American sign language understanding

Project 1 - TAA

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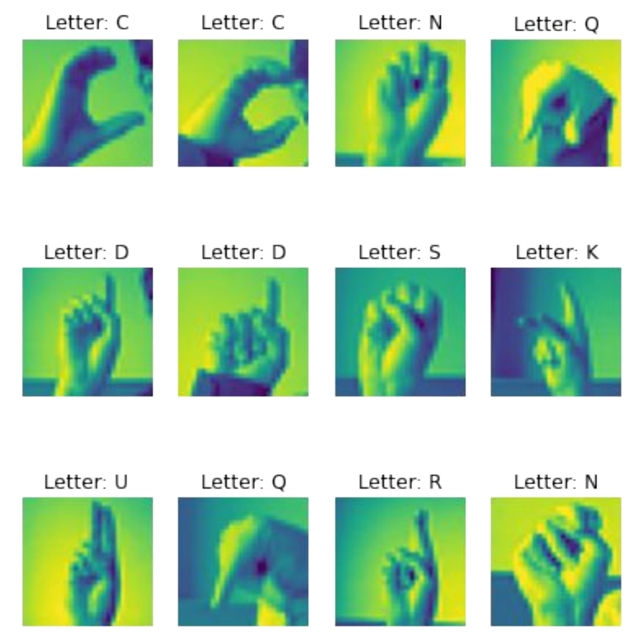
DATA VISUALIZATION

Why this dataset and data description

DATA VISUALIZATION

Training dataset

	label	pixel1	pixel2	...	pixel782	pixel783	pixel784
0	3	107	118	...	204	203	202
1	6	155	157	...	103	135	149
2	2	187	188	...	195	194	195
3	2	211	211	...	222	229	163
4	13	164	167	...	163	164	179
...	...	...	...	...	...	...	...
27450	13	189	189	...	200	222	225
27451	23	151	154	...	195	195	194
27452	18	174	174	...	202	200	200
27453	17	177	181	...	64	87	93
27454	23	179	180	...	205	209	215

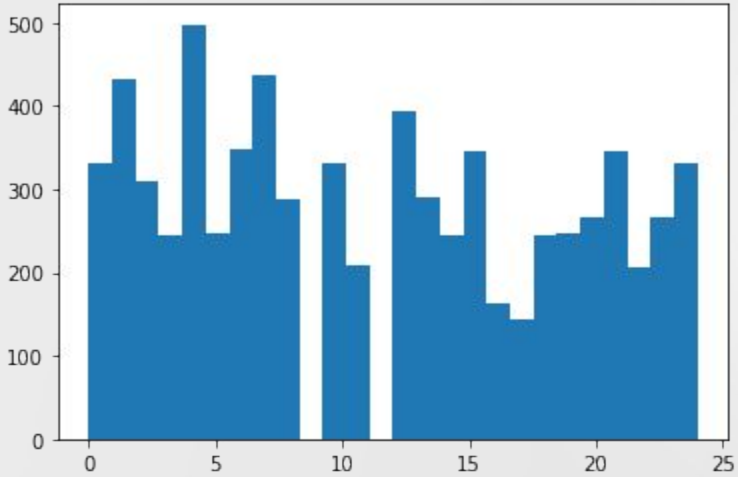


The author transformed the original dataset:
cropping to hands-only → gray-scaling → resizing

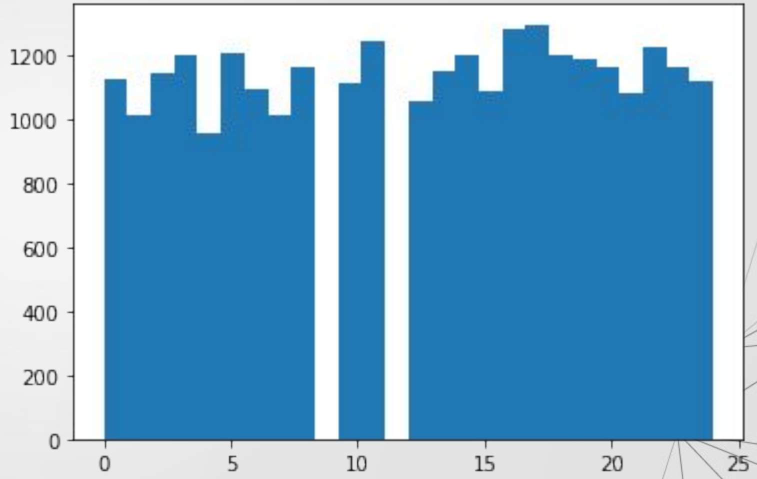
Also creating at least 50+ variations to enlarge the quantity:
Filters ('Mitchell', 'Robidoux', 'Catrom', 'Spline', 'Hermite') → 5% random pixelation → +/- 15% brightness/contrast → 3 degrees rotation.

