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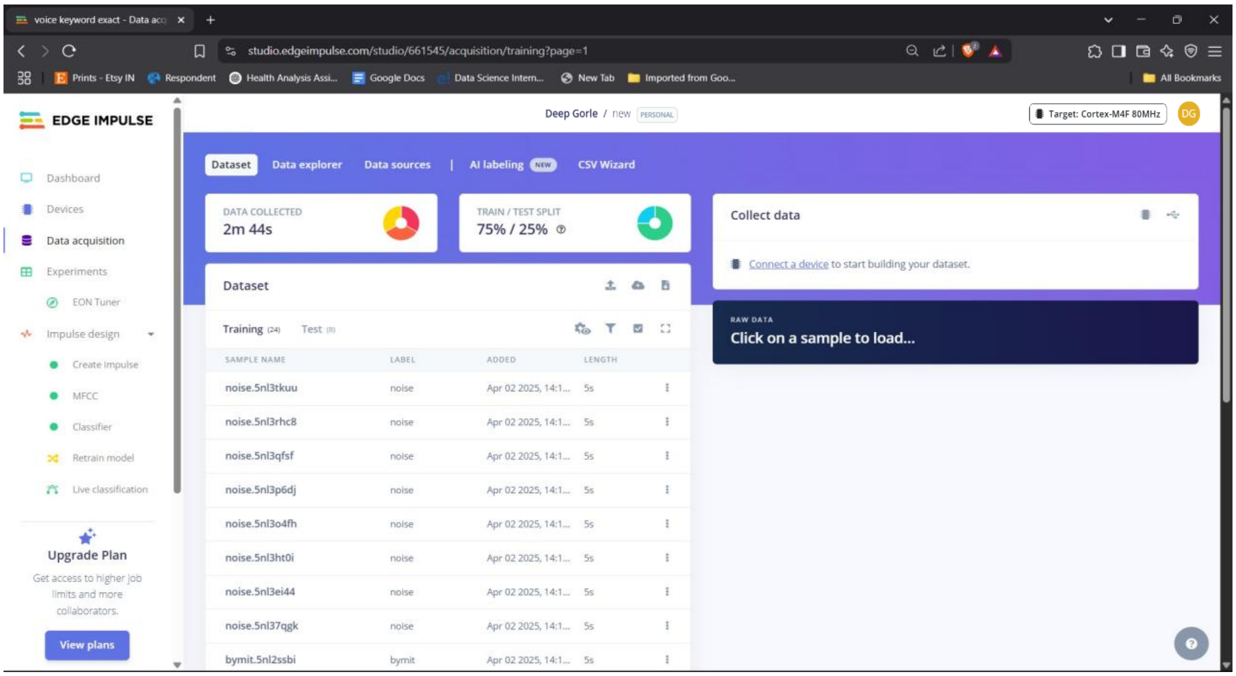
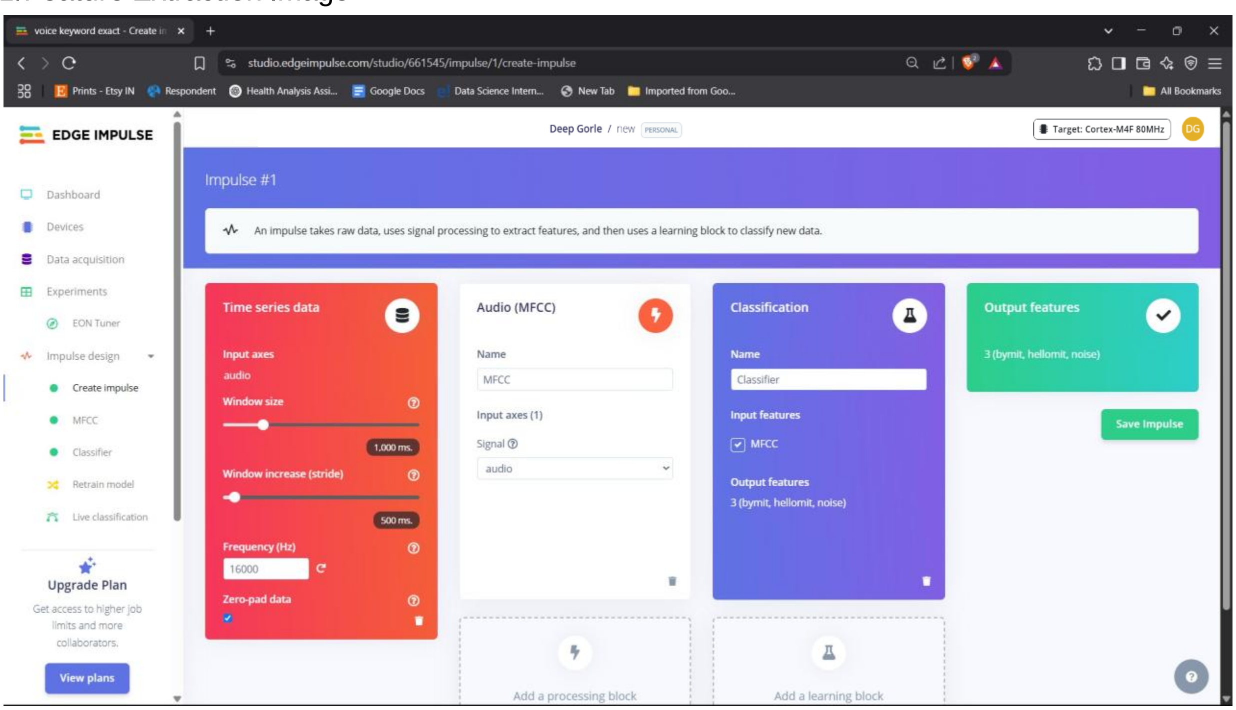
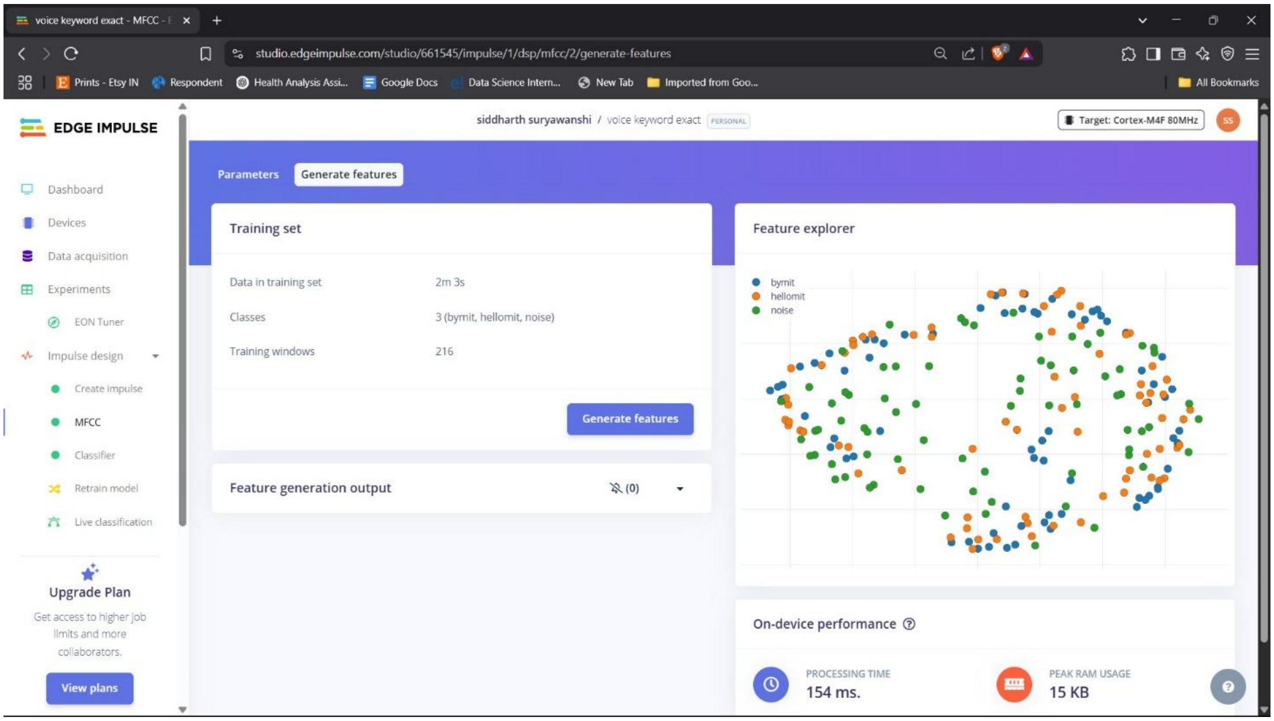
