Material Identification

Image Classification

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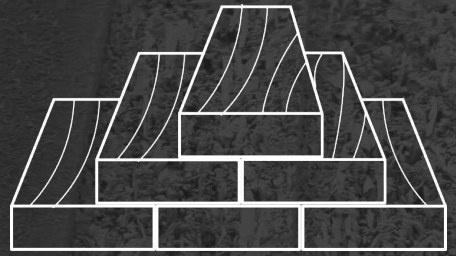
Project objective:

To develop a **Convolutional Neural Network** that can properly identify material types for warehouse and scrap material handling.

Project objective:

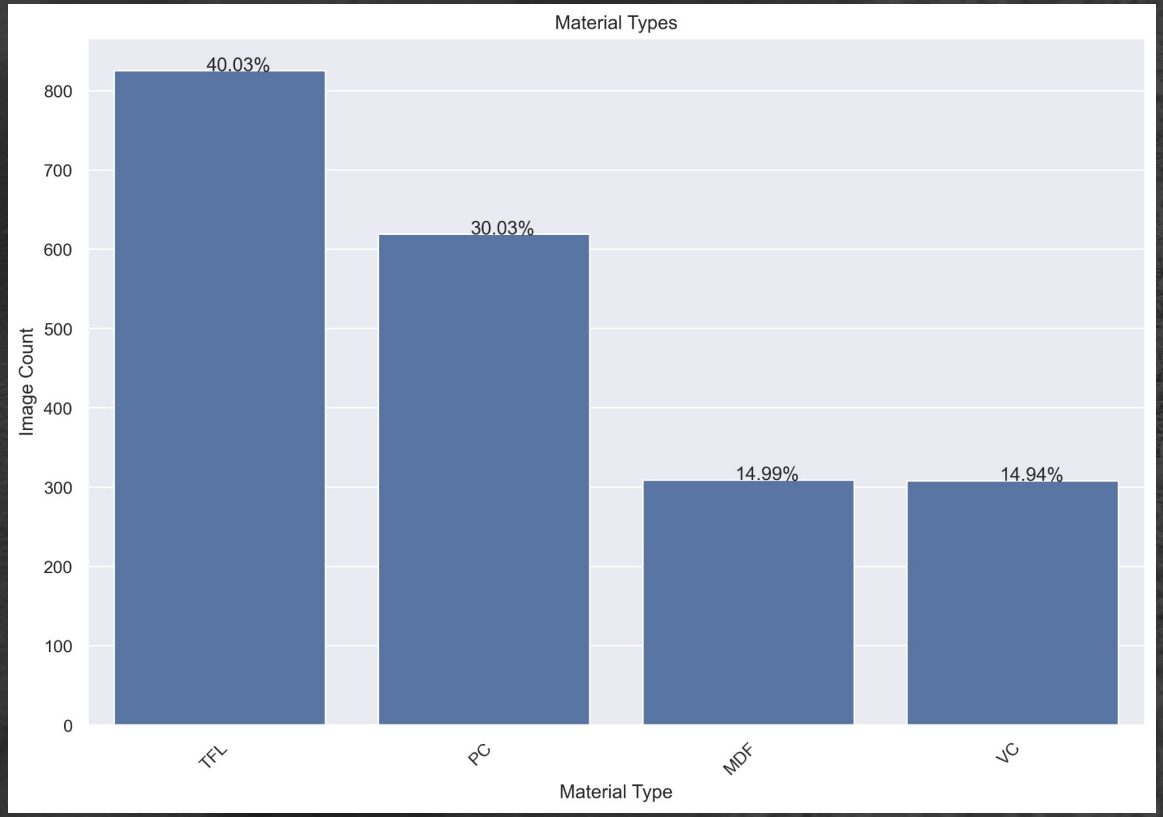
Receiving Material
from suppliers



Storing Scrap
in racks

Quality Control
check at machines

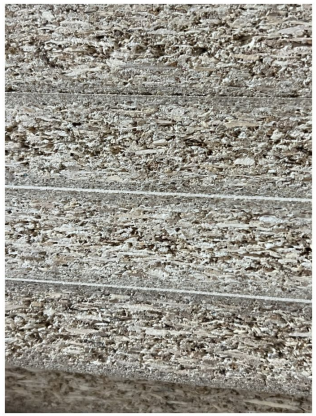
Data



- 2064 images in total, divided into 4 classes

- TFL and PC are the most common images as they are the most common materials used in the factory

