Deep Learning in remotely sensed image understanding for biodiversity and ecosystem services

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One of the greatest challenges in ecology is to forecast the impacts of climate change and habitat destruction on biodiversity. One promising practical tool is “agent-based modelling (ABM)”, which aims to determine population response to environmental change as the emergent property of simple rules that govern an individual’s physiology, life-history and behaviour across complex landscapes. These ecological models are used to both evaluate risk and help develop management strategies to reduce vulnerability. They often require detailed spatial and temporal information on the microclimate and resources that are difficult to obtain. Recent technological advances in remote sensing, specifically the use of unmanned aerial vehicles (UAVs), offer the possibility not only to map the microclimate in detail but also monitor changes in plant traits. Technological advances are now enabling high spatial resolution (< 1m) hyperspectral imaging from UAVs, covering the visible and near infrared spectra. Recent work has revealed strong relationships between hyperspectral reflectance and various leaf traits from grassland plants and tropical trees, a number of which are known to determine the quality of food for insect herbivores. In the study of butterflies, there is a large body of experimental work to parametrize the individual energy budgets of species in respect to food plant quality. Quantitative analysis of hyperspectral reflectance becomes important to precisely understand the food plant quality from hyperspectral images.

This studentship will investigate the potential of using UAV remote sensing to map both the microclimate and the spatial and temporal variability of the butterfly’s host plants, in terms of their cover density and quality. In order to establish quantitative relationships between information captured by hyperspectral images and the reality of the butterfly’s host plants, computer vision and machine learning technologies will be applied to analyze the captured images systematically with regards to the plant composition, traits and condition. Automated understanding remotely sensed imagery involves image-based pattern classification, in which Convolution Neural Network (CNN), as a deep learning mechanism, will be used in the learning process to interpret the information. The hypothesis is that CNNs are powerful to extract meaningful features from a large amount of hyperspectral images, from which it is not easy to find useful/representative features by individual spectrum analysis.
Training opportunities:
The core of the project well contains the study involving UAV data acquisition and pre-processing, programming, and modelling. The student will develop skills of fieldwork, data management, image processing, programming and modelling. Throughout this process the student will be working in, and bridging across ecology, remote sensing, and computer science (particularly computer vision, machine learning, and artificial intelligence).

Student profile:
The project is suitable for a student with a degree in Computer Science or other related Engineering and Science subjects, who desires and has aptitude to work with sophisticated image based data analysis, algorithm development, and programming.

Background Reading:
(Don’t be worried if these seem intimidating … one of the first goals of the project will be to make all these concepts familiar … no background in any of these will be assumed.)


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