Proceedings of the ASME 2021
MATLAB Final Project Report
MATLAB2021
June 06-05, 2021, Shenzhen, Guangdong, China

MATLAB2021

DEEP LEARNING APPLICATION TOOLBOX

Boyan Li[1]

[1]Southern University of Science and Technology, Shenzhen, China

ABSTRACT

Deep learning is one of the most popular fields in recent years. Deep learning technology has been widely applied in face recognition, object classification, autonomous driving, and other directions. Unlike traditional machine learning, deep learning workflows can automatically extract relevant features from objects, and in theory, a deep neural network can fit any function. Most of the existing popular learning frameworks are based on Python language, while MATLAB, as a powerful scientific computing tool, is also very excellent in the application level of deep learning technology. In order to enable more people to quickly experience deep learning technology and feel the power and charm of deep learning, in this project, I will use MATLAB language to develop a deep learning application toolbox. It includes two application modules: handwritten digit recognition and data fitting. The former is based on LeNet-5 Convolutional Neural Network, which is the first powerful work of Convolutional Neural Network. The latter is based on a deep full connection network that supports user-friendly custom parameters and can fit any data theoretically.

Keywords: MATLAB, Deep Learning, CNN, DNN

NOMENCLATURE

Place nomenclature section, if needed, here. Nomenclature should be given in a column, like this:

CNN	Convolutional Neural Network
DNN	Deep connection Network

1. INTRODUCTION

Image recognition is one of the most widely used fields of deep learning, including face recognition, vehicle detection, etc. Handwritten recognition is a very classic application case, which is regarded as the first model for deep learning introduction by many people. The handwritten digital recognition module of this project is based on the MNIST handwritten digital dataset, which contains 60,000 and 10,000 single channel handwritten digital pictures of 28*28 pixels (grayscale image), respectively. It is trained by LeNet-5 convolutional neural network, and various image processing methods are applied at the same time. The model with good robustness and accuracy is obtained. In the data fitting module, it supports the fitting of two kinds of data, 2-dimension data and 3-dimension data, which can be visually displayed in the form of GUI. Users will also be able to customize network parameters and training parameters to experience deep learning development through user-friendly interfaces.

2. MATERIALS AND METHODS

2.1 Image Processing Toolbox

Image Processing Toolbox in MATLAB provides a comprehensive set of reference-standard algorithms and workflow apps for image processing, analysis, visualization, and algorithm development. You can perform image segmentation, image enhancement, noise reduction, geometric transformations and image registration using deep learning and traditional image processing techniques.

2.2 Deep Learning Toolbox

Deep Learning Toolbox in MATLAB provides a framework for designing and implementing deep neural networks with algorithms, pretrained models, and apps. You can use convolutional neural networks (ConvNets, CNNs) and long short-term memory (LSTM) networks to perform classification and regression on image, time-series, and text data and so on. With the Deep Network Designer app, you can design, analyze, and train networks graphically.

2.3 App Designer

App Designer is a new generation of GUI design tool in MATLAB, embedded with many commonly used components, and introduced the object-oriented style of language design scheme.

2.4 Artificial Neural Network

An artificial neural network (ANN) is the piece of a computing system designed to simulate the way the human brain analyzes and processed information. It is the

foundation of artificial intelligence (AI) and solves problems that would prove impossible or difficult by human or statistical standards. ANNs have self-learning capabilities that enable them to produce better results as more data becomes available.

3. RESULTS AND DISCUSSION

3.1 Main Menu

When user start the main app, it will display the main menu like FIGURE 1. User can select which child module to start.

