

Project Proposal: Cascade-Based Segmentation Models

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Data Set

DRIVE (Digital Retinal Images for Vessel Extraction) dataset. This dataset contains 40 retinal fundus images with pixel-level vessel annotations, used for the task of imbalanced semantic segmentation. This dataset is also very lightweight, so it is ideal for our project.

Project Idea

We chose this task because the detection of tumors, cancers, and other abnormalities at the pixel level is important for early diagnosis and can be life saving. It is also an example of practical use of semantic imbalance segmentation in real world.

We were thinking about using machine learning algorithm called Random Forest. The Random Forest will be fed with features extracted from the images either from: **(1) deep learning-based features** obtained from U-Net or **(2) descriptor-based features** obtained from an algorithm such as SIFT. The training dataset will be DRIVE, as it is small and lightweight. After processing the images and extracting features, the Random Forest will be trained to classify pixels.

Our approach is only indicative and can be modified.

Software to Write

Software will be written in Python and we will use these libraries:

- NumPy for mathematical operations
- PyTorch or TensorFlow for training and feature extraction
- Scikit-learn for Random Forest implementation
- OpenCV for image processing and visualization

Papers to read

- [1] RONNEBERGER, Olaf; FISCHER, Philipp; BROX, Thomas; WELLS, William M; FRANGI, Alejandro F et al. U-Net: Convolutional Networks for Biomedical Image Segmentation. In: Medical Image Computing and Computer-Assisted Intervention – MICCAI 2015. 9351. Switzerland: Springer International Publishing, 2015, s. 234-241. ISBN 9783319245737. ISSN 0302-9743. From: https://doi.org/10.1007/978-3-319-24574-4_28.

- [2] BREIMAN, L. Random Forests. Machine Learning, 2001, vol. 45, no. 1, pp. 5–32. Available from: <https://doi.org/10.1023/A:1010933404324>. [Accessed: 2025-10-30].
- [3] SUDRE, Carole H.; LI, Wenqi; VERCAUTEREN, Tom; OURSELIN, Sebastien; JORGE CARDOSO, M. et al. Generalised Dice Overlap as a Deep Learning Loss Function for Highly Unbalanced Segmentations. In: Deep Learning in Medical Image Analysis and Multimodal Learning for Clinical Decision Support. 10553. Switzerland: Springer International Publishing, 2017, s. 240-248. ISBN 3319675575. ISSN 0302-9743. Dostupné z: https://doi.org/10.1007/978-3-319-67558-9_28.
- [4] YAQOOB, Muhammad Kashif; ALI, Syed Farooq; BILAL, Muhammad; HANIF, Muhammad Shehzad a AL-SAGGAF, Ubaid M. ResNet Based Deep Features and Random Forest Classifier for Diabetic Retinopathy Detection. Online. Sensors (Basel, Switzerland). 2021, vol. 21, no. 11, s. 3883. ISSN 1424-8220. From: <https://doi.org/10.3390/s21113883>. [cit. 2025-10-30].