Course project proposal

Rotation equivariant CNNs – implementation and performance analysis of different approaches

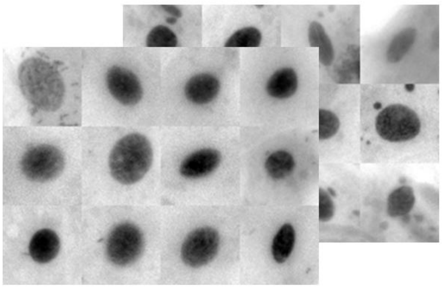
Background

Convolutional neural networks exhibit excellent performance in a variety of image processing tasks, being a particularly suitable tool to analyse input data with spatial structure (images). They are translation equivariant by definition: translation of an input image results in a corresponding translation of the feature map. Analogous behavior in case of rotation is not guaranteed, while being highly desirable in a number of applications, in particular in biomedical microscopy. Global rotation equivariance is typically addressed by data augmentation. However, data augmentation does not address local equivariance. At the same time, it often implies intensity interpolation, which may introduce undesired artifacts and have a negative impact on the analysis result. Equivariance inbuilt in the network architecture, on the other hand, leads to a reduced number of network parameters, more reliable learning, and improved performance, in particular in absence of large amounts of (annotated) training data.

Project description

The task is to evaluate several existing approaches to achieve rotation equivariance of CNNs, by comparing their performance on image-based classification, on a dataset acquired by bright-field microscopy. The selection of methods to be evaluated is a part of the project task. Some promising methods to be considered are proposed in [1-9].

Medical application



The most effective way of decreasing cancer mortality is early detection, which makes screening for cancer highly desired. Computer assisted analysis of cytology slides is a requirement for cost effective medical care. Fine intensity variation, due to the distribution of chromatin in the cell nucleus, is a most important diagnostic feature. Interpolation, potentially used for data augmentation, may corrupt this feature, and should therefore be avoided. Selected and implemented methods will be evaluated on the task of separating cell nuclei into the classes Cancer and Healthy in a provided annotated data set.

The project work should include

- Preparation of the project plan and distribution of the tasks within the team.
- A survey of the relevant literature and selection of 3-4 state of the art approaches to rotationally equivariant CNNs.
- Implementation of the selected methods in a common environment (e.g., Matlab or Python).
- Quantitative evaluation of the selected methods on the provided data.
- Writing of the project report.

References

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[5] T. S. Cohen and M. Welling. "Steerable CNNs". arXiv:1612.08498, 2016

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