

\*\*\*\*\*Draft\*\*\*\*\*

## TensorFlow for Raspberry Pi 4 64 bit and Raspberry Pi Pico 10/05/22

\*\*\*\*\*Draft\*\*\*\*\*

pip3 install runipy

pip3 install ipy

ipython3 Copy\_of\_train\_hello\_world\_model.ipynb

One of the first videos on Tensorflow that I watched was

video link <https://www.youtube.com/watch?v=tPYj3fFJGjk&t=339s>

TensorFlow 2.0 Complete Course - Python Neural Networks for Beginners Tutorial

About the Author

The author of this course is Tim Ruscica, otherwise known as “Tech With Tim” from his educational programming YouTube channel. Tim has a passion for teaching and loves to teach about the world of machine learning and artificial intelligence.

This has led to a journey of learning.

Spent many hours working on C/C++ using the <https://github.com/raspberrypi/pico-tflmicro>.

This repository provided an older version of Tensorflow Lite for the Raspberry Pi Pico.

Since then I have managed to update <https://github.com/develone/devel-pico-tflmicro> to early Sep 2022,

Installed Tensorflow 2.9 on a 64 bit Raspberry Pi 4 4Gb.  
10/3/2022

video link <https://youtu.be/QLZWQlg-Pk0>

## How to Install Tensorflow 2 on a Raspberry Pi

<https://www.samwestby.com/tutorials/rpi-tensorflow.html>

Sam Westby

This has led to several videos on Game On! - Flatbuffers

uname -m  
aarch64

```
python3 -V  
Python 3.9.2
```

```
cat /etc/os-release  
PRETTY_NAME="Debian GNU/Linux 11 (bullseye)"  
NAME="Debian GNU/Linux"  
VERSION_ID="11"  
VERSION="11 (bullseye)"  
VERSION_CODENAME=bullseye  
ID=debian  
HOME_URL="https://www.debian.org/"  
SUPPORT_URL="https://www.debian.org/support"  
BUG_REPORT_URL="https://bugs.debian.org/"
```

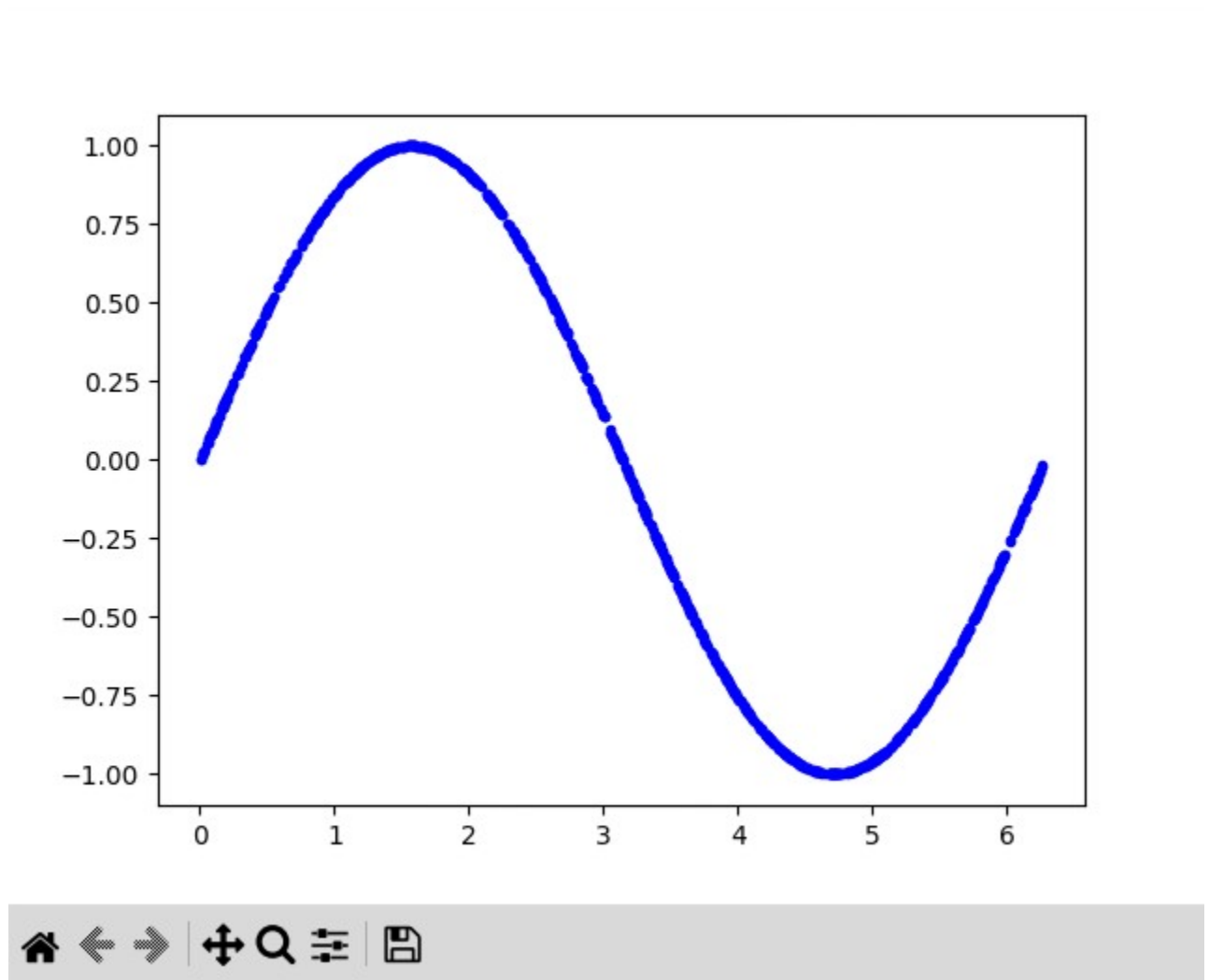
```
sudo apt-get install --yes libssl-dev zlib1g-dev libbz2-dev libreadline-dev libsqlite3-dev llvm  
libncurses5-dev libncursesw5-dev xz-utils tk-dev libgdbm-dev lzma lzma-dev tcl-dev libxml2-dev  
libxmlsec1-dev libffi-dev liblzma-dev wget curl make build-essential openssl
```

```
sudo apt-get install -y libhdf5-dev libc-ares-dev libeigen3-dev gcc gfortran libgfortran5 libatlas3-base  
libatlas-base-dev libopenblas-dev libopenblas-base libblas-dev liblapack-dev cython3 libatlas-base-dev  
openmpi-bin libopenmpi-dev python3-dev
```

