STAGES M2
Description Scientifique

ACRONYME et titre du projet :
TDA4DRP : Topological Data Analysis applied to Digital Rock Physics

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Description (2 pages) :

IFPEN has developed since early 2000 a full expertise and know how in the field of Digital Rock Physics (DRP) and digital petrophysics. On the one hand pioneer work has been patented and published over the past two decades on the use of 3D high resolution tomography images of rocks in order to characterize the porosity structure and to access the petrophysical properties by numerical simulation using Pore Network Model or Lattice Boltzmann methods [1]. On another hand state of the art technology has been developed to automate and to in-situ monitor the core flood thus allowing a fully digitalization and a substantial acceleration of the experimental workflow [2]. The large amount of data generated by these technologies is used today as an input for Deep Learning algorithms in

order to generate new models that will allow the prediction of the petrophysical properties from 3D rocks images on the fly [3].

To investigate further, a dedicated imagery campaign on several rock typestogether with the acquisition of the corresponding petrophysical properties have been launched in the beginning of 2020. Thus, a big amount of consistent data are now available. Moreover, a workflow using Lattice Boltzmann simulations was set up to make data augmentation leading to data sets that are well suited for Deep Learning training. Some DL models with several layers of 3D convolution were trained and give good prediction results. An example of a 3D model architecture is shown on the figure below as well as a cross-plot between predicted and computed permeabilities. Results are promising and work is still going on.
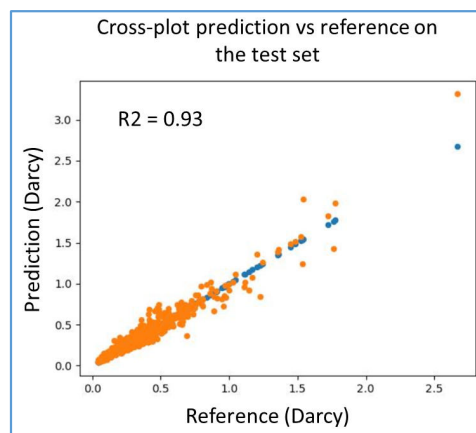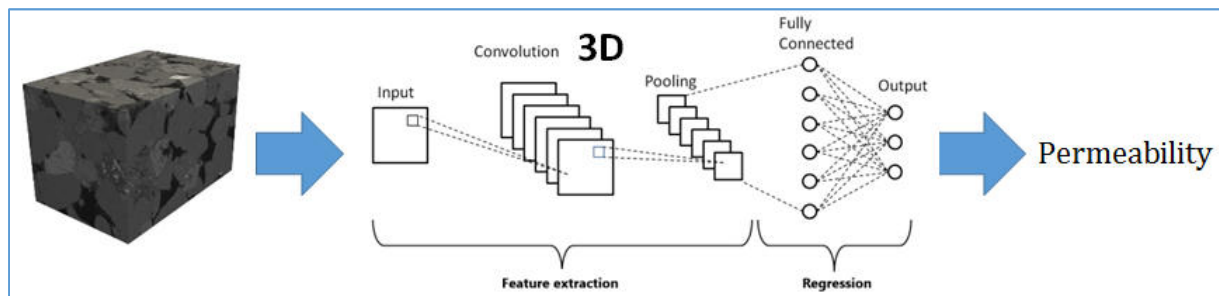
Since the Topological Data Analysis (TDA) helps to understand and exploit the topological and geometric structure underlying complex and possibly high-dimensional data [4], we believe that its outcome applied to our 3D images will provide useful information.

The objective of this work is to evaluate the benefits of the TDA within this context. It is mainly about finding relevant TDA features to add within our DL architecture in order to improve the prediction.

[1] - Analytical and numerical investigation of the advective and dispersive transport in Herschel–Bulkley fluids by means of a Lattice–Boltzmann Two-Relaxation-Time scheme, G. Batôt, L. Talon, Y. Peysson, M. Fleury, D. Bauer, Chemical Engineering Science, Volume 141, 2016, Pages 271-281, https://doi.org/10.1016/j.ces.2015.11.017.

[2] - High Throughput Coreflood Experimentation as a Tool for EOR Project Design, S. Youssef, M. Mascle, O. Vizika - SPE Improved Oil Recovery Conference, 2018, https://doi.org/10.2118/190166-MS

[3] - Digital core repository coupled with machine learning as a tool to classify and assess petrophysical rock properties, V. Hébert, T. Porcher, V. Planes, M. Léger, A. Alperovich, B. Goldluecke, O. Rodriguez and S. Youssef - E3S Web of Conferences, 2020, https://doi.org/10.1051/e3sconf/202014601003

[4] - Geometric and Topological Inference, J.D. Boissonnat, F. Chazal, M. Yvinec, Cambridge University Press, 2018, https://hal.inria.fr/hal-01615863v2

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Annexe financière

Récapitulatif

Titre du Projet	Noms des Porteurs	Montant du Financement demandé
TDA4DRP	Frédéric Chazal Jisu Kim François Cokelaer Mathieu Feraille	6 mois de stage : 3300 € d'aide

Durée et dates envisagées du projet :
6 mois - du 1er mars au 31 août

Etablissement bénéficiaire : INRIA Saclay-de-France

Noms et Contacts des gestionnaires administratifs et financiers du projet :
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Répartition et Typologie des dépenses

MOYENS A FINANCER		BUDGET
Types de dépenses	Description	Coûts Estimés
Rémunération du stagiaire	Rémunération du stagiaire de 550 euros par mois pour 6 mois	3300 €
TOTAL		**3300€**