

Vehicle Damage Detection



GROUP 3:

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Project Overview: Car Damage Detection–Image Classification

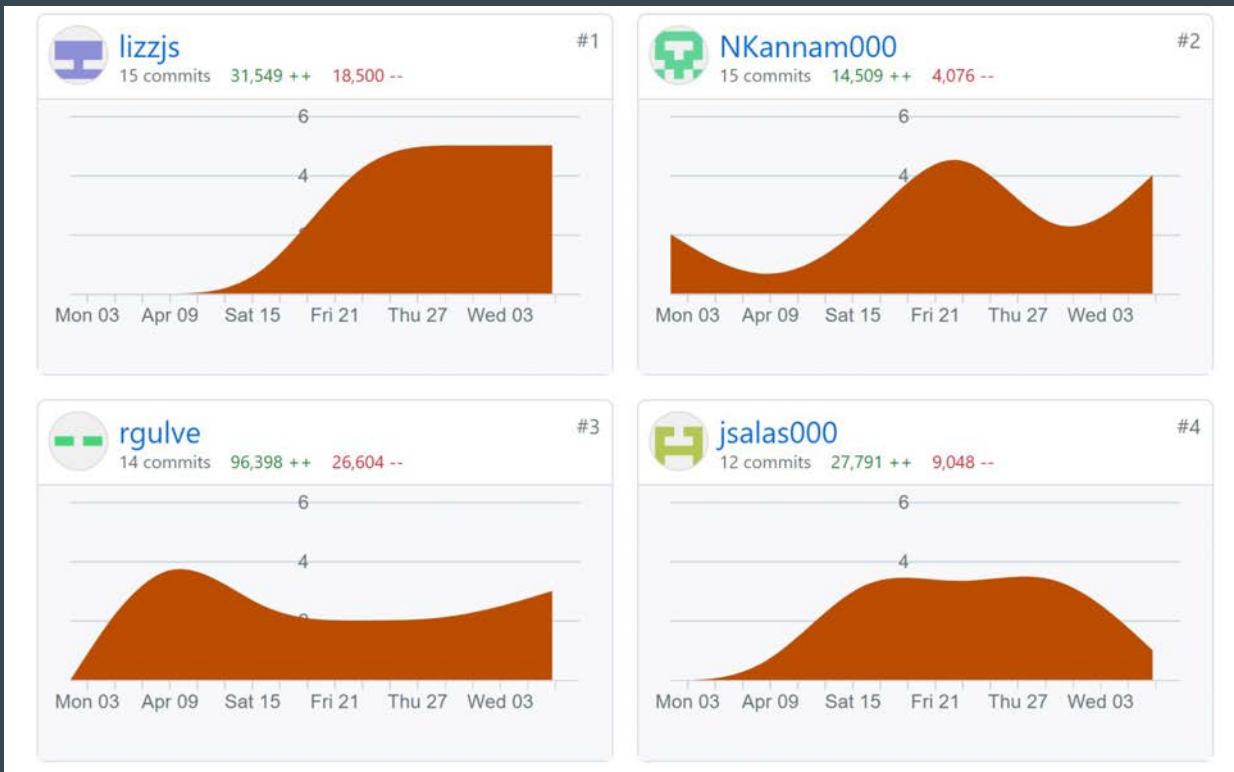
Data:

- Current format:
 - Numpy array
- Classification labels:
 - 0 - Minor,
 - 1 - Moderate,
 - 2 - Severe
- Number of images:
 - 8,000
- Image size:
 - 128x128

Summary of this week's tasks/goals:

- Statistics/Histograms of images for feature extraction
- CNN for feature engineering and Machine Learning
- Begin Deep Learning Modeling

Contributions



Statistical Approach - RF

Histograms, SHI-TOMASI -Corners, Gaussian Filter, Sato , sobel and Moments

Gray Level Co-Occurrence Matrix (GLCM) – energy, correlation, dissimilarity, homogeneity

190+ Features

Training

```
Accuracy = 1.0
Accuracy =          precision    recall  f1-score   support

    0.0         1.00        1.00        1.00        1487
    1.0         1.00        1.00        1.00        1513
    2.0         1.00        1.00        1.00        1537

 accuracy          1.00          1.00          1.00          4537
 macro avg         1.00          1.00          1.00          4537
 weighted avg      1.00          1.00          1.00          4537
```