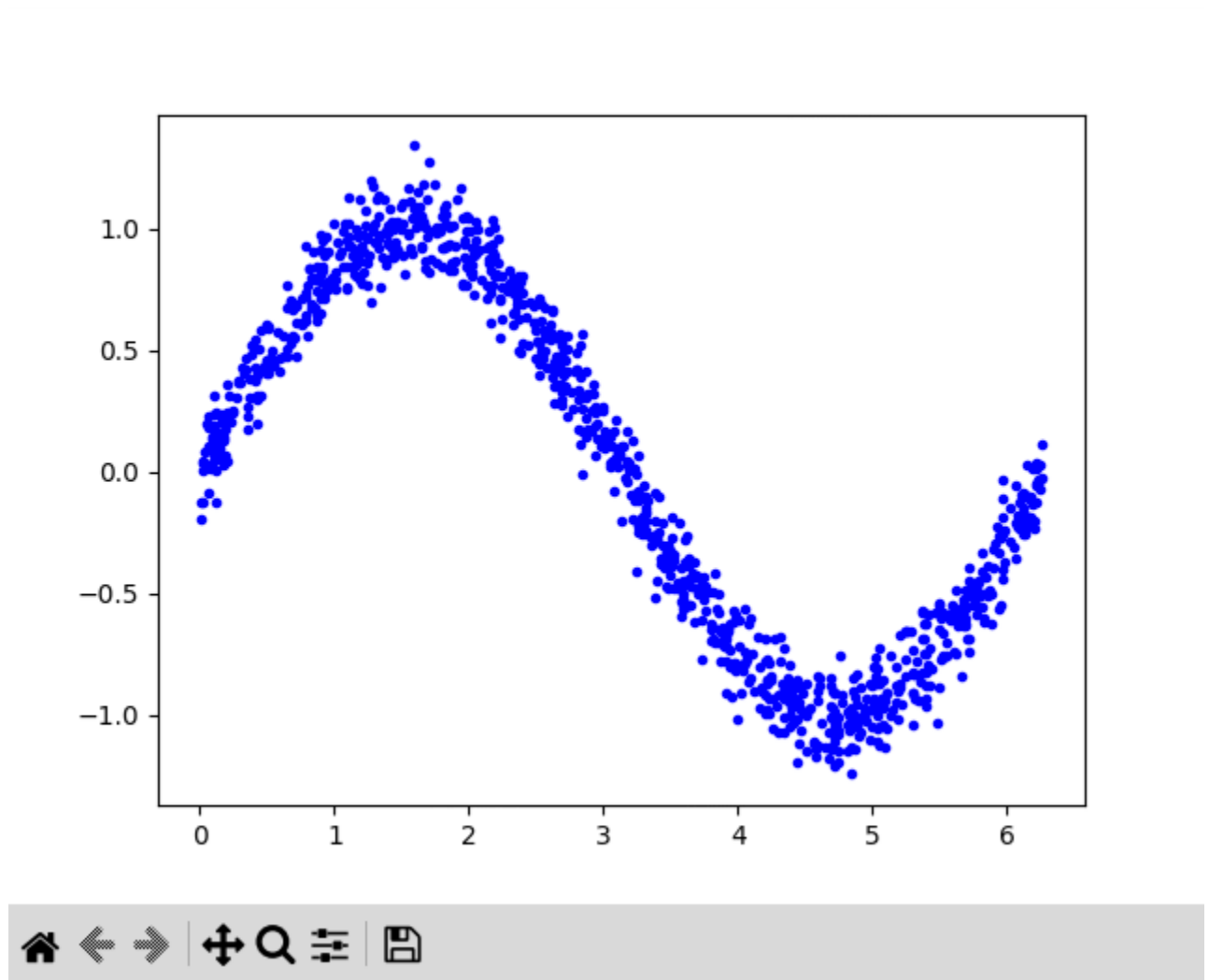
numpy was used to generate a 1000 point sin.

```
x_values = np.random.uniform(low=0, high=2*math.pi, size=SAMPLES).astype(np.float32)
```

