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# Towards multi-temporal data-driven models for extracting and learning information from remote sensing times series and existing ancillary data for land cover classification

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Up-to-date and dependable satellite-derived land cover maps are one crucial element of land use and climate related studies such as land change monitoring and carbon fluxes estimation. Whilst most of land cover mapping approaches are based on traditional machine learning algorithms (e.g. random forest, support vector machines, decision trees), it remains uncertain whether these models are learning or not temporal relationships and dependencies in remote sensing data. With the aim of contributing to the state-of-art of emerging alternatives capable to address this debate, this research presents a set of experimental case studies in Latin America where the feasibility of simple Recurrent Neural Networks (RNNs) and adapted RNNs such as Long Short Term Memory (LSTM) have been assessed to fully exploit all information from high-temporal resolution MODIS data and existing land cover information with the aim to produce per-pixel classification of annual land change trajectories over post-deforested areas. The following aspects are detailed i) an overview of RNNs, including theory and practice, in particular for remote sensing applications ii) how raw spectral data extracted from high temporal remote sensing images are formatted to feed the type of models assessed, ii) how calibration data (i.e. labelled data) can be collected and selected from existing land cover maps, iii) how the classifiers perform in comparison with related algorithms (e.g. feed forward neural networks), and iv) how the existing processing tools for handling earth observation data such as data cubes, computing resources (e.g. Graphics Processing Units or GPUs) and strategies for stratifying the area of interest (e.g. by agro-environmental conditions for calibrating stratum-specific algorithms) could boost the feasibility of the models assessed for large-scale applications. Despite the results illustrate how powerful RNNs might be for extracting and learning information from remote sensing data for land cover classification, several aspects and challenges exist for such type of models (e.g. the use of physical principles to constrain spatio-temporal patterns of land cover transitions).