

## Free Trial - Quick Start Guide

Building Your First App – Version 1.0

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# 1.0 Build Your First App

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**Prerequisites:** This guide assumes you have:

- Registered a team or account with SensiML ([Click here](#) if you do not have an account)
- Installed the SensiML **Data Capture Lab** and **Analytics Studio** (link):

<https://sensiml.cloud/downloads/>

The goal of this guide is to provide a step by step guide on creating your first basic sensor application using the SensiML Toolkit. You will learn how to create a sensor application and have it running on a real sensor device.

## Software Overview: What's included with SensiML

The SensiML Toolkit is a software suite that makes it easy for a software developer to take simple sensors and turn them into advanced event detectors.

The toolkit comes with four applications:

- **Data Capture Lab** – The DCL is a tool that helps you capture, organize, and label raw data from the sensor and transform it into the events you want to detect.
- **Data Capture Lab (Mobile)** – We also provide a mobile version of the DCL. This is an Android application that allows you to capture raw sensor data on the go.
  - Google Play Link:  
<https://play.google.com/store/apps/details?id=com.sensiml.suite.datacapturelab>
- **Analytics Studio** – The Analytics Studio is a python-based tool for filtering and optimizing your labeled sensor data through machine learning algorithms. It generates a device optimized SensiML Knowledge Pack (event detection algorithm) ready to be flashed onto your sensor of choice.
- **SensiML TestApp** – The SensiML TestApp is a simple application that allows you to see the real-time event classifications from the SensiML Knowledge Pack running on your sensor over Bluetooth-LE. It comes in a PC or Android version that can be downloaded from the Windows/Google Play stores.
  - Windows Store Link:  
<https://www.microsoft.com/store/apps/9NZK0X2026N2>
  - Google Play Link:  
<https://play.google.com/store/apps/details?id=com.sensiml.suite.testapp>

## Analytics Studio Tutorials

Once you have finished this Quick Start Guide, you can find more advanced tutorials on how to use the Analytics Studio at

<https://sensiml.atlassian.net/wiki/spaces/SS/pages/210894866/Analytics+Studio+Tutorials>

## 2.0 Quick Start Projects

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The free version of the SensiML Toolkit comes with several data sets that allow you to explore the features in the SensiML Toolkit. In this guide, we are going to reference a specific example called the **Slide Demo**.

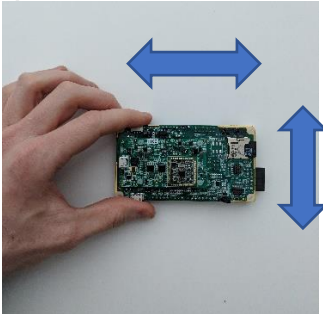
### Slide Demo Project

The **Slide Demo** has three continuous states. This demo is used to simulate a motor status. To make this more accessible for the demo we hold the sensor in our hand and make the actions, but in the real world you would attach the sensor to a motor.

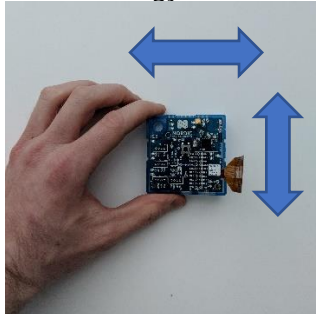
Events of interest:

- **Stationary** – Board is resting on a desk surface
- **Horizontal** – Board is slid back and forth (**left to right** or **forward to back**) on a flat surface in a repetitive rhythmic motion to simulate a part moving back and forth

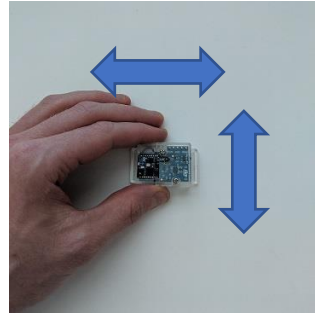
*QuickAI - Horizontal*



*Nordic Thingy - Horizontal*

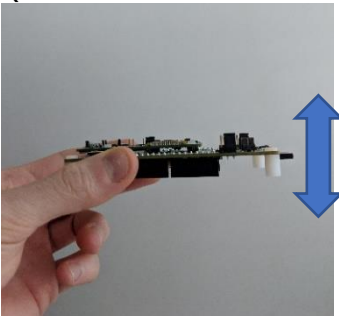


*SensorTile - Horizontal*

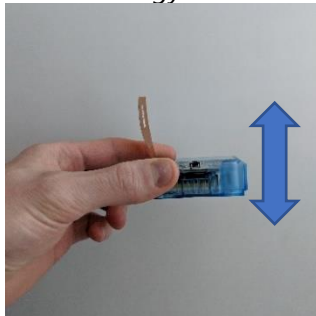


- **Vertical** – Board is lifted in an **up and down** motion in the air in repetitive rhythmic motion to simulate a part being lifted up and down