Validation

```
Accuracy = 0.6186384666226041
Accuracy =          precision    recall  f1-score   support

    0.0         0.68        0.69        0.69         496
    1.0         0.55        0.49        0.52         505
    2.0         0.61        0.67        0.64         512

 accuracy          0.62          0.62          0.62          1513
 macro avg         0.62          0.62          0.62          1513
 weighted avg      0.62          0.62          0.62          1513
```

Statistical Approach - RF

19 Features

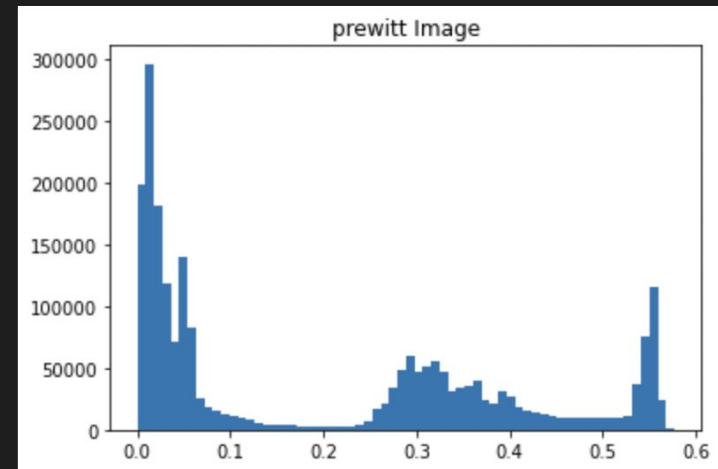
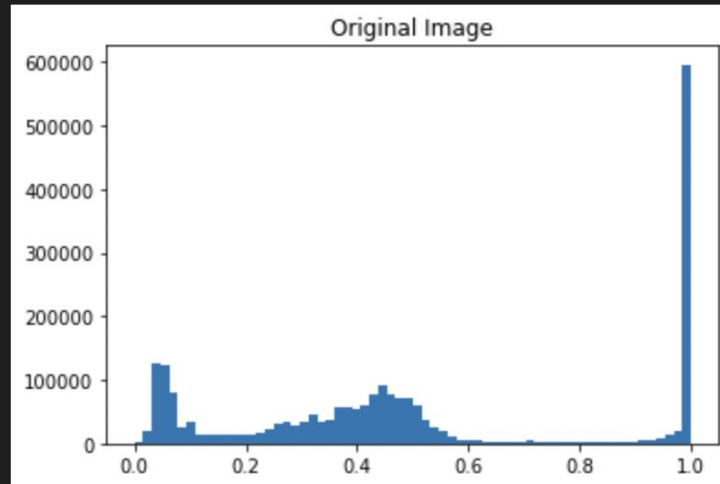
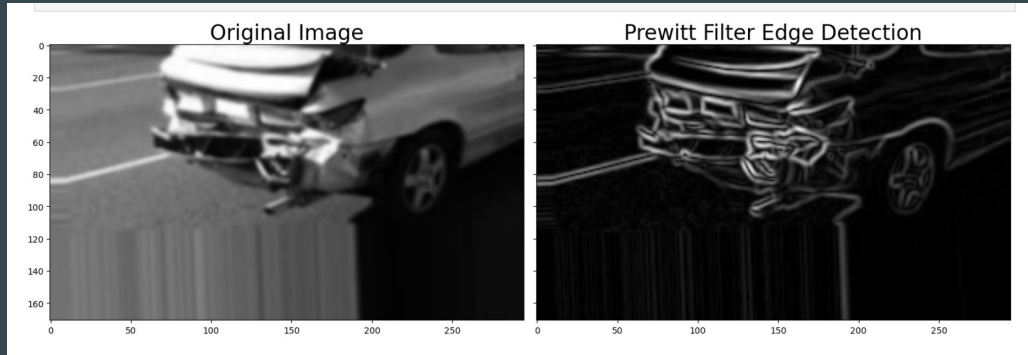
Training

Accuracy = 1.0					
Accuracy =		precision	recall	f1-score	support
0.0	1.00	1.00	1.00	1.00	1487
1.0	1.00	1.00	1.00	1.00	1513
2.0	1.00	1.00	1.00	1.00	1537
accuracy			1.00	4537	
macro avg	1.00	1.00	1.00	4537	
weighted avg	1.00	1.00	1.00	4537	

Validation

Accuracy = 0.6113681427627231					
Accuracy =		precision	recall	f1-score	support
0.0	0.67	0.71	0.69	0.69	496
1.0	0.53	0.48	0.50	0.50	505
2.0	0.62	0.65	0.63	0.63	512
accuracy			0.61	1513	
macro avg	0.61	0.61	0.61	1513	
weighted avg	0.61	0.61	0.61	1513	

