Keneskhanov Madiyar, MSc, Teacher, madiyar.kengeskanov@astanait.edu.kz

Astana IT University, Department of Computational and Data Science, office C1.1.337

Assignment 4 - MLA 7&8 weeks

Lecture 7: Dimensionality reduction techniques in machine learning.

Task 1: PCA (Principal Component Analysis)

Objective: Apply PCA to reduce the dimensionality of a dataset.

1. Load a dataset.
2. Standardize the dataset.
3. Perform Principal Component Analysis (PCA).
4. Analyze PCA loadings.
5. Identify important features for each principal component.
6. Visualize PCA loadings using a heatmap.
7. Create a Scree Plot to visualize explained variance.
8. Plot cumulative explained variance.
9. Explain your results.

Task 2: t-SNE (t-Distributed Stochastic Neighbor Embedding)

Objective: Apply t-SNE for dimensionality reduction and visualization.

1. Load a dataset.
2. Find Kullback-Leibler (KL) divergence and Perplexity.
3. Perform t-SNE.
4. Plot the results and comment on how well t-SNE clusters the data.

Task 3: Compare PCA and t-SNE

Compare the visualizations and variance explained by PCA versus t-SNE clustering.

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Lecture 8: Deep Learning Fundamentals

Task 4: Building a Simple Neural Network

Objective: Implement a simple feedforward neural network to classify a dataset.

1. Load a dataset.
2. Build a neural network with:
    a. An **input layer** matching the shape of the data.
    b. One, two or several **hidden layers** with corresponding number of neurons and the **ReLU activation** function.
    c. An **output layer** with several neurons and the **softmax activation** function.
3. Compile the model using the **cross-entropy loss function** and the **Adam optimizer**.
4. Train the model and evaluate it on the test set.
5. Make predictions.
6. Visualize needed parts.

Task 5: Gradient Descent and Backpropagation

1. Provide a brief explanation of how **gradient descent** minimizes the loss function.
2. Describe the role of **backpropagation** in updating the weights of a neural network.

Task 6: Activation Functions

Objective: Implement different activation functions and compare their effects on model performance.

1. Modify the model from Task 4 to use:
    a. Sigmoid activation in the hidden layer.
    b. Tanh activation in the hidden layer.
2. Compare the performance (accuracy) of the models using ReLU, Sigmoid, and Tanh.

P.S Please be prepared to explain your code/solution/answers.