Data Collection

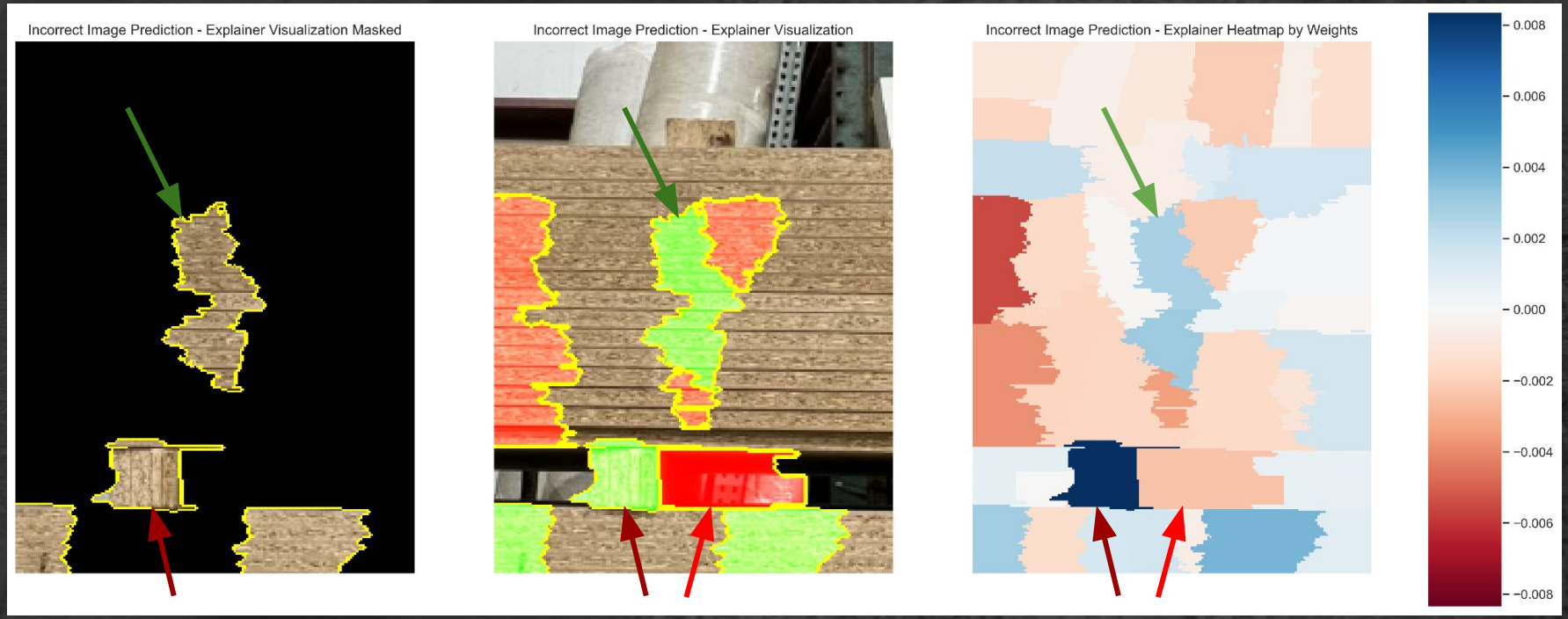


Data Collection

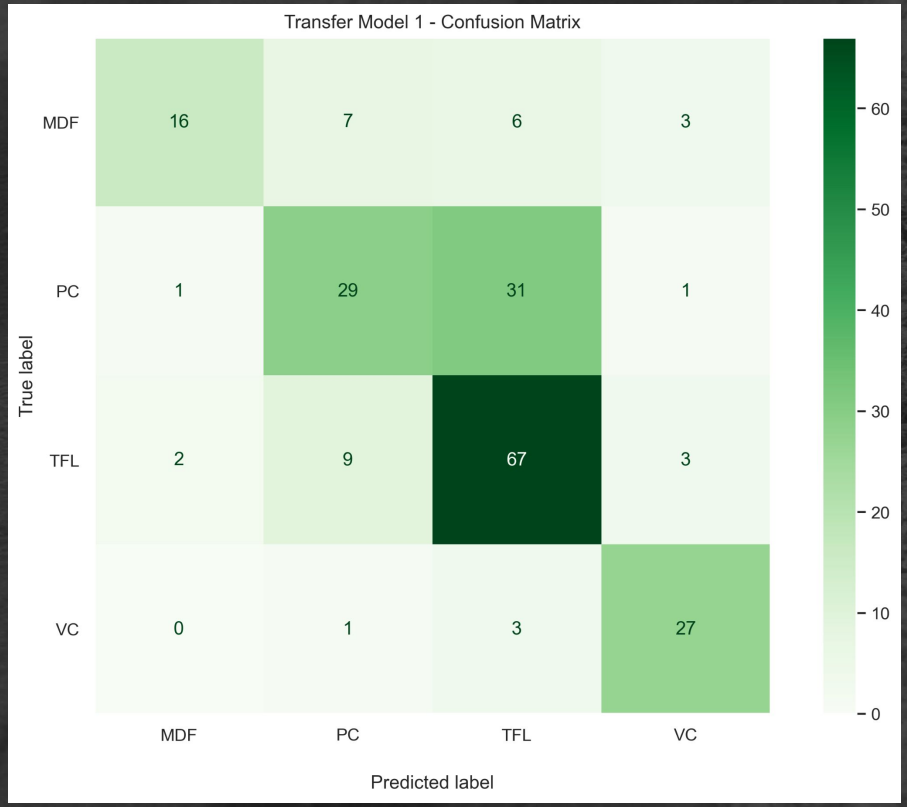
- Images taken from a variety of viewpoints in varied lighting conditions

- Human identified class of material centered in each image

Data


Incorrect Image Prediction - Explainer Visualization Masked
Incorrect Image Prediction - Explainer Visualization
Incorrect Image Prediction - Explainer Heatmap by Weights
0.008
0.006
0.004
0.002
0.000
−0.002
−0.004
−0.006
−0.008

