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Assignment 1:

1 Question Answering

Q1. **Supervised learning**: It is a machine learning approach in which labeled datasets are used to train a machine learning model.
Some examples are predicting stock prices, classifying emails into spam/non-spam
Unsupervised learning: It is a machine learning approach in which instances from unlabeled datasets are grouped or clustered together during the training process
Some examples are grouping customers based on the market, grouping news articles together based on similarity.

Q2. **Regression**: It is a supervised machine learning problem in which the output to be predicted is a continuous value.
Classification: It is a supervised machine learning problem in which the output to be predicted is a discrete value.

Q3. Three applications of regression:

Application	Problem	Input	Output
Predicting stock prices	Regression	Opening price, Highest price, Closing price, lowest price, volume, etc.	Future Stock Price
Predicting temperature of a region in weather forecast	Regression	Average Temperature,max temperature, Min temperature, Latitude, Longitude, etc	Temperature for the coming 10 days
Predicting future profits	Regression	Expenses, Region, Taxes, Profits	Future profits of a company

Three applications of classification:

Application	Problem	Input	Output
Classifying emails into spam/non-spam	Classification	Email content	Spam or Not spam
Classifying handwritten digits	Classification	Handwritten digits in the form of matrix of pixels active	Digit from 0 to 9
Credit card fraud detection	Classification	Time, amount	Fraud transaction or not

Q4. a = [1, -1, 0], b = [0, 1, 1], a - b = [1, -2, -1]

L1 norm of a: $(|1|^1 + |-1|^1 + |0|^1)^{1/1} = 1 + 1 + 0 = 2$

L1 norm of b: $(|0|^1 + |1|^1 + |1|^1)^{1/1} = 0 + 1 + 1 = 2$

L1 norm of a - b: $(|1|^1 + |-2|^1 + |-1|^1)^{1/1} = 1 + 2 + 1 = 4$

L2 norm of a: $\sqrt{(|1|^2 + |-1|^2 + |0|^2)} = \sqrt{(1+1+0)} = \sqrt{2} = 1.414$

L2 norm of b: $\sqrt{(|0|^2 + |1|^2 + |1|^2)} = \sqrt{(0+1+1)} = \sqrt{2} = 1.414$

L2 norm of a - b: $\sqrt{(|1|^2 + |-2|^2 + |-1|^2)} = \sqrt{(1+4+1)} = \sqrt{6} = 2.449$

2) Programming Questions:

P1. Matrix multiplication and element wise multiplication of matrices A and B

```
Matrix multiplication of A and B:
 [[31 20 17]
 [21  7 12]
 [55 17 26]]

Element wise multiplication of A and B:
 [[ 7 18  6]
 [ 0  4  9]
 [ 6  0 24]]
```

