# VGG NET Convolutional Neural Network Report

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### Dataset information

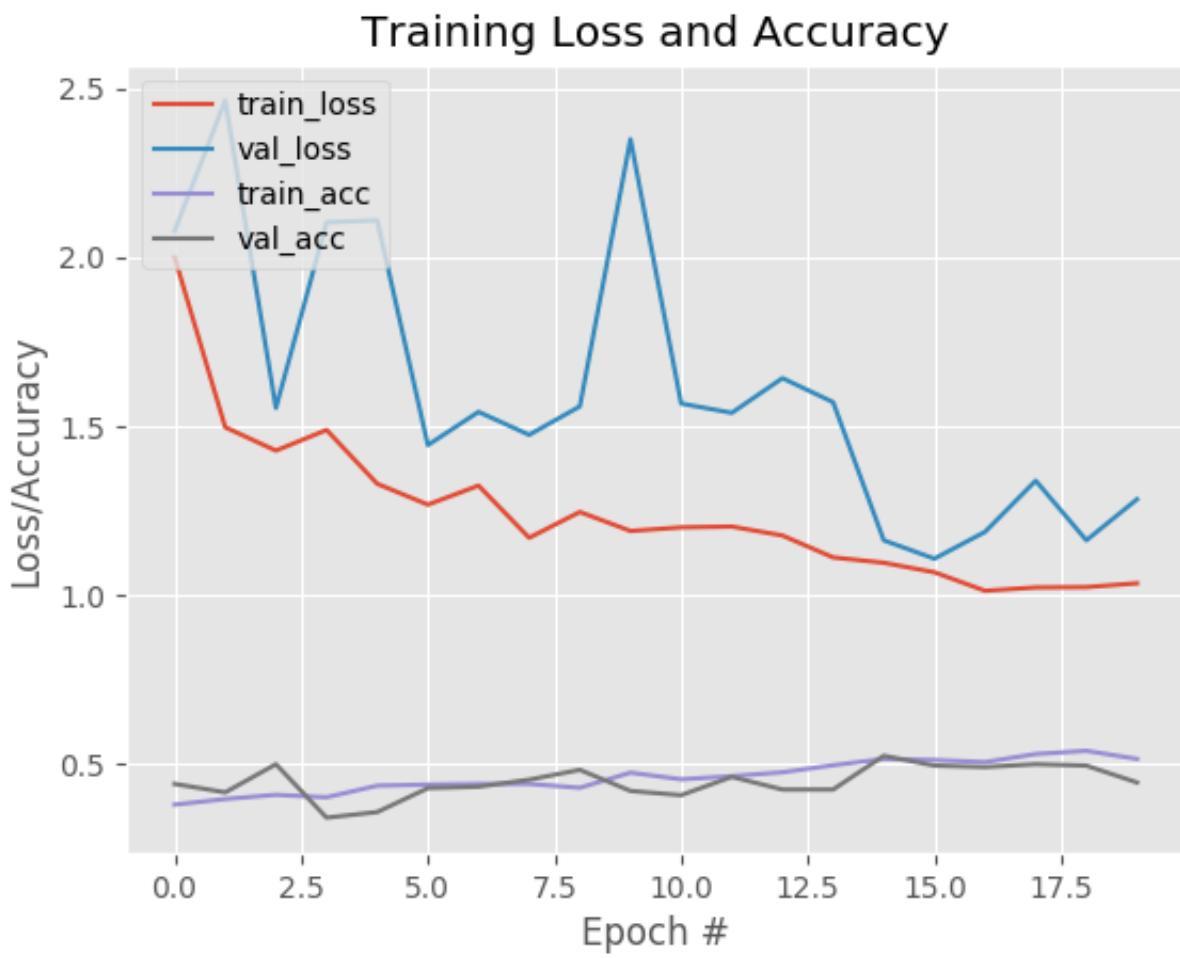
Our Data consists of three datasets Ford, Porsche, and Lexus. Each dataset contains 400 images sourced from Google. We have set aside 1 clean, 1 noisy images, and 1 nonsense image per car manufacturer. We choose these datasets because we want to test how well the CNN can differentiate between the subtle design differences of these car manufacturers.

Ford's design derives from the classical American muscle car, Porsches's design derives from the European sports luxury car, and Lexus derives from the Japanese practical luxury car. These cars are priced at very different price points and appeal to very distinct audiences. It would be very interesting to see if the CNN can pick up the visual subtleties that these manufactures employ in their design.

