Computer Vision / DL Engineer Assignment Report

For the Computer Vision/DL Engineer Assignment, two experiments were executed. In the initial trial, a CNN model was established from the ground up, while the second experiment used a transfer learning approach.

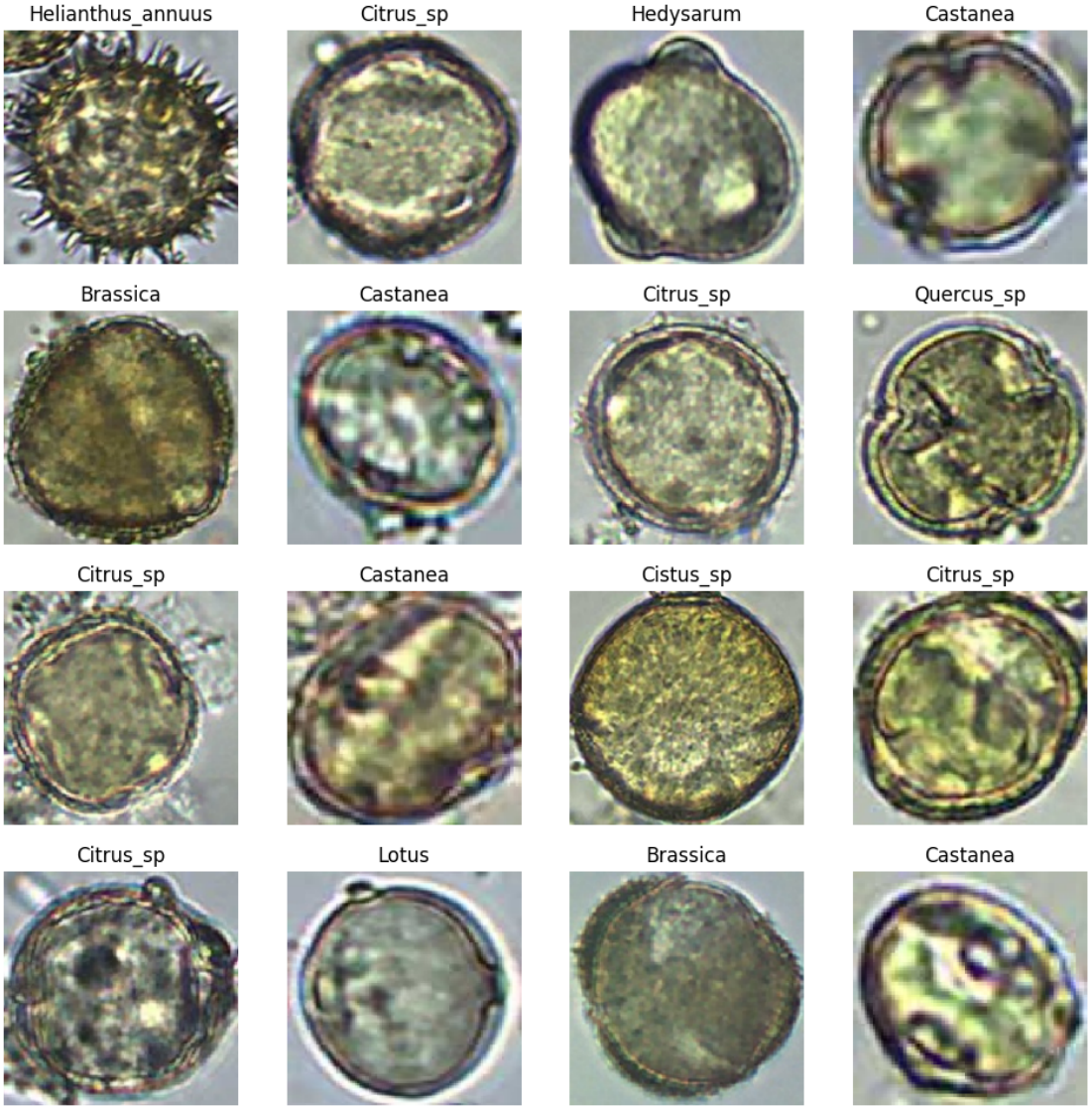

Figure 1. Dataset example.

The dataset was divided, allocating 80% for training and 20% for validation (training images: 2046, validation images: 512). The images in the training, validation, and test sets underwent resizing to 224 x 224 and normalization. Figure 1. shows an example of the images present in the dataset. The distribution of the images for each class is in Figure 2. The models are evaluated based on accuracy, precision, recall, and AUC metrics. For analyzing the experimental results, the confusion matrix is employed, offering insights into four outcomes: TP (True Positive), TN (True Negative), FP (False Positive), and FN (False Negative).

