****

**IBM Cloud**

**Detecting Anomalous IoT Behaviors**

**with Predictive Analytics**

Watson Data Platform

**Lab Guide**

Notices and Disclaimers

© Copyright IBM Corporation 2018.

The information contained in these materials is provided for informational purposes only, and is provided AS IS without warranty of any kind, express or implied. IBM shall not be responsible for any damages arising out of the use of, or otherwise related to, these materials. Nothing contained in these materials is intended to, nor shall have the effect of, creating any warranties or representations from IBM or its suppliers or licensors, or altering the terms and conditions of the applicable license agreement governing the use of IBM software. References in these materials to IBM products, programs, or services do not imply that they will be available in all countries in which IBM operates. This information is based on current IBM product plans and strategy, which are subject to change by IBM without notice. Product release dates and/or capabilities referenced in these materials may change at any time at IBM’s sole discretion based on market opportunities or other factors, and are not intended to be a commitment to future product or feature availability in any way.

This document is current as of the initial date of publication and may be changed by IBM at any time. Not all offerings are available in every country in which IBM operates.

IBM, the IBM logo and ibm.com are trademarks or registered trademarks of International Business Machines Corporation in the United States, other countries, or both. If these and other IBM trademarked terms are marked on their first occurrence in this information with a trademark symbol (® or ™), these symbols indicate U.S. registered or common law trademarks owned by IBM at the time this information was published. Such trademarks may also be registered or common law trademarks in other countries. A current list of IBM trademarks is available on the Web at “Copyright and trademark information” at ibm.com/legal/copytrade.shtml

Other company, product and service names may be trademarks or service marks of others

**Document Revision History**

|  |  |  |
| --- | --- | --- |
| Rev # | File Name | Date |
| 1.0 | Detecting Anomalous IoT Behaviors with Predictive Analytics.docx | 2/20/2018 |
| 2.0 | Detecting Anomalous IoT Behaviors with Predictive Analytics.docx | 7/17/2018 |
| 3.0 | Detecting Anomalous IoT Behaviors with Predictive Analytics.docx | 8/15/2018 |

**Prepared & Revised by:**

Loren Murphy – [lrmurphy@us.ibm.com](mailto:lrmurphy@us.ibm.com)

David Solomon- [dlsolomo@us.ibm.com](mailto:dlsolomo@us.ibm.com)

**Table of Contents**

[Lab Environment Overview 5](#_Toc519652670)

[Lesson 1: IBM Cloud Signup 6](#_Toc519652671)

[Lab 1 Workflow Overview 7](#_Toc519652672)

[Lesson 1 Instructions 8](#_Toc519652673)

[Lesson 2: IBM Watson Studio Signup 14](#_Toc519652674)

[Lesson 2: Workflow Overview 15](#_Toc519652675)

[Lesson 2: Instructions 16](#_Toc519652676)

[Lesson 3: Detect Anomalies using Z-Score 22](#_Toc519652677)

[Lesson 3: Workflow Overview 23](#_Toc519652678)

[Lesson 3: Instructions 24](#_Toc519652679)

[Lesson 4: Visualizing Data in the IoT Platform 48](#_Toc519652680)

[Lesson 4: Workflow Overview 49](#_Toc519652681)

[Lesson 4: Instructions 50](#_Toc519652682)

[Lesson 5: Persist IoT Data to Db2 Warehouse 60](#_Toc519652683)

[Lesson 5: Workflow Overview 61](#_Toc519652684)

[Lesson 6: Visualize Data in IBM Cognos Dashboard Embedded 71](#_Toc519652685)

[Lesson 6: Workflow Overview 72](#_Toc519652686)

[Lesson 6: Instructions 73](#_Toc519652687)

# Lab Environment Overview

**Software and Tools**

|  |  |
| --- | --- |
| **Software** | **Link** |
| **Watson Studio** | https://datascience.ibm.com/ |
| **GitHub** | https://github.com/team-wolfpack |
| **IBM Cloud** | https://www.ibm.com/cloud/ |

