

IBM Cloud

# Analyzing and Acting on IoT Data

Watson Data Platform



## Lab Guide





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## Document Revision History

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1.0	Detecting Anomalous IoT Behaviors with Predictive Analytics.docx	2/20/2018
2.0	Analyzing & Acting on IoT Data	6/10/2018

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## Lab Environment Overview

### Software and Tools

Software	Link
Watson Studio	<a href="https://datascience.ibm.com/">https://datascience.ibm.com/</a>
GitHub	<a href="https://github.com/team-wolfpack">https://github.com/team-wolfpack</a>
IBM Cloud	<a href="https://www.ibm.com/cloud/">https://www.ibm.com/cloud/</a>

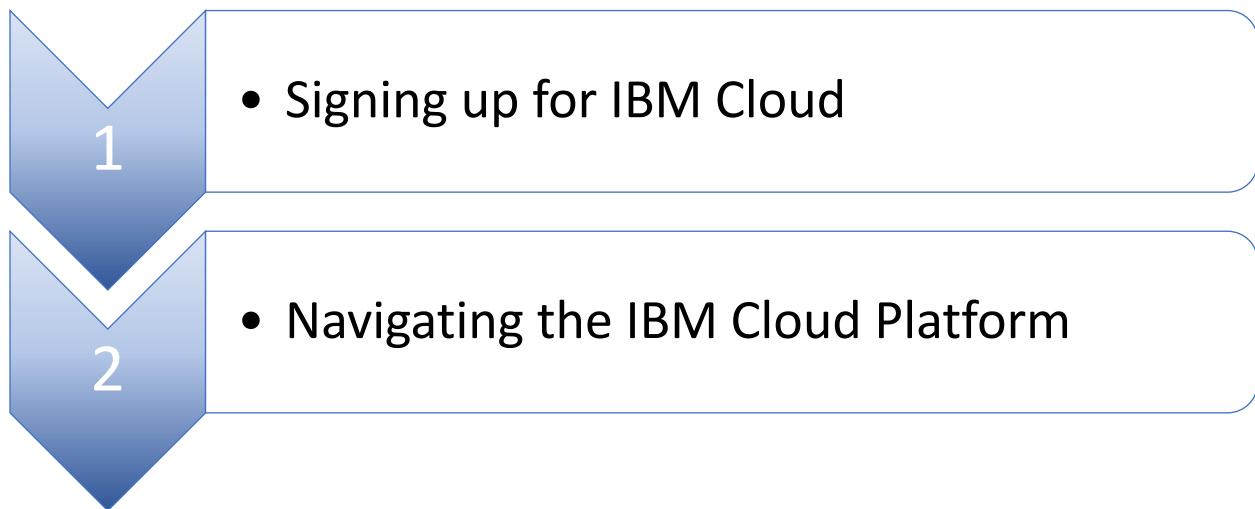


## Lesson 1: IBM Cloud Signup

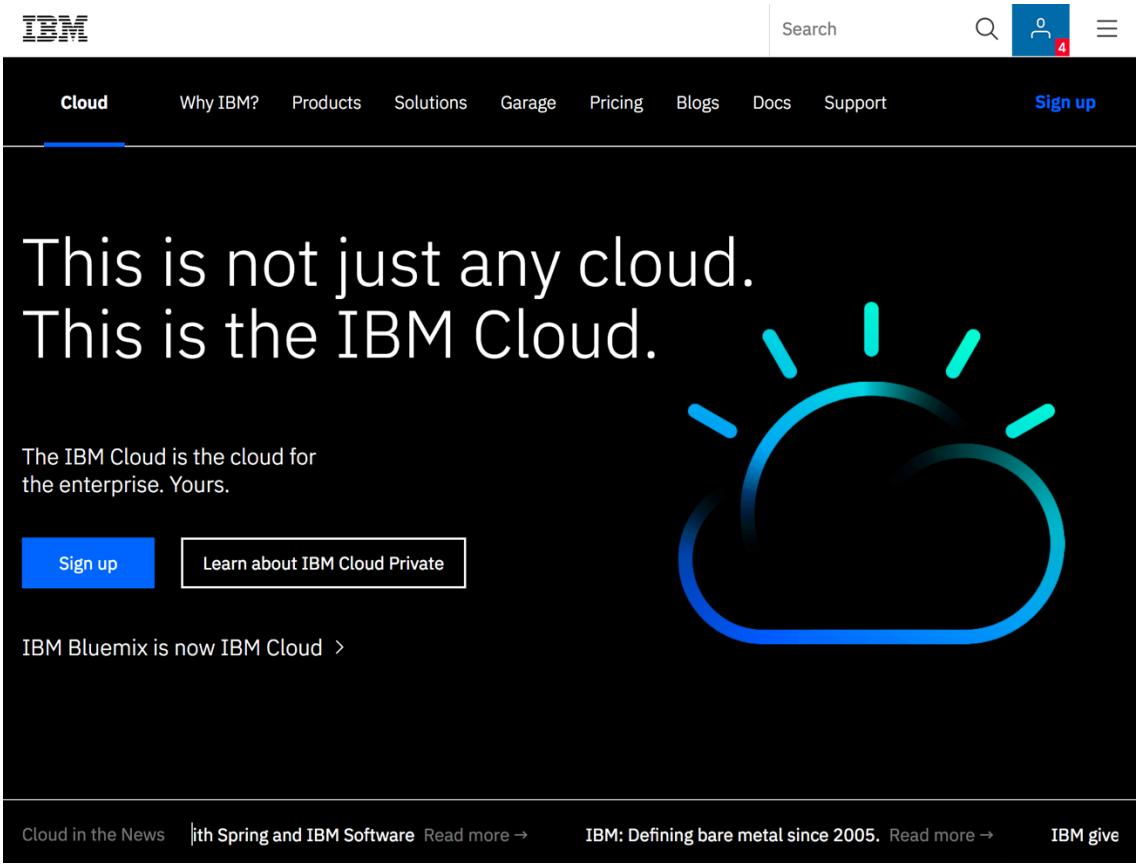
Purpose:	This lab introduces the subject of Cloud. After completing the lab, you should be able to: <ul style="list-style-type: none"><li>• Understand Cloud</li><li>• Navigate IBM Cloud Platform</li></ul>
Tasks:	Tasks you will complete in this lab exercise include: <ul style="list-style-type: none"><li>• Signing up for IBM Cloud</li><li>• Navigating the IBM Cloud Platform</li></ul>



## Lab 1 Workflow Overview



## Lesson 1 Instructions

Action
<p><b><u>1.Signing up for IBM Cloud</u></b></p> <ul style="list-style-type: none"><li>a. Go to <a href="https://www.ibm.com/cloud/">https://www.ibm.com/cloud/</a></li><li>b. We are going to sign up for a free IBM Cloud account.</li><li>c. Click “Sign up”.</li></ul> 



Action
d. Fill in the required boxes. e. Click “Create Account”.
 A screenshot of the IBM Cloud sign-up page. The left side has a dark blue background with text: "Sign up for an IBMid and create your IBM Cloud account", "Build on IBM Cloud for free with no time restrictions", "Guaranteed free development with Lite plans" (with a note about no cap), "Start on your projects right away" (with a note about skipping credit card info), "Get \$200 on us to try paid services" (with a note about ease into cloud pricing), and "Ready to get started? Sign up today!". The right side is a white form with fields for Email*, First Name*, Last Name*, Company, Country or Region* (set to United States), Phone Number*, Password*, and a checkbox for "Keep me informed of products, services, and offerings from IBM companies worldwide". There are also checkboxes for "By email" and "By telephone", and a link "By clicking Create Account, I accept the IBM Cloud privacy policy and IBM Cloud terms." A "Create Account" button is at the bottom.

### Action

IBM Cloud

Catalog Docs Support Manage

**Dashboard**

RESOURCE GROUP CLOUD FOUNDRY ORG CLOUD FOUNDRY SPACE LOCATION CATEGORY

All Resources All Organizations All Spaces All Locations All Categories

**Create resource**

**Fast-track your app development**

Get a preview of what IBM Cloud can do for you. Go from prototype to production in minutes with our starter kits and solution tutorials. Check out some of our popular examples.

 **Build a chatbot**  
Starter Kit · Lite Services · IBM

FEEDBACK

e. The Catalog is a compilation of the services offered on the IBM Cloud.

IBM Cloud

Catalog Docs Support Manage

Try the best of the Catalog for free with no time restrictions with Lite plans.  
The Lite filter is enabled. Remove the filter to see the full Catalog.

All Categories (48) >  Filter

**Infrastructure (2)**

- Compute
- Storage (1)
- Network
- Security
- Containers (1)
- VMware

**Platform (46)**

- Boilerplates (5)
- APIs (1)
- Application Services
- Blockchain

**Infrastructure**

**Storage**

Order storage.

**Object Storage**

Provides flexible, cost-effective, and scalable cloud storage.

Lite IBM

**Containers**

As you look around the catalog, there are a few places to observe. The page is laid out for simple navigation. We already selected the Catalog button to open the Catalog. The Docs link provides details on each of the services. We will touch on this when we initialize our service here in a bit. The Support page is available to answer any questions that cannot be found in Docs. And lastly

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## Action

Manage is where you can manage your account Space and Organization. You can have multiple Spaces. This is a way to keep different projects organized.

Services are organized in categories. These include Infrastructure, Compute, Storage, Watson, etc. Each service will have a title, icon, brief explanation of the service, and either a blue or green oval.

- f. IBM Cloud supports both IBM products and services, as well as third-party. They are indicated by the small ovals below each service description.

IBM

Third Party

Going along the same navigation bar as we found the catalog, we can see docs, support and manage.

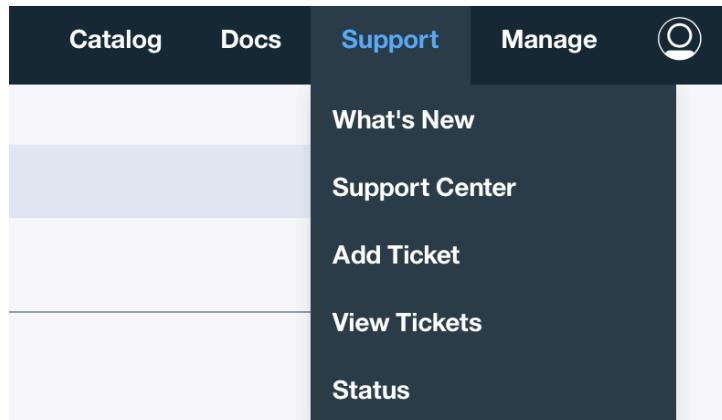
- g. Click on “Docs”.

This is the first “go to” resource if you have questions about any of the services. IBM Cloud Docs houses tutorials, demo’s, videos, starter kits...if you have questions about a service, this is a great resource. Scrolling down you can see that there are numerous links. Each service has a link. Click on one to look at the type of documentation. The documentation ranges from “getting started” and high level “what is this service” to technical details about deploying the services.

## Action

- h. Click on “**Support**”.

Support is a next level of information and help. When you click on it, it will display a drop down menu. If the answers cannot be solved by looking for Docs OR if an emergency situation arises with one of the services, this is where you go to open a ticket. Once the ticket is open, this is also where you can see the status of your tickets. The “What’s new” tab will show you what is new on IBM Cloud. This is where you can go to see recent updates or releases on services.



- i. Click on “**Manage**”.

Manage is where you can keep track of your own account, billing and usage and security. Within the account tab, you can monitor users, groups, organizations, etc.

- j. Click on the **head icon**.

Finally, the head icon will bring you to your personal account page. This is another way to access and manage your accounts such as organizations you are a part of or spaces you are working in.



- k. Return to the catalog

### Action

IBM Cloud

Try the best of the Catalog for free with no time restrictions with Lite plans.  
The Lite filter is enabled. Remove the filter to see the full Catalog.

All Categories (48) > Filter

Infrastructure (2)

- Compute
- Storage (1)
- Network
- Security
- Containers (1)
- VMware

Storage

Order storage.

Object Storage

Provides flexible, cost-effective, and scalable cloud storage.

Lite IBM

Platform (46)

- Boilerplates (5)
- APIs (1)
- Application Services
- Blockchain

Containers

FEEDBACK

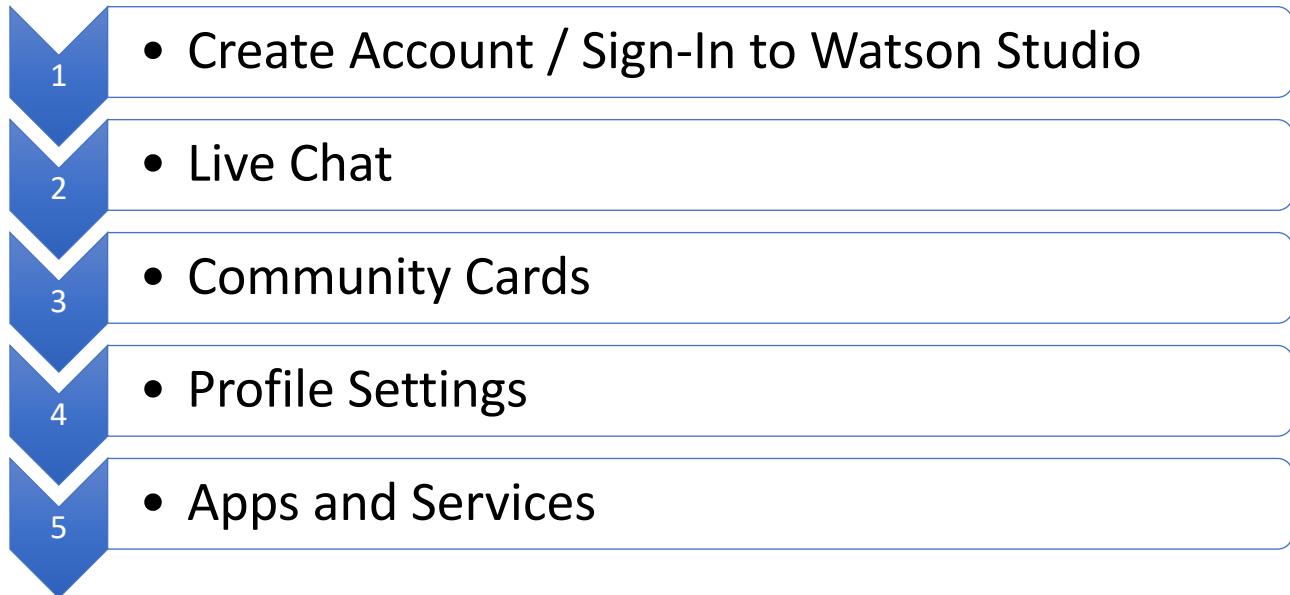
## End of Lesson 1



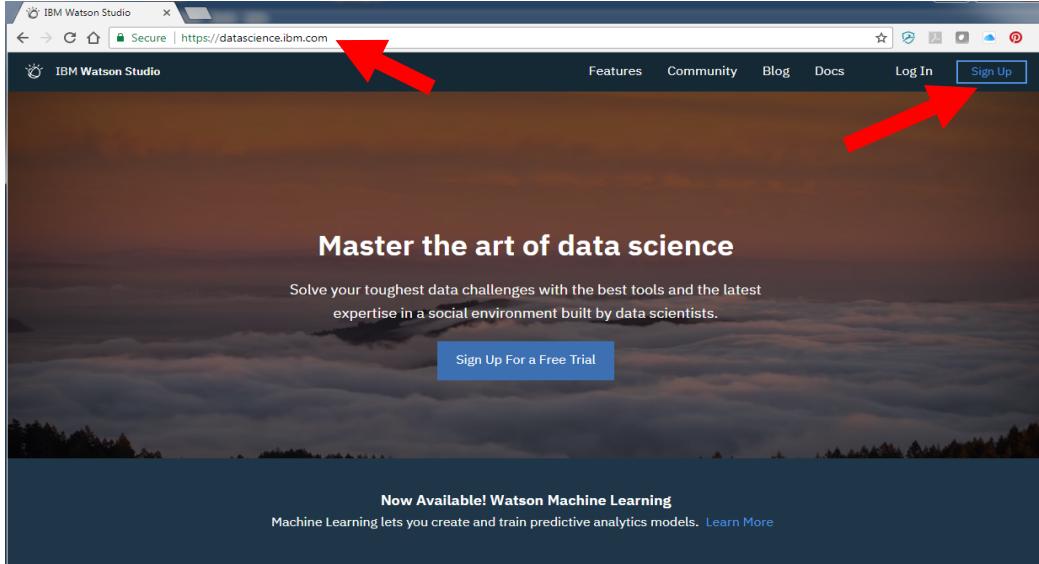
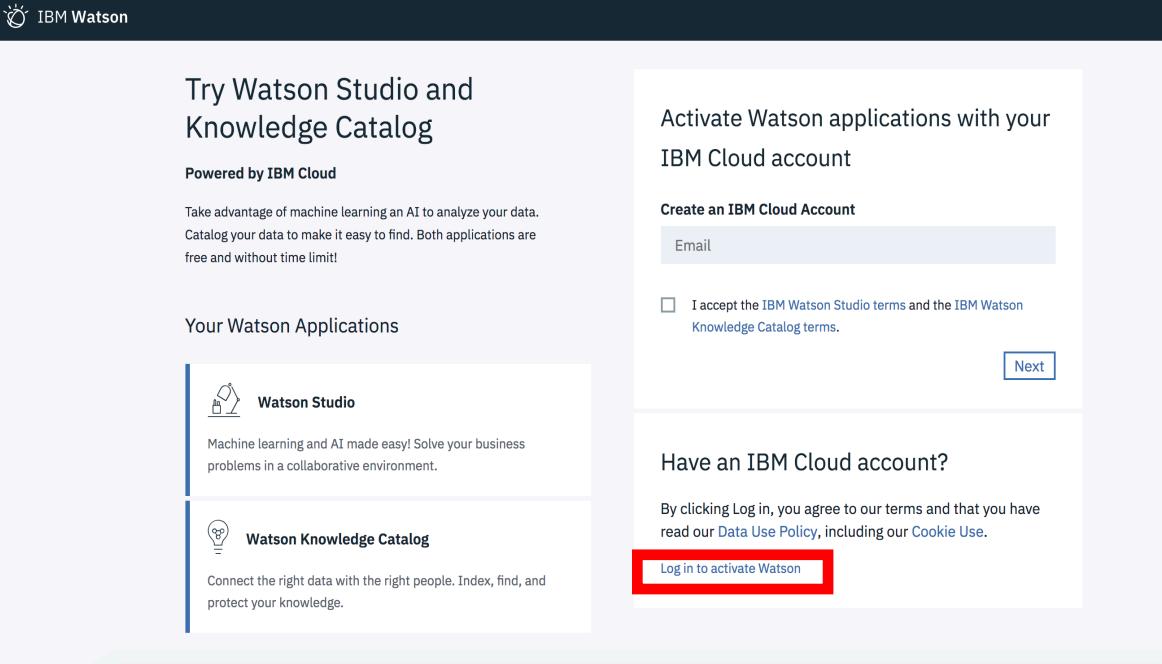
## Lesson 2: IBM Watson Studio Signup

Purpose:	This lab introduces Watson Studio, its sign up and walk-through of the features and functions.
Tasks:	<p>Tasks you will complete in this lab exercise include:</p> <ul style="list-style-type: none"><li>• Create/Sign-In to Watson Studio Account</li><li>• Engage Live Chat</li><li>• Differentiate Four Types of Community Cards</li><li>• Explore Personal Profile, Apps/Services, and Integrations</li></ul>

## Lesson 2: Workflow Overview



## Lesson 2: Instructions

Action
<p><b>1. Create Account/Sign In to Watson Studio</b></p> <ul style="list-style-type: none"> <li>Open web browser and navigate to: <a href="https://datascience.ibm.com">https://datascience.ibm.com</a></li> </ul>  <p>Master the art of data science</p> <p>Solve your toughest data challenges with the best tools and the latest expertise in a social environment built by data scientists.</p> <p>Sign Up For a Free Trial</p> <p>Now Available! Watson Machine Learning</p> <p>Machine Learning lets you create and train predictive analytics models. <a href="#">Learn More</a></p>
<ul style="list-style-type: none"> <li>Click on <b>Sign Up</b>. Under, “Have an IBM Cloud account”, select <b>Log in to activate Watson</b>.</li> </ul>  <p>Try Watson Studio and Knowledge Catalog</p> <p>Powered by IBM Cloud</p> <p>Take advantage of machine learning and AI to analyze your data. Catalog your data to make it easy to find. Both applications are free and without time limit!</p> <p>Your Watson Applications</p> <ul style="list-style-type: none"> <li><b>Watson Studio</b> Machine learning and AI made easy! Solve your business problems in a collaborative environment.</li> <li><b>Watson Knowledge Catalog</b> Connect the right data with the right people. Index, find, and protect your knowledge.</li> </ul> <p>Activate Watson applications with your IBM Cloud account</p> <p>Create an IBM Cloud Account</p> <p>Email</p> <p><input type="checkbox"/> I accept the IBM Watson Studio terms and the IBM Watson Knowledge Catalog terms.</p> <p>Next</p> <p>Have an IBM Cloud account?</p> <p>By clicking Log in, you agree to our terms and that you have read our <a href="#">Data Use Policy</a>, including our <a href="#">Cookie Use</a>.</p> <p><b>Log in to activate Watson</b></p>

- Click **Continue** to select the default organization and space.

