case

October 22, 2021

```
In [24]: from pathlib import Path
         from urllib.request import urlretrieve
         import zipfile
         from scipy.misc import imread
         from scipy.ndimage.interpolation import zoom#
         import numpy as np
         def fetch_cropped_yaleb(data_folder, zooming=0.5, max_n_subjects=None):
             """Returns a dictionary of paths

             Parameters
             ----------
             data_folder: string
             zooming: float, optional, default is 0.5
                 factor by which to resize the images
             max_n_subjects: {None, int}, optional, default is None
                 if not None, only the first max_n_subjects are returned

             Returns
             -------
             dict: {
                 subjects_1: {'images': [image_1, ... image_N],
                        'ambient': image_ambient,
                 }
             }

             images are stored as numpy arrays
             """
             url = 'http://vision.ucsd.edu/extyaleb/CroppedYaleBZip/CroppedYale.zip'
             yaleb_path = Path(data_folder).joinpath('cropped_yaleb')

             if not yaleb_path.joinpath('CroppedYale').exists():
                 yaleb_path.mkdir(parents=True)

             # If not already unzip, do it
             if not list(yaleb_path.iterdir()):
                 zip_path = yaleb_path.joinpath('yaleb.zip')

                 # If zip not already downloaded, download it
```

```
                if not zip_path.exists():
                    urlretrieve(url, zip_path.as_posix())

                zfile = zipfile.ZipFile(zip_path.as_posix())
                zfile.extractall(path=yaleb_path.as_posix())

            yaleb = {}
            for folder_path in yaleb_path.joinpath('CroppedYale').iterdir():
                if max_n_subjects is not None and len(yaleb) > max_n_subjects:
