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GENERATIVE DEEP LEARNING FOR ENHANCED MULTI-SPECTRAL SURFACE ANALYSIS AND DIMENSIONAL AUGMENTATION OF DATA

Abstract

Generative Models are a class of statistical methods that learn a joint probability in a dataset and generate new data instances by sampling from the learned distribution. This paper proposes the use of generative models for the creation and augmentation of satellite images. From a multi-spectral dataset of satellite imagery, we use a generative model to create synthetic images to extend existing datasets. The model is also trained to predict entire spectral bands from observed bands. This allows identification of which bands need to be collected during future mission and which bands can be generated later on the ground. It is investigated if the same model can also augment already collected, historical satellite images thus providing invaluable additional data for images collected in the past. For earth observation, this supports several use cases, with monitoring the history of global warming being one of the most salient. Further investigation will be conducted into the possibility of training the model to create Digital Elevation Models (DEM) from 2D ground images by exploiting the dimensional relationship between spectral bands such as NIR and RGB bands. In previous experiments, we demonstrated that it is possible to generate realistic satellite data using Denoising Diffusion Probabilistic Models (DDPM). Our model was trained on multi-spectral Sentinel-2 data using semi-supervised learning techniques following the classical design of a DDPM. Our results show that the model can produce realistic satellite images at high resolutions and is able to reconstruct NIR bands whose structural similarity compares to the true NIR band. The preliminary results provide a proof of concept that generative models can be used for the proposes presented in this paper. The paper is concluded by a comprehensive study of which bands can be best used to reconstruct other spectral bands and to investigate if historical data can be reliably augmented with additional bands.