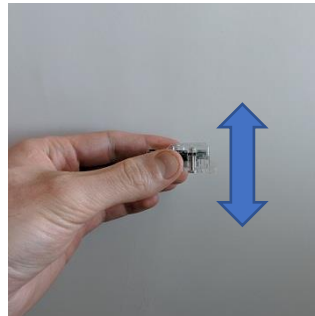
*QuickAI - Vertical*



*Nordic Thingy - Vertical*



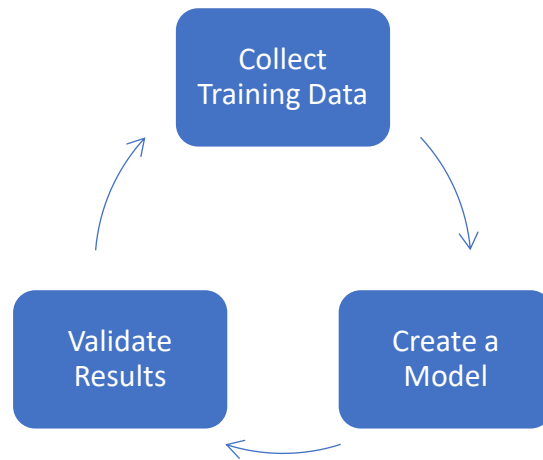
*SensorTile - Vertical*



## 3.0 Fundamentals

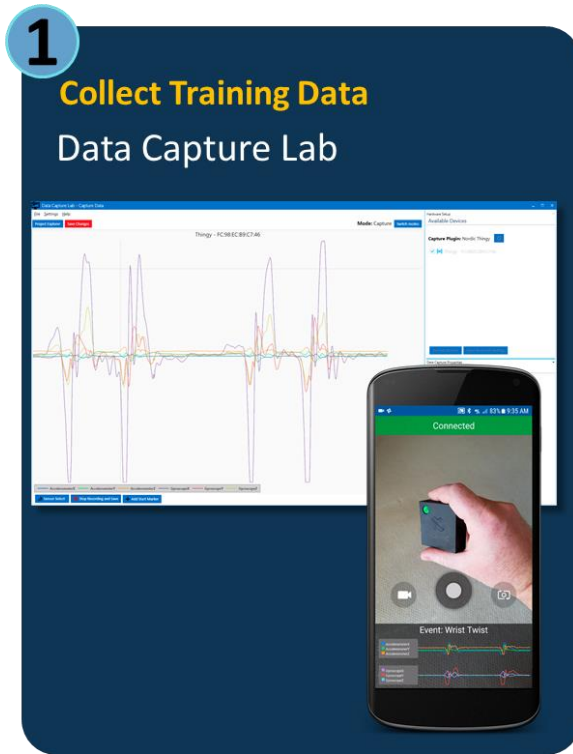
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Before you ever open the SensiML Toolkit, let's take a moment to think about the problem we are trying to solve. We need to build a smart algorithm that fits on a low-powered device. The SensiML Toolkit takes a 'train by example' approach to do this. This can be broken down into 3 steps.

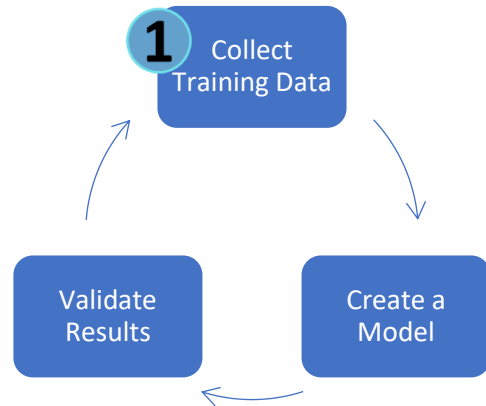


## 4.0 Getting Started with the Data Capture Lab

The first step of creating a sensor application is going to be collecting and labeling raw sensor data into events of interest through the **Data Capture Lab**.