## Select Organization and Space

Confirm your IBM Cloud organization and space information below.

[Or create new organization and space](#)

Select IBM Cloud account

Watson WolfPack's Account

IBM Cloud Organization

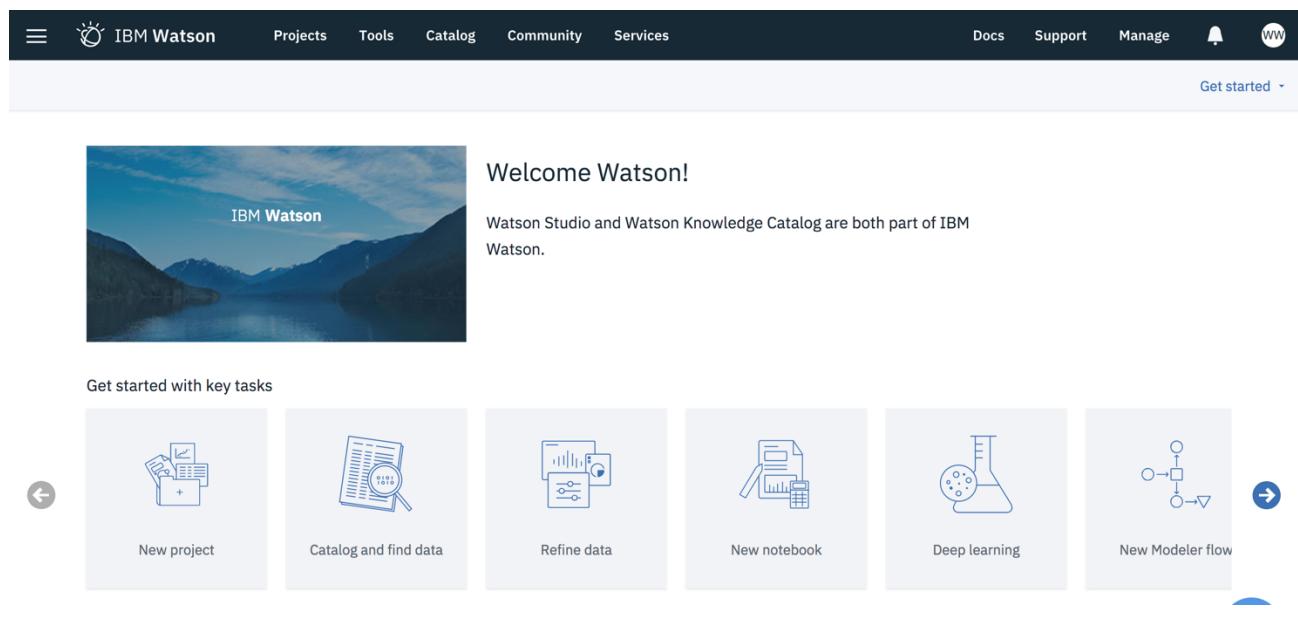
wolfpackwatson@yahoo.com

IBM Cloud Space

dev

**Continue**

- Once your account is activated, select **Get Started**
- You should now see your Watson Studio Homepage

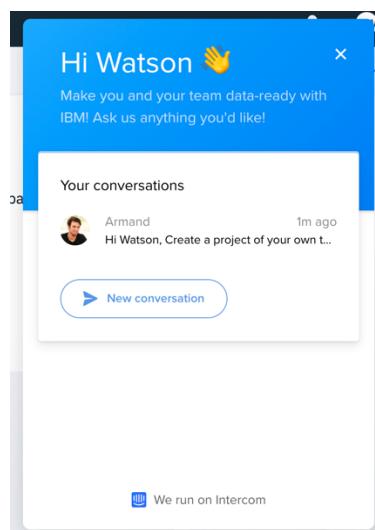


The screenshot shows the IBM Watson homepage. At the top, there is a navigation bar with links for IBM Watson, Projects, Tools, Catalog, Community, Services, Docs, Support, Manage, and a user icon. Below the navigation bar, a large banner features a scenic landscape with mountains and water, with the text "IBM Watson" overlaid. To the right of the banner, the text "Welcome Watson!" is displayed, followed by the subtext: "Watson Studio and Watson Knowledge Catalog are both part of IBM Watson." Below this, a section titled "Get started with key tasks" contains six cards, each with an icon and a label: "New project" (document icon), "Catalog and find data" (catalog icon), "Refine data" (database icon), "New notebook" (notebook icon), "Deep learning" (beaker icon), and "New Modeler flow" (flowchart icon). Navigation arrows are positioned at the bottom of the card grid.

## 2. Live Chat

This is the home page of Watson Studio. Here you have all the tools that you need in a single place to **Learn, Create, and Collaborate**.

- On the bottom right-hand corner, you will see a **Live Chat** feature. Click on the **Chat** icon to launch Live Chat:



If you need assistance, start typing your message in the box to connect with a live person. Through this Live Chat feature, you can also continue conversations the next time you log into Watson Studio.

We use feedback captured through **Live Chat** and the offerings instrumentation to guide our decisions in designing and developing **Watson Studio**.

## 3. Community Cards

At the top of the Home Page click on **Community**

IBM Watson
Projects
Tools
Community
Services



**Featured**

**ARTICLE**  
 Apple, IBM add machine learning to...

AUTHOR TechCrunch  
 DATE Mar 20, 2018  
 TOPIC Watson

FORMAT Web page

 1 

**ARTICLE**  
 Introducing IBM Watson Studio

AUTHOR Armand Ruiz  
 DATE Mar 20, 2018  
 TOPIC Watson

FORMAT Web page

 8 

**ARTICLE**  
 Webinar: April 11 - Thinking inside the box...

AUTHOR RStudio  
 DATE Apr 02, 2018  
 TOPIC Data Science

FORMAT Web page

 0 

Sort by: Featured ▾

**All content**

**ARTICLE**  
 Webinar: April 11 - Thinking inside the box...

**NOTEBOOK**  
 Watson Assistant Workspace Analysis with...

**TUTORIAL**  
 Build Deep Learning Architectures With...

**NOTEBOOK**  
 Connect to Db2 Warehouse on Cloud and Db2...

**NOTEBOOK**  
 From scikit-learn Model to Cloud with WML...

**NOTEBOOK**  
 Access MySQL with Python

**ARTICLE**  
 Using shell scripts to control data flows...

**ARTICLE**  
 Working with data flows using Watson Data...

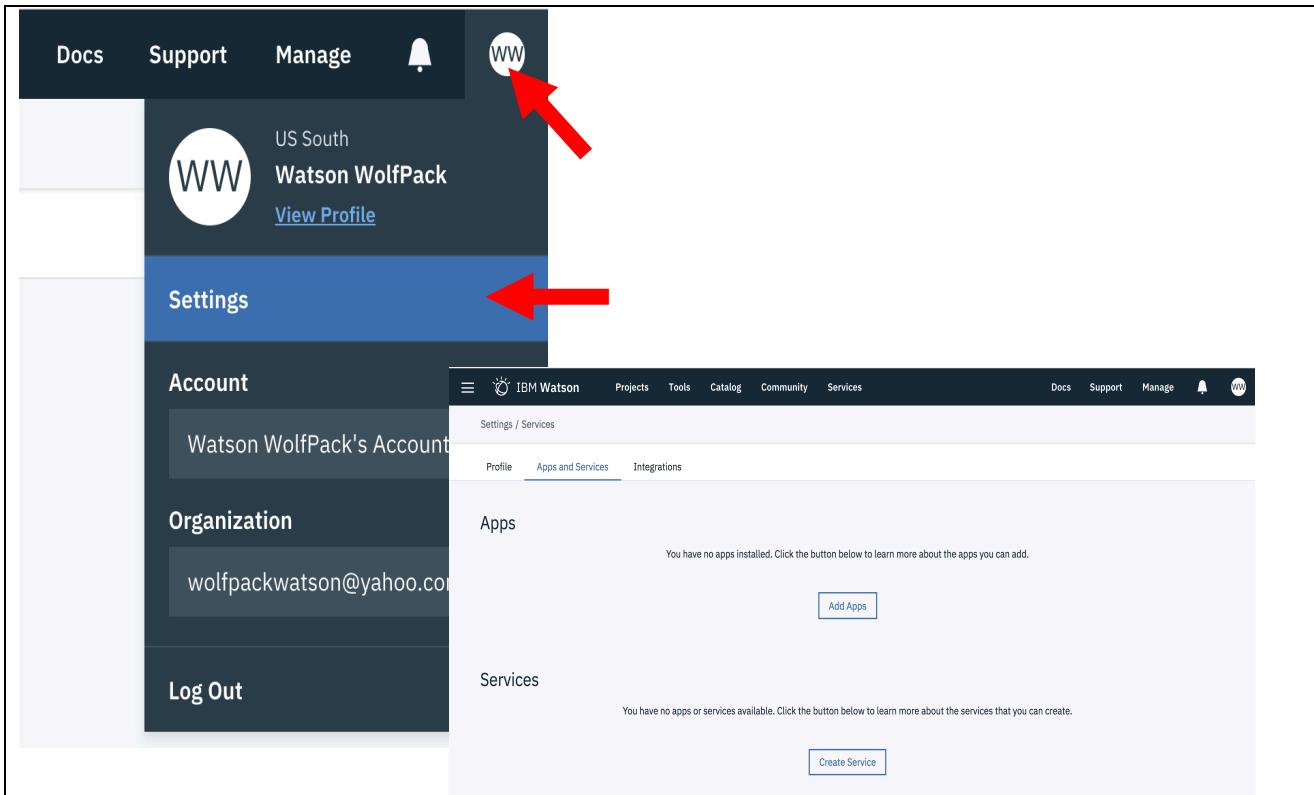
There are four types of cards – **Articles**, **Data Sets**, **Notebooks**, and **Tutorials**. These are designed to make it easier for you to learn about data science and experiment with its various tools and techniques.

#### **4. Profile Settings**

- Click on **Settings** to look at your **Profile, Apps and Services, and Integrations**. This is where you see the details of your IBM Cloud Account:

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The screenshot shows the Watson Studio interface. At the top left are links for 'Docs', 'Support', and 'Manage'. A red arrow points to the user profile icon ('WW') at the top right. Another red arrow points to the 'Settings' link in the sidebar. The sidebar also includes 'Account' (Watson WolfPack's Account), 'Organization' (wolfgangwatson@yahoo.com), and 'Log Out'. The main content area has a header with 'IBM Watson' and links for 'Projects', 'Tools', 'Catalog', 'Community', and 'Services'. Below this is a 'Settings / Services' section with tabs for 'Profile', 'Apps and Services' (which is selected and highlighted in blue), and 'Integrations'. Under 'Apps', it says 'You have no apps installed.' with a 'Add Apps' button. Under 'Services', it says 'You have no apps or services available.' with a 'Create Service' button.

**Integrations** is where you configure Watson Studio for GitHub integration.

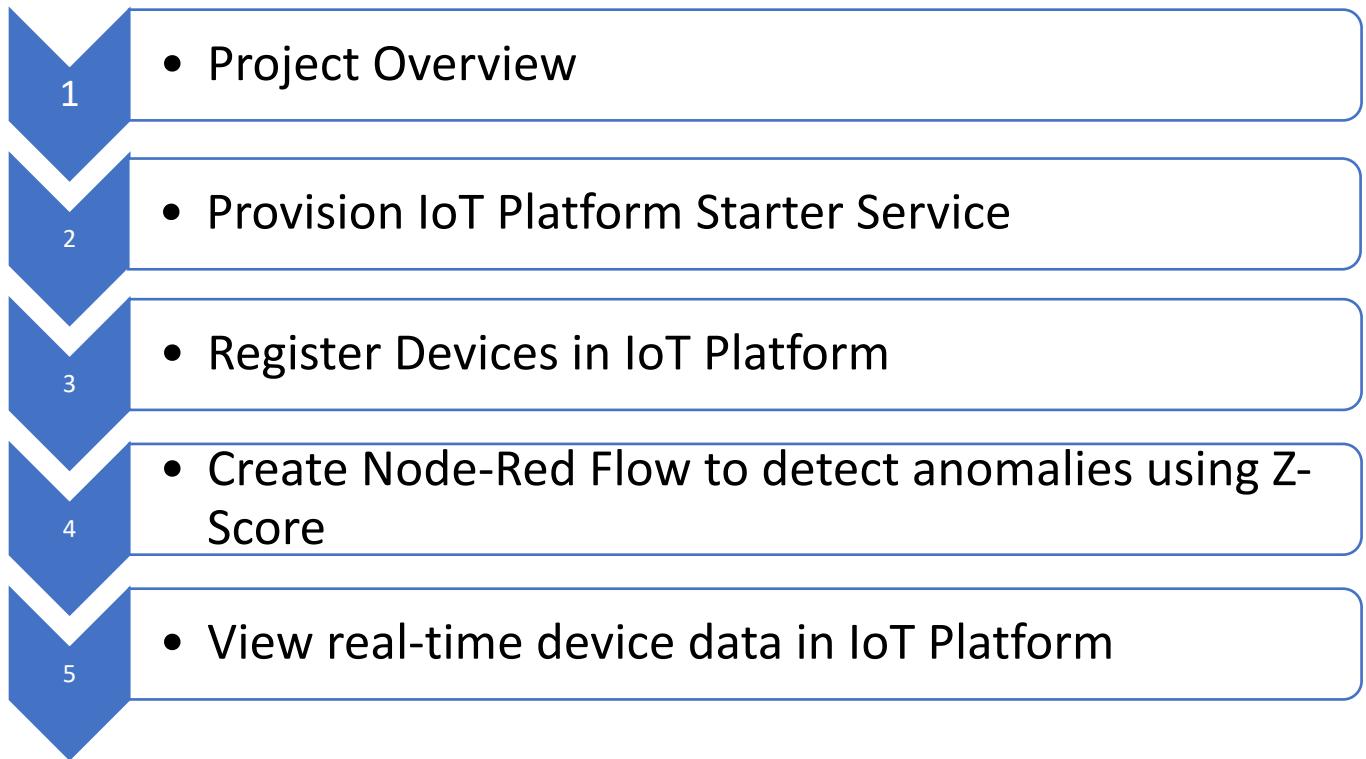
## End of Lesson 2



## Lesson 3: Detect Anomalies using Z-Score

Purpose:	This lesson introduces the Internet of Things (IoT) Platform Starter on IBM Cloud, how to create a Node-RED flow to simulate IoT devices, and how to use z-score to detect anomalies on edge devices.
Tasks:	<p>Tasks you will complete in this lab exercise include:</p> <ul style="list-style-type: none"><li>• Provision Internet of Things Platform Starter Service on IBM Cloud</li><li>• Create Node-RED Flow to detect anomalies using z-score</li><li>• Register devices in IoT Platform and view real-time data</li></ul>

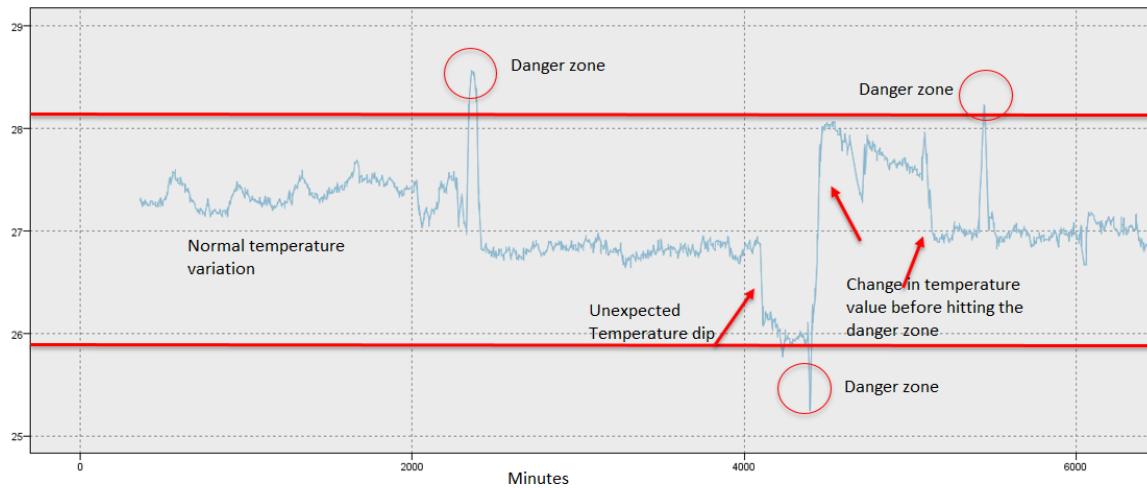
## Lesson 3: Workflow Overview



## Lesson 3: Instructions

### 1. Project Overview

The total amount of data produced by IoT devices and systems is humongous and arriving with a very high velocity. However more than 90% of this data gets lost unless it is analyzed. One way of performing this analysis is by setting threshold which would trigger an action to be taken once it is breached. This can be seen by the danger zone readings as shown in the time-series data shown below.



However, this approach is at best a reactive approach and at worst simply futile (as the event has already occurred).

The real benefit of this massive amount of data, produced by IoT, lies in performing a real-time analysis on it so to discover trends and patterns and to use these patterns to predict the failures in a timely manner (as can be seen by the unexpected temperature dip above). One of the mechanisms of performing this analysis is through the usage of Predictive analytics.

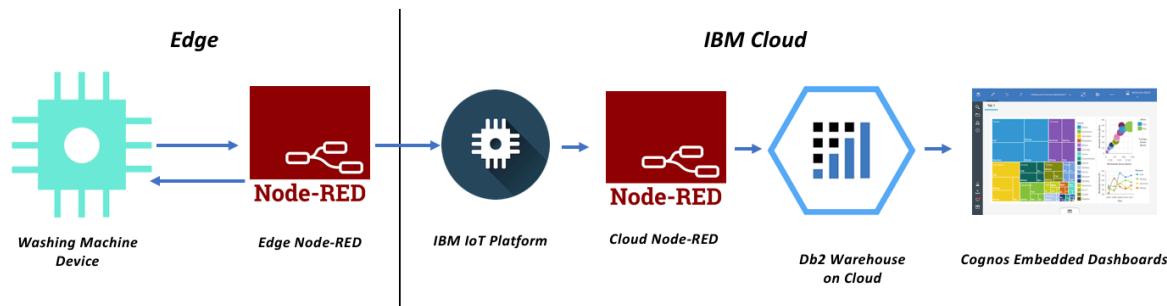
Predictive analytics encompasses a variety of statistical techniques from predictive modeling, machine learning, and data mining that analyze current and historical facts to make predictions about future. The core of predictive analytics relies on capturing relationships between explanatory variables and the predicted variables from past occurrences, and exploiting them to predict the unknown outcome. It is important to note, however, that the accuracy and usability of results will depend greatly on the level of data analysis and the quality of assumptions.