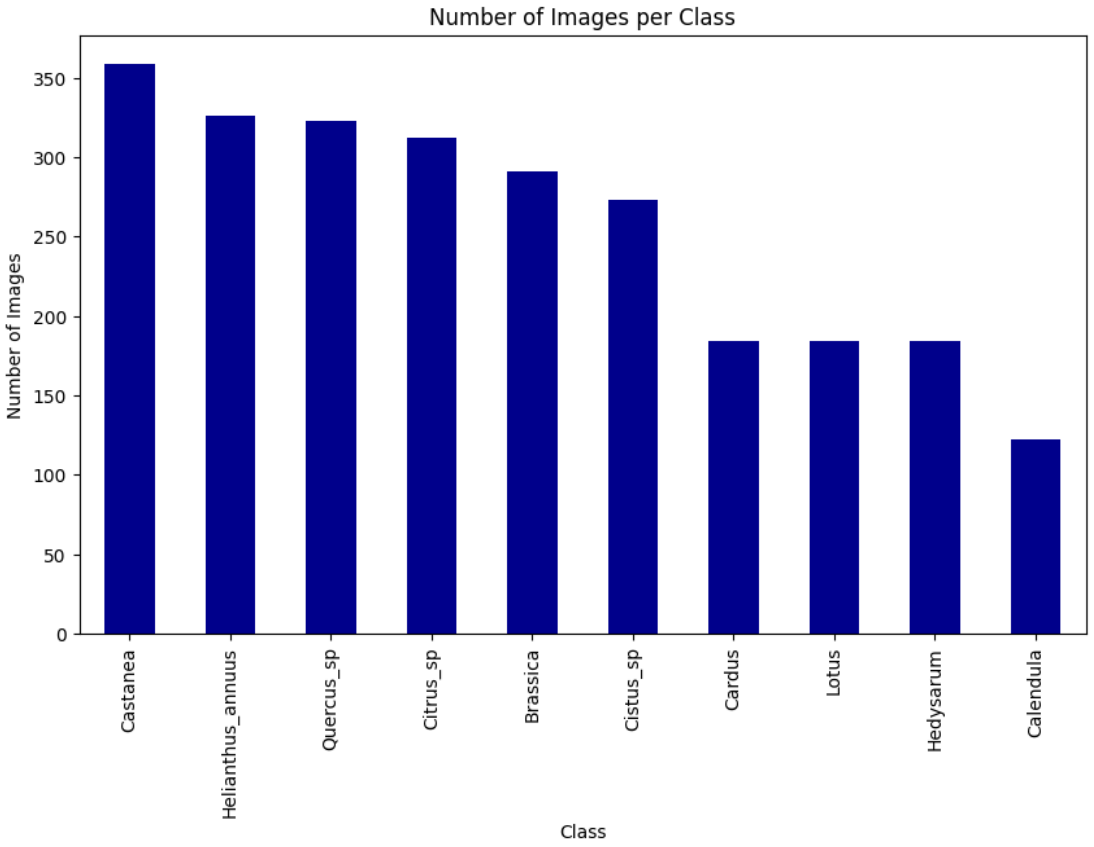

Figure 2. Distribution of the images for each pollen species.

Experiment 1:

The CNN model was created with 6 layers, with images set at an input size of 224 × 224. Rectified Linear Unit (ReLU) activation function was applied to each convolutional layer, and a dropout with a 0.2 rate was implemented to prevent overfitting. The softmax function served as the activation function in the output layer. The model comprised three convolutional layers and two fully connected layers. Adam optimizer with a learning rate 0.0001 was employed for training, and the model was trained for 14 epochs with a batch size of 32 [1].

Experiment 2:

Transfer learning has been used as a technique to improve the classification accuracy of pollen grain images [1, 2, 3]. In [1], the best results were obtained using the pre-trained CNN models with ResNeSt-101 and SE-ResNeX. For this particular experiment, the decision was made to use the pre-trained ResNeSt. Some layers of the pre-trained model were frozen, and adjustments were made to the output neurons to align with the specific requirements of the task. The transferred network was retrained by modifying the last layer to accommodate the 10 classes corresponding to the number of pollen species in the dataset.

