

# **PROPOSITION DE STAGE A L'IRIT (site n7) pour 2023**

Representation learning using GANs for turbulence modeling

**Durée du stage (en mois) :** 6

**Dates envisagées :** 01/03/23-30/12/23

**Niveau du stage:** M2

**Nom, mel, laboratoires et organismes des personnes encadrantes:**

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## **Problématique du stage:**

Generative adversarial networks (GANs) are a family of models which learn to generate similar and diverse synthetic data samples from observations. Many applications of GANs are developed in recent years in data science and artificial intelligence. The key machine learning problem of GANs is to understand the representations learnt in these models, in relation to the underlying structures of data. This internship aims to study this problem through a fundamental problem arising from physics, i.e. turbulence modeling.

Turbulence exists in our daily life, e.g. in cigarette smoke, aerodynamics and heat transfer of solar receiver. It is often described by Navier-Stokes equations and simulated using numerical methods of PDEs. The chaotic nature of turbulence results in complex and rich patterns in turbulent flows, which can potentially be learnt in machine learning models. In particular, we shall focus on particles driven by turbulent flows, like snow driven by a strong wind in the air. This is a hot research topic with potential applications to tele-communication, meteorology (rain formation), fusion and climate science. The tools used in this project may be applied more broadly in data science and artificial intelligence.

Throughout this internship, we shall study

- The principle of GANs and machine learning tools such as Pytorch, Tensorflow.
- Develop a generative model of particle turbulence, based on GANs.
- (Optional) Study statistics of turbulent flows, using point process and wavelet theory.

It is accompanied by potential collaborations with S. Gratton, B. Błaszczyszyn, K. Schneider in Toulouse INP, ENS/INRIA in Paris and I2M in Marseille.

## **Données, langages, méthodologie et outils:**

Language: Python, R

OS: Linux