*PC and Android Version*

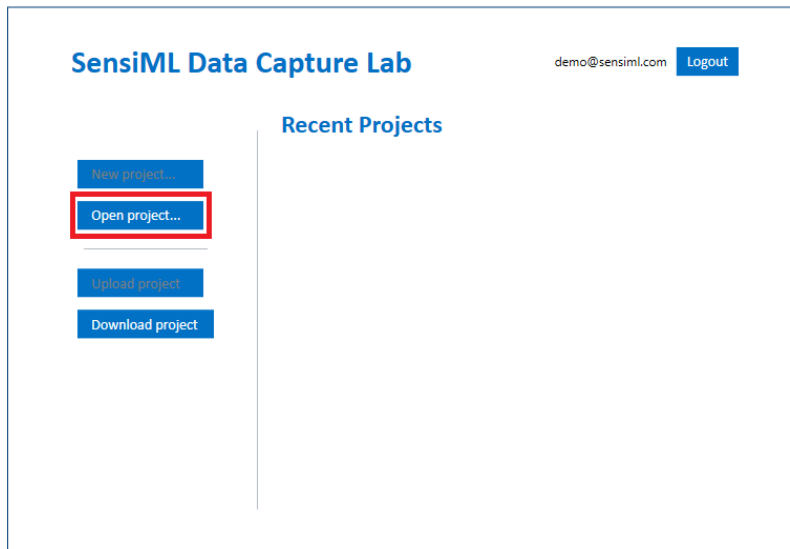


## Projects

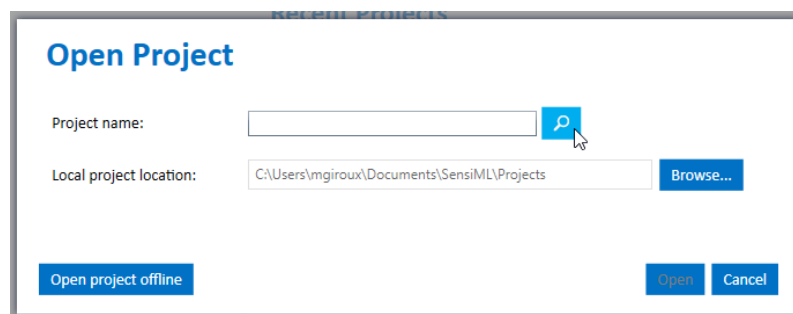
A project contains all your collected sensor data and algorithms. Your sensor data is saved to your local computer and synced with the cloud. Only your team has access to your data. This allows you to have multiple people collecting/labeling data on a project at the same time.

### Opening the Quick Start Projects

1. Open the Data Capture Lab and **Log in** to your account
2. Click **Open project...**



3. Click the **search icon** and you will see the projects that come with the free version of the SensiML Toolkit



*Optional: You can change the local project directory location where the project will be stored on your computer*

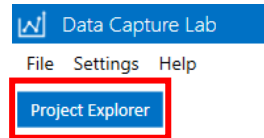
4. Open one of the versions of the Slide Demo (*QuickAI, Nordic Thingy, SensorTile*)



## 5.0 Exploring Your Project Data

### Viewing your capture files

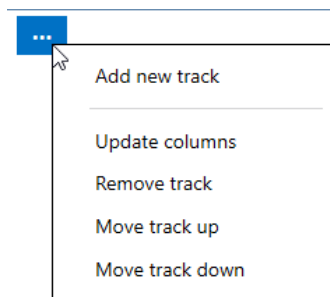
1. To open the raw sensor data files you have captured, use the **Project Explorer**. This can be found in the upper left-hand corner of the DCL.



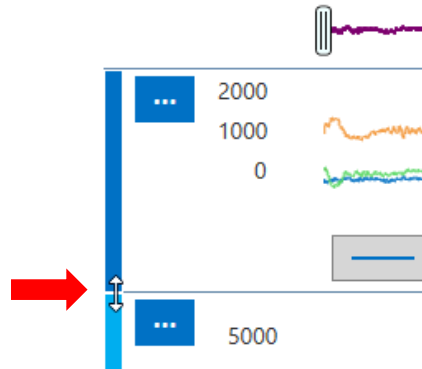
2. **Double-Click** on a file name to open the file
3. Depending on the project you have loaded, the file will open and look similar to this



4. You will notice the DCL has split the data into two tracks. These tracks can be customized to display as many sensor columns as you need. (Optional) Click on the track menu options to add new tracks, update columns, or remove tracks. This is a powerful feature that allows you to visualize your data easier.

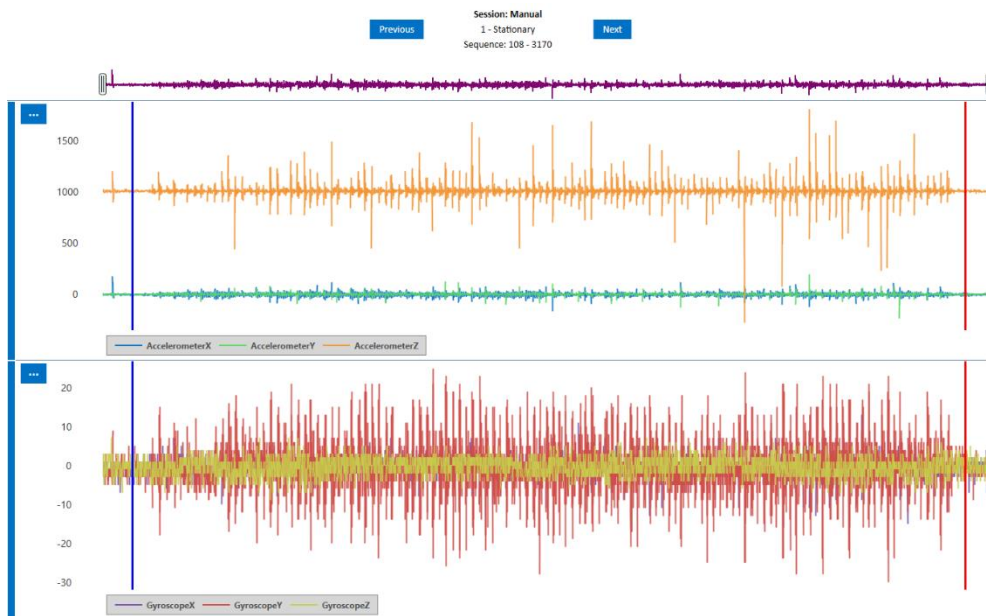


5. (Optional) Click and drag the area between tracks to adjust a track height



## Segments

**Segments** are how we label an **event** in the DCL. Open any of the provided files and you will see one or more segments in the sensor data graph depending on what project/file you opened. The pair of blue and red lines defines where our event is located and is called a **segment**. See screenshot below:



## Sessions



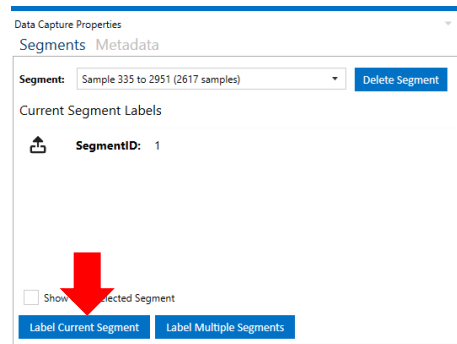
A session separates your labeled events (segments) into a group. This allows you to work on multiple use cases while using the same dataset. Note - The free trial of the SensiML Toolkit does not allow you to create new sessions.