Results from the CNN model

The model accuracy is 70.1%. Figure 3. illustrates the accuracy and loss of the model for each epoch. The confusion matrix is represented in Figure 4.

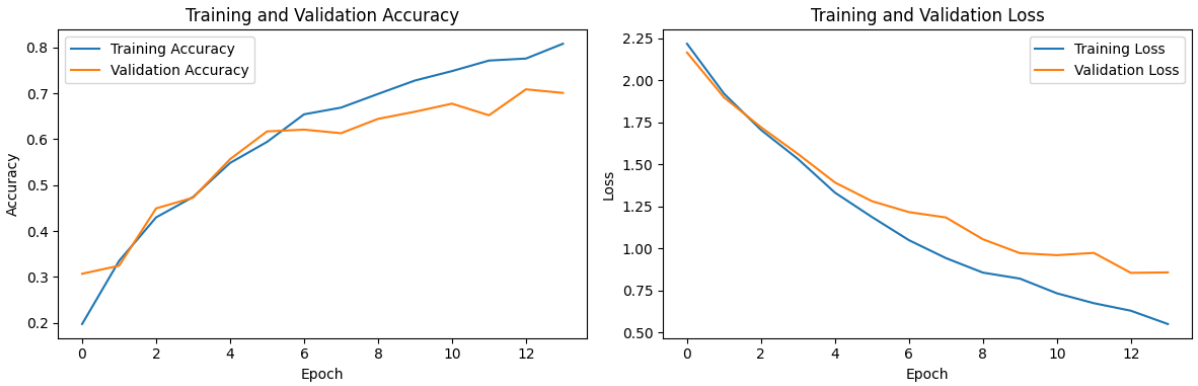

Figure 3. Accuracy and Loss for the training and validation sets.

The test dataset was used to assess the performance of the model. The model was used to predict the class for unseen images. An example of the predictions is visualized in Figure 5.

