**Paper 1:**

**Classification of Different Plant Species Using Deep Learning and Machine Learning Algorithms**

Deep learning has emerged as a transformative approach for automating the classification of medicinal plant species. This study evaluates the performance of a custom Convolutional Neural Network (CNN) compared to both traditional machine learning models and established deep learning architectures. The dataset includes images of six medicinal plants: Ashwagandha, Black Pepper, Garlic, Ginger, Basil, and Turmeric. Image augmentation techniques such as rotation, flipping, cropping, and brightness adjustment were employed to address the limitations of a small dataset.

The proposed CNN model achieved a remarkable accuracy of 99% (controlled environment), outperforming traditional machine learning techniques like Random Forest (95.3%), Support Vector Machine, and Gaussian Naïve Bayes. Among existing deep learning models, the proposed CNN surpassed benchmarks like AlexNet, VGG-19, and DenseNet in classification performance. The model utilizes the SoftMax activation function and dropout layers to mitigate overfitting while maintaining robustness during training and testing.

Cross-validation, with 75% of data for training and 25% for testing, confirmed the reliability of the model. The use of confusion matrices highlighted classification precision, with Garlic (93% accuracy) being the least accurately classified species. Overall, the study demonstrates the superiority of CNNs in feature extraction and classification over machine learning models, with enhancements like dropout layers and fine-tuned hyperparameters.

Future work will focus on extending the dataset and incorporating IoT devices for automated image acquisition. This research reinforces CNN's capability to provide a rapid and reliable solution for medicinal plant classification, addressing critical challenges in agriculture, medicine, and biodiversity conservation.

**Paper 2:**

**Deep neural network for multi-class classification of medicinal plant leaves.**

The accurate and timely detection of plant diseases is vital to mitigating economic losses in agriculture. Recent studies emphasize the effectiveness of deep learning techniques in automating plant disease detection, leveraging robust image datasets for classification tasks. For instance, a study utilized a dataset comprising images of leaves from 12 distinct crops across 22 categories, achieving an impressive average test accuracy of 97.69% through deep learning models like DenseNet201 combined with AdamW optimizer. This approach highlights the utility of five-fold cross-validation and advanced statistical analysis for robust model performance.

Image preprocessing techniques, such as flipping, rotating, and adjusting brightness or contrast, enhance the quality of input data, aiding model generalization. ResNet, a popular architecture, addresses vanishing gradient issues through skip connections, enabling efficient gradient propagation and yielding high accuracy in classification tasks. Similarly, AlexNet and VGG-19 have demonstrated significant potential in image-based plant disease diagnosis.

Machine learning classifiers like SVM, Random Forest, and Naive Bayes have also been explored for feature extraction and disease classification, achieving notable accuracies but requiring extensive feature engineering expertise. Furthermore, medicinal plant datasets, like the one used in this study, hold value due to their environmental, medicinal, and economic importance.

In conclusion, the integration of advanced neural networks and optimized hyperparameters offers a reliable framework for plant disease diagnosis, paving the way for more efficient, automated agricultural practices.

**Paper 3:**

**Identification and classification of medicinal plants using leaf with deep convolutional neural networks.**

The accurate classification of medicinal plant leaves plays a crucial role in various fields, including healthcare and agriculture. Numerous studies have demonstrated the effectiveness of deep learning and machine learning techniques for plant classification using leaf images. The Xception model, known for its depthwise separable convolutions, achieved a remarkable 97.65% accuracy in classifying 45 distinct medicinal plant leaves. Similarly, AousethNet, a modified version of AlexNet, delivered an impressive 98.61% accuracy, showcasing the potential of hybrid neural networks.

Preprocessing techniques such as region-based thresholding, Histogram of Oriented Gradients (HOG), and Local Binary Patterns (LBP) have been widely used for feature selection, enabling traditional classifiers like SVM to achieve up to 99% accuracy. Other studies utilized geometrical and textural features to classify leaves from diverse datasets, including 125 herb species. Techniques like Sobel segmentation were instrumental in extracting features with high precision.

Machine learning models, such as Random Forest, Bagging, and K-Nearest Neighbors (KNN), have also been extensively evaluated for leaf classification. Advanced classifiers like VGG16 and AlexNet demonstrated superior accuracy in recognizing leaf diseases, with VGG16 achieving 89.5% accuracy in citrus plant disease identification.

Transfer learning has been another focus, where pre-trained CNNs were fine-tuned for new datasets. This approach significantly reduces training time while achieving high accuracy. Studies highlight the potential of customized deep learning architectures for improved performance, emphasizing the importance of dataset quality and model optimization in medicinal plant classification.