Histograms on Prewitt Edge Detection



Random Forest Accuracy/Classification Reports

```
Testing
Accuracy for Random Forest: 0.432967032967033
Classification Report
      precision    recall  f1-score   support

     0       0.52      0.43      0.47       149
     1       0.34      0.39      0.36       140
     2       0.45      0.48      0.46       166

 accuracy          0.43      455
 macro avg       0.44      0.43      0.43      455
 weighted avg    0.44      0.43      0.44      455
```

```
Training
Accuracy for Random Forest: 0.6270066100094429
Classification Report
      precision    recall  f1-score   support

     0       0.70      0.63      0.66       347
     1       0.61      0.57      0.59       365
     2       0.59      0.69      0.63       347

 accuracy          0.63      1059
 macro avg       0.63      0.63      0.63      1059
 weighted avg    0.63      0.63      0.63      1059
```

```
Testing
Accuracy for Random Forest: 0.5348017621145374
Classification Report
      precision    recall  f1-score   support

     0.0       0.59      0.65      0.62       359
     1.0       0.47      0.33      0.39       396
     2.0       0.52      0.63      0.57       380

 accuracy          0.53      1135
 macro avg       0.53      0.54      0.53      1135
 weighted avg    0.53      0.53      0.52      1135
```

```
Training
Accuracy for Random Forest: 0.6018133736305251
Classification Report
      precision    recall  f1-score   support

     0.0       0.63      0.70      0.66       869
     1.0       0.54      0.36      0.44       871
     2.0       0.61      0.73      0.67       907

 accuracy          0.60      2647
 macro avg       0.59      0.60      0.59      2647
 weighted avg    0.59      0.60      0.59      2647
```

Last week's result (**without** histograms/statistics)

This week's result (**with** histograms/statistics)

CNN to Extract Features

RandomForestClassifier - Training Accuracy: 0.88
RandomForestClassifier - Validation Accuracy: 0.63

	precision	recall	f1-score	support
0	0.68	0.79	0.73	463
1	0.53	0.63	0.57	540
2	0.77	0.51	0.61	511
accuracy			0.63	1514
macro avg	0.66	0.64	0.64	1514
weighted avg	0.66	0.63	0.63	1514

AdaBoostClassifier - Training Accuracy: 0.65
AdaBoostClassifier - Validation Accuracy: 0.63

	precision	recall	f1-score	support
0	0.68	0.79	0.73	463
1	0.53	0.63	0.57	540
2	0.77	0.51	0.61	511
accuracy			0.63	1514
macro avg	0.66	0.64	0.64	1514
weighted avg	0.66	0.63	0.63	1514

Deep Learning

Running 100 epochs on VGG Model

Accuracy over the test set:
63.28 %

```
190/190 [=====] - 10s 55ms/step - loss: 0.5244 - accuracy: 0.7802 - val_loss: 1.5999 - val_accuracy: 0.6783
Epoch 84/100
190/190 [=====] - 10s 54ms/step - loss: 0.5282 - accuracy: 0.7796 - val_loss: 1.3712 - val_accuracy: 0.6731
Epoch 85/100
190/190 [=====] - 10s 52ms/step - loss: 0.5258 - accuracy: 0.7792 - val_loss: 1.4621 - val_accuracy: 0.6697
Epoch 86/100
190/190 [=====] - 11s 57ms/step - loss: 0.5183 - accuracy: 0.7849 - val_loss: 1.4043 - val_accuracy: 0.6810
Epoch 87/100
190/190 [=====] - 10s 53ms/step - loss: 0.5269 - accuracy: 0.7789 - val_loss: 1.5426 - val_accuracy: 0.6830
Epoch 88/100
190/190 [=====] - 10s 51ms/step - loss: 0.5228 - accuracy: 0.7802 - val_loss: 1.4393 - val_accuracy: 0.6783
Epoch 89/100
190/190 [=====] - 10s 52ms/step - loss: 0.5139 - accuracy: 0.7854 - val_loss: 1.5427 - val_accuracy: 0.6731
Epoch 90/100
190/190 [=====] - 10s 55ms/step - loss: 0.5220 - accuracy: 0.7814 - val_loss: 1.3809 - val_accuracy: 0.6764
Epoch 91/100
190/190 [=====] - 11s 58ms/step - loss: 0.5142 - accuracy: 0.7890 - val_loss: 1.4839 - val_accuracy: 0.6836
Epoch 92/100
190/190 [=====] - 10s 51ms/step - loss: 0.5072 - accuracy: 0.7897 - val_loss: 1.9278 - val_accuracy: 0.6691
Epoch 93/100
190/190 [=====] - 10s 52ms/step - loss: 0.5159 - accuracy: 0.7845 - val_loss: 1.6060 - val_accuracy: 0.6797
Epoch 94/100
190/190 [=====] - 10s 52ms/step - loss: 0.5081 - accuracy: 0.7941 - val_loss: 1.4536 - val_accuracy: 0.6731
Epoch 95/100
190/190 [=====] - 10s 51ms/step - loss: 0.4957 - accuracy: 0.7978 - val_loss: 1.4746 - val_accuracy: 0.6717
Epoch 96/100
190/190 [=====] - 10s 54ms/step - loss: 0.5033 - accuracy: 0.7936 - val_loss: 1.4960 - val_accuracy: 0.6731
Epoch 97/100
190/190 [=====] - 10s 51ms/step - loss: 0.5083 - accuracy: 0.7908 - val_loss: 1.3787 - val_accuracy: 0.6770
Epoch 98/100
190/190 [=====] - 10s 52ms/step - loss: 0.5190 - accuracy: 0.7862 - val_loss: 1.5278 - val_accuracy: 0.6704
Epoch 99/100
190/190 [=====] - 10s 54ms/step - loss: 0.5122 - accuracy: 0.7878 - val_loss: 1.3029 - val_accuracy: 0.6750
Epoch 100/100
190/190 [=====] - 10s 54ms/step - loss: 0.5114 - accuracy: 0.7877 - val_loss: 1.5636 - val_accuracy: 0.6750
```