## Network Training

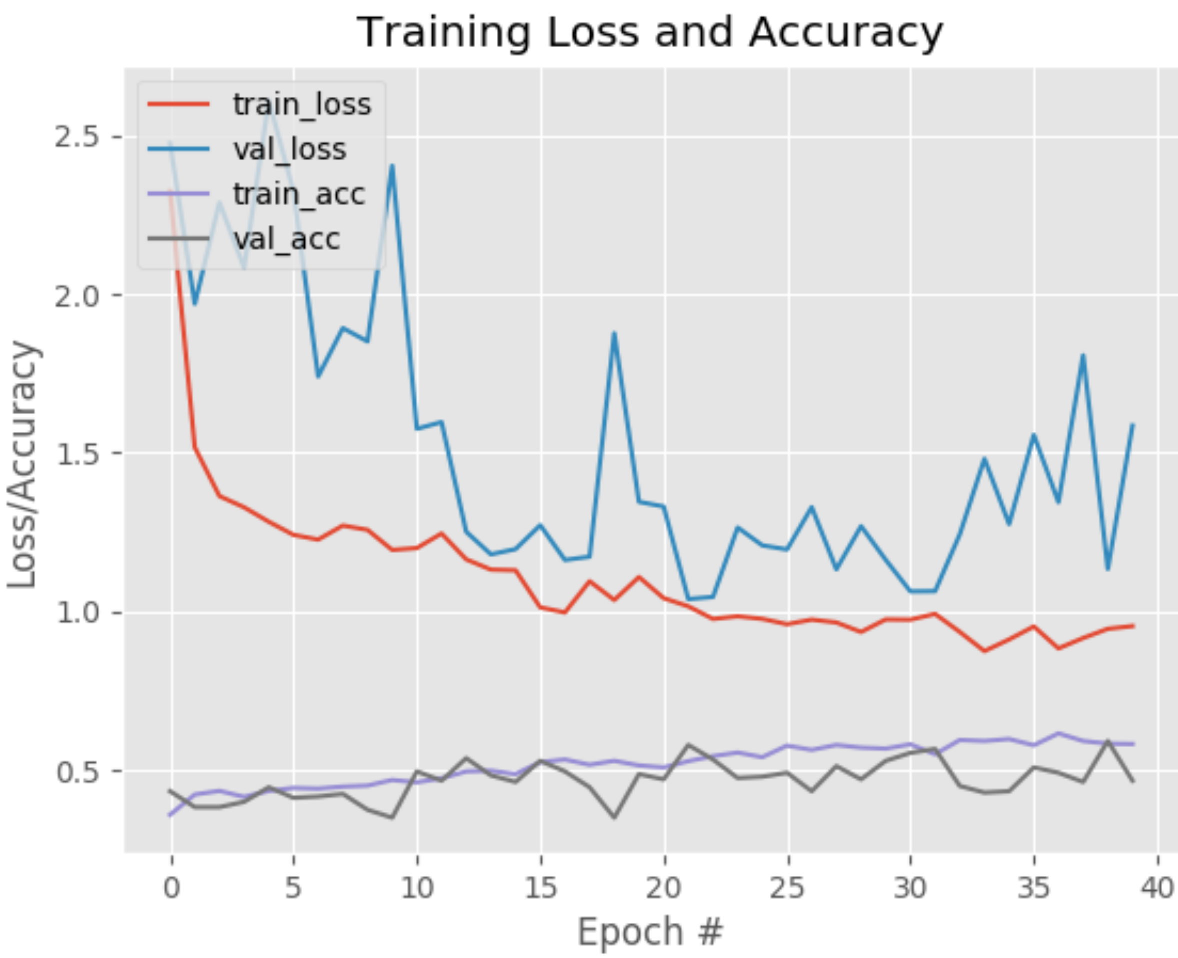
### *Trial 1*

We start by training the network with 20 epochs, 80% Train - 20% Test split, 96x96 image size, convolutional filter size of 3, and the ReLU activation function. With these parameters we obtain the following Loss/Accuracy Graph.




The validation set loss has very large spikes most likely due to the small size of the validation set. The validation set is only 80 images. As we expect the loss decreases with more epochs and the accuracy increases.

We can try the training process again with 40 epochs.




We can try the training process again with 80 epochs.


The accuracy seems to increase as we increase epochs. We achieve the greatest accuracy with 80 epochs.