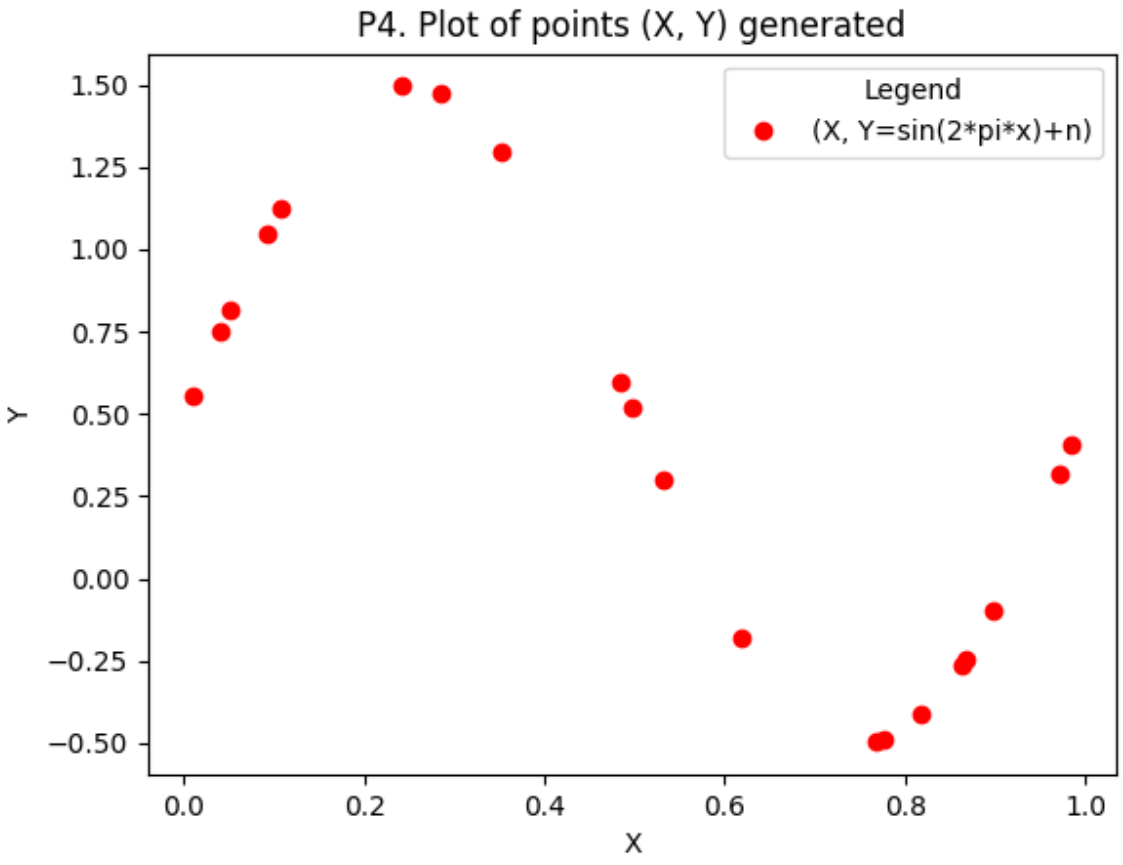
P2. Inverse(A), transpose(A), transpose(A)xA for matrix A:

```
Inverse matrix of A:
 [[ 0.72727273 -1.45454545  0.27272727]
 [ 0.27272727  0.45454545 -0.27272727]
 [-0.09090909  0.18181818  0.09090909]]

transpose matrix of A:
 [[1 0 1]
 [2 1 0]
 [3 3 8]]

Matrix multiplication of transpose(A) and A:
 [[ 2  2 11]
 [ 2  5  9]
 [11  9 82]]
```