In cognitive IoT solutions, predictive analytics or machine learning can take place in an edge computing architecture. Edge computing basically means that you push computing

away from the cloud or data center out toward the sensors. Two common reasons for edge computing are Latency and Transfer cost.

- **Latency** impacts some critical decisions that make a cloud route trip untenable. Think of a smart-connected car. If the car in front of you brakes suddenly, you want your car to respond immediately.
- **Transfer cost** can be too high if the amount of data that is created by a sensor is too much to transfer to the cloud completely. Either it is technically impossible due to link speed, or it is just too expensive, or both.

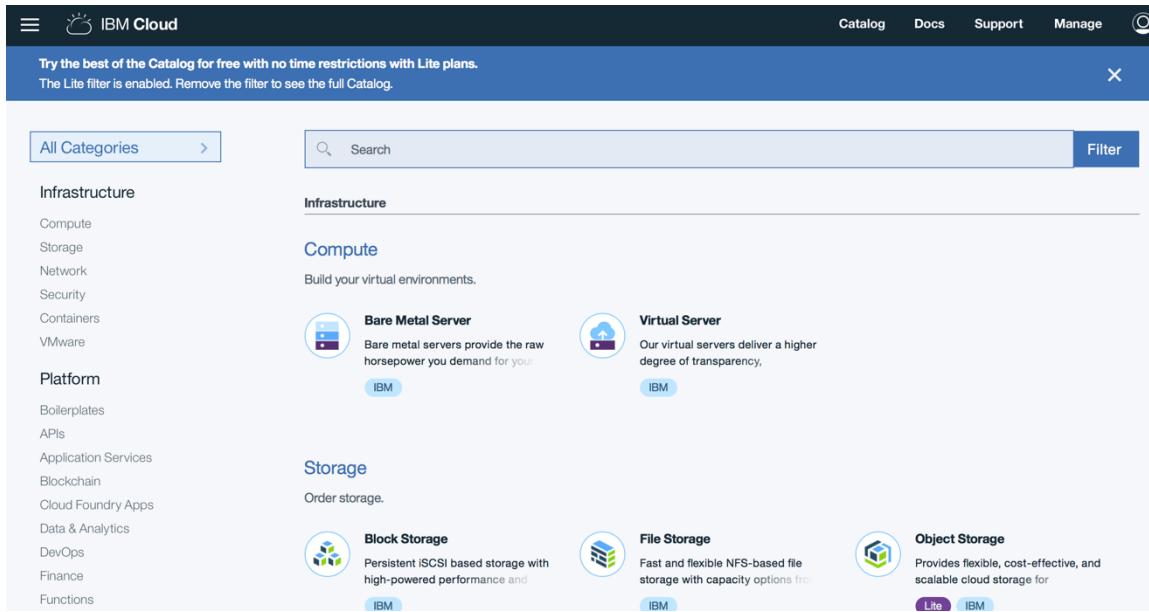
In this lab, you will simulate a Washing Machine IoT Device that is publishing voltage sensor events to the IBM Watson IoT Platform. We will use z-score to predict when an anomaly will occur and send the device a command to immediately shutdown. The predictive analytics will be performed on the edge device thus reducing the latency. In addition, we will visualize the data being sent to the Watson IoT Platform. We will then create a Node-RED flow in the IBM cloud to persist the data from the IoT Platform to a Db2 Warehouse on Cloud instance. Lastly, we will visualize the sensor data in Watson Studio using the Cognos Dashboard Embedded Service.



## Action

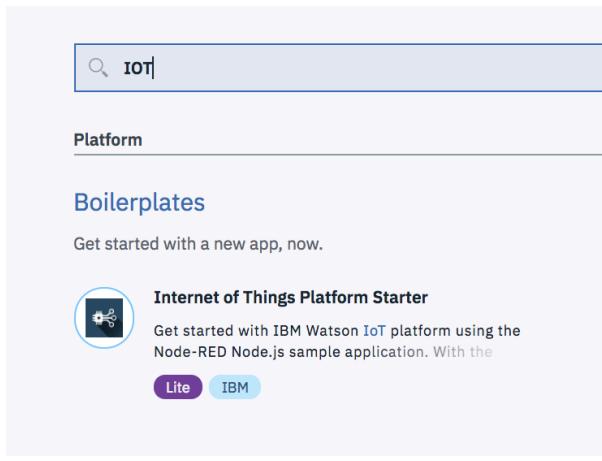
### 2. Provision Internet of Things Platform Service

- Login into your BM Cloud account
- Select **Catalog** from the upper right corner



The screenshot shows the IBM Cloud Catalog interface. At the top, there's a banner stating "Try the best of the Catalog for free with no time restrictions with Lite plans. The Lite filter is enabled. Remove the filter to see the full Catalog." Below the banner, there's a search bar and a "Filter" button. On the left, there's a sidebar with "All Categories" and a list of categories under "Infrastructure" (Compute, Storage, Network, Security, Containers, VMware) and "Platform" (Boilerplates, APIs, Application Services, Blockchain, Cloud Foundry Apps, Data & Analytics, DevOps, Finance, Functions). The main content area is titled "Infrastructure" and shows sections for "Compute" (with "Bare Metal Server" and "Virtual Server" options), "Storage" (with "Block Storage", "File Storage", and "Object Storage" options), and "Platform" (with "Internet of Things Platform Starter" listed under Boilerplates).

- In the search bar, type **IOT** and select **Internet of Things Platform Starter**. Internet of Things Platform Starter fall under the boilerplates section of the catalog.

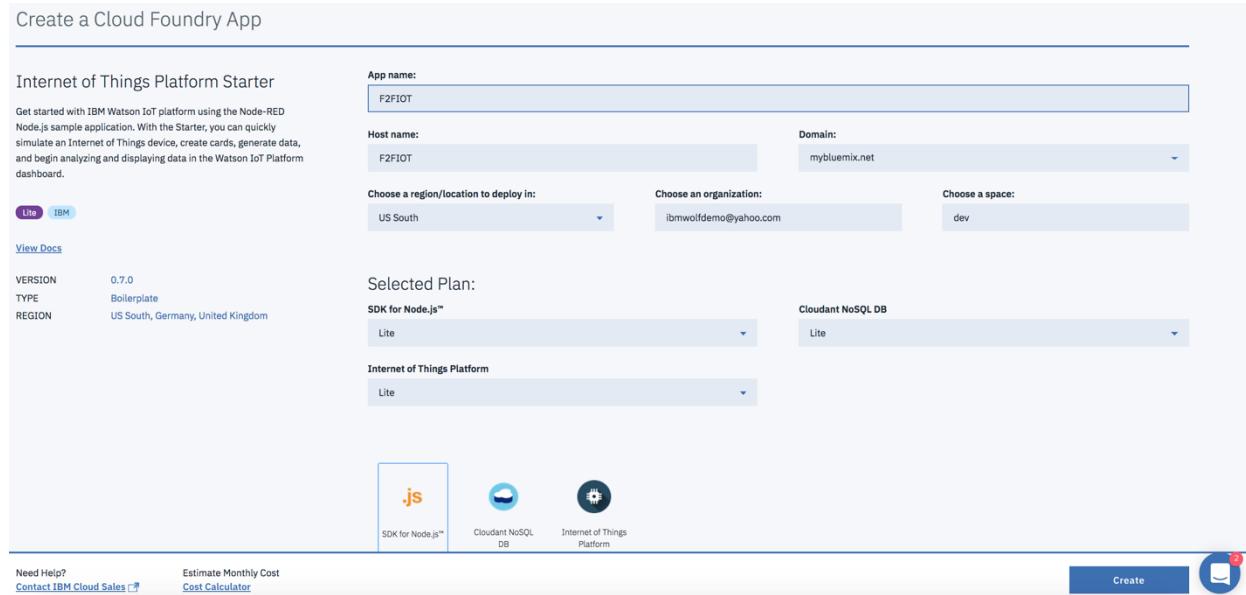


The screenshot shows the search results for "IOT" in the IBM Cloud Catalog. The search bar contains "IOT". The results are filtered under the "Boilerplates" section. One result is visible: "Internet of Things Platform Starter", which is described as "Get started with IBM Watson IoT platform using the Node-RED Node.js sample application. With the". There are "Lite" and "IBM" buttons next to it.

- Give the app an unique name. Once you type in an app name, it automatically becomes the host name as well.

## Action

### e. Click **Create**



The screenshot shows the 'Create a Cloud Foundry App' interface for the 'Internet of Things Platform Starter'. The app name is set to 'F2FIOT'. The host name is also 'F2FIOT'. The domain is 'mybluemix.net'. The region is 'US South', and the organization is 'ibmwolfdemo@yahoo.com'. The space is 'dev'. The selected plan is 'Lite' for all services: 'SDK for Node.js\*', 'Cloudant NoSQL DB', and 'Internet of Things Platform'. At the bottom, there are links for 'Need Help?', 'Estimate Monthly Cost', and 'Contact IBM Cloud Sales'. The 'Create' button is highlighted in blue.

f. The app will take a few minutes to start, as indicated by the icon next to the apps name. Your app is ready once the Visit App URL becomes active.

### 3. Register Devices in IoT Platform

- Select the **IBM Cloud icon** in the upper left corner. This will take you back to your dashboard.



Notice the Internet of Things Platform Starter provisioned three items: a Cloud Foundry App, a Cloudant NoSQL DB Service and the Internet of Things Platform Service.

## Action

IBM Cloud

Catalog Docs Support Manage

Dashboard

Cloud Foundry Applications

Name	Region	CF Org	CF Space	Status
PRIoTLRM	US South	wolfpackwatson	dev	<span>Running</span>

Cloud Foundry Services

Name	Region	CF Org	CF Space	Plan
KnowledgeCatalog	US South	wolfpackwatson	dev	Lite
PRIoTLRM-cloudantNoSQLDB	US South	wolfpackwatson	dev	Lite
PRIoTLRM-iotf-service	US South	wolfpackwatson	dev	Lite

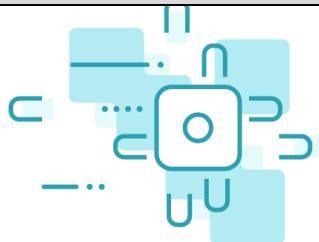
b. Under the “Cloud Foundry Services” section, click the [Internet of Things Platform](#) Service Offering. It will be named “xxxx – iotf – service,” where xxxx is the name of your app.

Cloud Foundry Services

Name	Region	CF Org	CF Space	Plan
KnowledgeCatalog	US South	wolfpackwatson	dev	Lite
PRIoTLRM-iotf-service	US South	wolfpackwatson	dev	Lite
PRIoTLRM-iotf-service	US South	wolfpackwatson	dev	Lite
WatsonStudio	US South	wolfpackwatson	dev	Lite

c. Select [Launch](#) to enter into the IBM Watson IoT Platform organization space

### Action



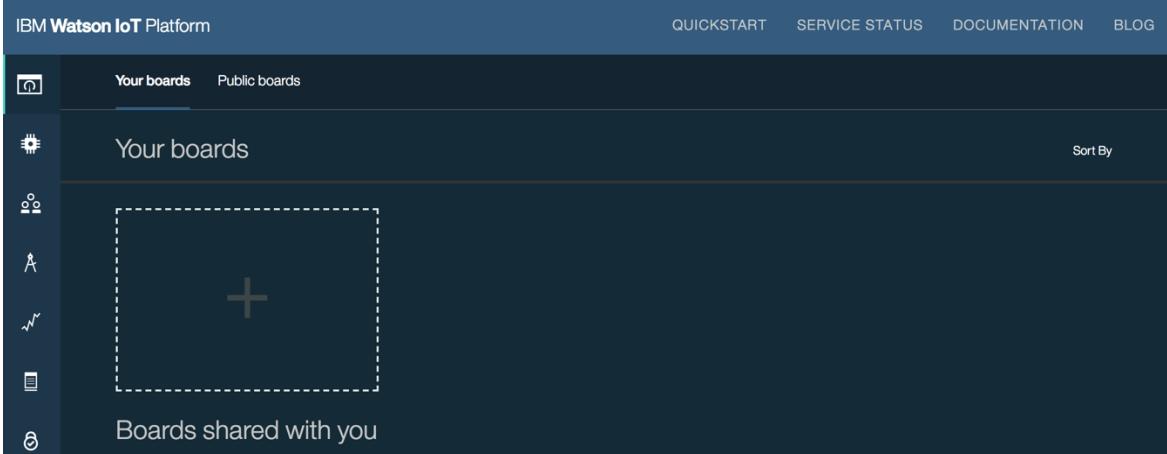
**Let's get started with Watson IoT Platform**

Securely connect, control, and manage devices. Quickly build IoT applications that analyze data from the physical world.

[Launch](#) [Docs](#)

The IoT organization is a space used for connecting and managing devices to the IoT Platform so your applications can access their live and historical data.

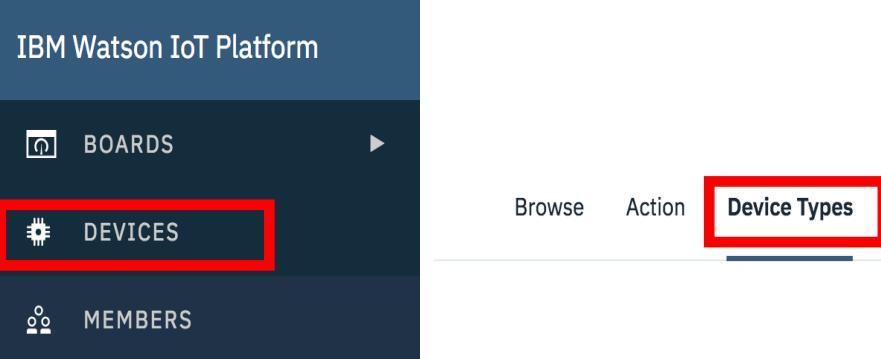
d. Observe that a new Organization is created where you can add, connect and manage IoT devices.



In the lab we will simulate a Washing Machine Sensor Device connecting to the IoT Platform. Each device connected to the IBM Watson IoT Platform is associated with a device type. Device types are intended to be groups of devices which share common characteristics. So in order to add devices in IBM Watson IoT Platform, one need to create a device type.

e. On the left-hand side of the dashboard, click the **Devices** tab, then click on the **Device Types** tab

### Action

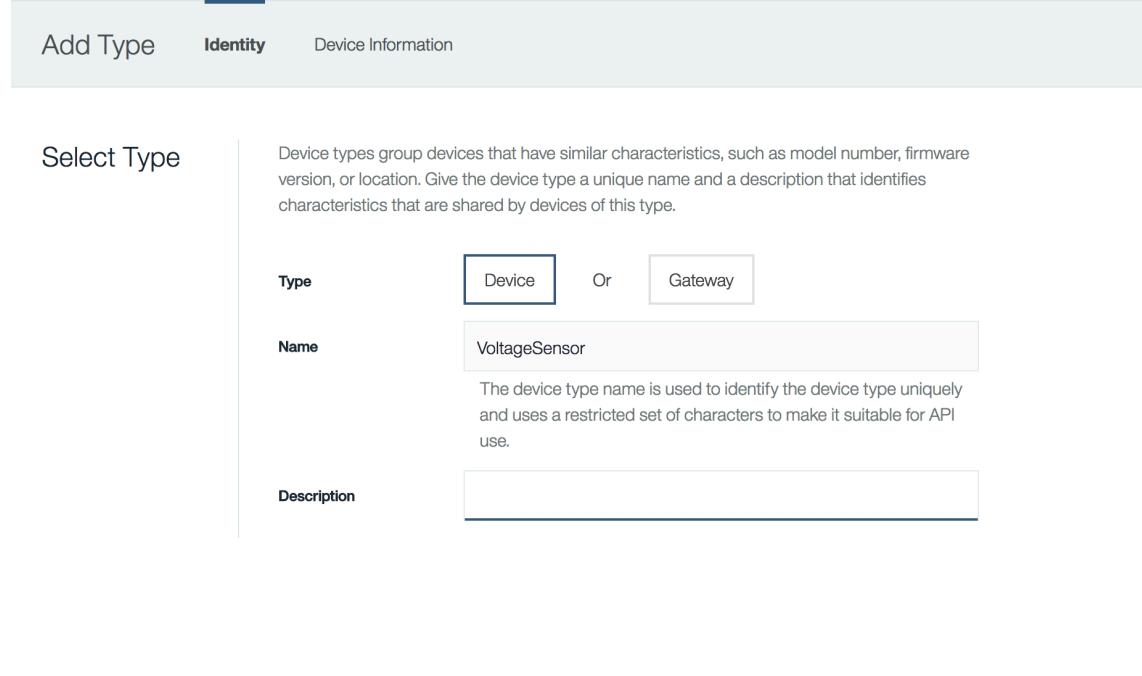


f. Select **Add Device Type**, from the upper right corner



Observe there are 2 options provided: Device type and Gateway type. This lab will focus on adding devices not a gateway. Gateways are a specialized class of devices in the IBM Watson IoT Platform which serve as access points to the Platform for other devices. Gateway devices can register new devices and can send and receive data on behalf of devices connected to them.

g. For Type, select **Device**. For Name, type **VoltageSensor**. Click **Next**.



## Action

- h. You can enter in additional Device Information, but we will leave it blank. Select **Done**. You have successfully added a new device type. Now we need to register Devices of that type.

You added the new device type: **VoltageSensor**

**Register Device**      Advanced Flow

---

**Optional**  
Register Devices, Define Interfaces

Now that you added a device type, you can register and connect devices for this type.

**Register Devices**

- i. Select **Register Devices**. For Device ID, type **Sensor01**. Click **Next**.

IBM Watson IoT Platform      QUICKSTART      SERVICE STATUS      DOCUMENTATION      BLOG      wolfpackwatson@yahoo.com  
ID: (aj4fer)

**Browse**    Action    Device Types

**Add Device**    **Identity**    Device Information    Groups    Security    Summary

**Identity**    Select a device type for the device that you are adding and give the device a unique ID.

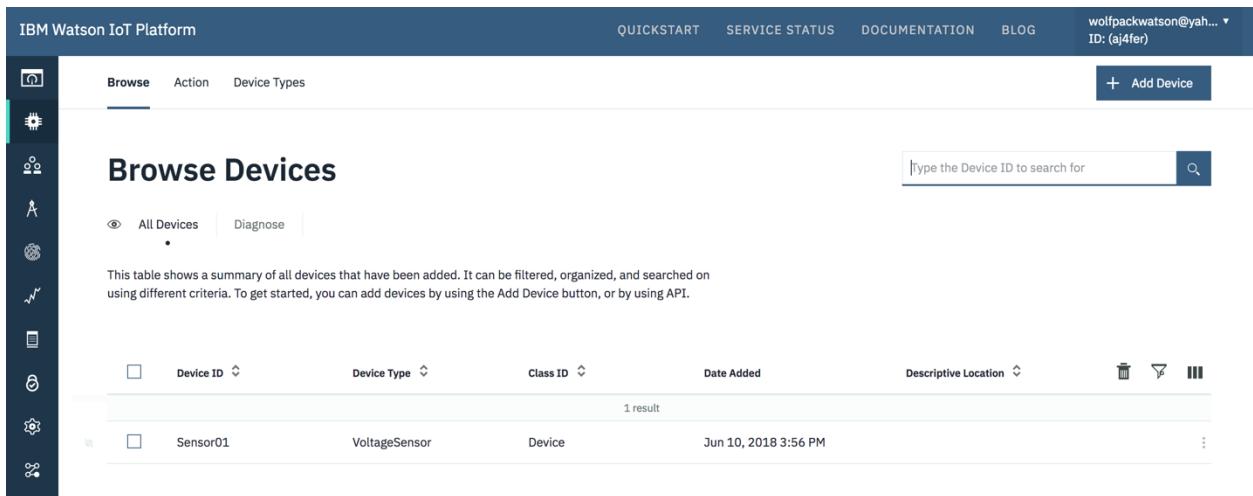
Device Type	VoltageSensor
Device ID	Sensor01

**Cancel**    **Next**

- j. You can enter additional Device Information, but we will leave it blank. Select **Next**.
- k. We will not assign a group to the device. Select **Next**
- l. Type **VoltSensor** as the authentication token. For purposes of this lab, we will provide our own authentication token versus having one auto-generated. Select **Next**.