DATA VISUALIZATION

Number of examples/class in the Test Dataset



Number of examples/class in the Train Dataset

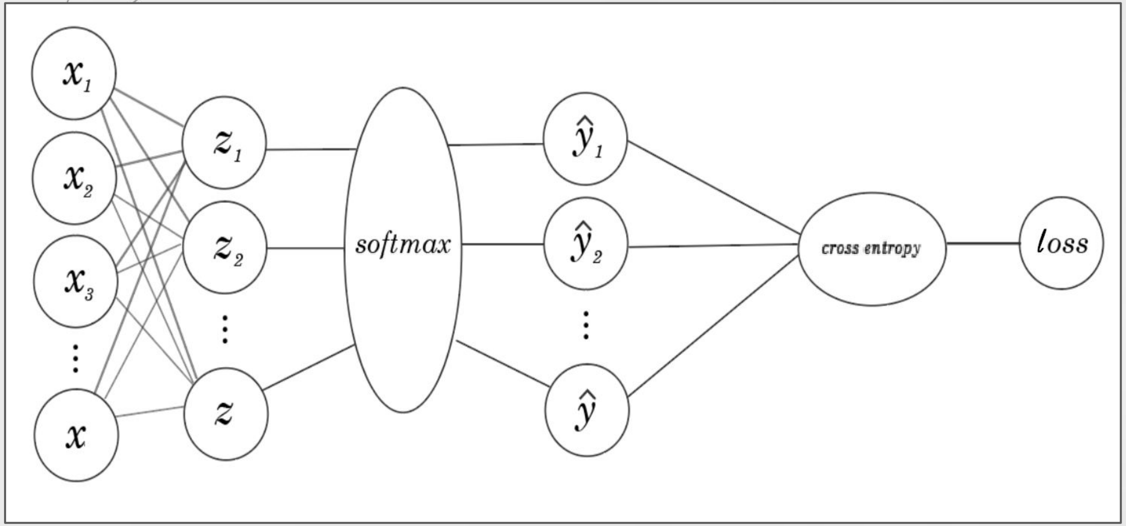


02

ML MODELS

Logistic Regression and
Convolutional Neural Network

ML MODELS
LOGISTIC REGRESSION



PyTorch

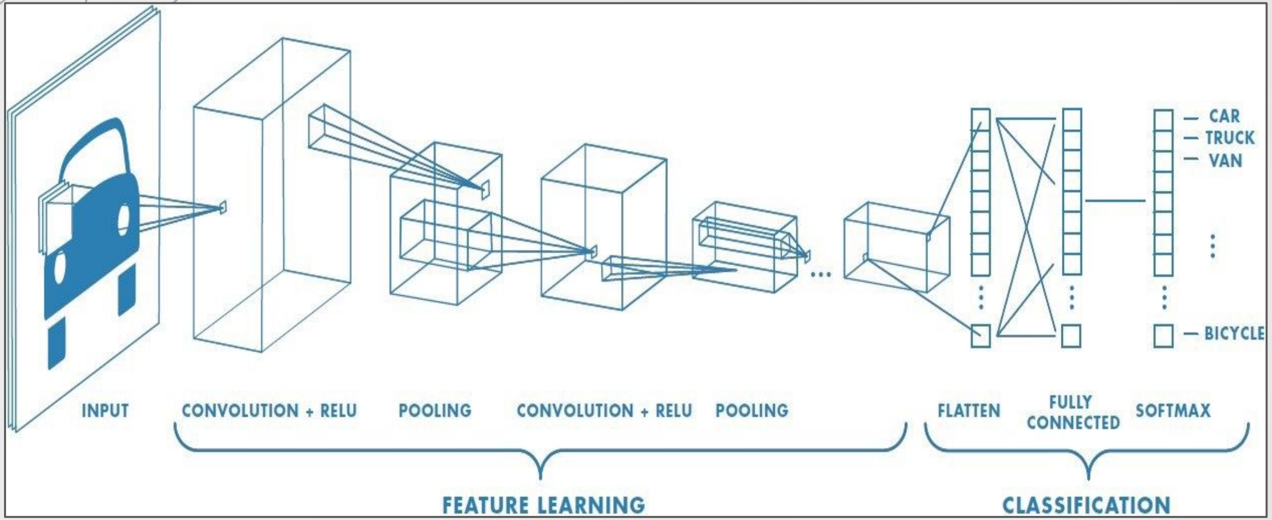
Linear model with multi class approach

1. Initially, the function returns a tensor with 26 elements with values ranging from negative infinity to positive infinity

2. cross_entropy function that combines the negative log likelihood and softmax function to normalize the resulting values from the linear function.