Results



Metrics

Accuracy

67%

Conclusions

Background in images caused noise in classifying images

Difficulty predicting the difference between **TFL and PC**

Multiple materials in one image **created issues** in correct predictions

Even with inconsistent data, we were able to come close to required 70% accuracy at the final model's **67% accuracy**

Human oversight required for the initial testing period

Future Work

1

Collect consistent image data by utilizing a standard hardware and lighting setup across all three work intervals

2

Increase amount of **data** to train on by gathering 10,000 or 20,000 images

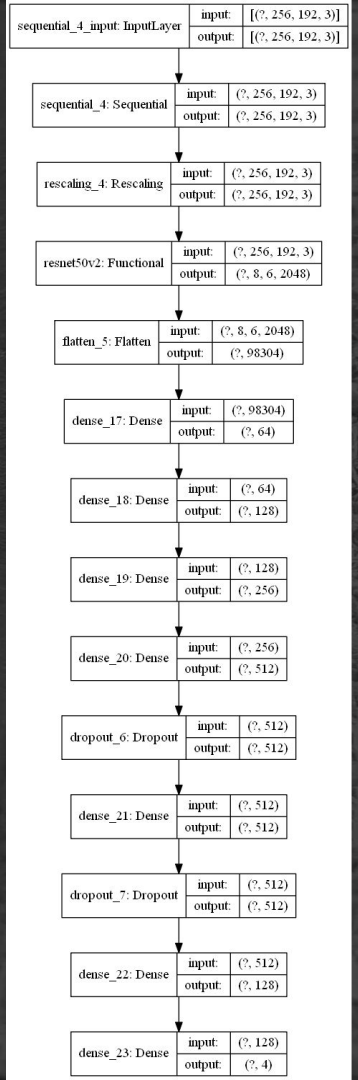
3

Better accuracy could be obtained **by fine tuning** the final model to the first two points presented here

