ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

D USYS D ERDW

Machine Learning for Paleoclimate predictions

Project Proposal for Master's Thesis

Motivation: The atmosphere is a highly dynamic and complex system. Climate models have been developed to approximate the functioning of the climate system and allow the prediction of atmospheric conditions under different constraints than those governing the climate today. To accommodate the complexity of ocean-land-atmosphere interactions, climate models are generally composed of multiple components, making them computationally intensive. As a consequence, they are inefficient to use in other ways than as stand alone models applied to a specific time period with a certain set of boundary conditions, including atmospheric composition and land distribution.
Here we want to explore whether a machine learning approach can be used to build a tool that approximates the functioning of a climate model and that allows fast translation of changing boundary conditions into climate predictions over geological timescales (540 million years ago up to present day). This tool should enable us to study interactions between the climate system, geodynamic processes (i.e. tectonics) and the biosphere by allowing a fast coupling between the models of the respective domains.

Objective: We aim to explore the use of deep neural networks to approximate the functions of climate models, allowing us to make predictions about temperature and moisture in ocean and land Earth cells. For training the neural network, we will use a large database of climate model outputs, representing runs of the Fast Ocean Atmosphere climate model (FOAM) for snapshots of Earth's changing land distribution.
As a first step, different machine learning methods should be explored to evaluate their potential usage for this problem. This analysis will be done based on recent simulation results. Based on these insights, an extended framework should be developed to guide the search for reconstructions of the most important climate variables (i.e. temperature, precipitation and runoff) for changing continental configurations and atmospheric settings throughout Phanerozoic time.

Background:
Strong background in programming, experience in the field of machine learning. An understanding of atmosphere physics is of advantage but not a prerequisite.

Supervision: Prof. Taras Gerya, Prof. Loïc Pellissier, Dominic Stemmler, Julian Rogger

Start of project: As soon as the candidate is available.

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Subject: PaleoML