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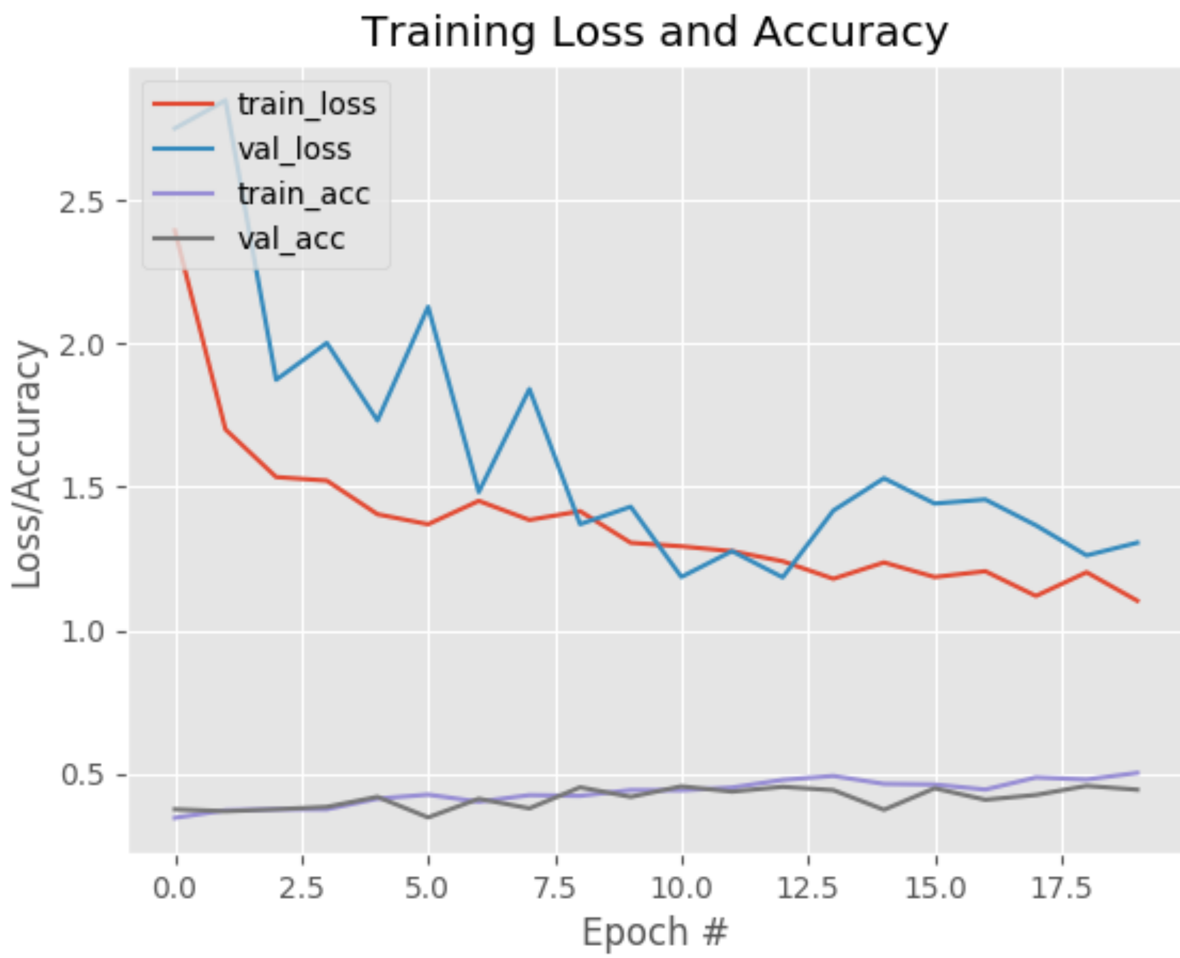
***Trial 2***

We modify trial 1 (20 epochs) by changing the train-test ratio to 50%. We hypothesize that the network will perform poorly at the same number of epochs because it has fewer images to train on.




As We can see the Train and Validation loss has increased over the 80% Train / 20% Test from trial 1. Even over many epochs we see trial 1 results in a lower Train and Validation loss over trial 2. The training accuracy also decreases faster in trial 1 as the number of epochs increases. This is because the training set is so much larger in trial 1 than in trial 2. The accuracy itself is only about 0.5 at 20 epochs. This is much less than trial 1 and we can attribute this to the small training set.

