Skin Lesion Classification Using Convolutional Neural Networks (CNNs)

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Objective

Problem Being Addressed:
Skin cancer is one of the most common types of cancer worldwide, with millions of new cases diagnosed each year. Among these, melanoma, a severe form of skin cancer, is particularly dangerous if not detected early. Current diagnostic methods, such as dermoscopy, improve accuracy but are still subject to human error and variability. This project aims to develop a deep learning model to classify skin lesions accurately into one of the seven diagnostic categories provided in the HAM10000 dataset. By leveraging the power of CNNs, the project seeks to enhance early detection and diagnostic precision, ultimately improving patient outcomes.

Current State-of-Art:
Recent advancements in deep learning, especially CNNs, have significantly improved image classification tasks across various domains, including medical imaging. State-of-the-art models like ResNet, DenseNet, and Inception have demonstrated high accuracy in skin lesion classification tasks. These models utilize large annotated datasets and employ techniques such as transfer learning and data augmentation to improve performance. Despite these advancements, challenges remain in achieving high diagnostic accuracy and generalizability across diverse patient populations.

Approach

Initial Rough Idea:
The project will follow a structured approach involving several stages:

- **Data Preprocessing:**
  - **Resizing and Normalizing:** All images from the HAM10000 dataset will be resized to a uniform size suitable for CNN input, typically 224x224 pixels, and normalized to standardize pixel values.
  - **Data Augmentation:** Techniques such as rotation, flipping, and scaling will be used to artificially expand the dataset, reducing overfitting and improving model generalization.
- **Model Selection and Development:**
  - **Architecture Design:** A suitable CNN architecture, such as ResNet or VGG, will be chosen. A custom architecture may also be developed based on the specific characteristics of the dataset.
  - **Transfer Learning:** Pre-trained models will be fine-tuned on the HAM10000 dataset to leverage existing knowledge and improve performance.
  - **Training:** The model will be trained using the augmented dataset, with hyperparameter tuning to optimize performance.
- **Evaluation:**
  - **Performance Metrics:** The model's performance will be evaluated using metrics such as accuracy, precision, recall, and F1-score.
  - **Validation:** Cross-validation techniques will be employed to ensure the model's robustness and generalizability.
- **Interpretability:**
  - **Visualization:** Techniques like Grad-CAM will be used to visualize the areas of images that the model focuses on, enhancing interpretability and trust in the model's decisions.

Dataset to be Used:
The HAM10000 dataset, which includes 10,015 dermatoscopic images of pigmented lesions categorized into seven diagnostic groups, will be utilized. This dataset is publicly available and unrestricted, making it suitable for this project's requirements. The dataset's diversity and the detailed annotations make it an excellent resource for training and evaluating deep learning models for skin lesion classification [**?**, **?**, **?**].

Progress Timeline

- **Week 1-2:** Literature review on CNN architectures and skin lesion classification techniques.
- **Week 3:** Dataset acquisition and preprocessing.
- **Week 4-5:** Initial model development and baseline training.
- **Week 6:** Implementation of data augmentation and transfer learning.

- **Week 7:** Hyperparameter tuning and model optimization.
- **Week 8:** Model evaluation and comparison with existing methods.
- **Week 9:** Finalizing results and preparing the final report.
- **Week 10:** Submission of deliverables and final presentation.

Deliverables

- **Results:** Detailed performance metrics including accuracy, precision, recall, and F1-score.
- **Code:** Well-documented codebase for dataset preprocessing, model training, and evaluation.
- **Final Paper:** A comprehensive report summarizing the project objectives, methodology, results, and conclusions.

Conclusion

This project aims to advance the field of medical image analysis by developing a robust and accurate CNN-based model for skin lesion classification. Utilizing the HAM10000 dataset ensures adherence to project guidelines while providing a comprehensive and diverse set of images for training and evaluation. The structured approach outlined in this proposal guarantees a thorough and systematic exploration of CNN-based skin lesion classification.

Citations

1. Tschandl, P. et al., "The HAM10000 dataset, a large collection of multi-source dermatoscopic images of common pigmented skin lesions," Harvard Dataverse, 2018. Available: `https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/DBW86T`.
2. Papers With Code, "HAM10000 Dataset," Available: `https://paperswithcode.com/dataset/ham10000`.
3. Activeloop, "HAM10000 Dataset," Available: `https://datasets.activeloop.ai/dataset/ham10000`.