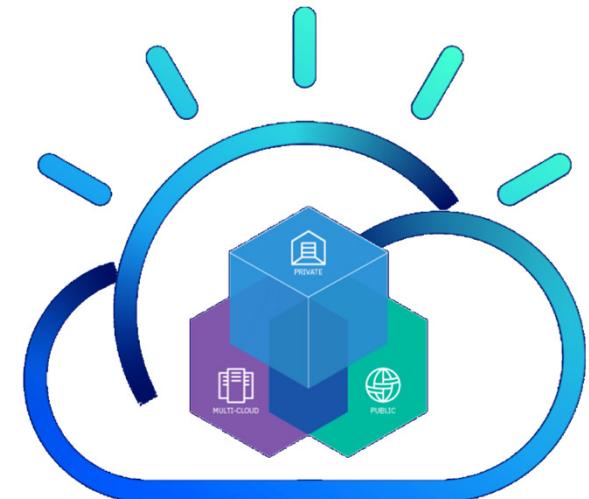


Watson Studio Local

Administration Management



Feb. 18, 2019

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Schedule Plan

09:00 – 10:30 Session I

10:30 – 10:45 Break

10:45 – 11:45 Session II

11:45 – 13:00 Lunch

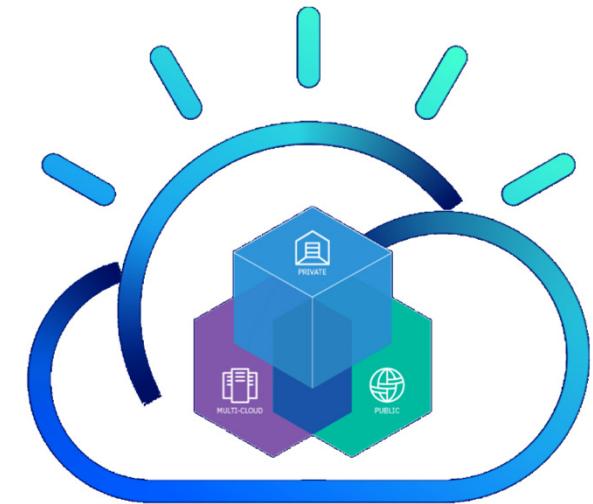
13:00 – 14:00 Session III

14:00 – 14:10 Break

14:10 – 15:30 Session IV

15:30 – 15:40 Break

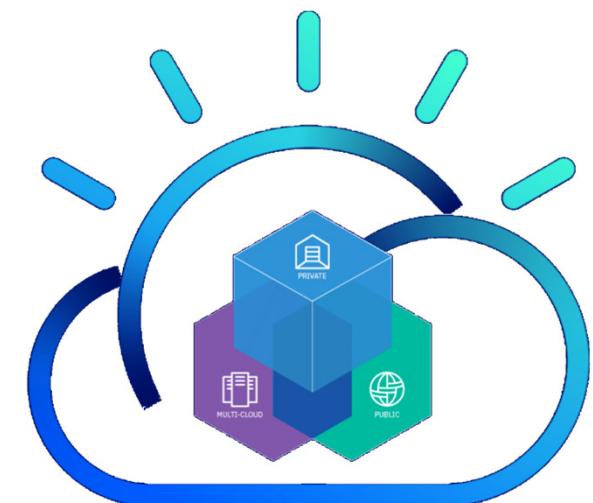
15:40 – 17:00 Session V



Agenda

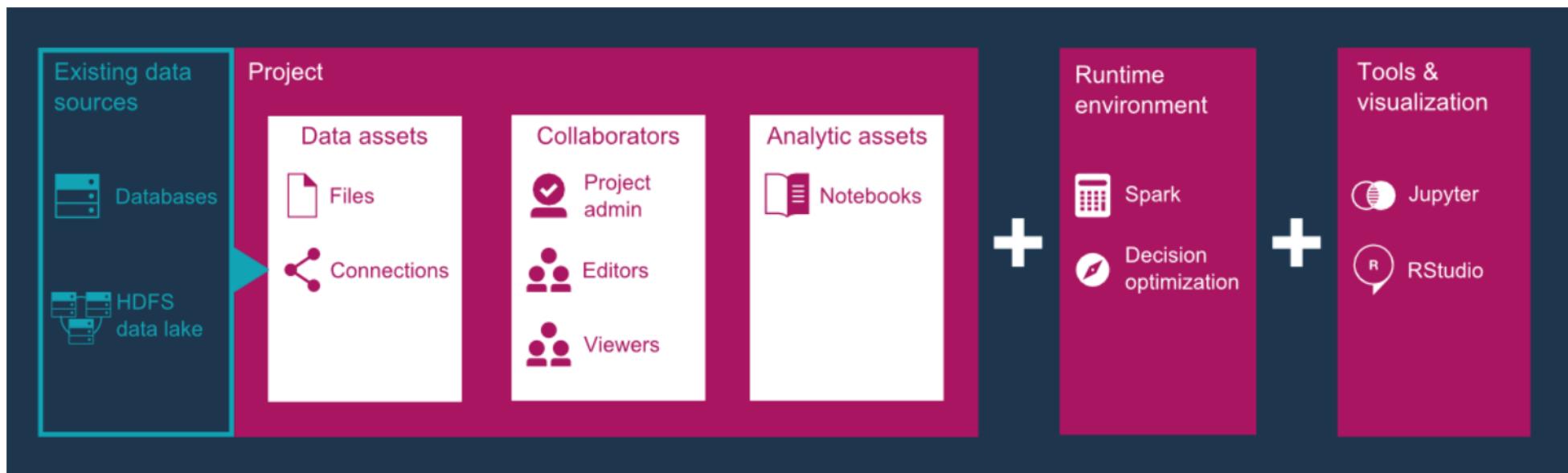
- **Architecture**
- **Cluster Administration**
 - Users
 - Nodes
 - Services
 - Pods
 - Alerts
 - Security & Auditing
 - SSHD
 - Replace Nodes
- **Manage Libraries and Packages**
- **Hadoop Integration**
- **Troubleshooting**
- **Health Check**
- **Image Management**
- **Deployment**
 - Assets Deployment
 - Manage a deployed job
 - Deployment dashboard
- **Additional Topics**
 - Kubernetes 101
 - Best Practices