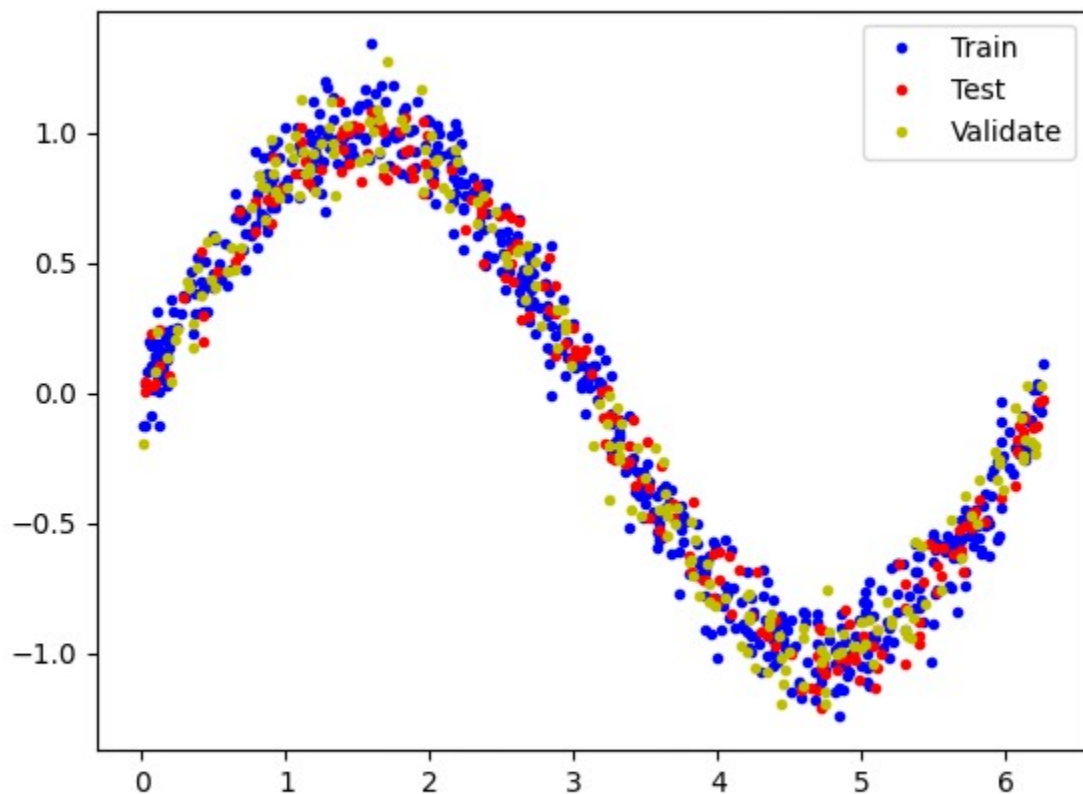
```
y_values = np.sin(x_values).astype(np.float32)
```



signal with noise.



Spiting into three sets Train, Test, and Validate



Epoch 1/500

10/10 [=====] - 2s 55ms/step - loss: 2.7676 - mae: 1.1393 -  
val\_loss: 2.8071 - val\_mae: 1.1649

Epoch 2/500

10/10 [=====] - 0s 10ms/step - loss: 2.6837 - mae: 1.1251 -  
val\_loss: 2.7240 - val\_mae: 1.1510

Epoch 3/500

10/10 [=====] - 0s 10ms/step - loss: 2.6044 - mae: 1.1115 -  
val\_loss: 2.6424 - val\_mae: 1.1373

Epoch 4/500

10/10 [=====] - 0s 10ms/step - loss: 2.5253 - mae: 1.0979 -  
val\_loss: 2.5640 - val\_mae: 1.1240

Epoch 5/500

10/10 [=====] - 0s 10ms/step - loss: 2.4516 - mae: 1.0850 -  
val\_loss: 2.4878 - val\_mae: 1.1109

Epoch 6/500

10/10 [=====] - 0s 10ms/step - loss: 2.3774 - mae: 1.0720 -  
val\_loss: 2.4156 - val\_mae: 1.0984

.  
.  
.

Epoch 494/500

10/10 [=====] - 0s 10ms/step - loss: 0.5033 - mae: 0.6320 -  
val\_loss: 0.5307 - val\_mae: 0.6552

Epoch 495/500

10/10 [=====] - 0s 11ms/step - loss: 0.5033 - mae: 0.6320 -  
val\_loss: 0.5307 - val\_mae: 0.6552

Epoch 496/500

10/10 [=====] - 0s 11ms/step - loss: 0.5033 - mae: 0.6320 -  
val\_loss: 0.5307 - val\_mae: 0.6552

Epoch 497/500

10/10 [=====] - 0s 11ms/step - loss: 0.5033 - mae: 0.6320 -  
val\_loss: 0.5307 - val\_mae: 0.6552

Epoch 498/500

10/10 [=====] - 0s 11ms/step - loss: 0.5033 - mae: 0.6320 -  
val\_loss: 0.5307 - val\_mae: 0.6552

