**Lab Module 2 Question: Regularization Techniques in Deep Learning**

**Objective:**  
To explore and implement various regularization techniques to prevent overfitting in a deep learning model.

**Task:**  
You are provided with a dataset for classification. Perform the following steps to design and evaluate a robust deep learning model by implementing regularization techniques:

1. **Baseline Model**:
   * Build and train a baseline model without any regularization.
   * Record training and validation accuracy, loss, and observe overfitting symptoms (if any).
2. **L1 and L2 Regularization**:
   * Modify the baseline model by applying L1 and L2 regularization (individually and together).
   * Experiment with different regularization strengths (e.g., λ = 0.01, 0.1, 0.5) and evaluate their impact on model performance.
3. **Dropout**:
   * Introduce dropout layers into your model architecture.
   * Experiment with different dropout rates (e.g., 0.2, 0.5) and observe how it affects overfitting and model performance.
4. **Early Stopping**:
   * Implement early stopping by monitoring validation loss.
   * Set appropriate patience and minimum delta values. Compare results with and without early stopping.
5. **Data Augmentation**:
   * Apply data augmentation techniques (e.g., flipping, rotation, cropping, brightness/contrast adjustment).
   * Train the model using augmented data and evaluate its impact on performance.
6. **Combined Regularization**:
   * Combine two or more regularization techniques (e.g., L2 + Dropout + Data Augmentation).
   * Compare the results with individual techniques and the baseline model.

**Dataset**

The MNIST dataset is a widely used collection of handwritten digits (0-9) that serves as a benchmark for evaluating image classification algorithms in machine learning, consisting of 60,000 training images and 10,000 testing images, each a 28x28 pixel grayscale image, making it a popular choice for beginners to practice with image recognition models due to its simplicity and readily available format; "MNIST" stands for "Modified National Institute of Standards and Technology" which is the source of the original data.

Key points about MNIST:

* **Data type:** Grayscale images of handwritten digits (0-9)
* **Image size:** 28x28 pixels
* **Split:** 60,000 training images, 10,000 testing images
* **Use case:** Commonly used for testing and training image classification models, especially when starting with machine learning due to its simplicity

https://www.google.com/search?q=regularization+in+deep+learning+analytics+vidhya+shubham+jain&oq=&gs\_lcrp=EgZjaHJvbWUqCQgCECMYJxjqAjIJCAAQIxgnGOoCMgkIARAjGCcY6gIyCQgCECMYJxjqAjIJCAMQIxgnGOoCMgkIBBAjGCcY6gIyCQgFECMYJxjqAjIJCAYQIxgnGOoCMgkIBxAjGCcY6gLSAQkxNTU2ajBqMTWoAgiwAgE&sourceid=chrome&ie=UTF-8