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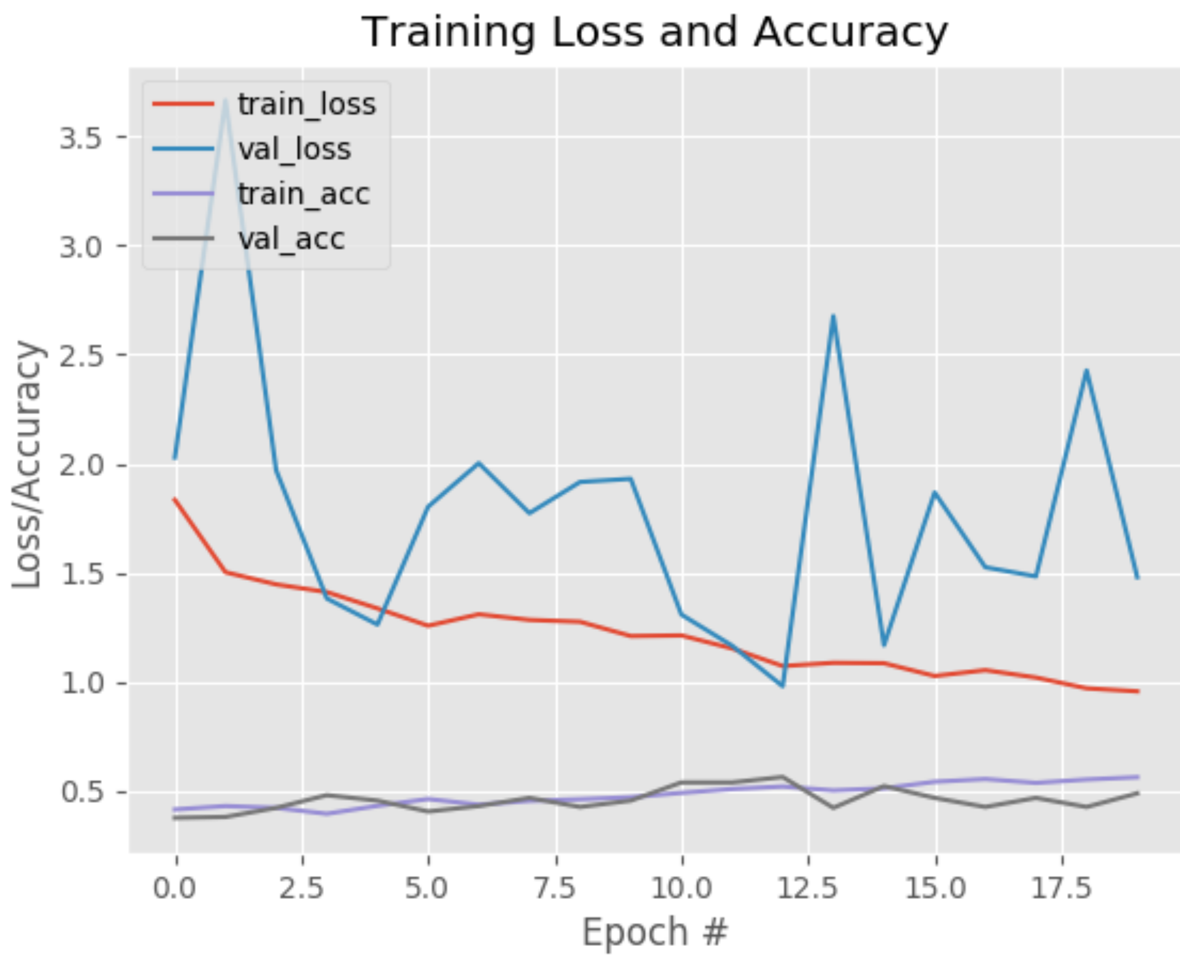
***Trial 3***

We Modify the image size by doubling the x and y dimensions from (96,96) in trial 1 (20 epochs). We keep all other parameters identical in trial 1. The new image size is (192, 192, 3). We hypothesize that doubling the image dimension will help the classifier catch more detail in each dataset and have a lower error as a result. The Training will increase as a results because we have significantly more data to work with.




The accuracy did not increase as much as trial 1. Increasing the image size should allow the CNN to better learn the subtle differences (such as logo) between cars. More epochs could result in a better result. A longer training time will better emphasize these subtle differences.