ECL Experiment 06

1.DataSet image

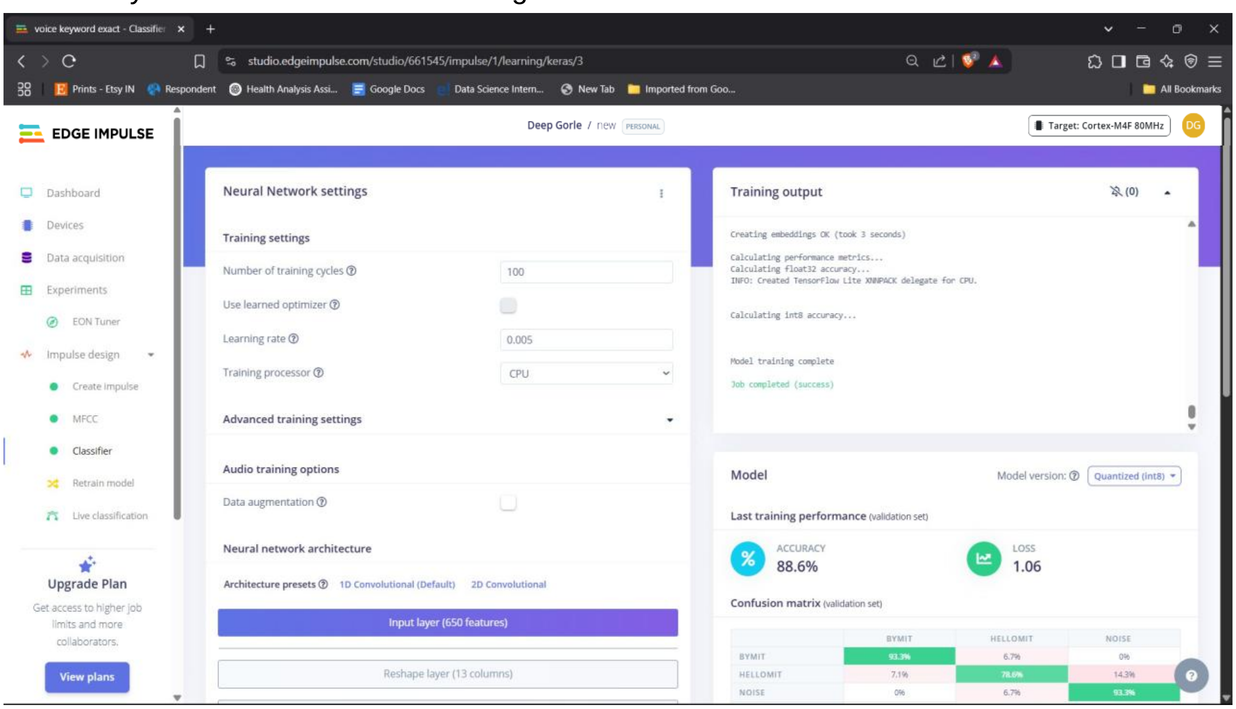


2.Feature Extraction Image

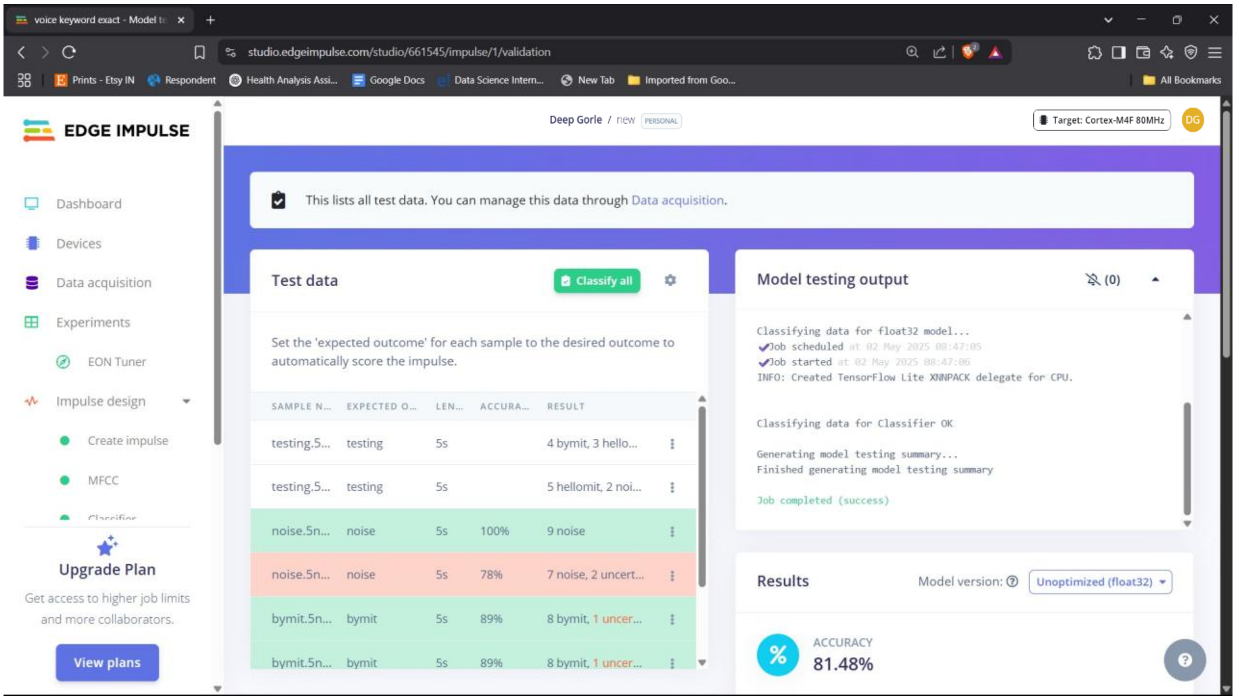




3. Accuracy / Loss Confusion Matrix Image



4. Validation Result



5. Copy of the Arduino Code

```
/* 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.