ML MODELS

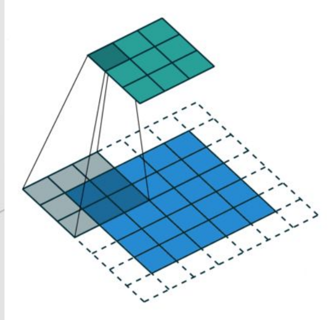
CONVOLUTIONAL NEURAL NETWORK



TensorFlow

Deep Learning algorithm

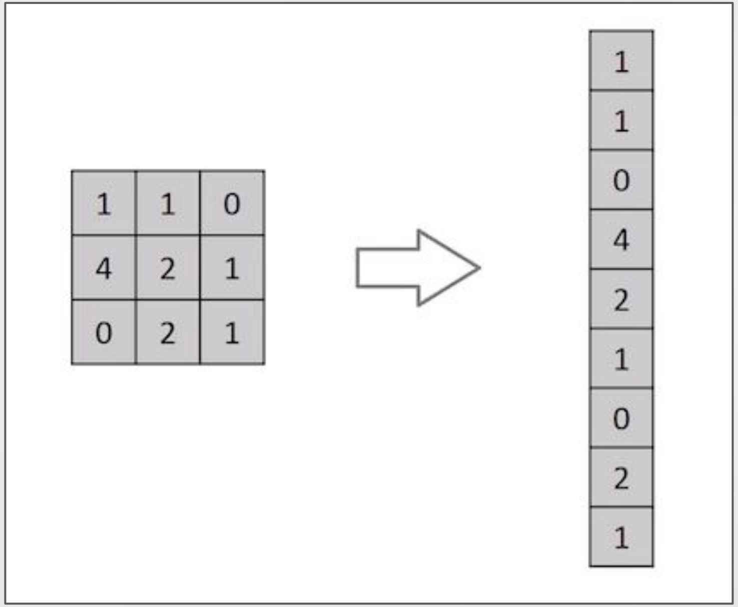
A ConvNet is able to successfully capture the **Spatial and Temporal dependencies** in an image..



The network can be trained to understand the sophistication of the image better.

ML MODELS

WHY 2 DIFFERENT ARCHITECTURES?

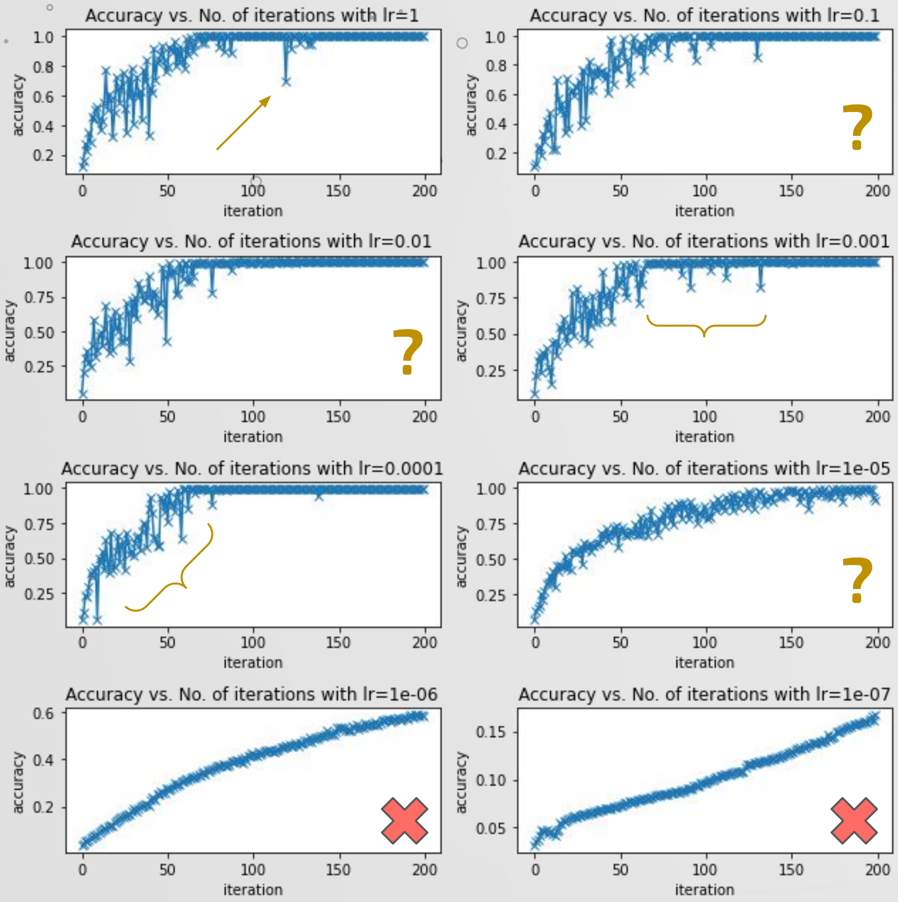


In **cases of extremely basic binary images**, a linear method might show an average precision score while performing prediction of classes, but would have **little to no accuracy when it comes to complex images having pixel dependencies throughout**.

