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Master Project

Scalable dictionary learning to learn high-level features

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Context

Dictionary Learning has been an upcoming method over the past years. The signal representation learning method can be applied to many types of signals. Take for example black and white images, which are two-dimensional signals. With the knowledge that a signal is a 'natural' signal, and thus admits sparsity, the method can be applied to many problems such as denoising, deblurring and inpainting. The inpainting problem is for example a problem in which missing pixels of images are reconstructed. Due to the computational complexity of Dictionary Learning algorithms, the training data usually consists of small image patches. An example of such a dictionary is shown in Figure 1. An image can be reconstructed by choosing the optimal sparse set of image patches.

By using small image patches, it is harder to reconstruct high-level features. Take for example Figure 2 where the input of an inpainting problem is shown. To recover the missing rectangle of pixels in this image, the reconstruction should include high-level features since the high-level feature of eyes is missing. Current methods are able to recover big rectangles of missing pixels. However, they are constricted to small images due to the computational complexity. The focus of this project is to create a Dictionary Learning algorithm that is able to recover the high-level features of images. This is done by combining Dictionary Learning with Compressed Sensing, in which low-dimensional measurements are recovered to high-dimensional images.
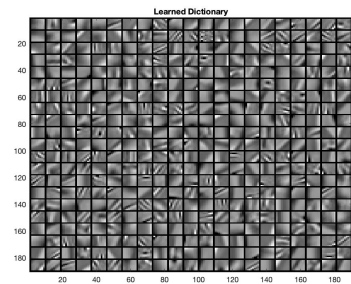

Figure 1: Example of a Learned Dictionary.

Figure 2: Input face image with missing rectangle [1].

Project tasks

This master thesis project is aimed at developing a Dictionary Learning algorithm that is capable of recovering high-level features of images. Requirements set on the method are:

1. Recover high-level features of images

2. Online implementation such that it is able to work with large data sets

3. Learn the dictionary within limited time

4. Explore connections to high-level features of dynamical systems

References

[1] Jeremias Sulam and Michael Elad. Large inpainting of face images with Trainlets. *IEEE Signal Processing Letters*, 23(12):1839–1843, 2016.