                    return yaleb

                if not folder_path.is_dir():
                    continue

                video_name = folder_path.name
                paths = sorted(list(folder_path.glob('*.pgm')))
                images = []
                for path in paths:
                    if 'Ambient' in path.name:
                        ambient = imread(path.as_posix())
                    else:
                        images.append(zoom(imread(path.as_posix()), zooming)[None, ...])

                data = {'images':np.concatenate(images),
                'ambient':ambient}
                yaleb[video_name] = data

            return yaleb
```

```
In [146]: dataset_path = '/Users/martinawu/Desktop/course-project-proposal-inf/mid/data/tensor
```

```
In [154]: data = fetch_cropped_yaleb(dataset_path, zooming=0.3, max_n_subjects=5)
          A=data['yaleB33']['images']
          A.shape
```

```
/Applications/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:60: DeprecationWarni
`imread` is deprecated in SciPy 1.0.0, and will be removed in 1.2.0.
Use ``imageio.imread`` instead.
/Applications/anaconda3/lib/python3.7/site-packages/scipy/ndimage/interpolation.py:583: UserWa
  "the returned array has changed.", UserWarning)
/Applications/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:58: DeprecationWarni
`imread` is deprecated in SciPy 1.0.0, and will be removed in 1.2.0.
Use ``imageio.imread`` instead.
```

```
Out[154]: (64, 58, 50)
```

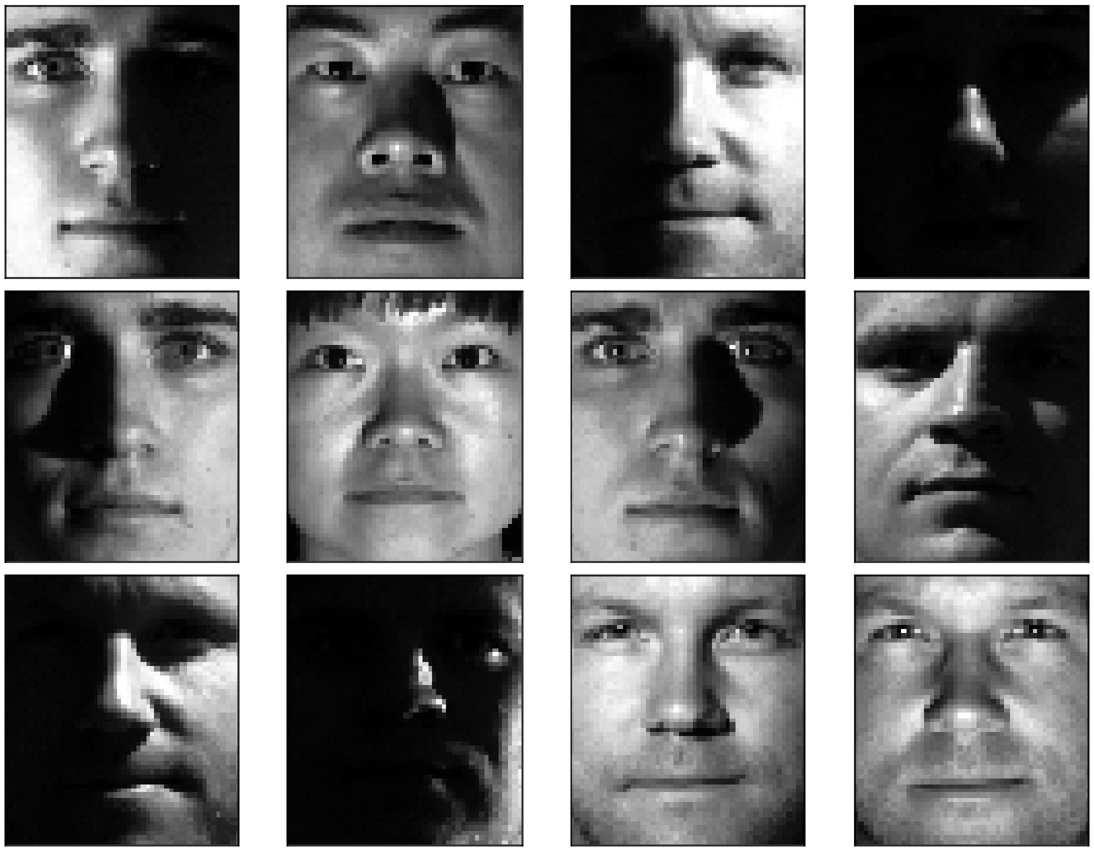
```
In [223]: X = np.concatenate([data[key]['images'] for key in data], axis=0)
          X.shape
```

```
Out[223]: (384, 58, 50)
```

```
In [149]: X = X.astype(np.float64)
          X -= X.mean()
```

```
In [131]: import matplotlib.pyplot as plt
          %matplotlib inline

          def visualise_images(X, n_images, n_columns, randomise=True):