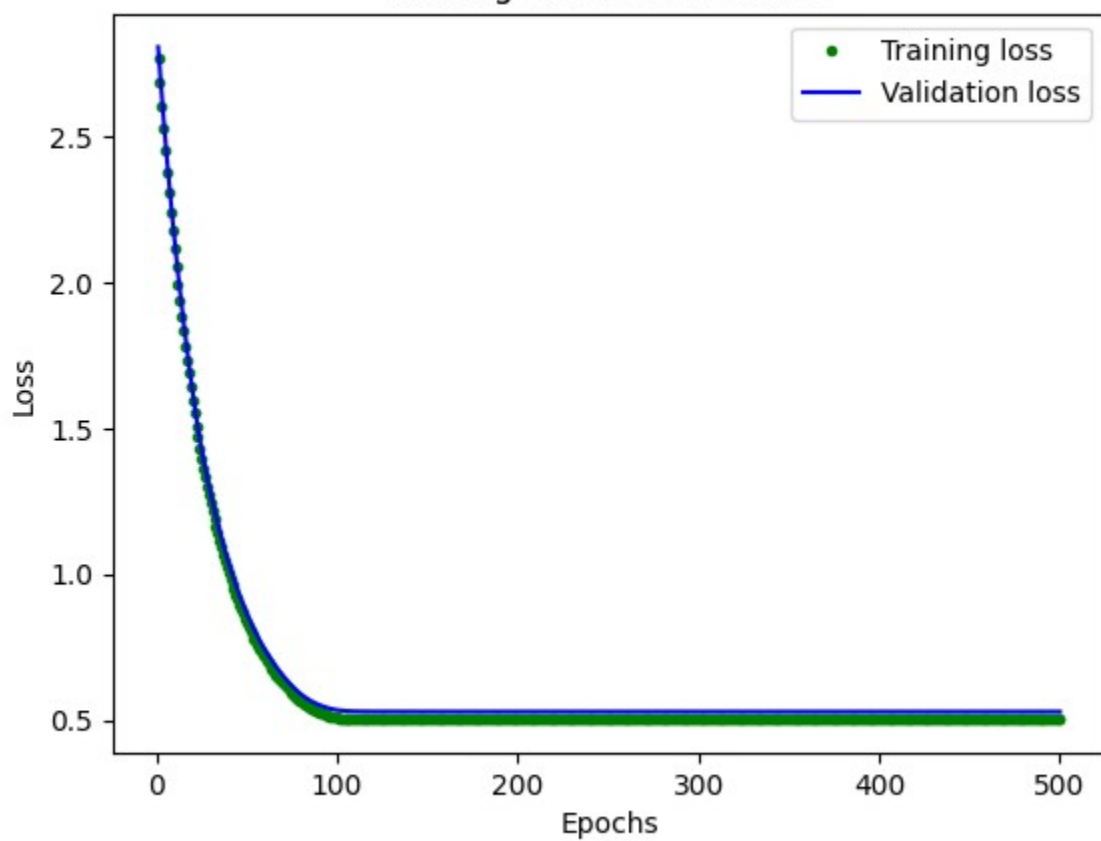
Epoch 499/500

10/10 [=====] - 0s 10ms/step - loss: 0.5033 - mae: 0.6320 -  
val\_loss: 0.5307 - val\_mae: 0.6552

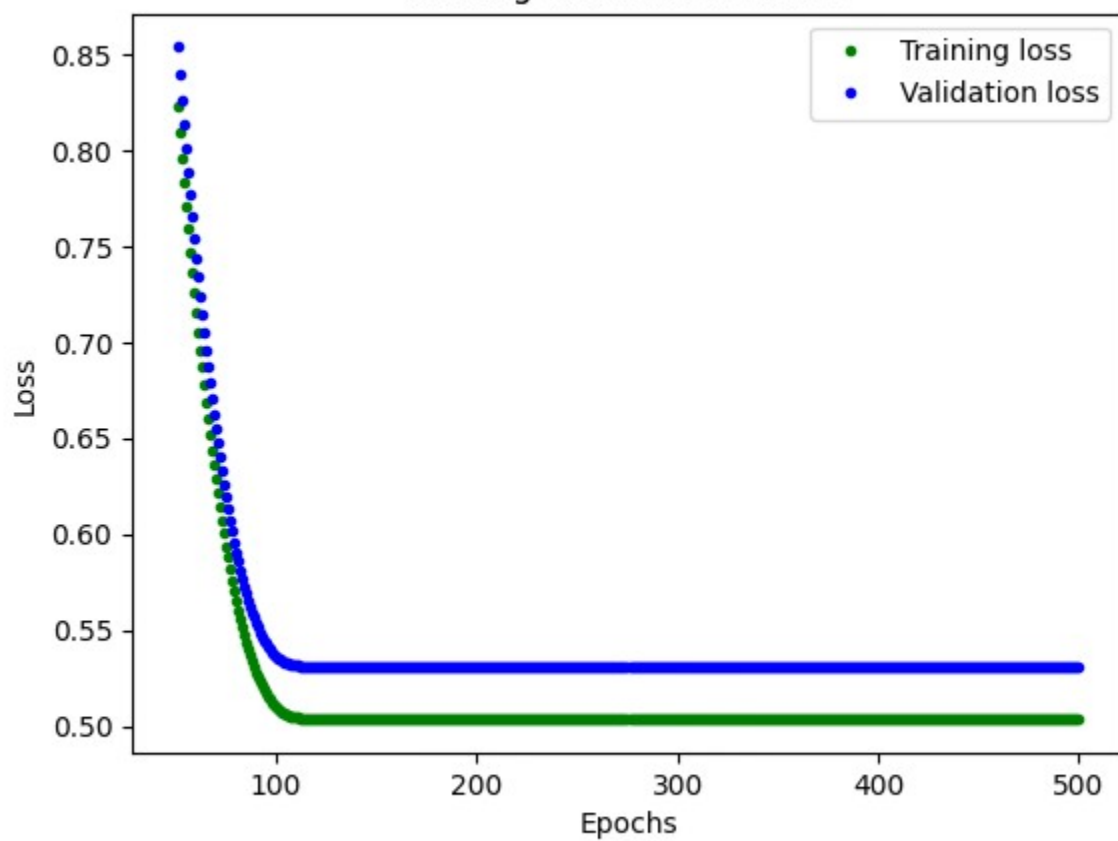
Epoch 500/500

10/10 [=====] - 0s 10ms/step - loss: 0.5033 - mae: 0.6320 -  
val\_loss: 0.5307 - val\_mae: 0.6552

