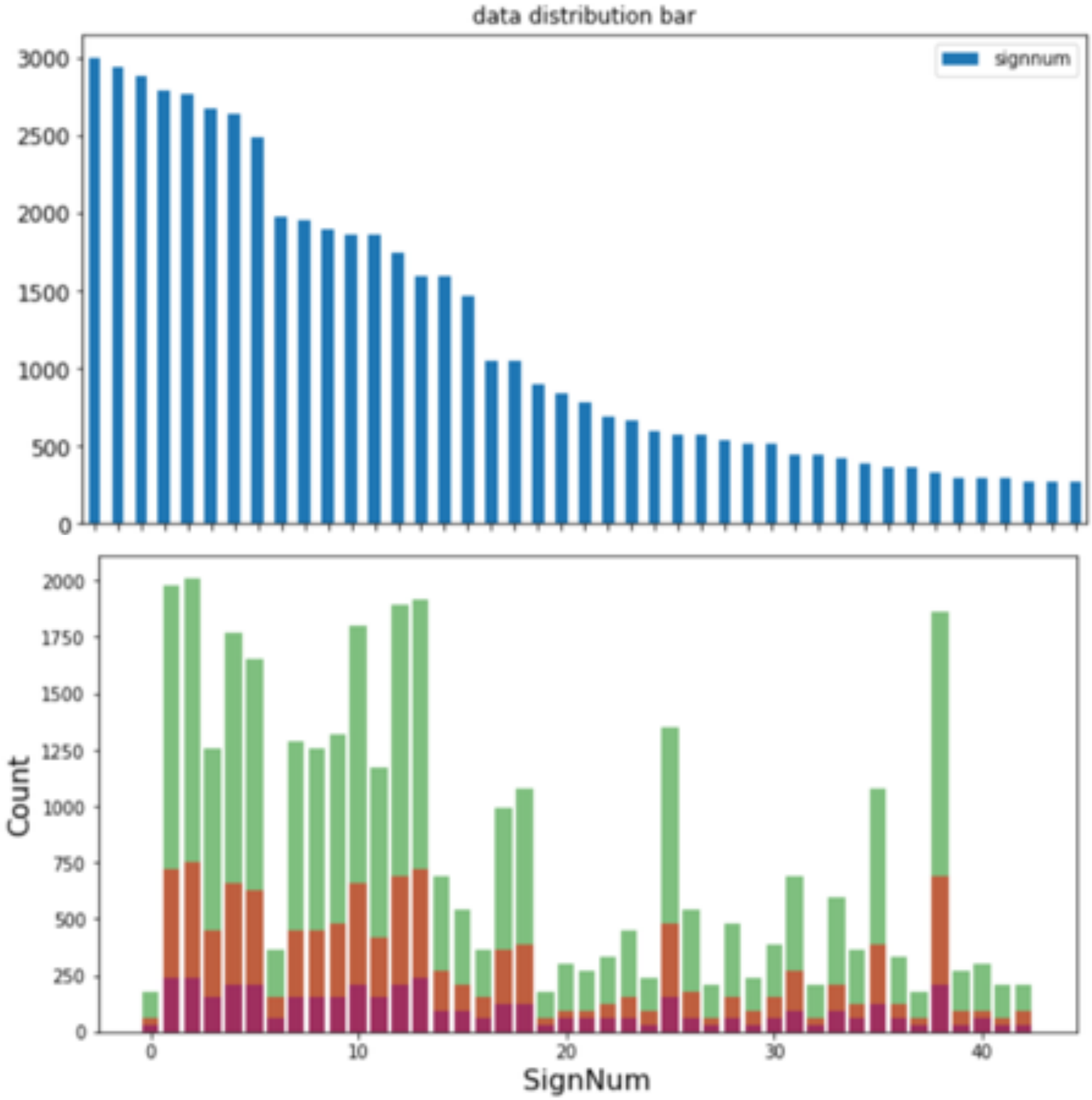
Traffic Sign Classifier

1. Dataset Summary

```
Training Set:   34799 samples
Validation Set: 4410 samples
Test Set:       12630 samples
Dataset shape is (32,32,3)
```

