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2025 09 15

Home Work No. **1**

Semantic Segmentation of Medical Images

The goal of this homework is to create a convolutional neural network that performs semantic segmentation on images of the fundus of the eye.

Main task [8 points]

When performing this HW, the following tasks must be completed:

1. Prepare data for feeding into the artificial neural network during training (you need to combine data from different data sets). Data splitting: use data from the "/DRIVE/test/" directory for testing, and divide the rest into training and validation sets at your discretion.

   The data can be downloaded using this link (three image data sets have been combined into one set for your convenience): https://www.dropbox.com/s/1ron8ntrgc0gt0b/FundusDataset.7z?dl=0

2. Select the appropriate loss function (see https://keras.io/api/losses/).

3. Select an optimizer. Try using the Adam optimizer at first. Try other optimizers (https://keras.io/api/optimizers/).

4. Set that during training (at each epoch), the following metrics are additionally calculated and output: AUC and MeanIoU (https://keras.io/api/metrics/).

5. Create a script that allows you to test the created network with new images and visualize the results. Calculate the AUC, F1, and MeanIoU metrics with the images in "/DRIVE/test/".

When completing this HW, use the example:
Image segmentation with a U-Net-like architecture
https://keras.io/examples/vision/oxford_pets_image_segmentation/
This example contains the most important elements needed for the homework assignment, but you will need to adapt it for segmenting fundus images.

Questions [2 points] [optional task]
1. What difficulties did you encounter while performing the task and how did you solve/resolve them?
2. Did you use data augmentation, and if so, what kind, and why did you choose it?
3. Did you try different optimizers, loss functions, perform other comparisons, and determine when more accurate segmentation results are achieved?
4. Were you able to train a segmentation model that could distinguish blood vessels in fundus images well enough? How could the segmentation results be improved?
5. Come up with your own question (related to this ND) and answer it.

Contents of the Report

As a report, send the **scripts prepared for training and testing** the neural network (*.py files or Jupyter Notebook file) and **additionally those files in PDF format**. Also, send your trained and selected best model (file with weights) according to the selected criteria. In the scripts, provide explanations in the form of comments about what you did and why you did it in the most important steps you had to take. Also, attach the images segmented with your best model /DRIVE/test/ and answers to the questions (answers to the questions are not a mandatory task). If you submit a Jupyter Notebook file (and its PDF) and all the results of your task solution are clearly visible among the script execution results, it is not necessary to submit the test results separately.

Report submission and evaluation

This LD task should be completed and sent by email to dalius.matuzevicius@vilniustech.lt by 23:59 on 2025-11-04. Late submission of the report will result in a 25% reduction in the task.

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Additional information may be useful:

Various practical examples of computer vision using Keras/TensorFlow tools:
https://keras.io/examples/vision/

An examples of transfer learning and fine-tuning:
https://keras.io/guides/transfer_learning/

Individual technical solutions for more advanced use of Keras:
https://keras.io/examples/keras_recipes/

KerasCV toolkit containing the most important structural elements of artificial neural networks (layers, metrics, error functions, data augmentation solutions) for computer vision tasks:
https://keras.io/keras_cv/