03

HYPERPARAMETERS AND NETWORK STRUCTURE

Learning rates, epochs, batch size,
convolutional layers, decaying learning rate.



HYPERPARAMETERS
LOGISTIC REGRESSION MODEL

Batch size and epochs

256 and 200, based on the literature and prior works related to this problem.

Learning rate

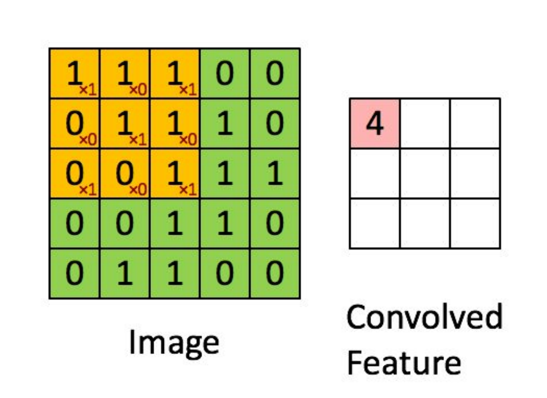
We tested 8 different learning rates and observed the accuracy graphs.

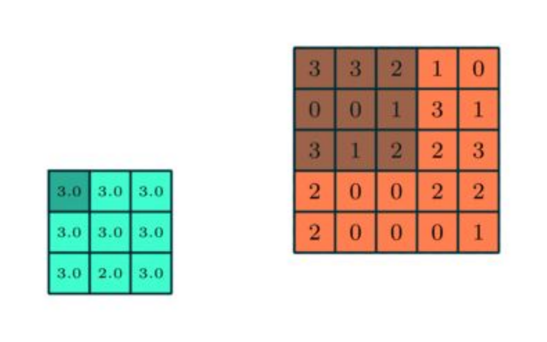
		Loss	Accuracy
lr=0.001 **worse**	**Validation**	0.4703	0.9985
	Test	1150.3939	0.6855
lr=1e-05 **better**	**Validation**	0.0703	0.9835
	Test	5.5739	0.5628

Convolutional may be better?

NETWORK STRUCTURE
CONVOLUTIONAL NEURAL NETWORK MODEL

```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_4 (Conv2D)            (None, 26, 26, 64)        640
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 13, 13, 64)        0
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 11, 11, 128)       73856
_________________________________________________________________
max_pooling2d_5 (MaxPooling2 (None, 5, 5, 128)         0
_________________________________________________________________
flatten_2 (Flatten)          (None, 3200)              0
_________________________________________________________________
dense_4 (Dense)              (None, 256)               819456
_________________________________________________________________
dense_5 (Dense)              (None, 26)                6682
=================================================================
```





Data Augmentation

Re-scales pixels of the image to 0-1 by dividing by 255.

Rotates images between 0 and 45 degrees.

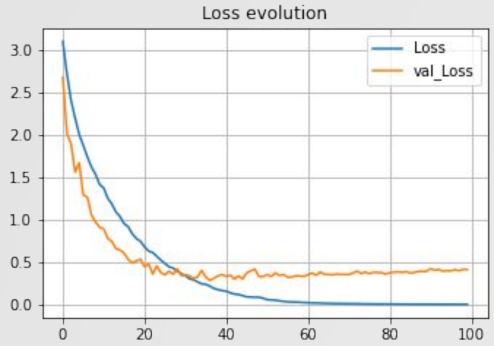
Shifts images horizontally and vertically by 15%.

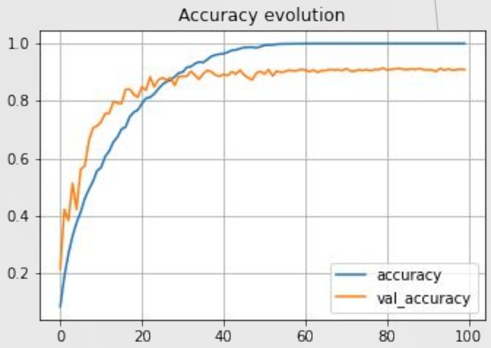
Zooms in and out images by 20%.

Flips images horizontally.

