Hyperparameter Selection for Anomaly Detection with Stacked Autoencoders - a Deep Learning Application

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Concept and Motivation
The aim of the project is an evaluation of the consequences of autoencoder variations on the results of an algorithm for anomaly detection on image data.

Autoencoders are a specific deep learning architecture, that gets trained to reconstruct certain input data from a dimensionality reduced, encoded state [GBC16]. Data for which the autoencoder is not optimized, is not reconstructed correctly. This is used to identify and detect anomalous data.

The choice of the correct autoencoder plays an important role for the success of the algorithm for anomaly detection. In this work, different autoencoder setups are varied and their performance for the task of anomaly detection is evaluated.

Anomaly Detection
The detection of anomalies has numerous applications. These include:
- Industrial defect detection, e.g. in assembly and maintenance
- Fraud detection
- Intruder detection in computer networks
- Medical and biological applications, e.g. for diagnosis of diseases and vermin detection
- Video surveillance in civil or military contexts

Algorithm
The Algorithm (figure 1) is a generic approach for anomaly detection on image data.

After a preprocessing step, training data is used to train an autoencoder. The fully trained autoencoder is used to reconstruct images from a new dataset. Differences between input and reconstruction are evaluated and detected as possible anomalies.

Improving Algorithm Performance: Better Malaria Detection
Through variation of autoencoder macro architecture (number and size of layers), regularization strength and application of other algorithm variations like denoising [VLL+10] and dropout [SHK+14], that both corrupt data at different autoencoder stages with random noise, algorithm performance can be significantly increased (compare figure 2). For a malaria detection dataset, the amount of correct detections among all detections (precision) and the amount of correct detections among all anomalies (recall) approaches or even exceeds human performance.

References

Supervision: Dipl.-Inform. Inga Boersch • Prof. Dr.-Ing. Sven Buchholz • Technische Hochschule Brandenburg • Dr.-Ing. Christian Wójcik • Carl Zeiss AG