2. Exploratory Visualization

Use pandas to summary the dataset:

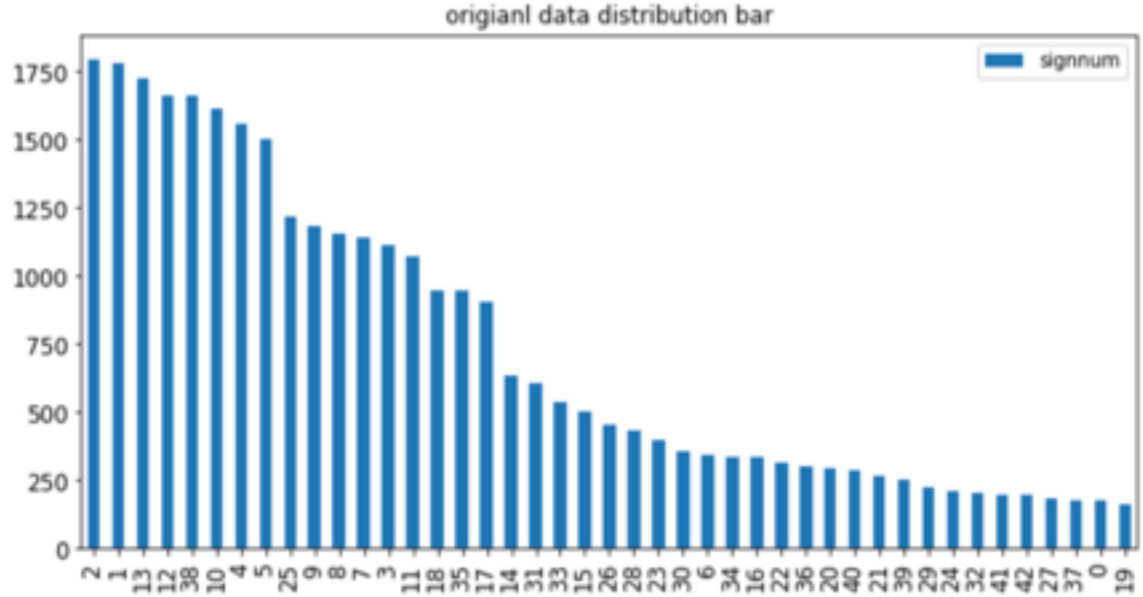


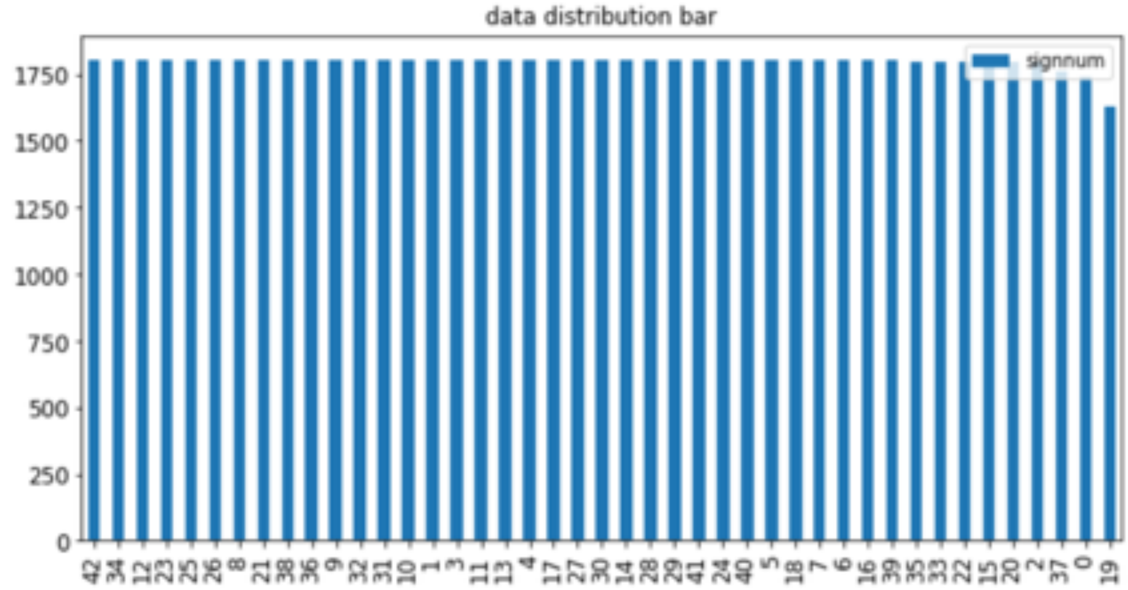
Summary:The training validation and test data is kind of has very similar distribution on different traffic sign, but the overall dataset is un-balanced, 50km/h traffic sign get 3000 samples, while 20km/h get only 500 below.