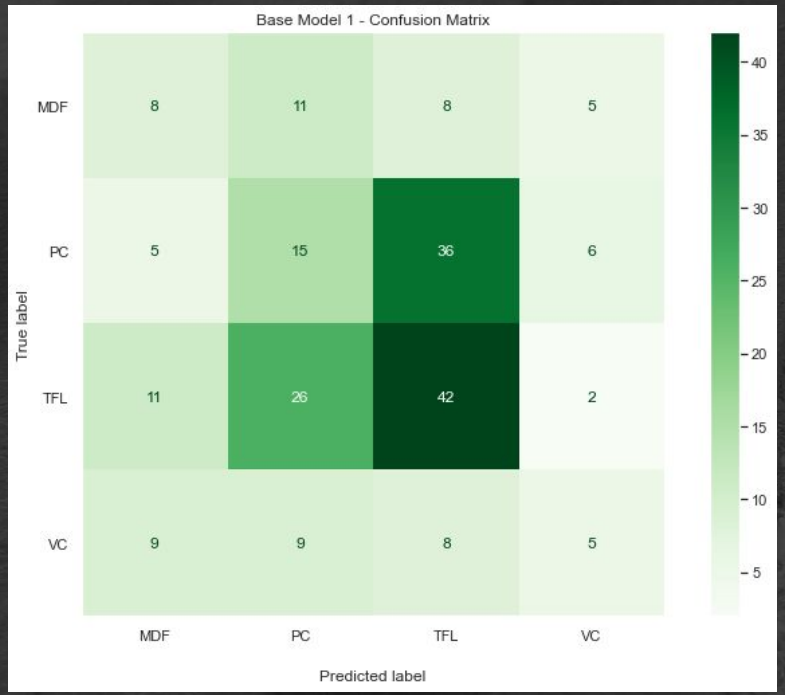
THANK YOU

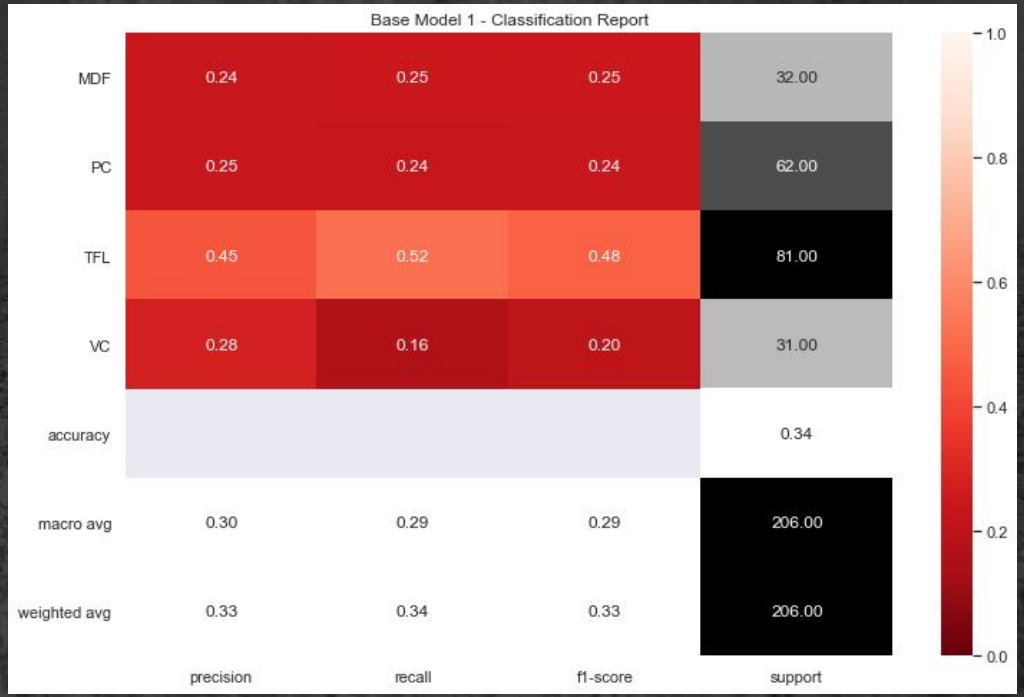
APPENDIX

Data

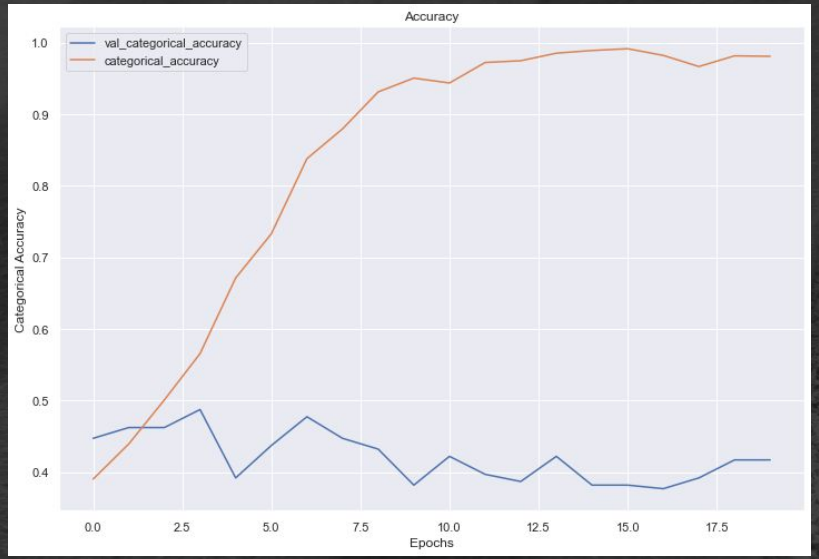

sequential_4_input: InputLayer
input: [(?, 256, 192, 3)]
output: [(?, 256, 192, 3)]
sequential_4: Sequential
input: (?, 256, 192, 3)
output: (?, 256, 192, 3)
rescaling_4: Rescaling
input: (?, 256, 192, 3)
output: (?, 256, 192, 3)
resnet50v2: Functional
input: (?, 256, 192, 3)
output: (?, 8, 6, 2048)
flatten_5: Flatten
input: (?, 8, 6, 2048)
output: (?, 98304)
dense_17: Dense
input: (?, 98304)
output: (?, 64)
dense_18: Dense
input: (?, 64)
output: (?, 128)
dense_19: Dense
input: (?, 128)
output: (?, 256)
dense_20: Dense
input: (?, 256)
output: (?, 512)
dropout_6: Dropout
input: (?, 512)
output: (?, 512)
dense_21: Dense
input: (?, 512)
output: (?, 512)
dropout_7: Dropout
input: (?, 512)
output: (?, 512)
dense_22: Dense
input: (?, 512)
output: (?, 128)
dense_23: Dense
input: (?, 128)
output: (?, 4)

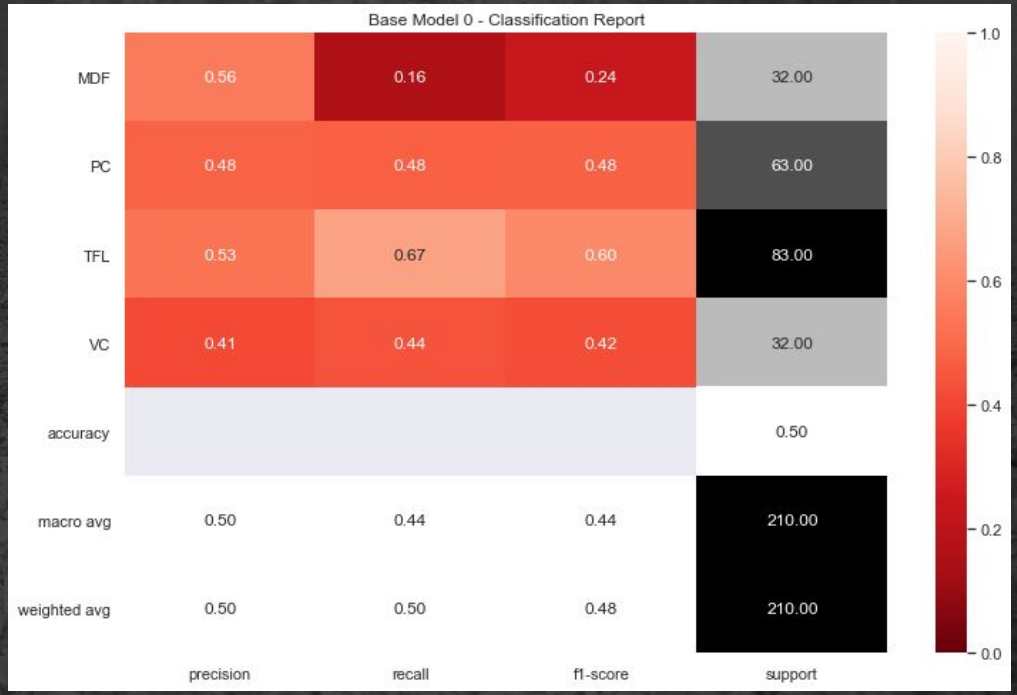
Data


Base Model 1 - Confusion Matrix
MDF
PC
TFL
VC
True label
8
11
8
5
5
15
36
6
11
26
42
2
9
9
8
5
MDF
PC
TFL
VC
Predicted label
40
35
30
25
20
15
10
5

