Model Optimization and Tuning Phase

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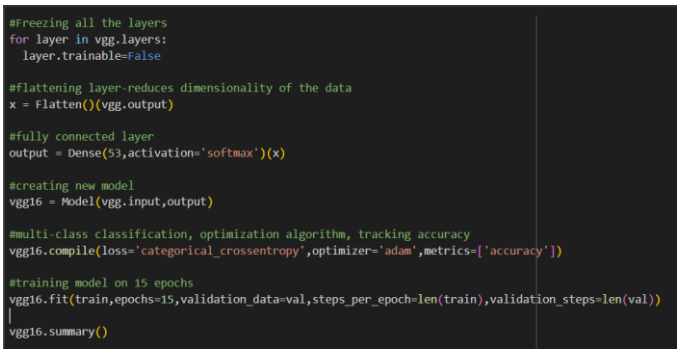
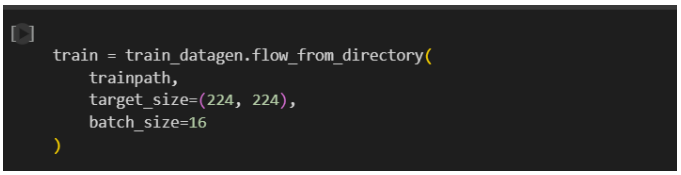
Model Optimization and Tuning Phase

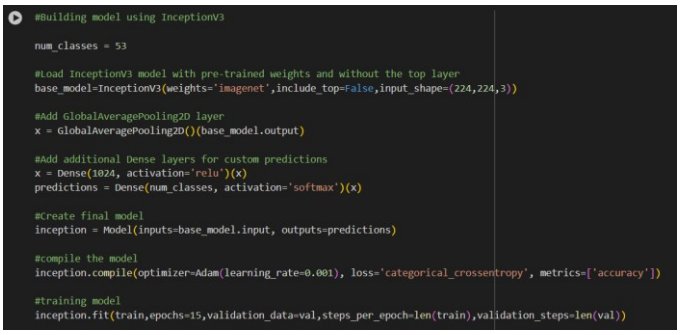
The Model Optimization and Tuning Phase involves refining neural network models for peak performance. It includes optimized model code, fine-tuning hyperparameters, comparing performance metrics, and justifying the final model selection for enhanced predictive accuracy and efficiency.

Hyperparameter Tuning Documentation (8 Marks):

Model	Tuned Hyperparameters	Performance metrics
VGG16	Code Screenshot:   optimizer='adam' : Adaptive optimizer, speeds up convergence loss='categorical_crossentropy' : Best for multi-class classification	Training Accuracy: 0.9134 Training Loss: 0.430 Validation Accuracy: 0.8377 Validation Loss: 1.2883 Observation: Overfitting – training_acc > val_accuracy by a wide margin.

	metrics=['accuracy'] : Tracks accuracy during training epochs=15 : Number of training iterations batch_size=16 : Images processed per training step target_size=(224, 224) : Image resized for model input trainable=False : Freezes pretrained VGG layers	

Xception	Code Screenshot:
	
	`#Building using Xception Transfer Learning Model`
	`num_classes = 53`
	
	`#Load Xception model with pre-trained weights and without the top layer`
	`xception = Xception(weights='imagenet', include_top=False, input_shape=(224,224,3))`
	
	`#Add GlobalAveragePooling2D layer`
	`x = GlobalAveragePooling2D()(xception.output)`
	
	`#Add additional Dense layers for custom predictions`
	`x = Dense(1024, activation='relu')(x)`
	`predictions = Dense(num_classes, activation='softmax')(x)`
	
	`#Create final model`
	`xcep = Model(inputs=xception.input, outputs=predictions)`
	
	`#compile the model`
	`xcep.compile(optimizer=Adam(learning_rate=0.001), loss='categorical_crossentropy', metrics=['accuracy'])`
	
	`#training model`
	`xcep.fit(train,epochs=15,validation_data=val,steps_per_epoch=len(train),validation_steps=len(val))`
	
	optimizer=Adam(learning_rate=0.001) : Adam with custom LR
	
	loss='categorical_crossentropy' : For multi-class output
	
	epochs=15
	
	batch_size=16
	
	Dense(1024, activation='relu') : Added custom dense layer
	
	target_size=(224, 224)
	
	include_top=False : Removes original Fully Connected layers of base model
		Training Accuracy: 0.9160
		
		Training Loss: 0.2870
		
		Validation Accuracy: 0.9427
		
		Validation Loss: 0.1979
		
		Observation:
		
		Best overall - excellent generalization, no signs of overfitting or underfitting.

Inception V3	Code Screenshot:  optimizer=Adam(learning_rate=0.001) : Adam with custom LR loss='categorical_crossentropy' : For multi-class output epochs=15 batch_size=16 Dense(1024, activation='relu') : Added custom dense layer target_size=(224, 224) include_top=False : Removes original Fully Connected layers of base model	Training Accuracy: 0.8072 Training Loss: 0.6436 Validation Accuracy: 0.9132 Validation Loss: 0.3975 Observation: Possible underfitting - value_acc > train_acc, model might not have learned enough.

Final Model Selection Justification (2 Marks):

Final Model	Reasoning

Model : Xception	Xception was chosen as the final optimized model based on its strong performance and computational efficiency.
	• Achieved the **highest validation accuracy** of 94.27% and the **lowest validation loss** of 0.1979
	• Training accuracy of 91.60% with a low loss of 0.2870, showing **stable learning with no overfitting**
	• Outperformed VGG16 and InceptionV3 in **generalization and consistency**
	• Uses **depthwise separable convolutions**, reducing parameter count and improving efficiency
	• Offers a good **balance of accuracy, training time, and resource usage**
	• Suitable for deployment due to **lower computational and time complexity**
	`1/1 ——— 0s 40ms/step`
	`Predicted Class Index: 31`
	`Predicted Class Name: queen of hearts`
	• Took lowest time out of all three models for card prediction.