Watson Studio Local Administration Architecture

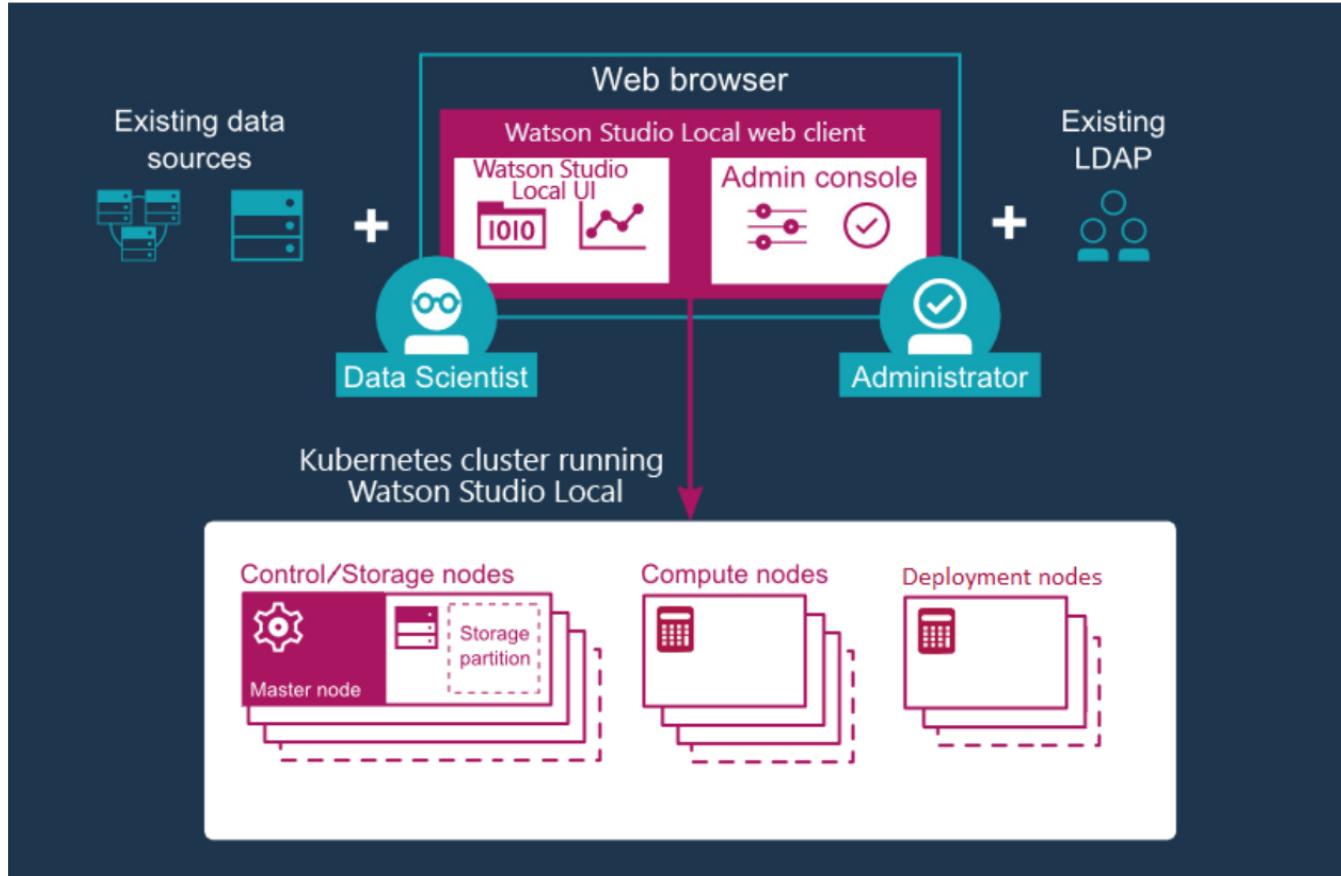


IBM Watson Studio Local (WSL) – Overview

- IBM Watson Studio Local is an out-of-the-box enterprise solution for data scientists and data engineers.
- It offers a suite of data science tools, such as RStudio, Spark, Jupyter, and Zeppelin notebooks, that are integrated with proprietary IBM technologies.