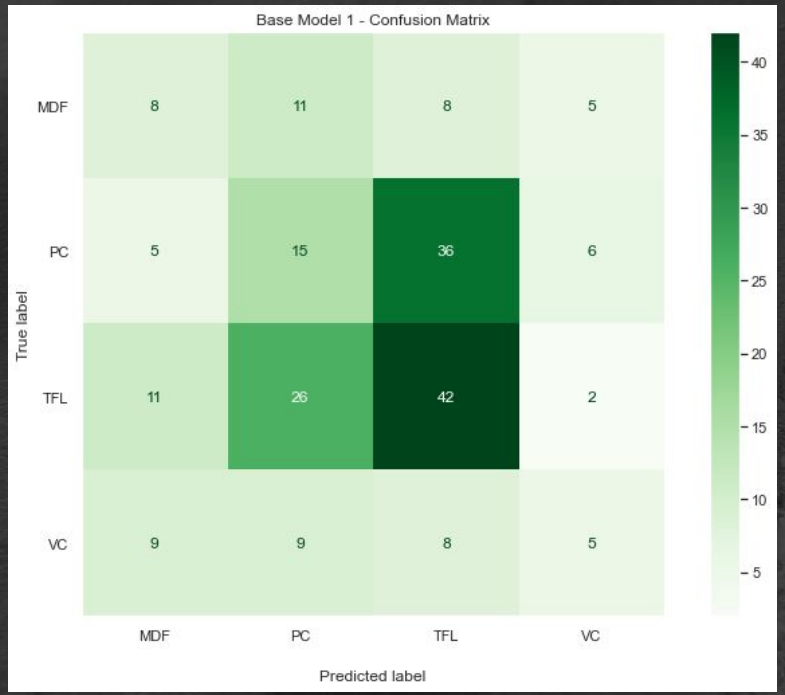

Base Model 1 - Classification Report
MDF
PC
TFL
VC
accuracy
macro avg
weighted avg
0.24
0.25
0.25
32.00
0.25
0.24
0.24
62.00
0.45
0.52
0.48
81.00
0.28
0.16
0.20
31.00
0.34
0.30
0.29
0.29
206.00
0.33
0.34
0.33
206.00
precision
recall
f1-score
support
1.0
0.8
0.6
0.4
0.2
0.0

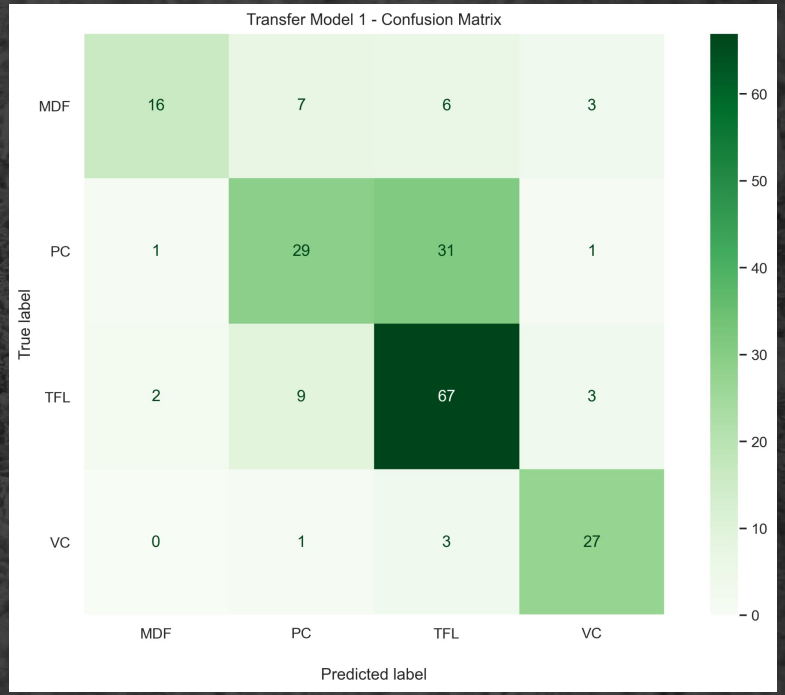
Data


Accuracy
val_categorical_accuracy
categorical_accuracy
Categorical Accuracy
Epochs
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5