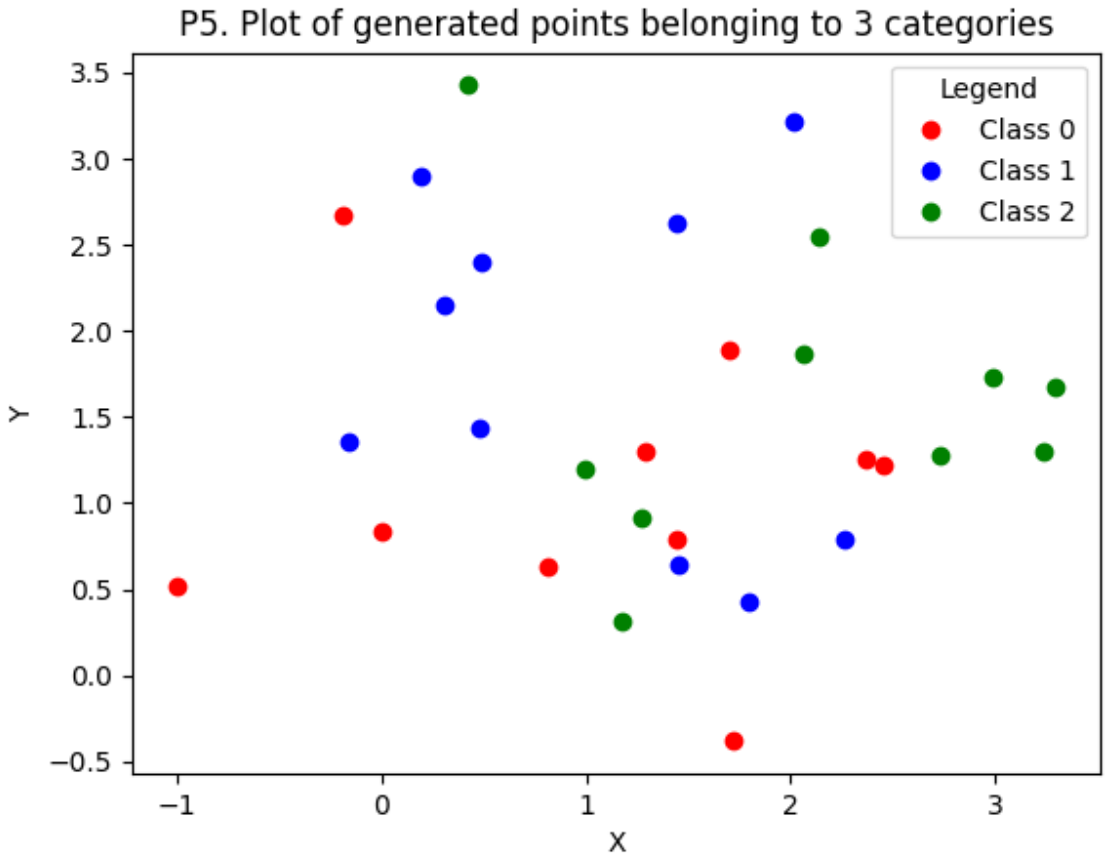
P3. L1 Norm and L2 Norm of a = [1, -1, 0], b = [0, 1, 1], a - b = [1, -2, -1]

```
L1 norm of a: 2.0
L1 norm of b: 2.0
L1 norm of a - b: 4.0

L2 norm of a: 1.4142135623730951
L2 norm of b: 1.4142135623730951
L2 norm of a - b: 2.449489742783178
```

P4.



P5.



3) <u>Optional Programming:</u>

O1.

```
eigenvalues of matrix C: [-1.05597412  2.90428388  8.15169024]

eigenvectors of matrix C:
 [[-0.71456202  0.68333611  0.14984287]
 [ 0.69510799  0.71768302  0.04190418]
 [ 0.07890504 -0.13410011  0.98782142]]

Reconstructed matrix using diag(eigenvalues) and eigenvectors:
 [[ 1.00000000e+00  2.00000000e+00  1.00000000e+00]
 [ 2.00000000e+00  1.00000000e+00 -6.84820097e-16]
 [ 1.00000000e+00 -4.43416417e-16  8.00000000e+00]]
```

Matrix C can be reconstructed using the formula:
matrix(eigenvectors).diag(eigenvalues).Inverse(matrix(eigenvectors))

If the values -6.84820097e-16 and -4.43416417e-16 can be approximated to zero, we get the same matrix as the initial matrix C.

O2.

```
Matrices from singular eigen decomposition of C:
[[-0.14984287 -0.68333611 -0.71456202]
 [-0.04190418 -0.71768302  0.69510799]
 [-0.98782142  0.13410011  0.07890504]]

[8.15169024 2.90428388 1.05597412]

[[-0.14984287 -0.04190418 -0.98782142]
 [-0.68333611 -0.71768302  0.13410011]
 [ 0.71456202 -0.69510799 -0.07890504]]

Reconstructed matrix using U, S, Vh:
 [[1.00000000e+00 2.00000000e+00 1.00000000e+00]
 [2.00000000e+00 1.00000000e+00 1.20456829e-15]
 [1.00000000e+00 1.91924831e-15 8.00000000e+00]]
> 
```