 *
 */

// If your target is limited in memory remove this macro to save
10K RAM
#define EIDSP_QUANTIZE_FILTERBANK   0

/**
 * Define the number of slices per model window. E.g. a model
window of 1000
ms
 * with slices per model window set to 4. Results in a slice
size of 250 ms.
 * For more info:
https://docs.edgeimpulse.com/docs/continuous-audio-sampling
 */
#define EI_CLASSIFIER_SLICES_PER_MODEL_WINDOW 4

/*
 ** 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.
 */
 /* Includes
----------------------------------------------------------------
*/
#include <PDM.h>
#include <Voice_Command_inferencing.h>

/** Audio buffers, pointers and selectors */
typedef struct {
    signed short *buffers[2];
    unsigned char buf_select;
    unsigned char buf_ready;
    unsigned int buf_count;
    unsigned int n_samples;
} inference_t;

static inference_t inference;
static bool record_ready = false;
static signed short *sampleBuffer;
static bool debug_nn = false; // Set this to true to see e.g.
features
generated from the raw signal
static int print_results =
-(EI_CLASSIFIER_SLICES_PER_MODEL_WINDOW);
```

```
/**
 * @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");

    // summary of inferencing settings (from model_metadata.h)
    ei_printf("Inferencing settings:\n");
    ei_printf("\tInterval: %.2f ms.\n",
(float)EI_CLASSIFIER_INTERVAL_MS);
    ei_printf("\tFrame size: %d\n",
EI_CLASSIFIER_DSP_INPUT_FRAME_SIZE);
    ei_printf("\tSample length: %d ms.\n",
EI_CLASSIFIER_RAW_SAMPLE_COUNT /
16);
    ei_printf("\tNo. of classes: %d\n",
sizeof(ei_classifier_inferencing_categories) /

sizeof(ei_classifier_inferencing_c
 ategories[0]));

    run_classifier_init();
    if (microphone_inference_start(EI_CLASSIFIER_SLICE_SIZE) ==
false) {
        ei_printf("ERR: Could not allocate audio buffer (size
%d), this could
be due to the window length of your model\r\n",
```

```
EI_CLASSIFIER_RAW_SAMPLE_COUNT);
        return;
    }
}

/**
 * @brief      Arduino main function. Runs the inferencing loop.