Action	
<p><b>Device Security</b></p> <p>There are two options for selecting a device authentication token.</p> <p><b>Auto-generated authentication token (default)</b></p> <p>Allow the service to generate an authentication token for you. Tokens are 18 characters and contain a mix of alphanumeric characters and symbols. The token is returned to you at the end of the device registration process.</p> <p><b>Self-provided authentication token</b></p> <p>Provide your own authentication token for this device. The token must be between 8 and 36 characters and contain a mix lowercase and uppercase letters, numbers, and symbols, which can include hyphens, underscores, and periods. Do not use repeated characters, dictionary words, user names, or other predefined sequences.</p> <p><b>Authentication Token</b> VoltSensor <span style="float: right;"> ⓘ</span></p> <p>Make a note of the generated token. Lost authentication tokens cannot be recovered. Tokens are encrypted before being stored.</p> <p>Authentication token are encrypted before we store them.</p>	<span style="font-size: 2em;">&lt;</span> <span style="font-size: 2em;">Next</span>

- m. Click **Done** to receive your device credentials. Be sure to **write down the credentials and save** for later use.
- n. Select **Back**. Your device should now be listed.



The screenshot shows the 'Browse Devices' section of the IBM Watson IoT Platform. The table displays the following data:

Device ID	Device Type	Class ID	Date Added	Descriptive Location	Action
Sensor01	VoltageSensor	Device	Jun 10, 2018 3:56 PM		<span style="font-size: 2em;">⋮</span>

#### 4.Create Node-RED Flow to Detect Anomalies using Z-Score

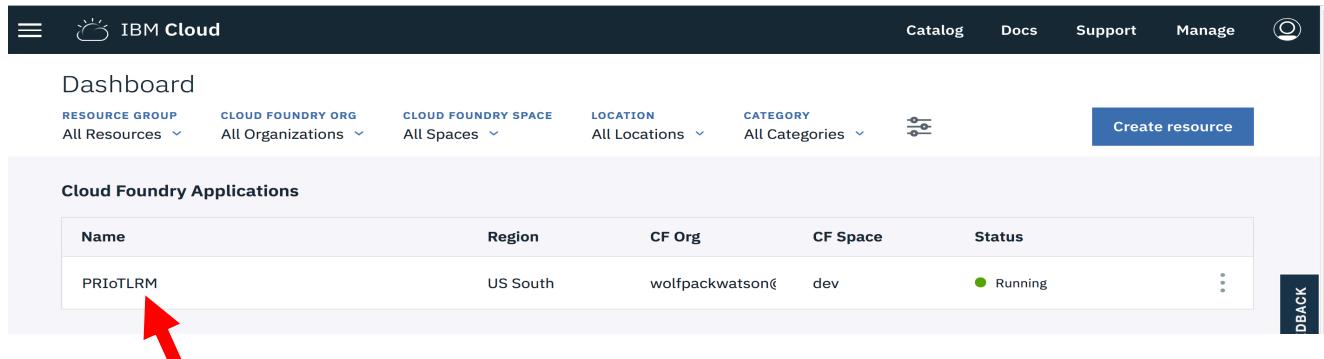
Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and interesting ways. It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click.

Z-Score, or standard score, is one of the simplest anomaly detection algorithms. It indicates how many standard deviations an element is from the mean. It tells how abnormal a reading is comparing to all the values in history.

## Action

In this lab, we will use Node-RED to create a flow that simulates a Washing Machine Device that has a voltage sensor. The Z-score will be calculated for the incoming voltage values to detect anomalies. If an anomaly is found an alert/shutdown command will be issued to the device. All incoming voltage values will also be sent to the IoT Platform for further visualization and analysis.

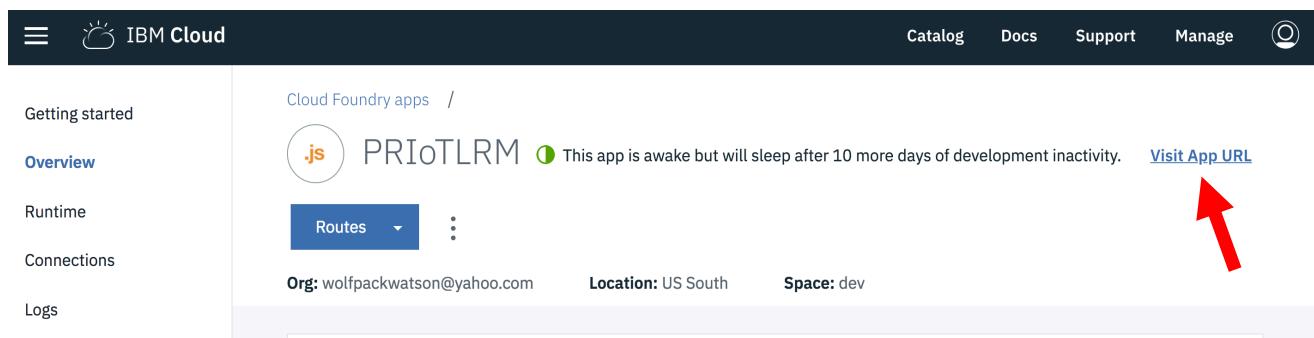
- Within your IBM Cloud account, go to your **Dashboard** and click on the name of your IoT Cloud Foundry app.



The screenshot shows the IBM Cloud dashboard with the 'Cloud Foundry Applications' section. The table lists one application:

Name	Region	CF Org	CF Space	Status
PRIoTLRM	US South	wolfpackwatson	dev	<span style="color: green;">●</span> Running

- From the app homepage, select **Visit App URL**



The screenshot shows the app homepage for 'PRIoTLRM'. On the right, there is a summary card with the app name, status (awake), and a 'Visit App URL' link. On the left, there is a sidebar with navigation links: Getting started, Overview, Runtime, Connections, and Logs.

- The Node-Red editor will give you a few options, make your selections and click **Next** through them.

(Example: fill in name and password for security, select “node-red-dashboard”, finish the install)

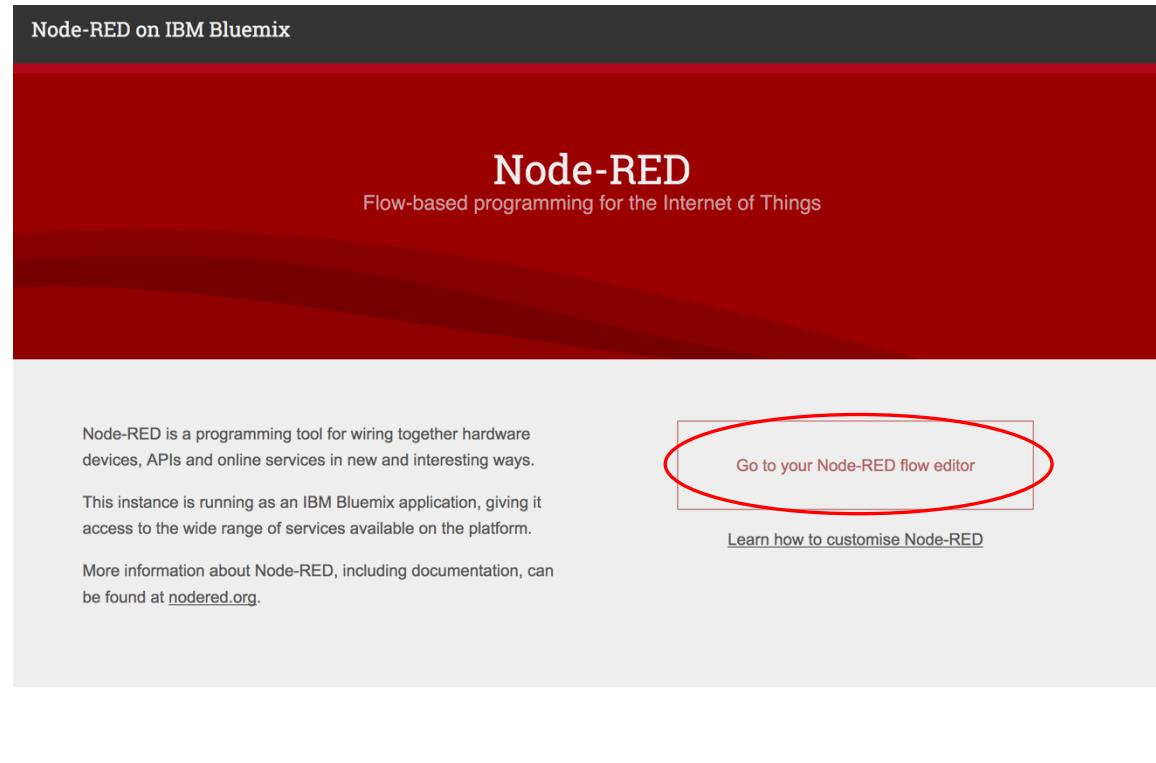
- Click **Finish**

## Action

## Applying your settings and starting Node-RED



- e. Click **Go to your Node-RED flow editor**



Node-RED on IBM Bluemix

# Node-RED

Flow-based programming for the Internet of Things

Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and interesting ways.

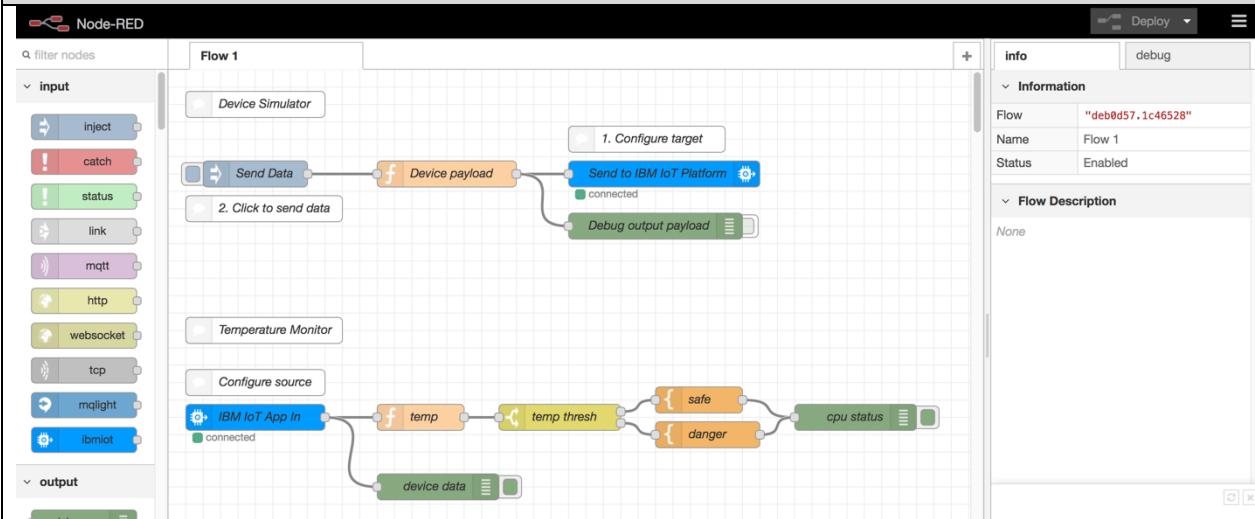
This instance is running as an IBM Bluemix application, giving it access to the wide range of services available on the platform.

More information about Node-RED, including documentation, can be found at [nodered.org](http://nodered.org).

[Go to your Node-RED flow editor](#)

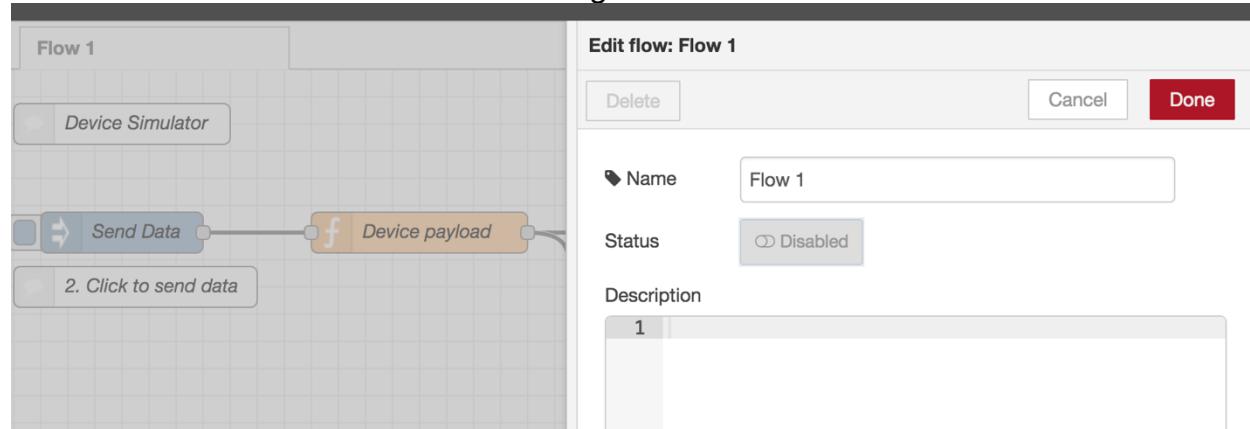
[Learn how to customise Node-RED](#)

## Action

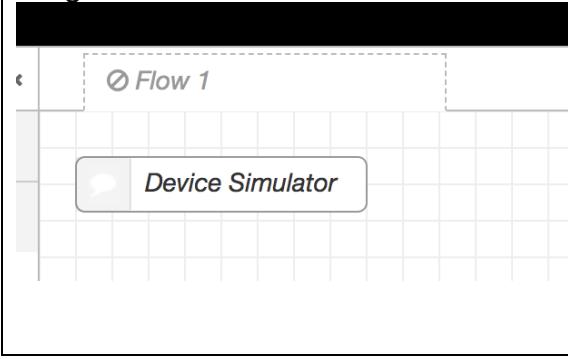


When you open the flow, you can see on the left all the nodes available in the palette that can contribute to a flow and a sample flow.

f. Double click the **Flow 1** tab. Change the status to **disabled**. Click **Done**

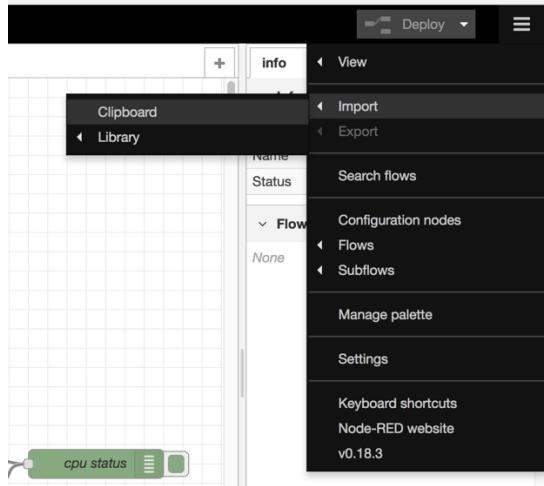


g. The **Flow 1** tab should now have a **disabled icon** beside it

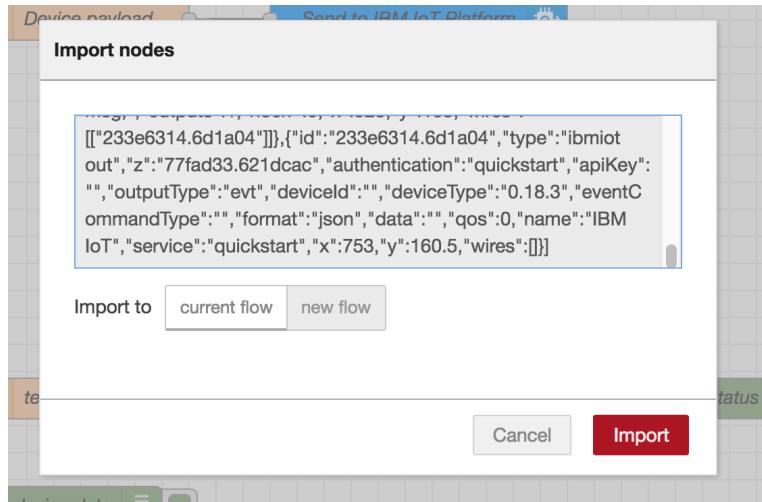


## Action

- h. A starter flow ([IOTLab StarterFlow.json](#)) has been provided to you for the lab. Open the file and copy its contents.
- i. Select the 3-bar menu tile in the upper right corner, select **Import -> Clipboard**

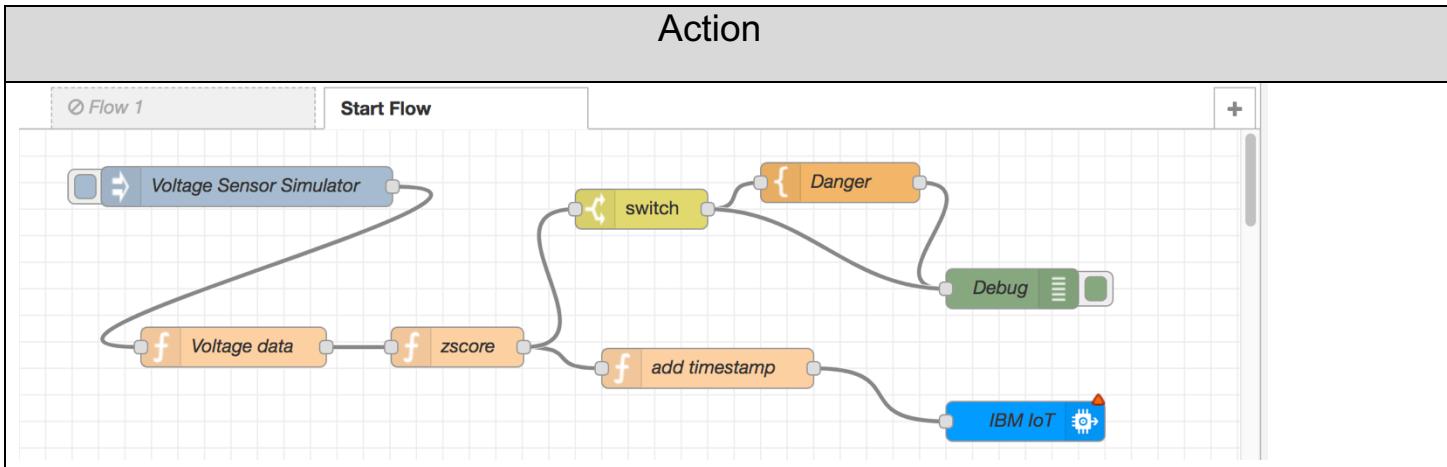


- j. Copy and paste the contents from the json file into the clipboard. Select import to **New Flow** and click **Import**



- k. Notice a new flow, called **Start Flow**, has been imported

### Action



The flow simulates voltage sensor data, calculates a Z-Score, determines if Z-Score is above threshold, and sends the data to the IoT Platform after a timestamp has been added to the data. Double click the following nodes to open and explore.

- **Voltage Sensor Simulator** – Simulates a voltage sensor device that is sending voltage and frequency data
- **Voltage data** – Randomizes voltage and frequency values so anomalies can occur
- **Z-Score** – Calculates the z-score for voltages
- **Add timestamp** – Adds a timestamp to each event so you know when the event occurred.
- **Switch** – Determines if the Z-Score is above a particular threshold.
- **Danger** – If Z-Score is above the danger threshold (0.3), send a Danger alert.
- **Debug** – Sends events to the debug panel
- **IBM IoT** – Connection node to the IoT Platform. Each event is sent to the platform for future analysis.

Anomalies will be detected if the Z-Score is above a certain threshold. We will now modify a couple of the nodes to complete the flow.

- I. Double click the **Switch node** and input the following properties. Select **Done**. We are setting the z-score threshold to 0.3. If the score is above 0.3, an anomaly has occurred.

## Action

Edit switch node

[Delete](#) [Cancel](#) [Done](#)

**node properties**

Name: Voltage Thres

Property: msg.payload.zscore

Rules:

- > 0.3 → 1
- ≤ 0.3 → 2

+ add

checking all rules

recreate message sequences

Finally, we need to input the credentials for our IoT Platform Service so we can connect to it.

