Advanced Methods – RPCA (Robust Principal Component Analysis)

In this week we will be implementing RPCA, RPCA is an algorithm that was introduced in 2011 and is a better substitute for PCA (Principal Component Analysis). RPCA fills in the gaps left by the normal PCA algorithm.

There are 3 different Images as input we will be working on this week.

The first is the original image of a table, we will be applying different distortions to this image for our experiment.

Fig1. Original Image

After which is the same Image but with a random object in the middle of it.

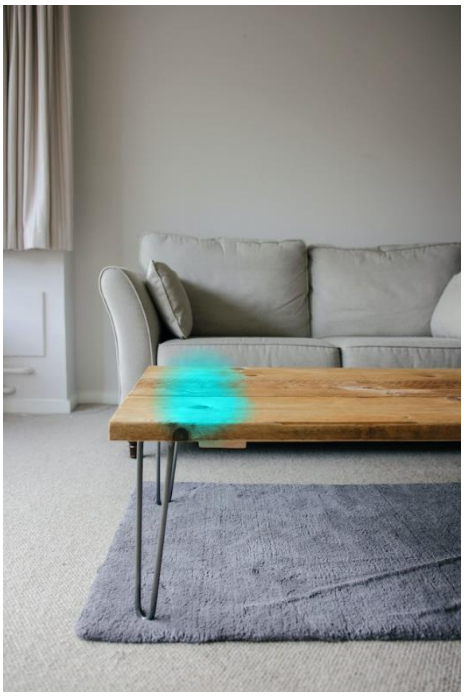

Fig2. Disturbed Image.

We also have an Image with salt & pepper noise applied.

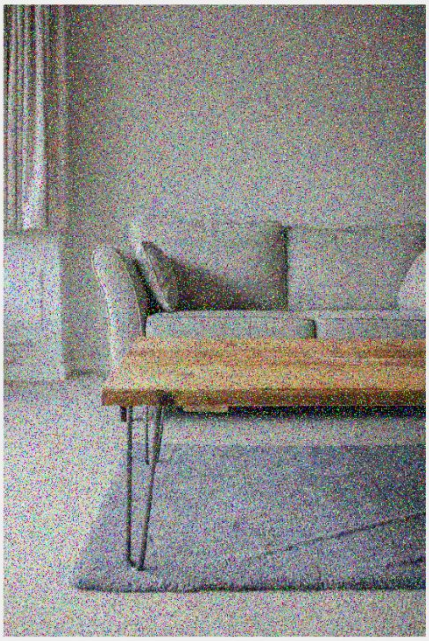

Fig3. Noisy Image.

Methodology: The simple way to understand how RPCA works is that it deconstructs an image into two different sets a Lower-Rank Matrix(L) and a sparse matrix(S).

$$X = L + S$$

$where, X\ is\ the\ original\ Image.$

The detailed algorithm used for this experiment can be found in section 3.7 of the book Data Driven Science & Engineering by Steven Brunton (https://www.databookuw.com/databook.pdf).

For this assignment, we will be working with 2 different scenarios,

The 1st scenario is an Image with a shape on it.

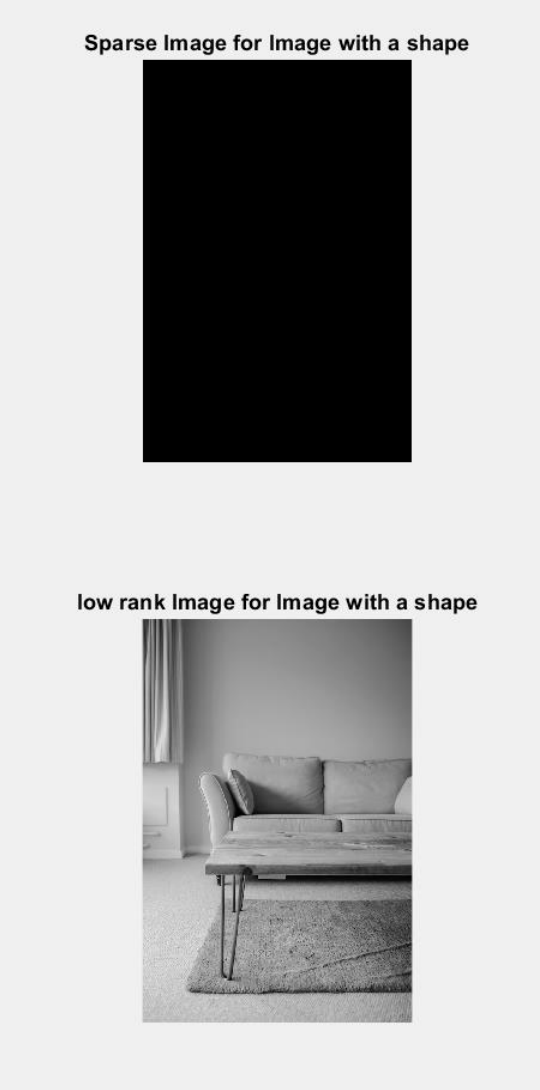

Fig4. Low Rank and Sparse Image for Scenario 1.

In Fig.4 we can see that low-rank Image clearly imitates the original Image, while in sparse Image we can see the faint hint of the shape that was added onto the Image.

In scenario 2 we added salt and pepper noise onto the Original Image, in this case as shown in Fig.5 the RPCA algorithm did its job in separating the noise from the Image showing that this can also be used as a noise reduction technique.

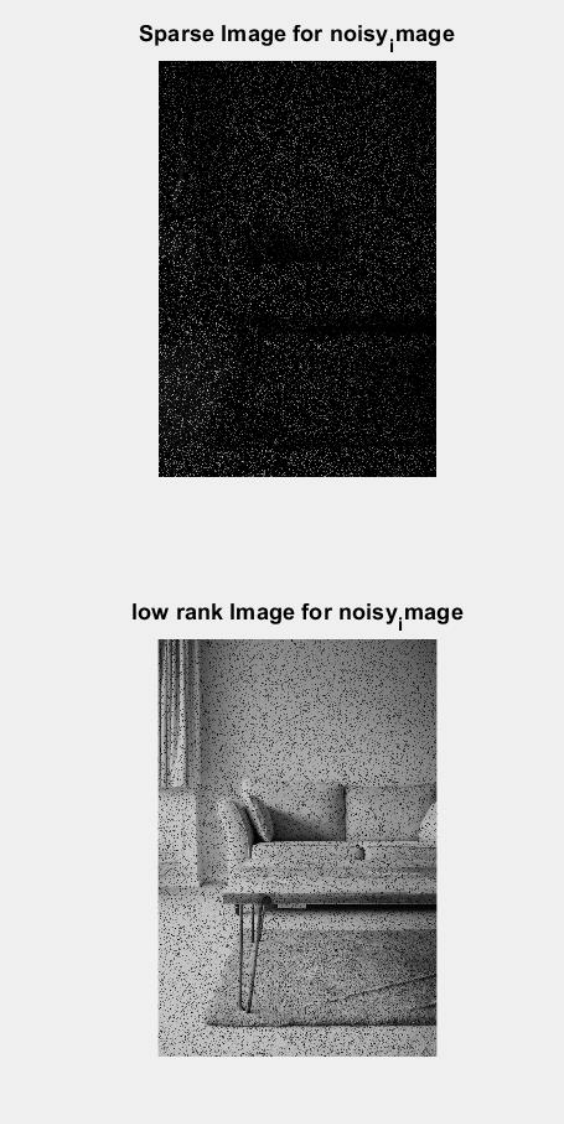

Fig5. Low Rank & Sparse Image for Scenario 2.