CNN Hyperparameters

EPOCHS





Batch Size

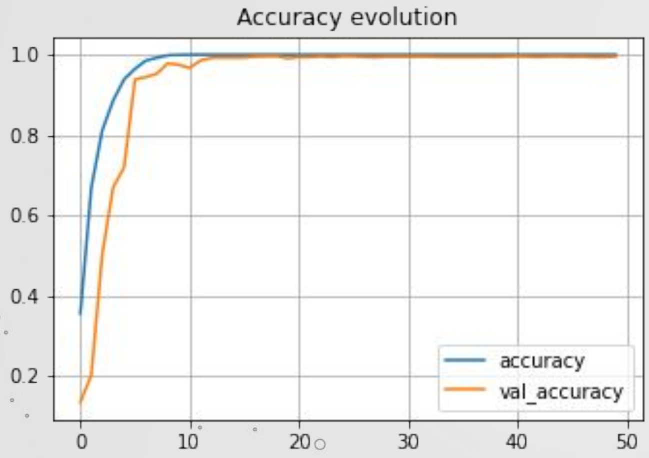
Batch Sizes	*Test Accuracies*
32	91%
64	95%
128	93%
256	92%
512	98%
1024	93%

Decaying Learning Rate

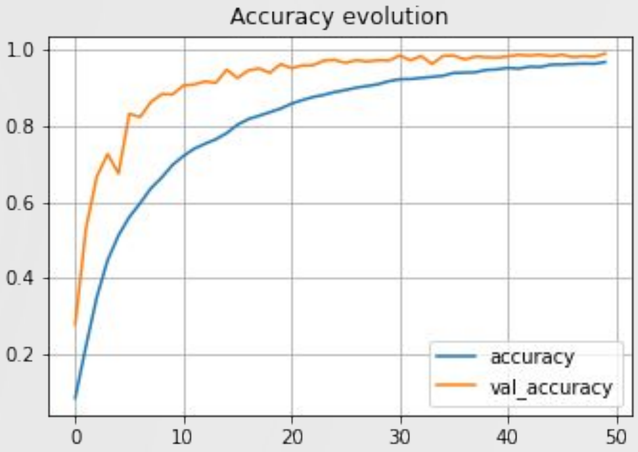
If the validation accuracies were fluctuating a lot the model could overshoot the optima. However, in our case, it didn't make much difference.

Changes in the Neural Network Structure

Batch Normalization Layer



Dropout Layer



04
RESULTS AND PERFORMANCE COMPARISON

Accuracy and Loss.
Comparison between models.

Accuracies and Losses

Logistic Regression Model

	Loss	Accuracy
Validation	0.0703	0.9835
Test	5.5739	0.5628

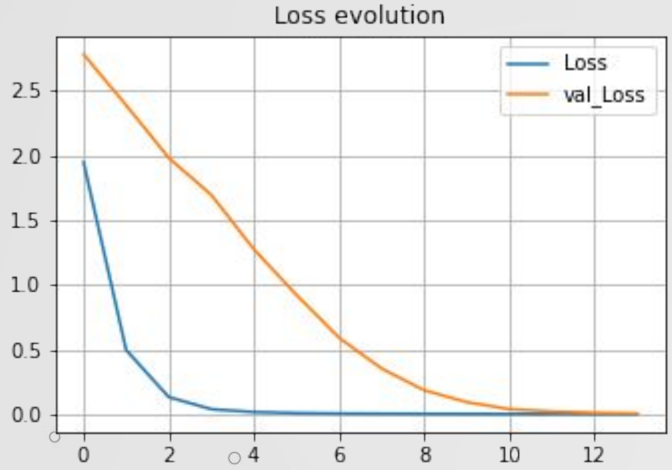
CNN Model Without Data Augmentation

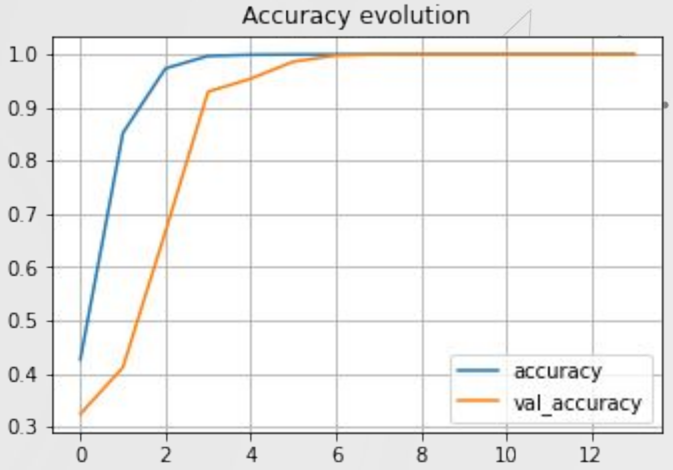
	Loss	Accuracy
Validation	0.0044	1.0
Test	0.2359	0.9331

