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Project 1 - Unitary Dictionary Learning

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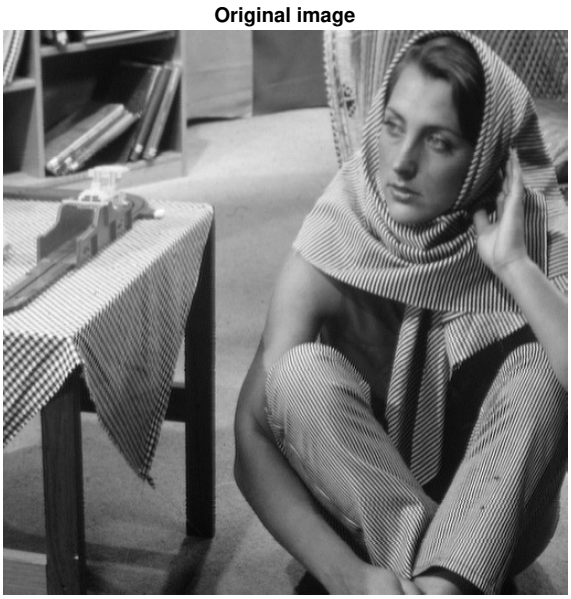
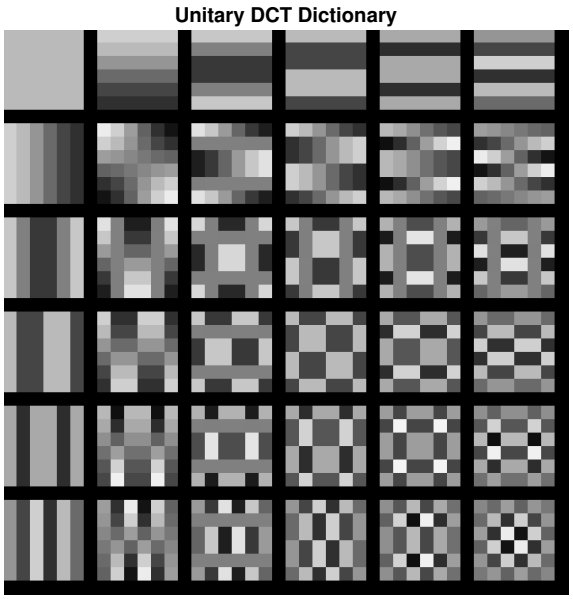
Part A: Data Construction and Parameter-Setting



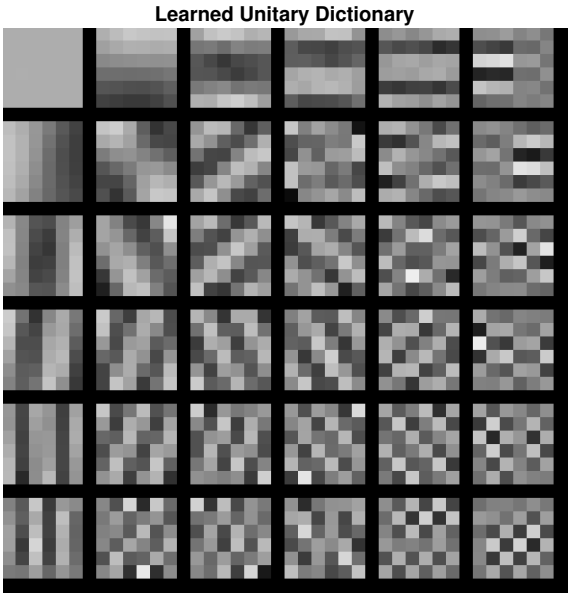


Part B: Compute the Representation Error Obtained by the DCT Dictionary

- Average MSE for train set: **104.73**
- Average MSE for test set: **101.86**
- Average number of non-zeros for train set: **4**
- Average number of non-zeros for test set: **4**