# Lesson 1: IBM Cloud Signup

|  |  |
| --- | --- |
| Purpose: | This lesson introduces the subject of Cloud. After completing the lesson, you should be able to:   * Understand Cloud * Navigate IBM Cloud Platform |
|  |  |
| Tasks: | Tasks you will complete in this exercise include:   * Signing up for IBM Cloud * Navigating the IBM Cloud Platform |

## Lab 1 Workflow Overview

## 

## Lesson 1 Instructions

| Action |
| --- |
| **1.Signing up for IBM Cloud**   1. Go to <https://www.ibm.com/cloud/> 2. We are going to sign up for a free IBM Cloud account.   ­­­   1. Click “Sign up”.      1. Fill in the required boxes. 2. Click “Create Account”. |
| **2.Navigating the IBM Cloud Platform**   1. Log into IBM Cloud at <https://console.bluemix.net/dashboard/apps/> 2. If this is the first time you are using IBM Cloud (formerly Bluemix), an “About your IBMid Account Privacy” window will appear. Select Proceed 3. We are now looking at the IBM Cloud Dashboard. 4. Click on the “Catalog” button found in the upper right hand corner of the screen.  1. The Catalog is a compilation of the services offered on the IBM Cloud.       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 Manage is where you can manager 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 a label (“IBM”, “Third Party”, “Lite”)   1. IBM Cloud supports both IBM products and services, as well as third-party. A “Lite” label indicates that you can provision a free version of the service using your Lite Cloud account.   Going along the same navigation bar as we found the catalog, we can see docs, support and manage.     1. 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.     1. 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.     1. 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.   1. 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.     1. Return to the catalog     **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: | Tasks you will complete in this lab exercise include:   * Provision Watson Studio Service * Engage Live Chat * Differentiate Four Types of Community Cards * Explore Personal Profile, Apps/Services, and Integrations |

## Lesson 2: Workflow Overview

## Lesson 2: Instructions

| Action |
| --- |
| **1. Provision Watson Studio Service**   1. Log into IBM Cloud at <https://console.bluemix.net/dashboard/apps/> 2. Click the “Catalog” button found in the upper right hand corner of the screen.      1. Within the catalog, search for “**Watson Studio**”      1. Click the **Watson Studio** tile 2. Rename the Watson Studio service name or keep the default name. Click **Create** to provision the service. Resource group should be default.      1. Once the service is provisioned, click **Get Started** to open Watson Studio.      1. You should now see the Watson Studio Homepage     **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**    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:   **Integrations** is where you configure Watson Studio for GitHub integration.  **End of Lesson 2** |

# Lesson 3: Detect Anomalies using Z-Score

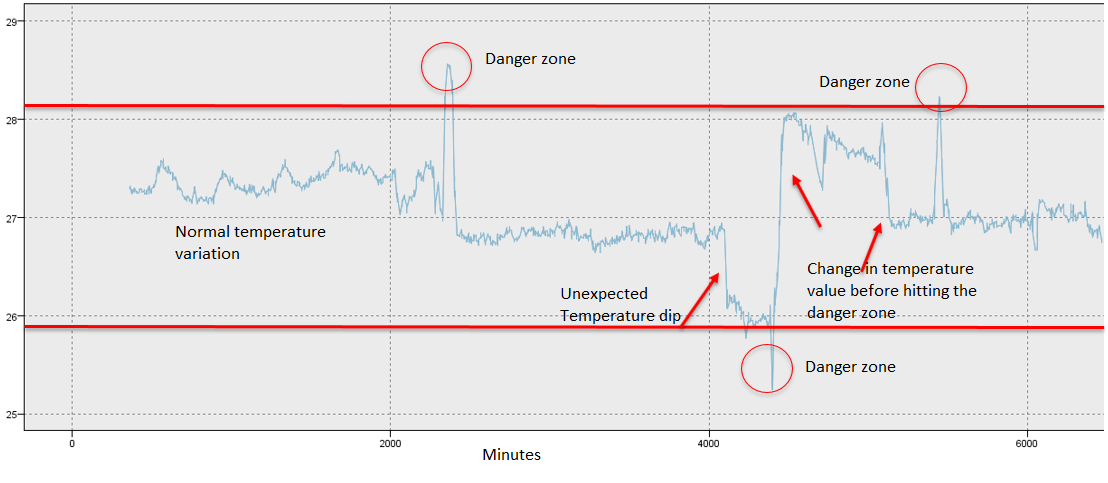
|  |  |
| --- | --- |
| Purpose: | This lesson introduces the Internet of Things (IoT) Platform Service on IBM Cloud, how to create a Node-RED flow to simulate IoT devices, and how to use z-score to detect anomalies on edge devices. |
|  |  |
| Tasks: | Tasks you will complete in this lab exercise include:   * Provision Internet of Things Platform Service on IBM Cloud * Register devices in IoT Platform and view real-time data * Create Node-RED Flow to detect anomalies using z-score |