CNN Model With Data Augmentation

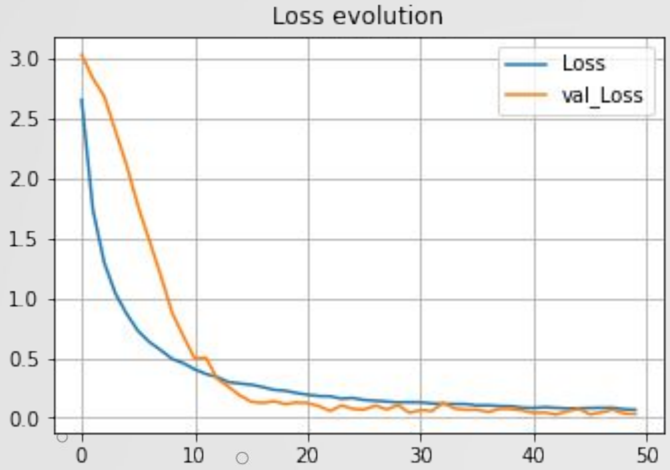
	Loss	Accuracy
Validation	0.0314	0.9950
Test	0.0315	0.9873

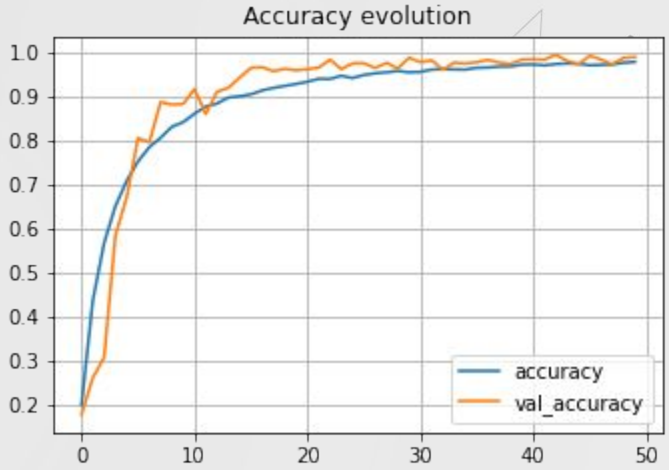
CNN Model Without Data Augmentation





CNN Model With Data Augmentation



