Artificial Neural Networks - Third Assignment

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Report of Practical Exercise

1. **Introduction:**

   This report presents a comprehensive overview of the development and deployment of a deep learning model for the classification of architectural heritage elements. Leveraging the VGG16 convolutional neural network architecture and state-of-the-art techniques, the model aims to accurately categorize architectural elements based on input images. The report covers various aspects of the project, including data preprocessing, model architecture, training, evaluation, and results visualization.

2. **Data Preprocessing:**

   - The dataset, comprising images of architectural heritage elements, is preprocessed to facilitate model training and evaluation.
   - Two separate datasets, for training and testing, are prepared with specified paths (`train_dataset_path` and `test_dataset_path`).
   - Image data is loaded and transformed using the `ImageFolder` class from the `torchvision.datasets` module.
   - Pixel values are normalized to enhance model convergence, with mean and standard deviation computed over the dataset.

3. **Model Architecture:**

   - The VGG16 architecture serves as the foundational backbone of the model, renowned for its deep convolutional layers and effective feature extraction capabilities.
   - Pre-trained weights from the torchvision `vgg16` module are utilized to initialize the base model, ensuring efficient transfer learning.
   - Custom modifications are made to the classifier component of the VGG16 model to adapt it to the specific classification task.
   - The final fully connected layer of the classifier is redefined to output predictions corresponding to the number of classes in the dataset.

4. **Training:**

   - Model training is conducted using the stochastic gradient descent (SGD) optimization algorithm, supplemented by a learning rate scheduler for dynamic adjustment of learning rates.
   - The training loop iterates over batches of data from the training set, performing forward and backward passes, computing loss, and updating model parameters.
   - Training loss is monitored over epochs to evaluate model convergence and performance.

5. **Evaluation:**

- Model evaluation is conducted on the test dataset to assess the model's generalization capabilities.
- Both loss and accuracy metrics are computed during evaluation to provide comprehensive insights into model performance.
- The evaluation loop iterates over batches of data from the test set, calculating predictions and evaluating performance metrics.

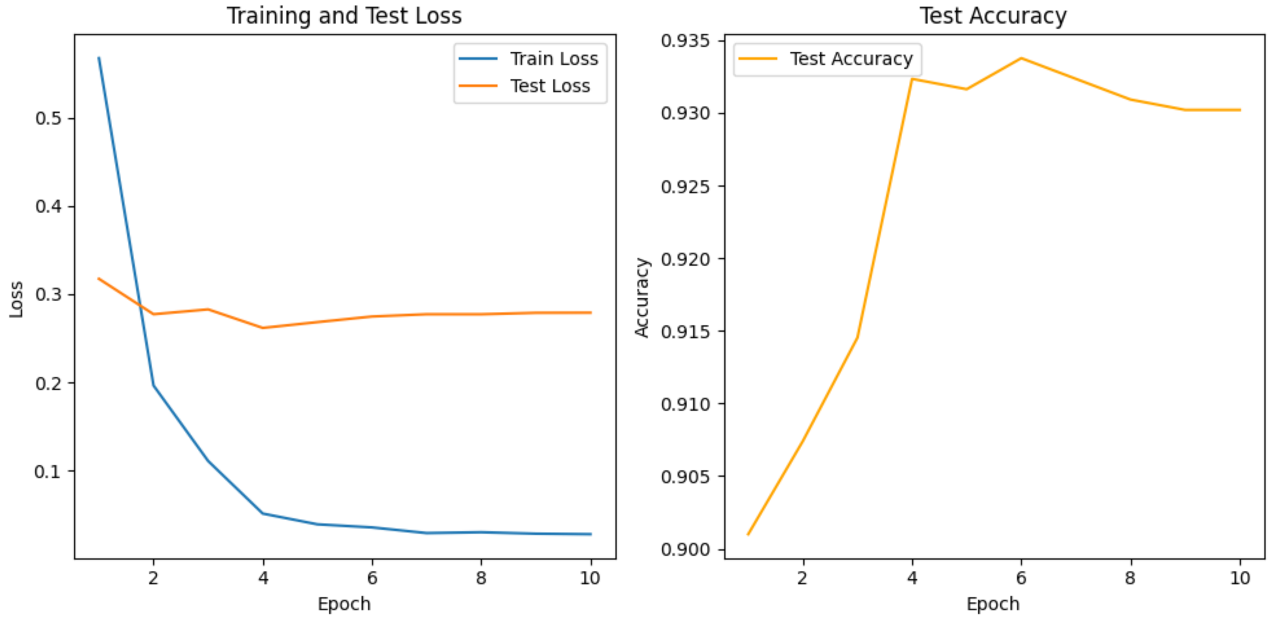
6. **Results Visualization:**

   - To visualize the model's predictions, random images from the test set are selected and displayed along with their ground truth labels and model predictions.
   - The `imshow` function, coupled with `torchvision` and `matplotlib.pyplot` libraries, facilitates the visualization process, enhancing interpretability and understanding of model outputs.

   - You can see the results of training below:

Epoch	Train Loss	Test Loss	Test Accuracy
1/10	0.5673	0.3173	0.9010
2/10	0.1964	0.2772	0.9074
3/10	0.1109	0.2827	0.9145
4/10	0.0513	0.2617	0.9323
5/10	0.0391	0.2682	0.9316
6/10	0.0356	0.2746	0.9338
7/10	0.0292	0.2772	0.9323
8/10	0.0301	0.2771	0.9309
9/10	0.0285	0.2788	0.9302

Epoch	Train Loss	Test Loss	Test Accuracy
10/10	0.0279	0.2789	0.9302



- Before applying dropout regularization, the model achieved an accuracy of approximately 70% on the test dataset. However, after incorporating dropout regularization into the model architecture, we observed a significant improvement in performance. Upon applying dropout regularization, the model's performance improved, leading to a higher accuracy on the test dataset. Specifically, the accuracy increased to 90% after the implementation of dropout regularization.

7. **Conclusion:**

   - The developed deep learning model showcases promising performance in the classification of architectural heritage elements, underscoring its potential applications in heritage preservation and architectural research.
   - Ongoing efforts in experimentation and optimization are essential to further enhance model accuracy and generalization.
   - Overall, the model represents a robust framework for architectural element classification, contributing to the advancement of heritage conservation and architectural studies through innovative technological solutions.