## Labeling Events

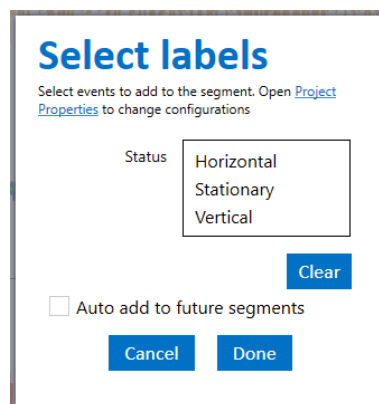
1. To label an event, we are going to create a segment. To do this, move your mouse onto the graph of your sensor data and **right-click + drag** your mouse over the area that you want to label as an event. This places a new **segment** in the file.



2. After creating the segment, you label this segment by clicking **Label Current Segment**.



3. Next select the label and click **Done**



## 6.0 Data Capture Lab - More Features

The free version of the SensiML Toolkit only comes with a few simple data sets that allow you to check out some of the features that make it so useful. Upgrading to a paid subscription enables the ability to create/modify your own data sets and unlocks several other features listed below:

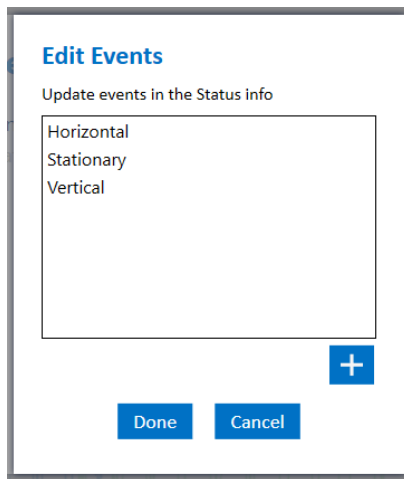
### Capture Mode

Capture live sensor data in real time from SensiML supported devices



### Custom Data Sets

The Slide Demo is a simple example to get you started. You can create your own events/metadata through the project properties screen



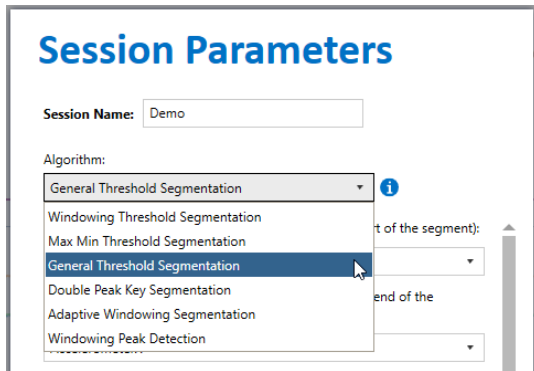
### Import External CSVs

Have you already collected your own data sets? The Data Capture Lab can import it into our file format! See more about the file format at the link:

<https://sensiml.atlassian.net/wiki/spaces/SS/pages/141754445/How+to+import+external+sensor+data+into+the+Data+Capture+Lab>