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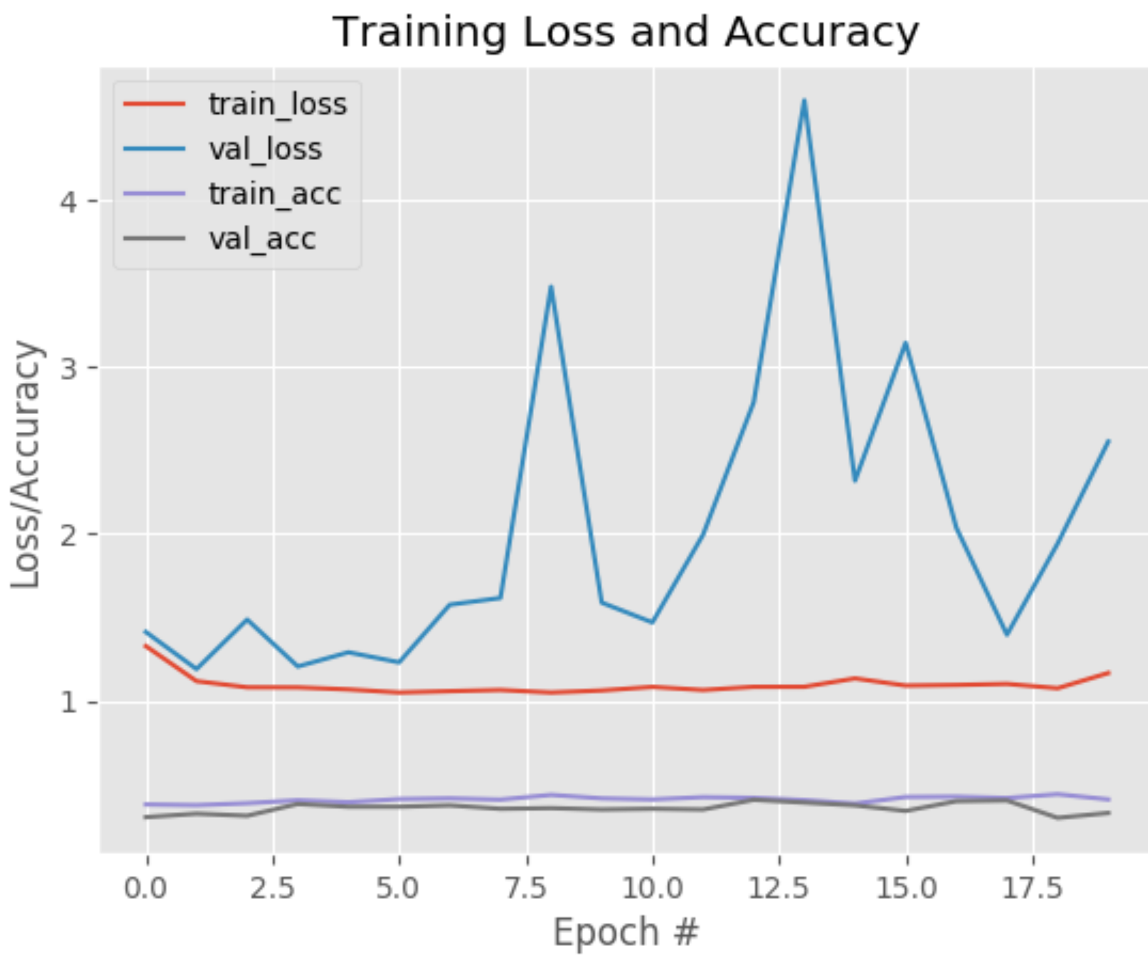
### *Trial 4*

We modify all layers with ReLU activation function with TanH. ReLU is one of the most popular activation functions. ReLU maps all negative values to zero whereas TanH maps negatives to a strongly negative value. The function is monatomic, but its derivative is not. This is unlike ReLU where both the function and its derivative are both monatomic.




The accuracy is much lower than Trial 1 (20 epochs). ReLU seems to perform much better than TanH in accuracy at a similar number of epochs. The accuracy doesn't seem to increase much at all over 20 epochs. The Training loss is also near constant past 2 epochs. Trial one has a decreasing loss over epochs.