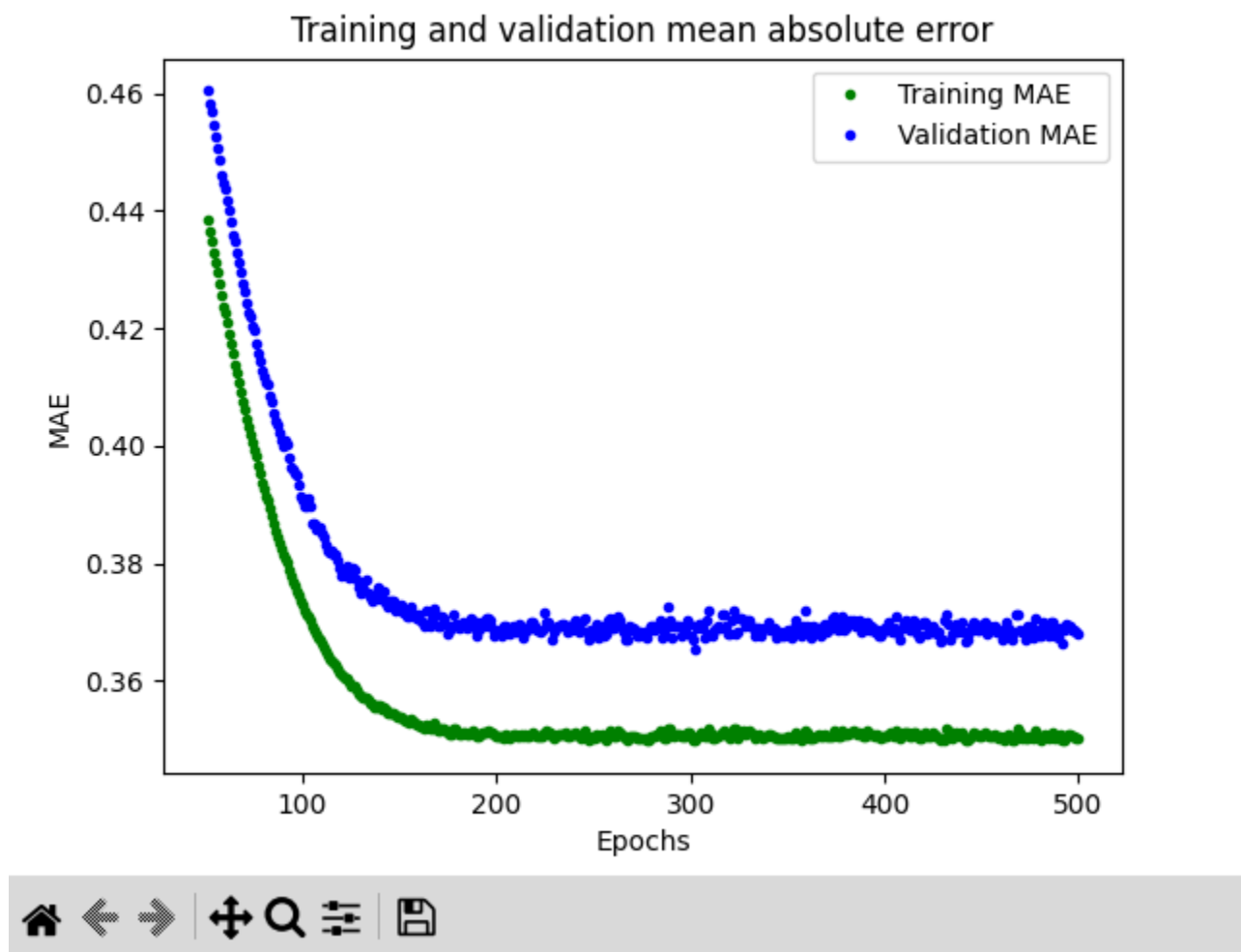
Training and validation loss



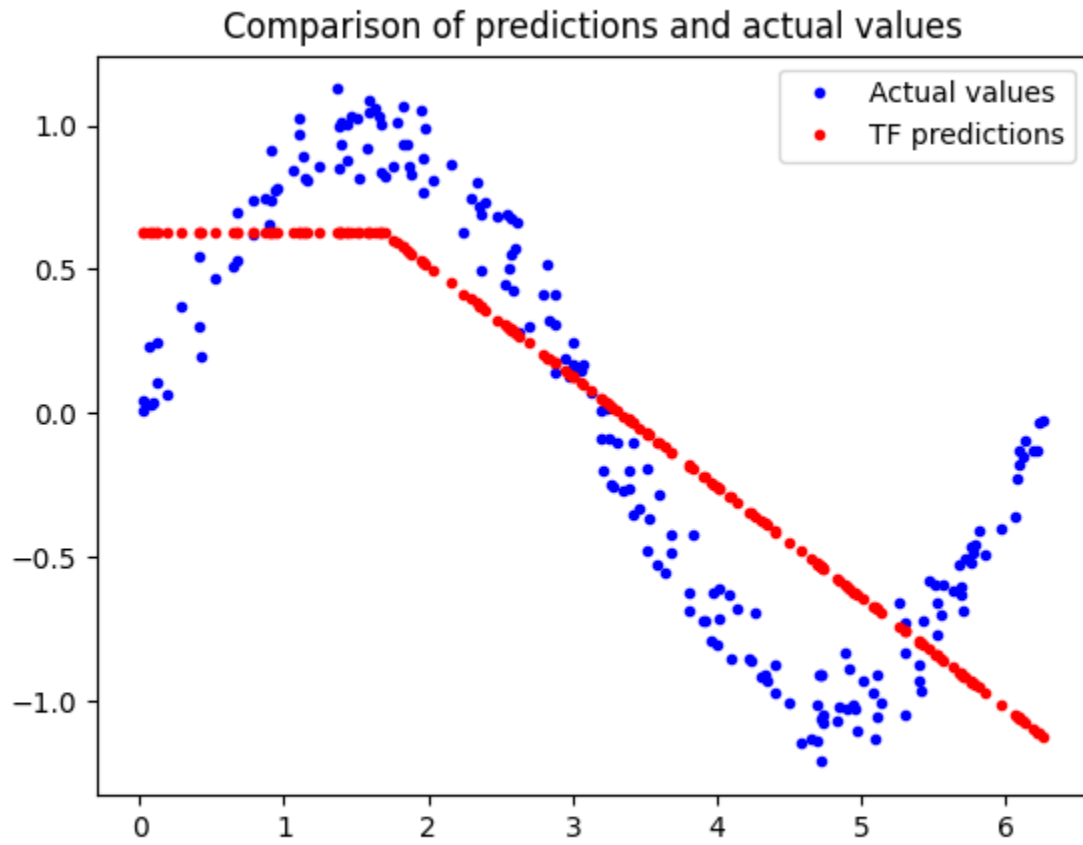
Training and validation loss





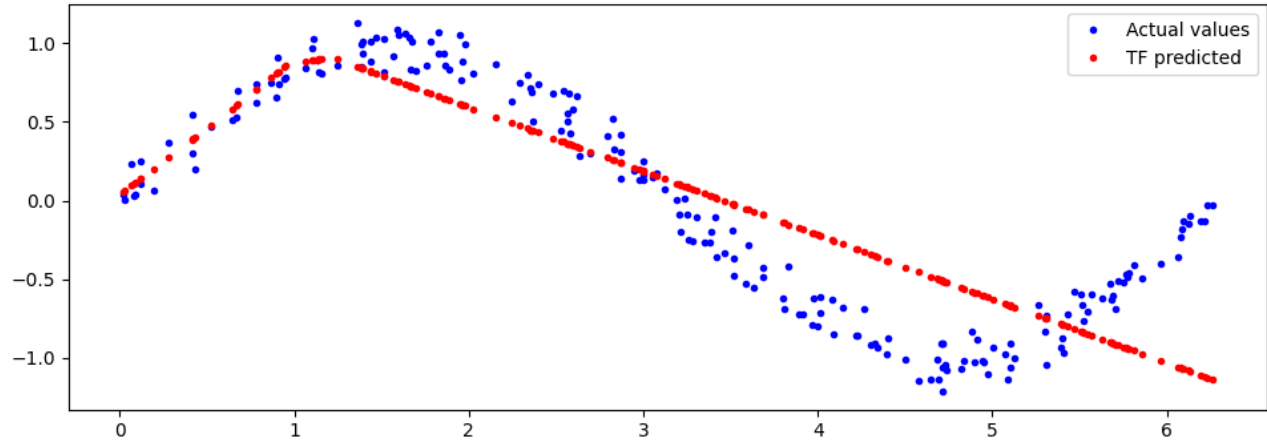


First model run.