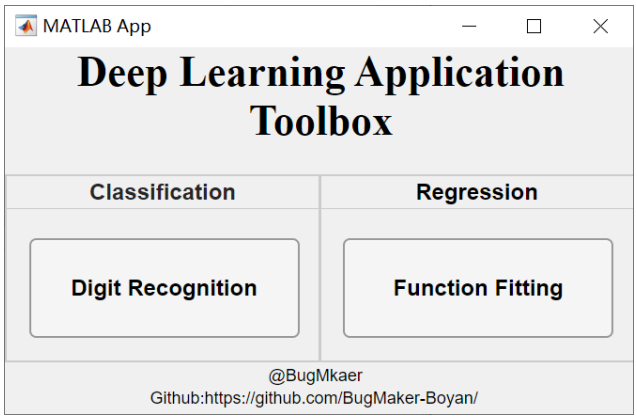

FIGURE 1: THE MAIN MENU FOR USERS

3.2 Digit Recognition Module

When user start digit recognition module, it will pop up the GUI window (FIGURE 2), which contain:

- Handwriting Board
- Clear Board Button
- Load Image Button
- Image Window Displaying Local Image
- Mode Selection
- Recognition Button
- Result and Possibility Display

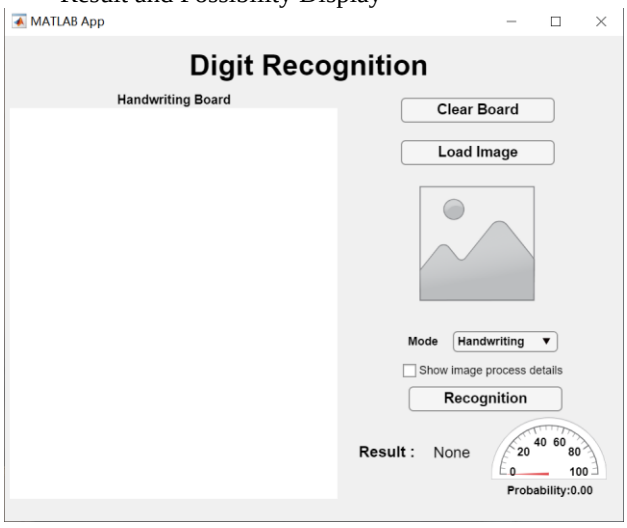

FIGURE 2: THE GUI FOR DIGIT RECOGNITION MODULE

When user use "Handwrting" mode, write a "3" in the board by mouse, then click the Recognition Button, the recognition result will be displayed (FIGURE 3):

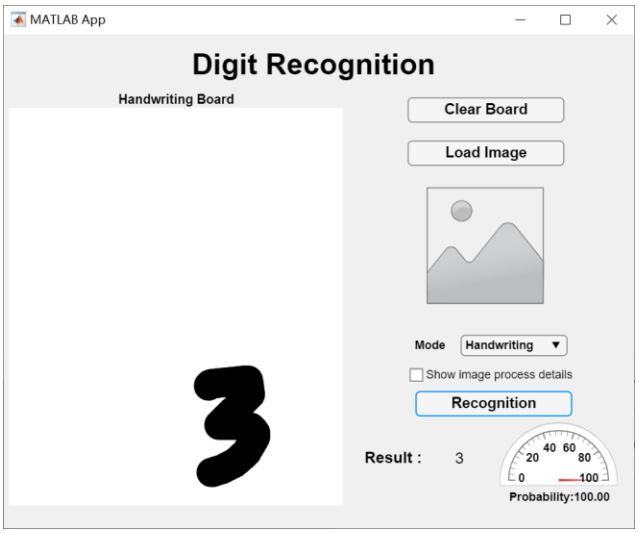

FIGURE 3: TEST FOR HANDWRITING MODE

When user use "Load Image" mode and select a picture file with digit 8 by Load Image Button, then the picture will be displayed in the Image Window. After clicking the Recognition Button, the recognition result will be displayed right (FIGURE 4):