Later I found out the sign that has less sample is more likely to be predict as result, it make sense since it has less feature to match with since it has data sample to capture the feature from.

3. Augment the training data
    rotation,
    translation
    zoom
    flips
    color perturbation

```
(31367, 32, 32, 3)
```





The translation process like perspective, affine method, I use the same method for all picture and rotate 8 times for every picture which is not suitable for some picture, like the one which rotation has real meaning, and I got validation accuracy and test accuracy drop a little bit by augment training data.

grayscale, normalize

```
0.971(validation accuracy)
0.904(test accuracy)
0(accuracy on real image)
```

augment, no normalize

```
0.941
0.846
0.231
```

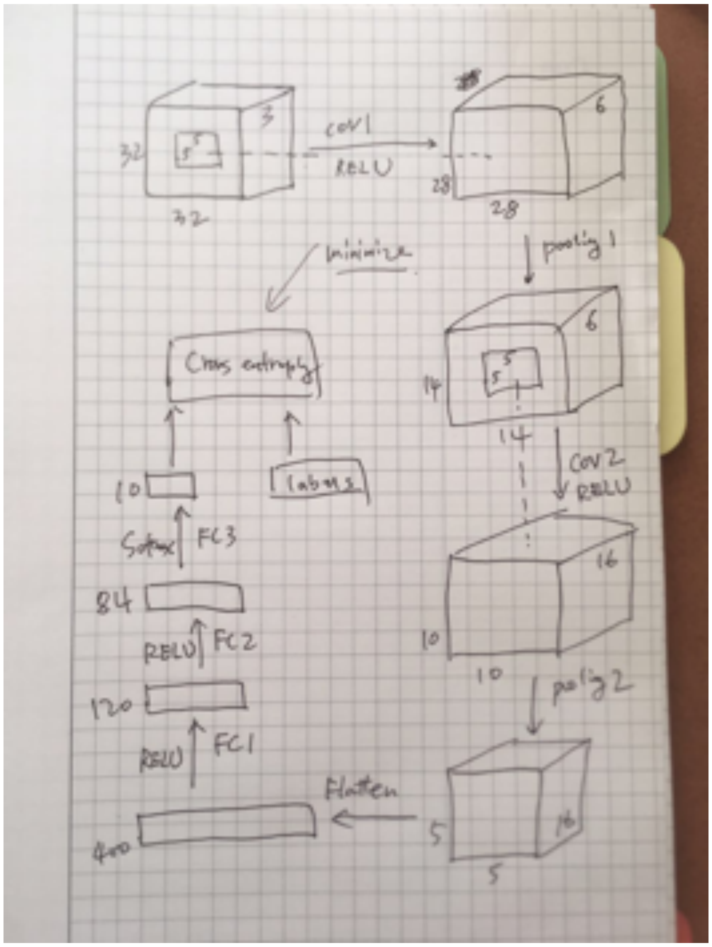
```
No augment, normalize
0.956
0.873
0.154
```

augment, normalize
0.965
0.857
0.231

Summary:
Grayscale help to increase the validation and test accuracy , but not on real accuracy, it overfit on the dataset.
Augment really help the real accuracy.
Normalize help at least not do harm in any situation