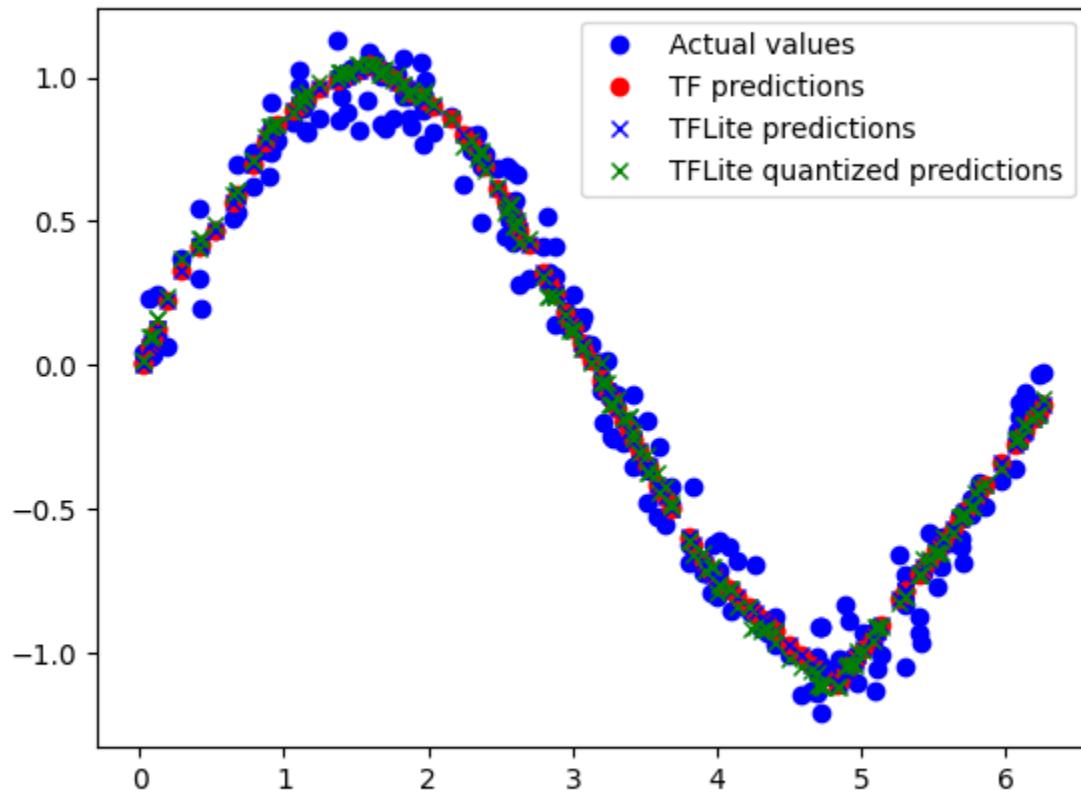


improved

Comparison of predictions and actual values



Comparison of various models against actual values



```
unsigned char g_model[] = {
    0x20, 0x00, 0x00, 0x00, 0x54, 0x46, 0x4c, 0x33, 0x00, 0x00, 0x00, 0x00,
    0x14, 0x00, 0x20, 0x00, 0x1c, 0x00, 0x18, 0x00, 0x14, 0x00, 0x10, 0x00,
    0x0c, 0x00, 0x00, 0x00, 0x08, 0x00, 0x04, 0x00, 0x14, 0x00, 0x00, 0x00,
    0x1c, 0x00, 0x00, 0x00, 0x94, 0x00, 0x00, 0x00, 0xec, 0x00, 0x00, 0x00,
    0xa8, 0x03, 0x00, 0x00, 0xb8, 0x03, 0x00, 0x00, 0xfc, 0x09, 0x00, 0x00,
    0x03, 0x00, 0x00, 0x00, 0x01, 0x00, 0x00, 0x00, 0x10, 0x00, 0x00, 0x00,
    0x00, 0x00, 0x0a, 0x00, 0x10, 0x00, 0x0c, 0x00, 0x08, 0x00, 0x04, 0x00,
    0x0a, 0x00, 0x00, 0x00, 0x0c, 0x00, 0x00, 0x00, 0x1c, 0x00, 0x00, 0x00,
    0x38, 0x00, 0x00, 0x00, 0x0f, 0x00, 0x00, 0x00, 0x73, 0x65, 0x72, 0x76,
    0x69, 0x6e, 0x67, 0x5f, 0x64, 0x65, 0x66, 0x61, 0x75, 0x6c, 0x74, 0x00,
    0x01, 0x00, 0x00, 0x00, 0x04, 0x00, 0x00, 0x00, 0x94, 0xff, 0xff, 0xff,
    0x09, 0x00, 0x00, 0x00, 0x04, 0x00, 0x00, 0x00, 0x07, 0x00, 0x00, 0x00,
    0x64, 0x65, 0x6e, 0x73, 0x65, 0x5f, 0x34, 0x00, 0x01, 0x00, 0x00, 0x00,
    0x04, 0x00, 0x00, 0x00, 0xf2, 0xfc, 0xff, 0xff, 0x04, 0x00, 0x00, 0x00,
    0x0d, 0x00, 0x00, 0x00, 0x64, 0x65, 0x6e, 0x73, 0x65, 0x5f, 0x32, 0x5f,
    0x69, 0x6e, 0x70, 0x75, 0x74, 0x00, 0x00, 0x00, 0x02, 0x00, 0x00, 0x00,
    0x34, 0x00, 0x00, 0x00, 0x04, 0x00, 0x00, 0x00, 0xdc, 0xff, 0xff, 0xff,
    0x0c, 0x00, 0x00, 0x00, 0x04, 0x00, 0x00, 0x00, 0x13, 0x00, 0x00, 0x00,
    0x43, 0x4f, 0x4e, 0x56, 0x45, 0x52, 0x53, 0x49, 0x4f, 0x4e, 0x5f, 0x4d,
    0x45, 0x54, 0x41, 0x44, 0x41, 0x54, 0x41, 0x00, 0x08, 0x00, 0x0c, 0x00,
    0x08, 0x00, 0x04, 0x00, 0x08, 0x00, 0x00, 0x00, 0x0b, 0x00, 0x00, 0x00,
    0x04, 0x00, 0x00, 0x00, 0x13, 0x00, 0x00, 0x00, 0x6d, 0x69, 0x6e, 0x5f,
    0x72, 0x75, 0x6e, 0x74, 0x69, 0x6d, 0x65, 0x5f, 0x76, 0x65, 0x72, 0x73,
