

# MNIST Handwritten Digit Recognition

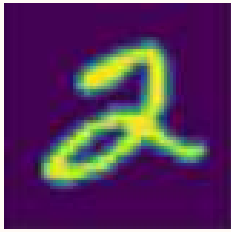


Sample images from MNIST test dataset

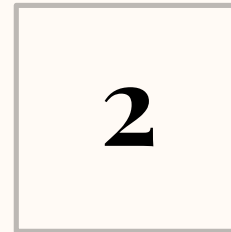
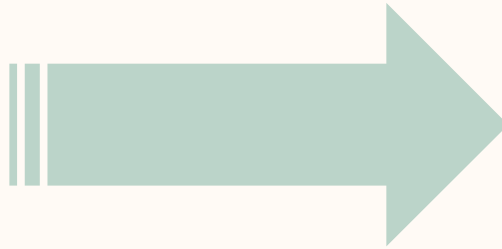
# Concept

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## Machine learning

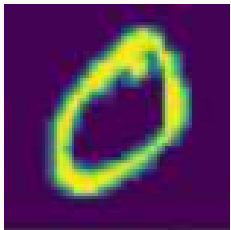


image

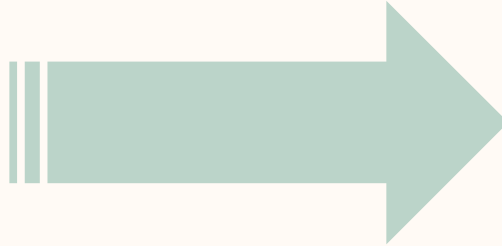


label

## Practical use



image



predict

# Methodology

## Data



**Dataset Collect**  
Load data from  
MNIST database

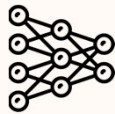


**Understand Dataset**  
Shape  
Data image sample



**Data Preparation**  
Reshape  
One-hot encoding  
Normalize

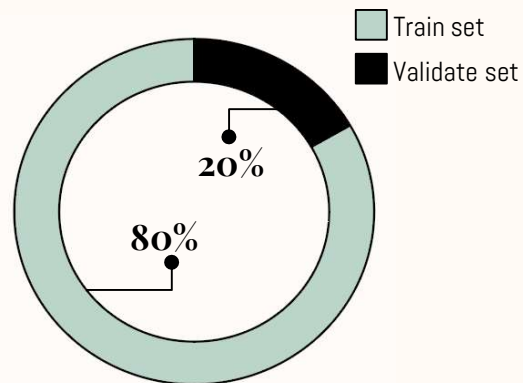
## Model



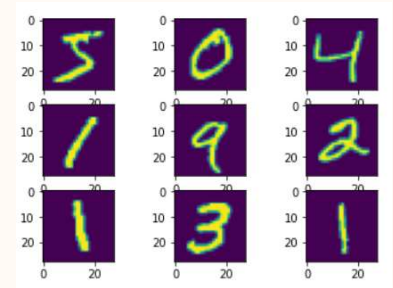
**Model**  
Convolutional Neural  
Network



