**Model Optimization and Tuning Phase**

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| Date | 20 June 2025 |
| Team ID | SWTID1750180744 |
| Project Title | Smart Sorting: Transfer Learning For Identifying Rotten Fruits And Vegetables |
| Maximum Marks | 10 Marks |

**Model Optimization and Tuning Phase**

The Model Optimization and Tuning Phase involved refining the VGG16 model through hyperparameter tuning, regularization techniques, and performance monitoring. Various training strategies were tested to enhance generalization, reduce overfitting, and ensure reliable performance. This section documents the tuned hyperparameters and justifies the final model selection.

### Hyperparameter Tuning Documentation (8 Marks):

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| **Model** | **Tuned Hyperparameters** |
| Model 1: **VGG16** | * **Learning Rate:** A learning rate of 0.0001 was selected to allow the model to converge smoothly using the Adam optimizer. Higher rates (e.g., 0.001) resulted in unstable training.      * **Batch Size:** After testing batch sizes of 16, 32, and 64, a batch size of 32 provided the best balance between computational efficiency and convergence stability.      * **Epochs:** The model was initially trained for 20 epochs, but EarlyStopping was used with patience of 3 to terminate training when validation performance plateaued, which typically occurred around epoch 10.      * **Data Augmentation:** ImageDataGenerator was used to augment the dataset with techniques such as 20° rotation, 0.2 zoom, and horizontal flips. This reduced overfitting and improved validation accuracy.      * **Dropout:** Dropout layers were tested in the dense layers with a rate of 0.5. This helped prevent overfitting on the relatively small dataset      * **Dense Layer Configuration:** The dense layers appended to the VGG16 base were tuned from 512 to 256 units, and then to 128, achieving better accuracy with reduced model complexity. |

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### Final Model Selection Justification (2 Marks):

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| **Final Model** | **Reasoning** |
| **VGG16** | VGG16 was selected as the final model due to its consistent high performance, stability during training, and compatibility with the dataset size. The model reached a validation accuracy of approximately 88%, with minimal signs of overfitting thanks to data augmentation and dropout. Compared to other models such as ResNet50, which was considered but not implemented due to its deeper structure and higher resource demands, VGG16 provided an optimal balance of accuracy and computational cost. Custom CNNs were also conceptually explored but not developed due to concerns over generalization and training time. Thus, VGG16 emerged as the most suitable and effective model for the fruit and vegetable health classification task. |