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# PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DTIS/MACI-2023-Numéro d'ordre**
*(à rappeler dans toute correspondance)*

Lieu : Palaiseau

Département/Dir./Serv. : DTIS

Tél. : +33(0) 146 734 645

Responsable(s) du stage : Éric Savin

Email. : eric.savin@onera.fr

## DESCRIPTION DU STAGE

Thématique(s) : Mathématiques appliquées et calcul scientifique

Type de stage : ☐ Fin d'études bac+5 ☒ Master 2 ☐ Bac+2 à bac+4 ☐ Autres

**Intitulé : Auto-encoders with physics-informed latent manifold. Application in acoustics**

Sujet : This project aims to develop a new strategy to blend the outcome of physics-based numerical simulations with massive experimental databases, such as in situ data routinely recorded for monitoring purposes. The proposed approach relies on generative adversarial networks with a twofold purpose: (i) finding two reduced-dimension non-linear representations of both synthetic and experimental data; (ii) training a stochastic generator of fake experimental responses conditioned by the physics-based simulation results. This approach has been developed by Gatti & Clouteau (2020) in the context of earthquake engineering to render synthetic acceleration time-histories on a large region employing high-fidelity numerical models. It accounts for the complex physics of earthquakes, but it is still limited to a low-frequency range prediction due to computational costs. In order to span the large uncertainty on the high-frequency part of the signal, whose signature is strictly related to complex scattering patterns at small wavelength, a database of millions of broad-band seismic signals was used to train a deep adversarial auto-encoder. The latter was taught to extract meaningful hidden features from experimental data and encode them into a latent Gaussian manifold. Those features were then used to generate realistic broad-band signals as stochastic realizations of the same low-frequency synthetic part. In this way, the parameter dimensionality that is responsible of the large uncertainty of the outcome of high-fidelity numerical simulation is not modelled directly but learnt from the data. Therefore, the hybrid signals resemble recorded earthquake time-histories in a broad frequency range. The scope of the work is to extend this strategy and apply it to acoustics with an objective to strengthen the physics constraints on the adversarial learning scheme, *i.e.* find a robust and non-intrusive algorithm to disentangle the latent space according to different wave propagation phenomena arising at different scales. In other words, the deep convolutional encoder shall be forced to infer a set of independent Gaussian components of the latent space, each one representing a scattering phenomenon taking place at a definite scale. The theory of radiative transfer shall be adopted in order to unify the wave propagation problem at different wavelength and constraint the learning phase accordingly.

Est-il possible d'envisager un travail en binôme ? **Non**

**Méthodes à mettre en oeuvre** :

☒ Recherche théorique ☐ Travail de synthèse

☒ Recherche appliquée ☒ Travail de documentation

☐ Recherche expérimentale ☐ Participation à une réalisation

Possibilité de prolongation en thèse : **Oui**

**Durée du stage** : Minimum : 4 mois Maximum : 6 mois

Période souhaitée : avril-septembre 2023

## PROFIL DU STAGIAIRE

| Connaissances et niveau requis | Ecoles ou établissements souhaités |
|---|---|
| Connaissances et niveau requis : Pytorch, tensorflow libraries, wave propagation theory. | Ecoles ou établissements souhaités : M2 recherche (écoles, universités) |