## 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).

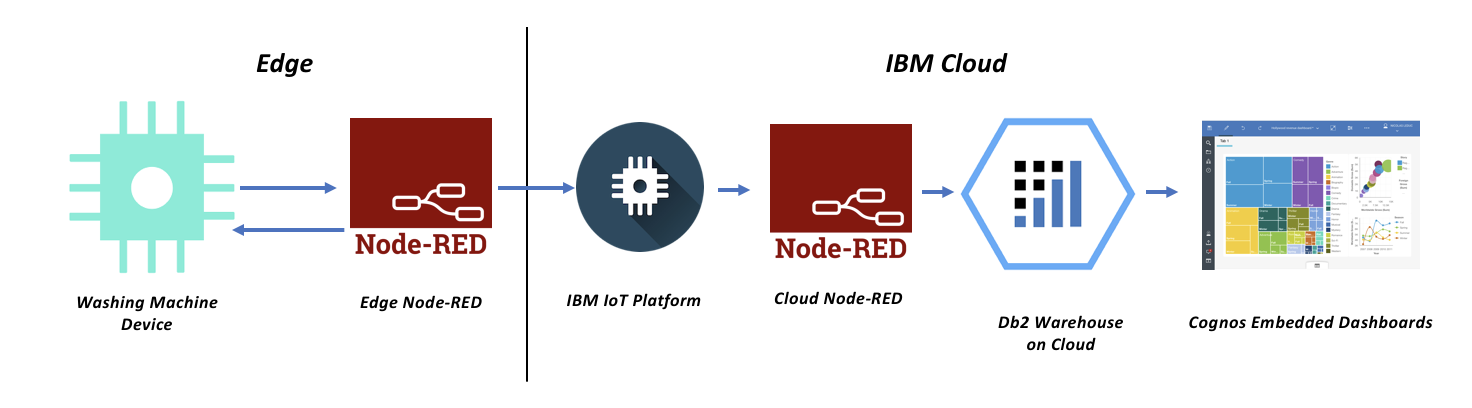
The real benefit of this massive amount of data, produced by IoT, lies in performing a real-time analysis on it so to discover trends and patterns and to use these patterns to predict the failures in a timely manner (as can be seen by the unexpected temperature dip above). One of the mechanisms of performing 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**   1. Log into IBM Cloud at <https://console.bluemix.net/dashboard/apps/> 2. Click the “Catalog” button found in the upper right hand corner of the screen.  1. In the search bar, type **internet of things** and select **Internet of Things Platform.**  1. Keep the default service name and select **Create**  1. Once provisioned, you will see the Internet of Things Platform page.     **3. Register Devices in IoT Platform**   1. Select **Launch** to enter into the IBM Watson IoT Platform organization space  1. You should now see the IBM Watson IoT Platform welcome screen. If you are not automatically logged in, in the upper right corner click **Sign In** and login with your IBM Cloud ID and password  1. Click your **IBM Cloud ID** in the upper right corner and select the **Bluemix Free Ord ID**. 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.  1. You should now see your Browse Devices page.     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. In order to add devices in IBM Watson IoT Platform, you need to create a device type.   1. From the Browse Devices page, select the Device Types tab in the upper left menu  1. 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.   1. For Type, select **Device.** For Name, type **VoltageSensor.** Click **Next.**  1. Leave Device Information blank. Select **Done.** You have successfully added a new device type. Now we need to register Devices of that type.      1. Select **Register Devices.** Device Type should be **VoltageSensor**. For Device ID, type **Sensor01.** Click **Next.**  1. Leave Device Information blank. Select **Next.**  1. Type **VoltSensor** as the authentication token. Select **Next.**      1. Click **Done** to add your device and to receive your device credentials. Be sure to **write down the credentials and save** for later use.  1. Click **Back** in the upper left corner. Your device should now be listed on the “Browse Devices” page.   **4.Provision Node-RED Service**  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.  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.   1. Go to your IBM Cloud account catalog at https://console.bluemix.net/catalog/ 2. Search for **node-red** and select the **Node-Red Starter** service.  1. Give the app a unique name and select **Create**.  1. Your cloud foundry application will now appear on your dashboard. **Click on the application name**.  1. On the left-hand side, select **Connections.** Notice Cloudant NoSQL DB is already connected to the application. The database is created by default when a Node-RED service is provisioned.  1. Select **Create Connection** and **connect your Internet of Things Platform Service**  1. **Restage** your app  1. Once your app is restaged, the **Visit App URL** link will become active.     **5. Create Node-RED Flow to Detect Anomalies using Z-Score**   1. From the cloud foundry application homepage, click **Visit App URL.