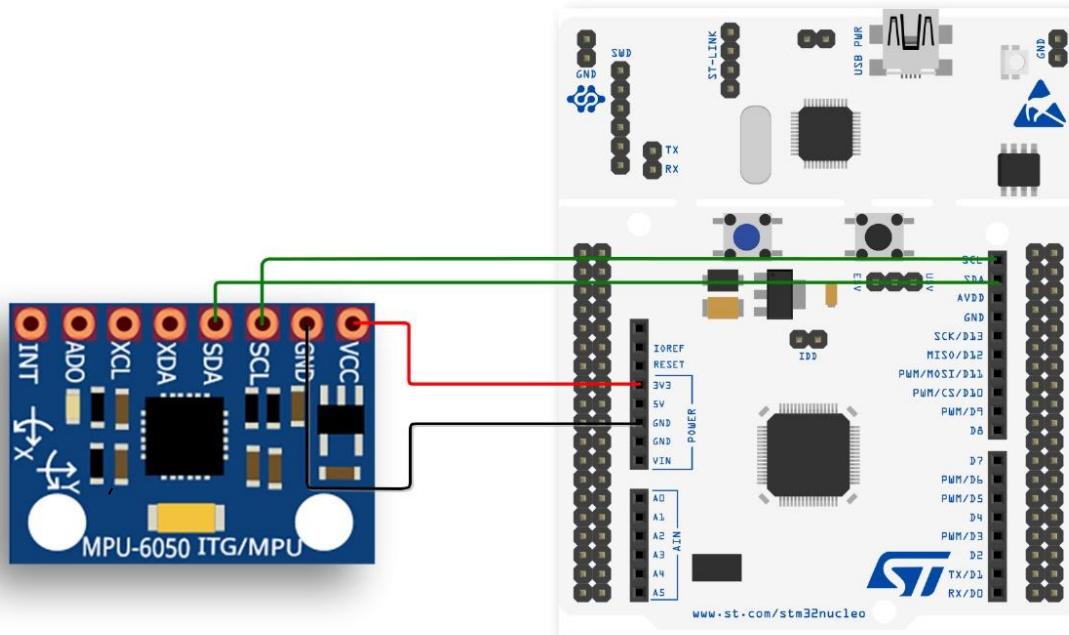


Running a Datalogger and building a Anomaly Detection project in NanoEdge AI Studio.

Experiment Overview:

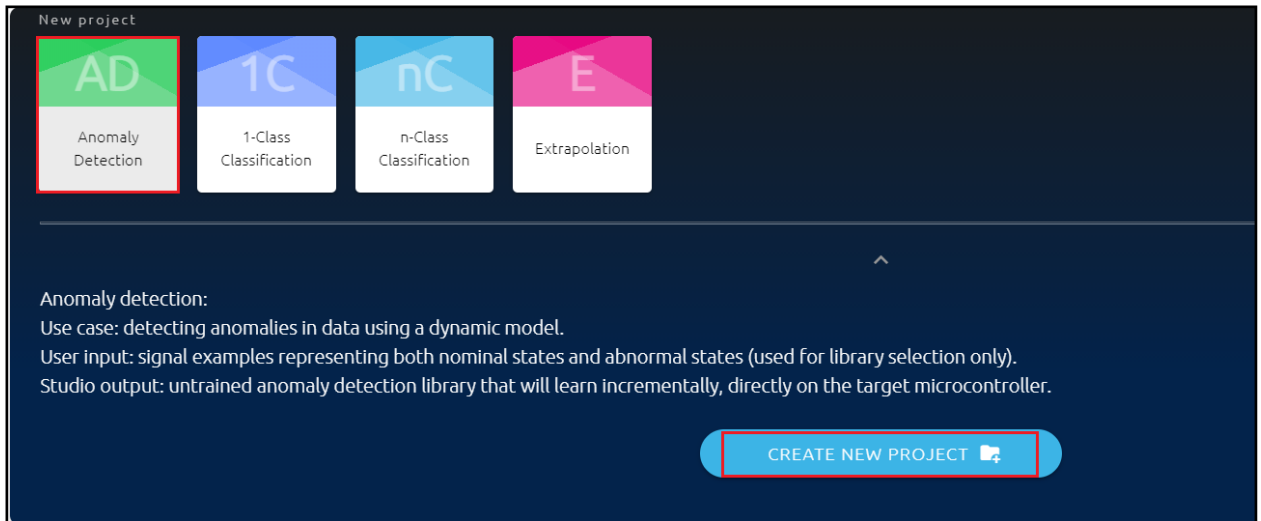
The goal of this experiment is to run a datalogger, so as to build our machine learning model on NanoEdge AI Studio. After uploading our code on the target Microcontroller, we will create a project on NanoEdge AI Studio for detecting the abnormal vibration patterns in machine.

Connection Diagram:

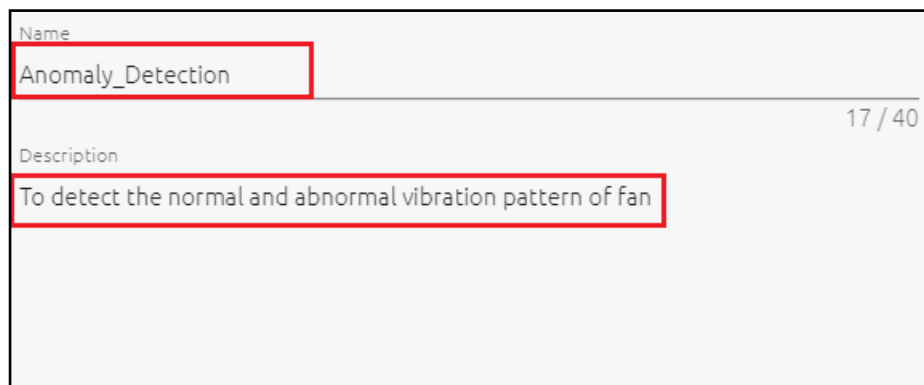


Procedure (NanoEdge AI Studio):

1. Open NanoEdge AI Studio.
2. Select **Anomaly Detection** project type and select **Create New Project**.



3. A new window will open. On the first step, **Project Settings**, name the project as **Anomaly Detection**. Under **Description** type “To detect the normal and abnormal vibration pattern of fan”.