- Double Click the **IBM IoT** node and input the following. Notice the Device Type and Device ID are what we previously registered within the IoT Platform. Click **Done**

## Action

**Edit ibmiot out node**

Delete      Cancel      Done

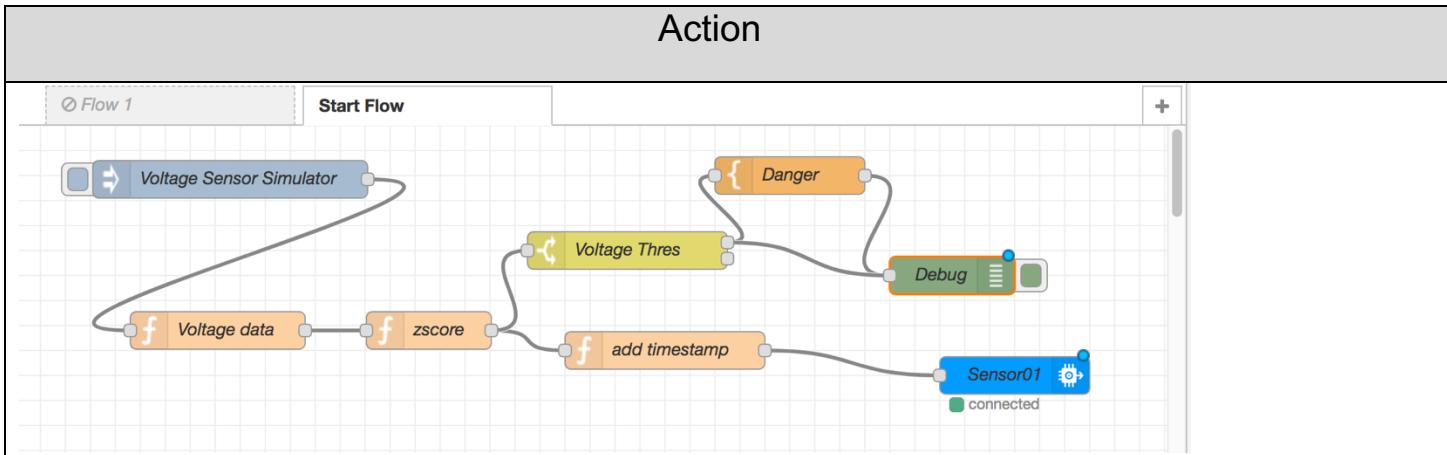
**node properties**

Authentication	Bluemix Service
Output Type	Device Event
Device Type	VoltageSensor
Device Id	Sensor01
Event Type	status
Format	json
Data	msg.payload
QoS	0
Name	Sensor01

**Note:** If there is a property in the message that corresponds to any of the values entered above, then the property in the message takes precedence. See the Info tab for more details.

> **node settings**

n. Your Node-RED Flow should look like the following:



- o. Double click the **Voltage Sensor Simulator** node. Change the repeat value to “**interval, every 1 second**”. Click **Done**

### Edit inject node

**Delete** **Cancel** **Done**

**node properties**

**Payload**: `{ "d": { "voltage": 240, "frequency": 50 } }`

**Topic**: (empty)

Inject once after `0.1` seconds, then

**Repeat**: `interval`

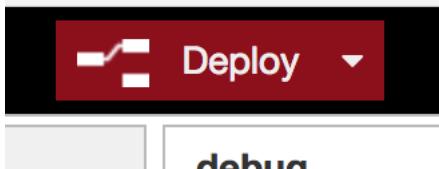
every `1` seconds

**Name**: `Voltage Sensor Simulator`

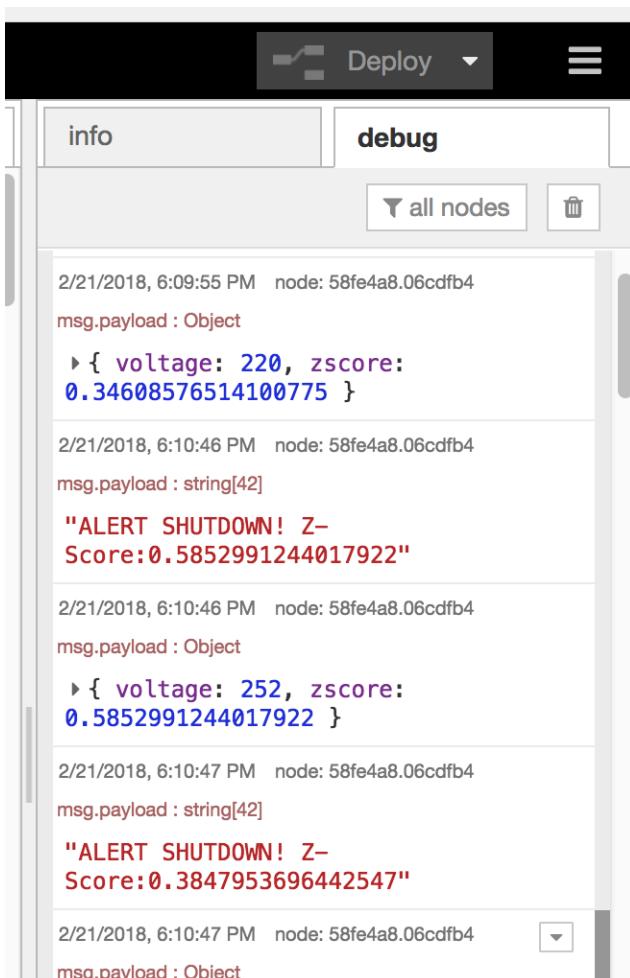
**Note:** "interval between times" and "at a specific time" will use cron.  
 "interval" should be less than 596 hours.  
 See info box for details.

## Action

- p. In the upper right corner, click **Deploy** button



- q. After about 30 seconds, you will start seeing voltage values and alerts appear within the Debug Window. If the zscore is above 0.3, an alert will appear. The 30 second delay is because the 1<sup>st</sup> 30 events are being used to create the sliding window for the z-score calculation.



```

info          debug
all nodes    delete

2/21/2018, 6:09:55 PM node: 58fe4a8.06cdfb4
msg.payload : Object
  ▶ { voltage: 220, zscore:
  0.34608576514100775 }

2/21/2018, 6:10:46 PM node: 58fe4a8.06cdfb4
msg.payload : string[42]
"ALERT SHUTDOWN! Z-
Score:0.5852991244017922"

2/21/2018, 6:10:46 PM node: 58fe4a8.06cdfb4
msg.payload : Object
  ▶ { voltage: 252, zscore:
  0.5852991244017922 }

2/21/2018, 6:10:47 PM node: 58fe4a8.06cdfb4
msg.payload : string[42]
"ALERT SHUTDOWN! Z-
Score:0.3847953696442547"

2/21/2018, 6:10:47 PM node: 58fe4a8.06cdfb4
msg.payload : Object
  
```

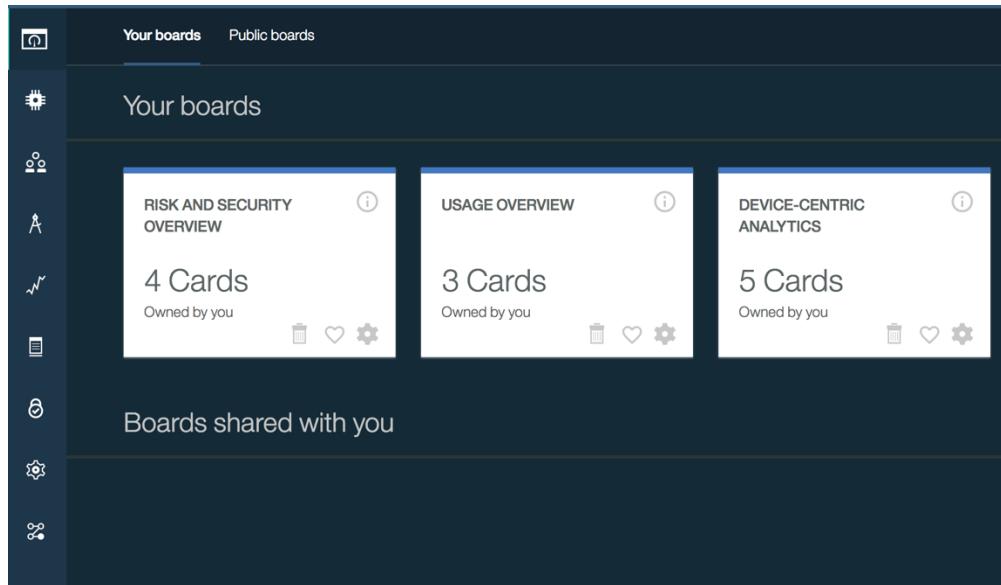
Congratulations! Your node-RED Flow is complete!

## Action

### **6. View Real-time Device Data in IoT Platform**

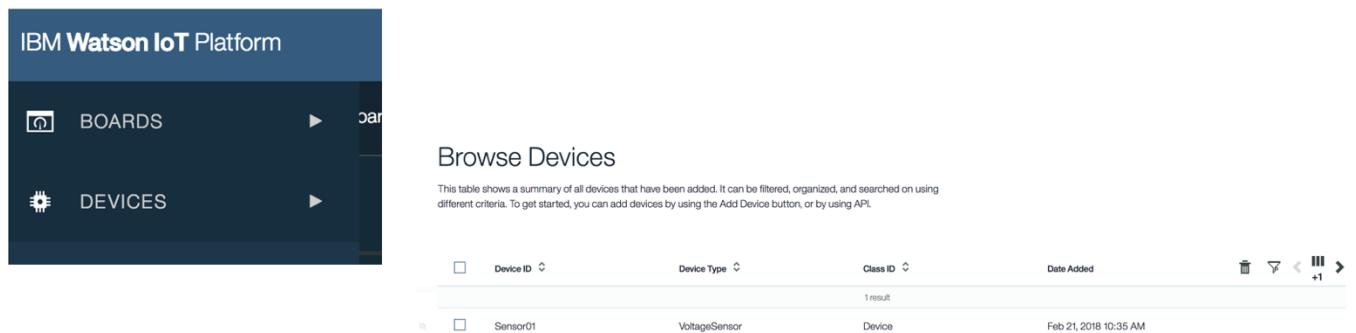
Next we need to validate that the voltage sensor data is being received within the IoT Platform.

- Go back to your IoT Platform Service



The screenshot shows the 'Your boards' section of the IBM Watson IoT Platform. It includes three cards: 'RISK AND SECURITY OVERVIEW' (4 Cards, Owned by you), 'USAGE OVERVIEW' (3 Cards, Owned by you), and 'DEVICE-CENTRIC ANALYTICS' (5 Cards, Owned by you). Each card has a trash, heart, and gear icon below it.

- Select the **device tab** from the left-hand menu. You will be taken to **the Browse Devices** list



The screenshot shows the 'Browse Devices' list in the IBM Watson IoT Platform. The table header includes columns for Device ID, Device Type, Class ID, and Date Added. There is one result listed: Sensor01, VoltageSensor, Device, Feb 21, 2018 10:35 AM. The left sidebar shows 'BOARDS' and 'DEVICES' options.

Device ID	Device Type	Class ID	Date Added
Sensor01	VoltageSensor	Device	Feb 21, 2018 10:35 AM

- Click **Sensor01** to see additional information about the device. Click the **Recent Events** tab. You should see the real-time sensor events coming in.

## Action

Sensor01      VoltageSensor      Device      Feb 21, 2018 10:35 AM

Identity    Device Information    **Recent Events**    State    Logs         X

 Showing Raw Data | The recent events listed show the live stream of data that is coming and going from this device.

Event	Value	Format	Last Received
voltage	{"voltage":220,"zscore":null,"time":1519257...	json	a few seconds ago
voltage	{"voltage":237,"zscore":null,"time":15192576...	json	a few seconds ago
voltage	{"voltage":230,"zscore":null,"time":1519257...	json	a few seconds ago
voltage	{"voltage":227,"zscore":null,"time":15192576...	json	a few seconds ago



Congratulations! You have successfully created an edge node-RED flow that simulates a washing machine voltage sensor. You detected event anomalies using Z-score and if an anomaly occurred ( $Z\text{-score} > 0.3$ ) an alert/command was sent to the device. You also registered the device within the IBM Watson IoT Platform and sent all device events to the Platform for further analysis.

## End of Lesson 3

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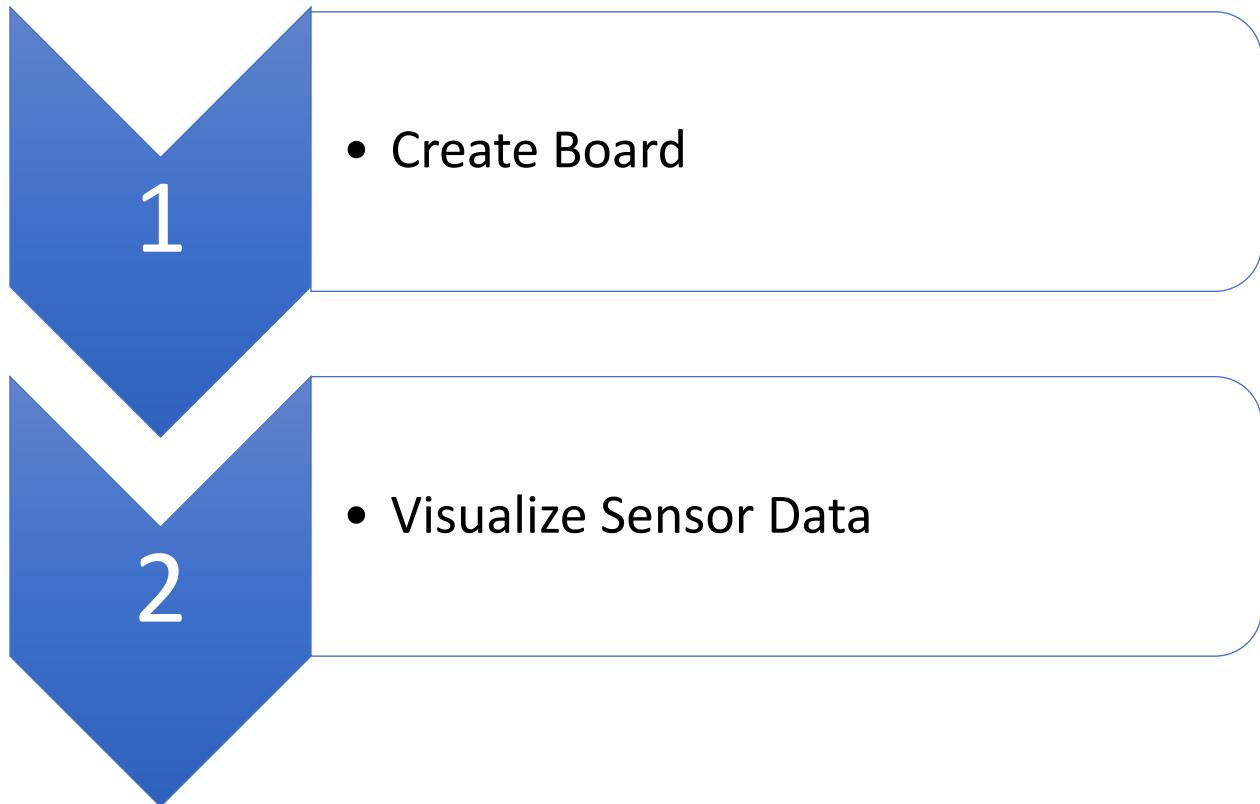
42



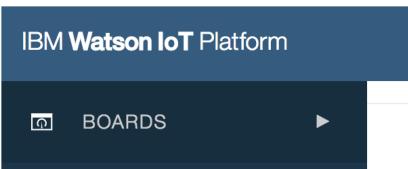
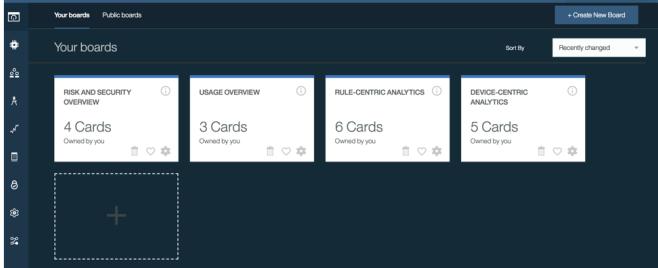
## Lesson 4: Visualizing Data in the IoT Platform

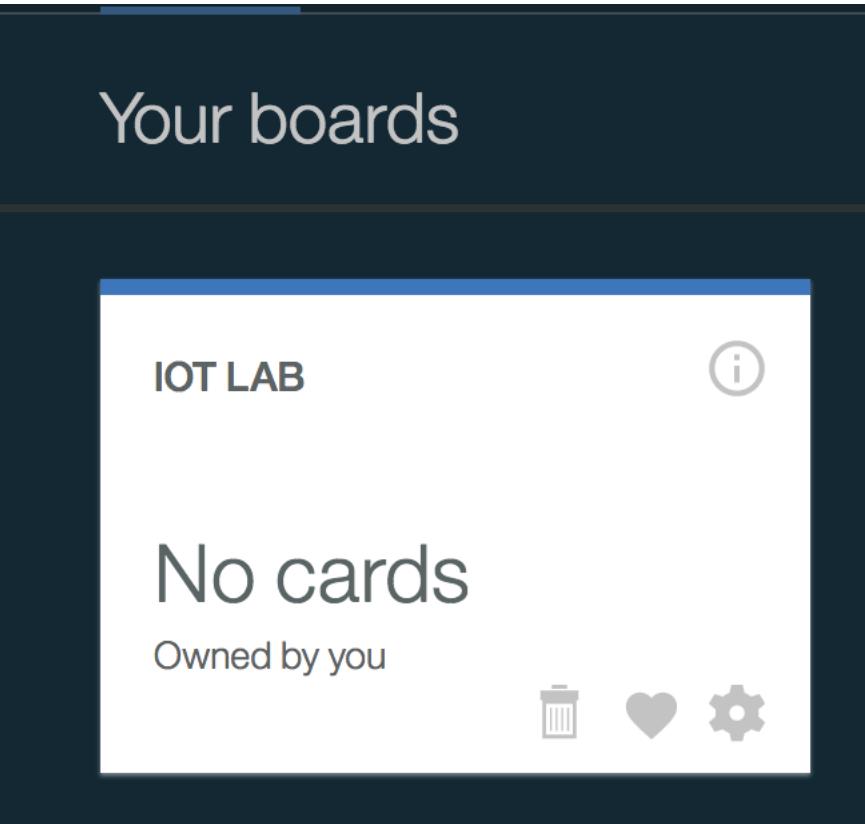
Purpose:	This lesson introduces boards within the IBM IoT Platform which are used to visualize data.
Tasks:	<p>Tasks you will complete in this lab exercise include:</p> <ul style="list-style-type: none"><li>• Create Board</li><li>• Visualize sensor data</li></ul>

## Lesson 4: Workflow Overview



## Lesson 4: Instructions

Action
<p><b>1. Create Board</b></p> <p>a. In the Watson IoT Platform Dashboard, select <b>Boards</b> from the menu pane. You will be taken to Your Boards.</p>   <p>b. Click <b>Create New Board</b>, from the upper right corner. Input the following information. Click <b>Next</b>.</p> <p style="text-align: center;">✖</p> <p>Board settings</p> <p>Provide a name and description for your new board.</p> <hr/> <p>Board name</p> <p>IoT Lab</p> <hr/> <p>Description</p> <hr/> <p> <input checked="" type="checkbox"/> Make this board my landing page.  <input checked="" type="checkbox"/> Favorite (this also adds this board to your navbar)     </p>

Action
<p>c. Keep the default Board Setting user privileges. Click <b>Submit</b>.</p> <p>d. Your board should now appear under <b>Your Boards</b>.</p>  <p>The screenshot shows the 'Your boards' section of the IBM Cloud interface. At the top, it says 'Your boards'. Below that, there is a card for a board named 'IOT LAB'. The card displays the text 'No cards' and 'Owned by you'. At the bottom of the card are three icons: a trash can, a heart, and a gear.</p>