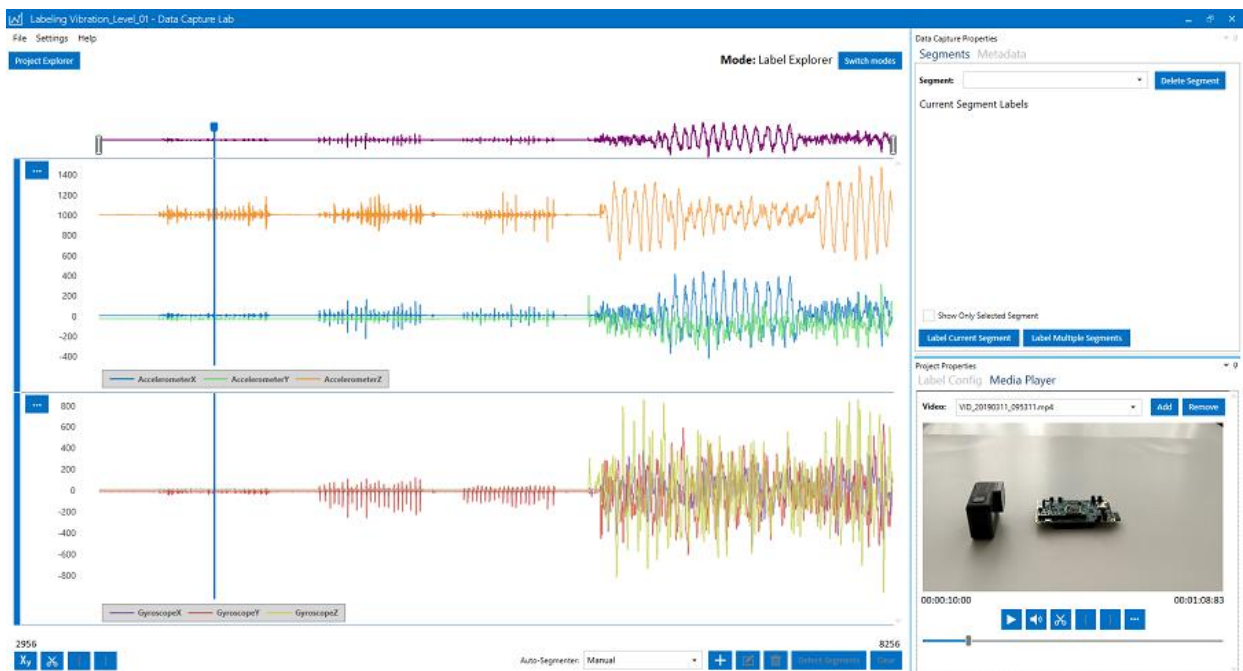
## Auto-Session Algorithms

Use the real device-side algorithms on your data set to preview the results before deploying to your hardware



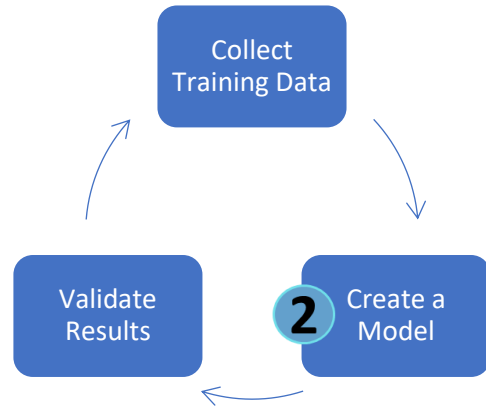
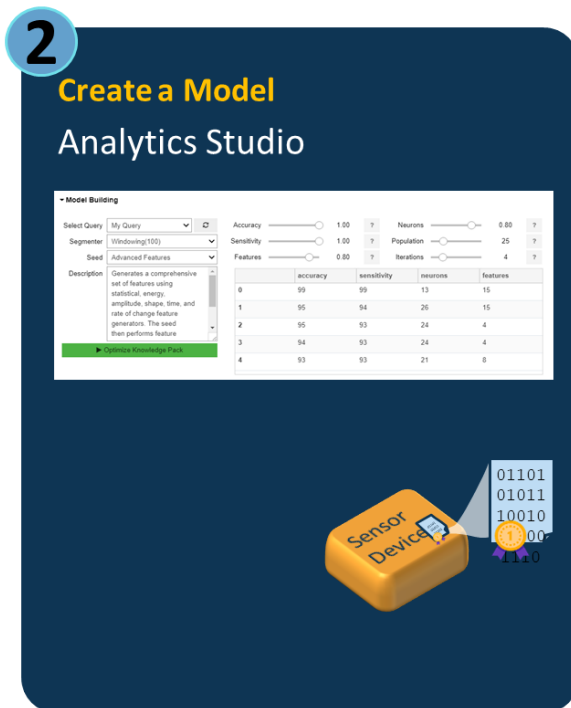
## Media Player

The Data Capture Lab can play WAV, MP4, and MOV files with your sensor data to make identifying your events of interest easier



## 7.0 Getting Started with Analytics Studio

Next it is time to use the **Analytics Studio** to build your machine learning algorithm for detecting events.



The Analytics Studio is a python-based tool for filtering and optimizing your labeled sensor data through machine learning algorithms. It generates a device optimized SensiML Knowledge Pack (event detection algorithm) ready to be flashed onto your device of choice. The most powerful part of the Knowledge Pack is that it will be detecting events on the low memory sensor without ever requiring a connection to the cloud.

### Jupyter Notebooks

The Analytics Studio is a tool based on jupyter notebooks. If you have not used jupyter notebooks before the following keyboard shortcuts will be useful.

- **Run a cell** - Shift + Enter
- **Auto-complete** - Press tab at any time while typing a function/command and the Analytics Studio will give you all available options

## Create a model: SensiML Dashboard and Advanced Model Building

The Analytics Studio can give you complex machine learning tools to build a model that detects your events. We created a **Dashboard** widget that abstracts the complexities of machine learning algorithms and translates them to a user-friendly interface. If you want to dive deeper into the underlying algorithms that the Dashboard uses, we also give you the tools to create and modify them on your own.

### SensiML Dashboard

The SensiML **Dashboard** widget uses advanced machine learning to build a model that gives you control of the features you want in your device. For example, if you build an algorithm that detects your events with 100% accuracy, the device might cost more money. But by tweaking parameters through our **Dashboard** widget you might find you can get an algorithm that cuts your device cost in half, while still getting 98% accuracy. We make this easy by emulating the cost of putting an algorithm on a device and being able to tell you if it will fit. This is a powerful concept that can save you a lot of time and money.

