
Vehicle image classification using CNN to determine vehicle make & model

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Problem Statement

Vehicle image classification using CNN to determine vehicle make & model

- Aims to develop an effective and precise VMMR model
- Existing Challenges
 - Outdoor Environment
 - Shadow and Reflections
 - Visual similarities between model of same manufacturer
 - Visual similarities between model of different manufacturer
- Modeling and Metric



Workflow

→ Image Collection

- ◆ Toyota Camry 2007 base model (1174)
- ◆ Random Car models (906)

→ Exploratory Data Analysis

→ Model preparation

→ Modeling

- ◆ Baseline model
- ◆ CNN model 1 (Original images)
- ◆ CNN model 2 (Augmented images)

→ Model selection

- ◆ Accuracy

→ Model Evaluation

- ◆ Misclassification
- ◆ Visual Activation layers

→ Conclusion

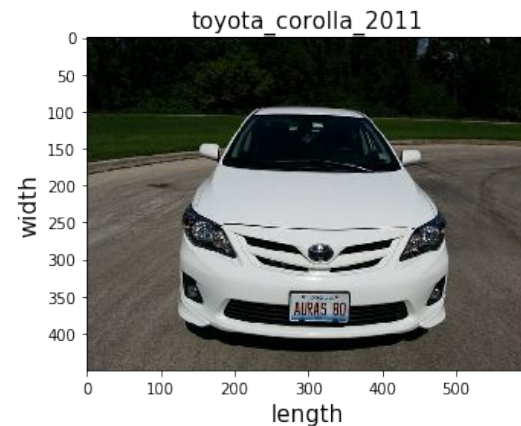
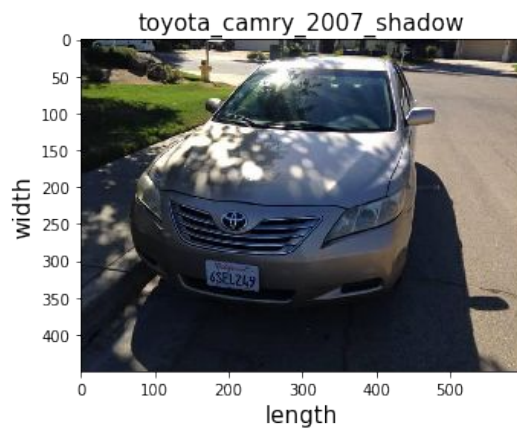
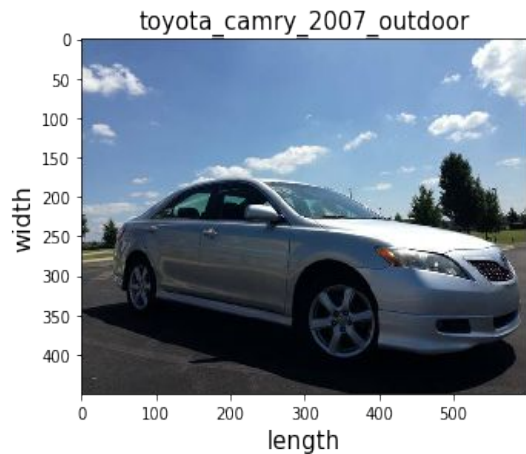
→ Recommendation