              indices = np.arange(X.shape[0])
              np.random.shuffle(indices)
              indices = indices[:n_images]
              cmap = plt.cm.Greys_r
              n_rows = np.ceil(n_images / n_columns)
              fig = plt.figure(figsize=(2*n_columns, 2*n_rows))
              fig.subplots_adjust(left=0, right=1, bottom=0, top=1, hspace=0.05, wspace=0.05)

              # plot the digits: each image is 8x8 pixels
              for i, e in enumerate(indices):
                  ax = fig.add_subplot(n_rows, n_columns, i + 1, xticks=[], yticks=[])
                  ax.imshow(X[e], cmap=cmap, interpolation='nearest')
```

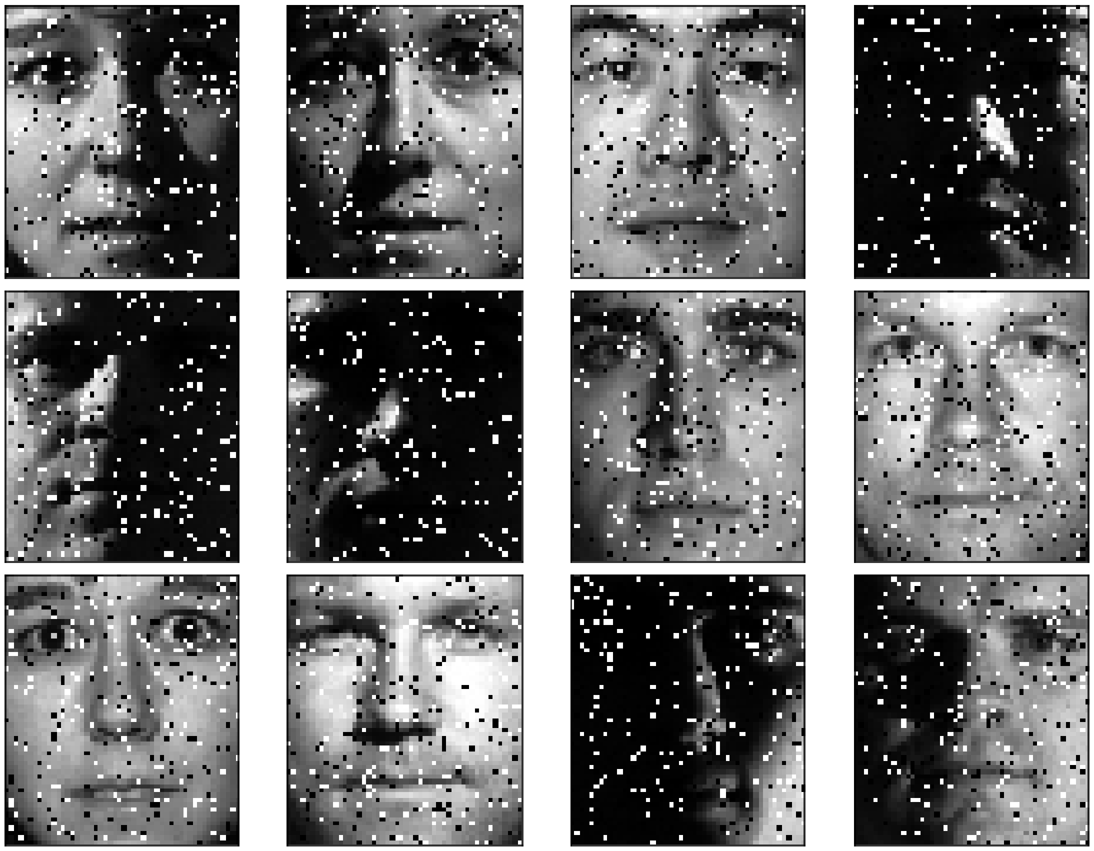
```
In [162]: visualise_images(X,12, 4)
          plt.savefig('./face.png')
```



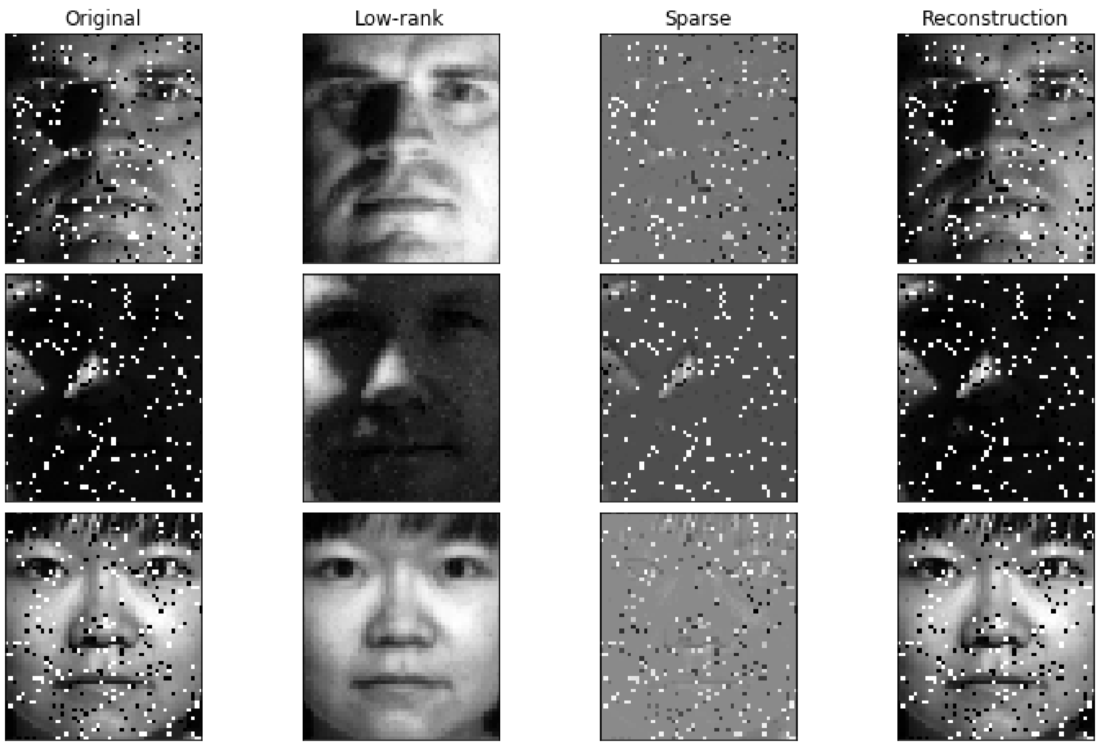
```
In [103]: import random
          def salt_and_pepper_noise(img, proportion=0.05):
              noise_img =img
              height,width =noise_img.shape[0],noise_img.shape[1]
              num = int(height*width*proportion)#
              for i in range(num):
                  w = random.randint(0,width-1)
                  h = random.randint(0,height-1)
                  if random.randint(0,1) ==0:
                      noise_img[h,w] =0
                  else:
                      noise_img[h,w] = 255
              return noise_img
```

```
In [156]: for i in range(384):
              X[i]=salt_and_pepper_noise(X[i], proportion=0.1)
          X = np.array(X, dtype=np.float64)
```

```
In [157]: visualise_images(X, 12, 4)
          plt.savefig('./face_with_salt_and_pepper_noise.png')
```

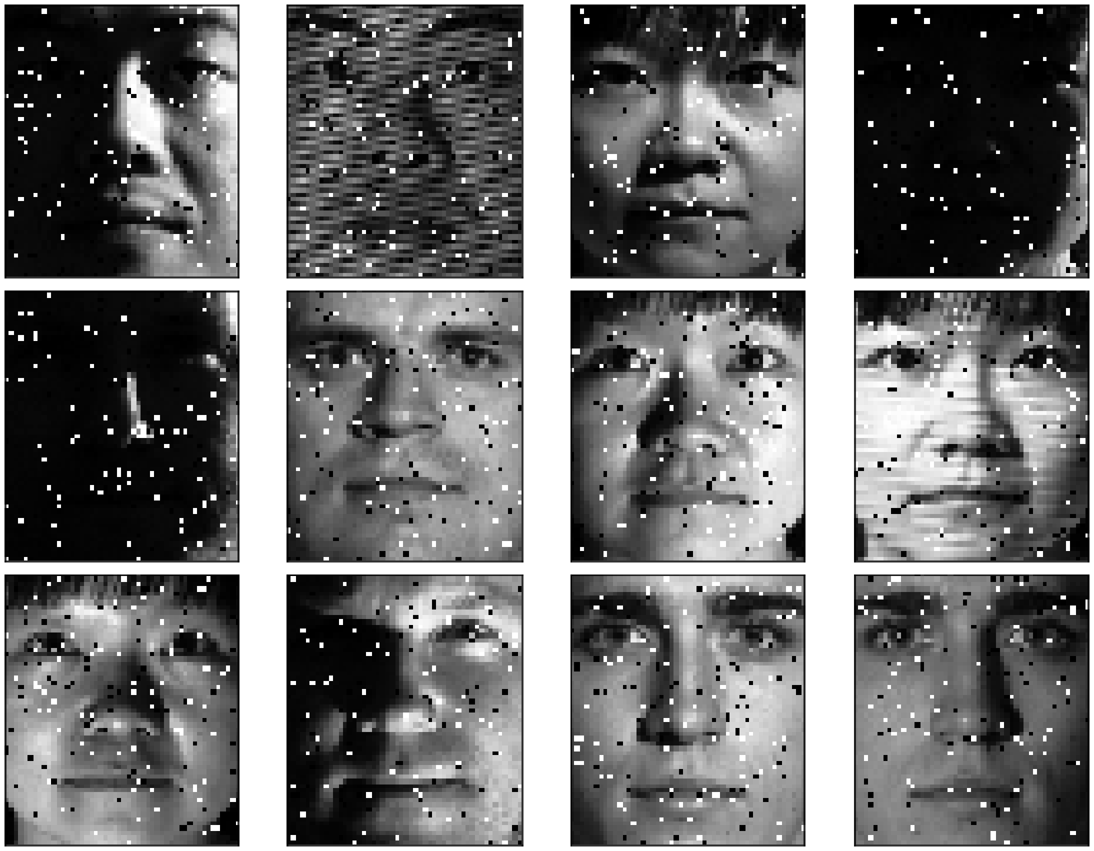


```
In [73]: from tensorly.decomposition import robust_pca

In [158]: low_rank_part, sparse_part = robust_pca(X, reg_E=0.04, learning_rate=1.2, n_iter_max=

In [159]: def visualise_rpca(X, low_rank_part, sparse_part, n_images=10):