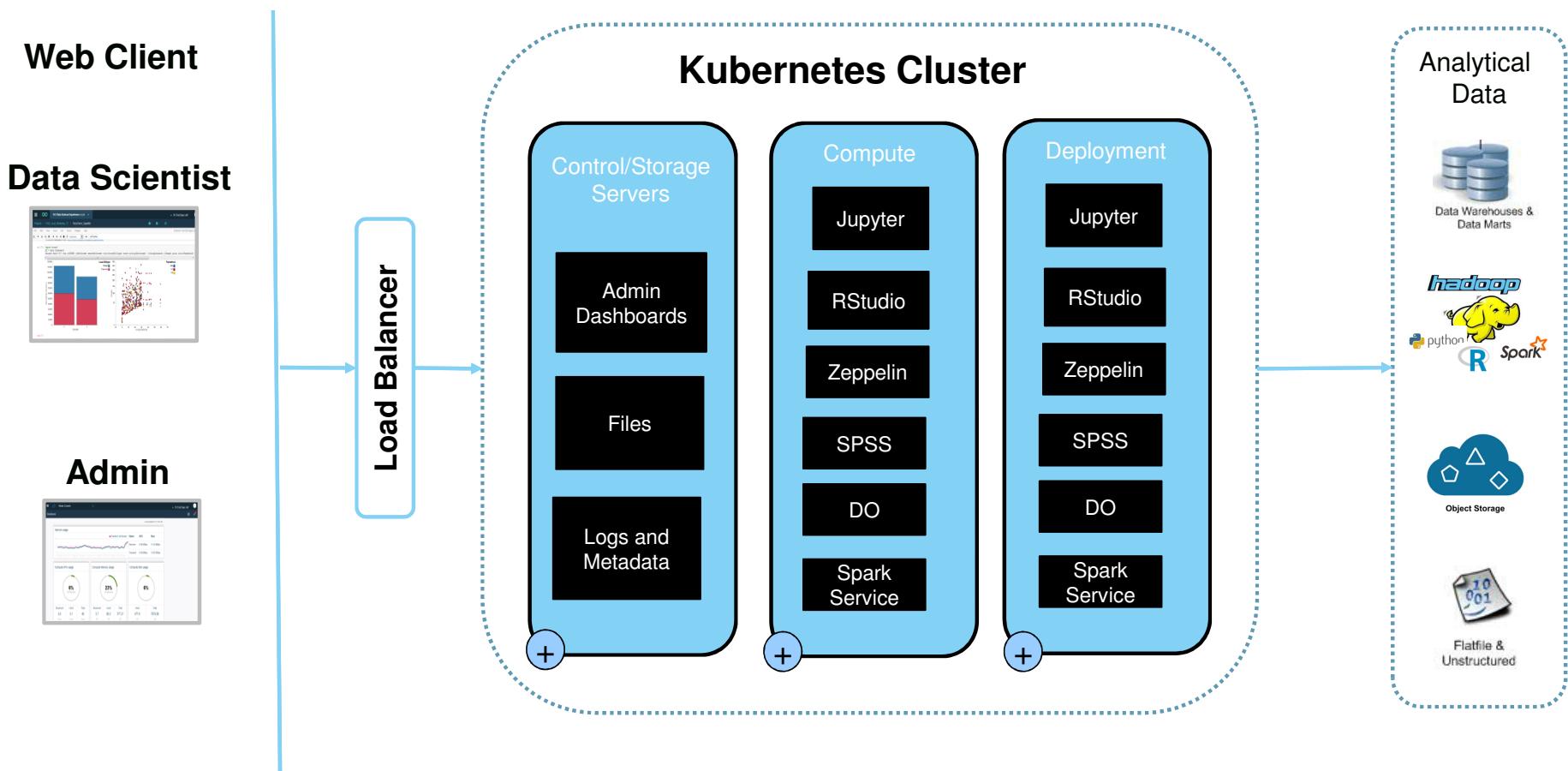


IBM Watson Studio Local (WSL) – Architecture



1. HA is available by default. The deployments cannot be made HA for a single deployment node.
2. Vertical and horizontal scalability. Control/Compute and Deployment nodes can be added at any time.
3. LDAP authentication supported. Native authentication available.
4. Connect to data using JDBC, API or built-in connectors.
5. Supports Remote execution of Spark, Python, in R in a Hadoop cluster

IBM Watson Studio Local (WSL) – Architecture



IBM Watson Studio Local (WSL) – Cluster Configuration

- WSL cluster has several types of nodes (systems)
 - Control/Storage: manage the system and store data/metadata
 - Compute: run development workload (Notebooks, RStudio, etc.)
