Experiment No. 10

Aim: Case Study: Applications of above algorithms as a case study (E.g. Hand Writing Recognition using MNIST data set, classification using IRIS data set, etc)

Theory:

1. **Linear Regression:**
    a. **Explanation:** Linear regression is a statistical method to model the relationship between a dependent variable and one or more independent variables by fitting a linear equation to observed data.
    b. **Applications:**
        i. Predicting housing prices based on features like square footage, number of bedrooms, etc.
        ii. Forecasting sales based on advertising expenditure.
2. **Logistic Regression:**
    a. **Explanation:** Logistic regression is a statistical method used for binary classification. It models the probability of a binary outcome based on one or more predictor variables.
    b. **Applications:**
        i. Predicting whether an email is spam or not.
        ii. Medical diagnosis: predicting whether a patient has a particular disease based on symptoms.
3. **Support Vector Machines (SVM):**
    a. **Explanation:** SVM is a supervised machine learning algorithm used for classification and regression tasks. It finds the optimal hyperplane that best separates data points into different classes.
    b. **Applications:**
        i. Image classification: distinguishing between different objects in images.
        ii. Spam detection in emails.
4. **Expectation-Maximization (EM) Algorithm:**
    a. **Explanation:** EM algorithm is used for finding maximum likelihood estimates of parameters in probabilistic models with latent variables. It alternates between performing an expectation step and a maximization step.
    b. **Applications:**
        i. Gaussian Mixture Models (GMM) for clustering data.
        ii. Incomplete data problems such as image segmentation.
5. **McCulloch Pitts Model:**
    a. **Explanation:** McCulloch Pitts model is one of the earliest artificial neural network models. It consists of binary threshold neurons and is capable of performing logical operations.

   b. **Applications:**
      i. Modelling neural networks for basic logical operations like AND, OR, and NOT gates.
      ii. Simple pattern recognition tasks.
6. **Single Layer Perceptron Learning Algorithm:**
   a. **Explanation:** Single-layer perceptron is a type of feedforward neural network that consists of a single layer of output nodes. It is trained using a supervised learning algorithm to perform binary classification.
   b. **Applications:**
      i. Binary classification problems like predicting whether a customer will buy a product or not.
      ii. Predicting the outcome of a sports game based on historical data.
7. **Error Backpropagation Perceptron Training Algorithm:**
   a. **Explanation:** Backpropagation is a supervised learning algorithm used for training neural networks. It adjusts the weights of connections in the network by propagating error gradients backward from the output layer to the input layer.
   b. **Applications:**
      i. Handwritten digit recognition using the MNIST dataset.
      ii. Predicting customer churn in a subscription-based service.
8. **Principal Component Analysis (PCA):**
   a. **Explanation:** PCA is a dimensionality reduction technique that transforms high-dimensional data into a lower-dimensional space while preserving the most important information.
   b. **Applications:**
      i. Dimensionality reduction in image processing tasks.
      ii. Feature extraction in facial recognition systems.

Conclusion:

In this case study, we explored various machine learning algorithms and their applications. From linear regression for predicting housing prices to logistic regression for spam detection, and from support vector machines for image classification to principal component analysis for dimensionality reduction, each algorithm offers unique capabilities suited for different tasks. Additionally, neural network models like the McCulloch Pitts model and the single-layer perceptron learning algorithm provide foundational concepts for understanding more complex deep learning architectures. By leveraging these algorithms and techniques, we can tackle a wide range of real-world problems efficiently and effectively, making significant advancements in fields such as healthcare, finance, and computer vision.