              """A little helper function to visualise the result of tensor RPCA
              """
              indices = np.arange(X.shape[0])
              np.random.shuffle(indices)
              indices = indices[:n_images]

              fig = plt.figure(figsize=(10, 2*n_images))
              fig.subplots_adjust(left=0, right=1, bottom=0, top=1, hspace=0.05, wspace=0.05)

              # plot the digits: each image is 8x8 pixels
              for i, e in enumerate(indices):
                  cmap = plt.cm.Greys_r

                  ax = fig.add_subplot(n_images, 4, 4*i + 1, xticks=[], yticks=[])
                  ax.imshow(X[e], cmap=cmap, interpolation='nearest')
                  if not i:
                      ax.set_title('Original')

                  ax = fig.add_subplot(n_images, 4, 4*i + 2, xticks=[], yticks=[])
                  ax.imshow(low_rank_part[e], cmap=cmap, interpolation='nearest')
                  if not i:
                      ax.set_title('Low-rank')

                  ax = fig.add_subplot(n_images, 4, 4*i + 3, xticks=[], yticks=[])
                  ax.imshow(sparse_part[e], cmap=cmap, interpolation='nearest')
                  if not i:
                      ax.set_title('Sparse')

                  ax = fig.add_subplot(n_images, 4, 4*i + 4, xticks=[], yticks=[])
                  ax.imshow(low_rank_part[e]+sparse_part[e], cmap=cmap, interpolation='nearest
                  if not i:
                      ax.set_title('Reconstruction')

In [160]: visualise_rpca(X, low_rank_part, sparse_part, n_images=3)
          plt.savefig('./Tensor_PCA.png')
```

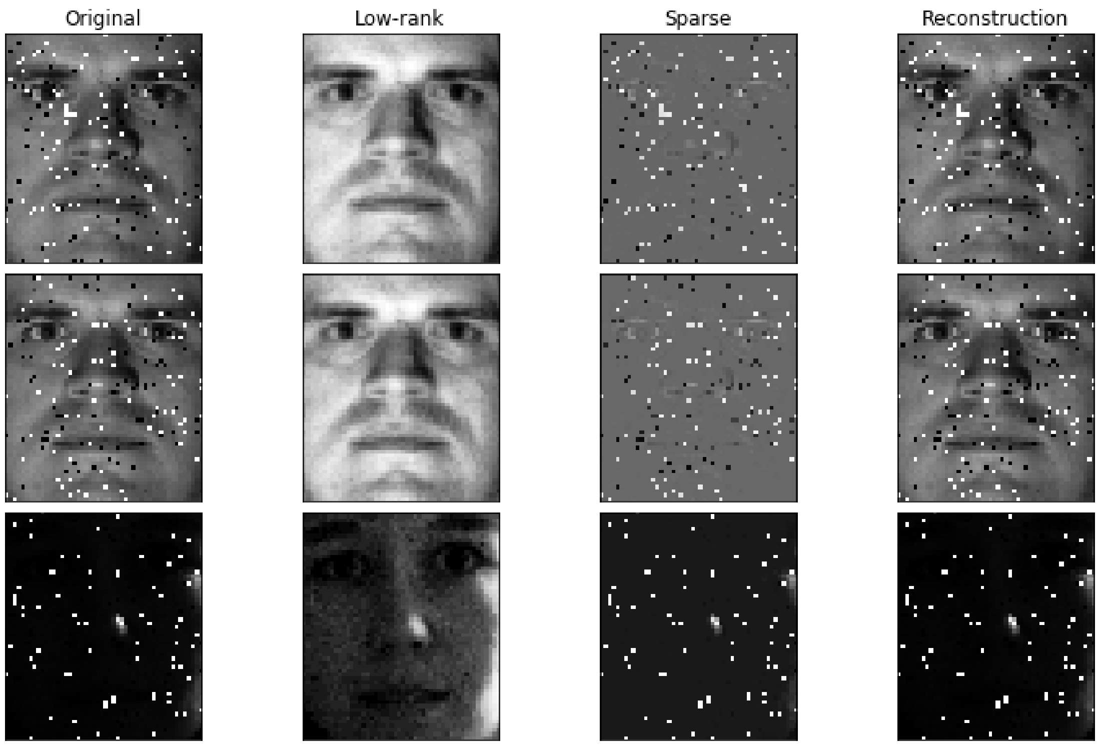


```
In [243]: #random_noise(image, mode='gaussian', seed=None, clip=True, **kwargs)
          #modestr, optional
          #One of the following strings, selecting the type of noise to add:

          #gaussian Gaussian-distributed additive noise.

