Edge Computing Lab

Class: TY-AIEC

School of Computing, MIT Art Design Technology University

Academic Year: 2024-25

Experiment No. 5

Title

The “Hello World” of Edge Impulse Platform

Introduction

Edge Impulse is a development platform for machine learning on edge devices, targeted at developers who want to create intelligent device solutions. The "Hello World" equivalent in Edge Impulse would typically involve creating a simple machine learning model that can run on an edge device, like classifying sensor data or recognizing a basic pattern.

Objective

TinyML: Building and Training a Model

Tasks

- Understand the Edge Impulse Platform
- Configure Raspberry Pi / Nano BLE Sense for Edge Impulse

Materials Required

- Raspberry Pi 4 / Nano BLE Sense Board

Theory

GPIO (General Purpose Input/Output) pins on the Raspberry Pi are used for interfacing with other electronic components. BCM numbering refers to the pin numbers in the Broadcom SOC channel, which is a more consistent way to refer to the GPIO pins across different versions of the

Here’s a high-level overview of steps you'd follow to create a "Hello World" project on Edge Impulse: **Steps to Configure the Edge Impulse:**

1. Create an Account and New Project:

    • Sign up for an Edge Impulse account.

    • Create a new project from the dashboard.

2. Connect a Device:

    • You can use a supported development board or your smartphone as a sensor device. • Follow the instructions to connect your device to your Edge Impulse project. 3. Collect Data:

    • Use the Edge Impulse mobile app or the Web interface to collect data from the onboard sensors.

    •

4. Create an Impulse:

- Go to the 'Create impulse' page.

- Add a processing block (e.g., time-series data) and a learning block (e.g., classification).

- Save the impulse, which defines the machine learning pipeline.

5. Design a Neural Network:

   - Navigate to the 'NN Classifier' under the 'Learning blocks'.

   - Design a simple neural network. Edge Impulse provides a default architecture that works well for most basic tasks.

6. Train the Model:

   - Click on the 'Start training' button to train your machine learning model with the collected data.

7. Test the Model:

   - Once the model is trained, you can test its performance with new data in the 'Model Testing' tab.

8. Deploy the Model:

   - Go to the 'Deployment' tab.

   - Select the deployment method that suits your edge device (e.g., Arduino library, WebAssembly, container, etc.).

   - Follow the instructions to deploy the model to your device.

9. Run Inference:

   - With the model deployed, run inference on the edge device to see it classifying data in real-time.

10. Monitor:

    - You can monitor the performance of your device through the Edge

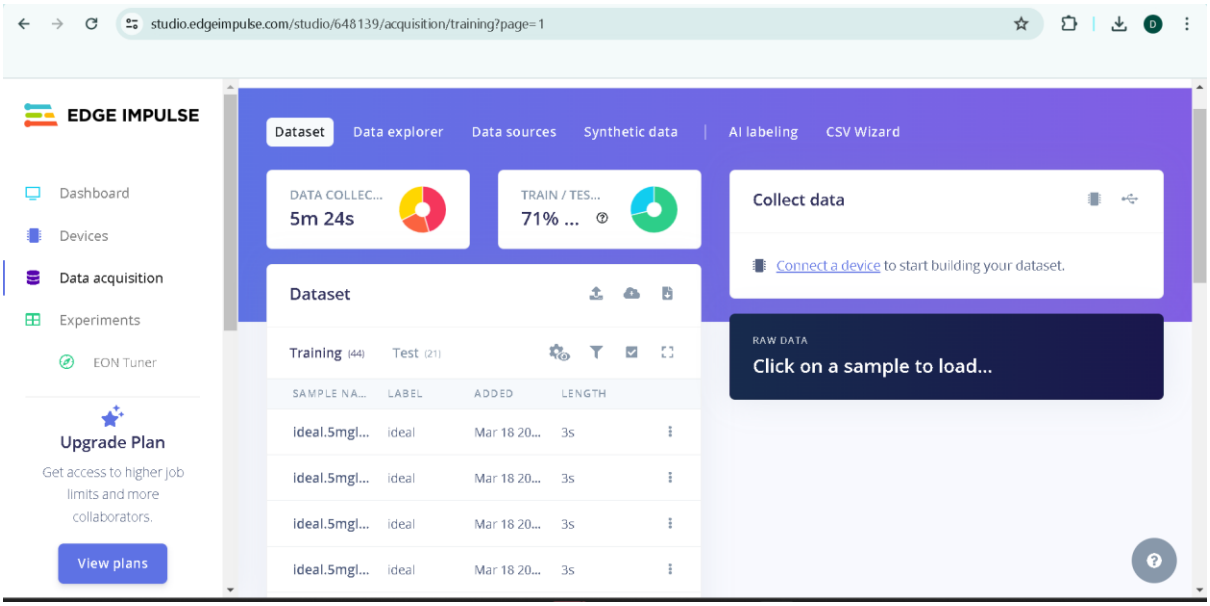
Impulse studio.