 - Deployment: dedicated to running production workload
- Cluster Configurations

Cluster Type	# Node breakdown	Notes
3 nodes	3 shared control / compute	Unable to deploy assets.
4 nodes	3 shared control / compute + 1 deploy	
5 nodes	3 shared control / compute + 2 deploy	
7 nodes	3 shared control + 3 compute + 1 deploy	
8 nodes	3 shared control + 3 compute + 2 deploy	
11 nodes	3 shared control + 6 compute + 2 deploy	

IBM Watson Studio Local (WSL) – Kubernetes

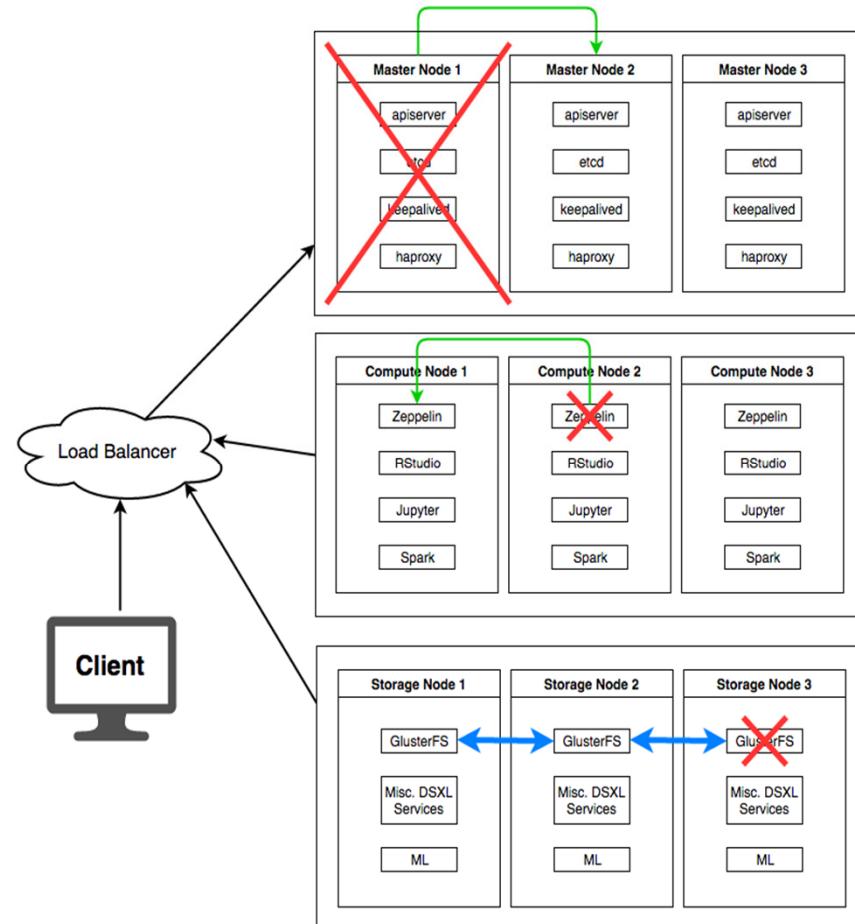
- WSL Local deploys into its own Kubernetes cluster or ICP (IBM Cloud Private)
 - Deployment into other clusters is not supported
- Kubernetes provides
 - High availability for services
 - Scalability
 - Monitor and display system status