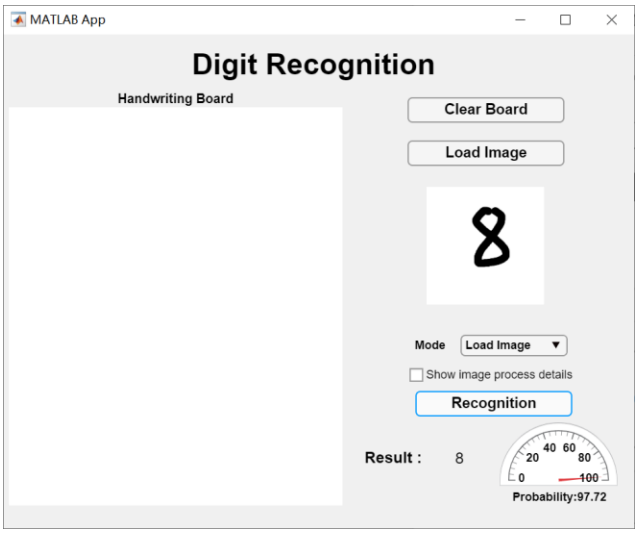

FIGURE 4: TEST FOR LOAD IMAGE MODE

When user check the "Show Image process details", the program will display more details about the image processing, like FIGURE 5, FIGURE 6, the final image input the network is the bottom-right image in FIGURE 6:

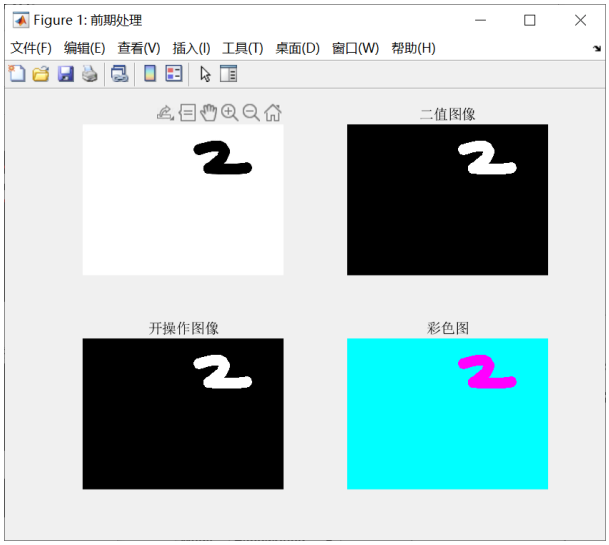

FIGURE 5: THE DETAILS ABOUT IMAGE PROCESSING

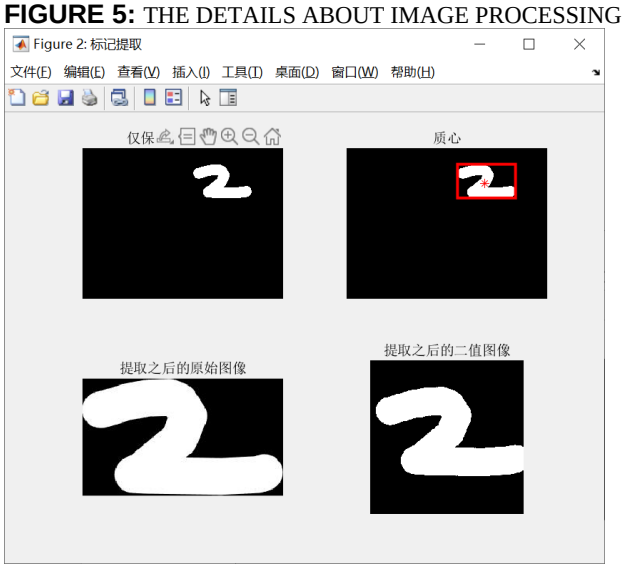

FIGURE 6: THE DETAILS ABOUT IMAGE PROCESSING

3.3 Function Fitting Module

When user start function fitting module, it will pop up the GUI window (FIGURE 7), which contain:

- Data config: Data dimension selection, Import data button, Plot data button.
- Net Config: Net layers input (the number of network layers), Neurons number (in one layer), Active function (support Relu, LeakyRelu, ClippedRelu, Tanh, Elu, Swish).
- Train Config: Epoch (the number of training rounds), Bath Size (the number of data for one batch), Train Environment (selection for CPU or GPU, the later need parallel tool and GPU hardware support).
- Generate Neural Net Button and Train net to fit Button.
- Predict Region.
- Curve Fitting Region: plot the data points and the fitting curve, including 2-dimension data and 3-dimension data.

