Machine Learning Final Project

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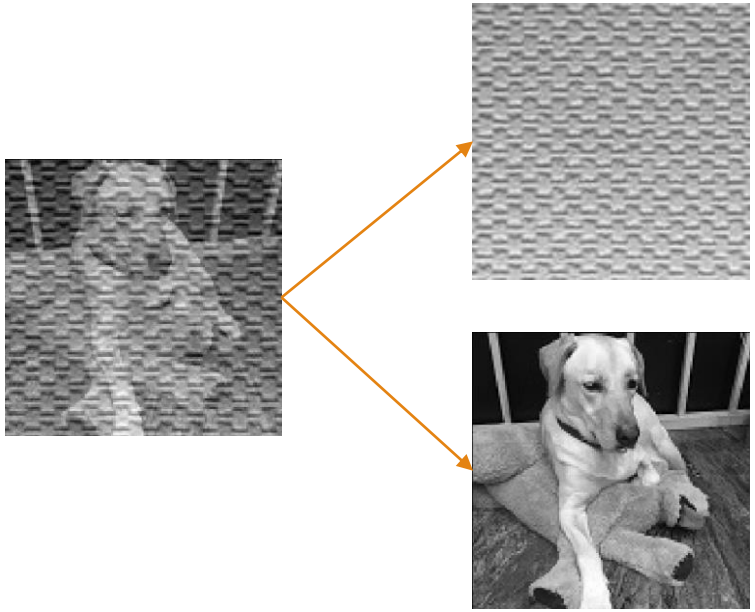
Dictionary Learning with two Dictionaries

$$\underset{D1,D2,x1,x2}{argmin} \|y_1 - D_1 x_1\|_F^2 + \|y_2 - D_2 x_2\|_F^2 + \lambda \left\| {D_1}^T D_2 \right\|_F^2 + \Gamma_x(x_1) + \Gamma_x(x_2) + \Gamma_D(D_1) + \Gamma_D(D_2)$$



y_1 : picture 1

y_2 : picture 2

D_1 : dictionary for picture 1

D_2 : dictionary for picture 2

x_1 : sparse representation of picture 1 for D_1

x_2 : sparse representation of picture 2 for D_2

λ : regularization parameters

Γ_x : constraint for x (make it sparse)

Γ_D : constraint for D (normalize)

Dictionary Training Method

1. Initial the dictionaries (D_1 and D_2) and the sparse representations (x_1 and x_2).
2. Update D_1, D_2, x_1, and x_2 simultaneously (greedy algorithm)
3. Fix D_1 and D_2, update x_1 and x_2 (soft threshold, soft_coef=0.01*mean)
4. Update D_1, D_2, x_1, and x_2 simultaneously (greedy algorithm)

Repeat step 3 and 4 until convergence

Sparse Coding with two Dictionaries

$$\underset{x1,x2}{arg\min}\frac{1}{2}\|y - D_1x_1 - D_2x_2\|_F^2 + \lambda_1\|x_1\|_0 + \lambda_2\|x_2\|_0$$

1. Initial the sparse representation (x_1 and x_2).
2. Update x_1 and x_2 (soft thresholding, soft_coef=0.01*mean).
3. Update x_1 and x_2 (greedy).

Sparse Coding with two Dictionaries and a Analysis Dictionary

$$\underset{x1,x2}{arg\min} \frac{1}{2}\|y - D_1x_1 - D_2x_2\|_F^2 + \lambda_1\|x_1\|_0 + \lambda_2\|x_2\|_0 + \frac{\lambda_3}{2}\|AD_1x_1 - z_1\|_F^2 + \frac{\lambda_4}{2}\|AD_2x_2 - z_2\|_F^2 + \lambda_5\|z_1\|_0 + \lambda_6\|z_2\|_0$$

1. Initial the sparse representation (x_1 and x_2).
2. Update x_1 and x_2 (soft thresholding, soft_coef=0.01*mean).
3. Update x_1 and x_2 (greedy).