IBM Watson Studio Local (WSL) – High Availability

- Platform HA
 - By default, the development nodes (Control/Compute/Storage) are configured for HA
 - 3 nodes in 4-node configuration
 - 6 nodes in a 7-node configuration
 - For Deployment nodes, the customer can configure active/active or active/passive HA
 - Active/active HA: at least 2 Deployment nodes
 - Active/passive HA: 1 Deployment node and 1 cold standby

IBM Watson Studio Local (WSL) – High Availability

- Platform HA
 - WSL can tolerate failure of
 - 1 node in a 3-node configuration
 - 3 nodes in a 6-node configuration



IBM Watson Studio Local (WSL) – High Availability

■ Service HA

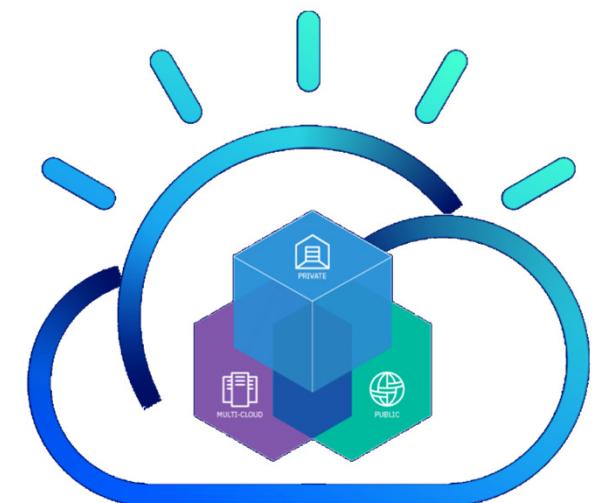
- For services that are deployed as pods, Kubernetes will monitor and redeploy services when they are down
- No session failover, which means that some services may be down for a few minutes
 - ✓ Any type of assets that requires a “session” (for example, batch scoring), will need to be restarted
- For online scoring, it’s possible to do deployment to multiple environments
 - ✓ Ensures uninterrupted online scoring

IBM Watson Studio Local (WSL) – Kubernetes and Docker

- Kubernetes and Docker are open source technologies
 - Used for deploying applications with microservices architecture
- Docker provides a container for services
 - Once the service is “dockerized”, it can run in any environment managed by Docker
- Kubernetes is a platform for managing *containers* (including Docker)
 - Deployment
 - Scalability
 - Environment status



Watson Studio Local Cluster Management

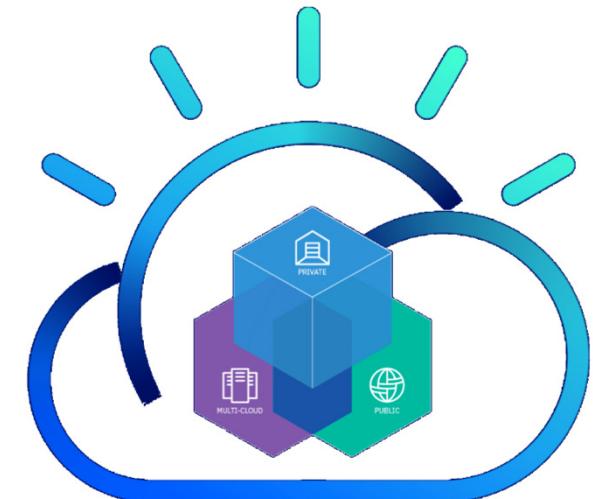


Cluster Administration

- The Admin Console enables system administrators to manage users and to monitor the health of the application and the Kubernetes deployment environment
- Kubernetes and Docker do a lot of the work for you to manage your Watson Studio Local deployment. You don't need to be familiar with these technologies to manage Watson Studio Local
- To open the Admin Console:
 - Sign in to the WSL client from a web browser
 - Use the dropdown menu in the banner to select **Admin Console**

