Partial Differential Equations for Oceanic Artificial Intelligence

Data-Model Coupling is a promising approach for developing Artificial Intelligences (AI). It allows to embed a priori knowledge via the sophisticated mathematical model the AI is based on.

This model involves parameters that bear the AI Learning capability. Indeed, its a fitting routine (from a Learning Base) that brings the parameter collection making the AI fits the data at best.

Cemracs Project "Padocari" is part of a research programme that aims at exploring the use of Partial Differential Equations as Mathematical Models of Data-Model Coupling based AIs.

The field of application of Project "Padocari" is Data Assimilation for micro-organism's density in ocean waters. It is visible in satellite images and data sets related to measurements of the associated fields are available.

The objectives of "Padocari" are to

- explore if an already existing AI (developed for a completely different context) has the capability to predict factors related with micro-organism's density and/or ocean surface temperature (a similar approach was led in `https://arxiv.org/abs/1711.07970`)
- enrich the model used in the existing AI and build a more suitable tool for the targeted applications

It is taken for granted that the underlying phenomena generating the data we want to address are: flowing, diffusion, accumulation and delayed use.

Hence, it seems relevant to base a Data-Model Coupling Based AI for the targeted applications on Differential Operators associated to that kinds of phenomena.

Yet, members of our team already developed a tool (that gives good results for an application that has nothing to do with the one here, see `https://hal.archives-ouvertes.fr/hal-02079750`) based on those kinds of operators. Hence, a first part of the project is to test this tool on a new field.

The existing tool embeds a model which is only one-dimensional in space. It seems reasonable to imagine that embed a bi-dimensional model will give better results. Then, a second part of the project is to implement a bi-dimensional in space variant of the model and to embed it within an AI tool. For doing this, Freefem++ will be used.

A third part consists in exploring the best way to estimate the optimized coefficients of the embedded mathematical. Several fitting methods are to be contemplated: classical Last Square, Lasso, Likelihood Maximum, etc. And of course, the selection criterion will be the capability to forecast the quantity to be predicted.