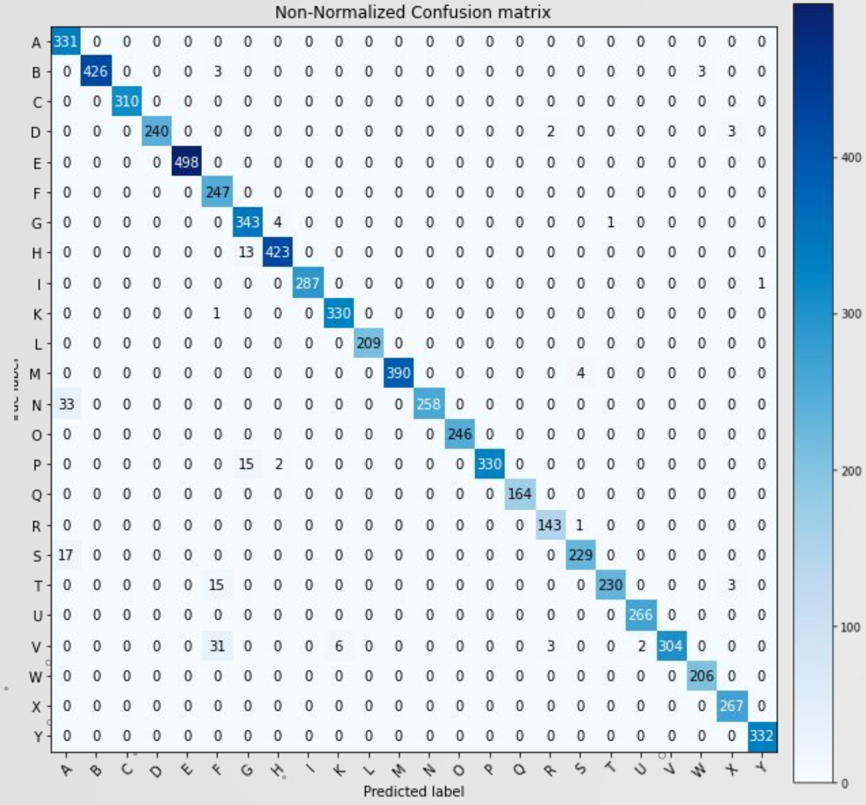


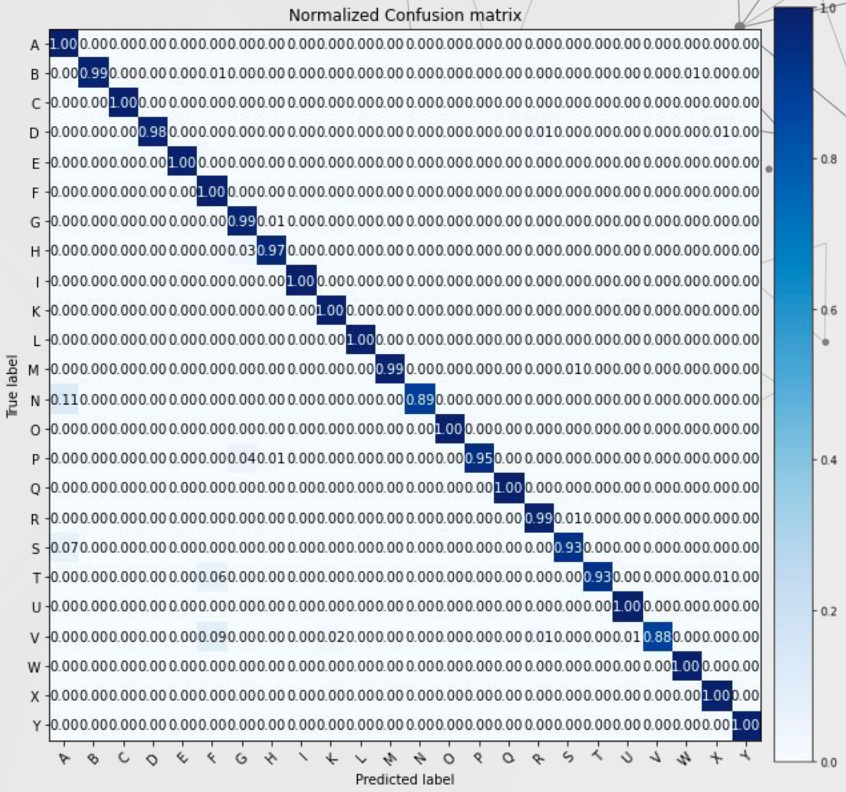
05

PREDICTIONS WITH DIFFERENT PICTURES

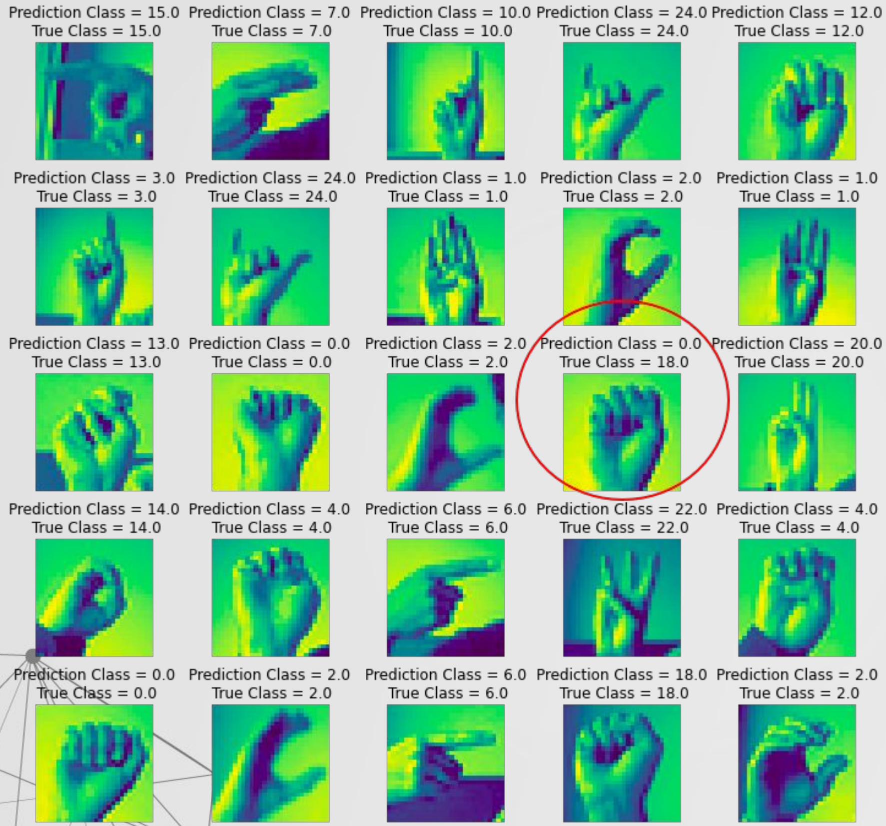
Predicting letters with images of the dataset and with our own.