Name

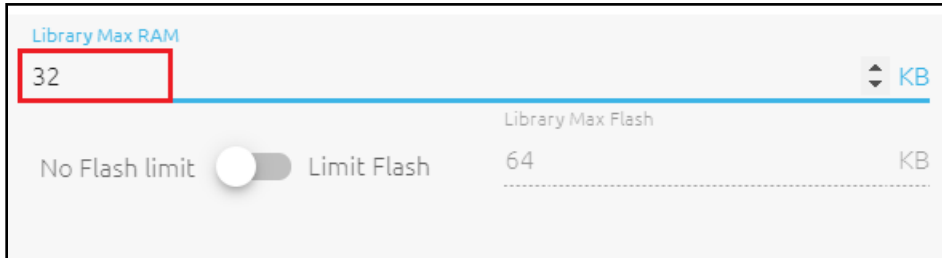
Anomaly_Detection

17 / 40

Description

To detect the normal and abnormal vibration pattern of fan

4. Let **Max RAM** and **Max Flash** option remain as default.



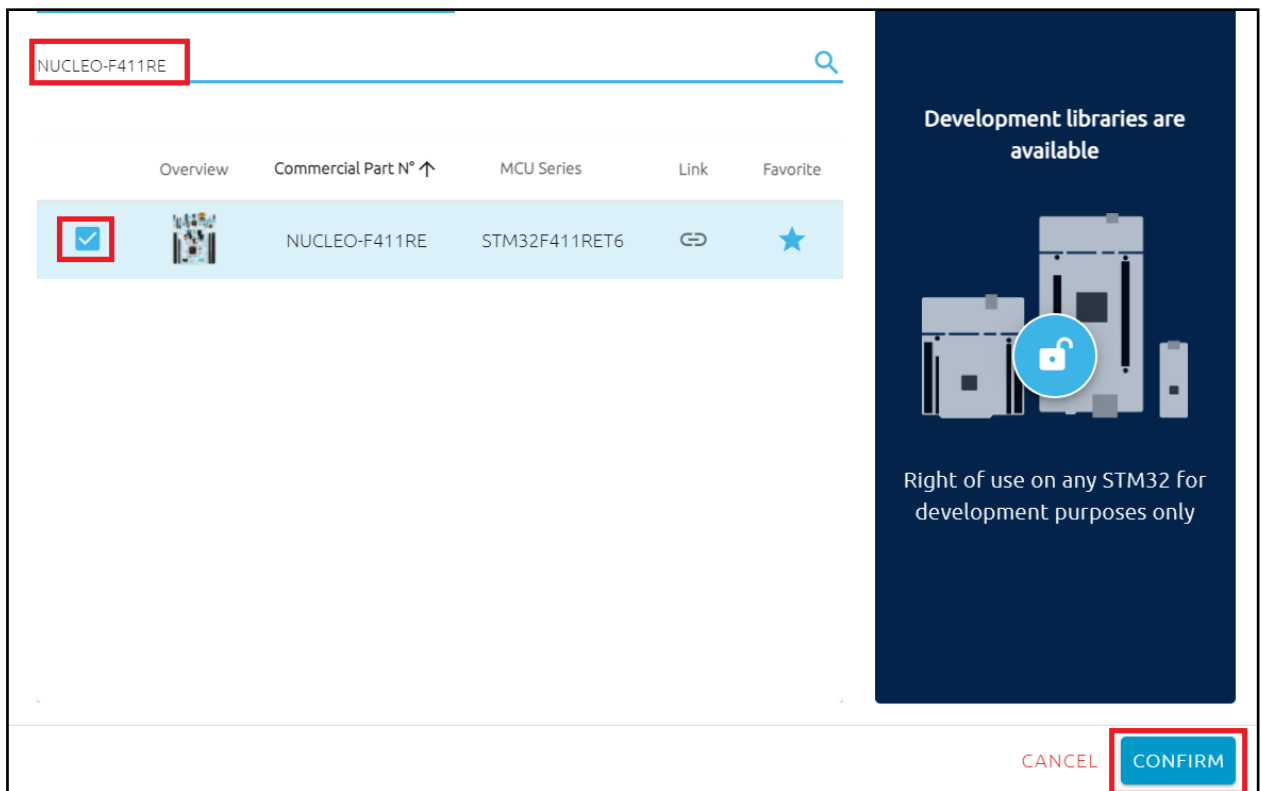
Library Max RAM

32 KB

No Flash limit ☐ Limit Flash ☐


Library Max Flash 64 KB

5. In **Target** section, select your proper STM32 Nucleo board. In **Sensor type** section, select the type of sensor you are working with. For this experiment you have to choose **Accelerometer 3-axes**.



NUCLEO-F411RE

Overview Commercial Part N° ↑ MCU Series Link Favorite

<input checked="" type="checkbox"/>		NUCLEO-F411RE	STM32F411RET6	Link	Favorite
-------------------------------------	---	---------------	---------------	----------------------	--------------------------

Development libraries are available

Right of use on any STM32 for development purposes only

CANCEL CONFIRM



Sensor type

Accelerometer 3 axes

- Click on **Save & Next** to move onto the next step.