**Model Evaluate**  
k-fold cross-validation  
(k=5)

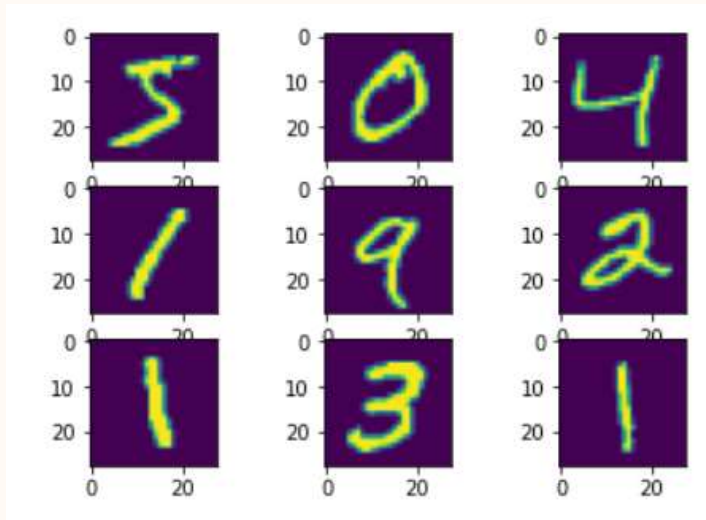


## Train/Test



- Train data (60,000)
- Test data (10,000)
- Accuracy
- Deploy

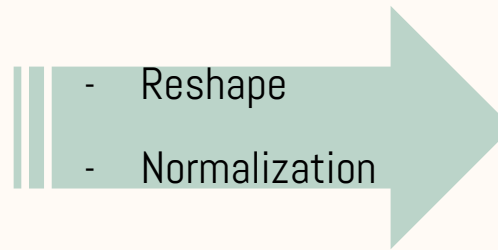
# Data preparation



Sample Input Image



Sample output

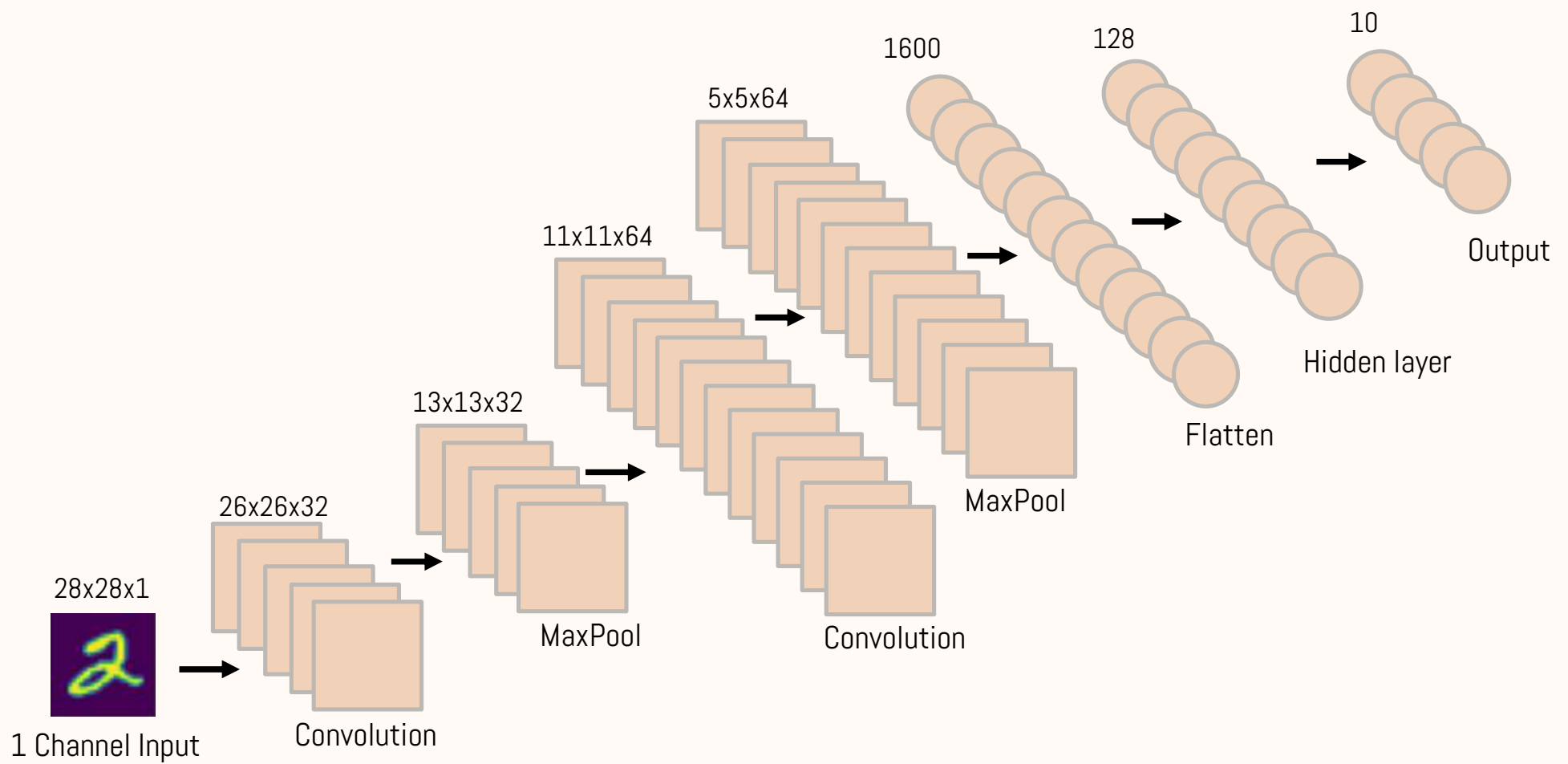


(60000, 28, 28,1)



[0. 0. 0. 0. 0. 1. 0. 0. 0. 0.]