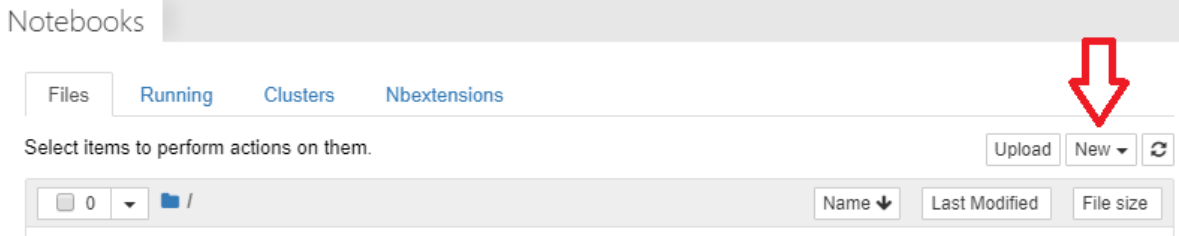
### Advanced Model Building

If you have experience with machine learning you might want to dive deeper into the functions that were used to generate a model in the **Dashboard** or skip the **Dashboard** all together and customize your own functions in the model. We give you the tools for this! See [Advanced Model Building](#) for how to get started.

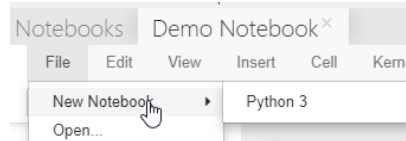
## 8.0 Building a Model with SensiML Dashboard

### Loading the Dashboard Widget

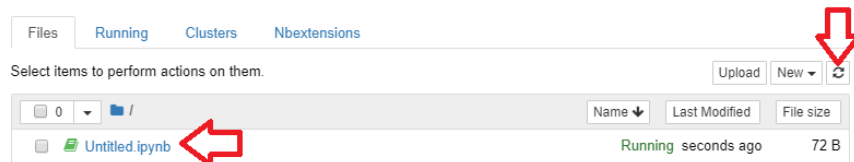
1. Open the Analytics Studio and click **New** -> **Notebook: Python 3**.



*(If you already have a notebook open, click File -> New Notebook -> Python 3)*



2. This should create an Untitled.ipynb notebook and open it for you. *(If it does not, click the Refresh icon and open it from the list)*



3. After you open your notebook, enter the following command into the cell and click **Run** (**SHIFT + Enter**)

```
from sensiml import *  
d = Dashboard()
```

4. This loads the Dashboard widget. **Login** and select the **Slide Demo** project
5. Enter the name **My First Pipeline** for your pipeline and click **Add**

New Pipeline  **+ Add**

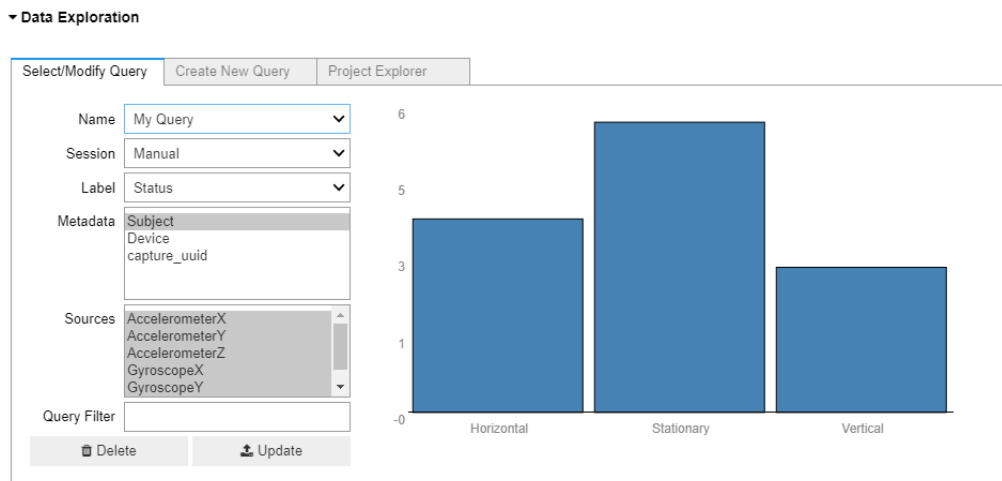
### Data Exploration: Setting up your query

The **query** step is used to select your sensor data from your project. If you need to filter out certain parts of your sensor data, you would do it here. In the free version of the SensiML Toolkit you cannot create new queries. But this is a great tool for getting more insight to your data.

1. Open the **Data Exploration** tab in the Dashboard widget
2. Select the pre-made query: **All Classes**



3. The graph will look similar to this:



The X-Axis shows the events in the query and the Y-Axis shows how many events you selected

## Model Building: Setting Up Your AutoSense Pipeline

The Model Building step is where the machine learning happens. Let's look at a screenshot and dive a little deeper.

▼ Model Building

The screenshot shows the 'Model Building' interface. It has three tabs: 'Main Settings', 'Pipeline Settings', and 'Advanced Settings'. The 'Main Settings' tab is active, showing 'Pipeline Name: My Pipeline'. Under 'Settings', there are fields for 'Query' (My Query) with a refresh icon and 'Segmenter' (empty). Under 'Target Constraints', there are fields for 'Optimization Metric' (Accuracy) and 'Classifier Size (B)' (32000). A green 'Optimize' button is at the bottom left. On the right, a table displays results for different classifier sizes (0 to 4). The table has columns for Accuracy, Classifier Size, Num. Feature, Sensitivity, and f1-score. All values in the table are 0. Below the table, it says 'Results Retrieved... Execution Time: 0 min. 0 sec.'