Name
Anomaly_Detection

Library Max RAM
32 KB

Description
To detect the normal and abnormal vibration pattern of fan

No Flash limit ☐ Limit Flash

Your target

 NUCLEO-F411RE

Warning: the sensor settings below may not be modified after the project settings are saved.

Sensor type
Accelerometer 3 axes

SAVE & NEXT

DELETE PROJECT

- In the second step on NanoEdge AI Studio – **Regular Signals**, click on **Add Signals**. A window will open with different source options for you to import signals, select **From Serial (USB)** as we are collecting sensor data connected to microcontroller board, which in turn is connected to your PC through a Serial USB Cable.

1 Project settings
NUCLEO-F411RE
32KB RAM
3 axes

2 Regular signals
0 File

3 Abnormal signals
0 File

4 Benchmark
0 Benchmark

5 Emulator

6 Validation

7 Deployment

ADD SIGNAL

Data format example:
n buffers of 256 values x 3 axes (x,y,z) with space separator

line 1
line 2
(...)

x_0 y_0 z_0 x_1 y_1 z_1 (...) x_{255} y_{255} z_{255}

x_0 y_0 z_0 x_1 y_1 z_1 (...) x_{255} y_{255} z_{255}

x_0 y_0 z_0 x_1 y_1 z_1 (...) x_{255} y_{255} z_{255}



Import signal

1

Type of signal source

2

Signal

3

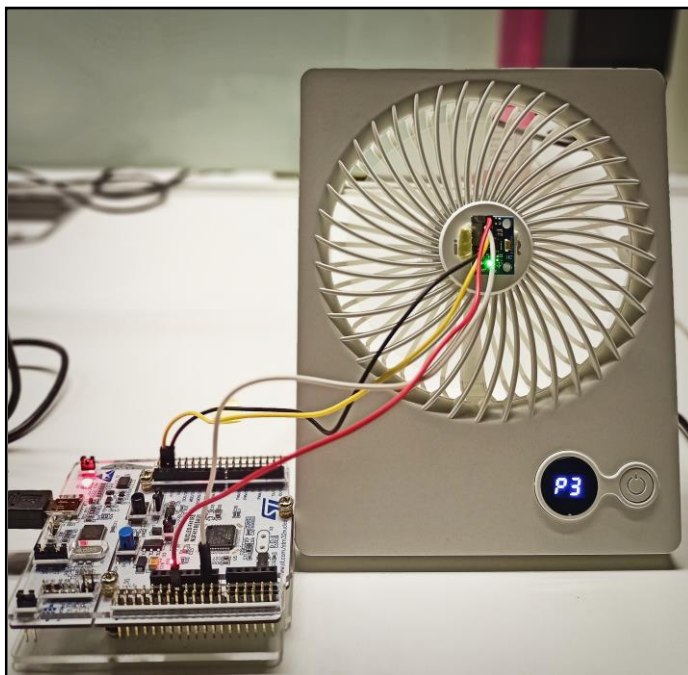
Preview

FROM FILE 

FROM SERIAL (USB) 

FROM FP-SNS-DATALOG 

8. Before adding signals, you have to attach your MPU6050 sensor at the middle of the fan for collecting the vibration data from the fan.



9. Now you can add your signals. In **COM Port** select the correct COM port based on device manager info. Select **Baud rate** as 115200. In **Maximum number of lines** enter the number of lines of data you want to collect. In this case we will collect 200 lines of data. Now turn on the fan and start collecting the vibration data from it.

Click on **Continue** to move onto importing the vibration samples.

Import signal

1 Type of signal source

2 Signal

3 Preview

COM Port

COM8

Baudrate

115200

Maximum number of lines

200

START/STOP

Number of lines:

200

Serial output

3.15 0.43 7.64 2.06 0.43 7.64 2.06 0.70 7.63 1.35 0.02 7.67 3.50 1.09 7.25 3.16 -0.08 7.46 2.96 0.10 7.51 2.02 -0.11 7.71
2.07 -0.11 7.71 2.07 -0.74 7.66 3.30 -0.06 7.30 2.60 -1.03 7.59 3.13 -0.23 7.55 1.97 -0.61 7.77 1.76

File name

log-10-05_18-41-37-41

Flow chart

axis 1

axis 2

axis 3



PREVIOUS

CONTINUE

10. In this window, select the **Delimiter** as **Space**. If any line of data has some corrupted values, an error message will be shown under the preview lines. You can select the particular line(s) and delete it. Select **Preview Lines** as 200 to check all the line of data you have collected, and click on **Import**.

Import signal

☒ Type of signal source
 ☒ ¹Signal
 ☐ ³Preview

Delimiter

☐ Comma
☐ Tab
☐ Semicolon
☒ Space
☐ Other:

Enter delimiter

DELETE LINES

< Preview of 20 lines >

delete	line_index	nb_columns	1	2	3	4	5	6	7
<input type="checkbox"/>	1	768	0.14	7.58	1.57	0.14	7.58	1.57	-0.86
<input type="checkbox"/>	2	768	-0.1	7.64	2.21	-0.1	7.64	2.21	0.5
<input type="checkbox"/>	3	768	0.02	7.42	2.93	0.42	7.72	2.22	0.35
<input type="checkbox"/>	4	768	-0.51	7.38	2.93	-0.09	7.52	2.36	-0.39

PREVIOUS **IMPORT**

Preview lines
20


11. In the new window, rename the sample under **Name** as **Normal_Vibration** and click on the **Blue Save Icon** to save the renamed sample.