→ Prediction



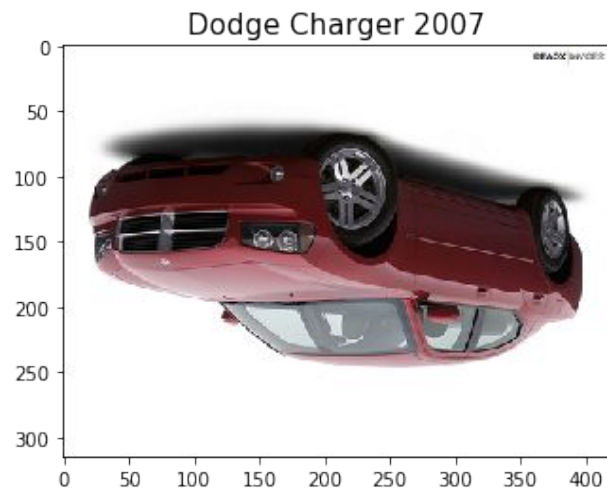
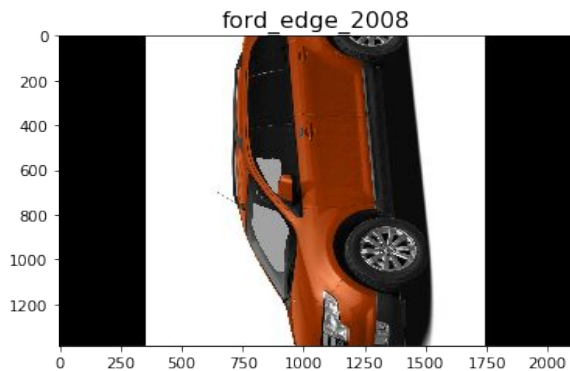
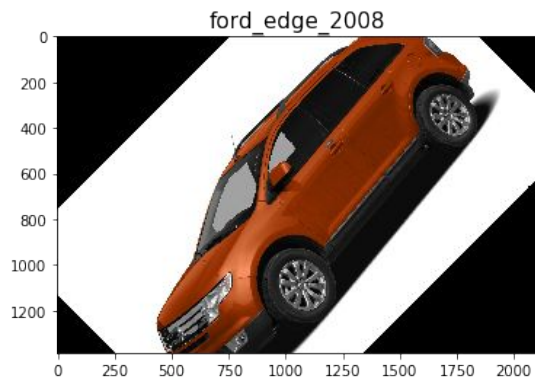
Glimpse of Images

Car images with challenges



Glimpse of Images

Rotation and Flipping



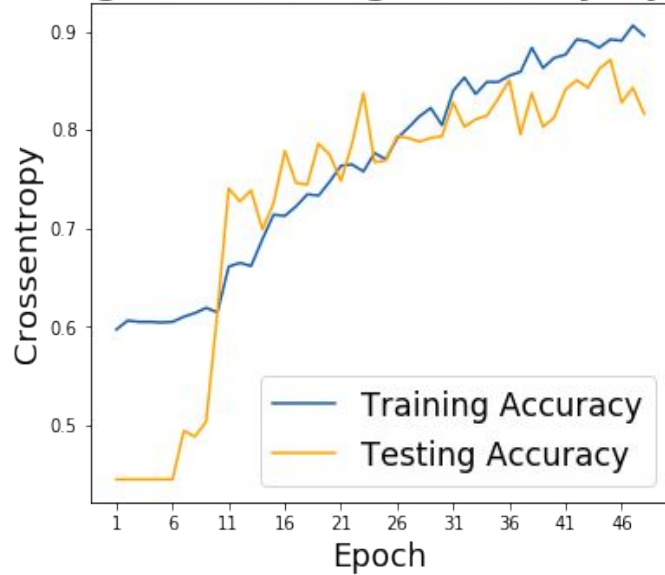
Modeling

1. **Baseline Model**
 2. **Convolutional Neural Network (CNN) Model 1: with original images**
 3. **Convolutional Neural Network (CNN) Model 2: With augmented images**
- Our models have all together 20 layers including convolutional layers, pooling layers, dropouts, flatten layers and dense layers
 - Our model uses over 130,000 parameters. Most of the parameters come from the second convolutional layer.



