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Prototype of a deep learning workflow to map dunes in the Kalahari

Maike Nowatzki, Richard Bailey, and David Thomas
School of Geography and the Environment, University of Oxford, Oxford, United Kingdom (maike.nowatzki@ouce.ox.ac.uk)

Linear dunes show a wide variety of morphometrical patterns; their sizes, spacing, defect density, and orientations differ not only between but also within dunefields (Thomas 1986; Bullard et al. 1995; Hesse 2011; Hugenholtz et al. 2012). The first step towards characterising dune patterning is to accurately and precisely map dunefields, which is challenging, especially when dunefields are too large to be mapped manually. Thus, (semi-)automatic approaches have been brought forward (Telfer et al. 2015; Shumack et al. 2020; Bryant & Baddock 2021). Here, we are presenting the prototype of a deep learning workflow that allows for the automated mapping of large linear dunefields through semantic segmentation.

The algorithm includes the following components: 1) the download of satellite imagery; 2) pre-processing of training and prediction data; 3) training of a Neural Network; and 4) applying the trained Neural Network to classify satellite imagery into dune and non-dune pixels. The workflow is python-based and uses the deep learning API keras as well as a variety of spatial analysis libraries such as earthengine and rasterio.

A case study to apply and test the algorithm's performance was conducted on Sentinel-2 satellite imagery (10 m spatial resolution) of the southwest Kalahari Desert. The resulting predictions are promising, despite the small amount of data the model was trained on.

The presented prototype is work in progress. Further developments will include parameter optimisation, exploring ways to improve the objectiveness of training data, and the conduction of case studies applying the algorithm to digital elevation rasters.