ADD SIGNAL


Normal_Vibration

×

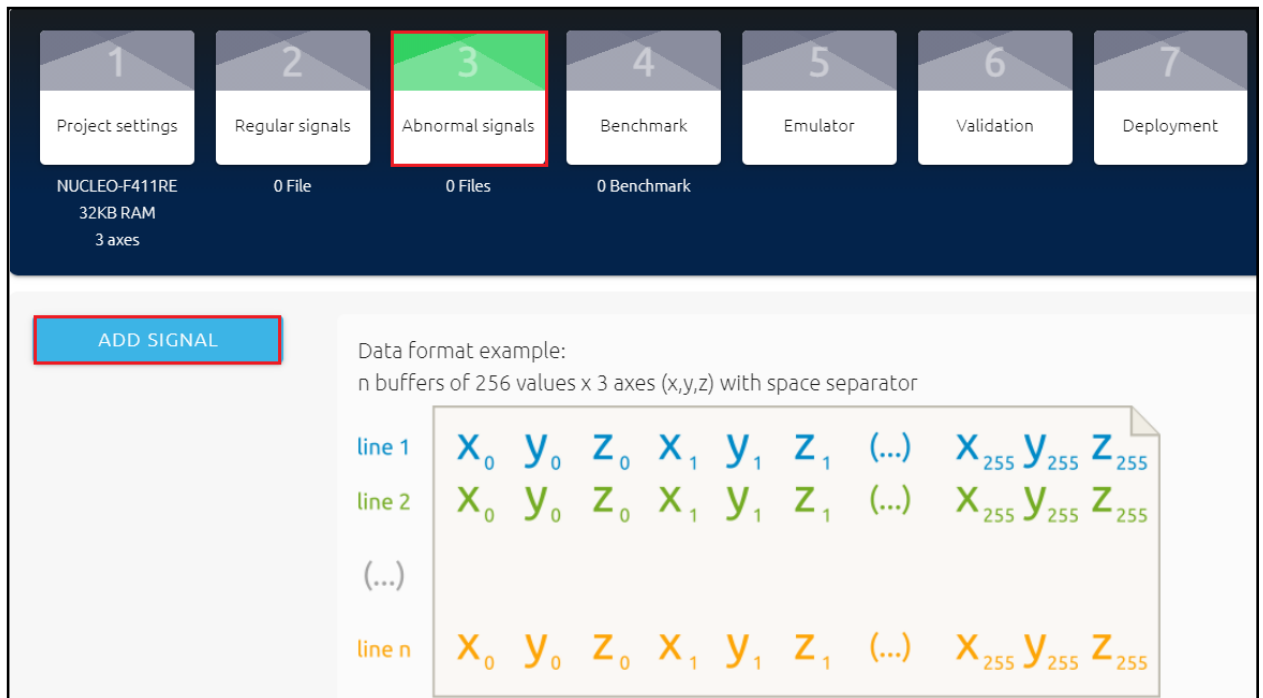
Name
Normal_Vibration



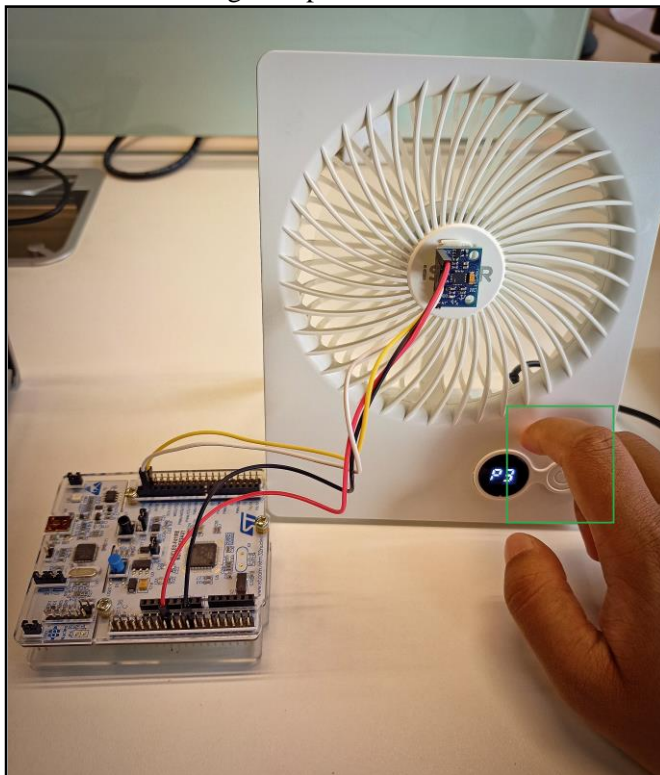
16 / 30

DOWNLOAD SIGNAL FILE 

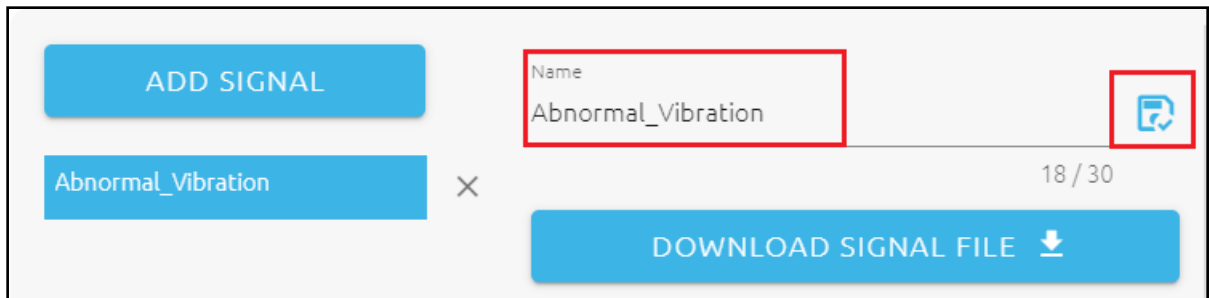
12. Now select **Abnormal Signals** and click on **Add Signal** again.