	Accuracy	Classifier Size	Num. Feature	Sensitivity	f1-score
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0

Results Retrieved... Execution Time: 0 min. 0 sec.

1. Click the **refresh** icon to populate the query from above and select **Query1** from the query list.
2. Select your **Segmenter**
  - a. Slide Demo: **Windowing**. Set size to **100**. The Windowing segmenter works well with continuous events. *100 refers to the window size in samples, so by picking Windowing(100) on 100hz data we have a 1 second window size, meaning every 1 second you will get a new classification.*

## Seeds

The AutoSense Pipeline starts with a seed, you can think of the seed like a template for how the Model Building widget should build an algorithm.

3. Select the **Pipeline Settings** tab and change the **Seed** to **Advanced Features**

You might be wondering when you should choose a given seed. Listed below are some examples

### *Basic Features:*

- You are wondering where to start
- You want execution to be as quick as possible
- You want simple, easy-to-interpret features

### *Advanced Features:*

- You tried "Basic Features" and didn't get a good model
- You don't mind if execution takes a while
- You want the best possible features, even if they are complex

### *Downsampled Features:*

- You are creating a gesture recognition application

### *Histogram Features:*

- You are creating a motor vibration application

### *Custom Seed:*

- You tried the other seeds and didn't get a good model
- You want to build your own pipeline and use the genetic algorithm to find the best number of features, best number of neurons, and other model-related parameters

### *No Feature Generation:*

- You do not want to generate any features, only test the ones you have made offline (Note: resulting knowledgepacks will not have a feature extraction algorithm, so will not operate on a device; intended for testing only)

4. Leave the other options as the default values
5. Click **Optimize** and the Analytics Studio will automatically build you a model to detect your events
6. You'll notice that after clicking **Optimize** a status will appear below the dashboard widget that tells you when the pipeline is complete. Depending on the amount of sensor data, the seed, and parameters you selected this could take some time to build an algorithm.
7. Once the pipeline is complete it will display 5 models on the right side of the Model Building widget. We provide an estimate of the classifier size in bytes and the number of features. In general, the more features a model has, the larger the latency required for classification. You can use this information to select a model that supports your device's resources while providing the level of accuracy your application needs. Keeping in mind that typically, there is an accuracy vs resource usage trade off, where the more resources you allocate to modeling, the higher accuracy of a model that can be built.

	Accuracy	Classifier Size (B)	Num. Features	Sensitivity	f1-score
0	100	980	3	100	100
1	100	1620	3	100	100
2	100	1833	3	100	100
3	100	1835	3	100	100
4	100	2123	3	100	100

Automation Pipeline Completed.

## Generating a Knowledge Pack

A SensiML **Knowledge Pack** takes the event detection model you generated in the pipeline and transforms it into a binary or library file that can be run on your hardware device at the edge. Once the Knowledge Pack is on your hardware device, it starts outputting classification IDs that correspond to your events of interest. Let's take a look at the **Knowledge Pack widget** below.

### ▼ Create Knowledge Pack

Model Name:  ↻ ⬇

Class Map: 

1 - Horizontal  
2 - Stationary  
3 - Vertical

Device Settings:

HW Platform	<input type="text" value="QuickLogic S3AI Merced 1.2"/>	Debug	<input type="text" value="False"/>	Output	<div style="border: 1px solid #ccc; padding: 5px;">BLE Serial</div>
Target OS	<input type="text" value="FreeRTOS"/>	Test Data	<input type="text" value="None"/>		
Format	<input type="text" value="Binary"/>	Data Source	<input type="text" value="Sensor 1"/>		

The free version of the SensiML Toolkit does not allow you to download Knowledge Packs, but you can explore the various features in the widget.

### HW Platform

SensiML Knowledge Packs are not locked to any specific hardware platform. This feature allows you to choose the platform where you will deploy your Knowledge Pack.

### Format

We provide two formats for your knowledge pack; **Binary** and **Library**. The binary format will build a package that is ready to flash to your device and includes the predefined **output** methods listed in the widget (for our demo this will be **BLE** and **Serial**).

*More on **Library** format: If you have your own application and want to integrate a Knowledge Pack to build application specific non-AI features (LEDS, GPIO, ADC, DAC), then download the library format. This allows you to make calls directly to the Knowledge Pack API from your*

*application. We will not be going into this during the quick start guide, but if you want to know more about library files [click here](#).*

### **Classification Output**

**Output** corresponds to how your events get broadcasted from the hardware device. BLE sends the events over Bluetooth Low Energy, LED will blink the LED light on the device a different color for each event, and serial allows you to plug your device into your PC over serial connection to send the events.