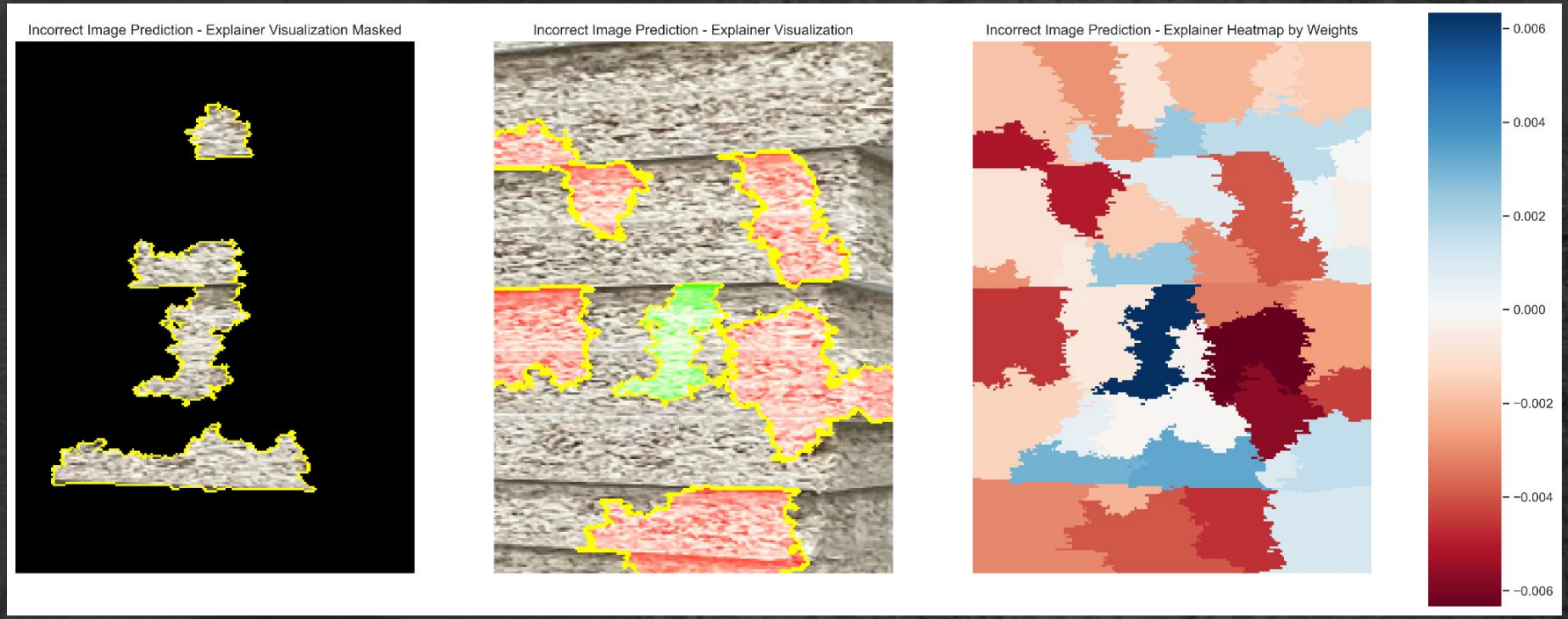

Base Model 0 - Classification Report
MDF 0.56 0.16 0.24 32.00
PC 0.48 0.48 0.48 63.00
TFL 0.53 0.67 0.60 83.00
VC 0.41 0.44 0.42 32.00
accuracy 0.50
macro avg 0.50 0.44 0.44 210.00
weighted avg 0.50 0.50 0.48 210.00
precision
recall
f1-score
support
1.0
0.8
0.6
0.4
0.2
0.0