Action
<p>&lt; IoT Lab</p> <p></p> <p>You currently have an empty board Begin by <a href="#">adding a card</a></p>

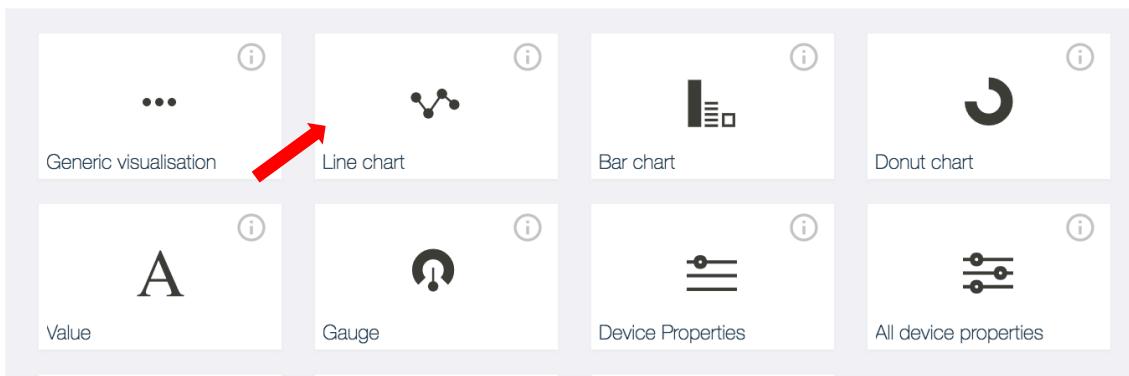
- b. Click **Add New Card** and click **Line Chart**

## Create Card

### Card type

Select card type

### Devices



- c. Select **Sensor01** as the Device ID. Click **Next**

- d. Click **Connect new data set** and input the following properties:

## Action

Card source data  
Sensor01

Card preview

Card information

Create Line chart Card

Connect data set

voltage

Event

voltage

Property

voltage

Name

voltage

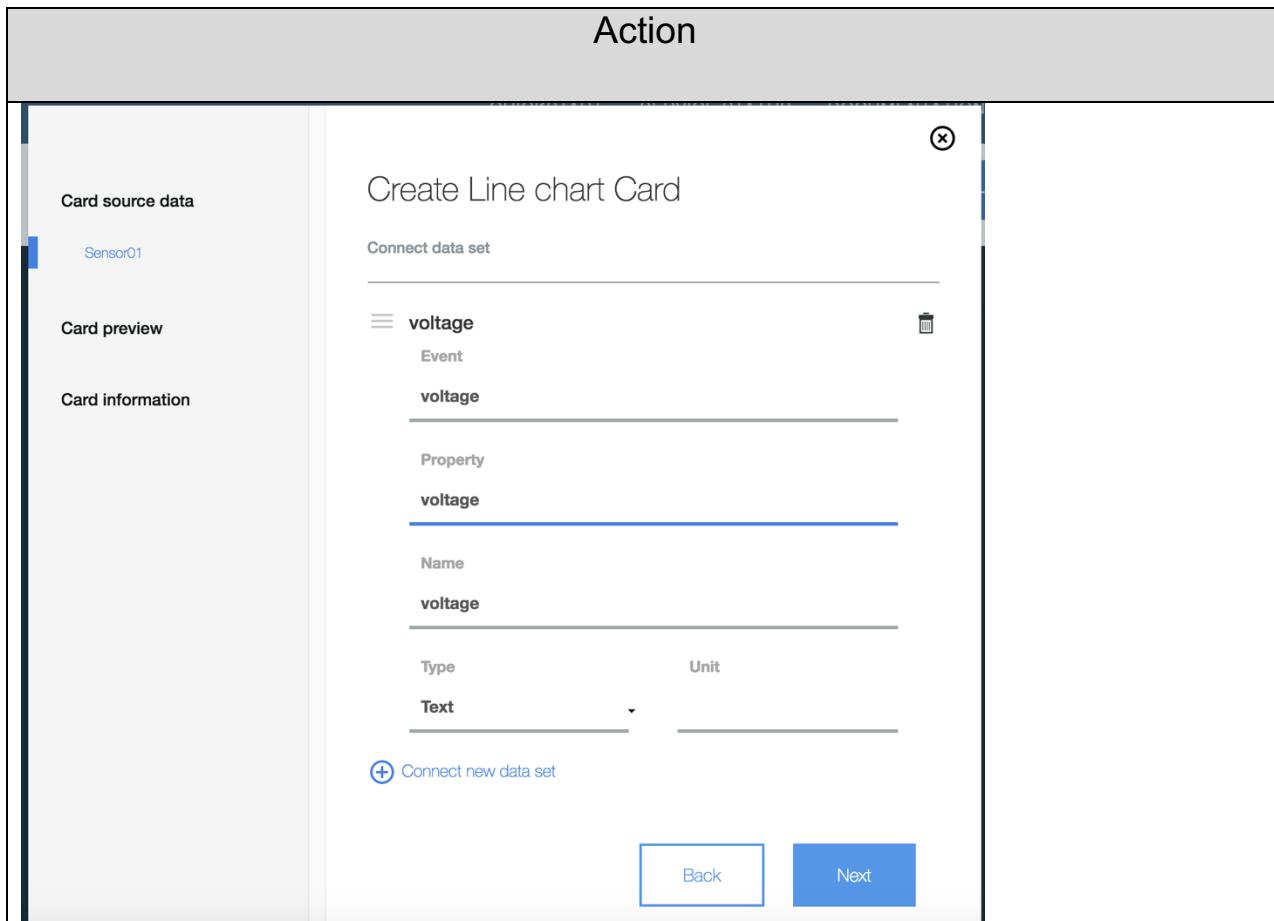
Type

Text

Unit

+ Connect new data set

Back Next



e. Select **L** as settings. Click **Next**

Create Line chart Card

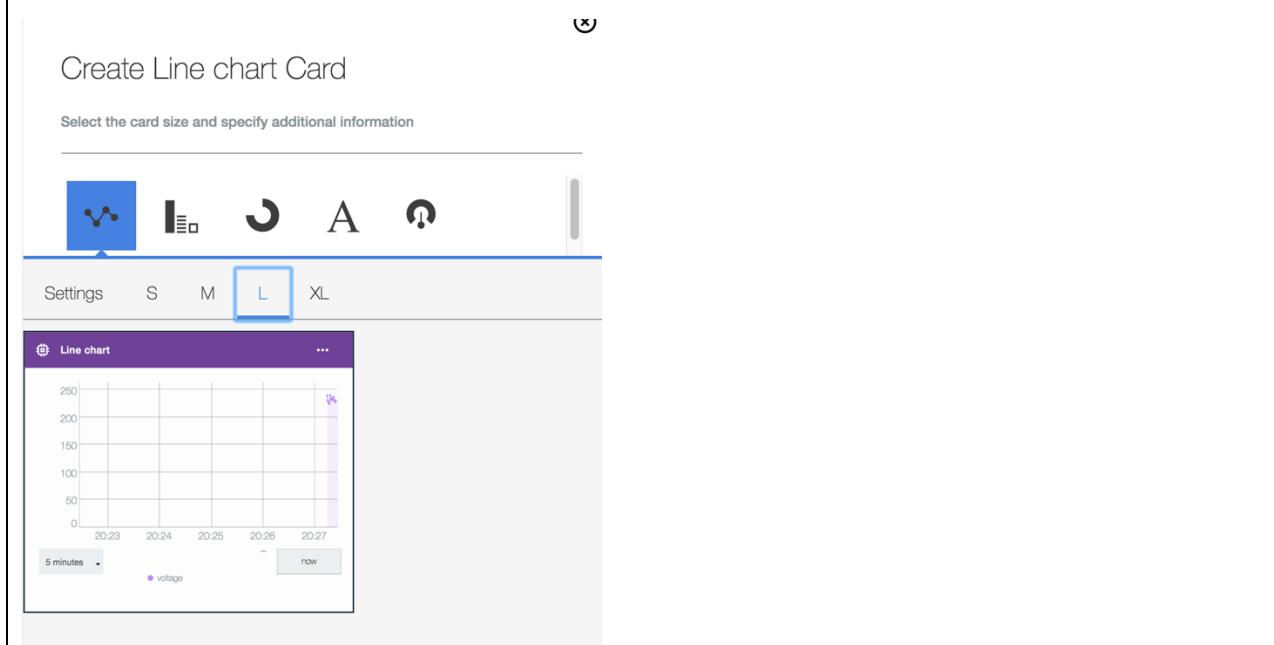
Select the card size and specify additional information

Line chart

5 minutes now

voltage

Back Next

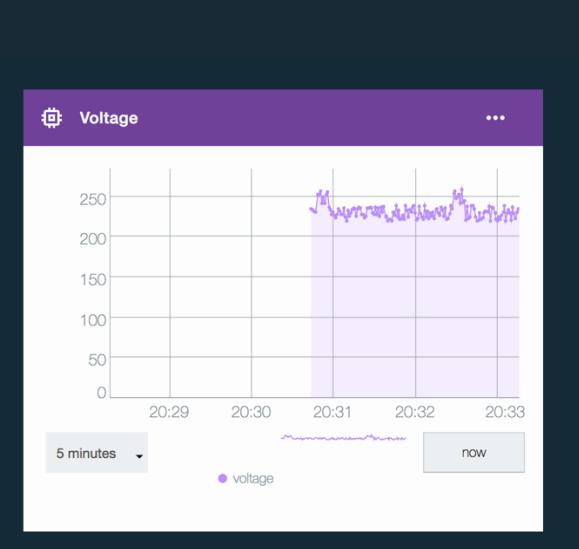


Action
f. Name the chart <b>Voltage</b> . Click <b>Submit</b> .
<hr/>
<b>Title</b>
<b>Voltage</b>
<hr/>
<b>Color scheme</b>

A line chart to display time series information with historic and live data
g. You should now see your voltage values displayed in Real-time.

**Action**

**IoT Lab**



h. We will now visualize our z-score data. Click **Add New Card**

i. Select **Value** for card type and select **Sensor01**. Click **Next**

Devices

Generic visualisation
Line chart
Bar chart
Donut chart

  
**Value**

  
**Gauge**

  
**Device Properties**

  
**All device properties**

j. Select **Connect new data set** and input the following properties. Click **Next**

**Action**

✖

Create Value Card

Connect data set

---

☰ **zscore** 

Event

voltage

---

Property

**zscore**

---

Name

**zscore**

---

Type  Unit

Text 

 Connect new data set

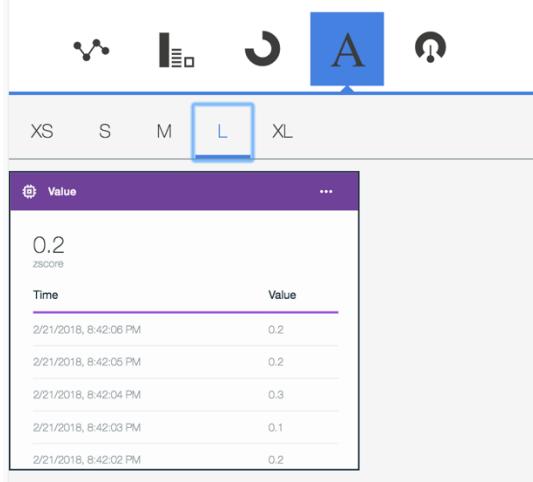
[Back](#) [Next](#)

k. Select **L**. Click **Next**

## Action

### Create Value Card

Select the card size and specify additional information



The screenshot shows the 'Create Value Card' interface. At the top, there are five icons: a wavy line, a bar chart, a circular arrow, a blue square with 'A', and a gear. Below these are size options: XS, S, M, L (which is highlighted with a blue box), and XL. A preview window shows a card titled 'Value' with a zscore of 0.2. The card displays a table of data points over time:

Time	Value
2/21/2018, 8:42:06 PM	0.2
2/21/2018, 8:42:05 PM	0.2
2/21/2018, 8:42:04 PM	0.3
2/21/2018, 8:42:03 PM	0.1
2/21/2018, 8:42:02 PM	0.2

- I. Name the card, **ZScore**. Click **Submit**

### Create Value Card

Enter title and description of the card

Title

**ZScore**

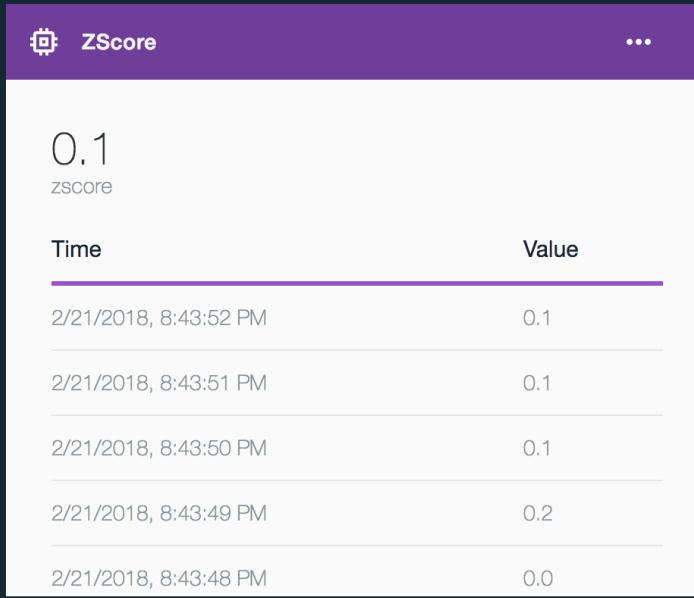
Color scheme



Display the value of one or more data points as text, table or chart

- m. You should now see your zscore values displayed in Real-time

## Action



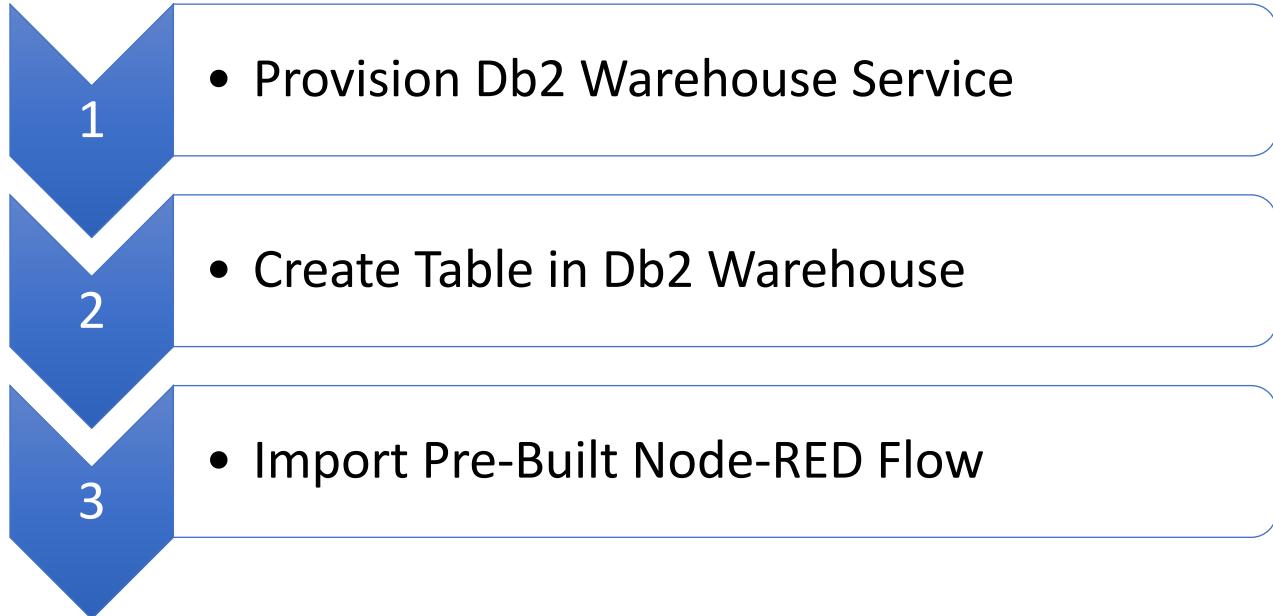
Congratulations! You have successfully visualized your sensor data.

**End of Lesson 4**

## Lesson 5: Persist IoT Data to Db2 Warehouse

Purpose:	This lab introduces how a Node-RED flow developed in IBM Cloud can be used to persist sensor data into Db2 Warehouse House.
Tasks:	<p>The Instructor will demonstrate this section of the lab</p> <ul style="list-style-type: none"><li>• Provision Db2 Warehouse Service</li><li>• Create Table in Db2 Warehouse</li><li>• Import Pre-Built Node-RED Flow</li></ul>

## Lesson 5: Workflow Overview

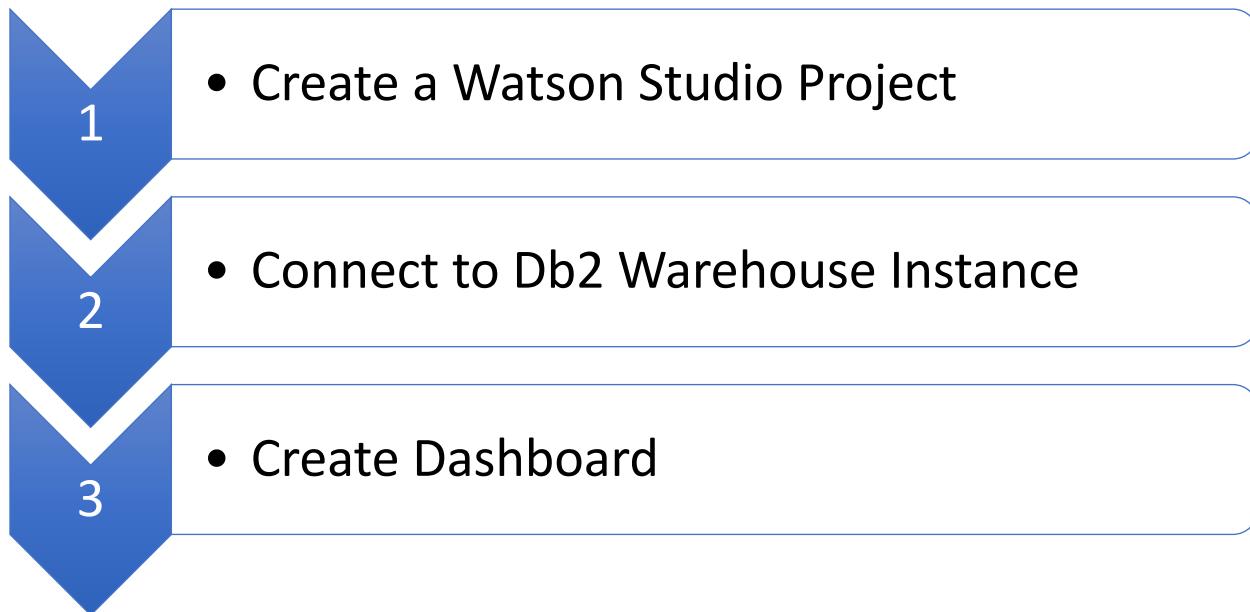




## Lesson 6: Visualize Data in Cognos Embedded Dashboard

Purpose:	This lab introduces how to visualize sensor data using Dashboards within Watson Studio.
Tasks:	<p>Tasks you will complete in this lab exercise include:</p> <ul style="list-style-type: none"><li>• Create a Watson Studio Project</li><li>• Connect to Db2 Warehouse Instance</li><li>• Create Dashboard</li></ul>