### **Debug Option**

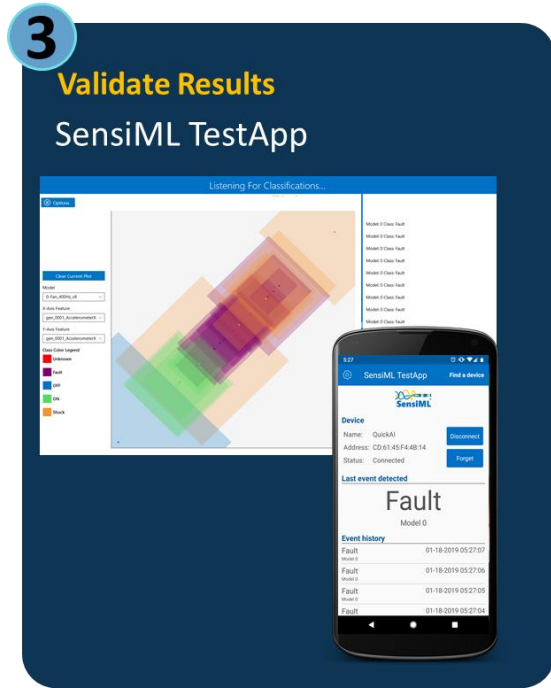
We provide a **Debug** option when generating a Knowledge Pack. When set to **True** the Knowledge Pack will log extra information like feature vectors, debug messages, and error messages over **serial** connection to help you debug the events of interest on a device.

1. See the link below for how to view debug output:

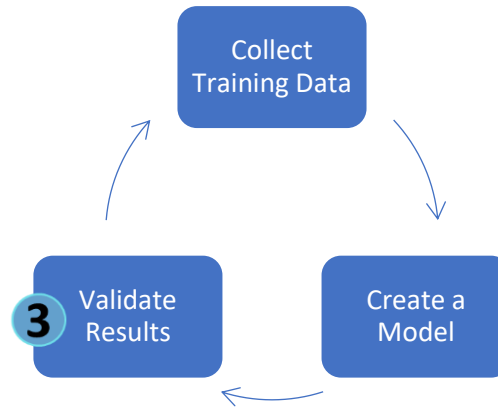
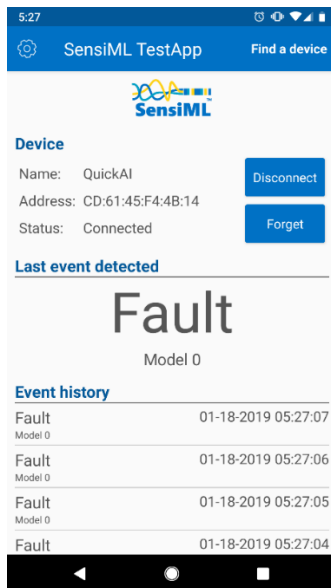
<https://sensiml.atlassian.net/wiki/spaces/SS/pages/141590531/How+to+view+debug+output+in+a+Knowledge+Pack>

## 9.0 Validating Your Results

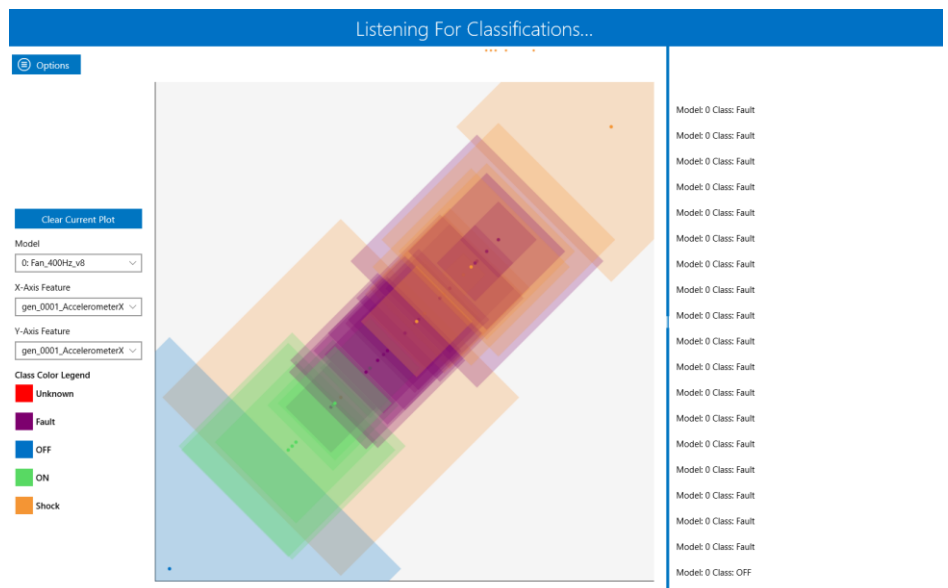
The easiest way to see the live event classification results of a Knowledge Pack running on your sensor is through the **SensiML TestApp**. Since the free version of the SensiML Toolkit does not have Knowledge Pack downloads you will not be able to use the app, but you can see the output in the screenshots below.



Android



PC



## 10.0 Advanced Model Building

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If you have experience with machine learning you might want to dive deeper into the functions used to generate a model in the Dashboard or skip the Dashboard all together and customize your own functions in the model.

### Creating a customized model

We provide a basic example [here](#) for how you can create a model using custom functions in the tutorial **Build Your First App – Advanced Model Building**. This tutorial gives you an understanding of the model building structure and how you can learn to build your own models without the machine learning approach that the Dashboard uses. Open the Analytics Studio and find it with the rest of the tutorials provided in the SensiML Toolkit.