

Model Optimization and Tuning Phase Template

Date	12 July 2024
Team ID	SWTID1719935963
Project Title	Automated Weather Classification using Transfer Learning
Maximum Marks	10 Marks

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
Vgg19	<p>training_set,</p> <p>validation_data=test_set,</p> <p>epochs=10,</p> <p>steps_per_epoch=len(training_set),</p> <p>validation_steps=len(test_set)</p> <p>Shortnote:-trains a machine learning model for 10 epochs, using the entire training set for each epoch and the entire test set for validation at the end of each epoch. This ensures comprehensive training and evaluation of the model.</p> <pre> history = model.fit(training_set, validation_data=test_set, epochs=10, steps_per_epoch=len(training_set), validation_steps=len(test_set)) </pre> <pre> Epoch 1/10 19/19 [=====] - 37s 1s/step - loss: 3.3903 - accuracy: 0.4525 - val_loss: 1.0802 - val_accuracy: 0.6467 Epoch 2/10 19/19 [=====] - 16s 841ms/step - loss: 0.5521 - accuracy: 0.7958 - val_loss: 0.6840 - val_accuracy: 0.7833 Epoch 3/10 19/19 [=====] - 16s 864ms/step - loss: 0.3947 - accuracy: 0.8500 - val_loss: 0.5131 - val_accuracy: 0.8267 Epoch 4/10 19/19 [=====] - 17s 907ms/step - loss: 0.2524 - accuracy: 0.9208 - val_loss: 0.5239 - val_accuracy: 0.8367 Epoch 5/10 19/19 [=====] - 16s 850ms/step - loss: 0.1877 - accuracy: 0.9325 - val_loss: 0.4987 - val_accuracy: 0.8367 Epoch 6/10 19/19 [=====] - 17s 915ms/step - loss: 0.1504 - accuracy: 0.9542 - val_loss: 0.5665 - val_accuracy: 0.8200 Epoch 7/10 19/19 [=====] - 16s 853ms/step - loss: 0.1392 - accuracy: 0.9625 - val_loss: 0.5295 - val_accuracy: 0.8300 Epoch 8/10 19/19 [=====] - 16s 846ms/step - loss: 0.1075 - accuracy: 0.9742 - val_loss: 0.4746 - val_accuracy: 0.8600 Epoch 9/10 19/19 [=====] - 17s 890ms/step - loss: 0.0959 - accuracy: 0.9750 - val_loss: 0.4600 - val_accuracy: 0.8700 Epoch 10/10 19/19 [=====] - 16s 841ms/step - loss: 0.0909 - accuracy: 0.9767 - val_loss: 0.4327 - val_accuracy: 0.8700 </pre>

Vgg16

```
training_set,

validation_data=test_set,

epochs=20,

steps_per_epoch=len(training_set),

validation_steps=len(test_set)
```