          #localvar Gaussian-distributed additive noise, with specified
          #local variance at each point of image.

          #poisson Poisson-distributed noise generated from the data.

          #salt Replaces random pixels with 1.

          #pepper Replaces random pixels with 0 (for unsigned images) or
          #-1 (for signed images).

          #s&p Replaces random pixels with either 1 or low_val, where
          #low_val is 0 for unsigned images or -1 for signed images.

          #speckle Multiplicative noise using out = image + n*image, where
          #n is uniform noise with specified mean & variance.
          #import skimage
          X2 = skimage.util.random_noise(X,mode='s&p',seed=None,clip=True)
```

```
visualise_images(X2, 12, 4)

plt.savefig('./salt_and_pepper_noise.png')
#X3=skimage.util.random_noise(X,mode='speckle',seed=None,clip=True)
#visualise_images(X3, 12, 4)
#plt.savefig('./Gaussian-distributed additive noise.png')
```

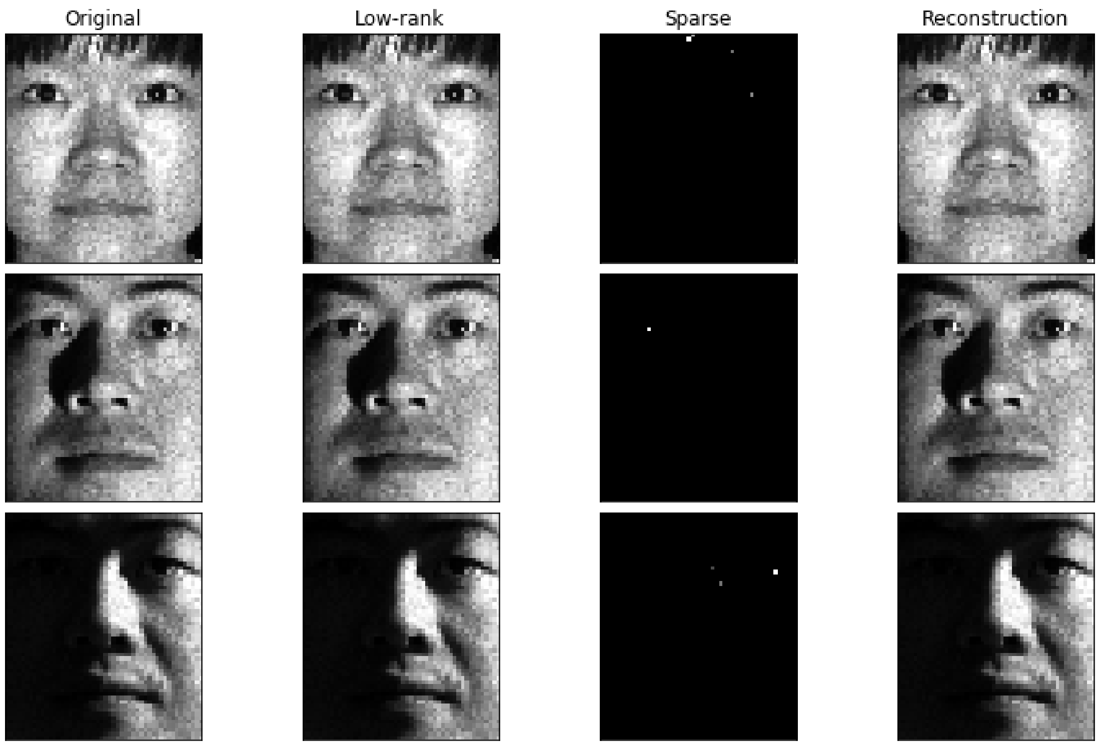


```
In [171]: low_rank_part, sparse_part = robust_pca(X2, reg_E=0.04, learning_rate=1.4, n_iter_ma

In [172]: visualise_rpca(X2, low_rank_part, sparse_part, n_images=3)
```

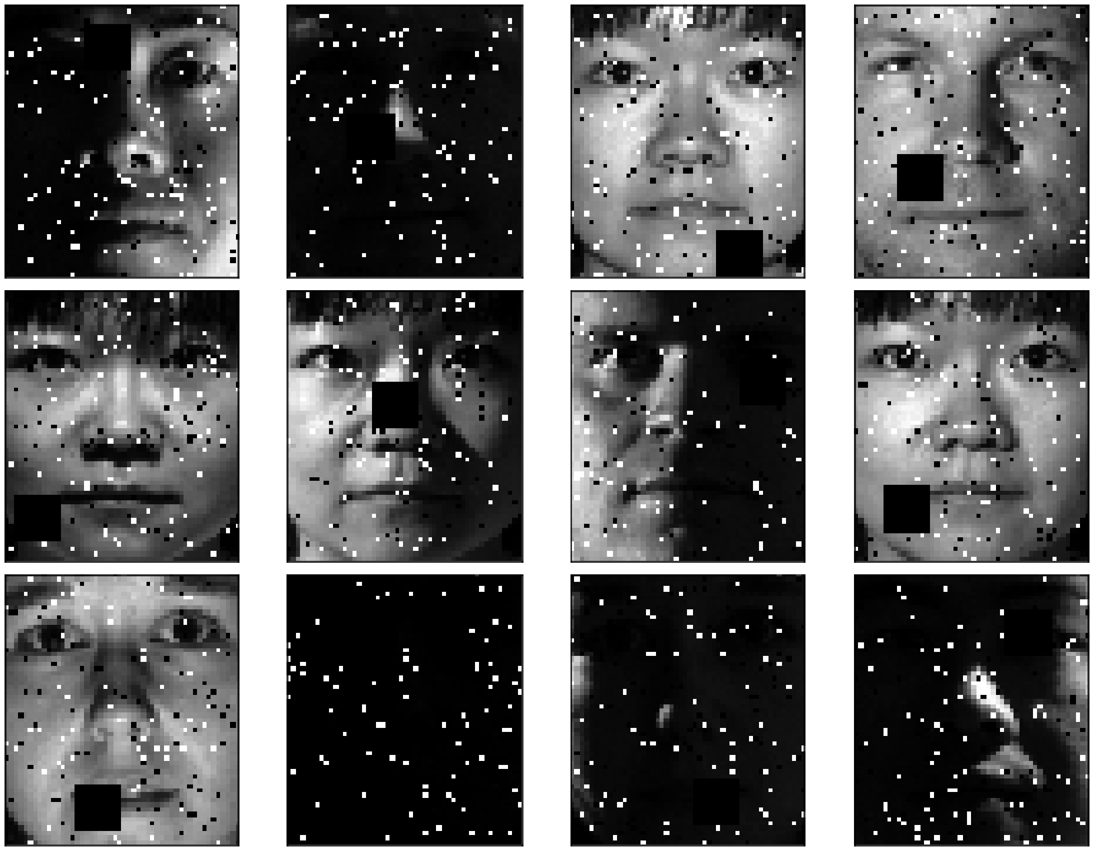


```