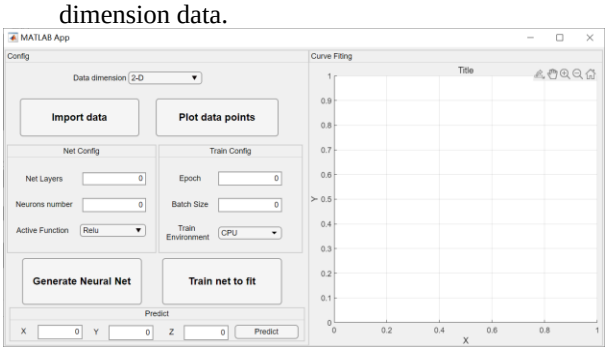

FIGURE 7: THE GUI FOR FUNCTION FITTING MODULE

For example, we import 2-dimension data from local file, and set 5 layers with 16 neurons in one layer, train for 500 epochs. The network structure is in FIGURE 8. After training, we will see the final fitting curve in the right window in FIGURE 9, the train process detail is in FIGURE 10, and the predict y value in x=2.3 is in FIGURE 11 predict region:

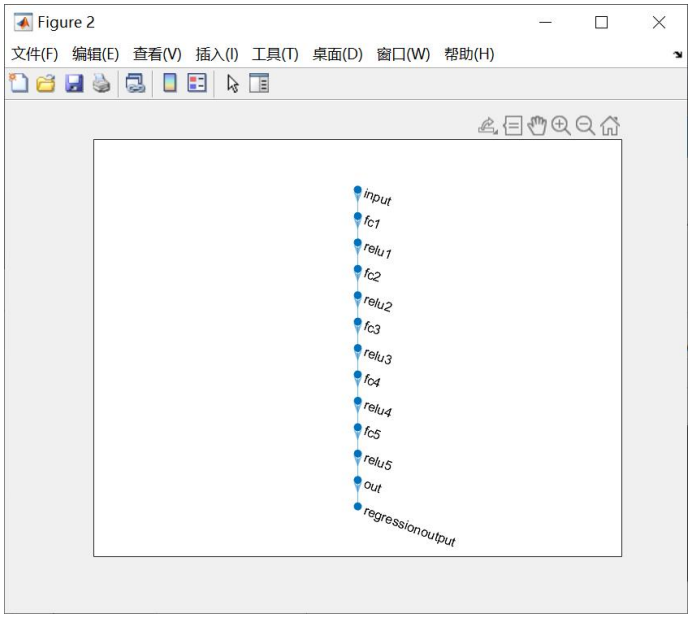

FIGURE 8: THE NETWORK STRUCTURE

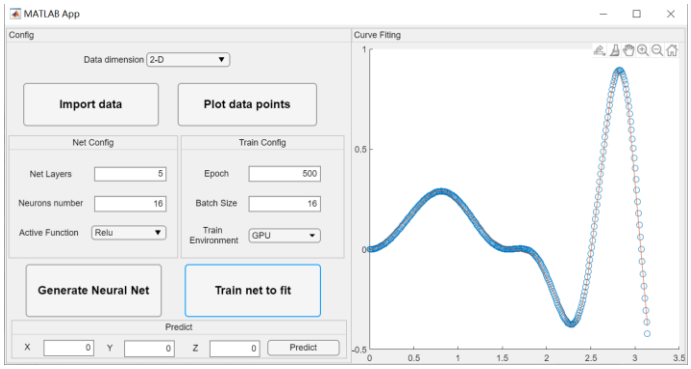

FIGURE 9: THE CURVE FITTING RESULT DISPLAY

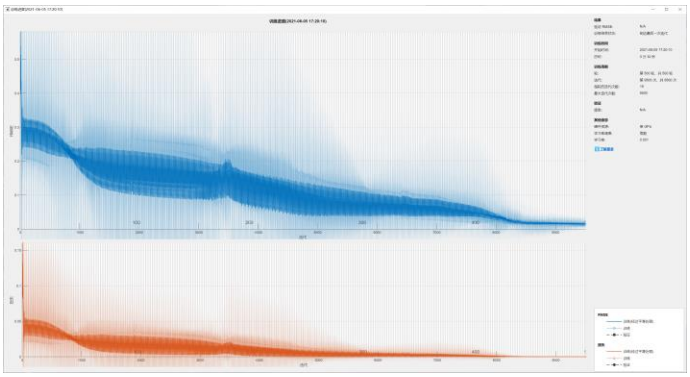

FIGURE 10: THE CURVE FITTING PROCESS DETAILS

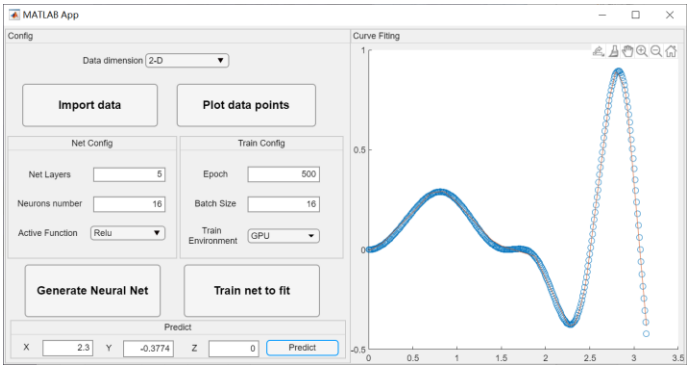

FIGURE 11: THE PREDICTION VALUE IN X=2.3 IS -0.3774

When user import 3-dimension data, the program also works very well, and we predict the value in x=0.5, y=0.5, the prediction value of z is 0.4227, like FIGURE 12:

