on-line Melissa can compute ubiquitous statistics,
i.e. for all spatio-temporal points explored by the simulations, from very large ensemble runs. So far the
largest Melissa ensemble runs handled 80 000 simulations, processed on-line 278 TB of data, using up to 27000 compute cores.
The objective of this PhD thesis is to extend this approach to on-line deep learning from simulations.
Deep Neural Networks (DNN) are inherently on-line data processing machines that easily fit into the
Melissa framework. The base ideas is to run many simulations producing data that are used on-line to
train a DNN (with the proper parallelization solutions to process the incoming flow of data). We will
focus on fast simulations, i.e. compute a NN based substitute of a classical large scale numerical model. A fast simulation, also called meta model, is an approximation of the simulation that is fast to compute. Classical approaches for computing meta-models rely on Kriging or Polynomial Chaos Expansions. But DNN could be used to learn a model of a simulation simply by training it to reproduce the outputs from a set of time indexed input parameters. We started to explore this approach. Melissa has been adapted to implement a DNN with TensorFlow into the Melissa server. The simulations executed provide the data to train the network on-line, without the performance bottleneck caused by intermediate storage. We worked with fluid simulations and managed to have a NN learn simple
And taste for teamwork. Creativity, writing abilities (English), good oral communication skills (English and possibly French), the quality required to pursue a successful research work: technical skills, autonomy, scientific theoretical developments with validation experiments on supercomputers. Candidates should have EDF supercomputers that rank amongst the 500 most powerful in the world with respectively 41000 international publications at journals and conferences. For experiments we will have access to two and 29000 cores and multiple GPUs (top500.org) as well as the Jean Zay national supercomputer equipped with 1000 GPUs.

This PhD work is at the crossroad between Large Scale Numerical Simulation and Deep Learning. We will target high impact international publications at journals and conferences. For experiments we will have access to two EDF supercomputers that rank amongst the 500 most powerful in the world with respectively 40000 and 290000 cores and multiple GPUs (top500.org) as well as the Jean Zay national supercomputer equipped with 1000 GPUs.

To apply submit you CV, references, recent marks, and if available your Master Thesis manuscript.

References:

- Melissa: https://hal.inria.fr/hal-01607479v1 and https://melissa-sc.github.io/
- Towards Efficient Large-Scale Graph Neural Network Computing https://arxiv.org/abs/1810.08403
- End-to-End Differentiable Physics for Learning and Control https://pdfs.semanticscholar.org/0932/7f8d33cf9f7e7aa83de9469f0d04250394.pdf
- TF-replicator: https://deepmind.com/blog/tf-replicator-distributed-machine-learning/
- TensorFlow: https://www.tensorflow.org/

Compétences

This PhD work is at the crossroad between Large Scale Numerical Simulation and Deep Learning. We expect candidates to have some good knowledge for at least one of these domains and the motivation to quickly acquire the missing complementary skills. This research work will involve theoretical developments with validation experiments on supercomputers. Candidates should have the quality required to pursue a successful research work: technical skills, autonomy, scientific creativity, writing abilities (English), good oral communication skills (English and possibly French), and taste for teamwork.