13. Turn on the fan, give some disturbances by your finger and start collecting data for the abnormal vibration. Collecting data process will be same as above.

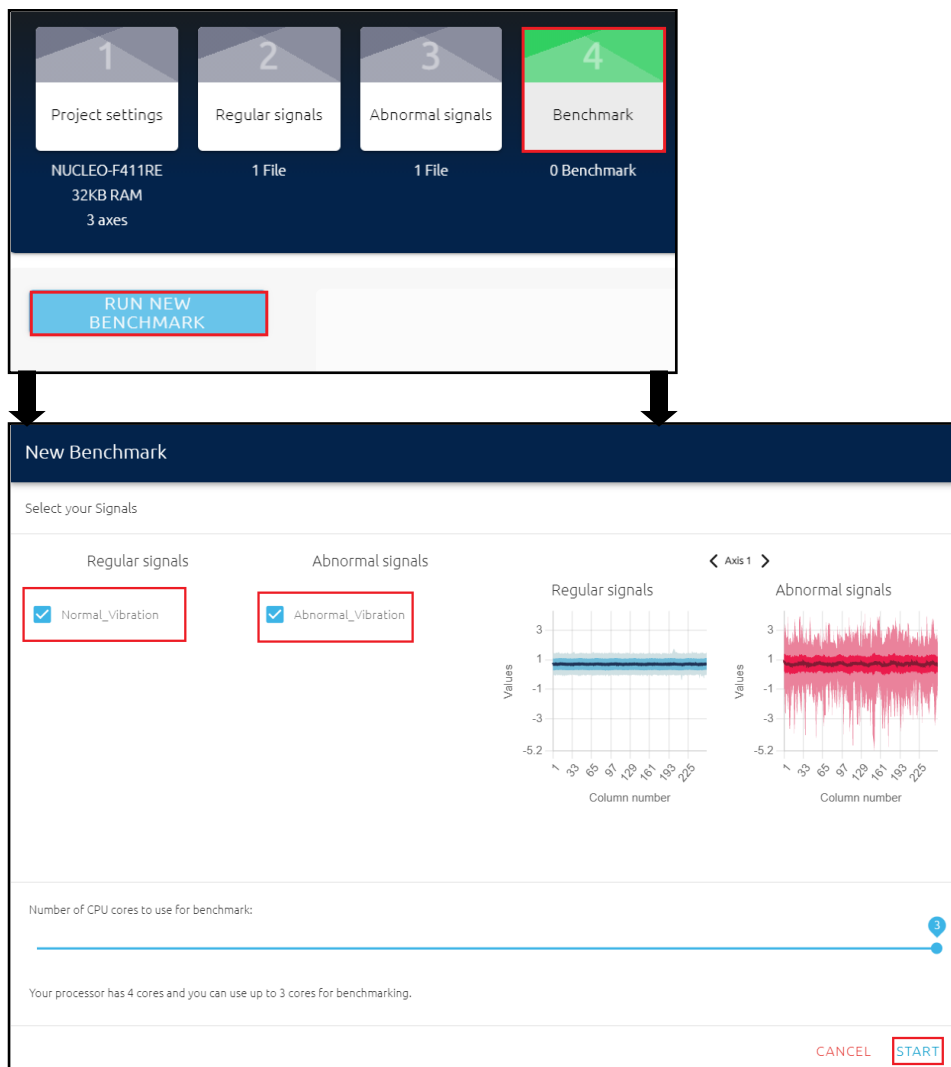


14. Now turn off the fan and name the file as **Abnormal_Vibration**.



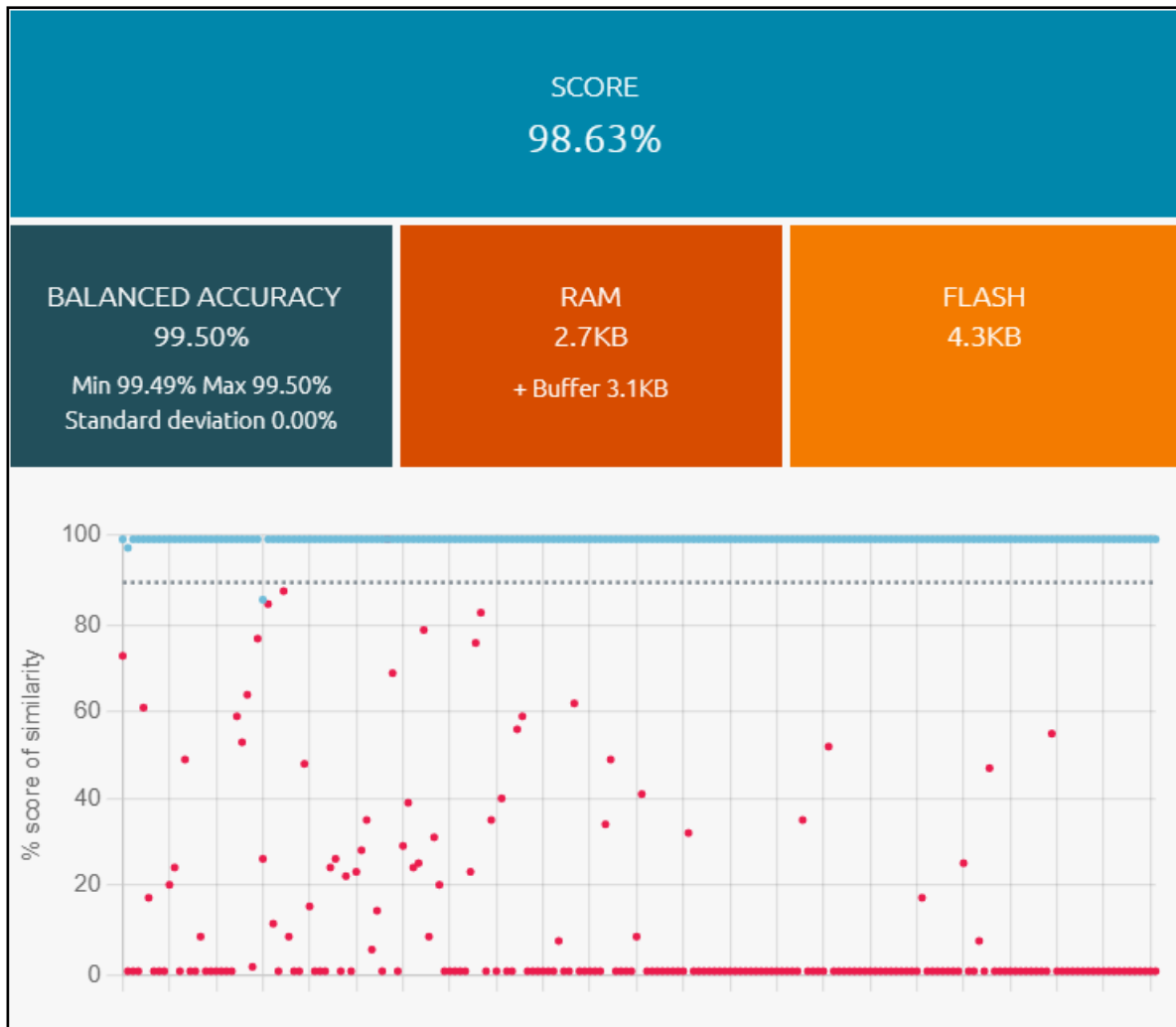
The screenshot shows a user interface for adding a signal. There is a blue button labeled 'ADD SIGNAL'. Below it, a blue box contains the text 'Abnormal_Vibration'. To the right of this box is a red 'X' icon. Further right is a text input field with the text 'Abnormal_Vibration'. To the right of the input field is a red square button with a download icon. Below the input field is a blue button labeled 'DOWNLOAD SIGNAL FILE' with a download icon. The text '18 / 30' is visible in the top right corner.

16. In the fourth step of the NanoEdge AI Studio- **Benchmark**, click on **Run Benchmark**. Next select **Regular Signals** and **Abnormal Signals** and click on **Start**.



The screenshot shows the 'New Benchmark' interface. At the top, there are four steps: 1. Project settings, 2. Regular signals, 3. Abnormal signals, and 4. Benchmark. Step 4 is highlighted with a green background. Below the steps, there is a blue button labeled 'RUN NEW BENCHMARK'. The main area is titled 'Select your Signals'. It has two columns: 'Regular signals' and 'Abnormal signals'. Under 'Regular signals', there is a checkbox labeled 'Normal_Vibration'. Under 'Abnormal signals', there