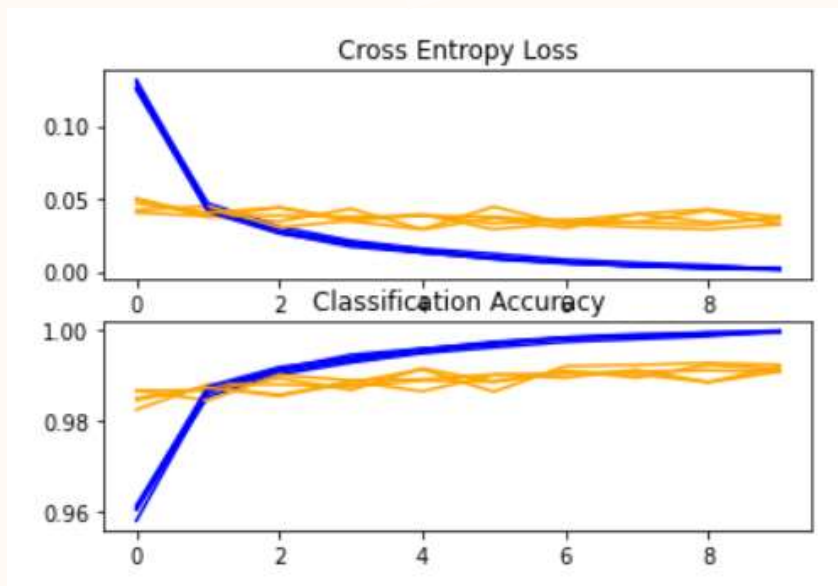
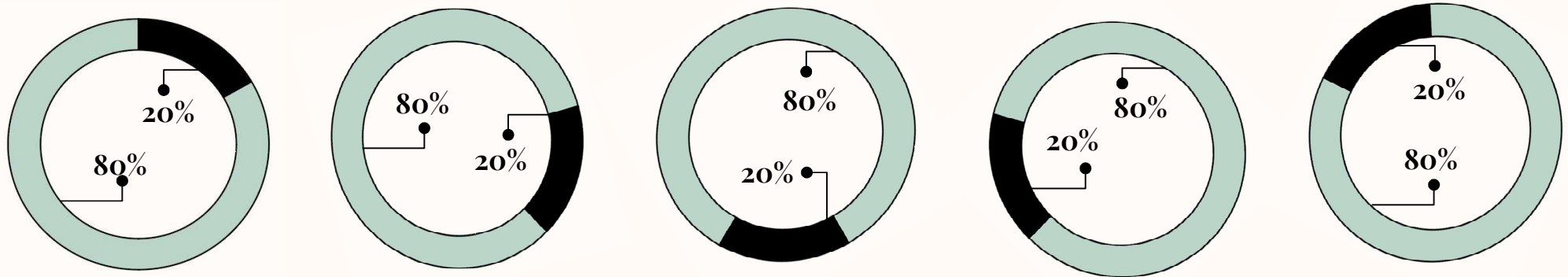
# Model



# Model Evaluation

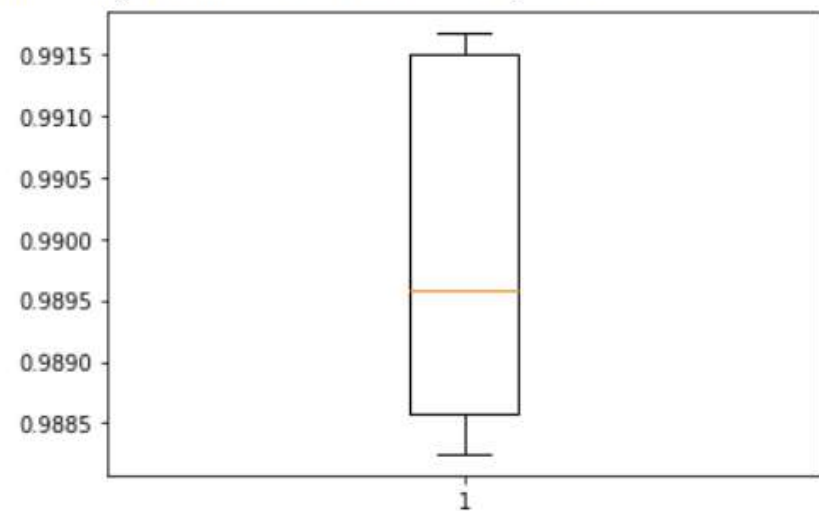
Train set  
Validate set

k-fold cross-validation ( $k = 5$ )