    0x69, 0x6f, 0x6e, 0x00, 0x0d, 0x00, 0x00, 0x00, 0xb8, 0x02, 0x00, 0x00,
    0xb0, 0x02, 0x00, 0x00, 0x90, 0x02, 0x00, 0x00, 0x38, 0x02, 0x00, 0x00,
    0x28, 0x01, 0x00, 0x00, 0xd8, 0x00, 0x00, 0x00, 0xb8, 0x00, 0x00, 0x00,
    0xa4, 0x00, 0x00, 0x00, 0x9c, 0x00, 0x00, 0x00, 0x94, 0x00, 0x00, 0x00,
    0x8c, 0x00, 0x00, 0x00, 0x6c, 0x00, 0x00, 0x00, 0x04, 0x00, 0x00, 0x00,
    0xa2, 0xfd, 0xff, 0xff, 0x04, 0x00, 0x00, 0x00, 0x58, 0x00, 0x00, 0x00,
    0x0c, 0x00, 0x00, 0x00, 0x08, 0x00, 0x0e, 0x00, 0x08, 0x00, 0x04, 0x00,
    0x08, 0x00, 0x00, 0x00, 0x10, 0x00, 0x00, 0x00, 0x28, 0x00, 0x00, 0x00,
    0x00, 0x00, 0x06, 0x00, 0x08, 0x00, 0x04, 0x00, 0x06, 0x00, 0x00, 0x00,
    0x04, 0x00, 0x00, 0x00, 0x01, 0x00, 0x00, 0x00, 0xeb, 0x03, 0x00, 0x00,
    0x00, 0x00, 0x0a, 0x00, 0x10, 0x00, 0x0c, 0x00, 0x08, 0x00, 0x04, 0x00,
    0x0a, 0x00, 0x00, 0x00, 0x01, 0x00, 0x00, 0x00, 0x02, 0x00, 0x00, 0x00,
    0x04, 0x00, 0x00, 0x00, 0x05, 0x00, 0x00, 0x00, 0x32, 0x2e, 0x39, 0x2e,
    0x30, 0x00, 0x00, 0x00, 0x06, 0xfe, 0xff, 0xff, 0x04, 0x00, 0x00, 0x00,
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    0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x84, 0xfd, 0xff, 0xff,
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    0x04, 0x00, 0x00, 0x00, 0x04, 0x00, 0x00, 0x00, 0x8c, 0xef, 0xff, 0xff,
    0x3e, 0xfe, 0xff, 0xff, 0x04, 0x00, 0x00, 0x00, 0x10, 0x00, 0x00, 0x00,
    0x21, 0xa5, 0x8b, 0xca, 0x5e, 0x1d, 0xce, 0x42, 0x9d, 0xce, 0x1f, 0xb0,
    0xdf, 0x54, 0x2f, 0x81, 0x5a, 0xfe, 0xff, 0xff, 0x04, 0x00, 0x00, 0x00,
    0x40, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0xb5, 0x04, 0x00, 0x00,
    0x78, 0x0a, 0x00, 0x00, 0x2d, 0x06, 0x00, 0x00, 0x71, 0xf8, 0xff, 0xff,
    0x00, 0x00, 0x00, 0x00, 0x99, 0x0a, 0x00, 0x00, 0xfe, 0xf7, 0xff, 0xff,
    0x0f, 0x05, 0x00, 0x00, 0xd4, 0x09, 0x00, 0x00, 0x47, 0xfe, 0xff, 0xff,
```