** This will open the Node-RED sample application.  1. 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)*  1. Click **Finish** to complete the Node-RED configuration.      1. Click **Go to your Node-RED flow editor** to open Node-RED. If you receive an error, restart the application.      1. The Node-RED flow editor will appear. The left panel lists all of the nodes available to build a Node-RED flow. The right panel, displays information about the Flow.      1. Double click the **Flow 1** tab. Change the status of the Flow to **disabled**. Click **Done**  1. The **Flow 1** tab should now have a **disabled icon** beside it   ../../Screen%20Shot%202018-02-27%20at%2011.24.55%20PM.png   1. A starter flow, **IoTNodeRed\_Flows.json**, has been provided to you for the lab. Open the file and copy its contents. 2. Select the **3-bar menu tile** in the upper right corner, select **Import** -> **Clipboard**  1. Paste the contents from the **IoTNodeRed\_Flows.json** file into the clipboard. Select import to **New Flow** and click **Import**   ../../../Desktop/Screen%20Shot%202018-02-21%20at%204.52.01%20PM.   1. Notice two new flows, **Simulator To IoT** and **DB2 Persist** have been imported.     The **Simulator To IoT** 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. * **Voltage Threshold –** Determines if the Z-Score is above a particular threshold. * **Danger –** If Z-Score is above the danger threshold, 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.   1. Double click the **IBM IoT** node and input the following: Once complete, click **Done**      * **Authentication** = Bluemix Service * **Output Type** = Device Event * **Device Type** = VoltageSensor * **Device ID** = Sensor01 * **Event Type=** status * **Format=** json * **Data=** msg.payload * **QoS =** 0 * **Name=** IBM IoT   Note: The Device Type and Device ID should be the same name that was registered within the IoT Platform.  ../../Screen%20Shot%202018-02-27%20at%2011.52.12%20PM.png   1. Your Node-RED Flow should look like the following:      1. Double click the **Voltage Sensor Simulator** node. Change the repeat value to “**interval, every 1 second**”. Click **Done**  1. In the upper right corner, click **Deploy** button   ../../../Desktop/Screen%20Shot%202018-02-21%20at%206.07.11%20PM.   1. 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 1st 30 events are being used to create the sliding window for the z-score calculation.   ../../../Desktop/Screen%20Shot%202018-02-21%20at%206.14.48%20PM.  Congratulations! Your node-RED Flow is complete.  **6.View Real-time Device Data in IoT Platform**  Next we need to validate the voltage sensor data is being sent the IoT Platform.   1. Open your IoT Platform Service and select the **Devices** tab from the menu on the left hand-side.        1. Click **Sensor01** to see additional information about the device.  1. Click the **Recent Events** tab. You should see the real-time sensor events coming in from your Node-RED flow.     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-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** |

|  |  |
| --- | --- |
| Purpose: | This lesson introduces boards within the IBM IoT Platform which are used to visualize data. |
|  |  |
| Tasks: | Tasks you will complete in this lab exercise include:   * Create a Board within the IBM IoT Platform * Visualize sensor data |

