Prepared by dr. D. Matuzevičius
2025 10 20

Laboratory Work No. **4**

Investigating Activation Map Features of CNNs

When an image is fed into a Convolutional Neural Network (SNN), we obtain a certain feature map/activation map at the output of each layer of this network. The features from this map can be used to represent/describe the image or part of it – if we take all the features from the output of the last layer, these features would represent the entire image (also called bottleneck features); if we took some of the features from the map, which is the output of the previous SDNT layers, we would represent part of the image. If the features represent the image or part of it well, then similar features will be obtained from similar images. In this way, features can be used to find similar images, i.e., to sort and group images according to similarity (cluster).

The aim of this laboratory work is to test and investigate the use of features from CNN activation maps for the clustering/similarity search of medical images.

Main task [8 points]

This task involves comparing images of medicine tablets/pills and finding the most similar images.

The data set required for this task can be found here: https://github.com/usuyama/ePillID-benchmark

(the link to download the data is under "Downloadable from the releases page")

Use the images from the directory "\ePillID_data\classification_data\segmented_nih_pills_224\"; select several hundred images.

When completing this laboratory assignment, the following tasks must be performed:

1. Select a pre-trained Keras network without the classification part. A list of Keras models available with weights and their performance accuracy on the ImageNet database is provided here: https://keras.io/api/applications/
2. Extract feature values from the last convolutional layer using three different approaches: (i) all features after Flattening; (ii) after Global Max Pooling; (iii) after Global Average Pooling.
3. Using the extracted features, perform a search for the most similar images. Select one image and find the 10 most similar other images. Image similarity should be evaluated by comparing the extracted image features. The similarity metric to be used is cosine similarity. Perform five or more such searches and visualize the results. Repeat the same searches using each type of features specified in point [2] of this assignment.

Questions [2 points] [optional task]

1. What difficulties did you encounter while performing the task and how did you solve/resolve them?
2. Which features from point [2] allowed you to find the most similar images?
3. What could improve the accuracy of this type of similar image search algorithm?
4. Come up with your own question related to this LW, answer it for yourself, and then answer it for others.

Contents of the Report

As a report, send the **script(s)** (*.py files or Jupyter Notebook file) prepared for the solution of this task and **additionally those files in PDF format**. 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 perform. Also, include the results of testing the algorithm/model you created to solve the 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. Also, include answers to the questions (answers to the questions are not a mandatory task).

Report Submission and Evaluation

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