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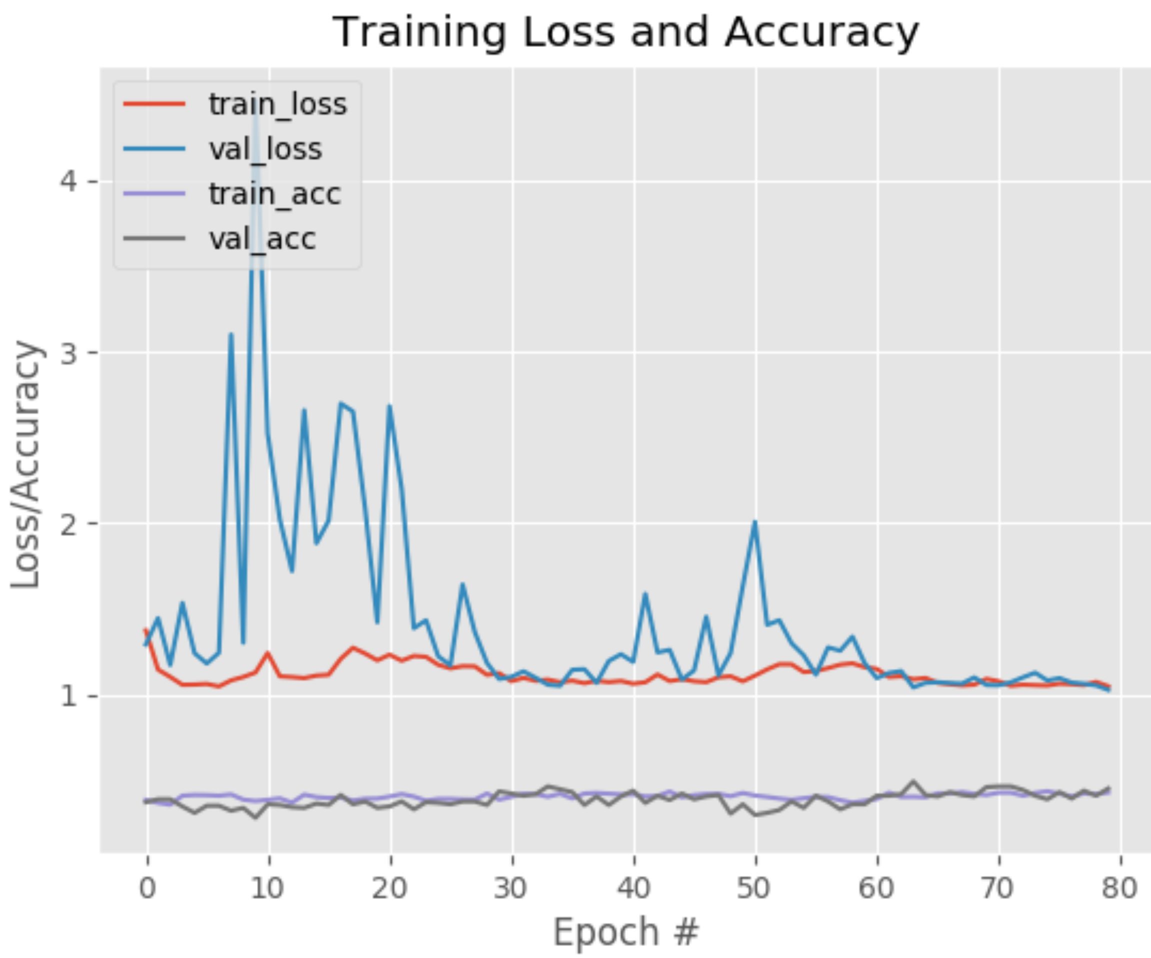
***Trial 5***

We modify trial 4 by increasing the number of epochs to 80. We can get a better idea of how slowly the TanH activation layers train opposed to the ReLU.




The accuracy is slightly better at 80 epochs, but it is far lower than ReLU from trial 1. We can see the loss stabilizes and decreases as we approach 80 epochs.

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### *Conclusion of trainings*

We can conclude the original parameters from trial 1 are ideal. We should keep the activation function as ReLU, keep the image size at 92x92, and keep the train test split at 80:20. We train the model with 80 epochs because it yields the greatest accuracy.

# Network Testing

The model has not seen any of the images discussed in this section. We are attempting to evaluate the models accuracy.

### Easy Image set

This dataset is comprised of easy images. These images show the car very prominently and should be easily recognizable by the classifier.

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We have one image from the Lexus test set. The image is very clean and has no background objects. The model is a Lexus NX and is easily recognizable as a Lexus due to its sharp lines, prominent grille, and L shaped running lights.


The Classifier is very confident in its assertion of the image being a Lexus. The car is very prominent in the photo and very easy to identify.

