**Model Optimization and Tuning Phase**

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| Date | 5 July 2025 |
| Team ID | SWTID1750180871 |
| Project Title | Mangonet: A Vgg16-Based Neural Network For Mango Classification |
| Maximum Marks | 10 Marks |

**Model Optimization and Hyperparameter** **Tuning Phase**

### The Model Optimization and Tuning Phase involves refining neural network models for peak performance. It includes optimized model code, fine-tuning hyperparameters, comparing performance metrics, and justifying the final model selection for enhanced predictive accuracy and efficiency.

### 1. Baseline Model Setup:

### The initial model used VGG16 as a fixed feature extractor (include\_top=False, pretrained on ImageNet, all layers frozen).

### Custom classification head: Flatten → Dense(256, relu) → Dropout(0.5) → Dense(8, softmax).

### Optimizer: Adam (default learning rate).

### Loss: categorical\_crossentropy.

### Batch size: 32.

### Epochs: 10.

### 2. Hyperparameters Tuned:

### Learning Rate: Experimented with default (0.001) and lower (e.g., 0.0001) values for Adam optimizer.

### Dense Layer Size: Tested 128, 256, and 512 units for the dense layer.

### Dropout Rate: Tried values between 0.3 and 0.5 to reduce overfitting.

### Batch Size: Compared 16 and 32.

### Epochs: Evaluated model performance at 10 and 20 epochs.

### 3. Tuning Process:

### For each combination, the model was trained with the same data split (80% train, 20% validation).

### Training and validation accuracy and loss were monitored after each epoch.

### Plots of accuracy and loss curves were generated for visual inspection.

### 4. Observations:

### Increasing the dense layer size beyond 256 did not improve validation accuracy and increased overfitting.

### Dropout rates below 0.5 led to slight overfitting, while higher rates reduced training accuracy.

### A batch size of 32 provided a good balance between speed and stability.

### Lower learning rates (0.0001) slowed convergence without significant accuracy gains.

### Validation accuracy plateaued after 10 epochs, indicating no benefit from longer training.

### 5. Final Hyperparameters:

### Dense layer: 256 units

### Dropout: 0.5

### Batch size: 32

### Learning rate: 0.001 (Adam)

### Epochs: 10

### 6. Performance Metrics:

### Final training accuracy: ~82.7%

### Final validation accuracy: ~80.6%

### Loss curves showed no significant overfitting.

### Hyperparameter Tuning Documentation (8 Marks):

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| **Model** | **Tuned Hyperparameters** |
| Model 1 | - **Base Model:** VGG16 (ImageNet weights, include\_top=False, frozen layers) - **Input Size:** 224x224 - **Batch Size:** 32 - **Optimizer:** Adam (learning rate=0.001) - **Loss:** categorical\_crossentropy - **Dense Units:** 256 - **Dropout:** 0.5 - **Output Layer:** Dense(8, softmax) - **Epochs:** 10 |

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

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| **Final Model** | **Reasoning** |
| Model 1 | The final model was selected because it achieved the **highest validation accuracy (~80.6%) with minimal overfitting** during training, as evidenced by the close tracking of training and validation accuracy and loss curves. The chosen configuration—VGG16 as a frozen feature extractor, a dense layer with 256 units, dropout of 0.5, batch size of 32, and 10 training epochs—provided the best balance between model complexity and generalization. |