In [178]: low_rank_part, sparse_part = robust_pca(X3, reg_E=0.4, learning_rate=1.4, n_iter_max
          visualise_rpca(X3, low_rank_part, sparse_part, n_images=3)
```

```
Converged in 77 iterations
```



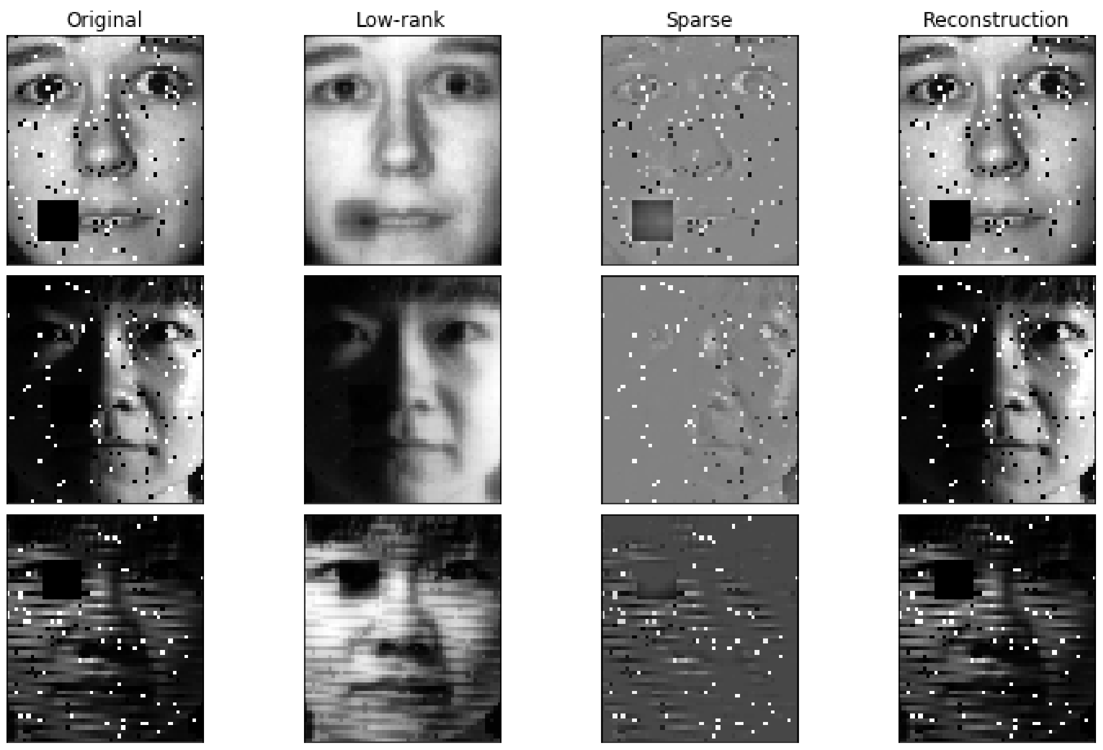
```
In [244]: #mask
          for i in range(X2.shape[0]):
              random.seed()
              x=random.randint(1,48)
              y=random.randint(1,40)
              #print(x,y)
              X2[i,x:x+10,y:y+10]=np.zeros((10,10))

In [245]: visualise_images(X2, 12, 4)
          plt.savefig('./salt_and_pepper_noise+mask.png')
```



```
In [248]: X2 = np.array(X2, dtype=np.float64)
          low_rank_part, sparse_part = robust_pca(X2, reg_E=0.04, learning_rate=1.8, n_iter_ma
```

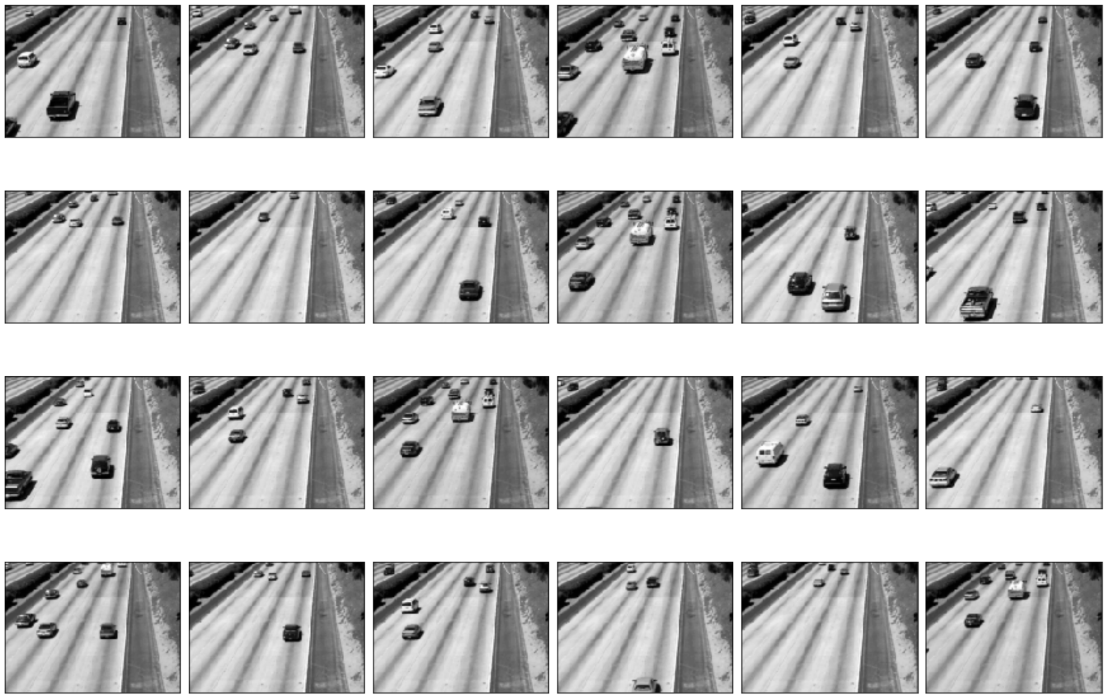
```
Converged in 41 iterations
```

```
In [249]: visualise_rpca(X2, low_rank_part, sparse_part, n_images=3)
```

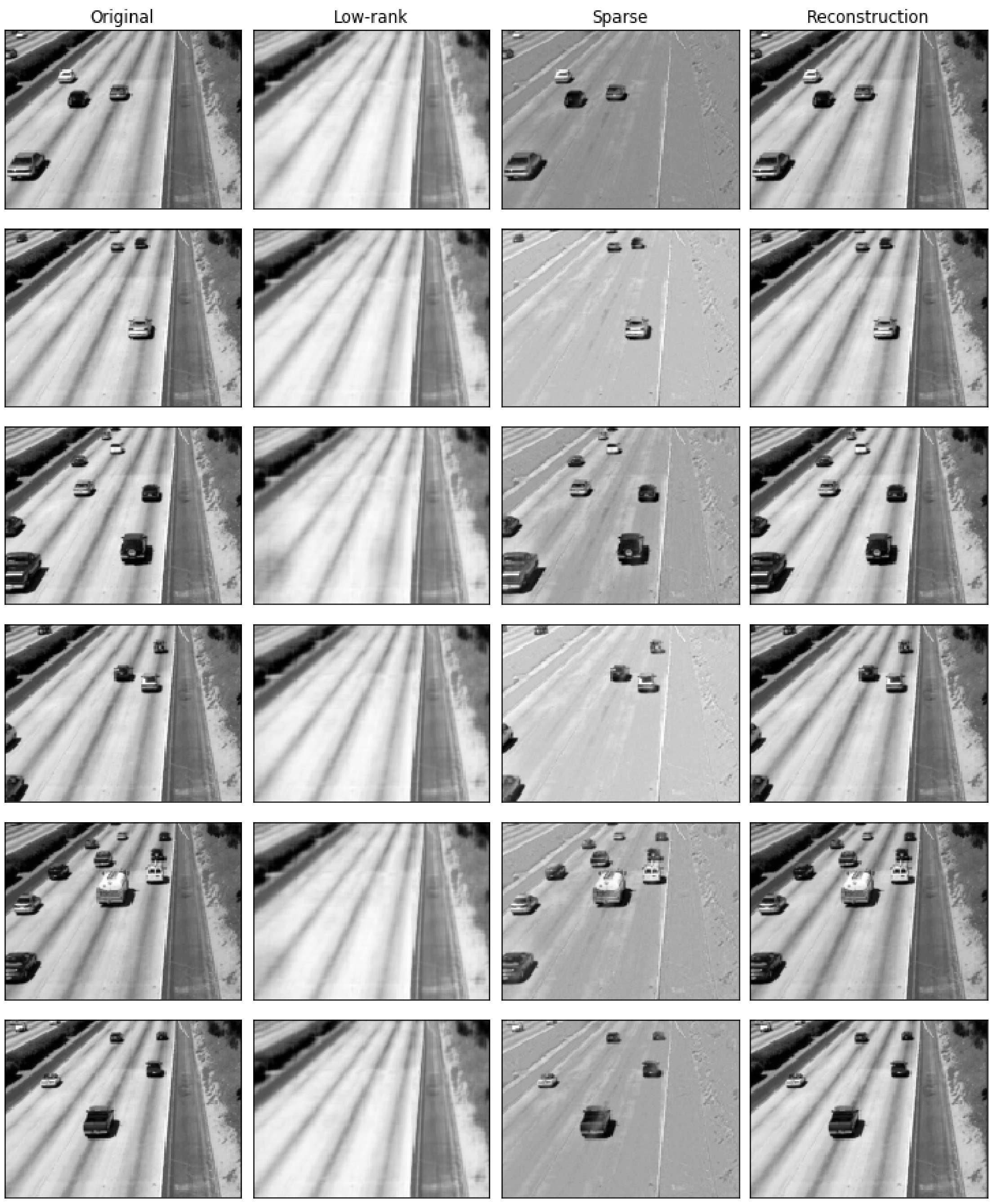


```
In [250]: from urllib.request import urlretrieve
          video_filename = 'highwayII_raw.AVI'
          urlretrieve ("http://cvrr.ucsd.edu/aton/shadow/data/highwayII_raw.AVI", video_filena

Out[250]: ('highwayII_raw.AVI', <http.client.HTTPMessage at 0xb1f249c50>)

In [252]: from scipy.misc import imresize

In [254]: from iopy2.collection import ImageCollection