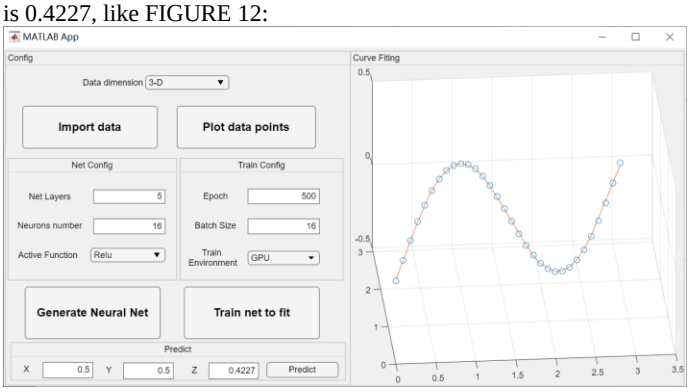

FIGURE 12: THE PREDICTION FOR 3-DIMENSION DATA

4. CONCLUSION

After the above discussion and verification, all the functions of the deep learning application toolbox are performed normally and the performance ability is excellent, which has reached our expectations.

ACKNOWLEDGEMENTS

Thanks for Ms. Wei Yan's MATLAB ENGINEERING APPLICATION COURSE. Under Ms. Wei Yan's guidance, the project was successfully realized and reached the expectation.

REFERENCES

[1] Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning." An MIT Press book. (2015).

[2] Krizhevsky, Alex, Ilya Sutskever, and Geoffrey E. Hinton. "Imagenet classification with deep convolutional neural networks." Advances in neural information processing systems. 2012.

[3] Simonyan, Karen, and Andrew Zisserman. "Very deep convolutional networks for large-scale image recognition." arXiv preprint arXiv:1409.1556 (2014).