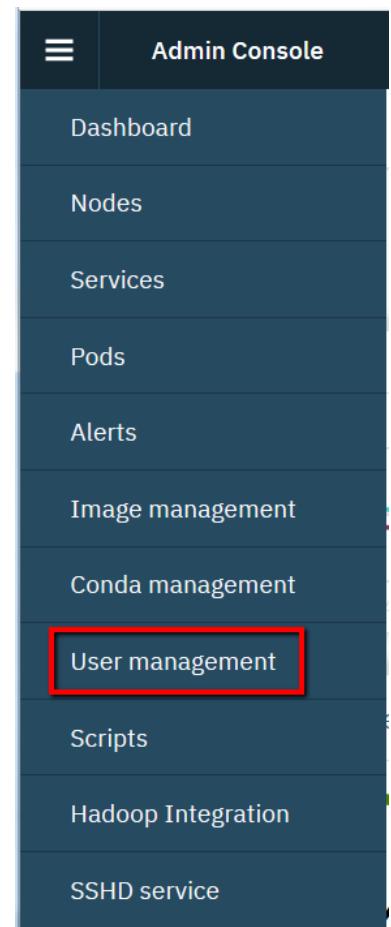


Watson Studio Local Cluster Management Users



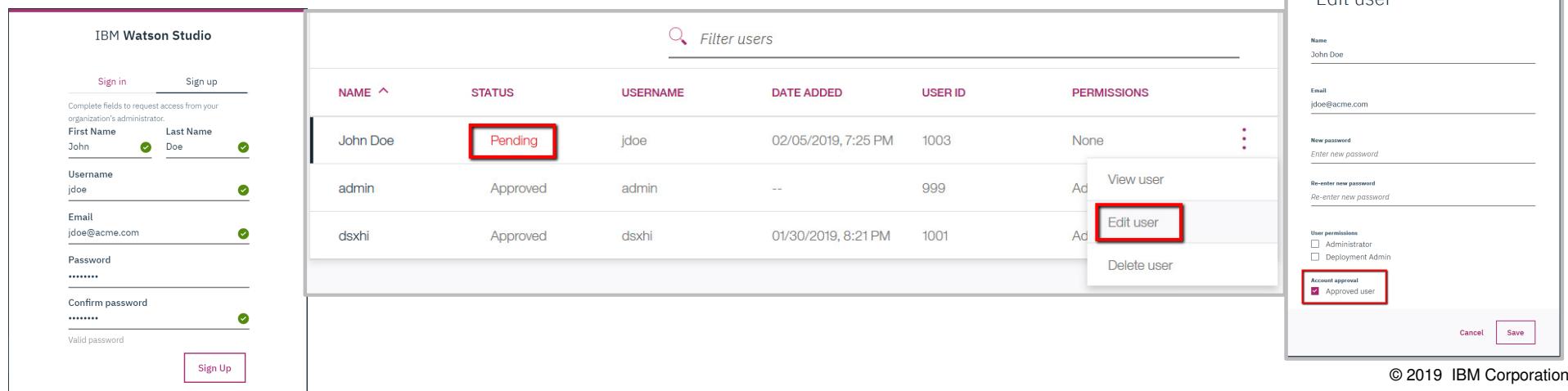
Manage Users

- WSL users can be managed from either an external LDAP server (recommended) or an internal repository database
- In the Admin Console, click the menu icon (≡) and click User Management to approve sign-up requests, add users, filter them, edit them, assign permissions to them, or delete them



Manage Users

- The user permissions are as follows:
 - Admin:** Can sign in to both the admin dashboard and the WSL client
 - Deployment Admin:** Can create project releases in IBM Watson Machine Learning
 - User:** Can sign in to the WSL client only. This is the default permission if neither Admin check box is selected
- If new users request an account, you must approve them by editing them and selecting Approved User
- Unapproved users have a status of pending

