Solution report

on the problem: “Soil erosion detection”

Soil erosion is a critical environmental problem that can lead to loss of fertile soil and degradation of land quality. The detection of soil erosion using remote sensing data and image segmentation techniques has become an important research area in recent years.

The most effective way to solve the soil erosion detection problem is by using convolutional neural networks, which are widely used in image segmentation tasks. Some of the proposed models for soil erosion detection include U-Net, DeepLabv3+, and Mask R-CNN.

Several research papers have proposed different approaches to detect soil erosion. In a study by Wu and Zhang [1], a new framework was proposed for soil erosion detection using U-Net model with an attention mechanism and achieved an accuracy of 97.2%. Another study by Samarin [2] proposed a U-Net-based deep learning approach for soil erosion detection for aerial images and concluded that this model is efficient for image segmentation problems. Flood's study [3] also compares the U-Net model with others such as support vector machines and computer vision methods and concludes that it is well suited for remote sensing problems.

So, to solve this urgent problem the U-Net model was chosen. In general, the solution workflow can be divided into three main parts: data preparation, model training, and analysis of the results.

First, since the received input data was raw and not prepared for image segmentation, it was necessary to properly clean and structure it. During these processes, it was noticed that only a small part of erosions was noted in shape files, while most of the data was not marked.

Further, the proposed model architecture was implemented using Keras. Every part of the layers also includes dropout regularization to prevent possible overfitting of the model. The model was trained on the available data for 20 epochs and gave a result with an accuracy of 99.8% and a loss of 1.29% (but these values may be unreliable due to the small amounts of data provided).

In the end, the study of results was obtained. It has been shown that the model gives adequate predictions in most test cases, but there are also those in which it overestimates the presence of erosion. Future analysis and improvements may be made to improve model performance. This may include:

- training and testing of the model on large amounts of data;
- experiment with cutoff threshold for masks;

- changing the architecture of the model (for example, adding some additional convolutional layers or tweaking hyperparameters);
- an attempt to implement various CNNs such as DeepLabv3+ or Mask R-CNN;
- the use of multi-scale feature fusion or attention mechanisms [4].

Conclusion

In conclusion, the problem of soil erosion detection can be effectively solved by using deep learning techniques, particularly CNNs. The proposed U-Net model have shown promising results in the segmentation of soil erosion. Moreover, the further improvements can be made to increase the accuracy of the model and make more adequate estimation of the model performance.

Literature

1. Wu, C. et al. (2021) Building damage detection using U-Net with attention mechanism from pre- and post-disaster remote sensing datasets, MDPI. Multidisciplinary Digital Publishing Institute. Available at: https://www.mdpi.com/2072-4292/13/5/905 (Accessed: March 21, 2023).
2. Samarin, M. et al. (2020) Identifying soil erosion processes in alpine grasslands on aerial imagery with a U-net convolutional neural network, MDPI. Multidisciplinary Digital Publishing Institute. Available at: https://www.mdpi.com/2072-4292/12/24/4149 (Accessed: March 21, 2023).
3. Neil Flood a et al. (2019) Using a U-net convolutional neural network to map woody vegetation extent from high resolution satellite imagery across Queensland, Australia, International Journal of Applied Earth Observation and Geoinformation. Elsevier. Available at: https://www.sciencedirect.com/science/article/pii/S0303243419302041 (Accessed: March 21, 2023).
4. Xingwei Xu et al. (2021) Deep learning-based tool wear prediction and its application for machining process using multi-scale feature fusion and channel attention mechanism, Measurement. Elsevier. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0263224121002645 (Accessed: March 21, 2023).