4. Model Architecture

2 conv, 2 polling, 3 fully-connected, 1 flatten and several activation node



5. Model Training

```
logits = MyNet(x)
cross_entropy =
tf.nn.softmax_cross_entropy_with_logits(labels=one_hot_y, logits=logits)
loss_operation = tf.reduce_mean(cross_entropy)
optimizer = tf.train.AdamOptimizer(learning_rate = rate)
training_operation = optimizer.minimize(loss_operation)
```

6. Solution Approach

Use Adam optimizer to minimize the cross entropy between predict and real labels of the label, and run 10 epoch with 128 as batch size and 0.001 as learning rate.

7. Acquiring New Images

Download 12 image from website.

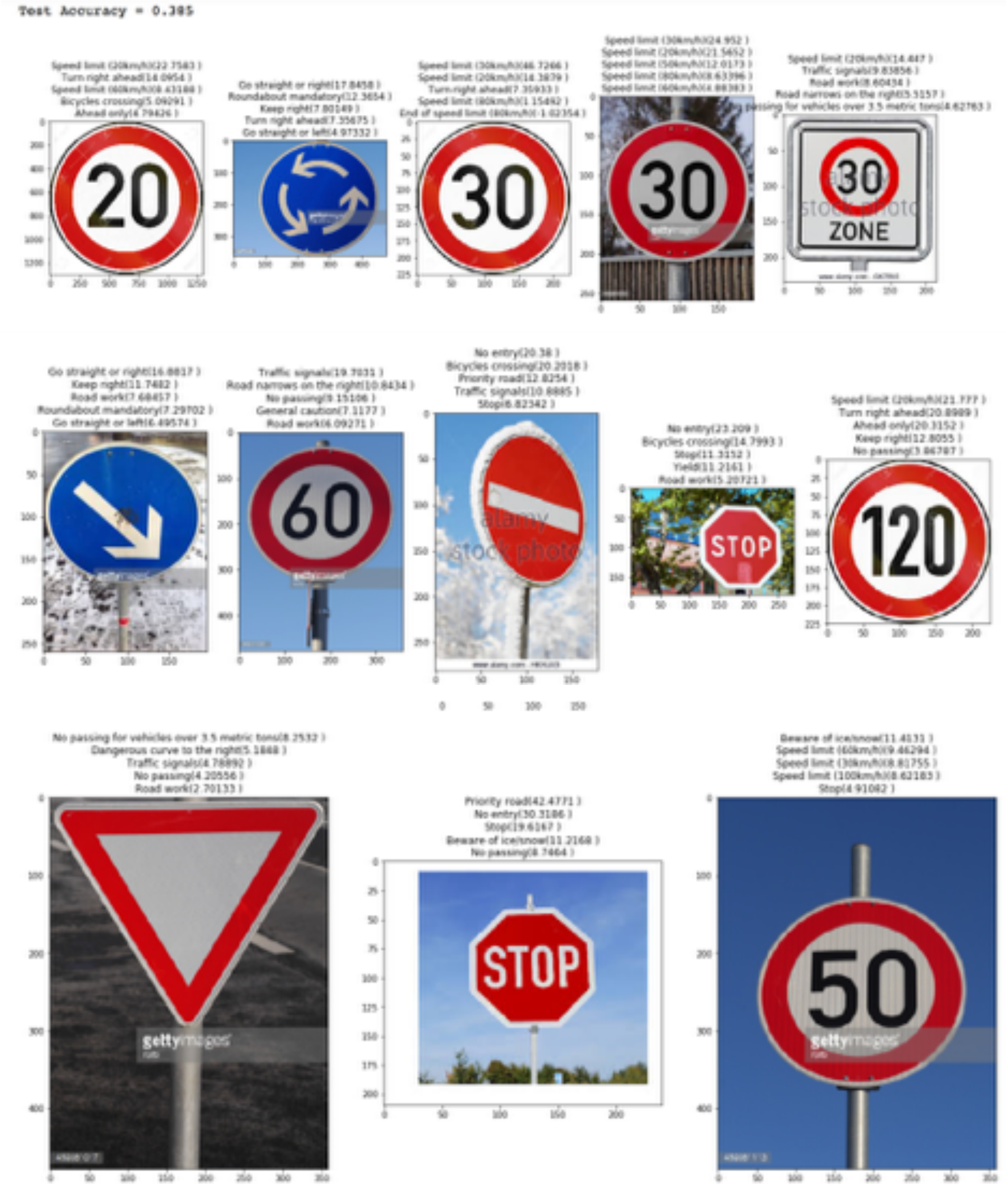
8. Performance on New real Image

Real Accuracy = 0.385, compare with test accuracy which is 0.85, which is far less accuracy.

Place to improvement: the color space and the photo clarity is quite different comping with dataset and real image, this could cause some error.Sometime the background and also perspective angle from the real image can give the model a hard time. and can we add more layer so the model can recognize more feature?

9. Model Certainty - Softmax Probabilities

The 1st and 3rd prediction is quite confidence since the closest estimation has more gap.
The 9th pic in face is predict wrong, but its third best estimation is correct which has confidence level 11.
The 10 pic which supposed for 120km/h, look like it care about 20 more which make it predict as 20km/h



```
Test Accuracy = 0.385
```

```
Speed limit (20km/h)(22.7583 )
Turn right ahead(14.0954 )
Speed limit (60km/h)(8.43188 )
Bicycles crossing(5.09291 )