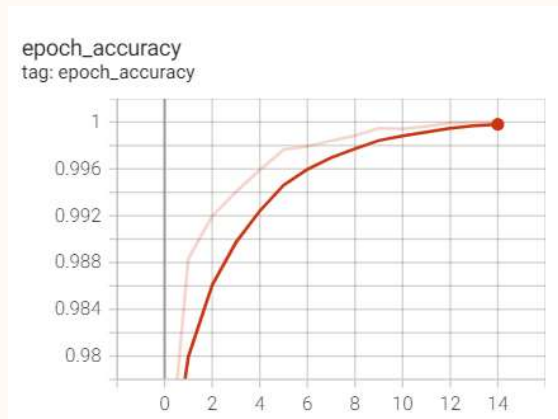
Loss and accuracy learning curve

Accuracy: mean=98.992 std=0.143, n=5

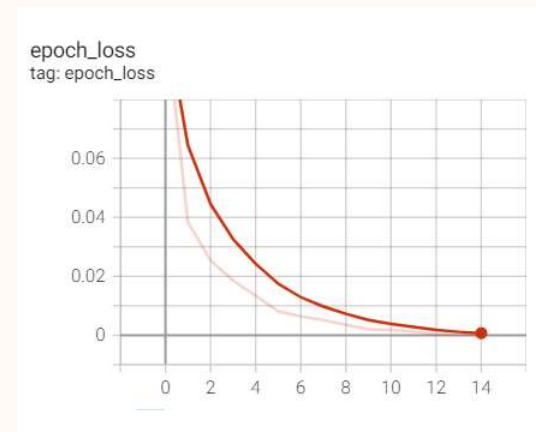


Average accuracy: 98.99

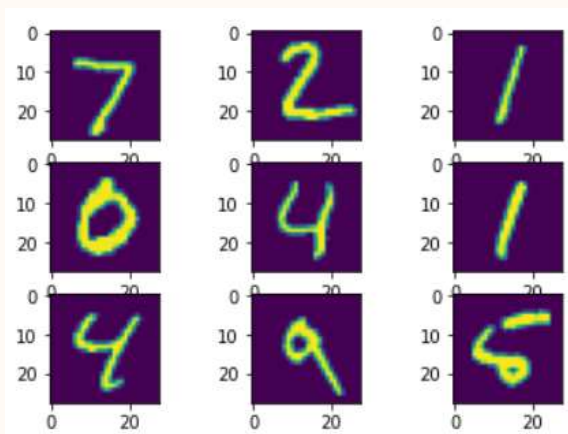
# Train/Test



Accuracy per epoch



Loss per epoch

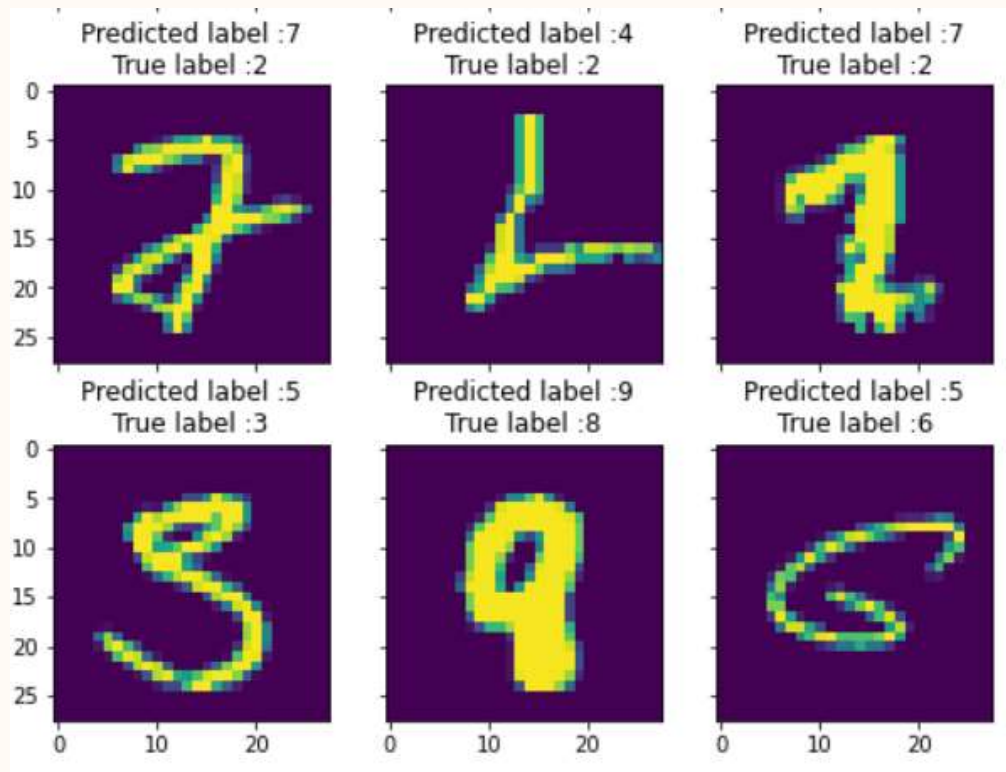


Sample test input