 */
void loop()
{
    bool m = microphone_inference_record();
    if (!m) {
        ei_printf("ERR: Failed to record audio...\n");
        return;
    }

    signal_t signal;
    signal.total_length = EI_CLASSIFIER_SLICE_SIZE;
    signal.get_data = &microphone_audio_signal_get_data;
    ei_impulse_result_t result = {0};

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

    if (++print_results >=
(EI_CLASSIFIER_SLICES_PER_MODEL_WINDOW)) {
        // 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

        print_results = 0;
    }
}

/**
 * @brief      PDM buffer full callback
 *             Get data and call audio thread callback
 */
 static void pdm_data_ready_inference_callback(void)
 {
     int bytesAvailable = PDM.available();

     // read into the sample buffer
     int bytesRead = PDM.read((char *)&sampleBuffer[0],
bytesAvailable);

     if (record_ready == true) {
         for (int i = 0; i<bytesRead>> 1; i++) {
```

```
inference.buffers[inference.buf_select][inference.buf_count++] =
 sampleBuffer[i];

            if (inference.buf_count >= inference.n_samples) {
                inference.buf_select ^= 1;
                inference.buf_count = 0;
                inference.buf_ready = 1;
            }
        }
    }
}

/**
 * @brief      Init inferencing struct and setup/start PDM
 *
 * @param[in]  n_samples  The n samples
 *
 * @return     { description_of_the_return_value }
 */
static bool microphone_inference_start(uint32_t n_samples)
{
    inference.buffers[0] = (signed short *)malloc(n_samples *
sizeof(signed
 short));

    if (inference.buffers[0] == NULL) {
        return false;
    }

    inference.buffers[1] = (signed short *)malloc(n_samples *
sizeof(signed
 short));
```

```
    if (inference.buffers[1] == NULL) {
        free(inference.buffers[0]);
        return false;
    }

    sampleBuffer = (signed short *)malloc((n_samples >> 1) *
sizeof(signed
 short));

    if (sampleBuffer == NULL) {
        free(inference.buffers[0]);
        free(inference.buffers[1]);
        return false;
    }

    inference.buf_select = 0;
    inference.buf_count = 0;
    inference.n_samples = n_samples;
    inference.buf_ready = 0;

    // configure the data receive callback
    PDM.onReceive(&pdm_data_ready_inference_callback);

    PDM.setBufferSize((n_samples >> 1) * sizeof(int16_t));

    // initialize PDM with:
    // - one channel (mono mode)
    // - a 16 kHz sample rate
    if (!PDM.begin(1, EI_CLASSIFIER_FREQUENCY)) {
        ei_printf("Failed to start PDM!");
    }

    // set the gain, defaults to 20
    PDM.setGain(127);
```

```
    record_ready = true;

    return true;
}

/**
 * @brief      Wait on new data
 *
 * @return     True when finished
 */
static bool microphone_inference_record(void)
{
    bool ret = true;

    if (inference.buf_ready == 1) {
        ei_printf(
            "Error sample buffer overrun. Decrease the number
of slices per
 model window "
            "(EI_CLASSIFIER_SLICES_PER_MODEL_WINDOW)\n");
        ret = false;
    }

    while (inference.buf_ready == 0) {
        delay(1);
    }

    inference.buf_ready = 0;

    return ret;
}

/**
```

```
  * Get raw audio signal data
  */
 static int microphone_audio_signal_get_data(size_t offset,
size_t length,
 float *out_ptr)
 {

numpy::int16_to_float(&inference.buffers[inference.buf_select ^
 1][offset], out_ptr, length);

     return 0;
 }

 /**
  * @brief       Stop PDM and release buffers
  */
 static void microphone_inference_end(void)
 {
     PDM.end();
     free(inference.buffers[0]);
     free(inference.buffers[1]);
     free(sampleBuffer);
 }

 #if !defined(EI_CLASSIFIER_SENSOR) || EI_CLASSIFIER_SENSOR !=
 EI_CLASSIFIER_SENSOR_MICROPHONE
 #error "Invalid model for current sensor."
 #endif
```

6. Output

```
Edge Impulse Inferencing Demo
Inferencing settings:
    Interval: 20.00 ms.
Frame size: 320
Sample length: 1000 ms.
No. of classes: 3
Predictions (DSP: 8 ms., Classification: 12 ms., Anomaly: 1
ms.):
hellomit: 0.85623
bymit: 0.09321
noise: 0.05056
Predictions (DSP: 7 ms., Classification: 11 ms., Anomaly: 1
ms.):
hellomit: 0.11234
bymit: 0.84219
noise: 0.04547
Predictions (DSP: 8 ms., Classification: 12 ms., Anomaly: 1
ms.):
hellomit: 0.04058
bymit: 0.02115
noise: 0.93827
Predictions (DSP: 7 ms., Classification: 12 ms., Anomaly: 1
ms.):
hellomit: 0.87129
bymit: 0.09876
noise: 0.02995
Predictions (DSP: 8 ms., Classification: 12 ms., Anomaly: 1
ms.):
hellomit: 0.05512
bymit: 0.91234
noise: 0.03254
Predictions (DSP: 7 ms., Classification: 11 ms., Anomaly: 1
ms.):
hellomit: 0.02345
```

```
bymit: 0.03487
noise: 0.94168
```