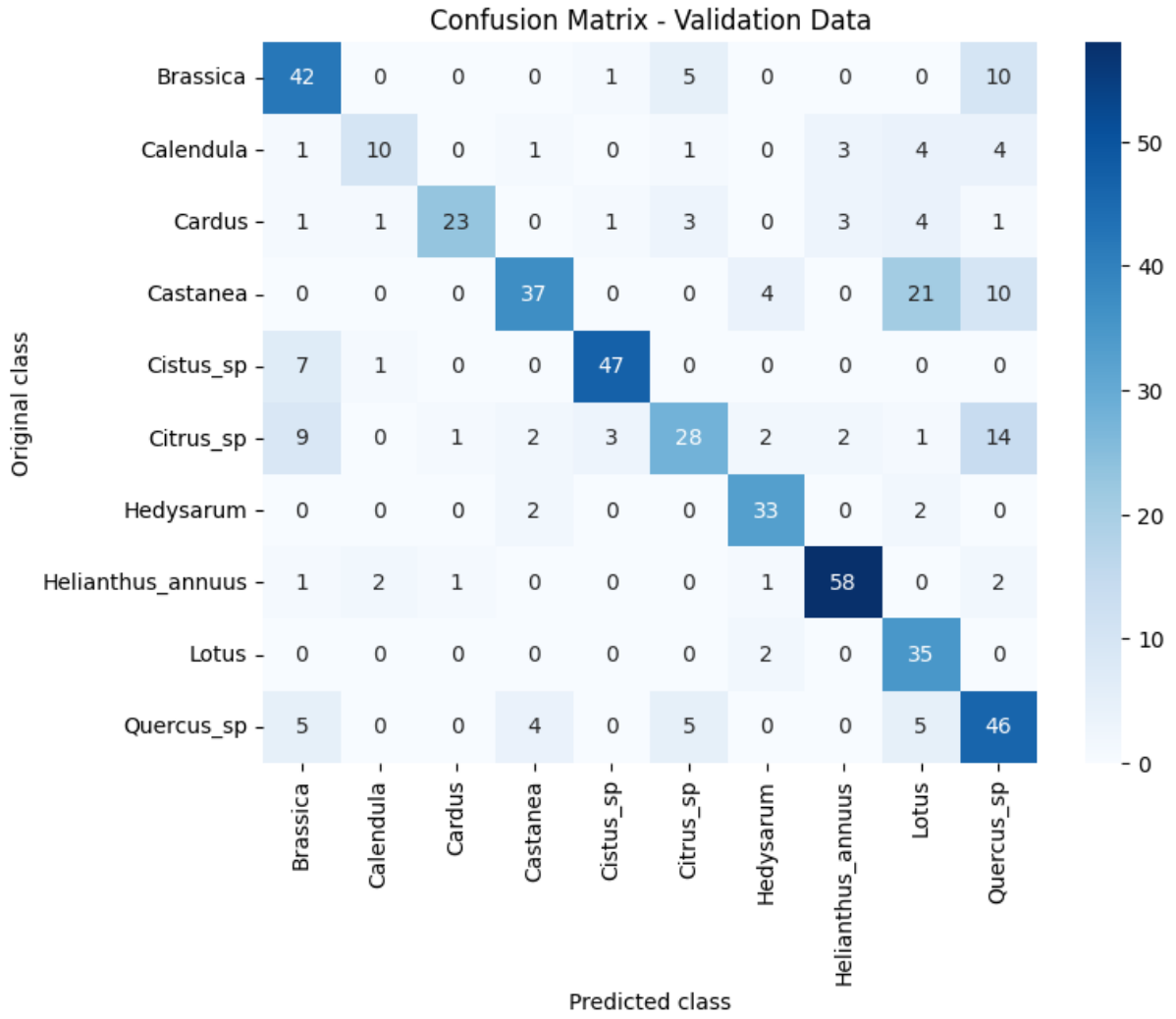

Figure 4. Confusion matrix for the validation set.

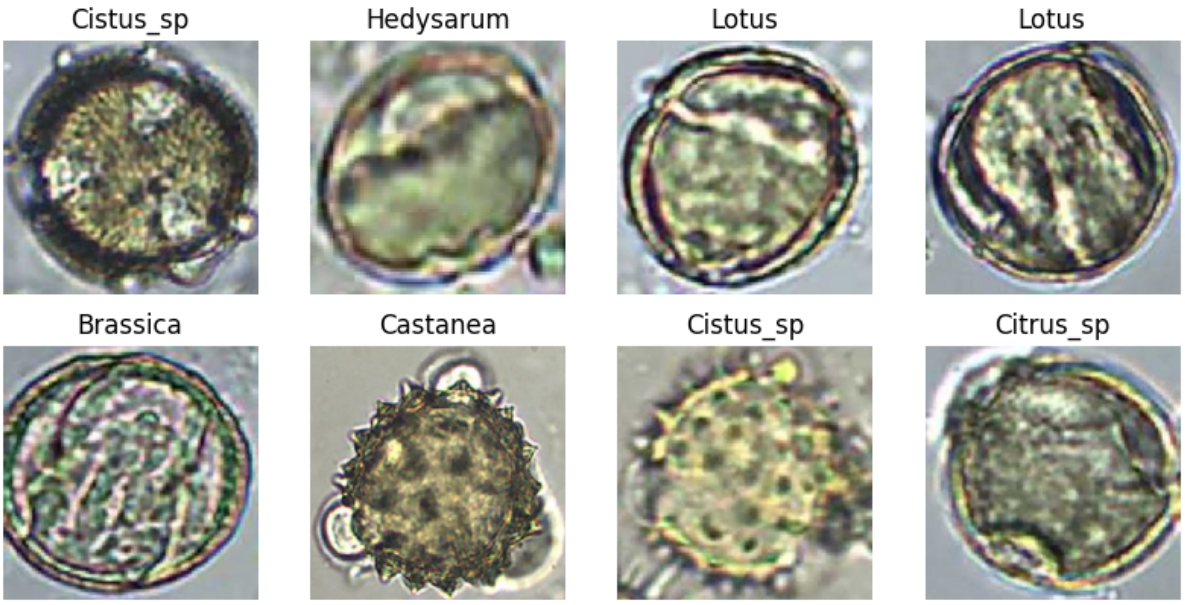

Figure 5. Example of classification images from the test set.

Results using a pre-trained model (ResNeSt-101)

The model accuracy is 85.2%. Similar to the results obtained for the CNN model, Figure 6. illustrates the accuracy and loss of the model for each epoch. The confusion matrix is represented in Figure 7.