is a checkbox labeled 'Abnormal_Vibration'. To the right of these columns are two line graphs. The first graph is titled 'Regular signals' and the second is titled 'Abnormal signals'. Both graphs show 'Values' on the y-axis (ranging from -5.2 to 3) and 'Column number' on the x-axis (ranging from 1 to 225). The 'Regular signals' graph shows a relatively flat line, while the 'Abnormal signals' graph shows a highly oscillatory line. Below the graphs, there is a slider for 'Number of CPU cores to use for benchmark:' with a value of 3. At the bottom right, there are 'CANCEL' and 'START' buttons.

17. After the Benchmark has reached a **Score** of above 95% stop the benchmark process.



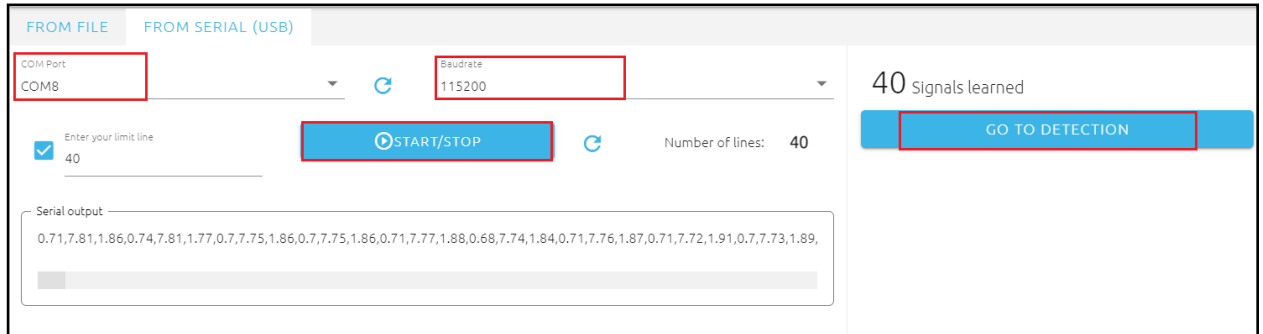
18. After the benchmark process is done, go to the fifth stage, **Emulator**. Click on **Initialize Emulator** to move on to test the library you have selected on the NanoEdge AI Studio.

Library emulator

Click the button below to test this specific NanoEdge AI Library using the associated Emulator, directly inside the Studio. You will be able to test your library, either from a data log file, or "live" from your device through serial port.

INITIALIZE EMULATOR

19. In the new window, select **From Serial (USB)**. Select **COM Port** according to info from Device Manager. Select Baud rate as 115200. Keep **the Maximum number of lines** as 40. Start the fan and let the ML Model learn the fan normal vibration for 40 cycles. Now select **GO TO DETECTION**.