A : analysis dictionary

z_1 : auxiliary variable 1

z_2 : auxiliary variable 2

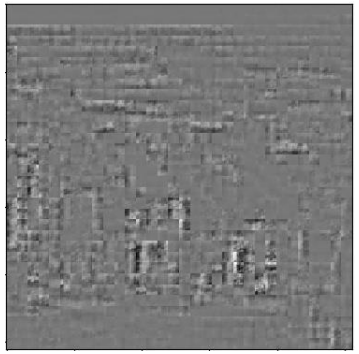
λ : regularization parameters

Experiment

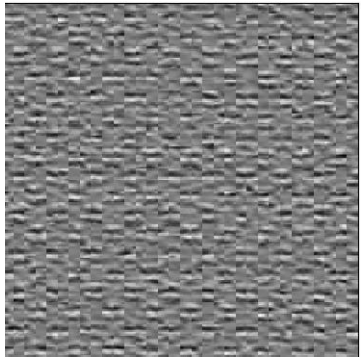
To simplify the problem, let$y_1 = D_1 * x_1, y_2 = D_2 * x_2$

Two sets of y1 and y2 for experiment

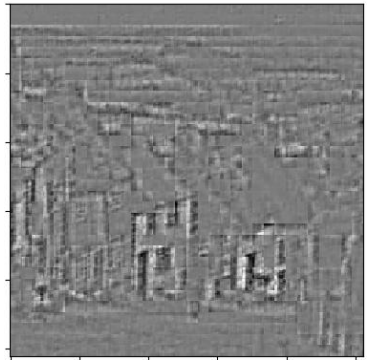
Set 1	Set 2
D have 32 atoms, x have 3 nonzeros y_1 PSNR: 23.2350, y_2 PSNR: 19.9591	D have 32 atoms, x have 10 nonzeros y_1 PSNR: 25.6146, y_2 PSNR: 23.5446



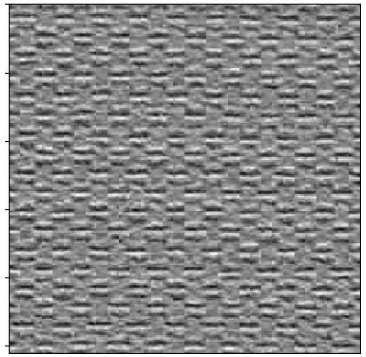
Set 1 y_1



Set 1 y_2



Set 2 y_1



Set 2 y_2

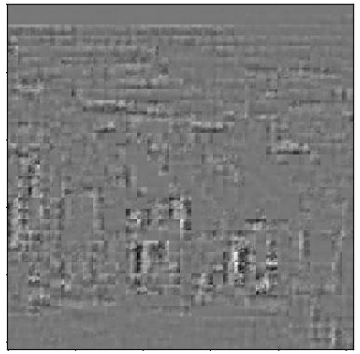
The Result of Sparse Coding for Image Set 1

Sparse Coding by two orthogonal dictionaries

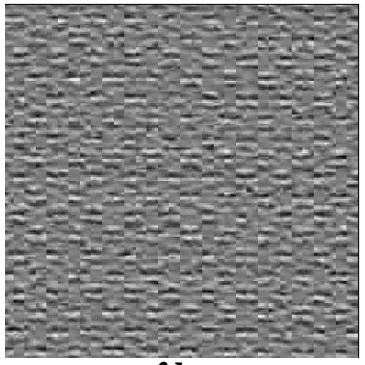
- Image 1 (sparse coding from y1+y2):

  y1(DL) PSNR=27.7252

  D1x1(after two orthogonal DL) PSNR=34.2670



y_1



y_2

- Image 2 (sparse coding from y1+y2):