Conclusion:- Created and deployed ML model with accelerometer data on

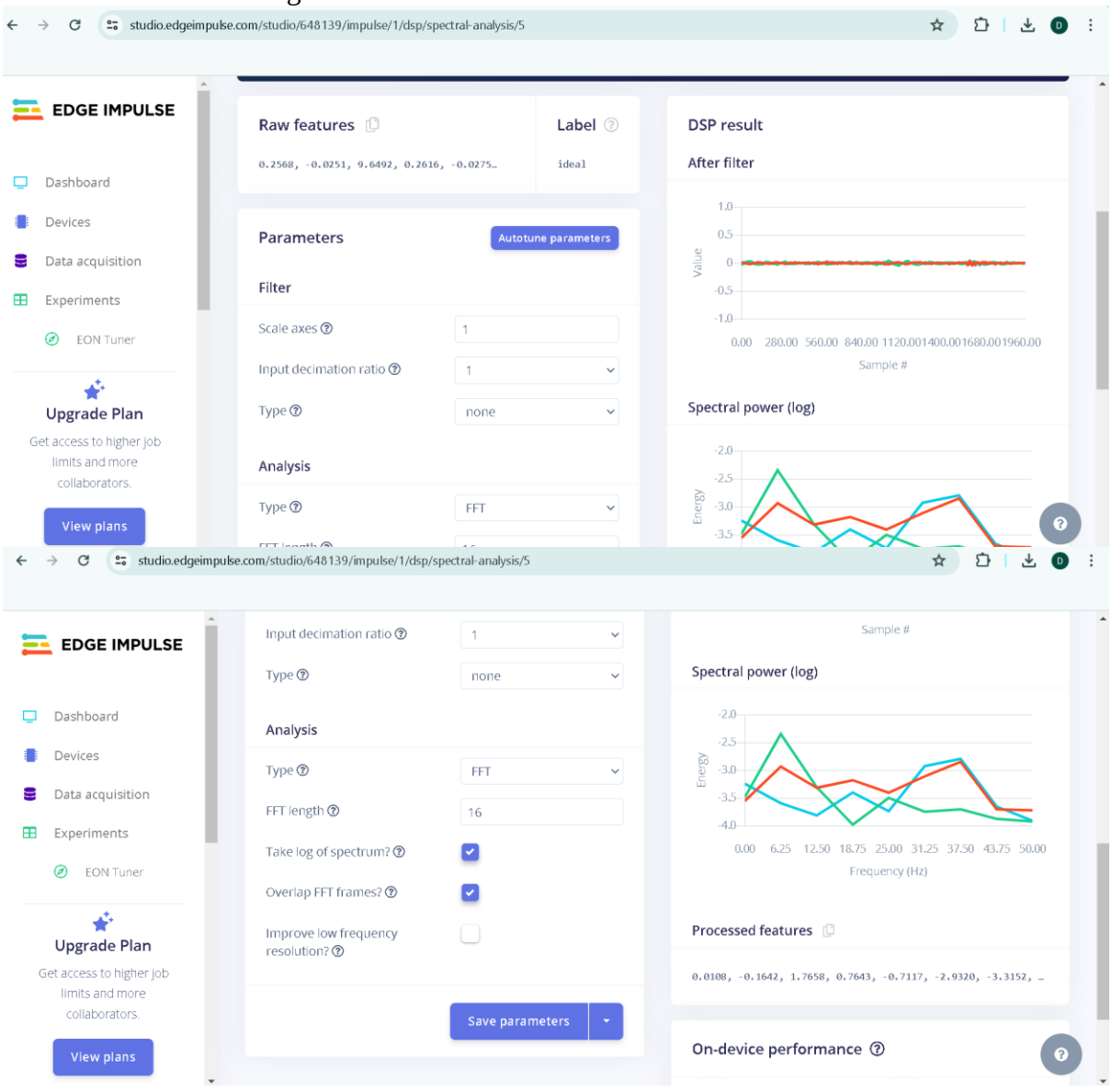
edge device

Edge Impulse project's Results:

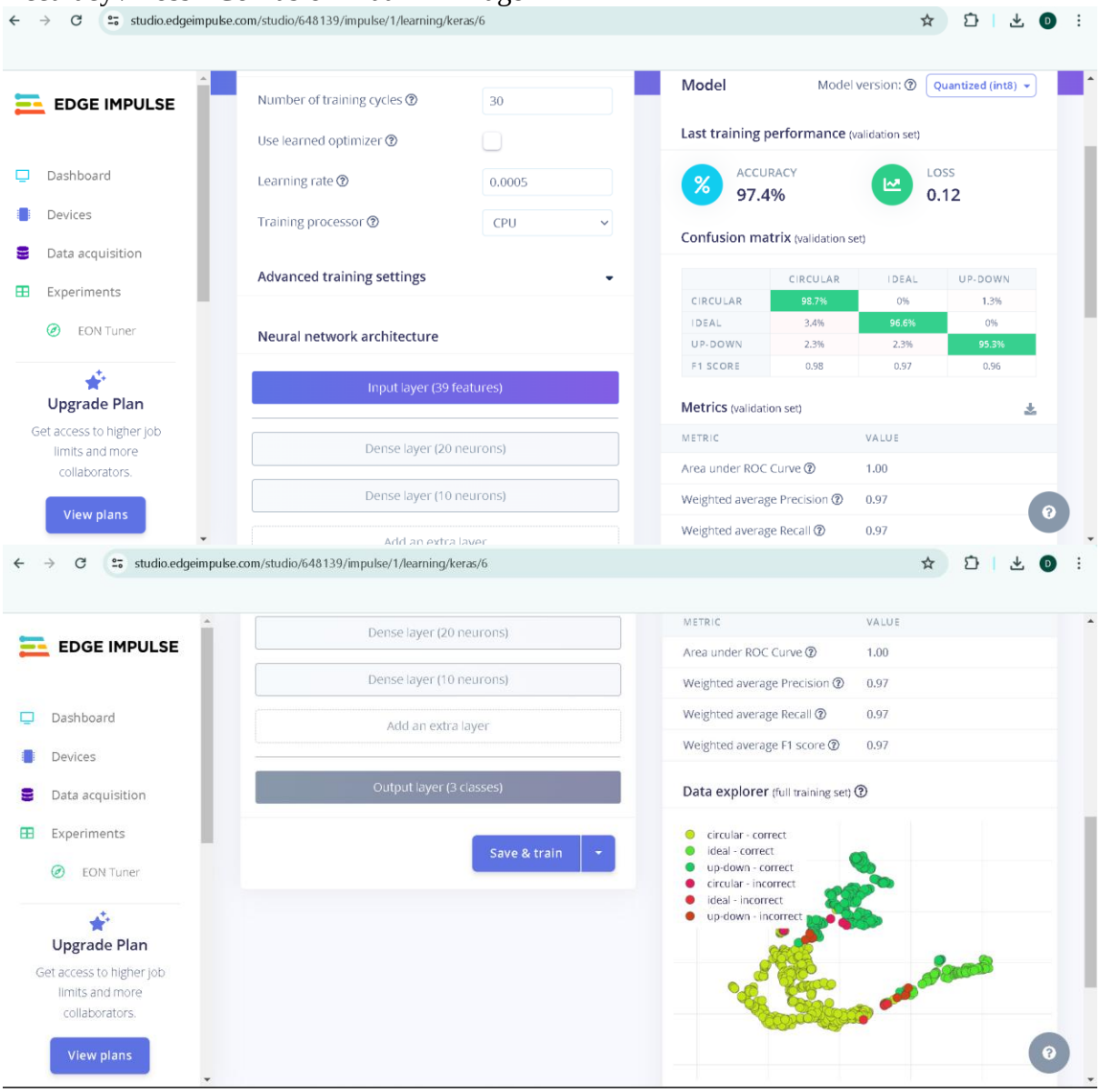
1. Dataset Image



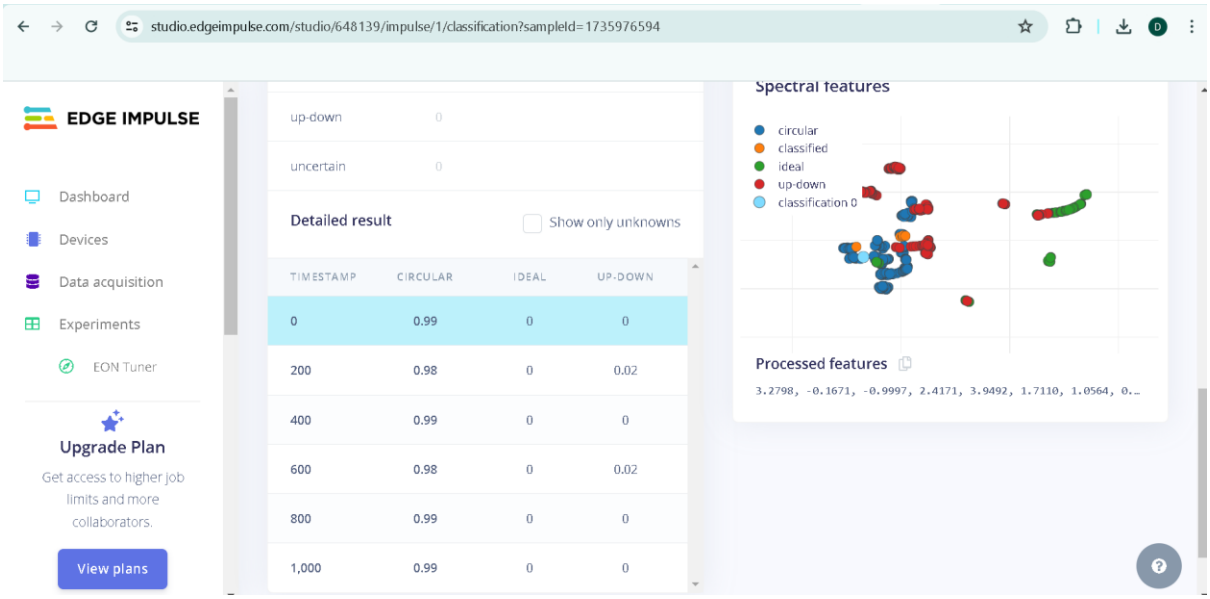
2. Feature extraction - Image



3. Accuracy / Loss - Confusion Matrix – image



4. Validation Result – Image



5. Copy the code of Arduino Sketch

```
/* Edge Impulse ingestion SDK
 * Copyright (c) 2022 EdgeImpulse Inc.
 *
 * Licensed under the Apache License, Version 2.0 (the "License");
 * you may not use this file except in compliance with the License.
 * You may obtain a copy of the License at
 * http://www.apache.org/licenses/LICENSE-2.0
 *
 * Unless required by applicable law or agreed to in writing, software
 * distributed under the License is distributed on an "AS IS" BASIS,
 * WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
 * See the License for the specific language governing permissions and
 * limitations under the License.
 *
 */

/* Includes ---------------------------------------------------------------- */
#include <dpar_inferencing.h>
#include <Arduino_LSM9DS1.h> //Click here to get the library: https://www.arduino.cc/reference/en/libraries/arduino_lsm9ds1/

/* Constant defines -------------------------------------------------------- */
#define CONVERT_G_TO_MS2    9.80665f
/**
 * When data is collected by the Edge Impulse Arduino Nano 33 BLE Sense
 * firmware, it is limited to a 2G range. If the model was created with a
```

```
 * different sample range, modify this constant to match the input values.
 * See https://github.com/edgeimpulse/firmware-arduino-nano-33-ble-sense/blob/master/src/sensors/ei_lsm9ds1.cpp
 * for more information.
 */
#define MAX_ACCEPTED_RANGE  2.0f

/*
 ** NOTE: If you run into TFLite arena allocation issue.
 **
 ** This may be due to may dynamic memory fragmentation.
 ** Try defining "-DEI_CLASSIFIER_ALLOCATION_STATIC" in boards.local.txt (create
 ** if it doesn't exist) and copy this file to
 **
 `<ARDUINO_CORE_INSTALL_PATH>/arduino/hardware/<mbed_core>/<core_version>/`.