**Paper 4:**

**Identification of Medicinal Plants using Deep Learning**

This literature review discusses the recent strides in automated medicinal plant identification with deep learning, concentrating on DenseNet architectures. Deep learning as a whole and specifically CNN-based architectures such as DenseNet121, revolutionized image classification through the ability to extract features efficiently.

The importance of some preprocessing techniques was stressed in the study though (e.g., imagery of both leaf surfaces may improve classification ability). We also used an activation function such as ReLU for hidden layers and Softmax for outputs which helps the model learn better. It contains available images of 50 medicinal plant species, ensuring strong generalization.

The performance metrics indicate a training accuracy of 91.6% at its best, signifying the model's proficiency. But there are still challenges in detecting sick leaves as well as the datasets. To ensure sustainable progress in the field of automated medicinal plant identification systems, we recommend future research on transfer learning and evaluation against more diverse datasets reducing the potential for overfitting for the models.

**Paper 5**

**Medicinal Plant Classification Using Particle Swarm Optimized Cascaded Network**

This study proposes a fusion of high-performance medicinal plant classification models based on ResNet50 with particle swarm optimization (PSO) and support vector machine (SVM) which is used for identification of medicinal plants in a precise and efficient way. Verification for ensuring data accuracy is done by ethnobotanists on a custom dataset of 6,427 images covering seven medicinal plants. The model starts with feature extraction using ResNet50, performs feature selection with PSO to minimize computational load, and completes classification with SVM.

For instance, preprocessing consists of resizing images and filtering based on quality metrics such as sharpness and brightness, which increases robustness across devices. With ReLU as the activation function in ResNet50, the cascaded structure reduces training efforts, which is efficient and can be implemented on low-power devices. It has a 99.60% classification accuracy rate of TEST data, where it takes an average of 0.15 seconds/classification/image, and has an average CV accuracy score of 98.39%.

We show that our cascaded approach achieves state of the art performance for the task, offering a fast and practical solution for medicinal plant identification to be used in the field with potentially high implications for low resource regions.

**Paper 6:**

**Automated Real-Time Identification of Medicinal Plants Species in Natural Environment Using Deep Learning Models—A Case Study from Borneo Region**

In their study, Malik, Ismail, Hussein, and Yahya provide real-time medicinal plant identification using an EfficientNet-B1 deep learning model for Borneo native plant species. Preprocessing procedures like Auto Augment and image resizing were used by the team to increase classification accuracy. The trained models use class weighting and focal loss to deal with dataset imbalance. Using (ImageNet-pretrained) EfficientNet-B1 with transfer learning, the model was fine-tuned on the Plant CLEF 2015 with over 23,000 images of 1,000 species and the UBD Botanical Garden dataset containing 2,097 images from 106 species empirically)

EfficientNet-B1 has 1.95 million parameters post-quantization; therefore, it was well suited for mobile deployment. Top-1 accuracies of 87% on private data and 84% on public data and real-time top-1 accuracy of 78.5% and-top 5 accuracy of 82.6% after mobile testing. The mobile app includes a feedback feature for 1st and 2nd enhancement of the model from user input. In addition to serving as a convenient resource for identifying plant species, this system has the potential to aid biodiversity conservation and can potentially be implemented as a scalable solution for monitoring of species across different environments.

**Paper 7:**

**CNN‑based medicinal plant identification and classification using optimized SVM**

Arindam Chaudhuri in this study proposes a nature inspired approach to medicinal plant classification by integrating a custom ResNet50 architecture with Progressive Transfer Learning (PTL) and Optimized Support Vector Machine (OSVM) to build an integrated sage of contextual knowledge of medicinal plant classification in a structured way. ResNet50 is used as feature extraction for the model, and OSVM as a classifier, tuned via the Adam optimizer. The images from Indian Medicinal Plants Database (IMPLAD) undergo preprocessing to perform segmentation, background replacement, and resizing, along with data augmentation to make sure that we have quality balanced input data.

We have used ReLU activation functions, Cross-Entropy Loss with Adam optimization, and batch normalization in the hidden layers to stabilize the training process and achieve higher classification accuracy. We freeze first few layers and few pooling layers during early training to reduce the number of parameters to be trained and thus maintain the efficiency

The results of testing are with a classification accuracy of 96.8% and outperforms the baseline models which are VGG16 and standard ResNet50. With this, 58.4% of testing errors are reduced, proving the strong applicability of the model for rapid and accurate identification of medicinal plants. Such improved architecture can be applied to field testing for live identification of medicinal plants.