**Project Documentation: CNN-Based Road Signs Classification**

**Dataset details:**

• **Images**: The road sign images that will be classified.
• **Label**: 30 classes or categories of road signs (e.g., speed limit, stop sign).
• **Dataset Split**: Distribution of data for training and testing.

**Step-by-Step Instructions:**

**Step 1: Data Collection and Preprocessing**

1. **Collecting the Dataset**
    - Download road signs dataset.
    - Labels are given in the excel sheet.
2. **Data Preprocessing**
    - **Resizing Images**: Resize the images to a consistent shape
    - **Normalization**: Normalize pixel values to be between 0 and 1 by dividing by 255.
    - **Label Encoding**: Encode labels as integers or one-hot vectors for classification.
3. **Data Augmentation**
    - Apply data augmentation techniques such as rotation, scaling, flipping, and cropping to increase the dataset's diversity and robustness.

**Step 2: Build the Convolutional Neural Network (CNN)**

1. **CNN Architecture Design**
    - **Input Layer**: Define the input shape based on the image dimensions (e.g., 64x64x3 for RGB images).
    - **Convolutional Layers**: Add several convolutional layers to extract features from the images.
    - **Pooling Layers**: Implement max-pooling layers to downsample the feature maps.

- **Fully Connected Layers**: Add dense layers at the end to classify the image based on extracted features.
- **Activation Functions**: Use ReLU for hidden layers and softmax for the output layer (for multi-class classification).

2. **Compilation of the Model**
   - Choose an optimizer (e.g., Adam, SGD), loss function (e.g., categorical cross-entropy), and evaluation metrics (e.g., accuracy).

**Step 3: Training the Model**

1. **Splitting the Data**
   - Split the data into training, validation, and test sets (e.g., 70% training, 15% validation, 15% testing).
2. **Model Training**
   - Train the CNN on the training dataset while monitoring performance on the validation set.
   - Use techniques like early stopping and checkpoints to avoid overfitting and ensure the model's generalization.

**Step 4: Model Evaluation and Testing**

1. **Evaluating Model Performance**
   - Evaluate the trained model on the test set using metrics like accuracy, precision, recall, and F1-score.
   - Visualize confusion matrices to show the performance across different road sign classes.
2. **Testing the Model with New Images**
   - Test the model on new, unseen images to verify its real-world performance.
   - Output predictions and compare them with actual labels.

**Step 5: Hyperparameter Tuning and Model Optimization**

1. **Grid Search / Random Search**

- Implement hyperparameter tuning to optimize learning rate, number of filters, kernel size, etc.

2. **Model Optimization**
    - Experiment with different architectures (e.g., adding more layers, changing the number of neurons in fully connected layers).
    - Apply regularization techniques (e.g., dropout) to improve model performance.

**Step 6: Create an UI for the trained model using Streamlit**

- Provide information on accuracy and class predictions for new test data.

**Final Deliverables**

1. **Trained Model**
    - The trained CNN model saved in a compatible format for future use.
2. **Performance Metrics**
    - Provide detailed performance metrics, including accuracy, precision, recall, F1-score, and confusion matrix.
3. **Visualizations**
    - Include graphs showing training and validation accuracy/loss, confusion matrices, and model performance per class.
4. **Documentation**
    - A complete written summary detailing the project objective, dataset description, model architecture, results, and insights.
5. **Presentation**
    - A slide deck (10 slides) summarizing the methodology, results, and key findings from the project.

**Evaluation Rubric for CNN-Based Road Sign Classification Project:**

| Evaluation Criteria | Marks |
|---|---|
| Data Preprocessing & Augmentation | 10 |
| Model Architecture Design | 15 |
| Model Training & Hyperparameter Tuning | 20 |
| Model Evaluation & Results | 15 |
| Visualization and Reporting | 10 |
| Documentation | 10 |
| Presentation | 20 |
| **Total Marks** | **100** |