## Lesson 6: Workflow Overview

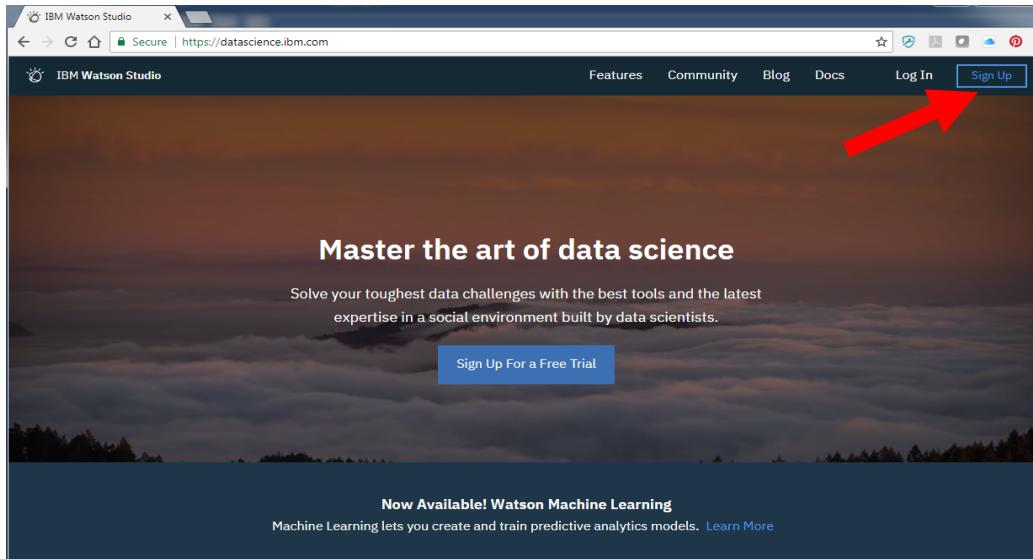


### Lesson 6: Instructions

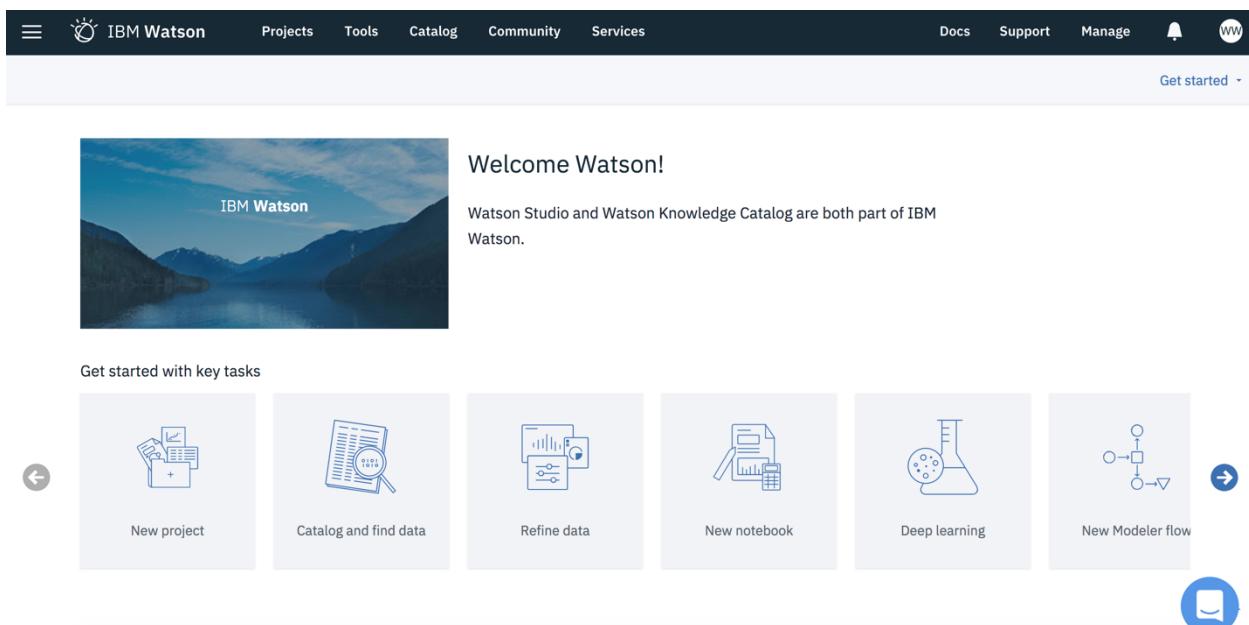
## Action

### 1.Create Watson Studio Project

- Log In to <https://datascience.ibm.com>



- You will be brought to your Home Page



The screenshot shows the IBM Watson Studio home page. At the top, there's a navigation bar with links for Projects, Tools, Catalog, Community, Services, Docs, Support, Manage, and a bell icon. Below the navigation bar is a "Get started" button. The main area features a "Welcome Watson!" message with a background image of a lake and mountains. To the left, there's a section titled "Get started with key tasks" with six cards: "New project", "Catalog and find data", "Refine data", "New notebook", "Deep learning", and "New Modeler flow". On the right side, there's a sidebar with links for "IBM Watson", "Watson Studio", "Watson Knowledge Catalog", "Watson Assistant", "Watson Language", "Watson Visual Recognition", "Watson Tone Analyzer", "Watson Personality Insights", "Watson Discovery", "Watson Data Platform", and "Watson Cloud Pak".

- Click **New Project** and select **Complete**. Click **OK**.

## Action

Get started with key tasks



New project



Catalog and find data

**New project**

Select a project tile to get the right tools and services for your work.  
You can add additional tools later as the needs of your project grow. All projects include data storage.

<b>Basic</b> Want to start simple? Upload data in your project and add tools later.	<b>Data Science</b> Analyze data to discover insights and share your findings with others.	<b>Visual Recognition</b> Tag and classify visual content using the Watson Visual Recognition service.
<b>Deep Learning</b> Build neural networks and deploy deep learning models.	<b>Modeler</b> Build modeler flows to train SPSS and Spark models or design deep neural networks.	<b>Business Analytics</b> Create visual dashboards from your data to gain insights faster.
<b>Data Engineering</b> Combine, cleanse, analyze, and shape data using Data Refinery.	<b>Complete</b>  Want to explore every corner of Watson Studio? See every tool in one project.	

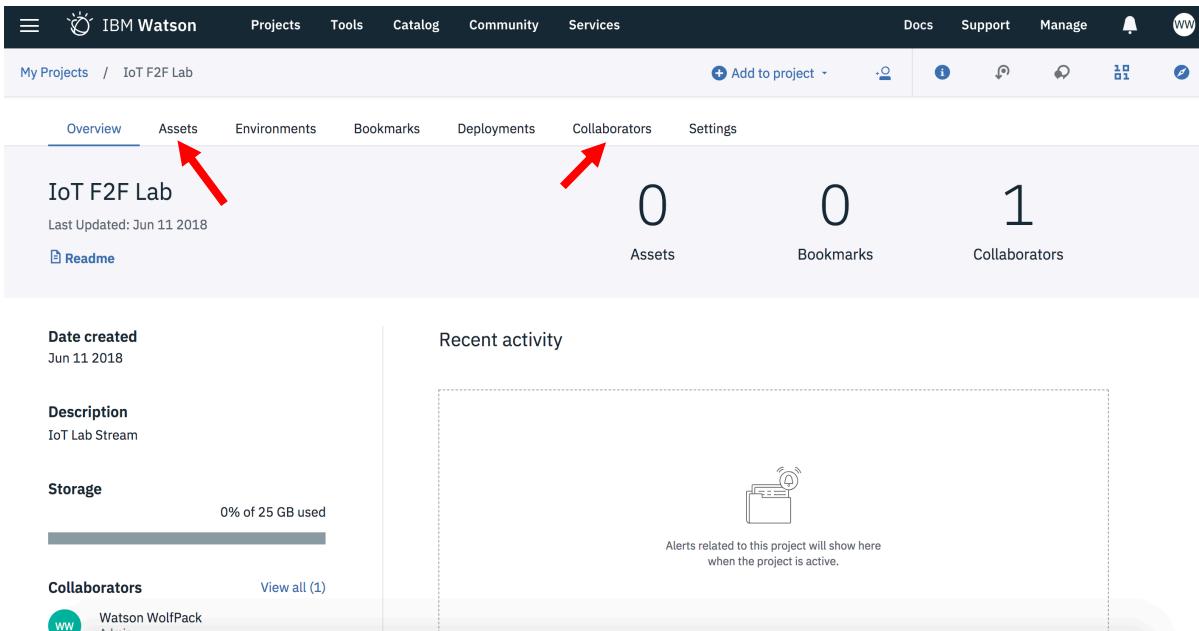
- d. Name the project **IoT F2F Lab** and add a meaningful description

Action
New project
Define project details
Name IoT F2F Lab
89
Description IoT Lab
2993
Choose project options
<input checked="" type="checkbox"/> Restrict who can be a collaborator <a href="#">(i)</a>
Project will include integration with <a href="#">Cloud Object Storage</a> for storing project assets.
Define Storage:
<ul style="list-style-type: none"><li>Under Define Storage, click <b>Add</b></li><li>Choose “Lite” plan then “Create”</li><li>Verify your options then “Confirm”</li><li>Refresh</li></ul>
Storage
cloud-object-storage-rk

## Action

e. Click **Create**

f. You now have a **Project** that is empty. You can use the tabs along the top to **add assets** to your project such as Connections, Notebooks, Data Assets, etc. You can also **add collaborators** to the Project.



IBM Watson Project Overview for IoT F2F Lab:

- Overview** (selected)
- Assets** (highlighted with a red arrow)
- Environments
- Bookmarks
- Deployments
- Collaborators** (highlighted with a red arrow)
- Settings

**IoT F2F Lab**  
Last Updated: Jun 11 2018  
[Readme](#)

**Recent activity**  
Alerts related to this project will show here when the project is active.

Date created Jun 11 2018	Description IoT Lab Stream
Storage 0% of 25 GB used	Collaborators  Watson WolfPack

## 2. Connect to Db2 Warehouse

a. In the upper right corner select **Add to Project**, then **Connection**

**Action**

+ Add to project ▾

- Connected assets
- Notebook
- Connection** ←
- Data asset
- Model
- Experiment BETA

---

b. Under **IBM Services**, select **Db2 on Cloud**

IBM services

<a href="#"> BigInsights HDFS</a> <a href="#"> Compose for MySQL</a> <a href="#"> Db2 for z/OS</a> <a href="#"> Informix</a> <a href="#"> Watson Analytics</a>	<a href="#"> Cloud Object Storage</a> <a href="#"> Compose for PostgreSQL</a> <a href="#"> Db2 Hosted</a> <a href="#"> Object Storage OpenStack Swift</a>	<a href="#"> Cloud Object Storage (infrastructure)</a> <a href="#"> Db2</a> <a href="#"> Object Storage OpenStack Swift (infrastructure)</a>	<a href="#"> Cloudant</a> <a href="#"> Db2 for i</a> <a href="#"> Db2 Warehouse</a> <a href="#"> PureData for Analytics</a>
--	---	--	---

c. Name the connection "**IoT DB2 Warehouse**" and enter the following connection details:

```
{
  "hostname": "dashdb-entry-yp-dal10-01.services.dal.bluemix.net",
  "password": "m9f1_nUM_LsU",
  "db": "BLUDB",
  "username": "dash5391",
}
```

## Action

**(+) New connection (IoT DB2 Warehouse - Db2 on Cloud)**

**Connection overview**

Name  
IoT DB2 Warehouse

Description  
IBM Db2 fully-managed cloud SQL database

2960

**Connection details**

Hostname or IP Address *	dashdb-entry-yp-dal10-01.services.dal.bluemix.net	Username *	dash5391
Database *	BLUDB	Password *	*****

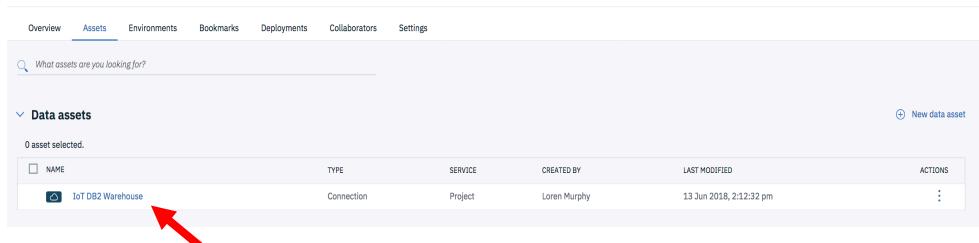
Secure Gateway  Use a secure gateway

Connection discovery  Discover data assets

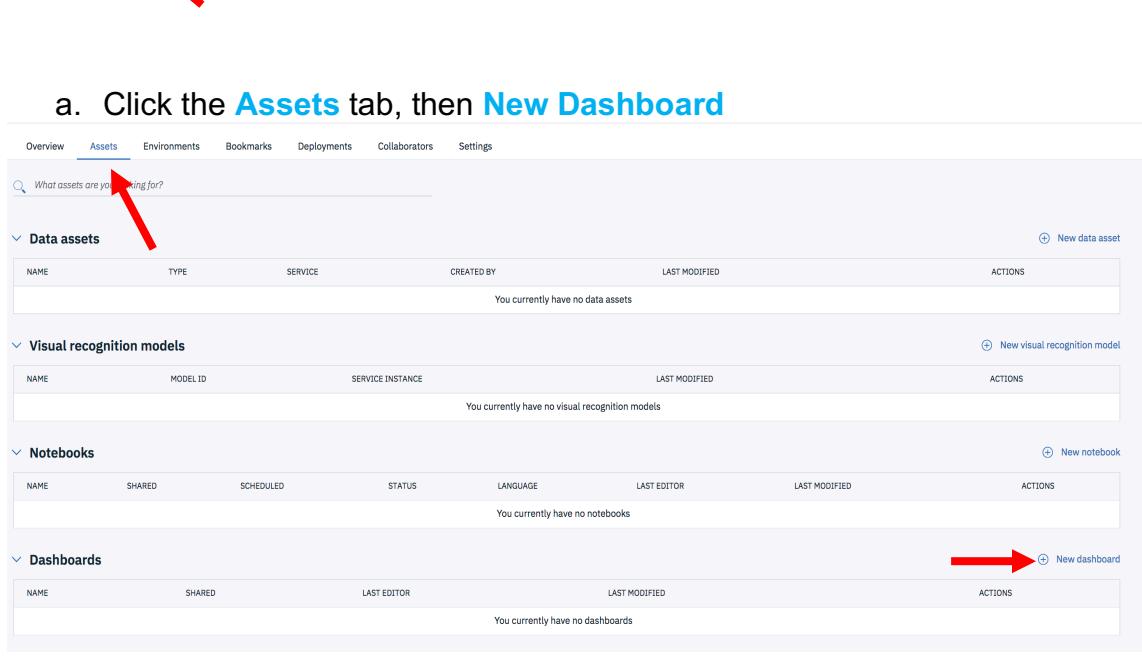
1/5 Connections with discovery [Learn more](#)

**d. Click Create**

**e. The connection now appears under Data Assets**

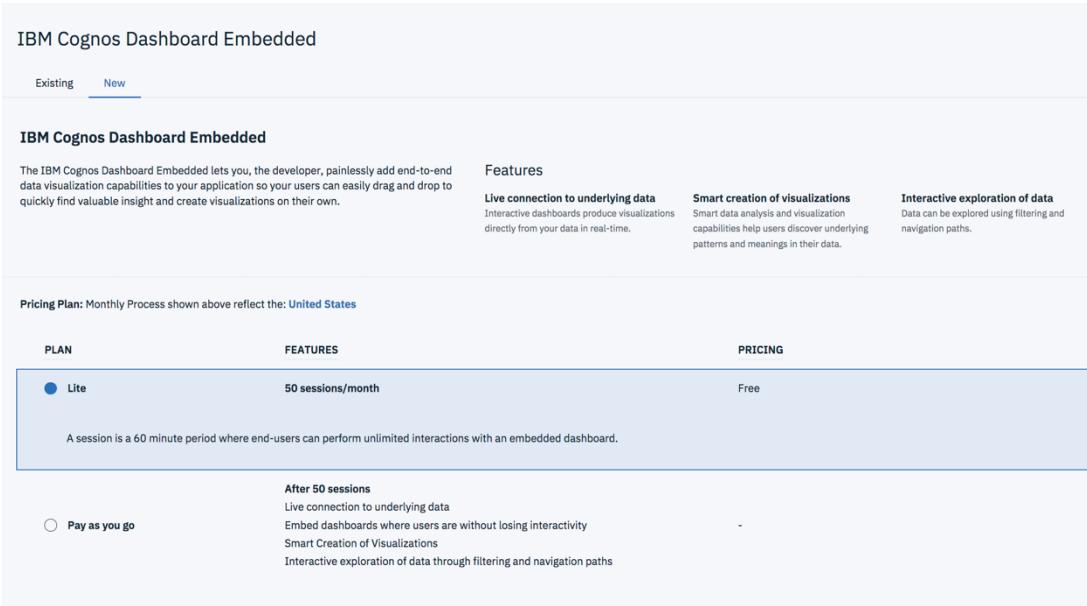
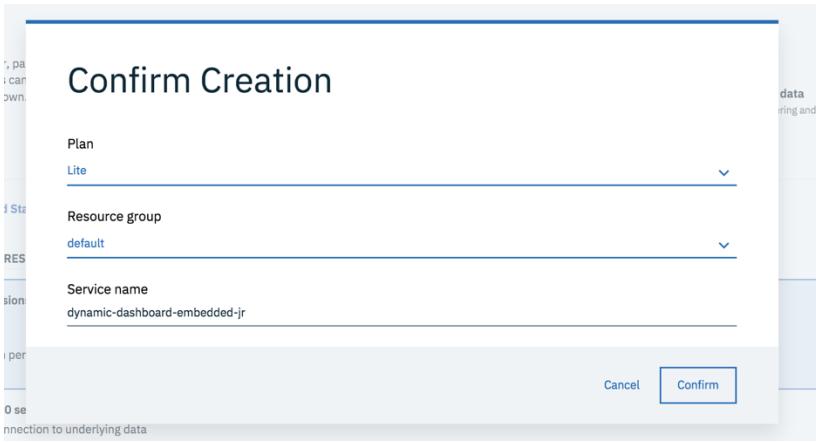


**a. Click the Assets tab, then New Dashboard**



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Action
<p>b. Click <b>Associate a Cognos Dashboard Embedded Service instance</b>. You will be taken to a page to provision the service</p> 
<p>c. Select the <b>Lite</b> Plan. Click <b>Create</b></p>
<p>d. Keep the default values and select <b>Confirm</b></p> 