  y2(DL) PSNR=24.5836

  D2x2(after two orthogonal DL) PSNR=28.0402

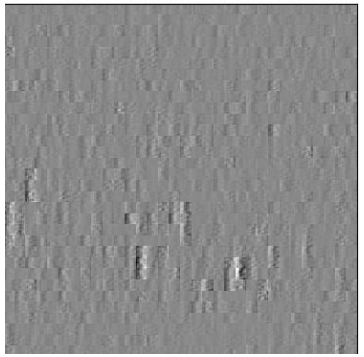


Image 1

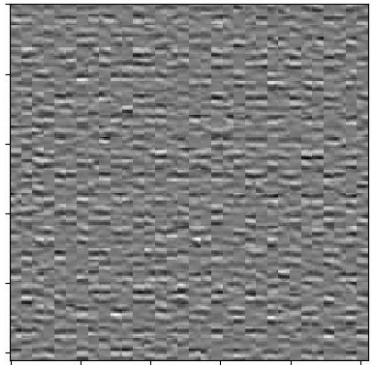


Image 2

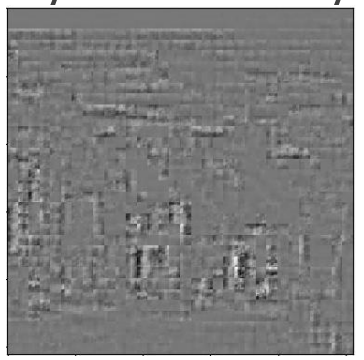
The Result of Sparse Coding for Image Set 1

Sparse Coding by two orthogonal dictionaries and a analysis dictionary

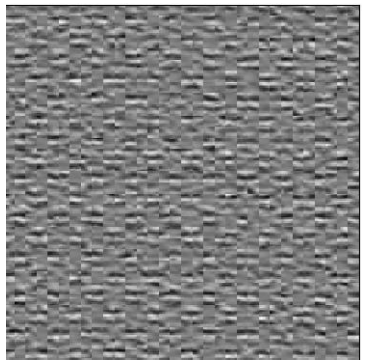
- Image 1 (sparse coding from y1+y2):

  y1(DL) PSNR=24.8747

  D1x1(after two orthogonal DL) PSNR=27.5470



y_1



y_2

- Image 2 (sparse coding from y1+y2):

  y2(DL) PSNR=19.2220

  D2x2(after two orthogonal DL) PSNR=21.3965

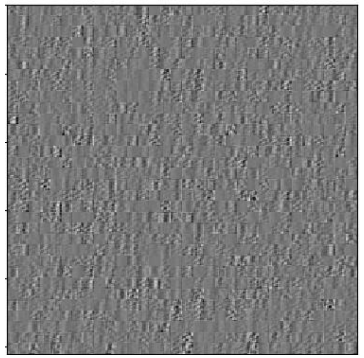


Image 1

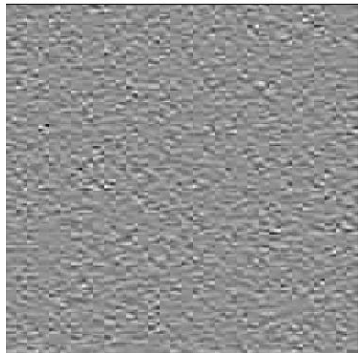


Image 2

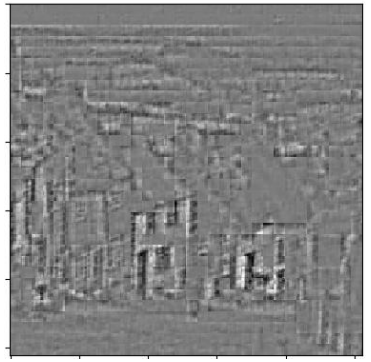
The Result of Sparse Coding for Image Set 2

