Mohammed VI Polytechnic University (UM6P)
International Artificial Intelligence Center of Morocco (Ai movement) & AgriTech Center of Excellence

Carbon Sequestration Modelling using Machine Learning Approaches

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1 Context

Climate change poses a significant threat to our planet, resulting in rising global temperatures, extreme weather events, and the loss of biodiversity. One of the key drivers of climate change is the accumulation of greenhouse gases, particularly carbon dioxide (CO2), in the atmosphere [1]. To mitigate this, carbon sequestration has emerged as a crucial strategy. Carbon sequestration refers to the process of capturing and storing carbon dioxide from the atmosphere, effectively reducing its concentration, and mitigating its impact on the Earth's climate system [2]. While there are various methods of carbon sequestration, natural sequestration by trees and soil plays a vital role. Through the process of photosynthesis, trees absorb carbon dioxide and convert it into organic compounds, storing carbon in their biomass. Additionally, soil acts as a significant reservoir for carbon, with organic matter being a key component of soil carbon sequestration. Therefore, understanding and enhancing the carbon sequestration potential of trees and soil are paramount in combating climate change. However, modelling carbon sequestration processes are difficult to be solved and scaled especially when using bio-chemical models (process-oriented or organism-oriented models) [3], thus require the development of hybrid methods intelligently combining bio-chemical methods and data-driven approaches relying on machine learning (ML) techniques, considering the different internal factors (e.g., soil characteristics, trees species) and external factors (e.g., agricultural practices, pedo-climatic parameters).

2 Research Objectives

The main objective of this thesis is to develop novel techniques at the intersection of machine learning and bio-chemical models that accurately estimate and assess carbon sequestration by the soil-plant system, with a specific focus on trees and soil. By integrating various environmental parameters, such as climate, soil type, land use, and vegetation characteristics, the model will provide insights into the potential carbon sequestration capacity of different ecosystems. To be specific, we will first model the carbon sequestration processes by exploring the calibration of internal parameters of bio-chemical models. This modelling will aim at studying the possibilities of where machine learning can intersect with bio-chemical models. Secondly, we investigate embedding machine learning approaches and the way they could enhance the accuracy and complexity of the conventional models. Third, we propose a novel efficient method combining bio-chemical models with machine learning to guide carbon sequestration modelling.

3 Admission Criteria

The PhD position is available at Ai movement, the International Center for Artificial Intelligence of Morocco of UM6P in collaboration with the AgriTech Center of Excellence of UM6P. Applicants with excellent academic credentials must be holders of a Master's, an engineering, or an equivalent recognized degree with good skills in applied mathematics, in relation to machine learning and optimization. Past experiences in relation with agronomic modelling are a bonus. The candidate should also be excellent in programming (Python, Java or C++), should have soft skills of problem solving, autonomy, and be fluent in English and French languages. Letters of recommendation are welcome.

References

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