Compressed Sensing

a) Create a sparse vector of 512 random sensory values. Plot this vector
b) Create a random measurement matrix to compress the sensory vector in a) to a compressed version consisting of 128 values. Plot this vector.
c) Use the MATLAB function l1eq_pd function to recover the 512 sensory data. Plot the recovered signal and compare to the original one in (a) by computing the correlation factor between the two signals).

Solution:

Compressed sensing is one of the signal processing technique which helps in acquiring the signals from taking few samples. It reconstructed the signal from its compact representation.
For accurate compressed sensing, two conditions need to be fulfilled,

a) The signal must be sparse.
b) Using special matrix which must satisfy 'Restricted Isometry Property'

Working:
suppose , we have signal X (a time domain signal) of length N.
Also, we have sample or vector Y with M no of values .Here, M should be less than N for compression.
Then, we will use sensing matrix A to convert X into Y by using the equation:
$Y = AX$.
Thus, X is $N\times1$ vector representing original signal ; Y is $M\times1$ vector representing compressed values ; and A is $M\times N$ sensing matrix .
These compressed signals can be recovered by compressed sensing removing methods, such as l1-magic which is based upon L1 norm minimization.

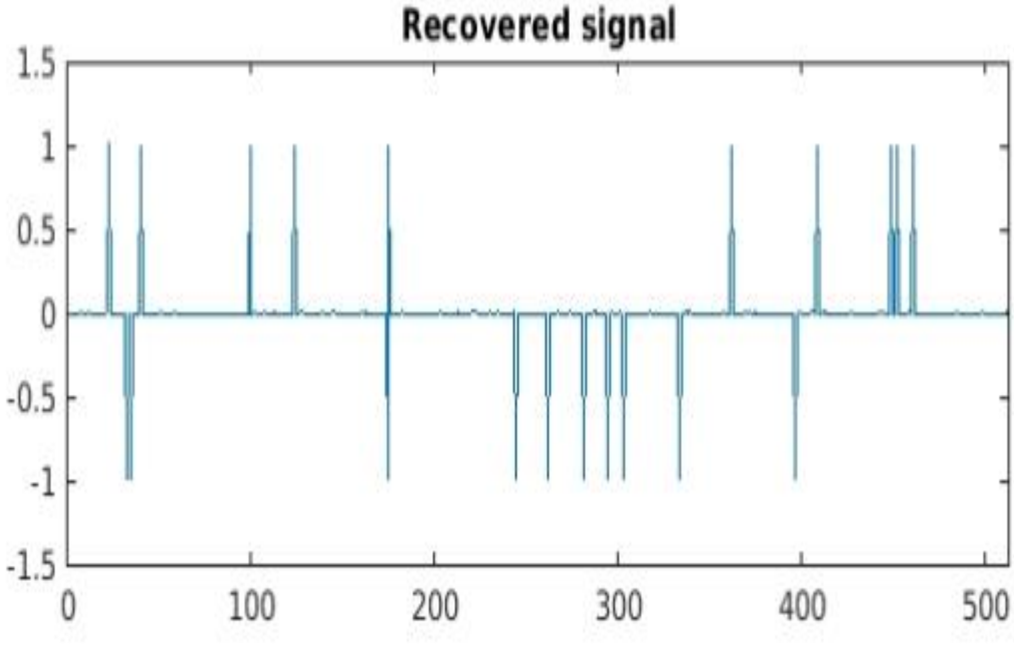
Implementation:
In our implementation,

- Firstly, we will create a sparse vector named X with 512 randomly generated values . Here, 20 non-zero values are designated between -1 and 1. The plot of original signal is as follows:

- Second step is to generate Y or compressed vector with 128 values. Thus, A sensing matrix will be created with rows and N columns. Then , Y = AX equation will be applied which will return compressed values as shown in figure below.

- Now the next step is to recover the signal from the sample compressed signal, by using l1eq_pd function. It will return the below graph with recovered signal representation.

To check the similarity between recovered and original signal , we will compute the correlation factor between recovered and original signal which returned 1 ensuring the 100% accuracy of the reconstructed signal.



Then, we will plot both of the recovered and original signal in one graph to see their overlapping which will further proves that the recovered signal is accurate and same as the original signal.