Data

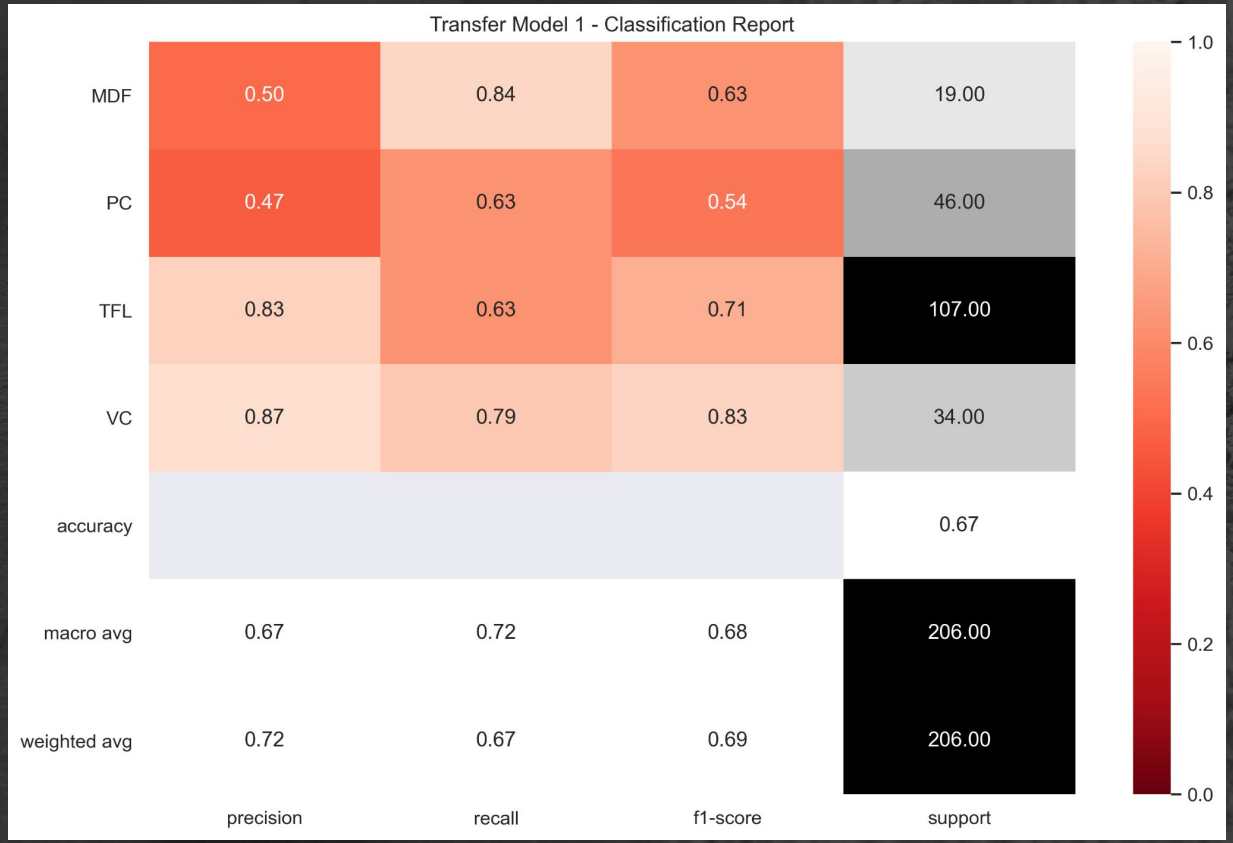

Base Model 1 - Confusion Matrix
MDF
PC
TFL
VC
True label
8
11
8
5
5
15
36
6
11
26
42
2
9
9
8
5
MDF
PC
TFL
VC
Predicted label
40
35
30
25
20
15
10
5


Transfer Model 1 - Confusion Matrix
MDF
PC
TFL
VC
True label
16
7
6
3
1
29
31
1
2
9
67
3
0
1
3
27
MDF
PC
TFL
VC
Predicted label
60
50
40
30
20
10
0

