Week 1 Assignment

Summer of Code
Hands on Reinforcement Learning

Instructions

1.All code fragments need to be written within the TODO blocks in the given Python files (you need to complete q1.py, q2.py and q3.py)

2.Submission file should contain a zip file named week1_rollno and should contain only the three python files to be modified.

3.You are encouraged to learn and explore more about the libraries used by surfing the internet but not for getting the exact solutions.

4.You are also given links to relevant pages to look at in each of the questions.

5.The deadline for this assignment is 2nd May EOD.

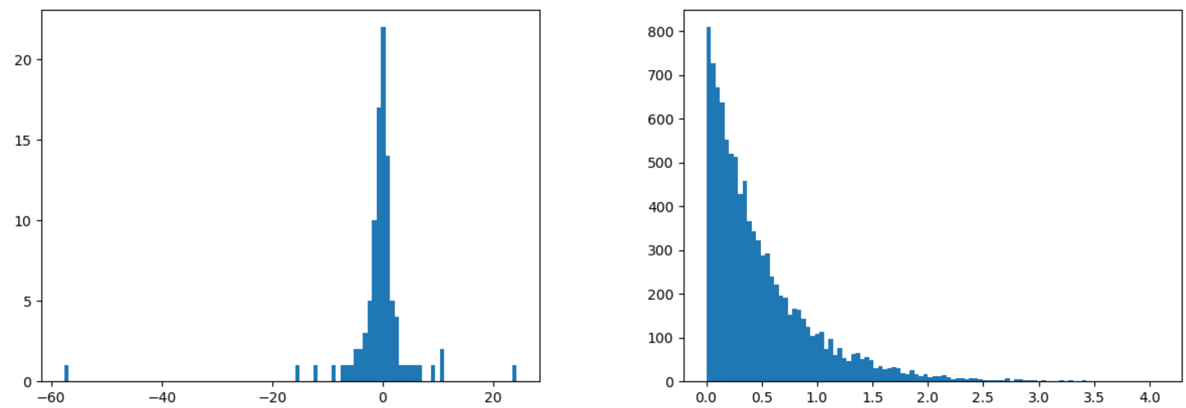
1 Inverse Transform Sampling

Inverse transform sampling provides a way to generate random numbers that follow a specific probability distribution, even if there isn't a direct method available for sampling from that distribution. Go through this page to understand the necessary ideas.

Complete the function `inv_transform`, which generates samples from a given probability distribution using uniform random samples from $[0, 1]$. The arguments to the function are:

- `distribution` - One out of `exponential` or `cauchy`.
- `num_samples` - The number of random samples to be generated from the given distribution.
- `kwargs` - A dictionary containing parameters for the given distribution. Check out `q1_cauchy.json` and `q1_exponential.json` for the exact format of `kwargs`.

The generated random numbers should be **rounded to 4 decimal places**. You also need to create a histogram of the generated samples, which will look as shown in Figure 1.



(a) Cauchy Distribution

(b) Exponential Distribution

Figure 1: Generated Histograms

2 Principal Component Analysis (PCA)

PCA is a popular statistical dimensionality reduction technique in Machine Learning. It uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. Necessary formulas for conversion are given here.

You will be given a text file (`pca_data.csv`). This file contains N lines, each with D comma-separated values. Read the file (using `pandas.read_csv`) and generate an $N \times D$ matrix.

Steps for PCA

1. Standardize the $N \times D$ matrix (**Do not divide by standard deviation**).
2. Calculate the covariance matrix for the D dimensions in the matrix.
3. Calculate the eigenvalues and eigenvectors for the covariance matrix.
4. Sort eigenvalues (in decreasing order) and their corresponding eigenvectors.
5. Pick $K = 2$ ($K < D$) eigenvalues and form a matrix of eigenvectors.
6. Transform the original matrix and store the $N \times K$ transformed matrix in the same directory with the name `transform.csv`.
7. Plot the projected data (using a scatter plot from `matplotlib`) and save the plot to the current directory as `out.png`. While plotting, ensure the x and y axes have the same aspect, and show the values from $[-15, 15]$.

Output

1. Return the sorted eigenvalues (**rounded up to** 4 **decimal places**).
2. Save the transformed matrix in `transform.csv`.
3. Save a scatter plot in `out.png` (example shown in Figure 2).

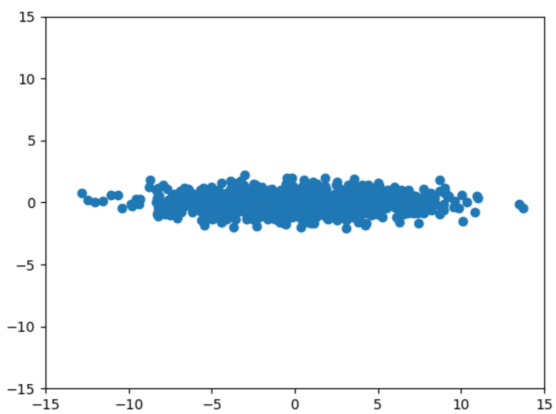


Figure 2: Scatter Plot of Transformed $N \times K$ Matrix

3 Curve Fitting

A magnet slides on a rough non-magnetic metallic inclined plane, which makes an angle with the horizontal. The equation models the displacement of the magnet with time

$$S(t) = v\left[t - \frac{(1 - e^{-kt})}{k}\right]$$

Given experimental data of $S(t)$ of a magnet with time t in file `data.csv`, your task is to find the value of constants v and k by fitting a curve.

t	$S(t)$
0.016	0.001
0.049	0.003
0.070	0.006
0.090	0.010
0.120	0.017
0.174	0.029
0.230	0.046
0.270	0.058
0.320	0.074
0.370	0.091

Table 1: Experimental Data

1. Read the data from `data.csv`.
2. Fit a curve over the given data using `scipy.optimize.curve_fit`.
3. Calculate the values of v and k (rounded up to 4 decimal places).
4. Plot the experimental data and the fitted curve, and save in `fit_curve.png`.

Code your solution in `q1.py`, in the given TODO blocks. An example fitted curve for the data above is shown in Figure 3 (replace the ? mark with the actual value of v and k).

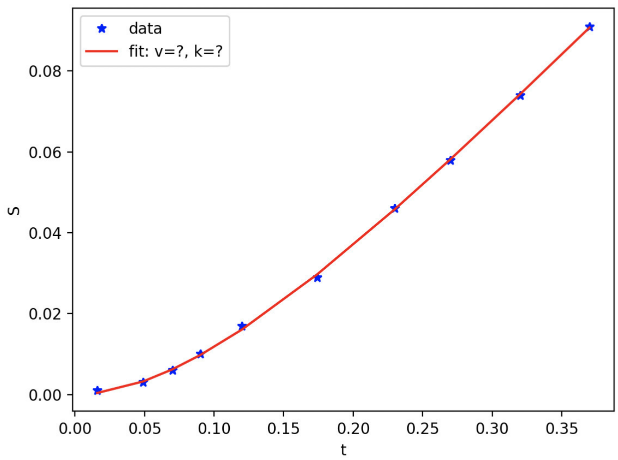


Figure 3: Fitted Curve for the given Experimental Data