0xb6, 0x04, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0xac, 0xf7, 0xff, 0xff,  
0x4b, 0xf9, 0xff, 0xff, 0x4a, 0x05, 0x00, 0x00, 0xa6, 0xfe, 0xff, 0xff,  
0x04, 0x00, 0x00, 0x00, 0x00, 0x01, 0x00, 0x00, 0xee, 0xfc, 0x00, 0xec,  
0x05, 0x17, 0xef, 0xec, 0xe6, 0xf8, 0x03, 0x01, 0x00, 0xfa, 0xf8, 0xf5,  
0xdc, 0xeb, 0x27, 0x14, 0xf1, 0xde, 0xe2, 0xdb, 0xf0, 0xde, 0x31, 0x06,  
0x02, 0xe6, 0xee, 0xf9, 0x00, 0x16, 0x07, 0xe0, 0xfe, 0xff, 0xe9, 0x06,  
0xe7, 0xef, 0x81, 0x1b, 0x18, 0xea, 0xc9, 0x01, 0x0f, 0x00, 0xda, 0xf7,  
0x0e, 0xec, 0x13, 0x1f, 0x04, 0x13, 0xb4, 0xe6, 0xfd, 0x06, 0xb9, 0xe0,  
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0xde, 0x13, 0xf6, 0x19, 0xff, 0xf6, 0x1b, 0x18, 0xf0, 0x1c, 0xda, 0x1b,  
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0x1f, 0x13, 0x36, 0x1c, 0x12, 0xeb, 0x3b, 0x0c, 0xb4, 0xcb, 0xe6, 0x13,  
0xfa, 0xeb, 0xf1, 0x06, 0x1c, 0xfa, 0x18, 0xe5, 0xeb, 0xcb, 0x0c, 0xf4,  
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0x08, 0x00, 0x00, 0x00, 0x03, 0x00, 0x00, 0x00, 0x07, 0x00, 0x00, 0x00,  
0x03, 0x00, 0x00, 0x00, 0x04, 0x00, 0x00, 0x00, 0x00, 0x00, 0x0e, 0x00,  
0x16, 0x00, 0x00, 0x00, 0x10, 0x00, 0x0c, 0x00, 0x0b, 0x00, 0x04, 0x00,  
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0x00, 0x00, 0x00, 0x00, 0x01, 0x00, 0x00, 0x00, 0x02, 0x00, 0x00, 0x00,  
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0x00, 0x00, 0x00, 0x00, 0x0a, 0x00, 0x00, 0x00, 0xac, 0x04, 0x00, 0x00,  
0x2c, 0x04, 0x00, 0x00, 0xa8, 0x03, 0x00, 0x00, 0x3c, 0x03, 0x00, 0x00,  
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0x34, 0x01, 0x00, 0x00, 0x80, 0x00, 0x00, 0x00, 0x04, 0x00, 0x00, 0x00,  
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0x65, 0x66, 0x75, 0x6c, 0x50, 0x61, 0x72, 0x74, 0x69, 0x74, 0x69, 0x6f,  
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0x01, 0x00, 0x00, 0x00, 0xd6, 0x4d, 0x0b, 0x3c, 0x1b, 0x00, 0x00, 0x00,  
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0x2f, 0x42, 0x69, 0x61, 0x73, 0x41, 0x64, 0x64, 0x2f, 0x52, 0x65, 0x61,  
0x64, 0x56, 0x61, 0x72, 0x69, 0x61, 0x62, 0x6c, 0x65, 0x4f, 0x70, 0x00,  
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0x04, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x09
```

```
};
```

```
unsigned int g_model_len = 2648;
```