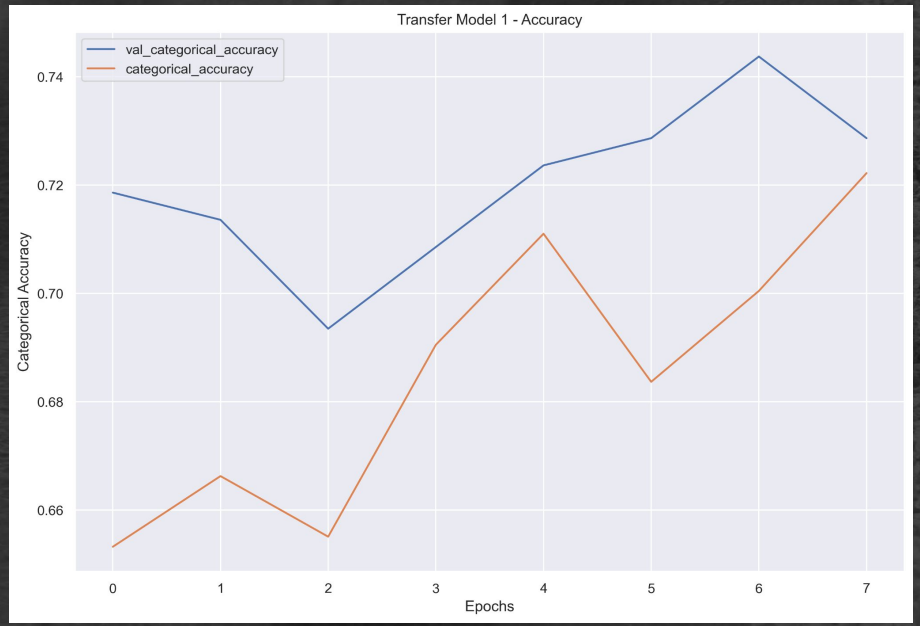
Data

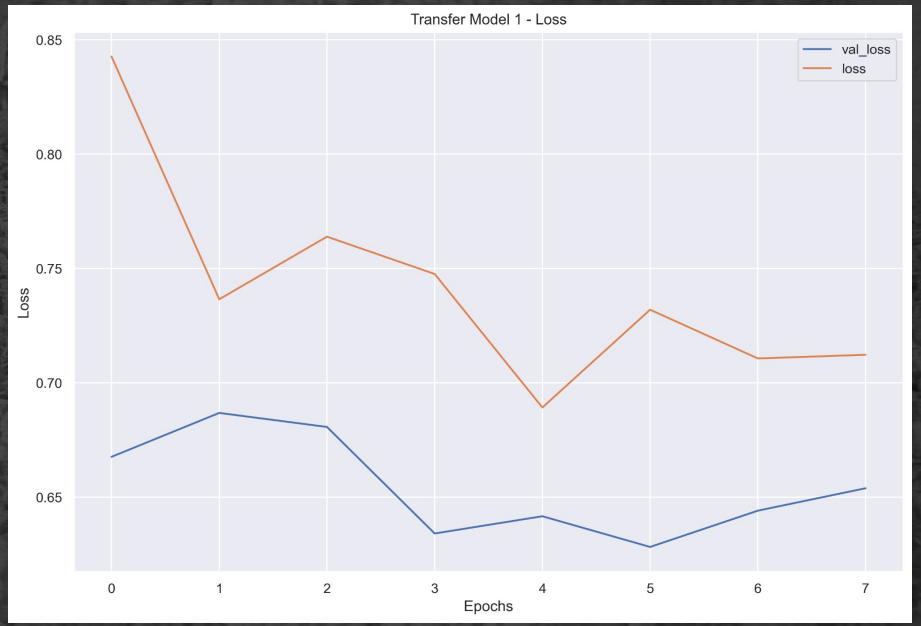

Incorrect Image Prediction - Explainer Visualization Masked
Incorrect Image Prediction - Explainer Visualization
Incorrect Image Prediction - Explainer Heatmap by Weights
0.006
0.004
0.002
0.000
−0.002
−0.004
−0.006

Data


Transfer Model 1 - Classification Report
MDF
PC
TFL
VC
accuracy
macro avg
weighted avg
0.50
0.84
0.63
19.00
0.47
0.63
0.54
46.00
0.83
0.63
0.71
107.00
0.87
0.79
0.83
34.00
0.67
0.67
0.72
0.68
206.00
0.72
0.67
0.69
206.00
precision
recall
f1-score
support
1.0
0.8
0.6
0.4
0.2
0.0

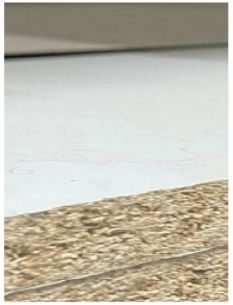
Data


Transfer Model 1 - Accuracy
val_categorical_accuracy
categorical_accuracy
Categorical Accuracy
0.74
0.72
0.70
0.68
0.66
0
1
2
3
4
5
6
7
Epochs


Transfer Model 1 - Loss
val_loss
loss
Loss
0.85
0.80
0.75
0.70
0.65
0
1
2
3
4
5
6
7
Epochs

Data

Predicted Class 2.0
Class Probabilities
[7.3895621e-04 1.7263006e-02 9.0939170e-01 7.2606310e-02]
Actual Class 2.0



Predicted Class 2.0
Class Probabilities
[0.00211949 0.04386708 0.9339769 0.02003648]
Actual Class 2.0

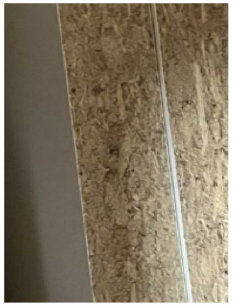
Predicted Class 3.0
Class Probabilities
[4.7517220e-13 1.2565894e-15 3.2047959e-18 1.0000000e+00]
Actual Class 3.0

Predicted Class 0.0
Class Probabilities
[0.94563746 0.04523665 0.00280008 0.00632574]
Actual Class 0.0

Predicted Class 3.0
Class Probabilities
[2.0396615e-07 8.1974543e-09 3.9274298e-10 9.9999976e-01]
Actual Class 3.0

Predicted Class 2.0
Class Probabilities
[0.01709751 0.322497   0.63659513 0.02381043]
Actual Class 2.0

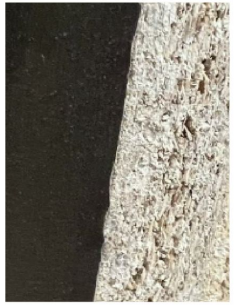
Predicted Class 2.0
Class Probabilities
[0.00535782 0.05669128 0.9181479 0.01980296]
Actual Class 2.0



Predicted Class 2.0
Class Probabilities
[0.00185509 0.04930112 0.910634   0.03820993]
Actual Class 2.0

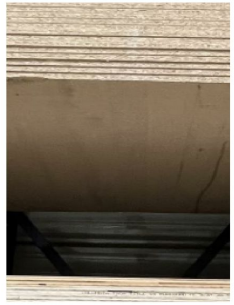
Data

Predicted Class 1.0
Class Probabilities
[0.00144711 0.67981774 0.31168923 0.00704592]
Actual Class 2.0



Predicted Class 2.0
Class Probabilities
[0.00096951 0.12047435 0.8758613 0.00269485]
Actual Class 1.0

Predicted Class 2.0
Class Probabilities
[6.9177937e-04 2.9557666e-02 9.5574236e-01 1.4008219e-02]
Actual Class 1.0



Predicted Class 1.0
Class Probabilities
[0.01878139 0.67850286 0.27447474 0.02824103]
Actual Class 2.0

Predicted Class 1.0
Class Probabilities
[0.26434466 0.69682664 0.03191096 0.00691778]
Actual Class 0.0

Predicted Class 2.0
Class Probabilities
[0.00886629 0.174915   0.80340356 0.01281517]
Actual Class 1.0

Predicted Class 0.0
Class Probabilities
[0.95940053 0.03071805 0.0037238 0.00615769]
Actual Class 2.0

Predicted Class 2.0
Class Probabilities
[0.01416221 0.11130761 0.8083749 0.06615534]
Actual Class 1.0