 **
 ** See
 ** (https://support.arduino.cc/hc/en-us/articles/360012076960-Where-are-the-installed-cores-located-)
 ** to find where Arduino installs cores on your machine.
 **
 ** If the problem persists then there's not enough memory for this model and application.
 */

/* Private variables ------------------------------------------------------- */
static bool debug_nn = false; // Set this to true to see e.g. features generated from the raw signal

/**
* @brief      Arduino setup function
*/
void setup()
{
    // put your setup code here, to run once:
    Serial.begin(115200);
    // comment out the below line to cancel the wait for USB connection (needed for native USB)
    while (!Serial);
    Serial.println("Edge Impulse Inferencing Demo");

    if (!IMU.begin()) {
        ei_printf("Failed to initialize IMU!\r\n");
    }
```

```
    else {
        ei_printf("IMU initialized\r\n");
    }

    if (EI_CLASSIFIER_RAW_SAMPLES_PER_FRAME != 3) {
        ei_printf("ERR: EI_CLASSIFIER_RAW_SAMPLES_PER_FRAME should be equal to 3 (the 3 sensor axes)\n");
        return;
    }
}

/**
 * @brief Return the sign of the number
 *
 * @param number
 * @return int 1 if positive (or 0) -1 if negative
 */
float ei_get_sign(float number) {
    return (number >= 0.0) ? 1.0 : -1.0;
}

/**
* @brief      Get data and run inferencing
*
* @param[in]  debug  Get debug info if true
*/
void loop()
{
    ei_printf("\nStarting inferencing in 2 seconds...\n");

    delay(2000);

        ei_printf("Sampling...\n");

        // Allocate a buffer here for the values we'll read from the IMU
        float buffer[EI_CLASSIFIER_DSP_INPUT_FRAME_SIZE] = { 0 };

        for (size_t ix = 0; ix < EI_CLASSIFIER_DSP_INPUT_FRAME_SIZE; ix += 3) {
            // Determine the next tick (and then sleep later)
            uint64_t next_tick = micros() + (EI_CLASSIFIER_INTERVAL_MS * 1000);

