ex3

May 15, 2019

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## Low rank approximation via SVD
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0.0.1 Exercise 3. Read the image peppers.png and convert it to grayscale. Perform its low-rank approximation for k = 1, ..., n.

0.0.2 Plot the dependence between the k and MSE of k-rank approximation version of original image. Make a conclusion.

0.0.3 Conclusion:

As we see in the experiment below each K component adds more of the "information" on the image. This is consistent with the theory since the compoents include variance of the information. This relationship is not linear since the first components are sorted to hold more of the variance observed in our data.

[2]:
```
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import numpy as np
imagePepperMatrix = mpimg.imread("./data/peppers.png")
plt.imshow(imagePepperMatrix)
U, S, VT = np.linalg.svd(imagePepperMatrix)

def mse(imageA, imageB) -> float:
        err = np.sum((imageA.astype("float") - imageB.astype("float")) ** 2)
        err /= float(imageA.shape[0] * imageA.shape[1])
        return err



def compress_svd(image,k):
    """
    Perform svd decomposition and truncated (using k singular values/vectors)␣
 ↪reconstruction
    returns
    --------
      reconstructed matrix reconst_matrix, array of singular values s
    """
    U,s,V = np.linalg.svd(image,full_matrices=False)
    reconst_matrix = np.dot(U[:,:k],np.dot(np.diag(s[:k]),V[:k,:]))
    return reconst_matrix,s


def compress_show_color_images_layer(image, k):
    """
     compress and display the reconstructed color image using the layer method
    """
    original_shape = image.shape
    image_reconst_layers = [compress_svd(image[:,:,i],k)[0] for i in range(3)]
    image_reconst = np.zeros(image.shape)
    for i in range(3):
        image_reconst[:,:,i] = image_reconst_layers[i]
    return image_reconst

fig=plt.figure(figsize=(8, 8))
columns = 4
rows = 5
k=1
for i in range(1, columns*rows +1):
    fig.add_subplot(rows, columns, i)
    img = compress_show_color_images_layer(imagePepperMatrix,k)
    plt.imshow(img)
    k+= 1

plt.show()

mses = [
    (
        k,
        mse(
            imagePepperMatrix,
            compress_show_color_images_layer(imagePepperMatrix,k)
        )
    )
    for k in range(1,384)
]
plt.plot(
    [i[0] for i in mses],
    [i[1] for i in mses]
)
plt.ylabel('k')
plt.xlabel('mse')
plt.show()
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Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
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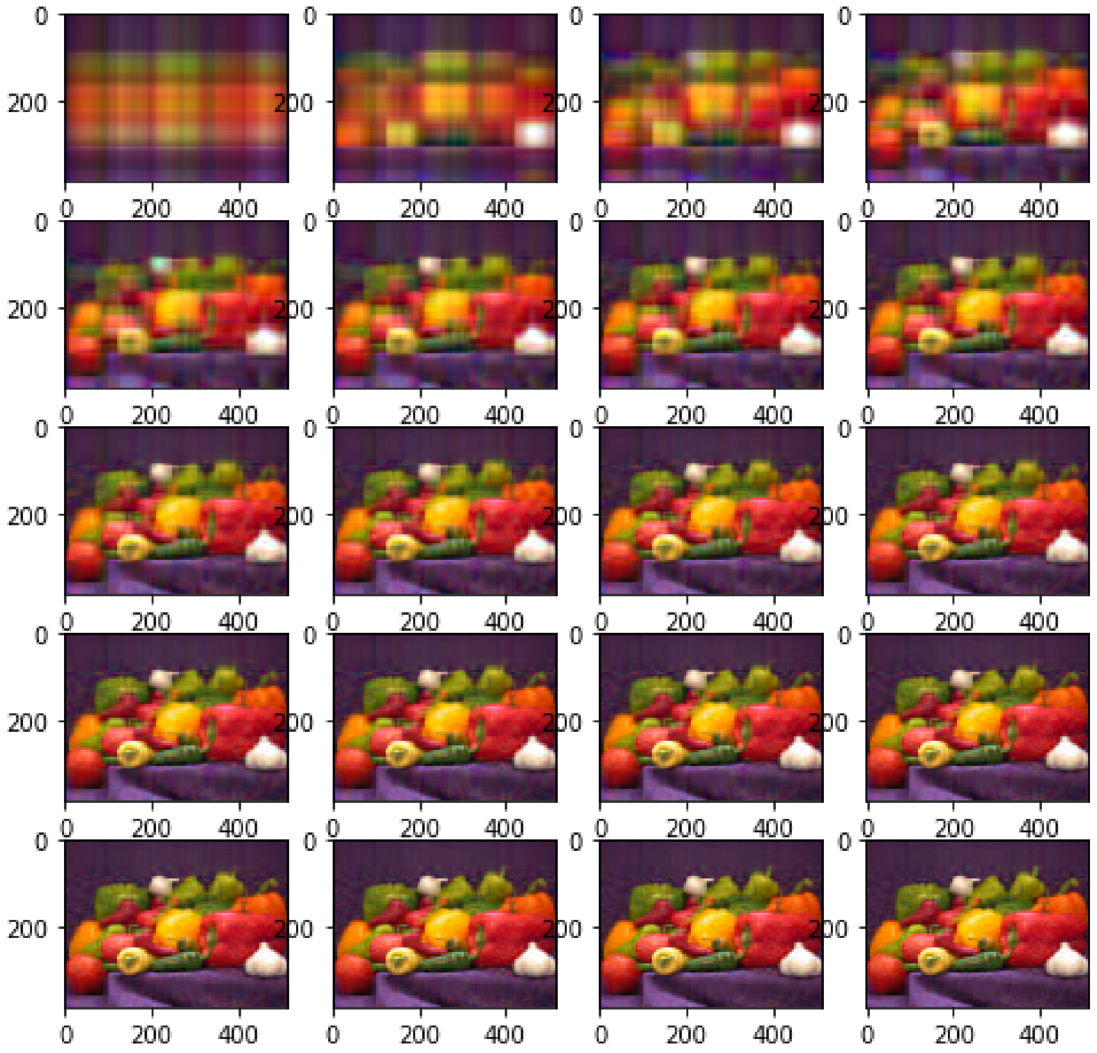
0
50
100
150
200
250
300
350
0
100
200
300
400
500


0
200
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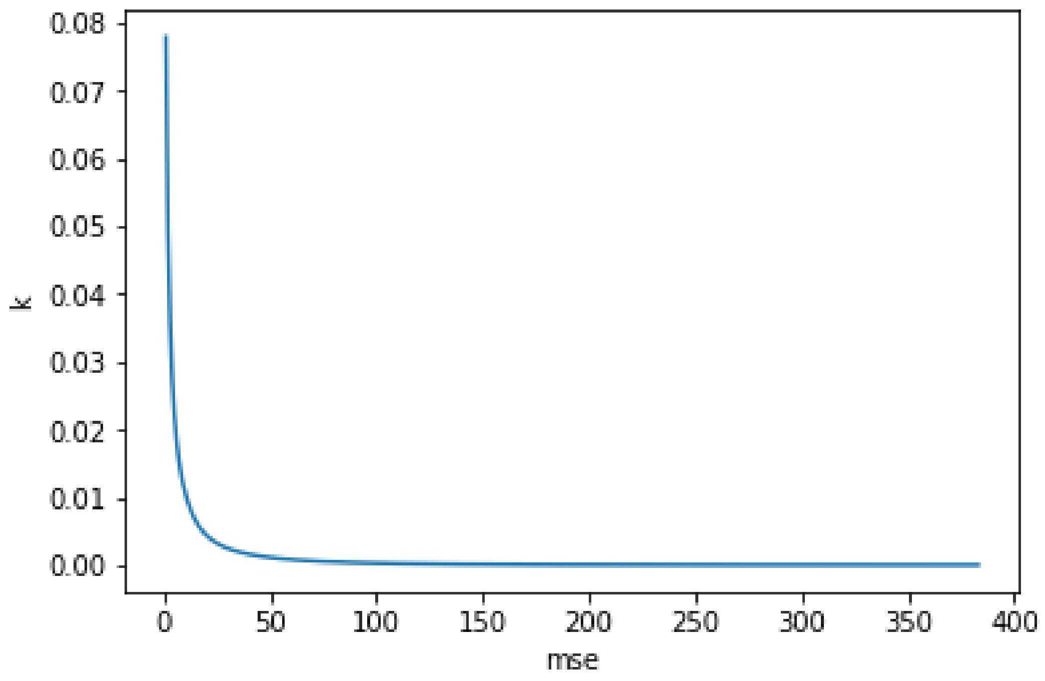

0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
k
0
50
100
150
200
250
300
350
400
mse