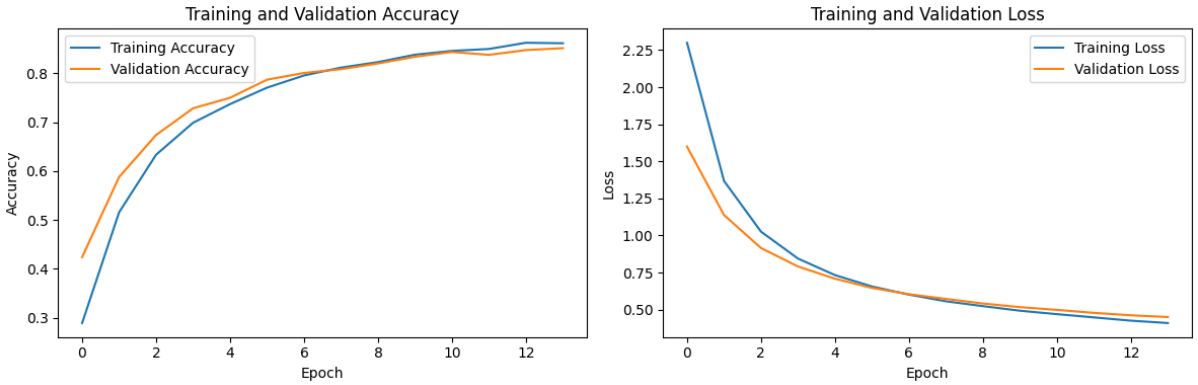

Figure 6. Accuracy and Loss for the training and validation sets.

The test dataset was used to assess the performance of the model. The model was used to predict the class for unseen images. An example of the predictions is visualized in Figure 8.