CNN Model Confusion Matrix





CNN Model Predictions With Data Set Images



Our Pictures

Label = T

Label = A

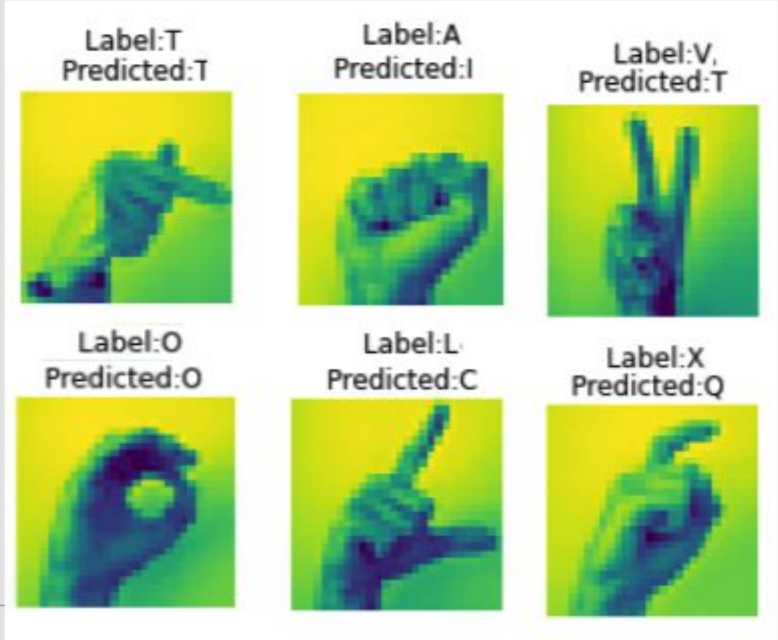
Label = V

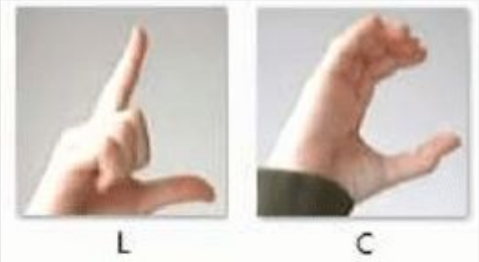
Label = O

Label = L

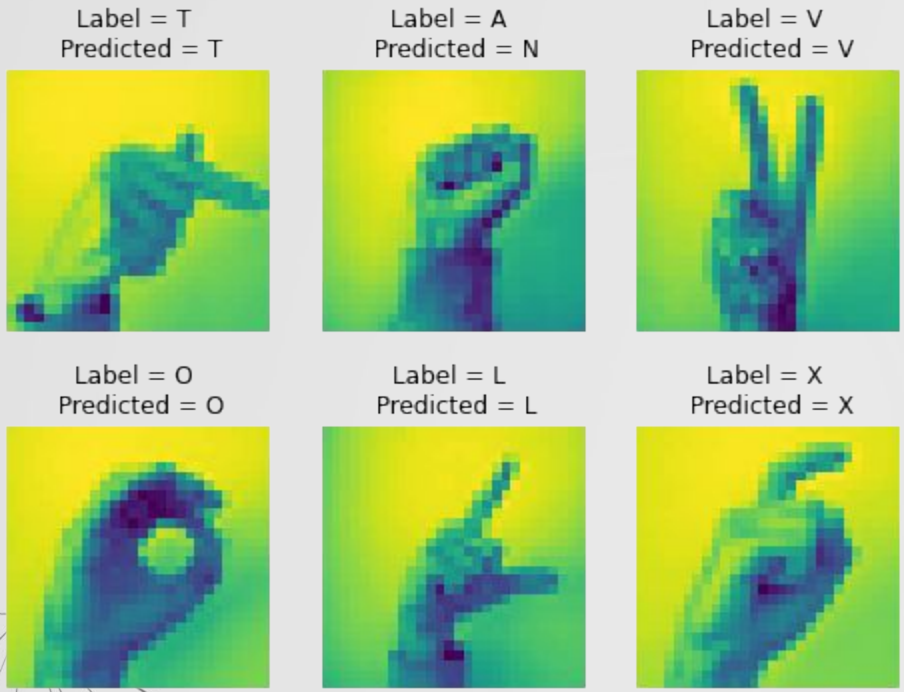
Label = X

Logistic Regression Model Predictions With Our Pictures





CNN Model Predictions With Our Pictures



06
Conclusion

How can we improve?