Sparse Coding from two orthogonal dictionaries

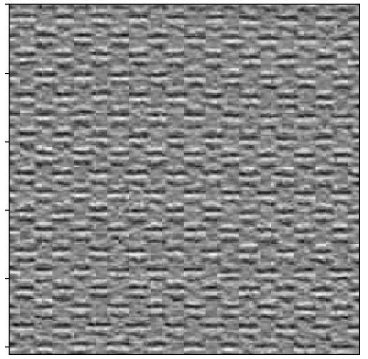
- Image 1 (sparse coding from y1+y2):

  y1(DL) PSNR=25.5493

  D1x1(after two orthogonal DL) PSNR=31.1082



y_1



y_2

- Image 2 (sparse coding from y1+y2):

  y2(DL) PSNR=22.2436

  D2x2(after two orthogonal DL) PSNR=26.8120

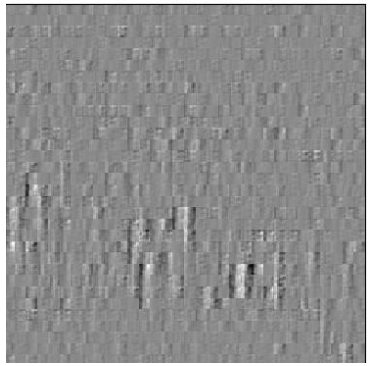


Image 1

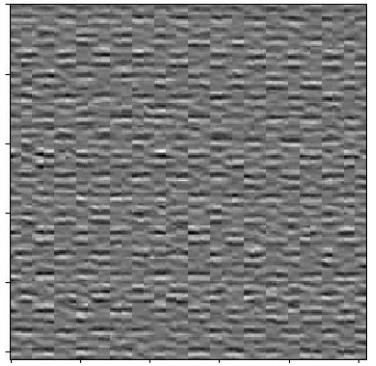


Image 2

The Result of Sparse Coding for Image Set 2

Sparse Coding from two orthogonal dictionaries and a analysis dictionary

- Image 1 (sparse coding from y1+y2):

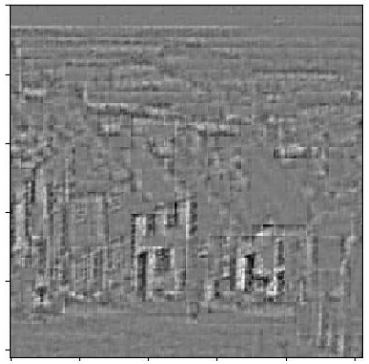
  y1(DL) PSNR=23.3555

  D1x1(after two orthogonal DL) PSNR=26.7490

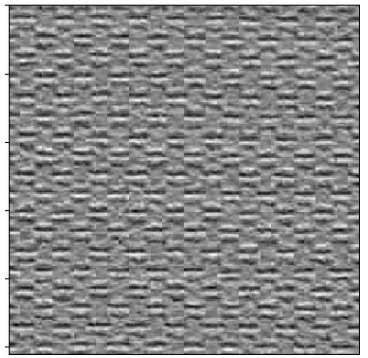
- Image 2 (sparse coding from y1+y2):

  y2(DL) PSNR=17.5180

  D2x2(after two orthogonal DL) PSNR=20.1070



y_1



y_2

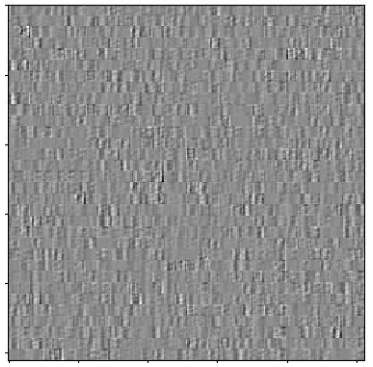


Image 1

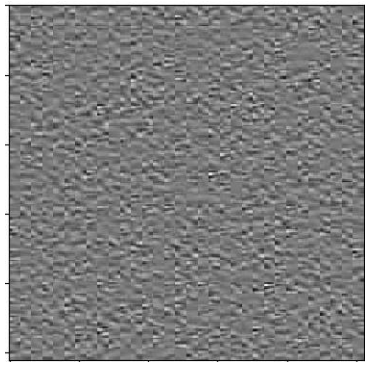


Image 2