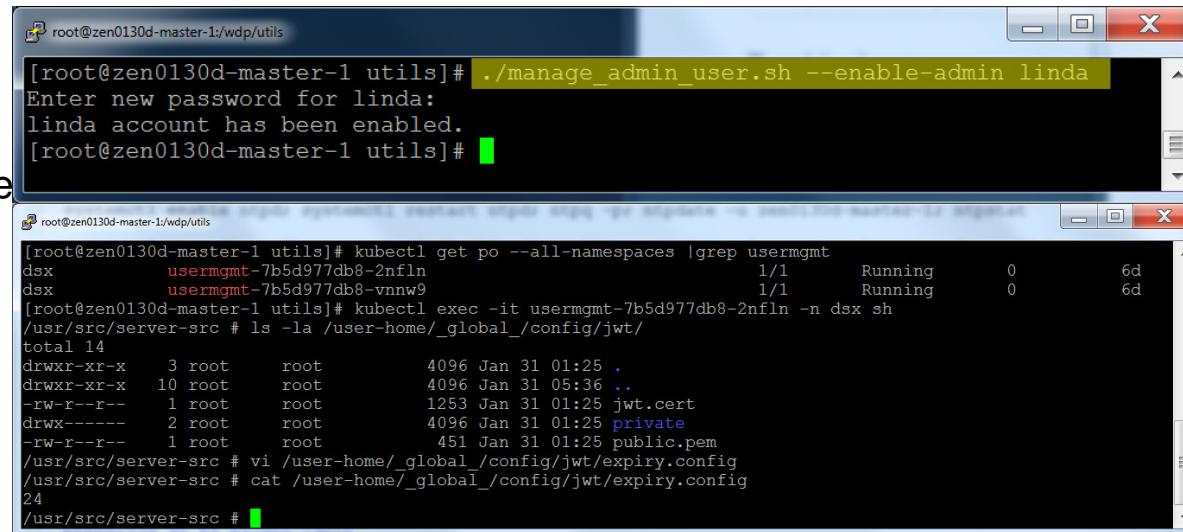


The screenshot shows the IBM Watson Studio user management interface. On the left, there is a sign-up form for a new user named 'John Doe' with fields for First Name, Last Name, Username, Email, Password, and Confirm password. The 'Status' field is set to 'Pending'. In the center, a table lists existing users: 'John Doe' (Status: Pending), 'admin' (Status: Approved), and 'dsxhi' (Status: Approved). A context menu is open over the 'John Doe' row, with options 'View user', 'Edit user' (which is highlighted with a red box), and 'Delete user'. On the right, a detailed 'Edit user' dialog is displayed for 'John Doe'. It includes fields for Name (John Doe), Email (jdoe@acme.com), and Password (with 'Approved user' checked). Under 'User permissions', there are checkboxes for 'Administrator' and 'Deployment Admin', both of which are unchecked. At the bottom of the dialog are 'Cancel' and 'Save' buttons.

NAME	STATUS	USERNAME	DATE ADDED	USER ID	PERMISSIONS
John Doe	Pending	jdoe	02/05/2019, 7:25 PM	1003	None
admin	Approved	admin	--	999	Administrator
dsxhi	Approved	dsxhi	01/30/2019, 8:21PM	1001	Administrator

Manage Users & Others

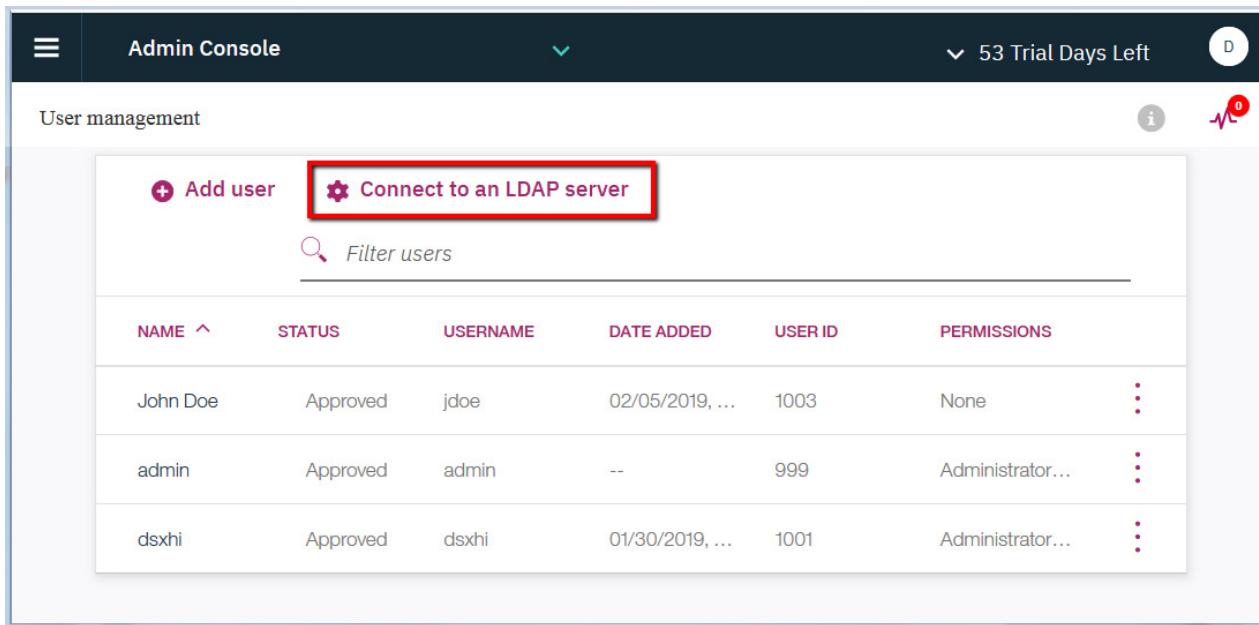
- Enable and set a new password for the WSL admin, enter the following command:
 - ./wdp/utils/manage_admin_user.sh --enable-admin <userid>
- Disable a WSL admin, enter the following command:
 - ./wdp/utils/manage_admin_user.sh --disable-admin <userid>
- Modify the session expiration time
 1. SSH to WSL cluster node
 2. Run kubectl exec to a usermgmt pod.
 3. Edit or create the following file to specify the number of hours. (default is 12 hours)
- \$cat /user-home/_global_/config/jwt/expiry.config
 4. Restart usermgmt pod by deleting all of the current usermgmt pods.



