Early Detection of Plant Diseases Using Imaging Data

DSCI 6011-02: Deep Learning Term Project

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Project Objectives

- Designing a deep learning model to detect diseases at an early stage in medical images.
- Improving diagnostic accuracy and speed through automated deep learning-based analysis.
- Evaluating the model's performance in terms of sensitivity, specificity, and other relevant metrics.

Statement of Value

- Early disease detection using deep learning holds immense value in the realm of healthcare. By harnessing the power of advanced algorithms and deep learning techniques, our project aims to detect diseases at their nascent stages, enabling timely interventions and tailored treatment plans. This proactive approach not only improves patient outcomes, leading to higher survival rates and better quality of life, but also reduces the economic burden on healthcare systems by minimizing the need for extensive treatments for advanced-stage diseases.

- Automating disease detection tasks through deep learning models empowers healthcare professionals to make accurate diagnoses swiftly, enhancing clinical decision-making and patient care. This translates to improved resource allocation within healthcare systems, optimized utilization of healthcare facilities, and ultimately, a more efficient and effective healthcare ecosystem benefiting both patients and healthcare providers alike.

State of the Art

- Puttagunta and Ravi [1] in their project they utilized convolutional neural networks (CNNs) and transfer learning with models like VGG19 to detect Alzheimer's disease (AD) early and classify its stages using medical image data. Two methods were employed: one involving simple CNN architectures trained on 2D and 3D brain scans from the ADNI dataset, and the other utilizing transfer learning with the VGG19 model. The CNN architectures achieved promising accuracy rates of 93.61% and 95.17% for multi-class AD stage classifications in 2D and 3D respectively. Additionally, the fine-tuned VGG19 model achieved an impressive accuracy of 97% for multi-class AD stage classifications. These results demonstrate the effectiveness of deep learning methods in early AD detection and classification, paving the way for improved remote monitoring and patient care.

State of the Art

- Helaly and Badawy and Haikal, [2] conducted a comprehensive analysis of Deep Learning Approach (DLA)techniques applied to X-ray images, computerized tomography scans, mammography images, and digital histopathology images. It highlighted the effectiveness of DLA in classifying, detecting, and segmenting medical images, showcasing promising results in disease identification and evaluation. The systematic review of DLA implementations provided valuable insights for researchers, guiding them in making informed decisions and enhancing medical image analysis techniques for improved clinical outcomes.
- Kim et al, [3] deep neural networks, evolved from artificial neural networks (ANNs), have revolutionized medical imaging with their superior performance. Initially, ANNs struggled with overfitting and gradient vanishing due to limited computing power and data. However, advancements like graphics processing units (GPUs) and abundant data have propelled deep neural networks to outperform humans and traditional machine learning in tasks like computer vision and speech recognition.

Approach

- **Dataset:** Utilizing the publicly available Plant Disease Detection dataset from GitHub - Plant Disease Detection for training and testing the deep learning model for early disease detection in medical imaging data.
- **Model Architecture:** Designing a convolutional neural network (CNN) or a similar deep learning architecture suitable for medical image classification. The architecture will be customized to handle the specific characteristics of plant disease images.
- **Training Procedure:** Implementing data preprocessing techniques such as image normalization, resizing, and augmentation to enhance model generalization. Utilizing model training and optimization techniques to fine-tune the CNN for optimal performance in disease detection.
- **Tools and Technologies:** Utilizing Python as the programming language along with TensorFlow and Keras deep learning frameworks. Additionally, leveraging other relevant libraries and tools for data handling, visualization, and model evaluation to ensure robustness and accuracy in disease detection.

Deliverables

1. Trained deep learning model for early disease detection in medical images: The main output of the project will be a robust and accurate deep learning model capable of detecting diseases at an early stage in medical imaging data, contributing to improved patient outcomes and healthcare efficiency.

2. Evaluation results including sensitivity, accuracy, ROC curve analysis, and confusion matrix: These metrics, including sensitivity and specificity, are crucial for assessing the model's ability to correctly identify diseased and non-diseased cases, ensuring its clinical utility and reliability.

3. Codebase with documented model architecture, training scripts, and deployment guidelines for reproducibility: The project will provide a well-documented codebase containing the deep learning model architecture, training scripts, and guidelines for model deployment. This documentation ensures reproducibility and allows for further enhancements or adaptations of the model by researchers and practitioners in the healthcare domain.

Evaluation Methodology

- Metrics: Sensitivity, specificity, accuracy with Target accuracy of 90%, precision, recall, F1 score, area under the ROC curve (AUC-ROC) with Target AUC-ROC of 0.9

- Validation Techniques: The model will undergo rigorous validation to ensure its generalization and reliability. Validation techniques will include Cross-validation: Dividing the dataset into multiple subsets for training and validation, ensuring robustness across different data partitions.

- Comparison: The model's performance will be benchmarked against existing deep learning models or state-of-the-art methods in medical image analysis. This comparison will provide insights into the model's effectiveness, highlighting its strengths and potential areas for improvement compared to established benchmarks.

Cited Work

1. M. Puttagunta and S. Ravi, "Medical image analysis based on deep learning approach," *Multimedia Tools and Applications*, vol. 80, pp. 24365–24398, Apr. 2021.

2. H. A. Helaly, M. Badawy, and A. Y. Haikal, "Deep Learning Approach for Early Detection of Alzheimer's Disease," *Cognitive Computation*, vol. 14, pp. 1711–1727, Nov. 2021.

3. M. Kim et al., "Deep Learning in Medical Imaging," *Neurospine*, vol. 16, no. 4, pp. 657–668, Dec. 2019.

THANK YOU