# Lesson 4: Visualizing Data in the IoT Platform

## Lesson 4: Workflow Overview

## Lesson 4: Instructions

| Action |
| --- |
| **1. Create Board**   1. In the Watson IoT Platform, select **Boards** from the menu on the left hand-side.  1. Click **Create New Board**, from the upper right corner.  1. Name the board, **IoT Lab**, and provide a short description. Click **Next**  1. Keep the default Board Settings and click **Submit.**  1. Your board should now appear under **Your Boards**.   ../../../Desktop/Screen%20Shot%202018-02-21%20at%208.19.37%20PM.  **2.Visualize Sensor Data**   1. First, we will visualize our voltage data. Click on the **IOT LAB** board and select **Add New Card** from the upper right corner  1. Select **Line Chart** as the card type andselect **Sensor01** as the Device. Click **Next**  1. Click **Connect new data set** and input the following properties. Click **Next**  * **Event** = voltage * **Property** = voltage * **Name** = voltage * **Type** = Text  1. Select **L** as the chart size. Click **Next**   ../../../Desktop/Screen%20Shot%202018-02-21%20at%208.27.23%20PM.   1. Name the chart **Voltage** and click **Submit**.  1. You should now see your voltage values displayed in Real-time.   ../../../Desktop/Screen%20Shot%202018-02-21%20at%208.33.13%20PM.   1. Next, we will visualize our z-score data. Click **Add New Card** in the upper right corner.  1. Select **Value** for card type and select **Sensor01** as the device. Click **Next**  1. Select **Connect new data set** and input the following properties. Click **Next**  * **Event** = voltage * **Property**= zscore * **Name** = zscore * **Type** = Text  1. Select **L** as the card size**.** Click **Next**  1. Name the card, **ZScore**. Click **Submit**  1. You should now see your zscore values displayed in Real-time   ../../../Desktop/Screen%20Shot%202018-02-21%20at%208.43.49%20PM.  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: | The tasks you will complete in this section are:   * Provision Db2 Warehouse on Cloud Service * Create Table in Db2 Warehouse * Import Pre-Built Node-RED Flow |

## Lesson 5: Workflow Overview

| Action |
| --- |
| **1. Provision Db2 Warehouse on Cloud Service**   1. Go to your IBM Cloud catalog at <https://console.bluemix.net/catalog/> 2. Search for **db2 warehouse** and select the **Db2 Warehouse** Service  1. Keep the default service name and click **Create**  1. From the Db2 Warehouse on Cloud service page, click **Service Credentials**  1. Click **New Credential** and **Add** to create a new credential  1. **Copy and save** the service credentials   **2. Create Table in Db2 Warehouse on Cloud**   1. Select **Manage** from the menu on the left-hand side to return to the main page. Click **Open** to launch the Db2 Warehouse on Cloud service  1. From the menu, select **Explore**. Select the schema called **DASHXXXX,** then click **New Table**  1. Name the table, **IOTLAB**, and enter the following columns. When done, click **Create**   VOLTAGE DOUBLE  ZSCORE DOUBLE  TIME DOUBLE    **3. Import Pre-Build Node-RED Flow to Persist Data to Db2 Warehouse**   1. Within Node-RED, click on the **DB2 Persist** tab. You should see the following:      1. Double click on the **IOTLAB** node. Click the “**edit pencil**” icon to configure a connection to you Db2 Warehouse on Cloud instance.  1. Name the connection **Db2 Warehouse** and input the **hostname, database, username, and password** for your Db2 Warehouse on Cloud instance. This is the information you previously saved. Click **Add**  1. Click **Done** to save your edits  1. Your Node-RED flow is complete. Click **Deploy** in the upper right to deploy your changes.      1. Your IoT data is now being persisted into Db2 Warehouse on Cloud. To verify, return back to your Db2 Warehouse on Cloud instance. The **number of rows has increased**. You can also **view the data**  1. Once data has been persisted into Db2 Warehouse, you need to stop the simulator so it will not continuously run. 2. Within Node-RED, click the **Simulator To IoT** tab. You should see the following:      1. Double click the **Voltage Sensor Simulator** node. Change Repeat to **none**. Click **Done**  1. Click the **Deploy** button to deploy the changes and stop the simulator.       **End of Lesson 5** |