Ahead only(4.79426 )

Go straight or right(17.8458 )
Roundabout mandatory(12.3654 )
Keep right(7.80149 )
Turn right ahead(7.35675 )
Go straight or left(4.97332 )

Speed limit (30km/h)(46.7266 )
Speed limit (20km/h)(14.3879 )
Turn right ahead(7.35933 )
Speed limit (80km/h)(1.15492 )
End of speed limit (80km/h)(-1.02354 )

Speed limit (30km/h)(24.952 )
Speed limit (20km/h)(21.5652 )
Speed limit (50km/h)(12.0173 )
Speed limit (80km/h)(8.63396 )
Speed limit (60km/h)(4.88383 )

Speed limit (20km/h)(14.447 )
Traffic signals(9.83856 )
Road work(8.60434 )
Road narrows on the right(5.5157 )
passing for vehicles over 3.5 metric tons(4.62763 )

Go straight or right(16.8817 )
Keep right(11.7482 )
Road work(7.68457 )
Roundabout mandatory(7.29702 )
Go straight or left(6.49574 )

Traffic signals(19.7031 )
Road narrows on the right(10.8434 )
No passing(9.15106 )
General caution(7.1177 )
Road work(6.09271 )

No entry(20.38 )
Bicycles crossing(20.2018 )
Priority road(12.8254 )
Traffic signals(10.8885 )
Stop(6.82342 )

No entry(23.209 )
Bicycles crossing(14.7993 )
Stop(11.3152 )
Yield(11.2161 )
Road work(5.20721 )

Speed limit (20km/h)(21.777 )
Turn right ahead(20.8989 )
Ahead only(20.3152 )
Keep right(12.8055 )
No passing(3.86787 )

No passing for vehicles over 3.5 metric tons(8.2532 )
Dangerous curve to the right(5.1868 )
Traffic signals(4.78892 )
No passing(4.20556 )
Road work(2.70133 )

Priority road(42.4771 )
No entry(30.3186 )
Stop(19.6167 )
Beware of ice/snow(11.2168 )
No passing(8.7464 )

Beware of ice/snow(11.4131 )
Speed limit (60km/h)(9.46294 )
Speed limit (30km/h)(8.81755 )
Speed limit (100km/h)(8.62183 )
Stop(4.91082 )
```