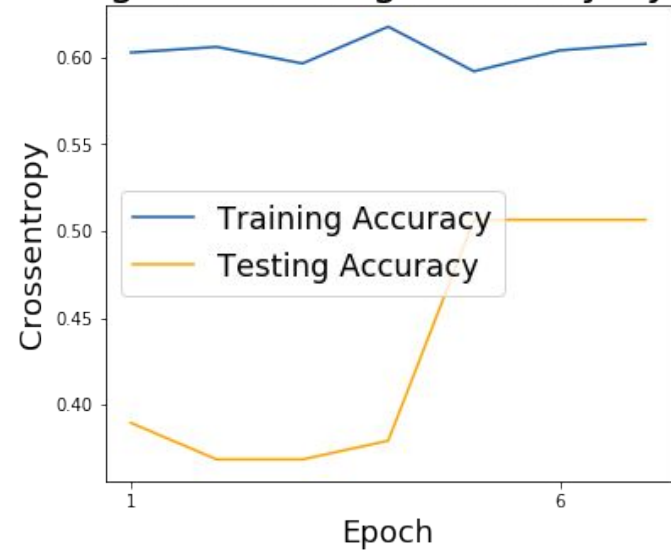
Accuracy Graphs

Training and Testing Accuracy by Epoch



CNN Model 1

Training and Testing Accuracy by Epoch



CNN Model 2



Model Selection

Model	Accuracy on test set	Accuracy on train set
Baseline Model	60.5%	55.5%
CNN Model 1	89.2%	87.1%
CNN Model 2	60.8%	50.6%



Model Evaluation

Investigating misclassified images:

False Positive:

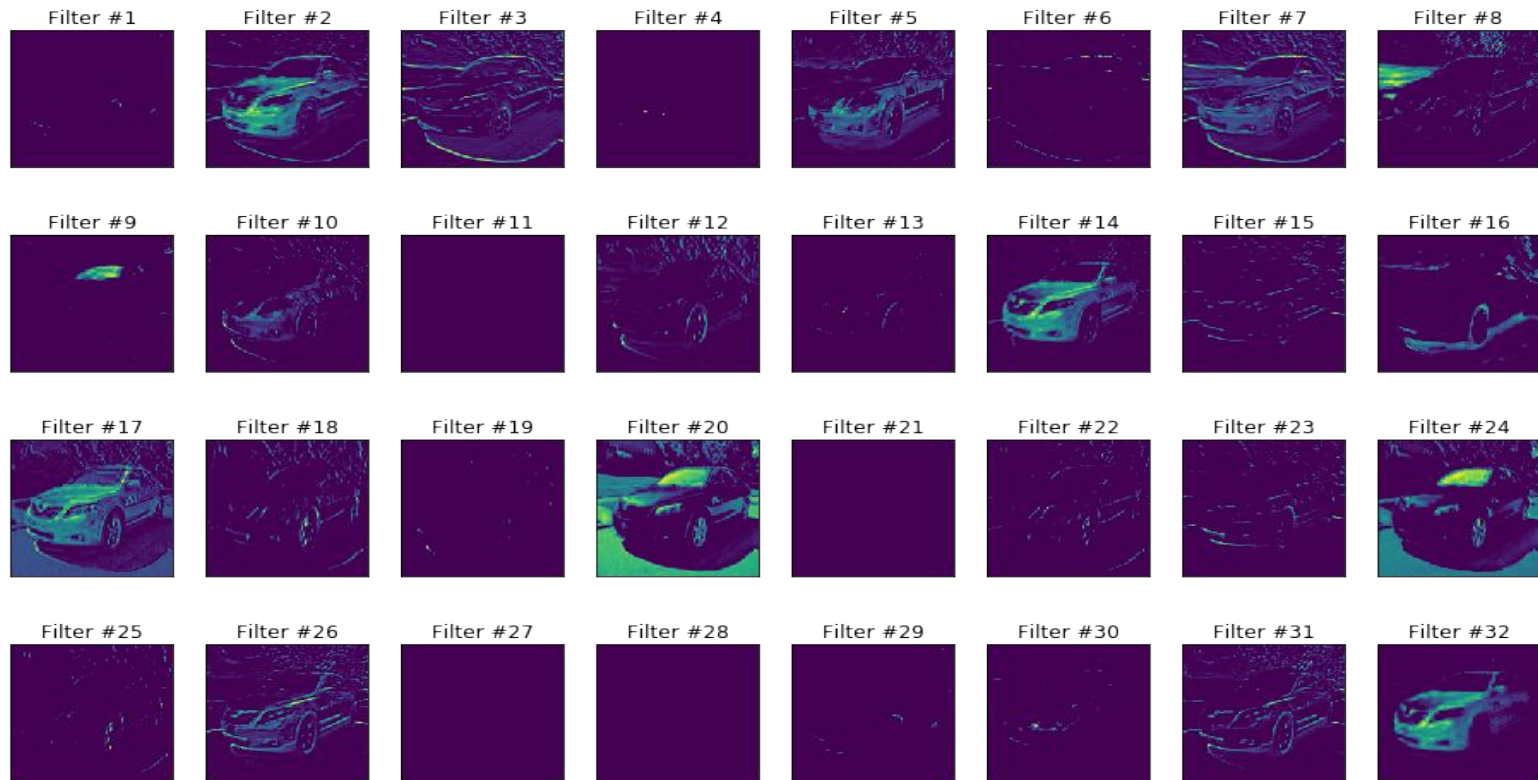


False Negative:



CNN Activation Visualization

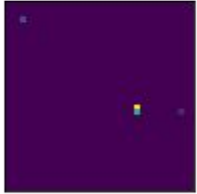
Convolutional Layer #1



CNN Activation Visualization

Convolutional Layer #3

Filter #1



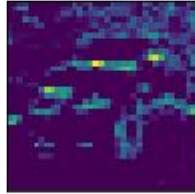
Filter #2



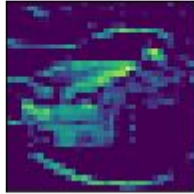
Filter #3



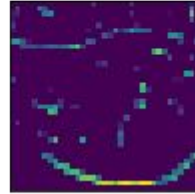
Filter #4



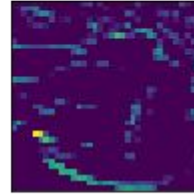
Filter #5



Filter #6



Filter #7



Filter #8



Conclusion and Recommendation

★ **Best model : CNN Model with original images**

★ **Future Steps**

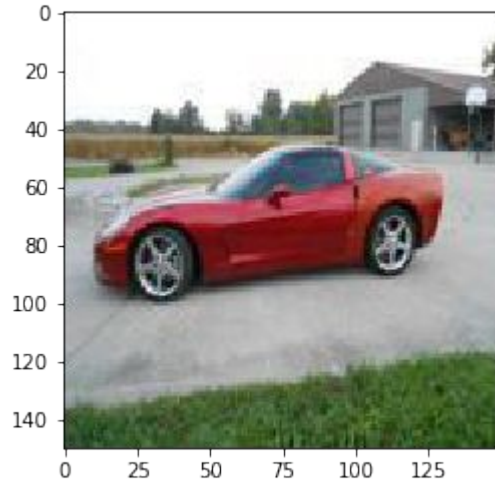
- **Multi Classifications**
- **Improve accuracy**
 - What we need to achieve that?
 - More Images
 - More Images
 - More Images
 - High resolution images
 - Images with different surroundings



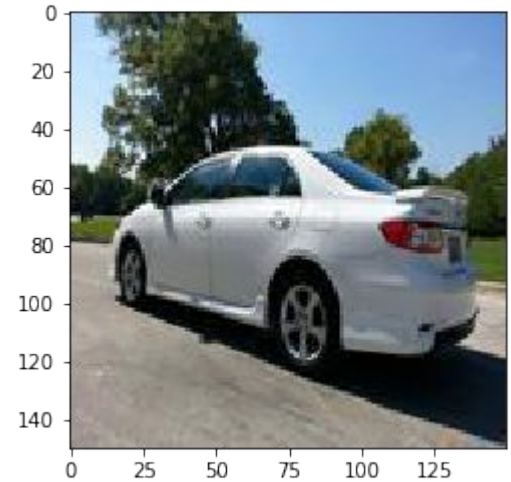
Predictions



Predicted Class [1]



Predicted Class [0]



Predicted Class [0]



Thank you