In [257]: collection = ImageCollection.from_video_filename(video_filename, image_to_gray=True,

In [260]: collection

Out[260]: ImageCollection, collection of 500 elements, cachine disabled..

In [261]: def resize(image):
              return imresize(image, 0.5)

In [262]: Y = collection.to_matrix(flatten_images=False, apply_fun=resize)

/Applications/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:2: DeprecationWarnin
`imresize` is deprecated in SciPy 1.0.0, and will be removed in 1.2.0.
Use ``skimage.transform.resize`` instead.
```

```
In [263]: Y.shape

Out[263]: (500, 120, 160)

In [269]: visualise_images(Y, n_images=24, n_columns=6)
          plt.savefig('./video.png')
```



```
In [266]: low_rank_part, sparse_part = robust_pca(Y, reg_E=0.01, learning_rate=1.2, n_iter_max

In [271]: visualise_rpca(Y, low_rank_part, sparse_part, n_images=6)
          plt.savefig('./PCA_video.png')
```



```
In [270]: plt.savefig('./PCA_video.png')
```

```
<Figure size 432x288 with 0 Axes>
```

```
In [272]: from iopy2.video import ffmpeg_image_list_to_video
In [273]: def normalise(array):
              """Renormalise the array in the range [0, 255]

                 Return an array of uint8 with 3 channels
              """
              if array.min() < 0 or array.max()>255:
                  array = array - array.min()
                  array /= array.max()
                  array *= 255
              normalised = np.empty(list(array.shape) + [3])
              for i in range(3):
                  normalised[..., i] = array
              return normalised.astype(np.uint8)

In [274]: video_img = np.concatenate((normalise(Y), normalise(low_rank_part), normalise(sparse_

In [275]: ffmpeg_image_list_to_video('campus_RPCA.mp4', video_img, fps=10)

Creating the video:  [] 100%  Processing frame 500/500Done.

In [279]: import io
          import base64
          from IPython.display import HTML

          def video_to_html(video_filename):
              """Function to embed a video in the web page

              Inspired from:
              http://stackoverflow.com/questions/18019477/how-can-i-play-a-local-video-in-my-i
              """
              ext = video_filename.split('.')[-1]
              video = io.open('campus_RPCA.mp4', 'rb').read()
              encoded = base64.b64encode(video)
              return HTML(data="".format(encoded.decode('ascii'), ext))

In [278]: video_to_html('campus_RPCA_short.mp4')

Out[278]: <IPython.core.display.HTML object>

In [ ]:
```