## Result

|                |           |
|----------------|-----------|
| Train Accuracy | : ~1      |
| Train Loss     | : ~0      |
| Test Accuracy  | : 99.24 % |

# Error case



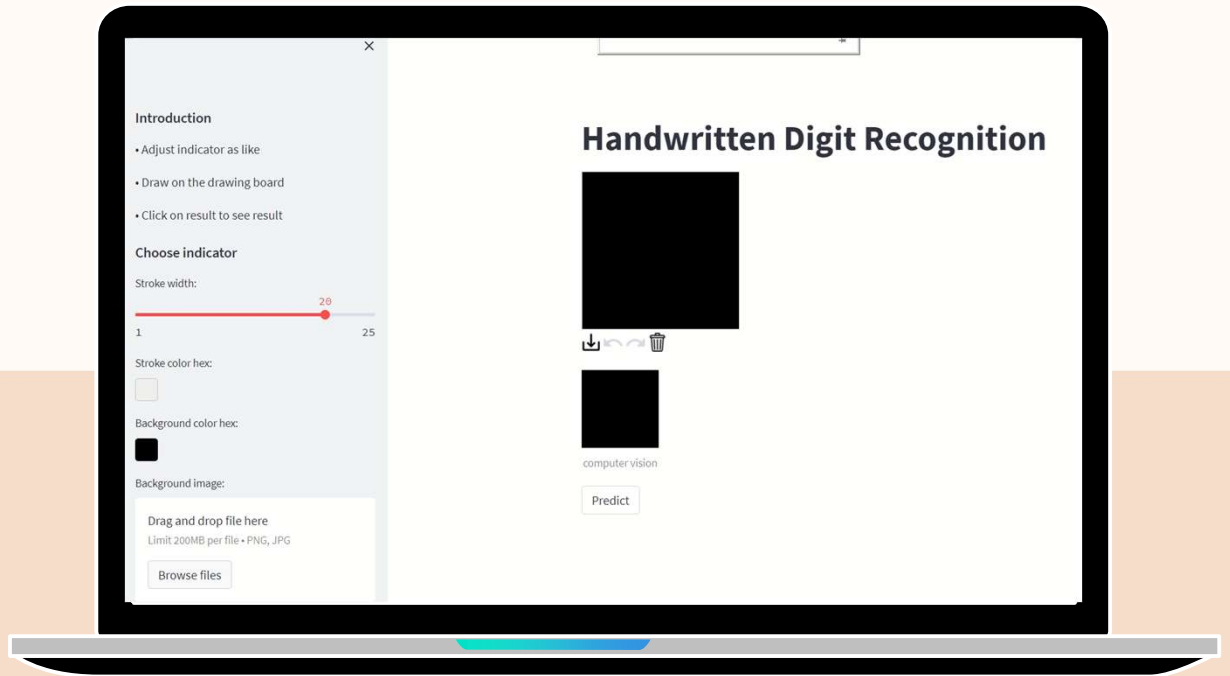
Error case from prediction



# App trial



<https://mniststreamlit.herokuapp.com/>



**Thank you**