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We have one clean image from the Porsche test set. This image is has a foliage in the background. The car is the distinctive Porsche 911 GT3 RS. This car is an icon among the Porsche brand and should be easily recognizable due to its high wing, decals, and distinctive color.


The classifier was very accurate in its classification of the GT3 and had very high confidence. Porsche is very well known for this car so this is expected.

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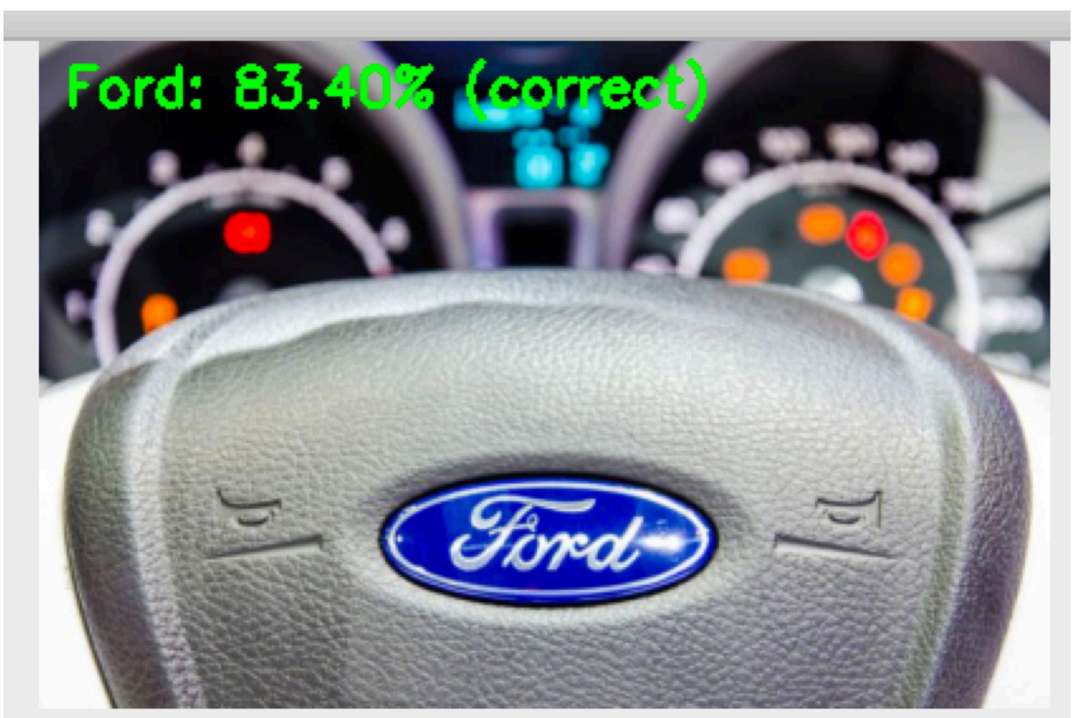
Our last clean "easy" image is from the Ford test set. The image is a the steering wheel of a modern ford car. The logo is very prominent and easily readable.



The classifier accurately classifies the image as a Ford. It isn't as confident as the previous two images most likely due to few training images with this type of photo.

## Hard Image set

This dataset is comprised of difficult images. These images show the car at different angles or show items related to the manufacturer.