Running 200 epochs on VGG Model

Accuracy over the test set:
68.49 %

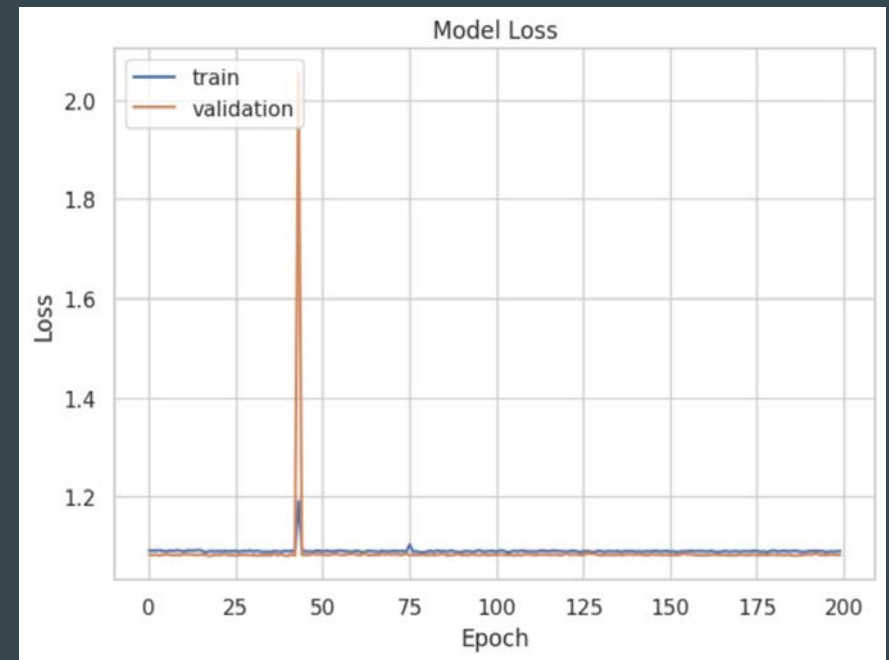
```
190/190 [=====] - 10s 52ms/step - loss: 0.4357 - accuracy: 0.8163 - val_loss: 2.2259 - val_accuracy: 0.6754
Epoch 184/200
190/190 [=====] - 11s 56ms/step - loss: 0.4486 - accuracy: 0.8087 - val_loss: 2.0987 - val_accuracy: 0.6711
Epoch 185/200
190/190 [=====] - 10s 52ms/step - loss: 0.4512 - accuracy: 0.8067 - val_loss: 2.3012 - val_accuracy: 0.6717
Epoch 186/200
190/190 [=====] - 11s 55ms/step - loss: 0.4532 - accuracy: 0.8054 - val_loss: 2.0847 - val_accuracy: 0.6684
Epoch 187/200
190/190 [=====] - 10s 52ms/step - loss: 0.4398 - accuracy: 0.8130 - val_loss: 1.9855 - val_accuracy: 0.6625
Epoch 188/200
190/190 [=====] - 10s 52ms/step - loss: 0.4468 - accuracy: 0.8095 - val_loss: 2.2388 - val_accuracy: 0.6717
Epoch 189/200
190/190 [=====] - 10s 55ms/step - loss: 0.4448 - accuracy: 0.8116 - val_loss: 1.9760 - val_accuracy: 0.6711
Epoch 190/200
190/190 [=====] - 10s 52ms/step - loss: 0.4396 - accuracy: 0.8135 - val_loss: 2.1845 - val_accuracy: 0.6717
Epoch 191/200
190/190 [=====] - 10s 52ms/step - loss: 0.4402 - accuracy: 0.8141 - val_loss: 2.0553 - val_accuracy: 0.6731
Epoch 192/200
190/190 [=====] - 11s 56ms/step - loss: 0.4361 - accuracy: 0.8171 - val_loss: 2.0331 - val_accuracy: 0.6790
Epoch 193/200
190/190 [=====] - 10s 55ms/step - loss: 0.4341 - accuracy: 0.8164 - val_loss: 1.9653 - val_accuracy: 0.6671
Epoch 194/200
190/190 [=====] - 11s 55ms/step - loss: 0.4313 - accuracy: 0.8206 - val_loss: 2.0683 - val_accuracy: 0.6664
Epoch 195/200
190/190 [=====] - 11s 56ms/step - loss: 0.4403 - accuracy: 0.8120 - val_loss: 2.1537 - val_accuracy: 0.6598
Epoch 196/200
190/190 [=====] - 10s 52ms/step - loss: 0.4355 - accuracy: 0.8159 - val_loss: 1.9168 - val_accuracy: 0.6651
Epoch 197/200
190/190 [=====] - 10s 52ms/step - loss: 0.4352 - accuracy: 0.8144 - val_loss: 2.0982 - val_accuracy: 0.6671
Epoch 198/200
190/190 [=====] - 10s 52ms/step - loss: 0.4465 - accuracy: 0.8098 - val_loss: 2.0633 - val_accuracy: 0.6697
Epoch 199/200
190/190 [=====] - 10s 53ms/step - loss: 0.4345 - accuracy: 0.8174 - val_loss: 2.1141 - val_accuracy: 0.6764
Epoch 200/200
190/190 [=====] - 10s 52ms/step - loss: 0.4319 - accuracy: 0.8196 - val_loss: 1.9851 - val_accuracy: 0.6691
```