# Lesson 6: Visualize Data in IBM Cognos Dashboard Embedded

|  |  |
| --- | --- |
| Purpose: | This lab introduces how to visualize sensor data using IBM Cognos Dashboard Embedded within Watson Studio. |
|  |  |
| Tasks: | Tasks you will complete in this lab exercise include:   * Create a Watson Studio Project * Connect to Db2 Warehouse Instance * Create Dashboard |

## Lesson 6: Workflow Overview

## Lesson 6: Instructions

| Action |
| --- |
| **1.Create Watson Studio Project**   1. Log into IBM Cloud at <https://console.bluemix.net/dashboard/apps/> 2. Select the previously provisioned **Watson Studio service** from your IBM Cloud Dashboard  1. Click **Get Started** to launch Watson Studio  1. You will be brought to your **Home Page**      1. Click **New Project** and select **Complete**. Click **OK.**      1. Name the project **IoT F2F Lab** and add a meaningful description     Define Storage:   * Under Define Storage, click **Add** * Choose “Lite” plan then “Create” * Verify your options then “Confirm” * Refresh      1. Click **Create** 2. 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.   **2.Connect to Db2 Warehouse**   1. In the upper right corner select **Add to Project**, then **Connection**  1. Under **IBM Services**, select **Db2 on Cloud**  1. Name the connection “**IoT DB2 Warehouse**” and enter your **previously saved DB2 Warehouse on Cloud credentials**      1. The connection to Db2 Warehouse now appears under **Data Assets**  1. Clickthe **Assets** tab, then **New Dashboard**  1. Click **Associate a Cognos Dashboard Embedded Service instance.** You will be taken to a page to provision the service**.** Select the **Lite** Plan and click **Create**      1. Keep the default Resource group and service name values and select **Confirm**  1. Click **Reload** and the newly provisioned **Cognos Dashboard Embedded Service** will appear.  1. Name the dashboard **IoT Dashboard** and click **Save**  1. On the Select a Template page, select **Single Page** dashboard and **Freeform**. Click **OK**  1. You will be taken to the homepage.Click the **+ button** beside **Selected Sources** to add data and build your dashboard.  1. Click the **Connections** tab.Select **IoT Db2 Warehouse** as the connection, **DASHXXXX** as the Schemas and **IOTLAB** as the Table. Click **Select**  1. The **IOTLAB** table now appears under Selected source. Click **IOTLab** and select the **dropdown arrow**. The table columns are now listed.  1. Hover over the **Voltage** column and click the 3 buttons that appear. Select **Properties**  1. Change the Usage Property to **Measure** and the Aggregate Property to **Average**. Click **Close**      1. The icon beside the Voltage column is now a ruler.      1. Select the **Voltage** and **Time** columns and drag them both onto the dashboard. You should see the following:      1. Click the **expand icon** in the upper right corner of the visualization to enlarge the graph and modify properties.  1. Click the **dropdown arrow** beside Scatter and change the visualization type to **Line.**  1. Click the **minimize icon** in the upper right corner of the visualization to minimize the visualization.  1. The line graph now appears on the dashboard.      1. Next, select the **ZScore column** and drag and drop it onto the dashboard.  1. Click on the zscore visualization and select the **Summarize icon**.  1. Select **Average** as the summarize type. The visualization will now display the average zscore.  1. Your dashboard should now look like the following:     **End of Hands-on Workshop!** |