            IMU.readAcceleration(buffer[ix], buffer[ix + 1], buffer[ix + 2]);

            for (int i = 0; i < 3; i++) {
```

```
                if (fabs(buffer[ix + i]) > MAX_ACCEPTED_RANGE) {
                    buffer[ix + i] = ei_get_sign(buffer[ix + i]) *
   MAX_ACCEPTED_RANGE;
                }
            }

            buffer[ix + 0] *= CONVERT_G_TO_MS2;
            buffer[ix + 1] *= CONVERT_G_TO_MS2;
            buffer[ix + 2] *= CONVERT_G_TO_MS2;

            delayMicroseconds(next_tick - micros());
        }

        // Turn the raw buffer in a signal which we can the classify
        signal_t signal;
        int err = numpy::signal_from_buffer(buffer,
   EI_CLASSIFIER_DSP_INPUT_FRAME_SIZE, &signal);
        if (err != 0) {
            ei_printf("Failed to create signal from buffer (%d)\n",
   err);
            return;
        }

        // Run the classifier
        ei_impulse_result_t result = { 0 };

        err = run_classifier(&signal, &result, debug_nn);
        if (err != EI_IMPULSE_OK) {
            ei_printf("ERR: Failed to run classifier (%d)\n", err);
            return;
        }

        // print the predictions
        ei_printf("Predictions ");
        ei_printf("(DSP: %d ms., Classification: %d ms., Anomaly: %d
   ms.)",
            result.timing.dsp, result.timing.classification,
   result.timing.anomaly);
        ei_printf(": \n");
        for (size_t ix = 0; ix < EI_CLASSIFIER_LABEL_COUNT; ix++) {
            ei_printf("    %s: %.5f\n",
   result.classification[ix].label, result.classification[ix].value);
        }
    #if EI_CLASSIFIER_HAS_ANOMALY == 1
        ei_printf("    anomaly score: %.3f\n", result.anomaly);
    #endif
    }

```

```
154.      #if !defined(EI_CLASSIFIER_SENSOR) || EI_CLASSIFIER_SENSOR !=
   EI_CLASSIFIER_SENSOR_ACCELEROMETER
155.      #error "Invalid model for current sensor"
156.      #endif
157.
```