Plotting Training and Validation Loss for VGG Model

```
history = model.fit(X_train, y_train, validation_split=0.1, epochs=50, batch_size=4)
```



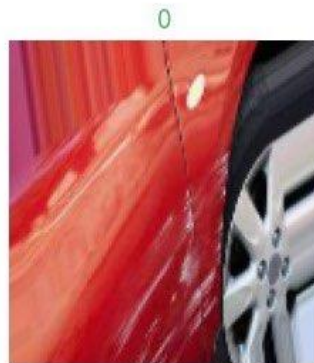
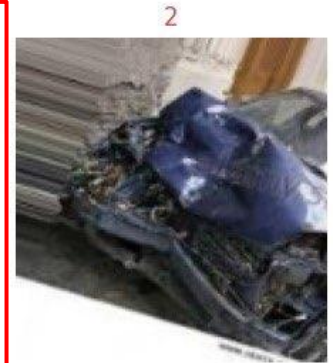
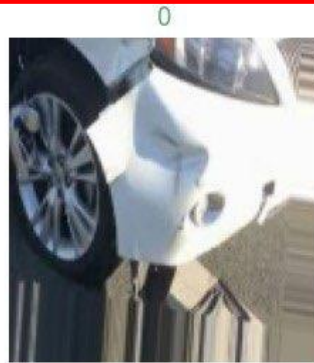
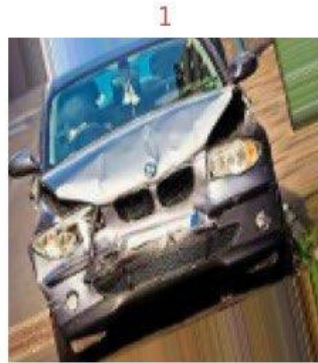
```
history = model.fit(X_train, y_train, validation_split=0.1, epochs=200, batch_size=4)
```



Deep Learning VGG Model – Classifying Images

Classification Labels:

- 0 - Minor
- 1 - Moderate
- 2 - Severe



misclassified