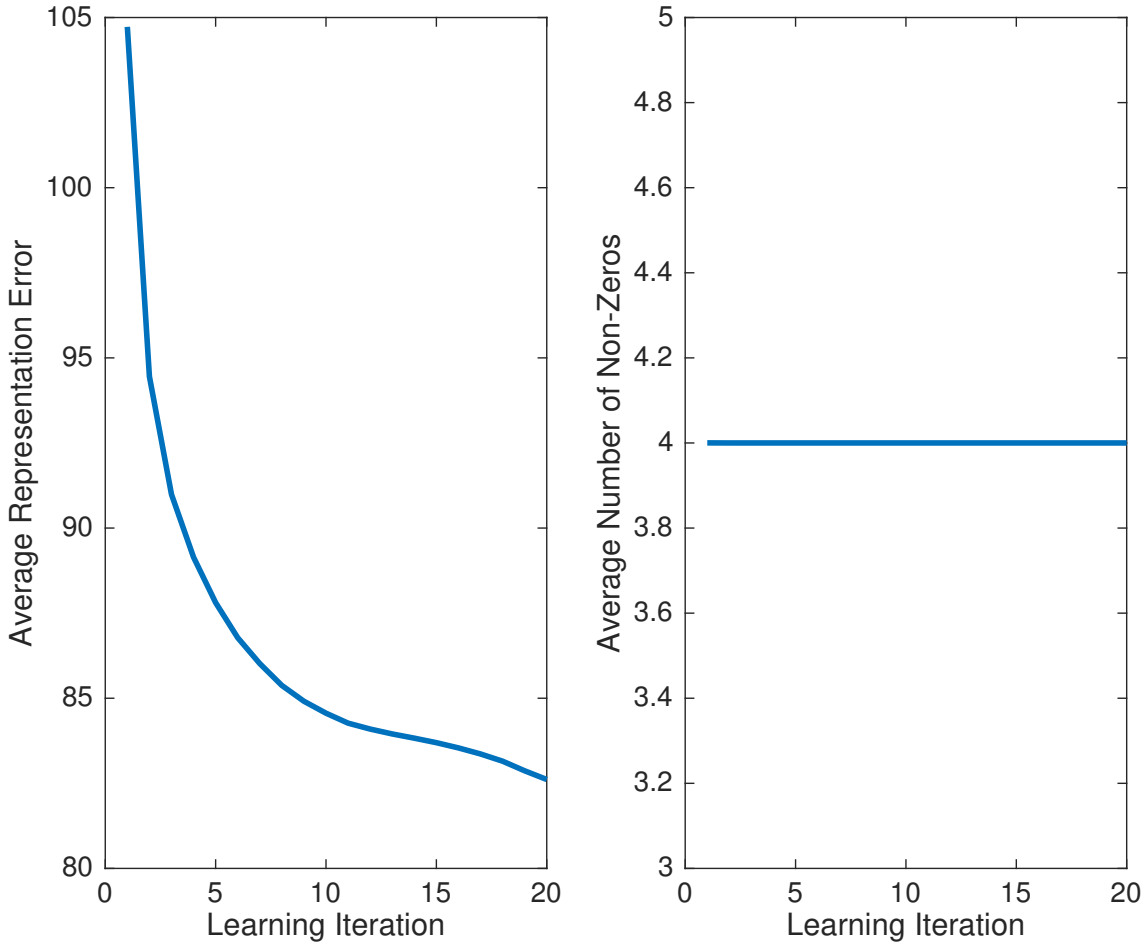
Part C: Procrustes Dictionary Learning

The obtained learned dictionary:



The obtained dictionary consists of piecewise smooth atoms and textured ones, because of the nature of the Barbara image.

Average MSE and number of nonzeros as a function of the iteration (train-set):



- Only about 10 iterations are necessary to significantly reduce the MSE, so the algorithm is pretty fast.
- The average number of non-zeros per patch is constant, due to the fact that we use a fix budget of K non-zeros per patch: $\frac{1}{N}\sum_{i=1}^{N}||\alpha_i||_0 = K$
- Average MSE for train set: **82.41**
- Average MSE for test set: **81.27**
- Average number of non-zeros for train set: **4**
- Average number of non-zeros for test set: **4**

Even though the DCT is commonly used to sparsely represent images, the learned unitary dictionary obtained via the Procrustes Dictionary Learning algorithm improves the error beyond its initial value. The trained dictionary leads to an error close to the errors observed on the training set implying that the learning process generalizes well for the other patches in the image.