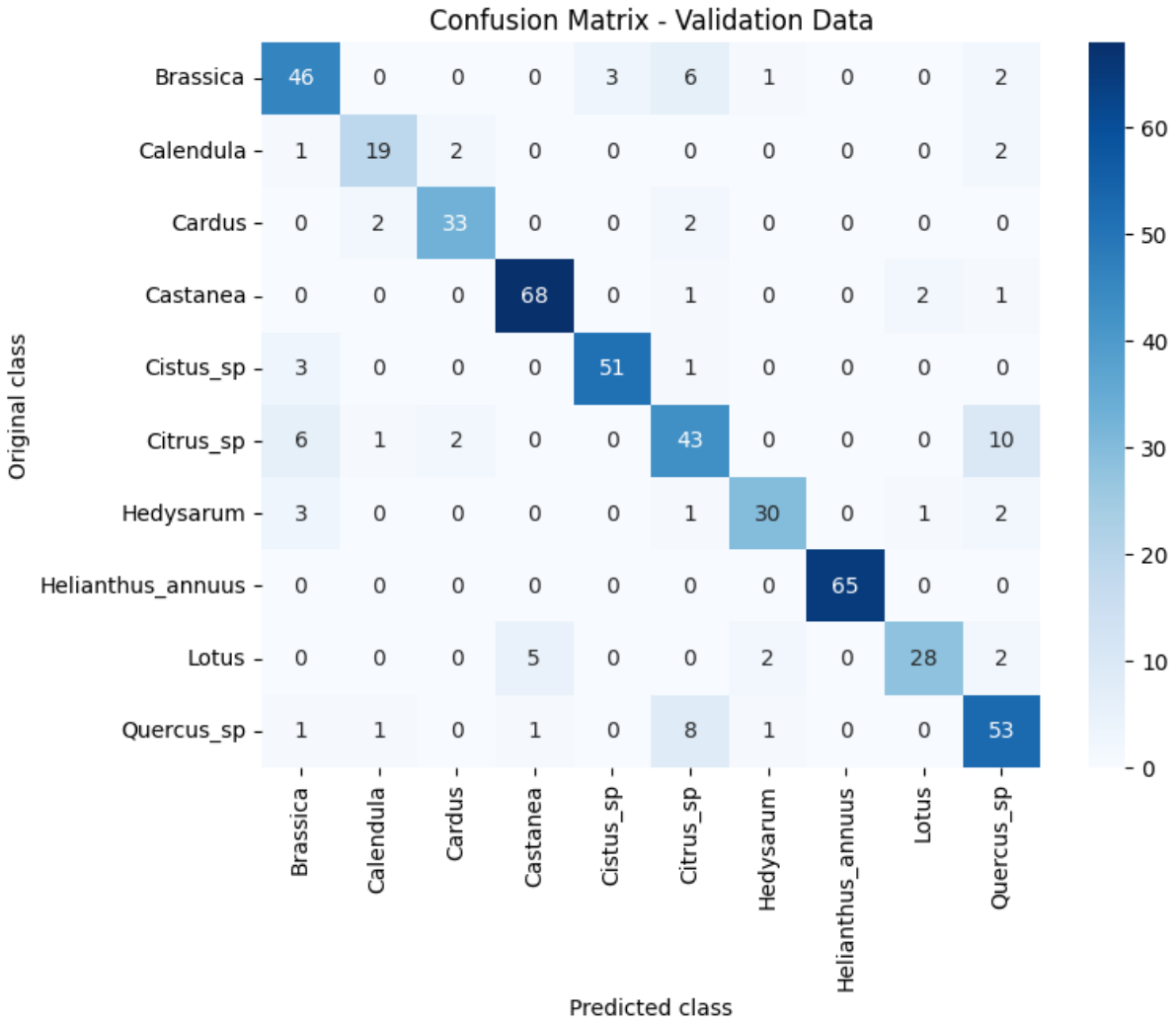

Figure 7. Confusion matrix for the validation set.

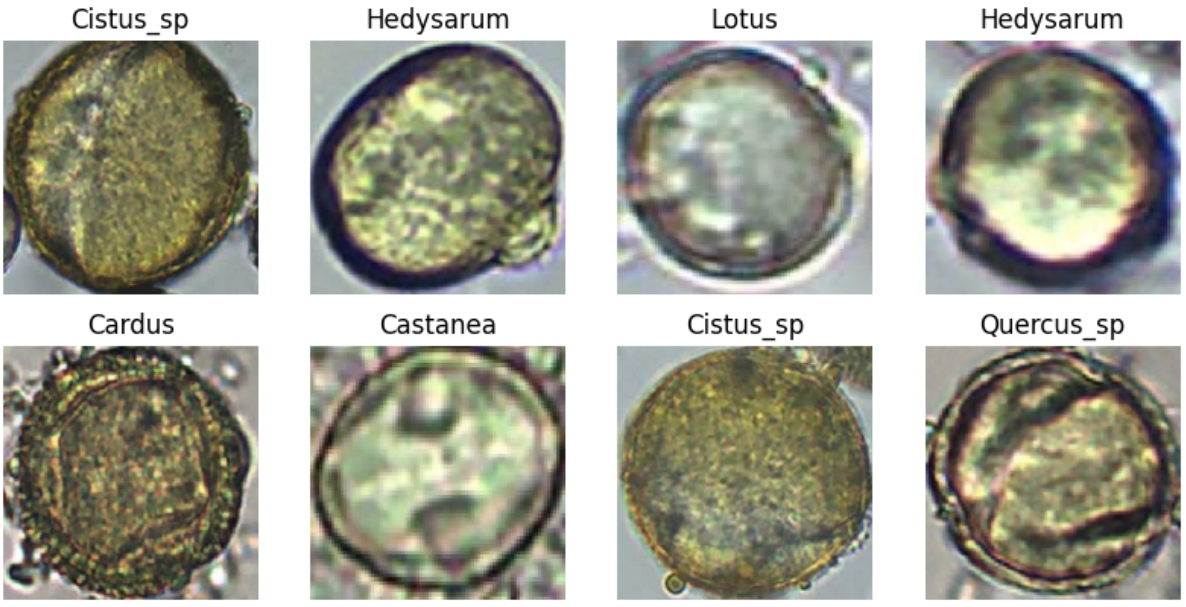

Figure 8. Example of classification images from the test set.

In this assignment, a CNN model from scratch with six layers was created, fine-tuned the hyperparameters, and obtained an accuracy of 70%. Using the transfer learning technique for the classification of pollen species, the accuracy of the model improves. The performance improved using ResNeSt-101.

References

[1] Rostami, M.A., Balmaki, B., Dyer, L.A. et al. Efficient pollen grain classification using pre-trained Convolutional Neural Networks: a comprehensive study. J Big Data 10, 151 (2023). https://doi.org/10.1186/s40537-023-00815-3

[2] Mahbod, A., Schaefer, G., Ecker, R., Ellinger, I. (2021). Pollen Grain Microscopic Image Classification Using an Ensemble of Fine-Tuned Deep Convolutional Neural Networks. In: Del Bimbo, A., et al. Pattern Recognition. ICPR International Workshops and Challenges. ICPR 2021. Lecture Notes in Computer Science(), vol 12661. Springer, Cham. https://doi.org/10.1007/978-3-030-68763-2_26

[3] Olsson, O., Karlsson, M., Persson, A.S., Smith, H.G., Varadarajan, V., Yourstone, J. and Stjernman, M., 2021. Efficient, automated and robust pollen analysis using deep learning. *Methods in Ecology and Evolution*, *12*(5), pp.850-862.