FROM FILE FROM SERIAL (USB)

COM Port: COM8 Baudrate: 115200

☒ Enter your limit line: 40

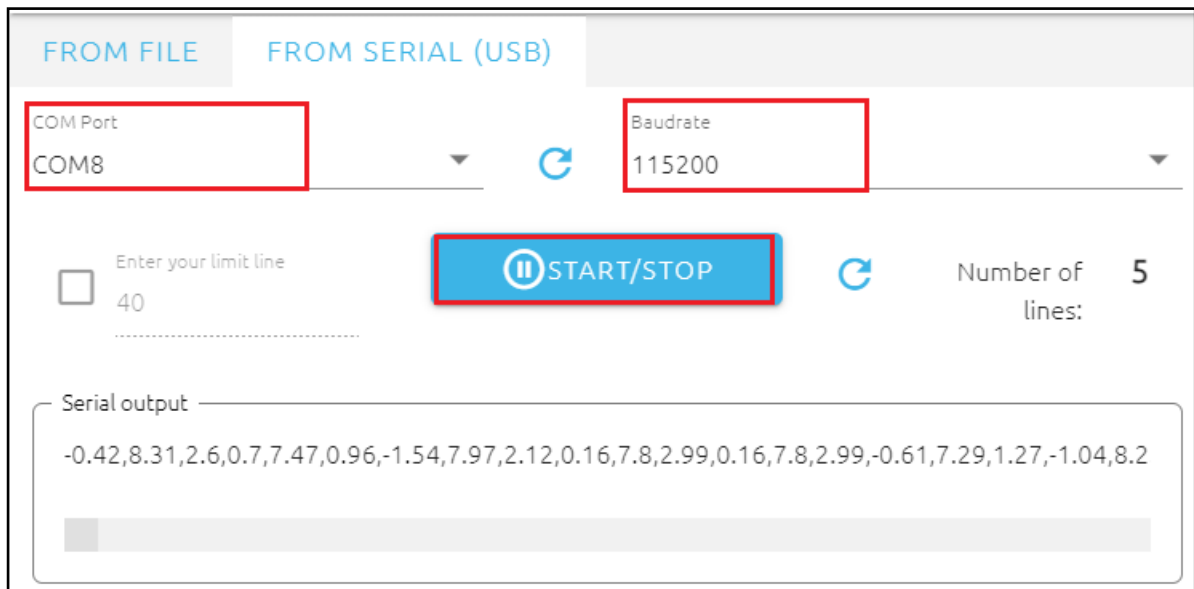
START/STOP Number of lines: 40

40 Signals learned

GO TO DETECTION

Serial output: 0.71,7.81,1.86,0.74,7.81,1.77,0.7,7.75,1.86,0.7,7.75,1.86,0.71,7.77,1.88,0.68,7.74,1.84,0.71,7.76,1.87,0.71,7.72,1.91,0.7,7.73,1.89,

20. In the Detection part, select From Serial (USB). Select COM Port according to info from Device Manager. Select **Baud rate** as 115200. Click on **START/STOP**. So for normal vibration it will show **100% Similarity** and when there is some disturbances on the fan, the similarity score drops down.



FROM FILE FROM SERIAL (USB)

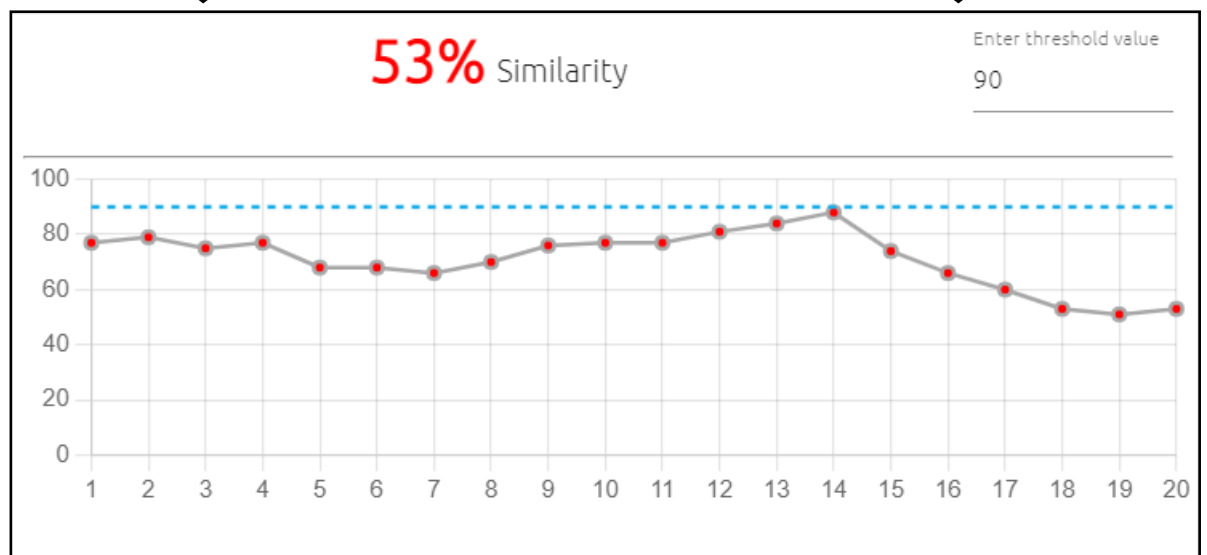
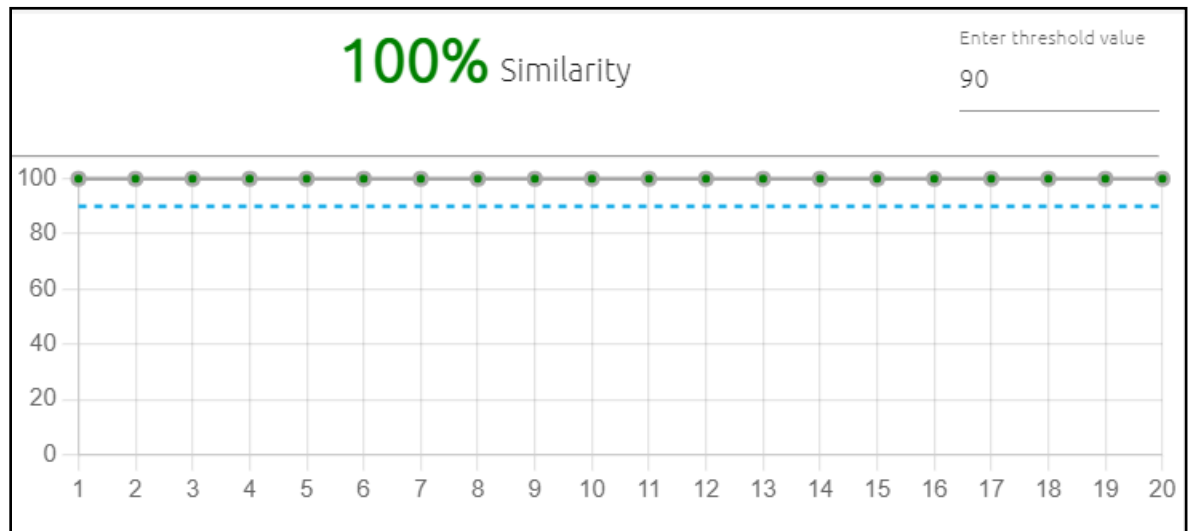
COM Port: COM8 Baudrate: 115200