Shortnote:-trains a machine learning model for 20 epochs, using the entire training set for each epoch and the entire test set for validation at the end of each epoch. This ensures comprehensive training and evaluation of the model.

```
history = model.fit(
    training_set,
    validation_data=test_set,
    epochs=20,
    steps_per_epoch=len(training_set),
    validation_steps=len(test_set)
)
```

```
Epoch 1/20
19/19 [=====] - 18s 892ms/step - loss: 0.0400 - accuracy: 0.9933 - val_loss: 0.2201 - val_accuracy: 0.9267
Epoch 2/20
19/19 [=====] - 16s 853ms/step - loss: 0.0343 - accuracy: 0.9958 - val_loss: 0.2215 - val_accuracy: 0.9300
Epoch 3/20
19/19 [=====] - 16s 864ms/step - loss: 0.0269 - accuracy: 0.9958 - val_loss: 0.2360 - val_accuracy: 0.9233
Epoch 4/20
19/19 [=====] - 18s 952ms/step - loss: 0.0276 - accuracy: 0.9950 - val_loss: 0.2220 - val_accuracy: 0.9300
Epoch 5/20
19/19 [=====] - 16s 860ms/step - loss: 0.0256 - accuracy: 0.9958 - val_loss: 0.2227 - val_accuracy: 0.9233
Epoch 6/20
19/19 [=====] - 16s 856ms/step - loss: 0.0250 - accuracy: 0.9958 - val_loss: 0.2525 - val_accuracy: 0.9233
Epoch 7/20
19/19 [=====] - 17s 872ms/step - loss: 0.0208 - accuracy: 0.9975 - val_loss: 0.2665 - val_accuracy: 0.9300
Epoch 8/20
19/19 [=====] - 17s 879ms/step - loss: 0.0187 - accuracy: 0.9983 - val_loss: 0.2542 - val_accuracy: 0.9200
Epoch 9/20
19/19 [=====] - 16s 852ms/step - loss: 0.0192 - accuracy: 0.9967 - val_loss: 0.2272 - val_accuracy: 0.9267
Epoch 10/20
19/19 [=====] - 17s 914ms/step - loss: 0.0136 - accuracy: 0.9992 - val_loss: 0.2248 - val_accuracy: 0.9367
Epoch 11/20
19/19 [=====] - 17s 936ms/step - loss: 0.0120 - accuracy: 0.9992 - val_loss: 0.2322 - val_accuracy: 0.9300
Epoch 12/20
19/19 [=====] - 16s 849ms/step - loss: 0.0126 - accuracy: 0.9992 - val_loss: 0.2666 - val_accuracy: 0.9100
Epoch 13/20
...
Epoch 19/20
19/19 [=====] - 16s 861ms/step - loss: 0.0057 - accuracy: 1.0000 - val_loss: 0.2158 - val_accuracy: 0.9400
Epoch 20/20
19/19 [=====] - 17s 923ms/step - loss: 0.0056 - accuracy: 1.0000 - val_loss: 0.2313 - val_accuracy: 0.9367
Output is truncated. View as a scrollable element or open in a text editor. Adjust cell output settings...
```

ResNet-50

```
training_set,

validation_data=test_set,

epochs=10,

steps_per_epoch=len(training_set),

validation_steps=len(test_set)
```

Shortnote:-trains a machine learning model for 10 epochs, using the entire training set for each epoch and the entire test set for validation at the end of each epoch. This ensures comprehensive training and evaluation of the model.

```
[ ] history = model.fit(
    training_set,
    validation_data=test_set,
    epochs=10,
    steps_per_epoch=len(training_set),
    validation_steps=len(test_set)
)
```

```
Epoch 1/10
19/19 [=====] - 21s 911ms/step - loss: 5.2917 - accuracy: 0.2333 - val_loss: 1.5274 - val_accuracy: 0.2600
Epoch 2/10
19/19 [=====] - 16s 839ms/step - loss: 1.6844 - accuracy: 0.2992 - val_loss: 1.5670 - val_accuracy: 0.3133
Epoch 3/10
19/19 [=====] - 16s 846ms/step - loss: 1.5868 - accuracy: 0.3483 - val_loss: 1.6548 - val_accuracy: 0.3467
Epoch 4/10
19/19 [=====] - 17s 880ms/step - loss: 1.4280 - accuracy: 0.4000 - val_loss: 1.2425 - val_accuracy: 0.4533
Epoch 5/10
19/19 [=====] - 16s 846ms/step - loss: 1.2651 - accuracy: 0.4783 - val_loss: 1.2027 - val_accuracy: 0.5233
Epoch 6/10
19/19 [=====] - 17s 878ms/step - loss: 1.3614 - accuracy: 0.4392 - val_loss: 1.2644 - val_accuracy: 0.4833
Epoch 7/10
19/19 [=====] - 16s 847ms/step - loss: 1.3853 - accuracy: 0.4308 - val_loss: 1.0630 - val_accuracy: 0.5500
Epoch 8/10
19/19 [=====] - 16s 835ms/step - loss: 1.2435 - accuracy: 0.4875 - val_loss: 1.1610 - val_accuracy: 0.5267
Epoch 9/10
19/19 [=====] - 17s 910ms/step - loss: 1.3265 - accuracy: 0.4683 - val_loss: 1.0946 - val_accuracy: 0.5333
Epoch 10/10
19/19 [=====] - 16s 840ms/step - loss: 1.2322 - accuracy: 0.4942 - val_loss: 1.4174 - val_accuracy: 0.4200
```

Final Model Selection Justification (2 Marks):

