JOINT TECH INTERNSHIP COMMUNITY PROGRAM

Assignment 1

BY

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Problem Description:

- **Input**: 32x32 color images across 10 different classes
- **Output**: A class label is between 0 and 9

Sample Data:

The CIFAR-10 dataset consists of 50,000 training images and 10,000 test images. Each image each image belongs to one of 10 categories: airplane, car, bird, cat, deer, dog, frog, horse, ship, and truck.

Index	Image (32x32 pixels)	Label (Class)
1	Airplane color image	Airplane
2	Automobile color image	Automobile
3	Bird color image	Bird
4	Cat color image	Cat
5	Deer color image	Deer
6	Dog color image	Dog
7	Frog color image	Frog
8	Horse color image	Horse
9	Ship color image	Ship
10	Truck color image	Truck

Key Terminologies and Parameters:

1. **Neural Network**:

   A neural network is a collection of algorithms that seek to uncover underlying linkages in a set of data using a method similar to how the human brain works. It will utilize a Convolutional Neural Network (CNN) for CIFAR-10 because it is efficient at image recognition.

2. **Layer**:

   A layer is made up of many neurons. Input, hidden, and output layers are the different categories for layers.

3. **Input layer** :

   The neural network's initial layer is in charge of receiving input data. CIFAR-10 would have 3072 neurons and 32x32 pixels with three color channels.

4. **Hidden layer** :

   The input and output layer are seperated by intermediate layers.They uncover patterns by applying changes to the input data.

5. **Output layer** :

   The last layer of the neural network that produces output. CIFAR-10 has ten neurons, one for each class.

6. **Neuron :**

   Neurons in deep learning models are nodes through which data and computations flow. They receive one or more input signals. These input signals can come from either the raw data set or from neurons positioned at a previous layer of the neural net.

7. **Convolutional layer :**

   It is a hidden layer that contains several convolution units in a convolutional neural network, which is used for feature extraction. In CIFAR-10 this layer is used to detect edges, textures and shapes.

8. **Convolutional Neural Network (CNN) :**

   It is a type of artificial neural network used primarily for image recognition and processing, due to its ability to recognize patterns in images and CNNs are effective for image classification tasks like CIFAR-10.

9. **Recurrent Neural Network (RNN) :**

   A deep learning model that is trained to process and convert a sequential data input into a specific sequential data output and RNN is not typically used for image data but for tasks like time series analysis and natural language processing.

10. **Activation Function :**

    The Activation function decides whether a neuron should be active or not that means it will decide whether the neuron's input to the network is important or not in the process of prediction using simpler mathemathical operations. Common activation functions include ReLU, Sigmoid, Tanh, and Softmax.

11. **ReLU (Rectified Linear Unit) :**

    It is one type of activation function and it helps the network to learn non-linear patterns. It is commonly used in hidden layers of CNNs for tasks like CIFAR-10.

12. Sigmoid :

It is often used in binary classification problems and this function outputs the values between 0 and 1.

13. Tanh :

Tanh is a hyperbolic tangent functions and it outputs values between -1 and 1. It is used in hidden layers of neural networks.

14. Softmax :

It is used in the last layer of a neural network to predict the class of an input image and used for multi-class classification tasks like CIFAR-10.

15. Forward Propagation :

Forward propagation is the way data moves from left (input layer) to right (output layer) in the neural network. For CIFAR-10, the image data is passed through the convolutional layers, pooling layers, and fully connected layers to get the class probabilities.

16. Backpropagation :

Backpropagation is an algorithm used in artificial intelligence and machine learning to train artificial neural networks through error correction. The computer learns by calculating the loss function, or the difference between the input you provided and the output it produced.

17. Loss Function :

The loss function is a method of evaluating how well your machine learning algorithm models your featured data set. For CIFAR-10, cross-entropy loss is commonly used for multi-class classification.

18. Cost Function :

The cost function is the average and loss over the entire training dataset and it quantifies the overall error of the model.

19. Gradient Descent :

Gradient Descent is an optimization algorithm for finding a local minimum of a differentiable function and it updates the weights in the direction opposite to the gradient of the cost function.

20. Learning Rate :

It determines how far the neural network weights change within the context of optimization while minimizing the loss function.

21. Batch Size :

It represents the number of samples used in one forward and backward pass through the network. For CIFAR-10, a common batch size might be 32 or 64 images.

22. Epoch :

It is a one complete pass through the entire training dataset and it typically involves multiple epochs to allow the model learn from the data iteratively.

23. Overfitting :

Overfitting occurs when the model cannot generalize and fits too closely to the training dataset that means the model performs well on training data but poorly on unseen data.

24. Underfitting :

Underfitting is a scenario in data science where a data model is unable to capture the relationship between the input and output variables accurately, generating a high error rate on both the training set and unseen data.

25. Training Set :

training sets are used to train Machine Learning models to make predictions. It consists of input-output pairs that the model learns from during the training process. For CIFAR-10, this includes 50,000 images and their labels.

26. Validation Set :

The validation sets are used to tune the hyperparameters and validates the model during training ang it helps to monitor the model's performance and prevent overfitting.

27. Test Set :

The test dataset is used to evaluate the final performance of the model. For CIFAR-10, this includes 10,000 images and their label.

28. Cross – Validation :

Cross-validation is a technique for evaluating ML models by training several ML models on subsets of the available input data and evaluating them on the complementary subset of the data.

29. Hyperparameters :

Hyperparameters are settings that control the learning process of the model, such as the learning rate, the number of neurons in a neural network, or the kernel size. They are not learned from the data but chosen based on experimentation and validation.

30. Model Parameters :

This parameters are parameters learned during training and they are optimized during the training process to minimize the loss function.

31. Regularization :

Regularization is a technique used in machine learning and deep learning to prevent overfitting and improve the generalization performance of a model. Common methods include L1/L2 regularization, which add penalties to the loss function based on the magnitude of the weights.

32. Dropout :

Drop out is one of the regularization technique where randomly selected neurons are ignored during training. It prevents the network from becoming too reliant on specific neurons.

33. Weight Initialization :

Weight initialization is a procedure to set the weights of a neural network to small random values that define the starting point for the optimization (learning or training) of the neural network model.

34. Normalization :

Normalization is a data preparation technique that is frequently used in machine learning. The process of transforming the columns in a dataset to the same scale is referred to as normalization. It scales input data to have a mean of zero and a standard deviation of one.

35. Standardization :

Standardization is a data preprocessing technique used in statistics and machine learning to transform the features of dataset so that they have a mean of 0 and a standard deviation of 1 and it is a another term of normalization.