☐ Enter your limit line: 40

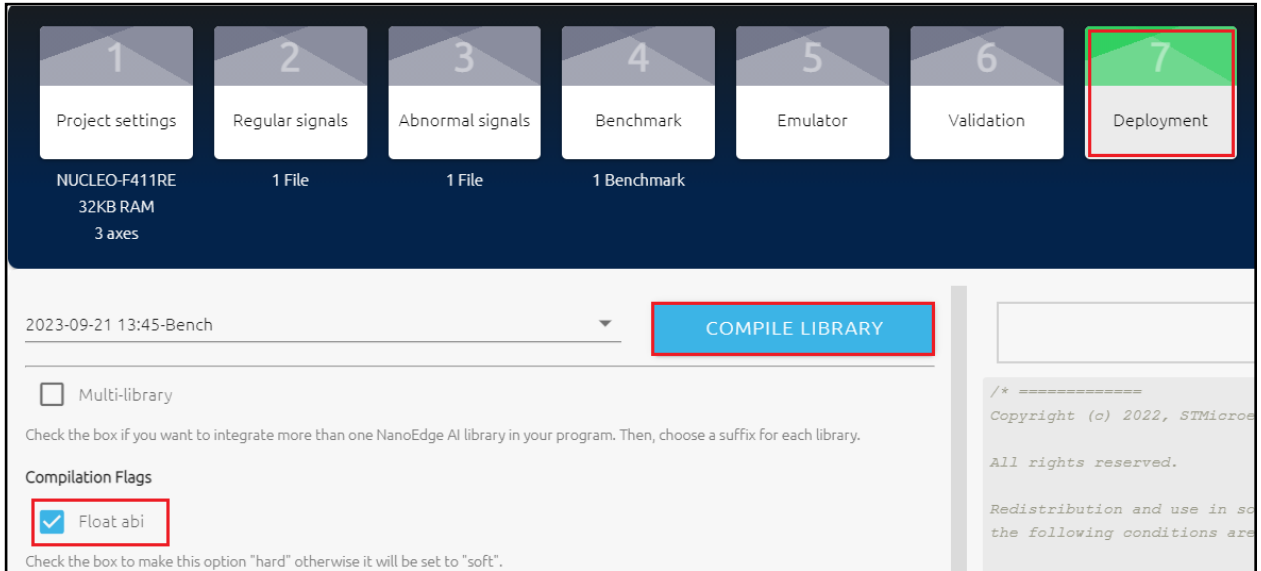
START/STOP Number of lines: 5

Serial output: -0.42,8.31,2.6,0.7,7.47,0.96,-1.54,7.97,2.12,0.16,7.8,2.99,0.16,7.8,2.99,-0.61,7.29,1.27,-1.04,8.2





21. Finally go to **Deployment** stage, select **Float abi** and click on **Compile Library**. Click on **Get Library**, and save your library on the PC.



The screenshot displays the DigiToad Technologies web interface. At the top, there is a navigation bar with seven stages: 1 Project settings, 2 Regular signals, 3 Abnormal signals, 4 Benchmark, 5 Emulator, 6 Validation, and 7 Deployment. Stage 7 is highlighted with a green background. Below the navigation bar, the main content area shows the 'Deployment' stage. A dropdown menu displays '2023-09-21 13:45-Bench'. To the right of the dropdown is a blue button labeled 'COMPILE LIBRARY'. Below the dropdown, there is a checkbox labeled 'Multi-library' which is unchecked. Below this, there is a section titled 'Compilation Flags' with a checkbox labeled 'Float abi' which is checked. To the right of the 'Float abi' checkbox, there is a text area containing a copyright notice: '/* =====
Copyright (c) 2022, STMicro
All rights reserved.
Redistribution and use in so
the following conditions are

Note: All important steps and parts are highlighted with a red colour box for the proper understanding of the user. This document is meant for the use of education purpose only.