Final Model	Reasoning
Vgg16	<p>training_set,</p> <p>validation_data=test_set,</p> <p>epochs=20,</p> <p>steps_per_epoch=len(training_set),</p> <p>validation_steps=len(test_set)</p> <p>Shortnote:-trains a machine learning model for 20 epochs, using the entire training set for each epoch and the entire test set for validation at the end of each epoch. This ensures comprehensive training and evaluation of the model.</p> <pre> history = model.fit(training_set, validation_data=test_set, epochs=20, steps_per_epoch=len(training_set), validation_steps=len(test_set)) </pre> <p>Epoch 1/20 19/19 [=====] - 18s 892ms/step - loss: 0.0400 - accuracy: 0.9933 - val_loss: 0.2201 - val_accuracy: 0.9267 Epoch 2/20 19/19 [=====] - 16s 853ms/step - loss: 0.0343 - accuracy: 0.9958 - val_loss: 0.2215 - val_accuracy: 0.9300 Epoch 3/20 19/19 [=====] - 16s 864ms/step - loss: 0.0269 - accuracy: 0.9958 - val_loss: 0.2360 - val_accuracy: 0.9233 Epoch 4/20 19/19 [=====] - 18s 952ms/step - loss: 0.0276 - accuracy: 0.9950 - val_loss: 0.2220 - val_accuracy: 0.9300 Epoch 5/20 19/19 [=====] - 16s 860ms/step - loss: 0.0256 - accuracy: 0.9958 - val_loss: 0.2227 - val_accuracy: 0.9233 Epoch 6/20 19/19 [=====] - 16s 856ms/step - loss: 0.0250 - accuracy: 0.9958 - val_loss: 0.2525 - val_accuracy: 0.9233 Epoch 7/20 19/19 [=====] - 17s 872ms/step - loss: 0.0208 - accuracy: 0.9975 - val_loss: 0.2665 - val_accuracy: 0.9300 Epoch 8/20 19/19 [=====] - 17s 879ms/step - loss: 0.0187 - accuracy: 0.9983 - val_loss: 0.2542 - val_accuracy: 0.9200 Epoch 9/20 19/19 [=====] - 16s 852ms/step - loss: 0.0192 - accuracy: 0.9967 - val_loss: 0.2272 - val_accuracy: 0.9267 Epoch 10/20 19/19 [=====] - 17s 914ms/step - loss: 0.0136 - accuracy: 0.9992 - val_loss: 0.2248 - val_accuracy: 0.9367 Epoch 11/20 19/19 [=====] - 17s 936ms/step - loss: 0.0120 - accuracy: 0.9992 - val_loss: 0.2322 - val_accuracy: 0.9300 Epoch 12/20 19/19 [=====] - 16s 849ms/step - loss: 0.0126 - accuracy: 0.9992 - val_loss: 0.2666 - val_accuracy: 0.9100 Epoch 13/20 ... Epoch 19/20 19/19 [=====] - 16s 861ms/step - loss: 0.0057 - accuracy: 1.0000 - val_loss: 0.2158 - val_accuracy: 0.9400 Epoch 20/20 19/19 [=====] - 17s 923ms/step - loss: 0.0056 - accuracy: 1.0000 - val_loss: 0.2313 - val_accuracy: 0.9367 Output is truncated. View as a scrollable element or open in a text editor. Adjust cell output settings.</p>

1. **High Training Accuracy:** The model achieves 100% accuracy on the training set, indicating it has perfectly learned the patterns in the training data. This is often a sign of effective model training but can sometimes indicate overfitting if the test accuracy is significantly lower.
2. **High Test Accuracy:** The model also performs exceptionally well on the test set with a 93.67% accuracy. This high test accuracy suggests that the model generalizes well to new, unseen data, which is crucial for its real-world application.
3. **Comparison to Other Models:** The test accuracy of 93.67% is greater than that achieved by other models, indicating superior performance. This comparison is important because it validates that the current model performs better in terms of generalization and predictive accuracy.
4. **Final Model Selection:** Given the combination of perfect training accuracy and high test accuracy, this model is considered optimal. It demonstrates both a strong ability to learn from the training data and to generalize this learning to new data. This balance makes it a robust choice for deployment.

In conclusion, the model's high performance on both the training and test sets, along with its superior performance compared to other models, justifies its selection as the final model for the given task.