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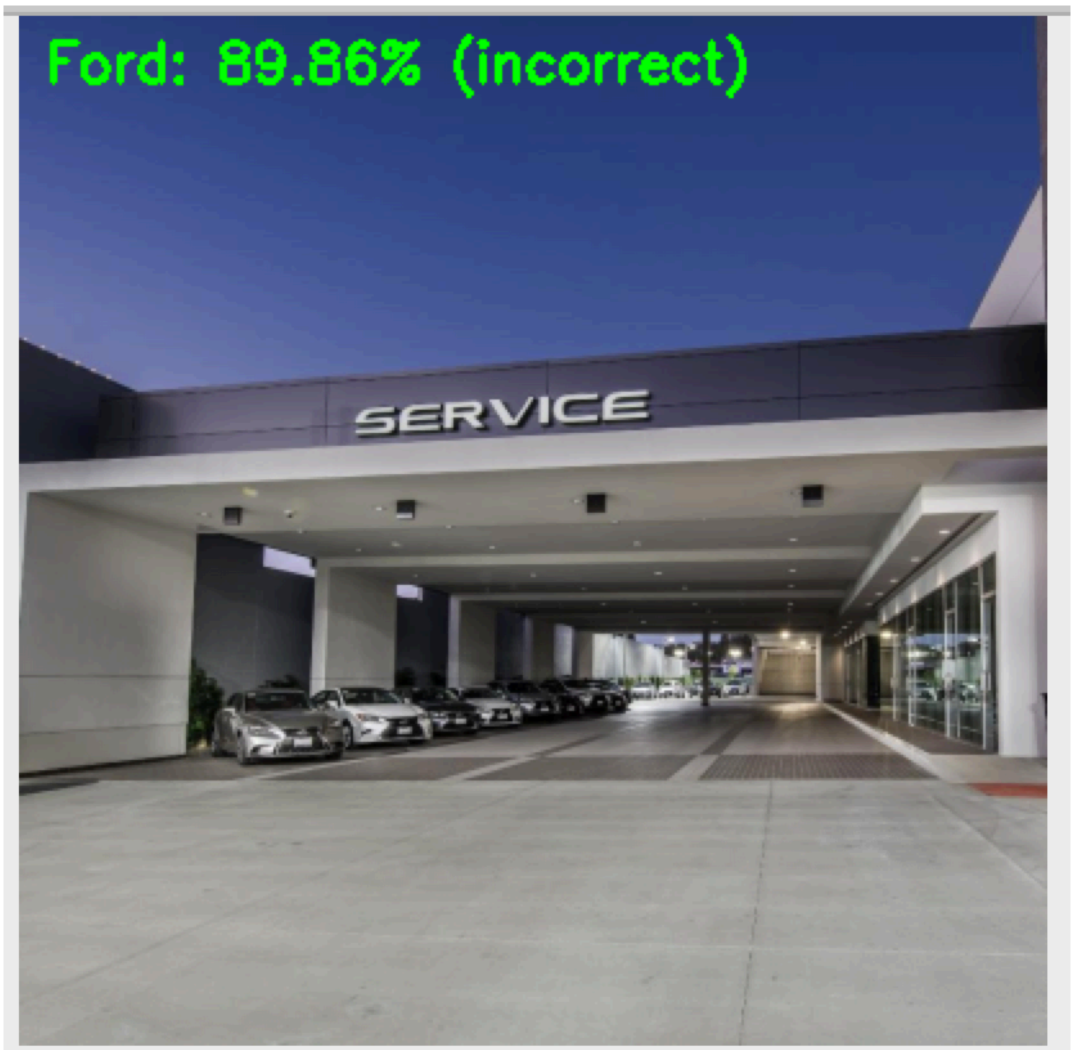
We have one image from the Lexus test set. This image has many cars in the background but is taken to emphasize the Lexus service station. One give away outside of the cars in the distance is the font of the service logo




The classifier inaccurately selected Ford as the category. The training set could have had a larger number of dealer photos with the Ford label. The CNN may have associated buildings with Ford for this reason. Ford cars also tend to be more square than Lexus and Porsche. This may have influenced the classifiers decision.

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We have another image from the Ford test set. This image depicts a Ford dealership but has the cars cut off. Only the tops of the cars are visible and the logo itself.


The Classifier accurately selects Ford, but the classifier has a very low confidence. This image was taken at a strange angle and the Ford logo was shifted. The classifier may have had trouble properly identifying the Logo. The tops of the car displayed are also curved. The Porsche and Lexus tend to apply curved roofs to their models so the classifier may have had trouble differentiating.

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Our last image is of a person holding up an IPhone near a Porsche. This image has the car far in the background where the IPhone is much more prominent.


The classifier incorrectly classified this image as Ford. Although the entire Porsche body was depicted in the image, the classifier may not have been able to identify the logo. The car itself does look similar to a Ford Taurus at some angles.

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## Nonsense image set

This dataset is comprised of nonsense images. We are curious to see how the classifier behaves with new images not related to the training set.

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The first image is a childs toy riding car. This car does have the prominent label Porsche although the design may not follow Porsche design.


We see the classifier did accurately classify this image by the logo as Porsche.

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The second image is of a HotDog. This image should not be classifier with high confidence because it is very different from a automobile.


The classifier is relatively confident that this hotdog is in fact a Ford. Although both products are American this classification was inaccurate. The colors and lines of the image may have confused the classifier.

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The last image is of a Apple Macbook Pro laptop. The classifier should struggle with this item as it is not related to any of the other training images.


The classifier did classify this as a Porsche. Porsche has designed computer equipment in the past so it could be possible that the training set contained a computer related accessory.