## Action

- e. Click **Reload** on your **Embedded Service** will appear. Click **Save**

## New Dashboard

[Blank](#)   [From file](#)**Name\***

IoT Dashboard

87

**Description**

Type your description here

300

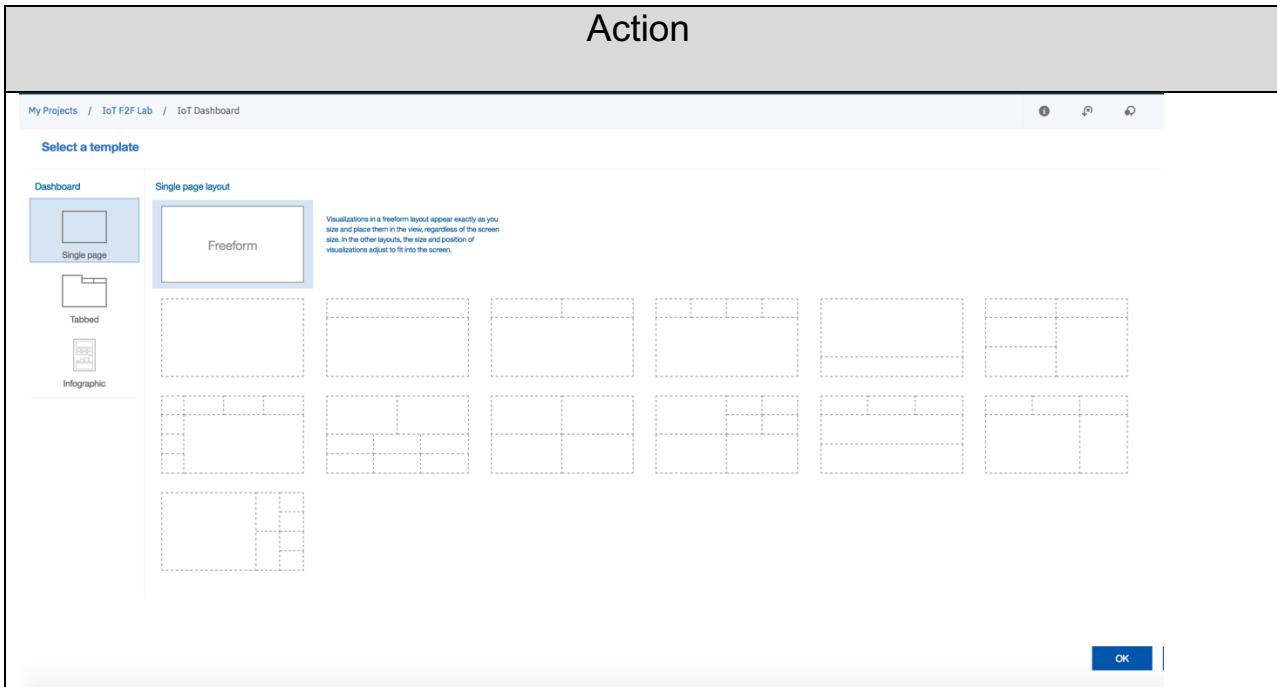
**Cognos Dashboard Embedded Service**

dynamic-dashboard-embedded-jr

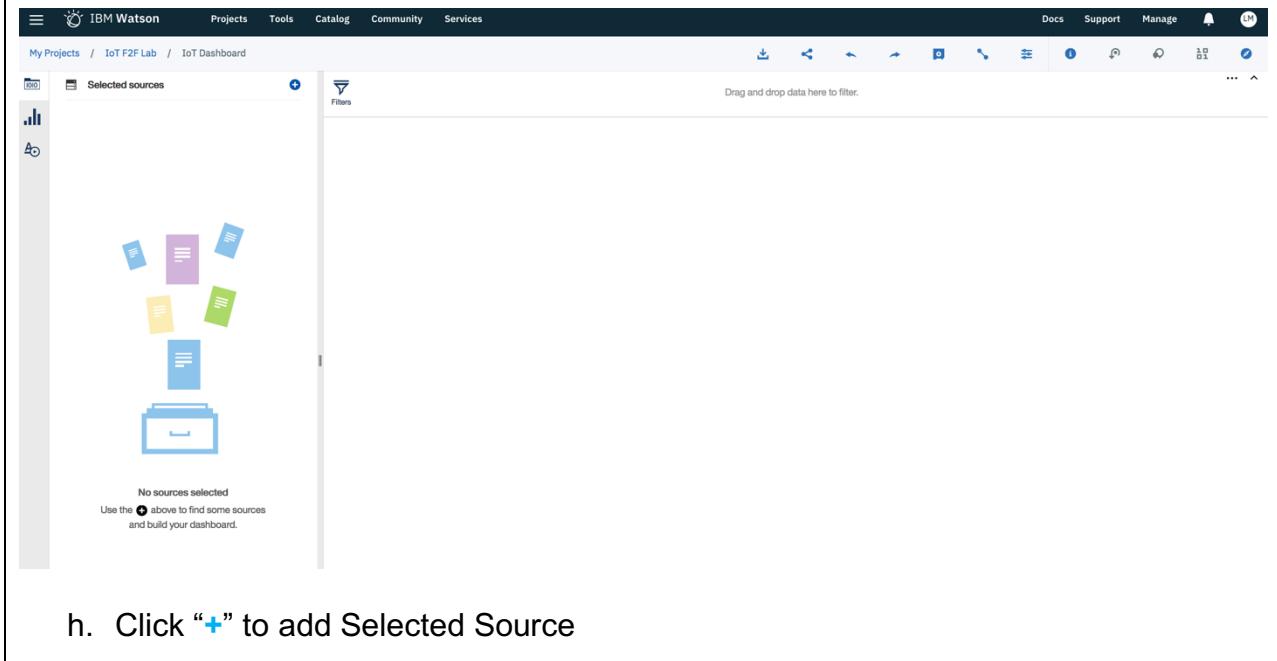


- f. On the **Select a Template** page, select **Single Page** dashboard and **Freeform**. Click **OK**

## Action



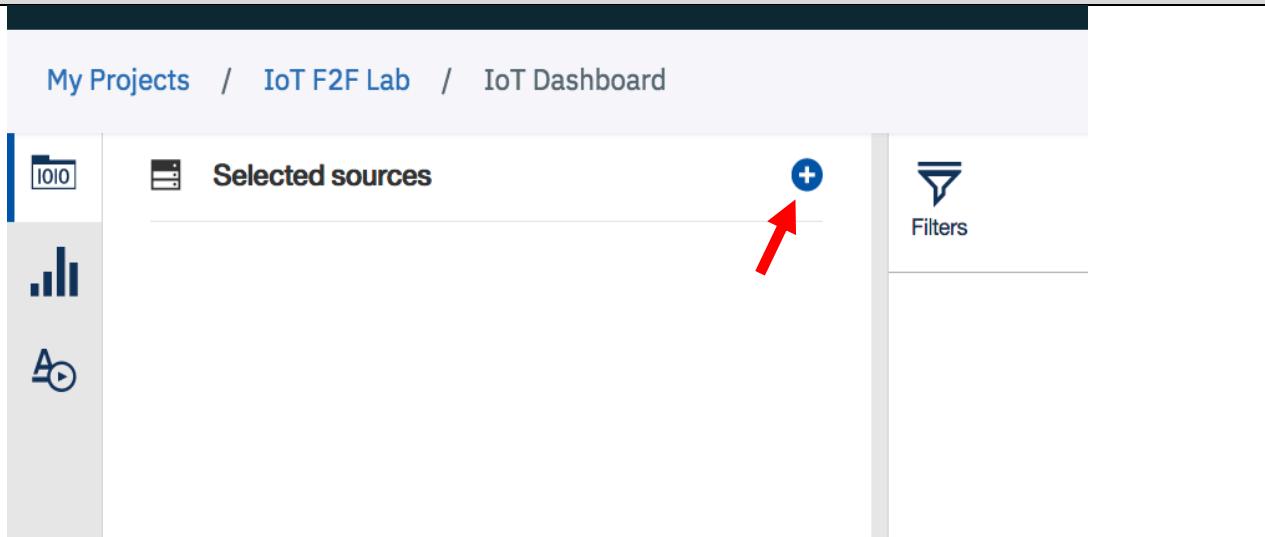
g. You will be taken to the [homepage](#)



h. Click “+” to add Selected Source

Action

My Projects / IoT F2F Lab / IoT Dashboard



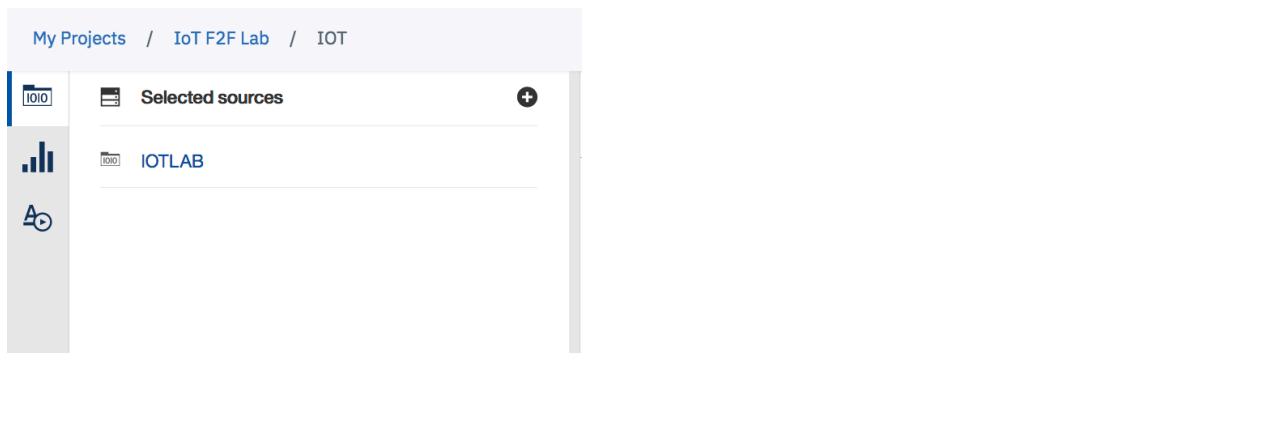
- i. Click **Connections**. Select **DASH5391** as the DB2 Warehouse and **IOTLAB** as the Table. Click **Select**

Select connection source

IoT F2F Lab	IoT DB2 Warehouse	DASH5391
Data assets	Schemas (34)	Tables (1)
IoT DB2 Warehouse >	DASH5391 >	IOTLAB <
	DB2GSE >	
	DB2INST1 >	
	DSJOBMGR >	
	DSSCHED >	
	DSSHV1 >	

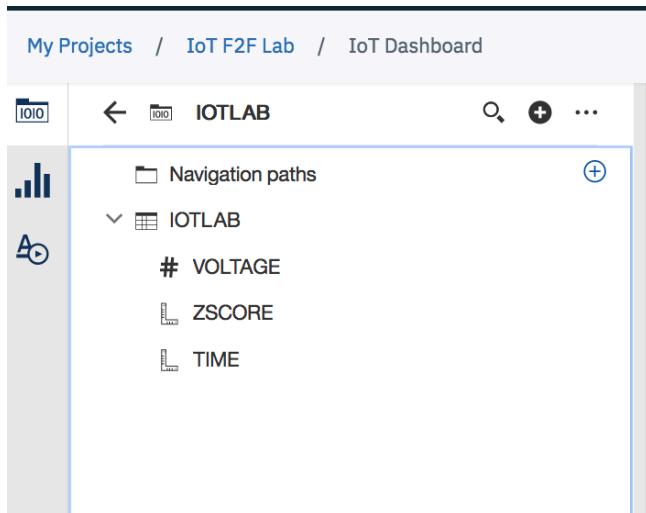
- j. The **IOTLAB** table now appears under Selected source .

My Projects / IoT F2F Lab / IOT



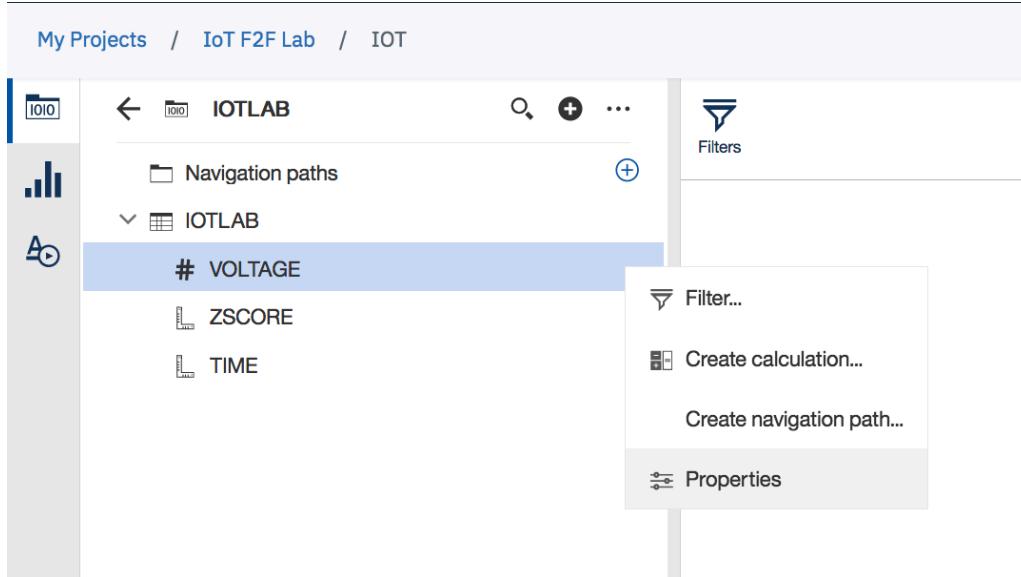
## Action

- k. Click **IOTLAB**, and select the dropdown beside IOTLAB. You should now see the columns within the table.



The screenshot shows the 'My Projects' section with 'IoT F2F Lab' selected. Under 'IoT F2F Lab', 'IOTLAB' is expanded, revealing three items: '# VOLTAGE', 'ZSCORE', and 'TIME'. On the left sidebar, there are icons for 'IOT' (blue bar), 'Metrics' (bar chart), and 'Actions' (refresh/circular arrow).

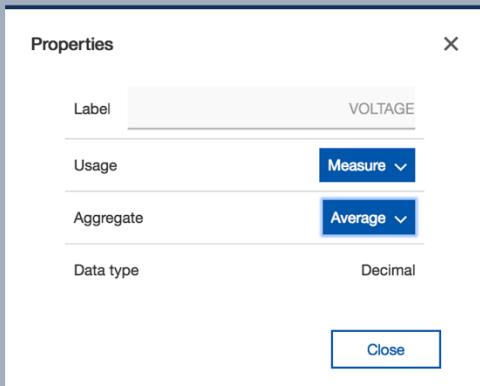
- l. Hover over **Voltage** and click the 3 buttons that appear. Select **Properties**



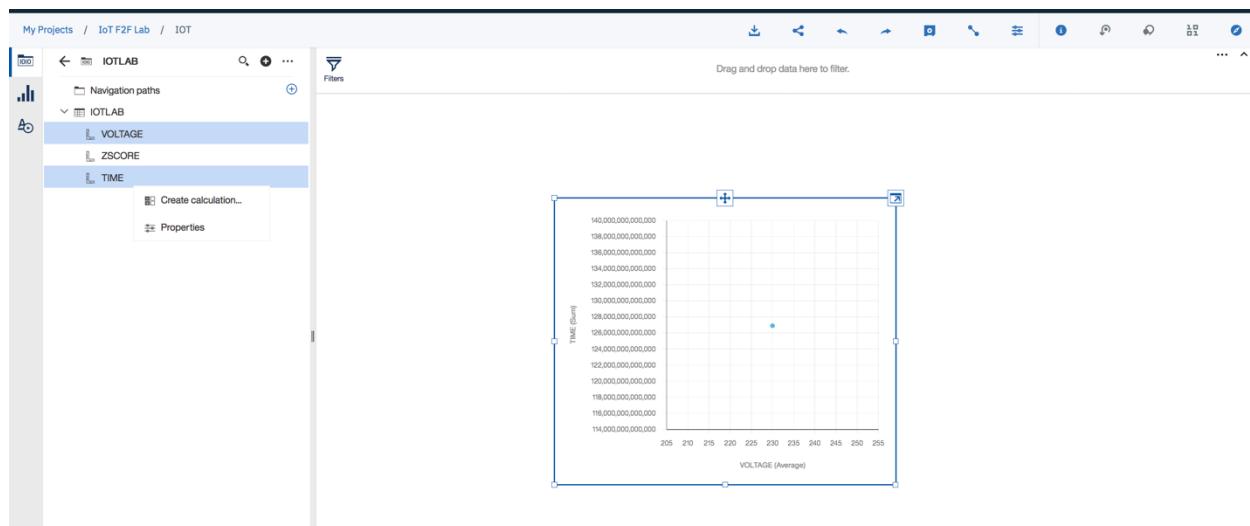
The screenshot shows the same interface as above, but the '# VOLTAGE' item under 'IOTLAB' is highlighted with a blue selection bar. A context menu is open next to it, listing four options: 'Filter...', 'Create calculation...', 'Create navigation path...', and 'Properties'. The 'Properties' option is highlighted with a grey selection bar.

- m. Change the properties to the following:

## Action

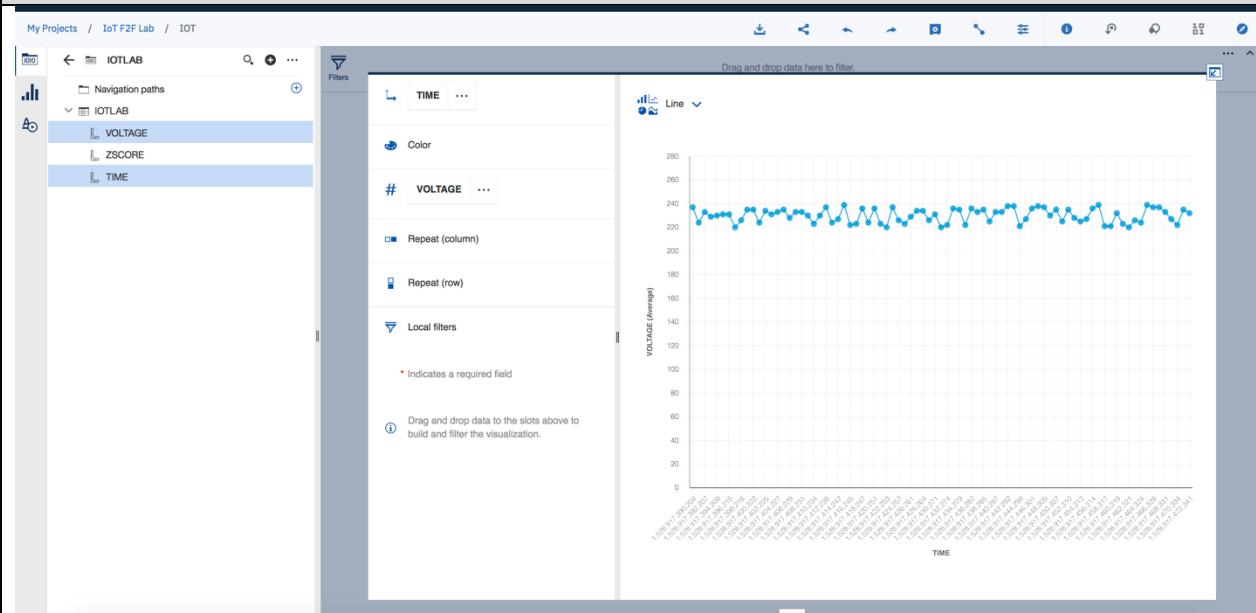


- n. Select Voltage and Time and drag them onto the screen. You should see the following:

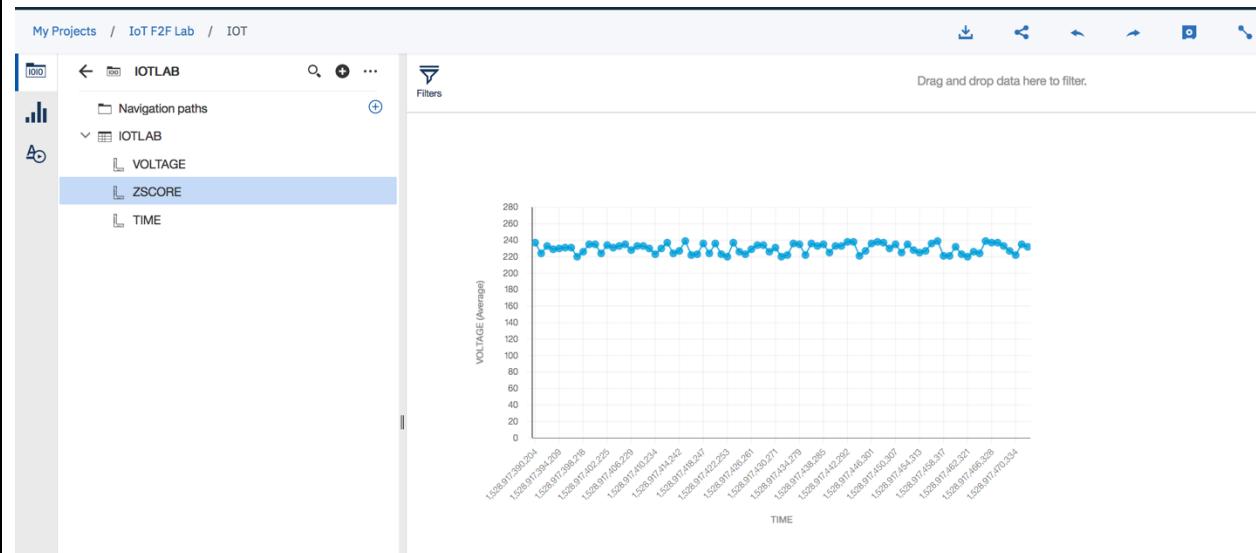


- o. Expand the graph and change the properties to the following. Be sure **Line graph** is selected.

## Action



p. Minimize the graph. You should now see the line graph.



Congrats you have just visualized your IoT data!

**End of Hands-on Workshop!**



Action