The screenshot shows two terminal sessions. The top session is a root shell on a 'zen0130d-master-1' node, running the command `./manage_admin_user.sh --enable-admin linda`. It prompts for a new password for the user 'linda', which is then confirmed. A message indicates that the 'linda' account has been enabled. The bottom session shows the root user executing `kubectl get po --all-namespaces |grep usermgmt`, listing two pods: 'usermgmt-7b5d977db8-2nfln' and 'usermgmt-7b5d977db8-vnnw9'. Both are shown as 'Running' with 0/1 containers. The user then runs `kubectl exec -it usermgmt-7b5d977db8-2nfln -n dsx sh` to enter the pod's shell. Inside the shell, they run `ls -la /user-home/_global_/config/jwt` to view the directory contents, which include files like 'jwt.cert', 'private', and 'public.pem'. Finally, they edit the configuration file with `vi /user-home/_global_/config/jwt/expiry.config` and verify the changes with `cat /user-home/_global_/config/jwt/expiry.config`.

Manage Users – LDAP Server

- By default, WSL user records are stored in its internal repository database
- Alternatively, you can use your own external LDAP server instead. To set up your own LDAP server, click Connect to an LDAP server



The screenshot shows the Admin Console User management interface. At the top, there are buttons for 'Add user' and 'Connect to an LDAP server'. The 'Connect to an LDAP server' button is highlighted with a red box. Below these buttons is a search bar labeled 'Filter users'. The main area displays a table of user records:

NAME ^	STATUS	USERNAME	DATE ADDED	USER ID	PERMISSIONS
John Doe	Approved	jdoe	02/05/2019, ...	1003	None
admin	Approved	admin	--	999	Administrator...
dsxhi	Approved	dsxhi	01/30/2019, ...	1001	Administrator...

Manage Users – LDAP Server

- In the LDAP host field, use the *ldap://* prefix for a non-secure port and the *ldaps://* prefix for a secure port
- If you opt to authenticate LDAP with search, then specify the domain search user, password, and base. If you opt to authenticate by distinguished name without search, ensure the **LDAP Prefix** and **LDAP Suffix** fields match the distinguished name exactly. For example, uid for the prefix and ou = dsxusers, dc = ibm, dc = com for suffix for the setup to succeed
- When finished, click the **Set up LDAP** button. If the LDAP setup succeeds, WSL no longer displays password fields whenever you sign up a new user in the Admin Console.

Manage Users – LDAP Server

- Because the WSL user records are stored in the external LDAP server, only the LDAP administrator can perform user management tasks like password resets and changes
- Note that after LDAP is enabled, both local and LDAP users can sign in, but only LDAP users can be added.
- **Tip:** To save time from approving LDAP users, you can select **Auto-Signup** to automatically approve all LDAP user sign-up requests.

Manage Users – LDAP Server

- Example “with search” configuration
- Notes:
 - Domain search user and password are optional for testing connectivity
 - Username and Password for testing must be valid LDAP user

Connect LDAP

- with search
- without search

LDAP host

ldaps://bluepages.ibm.com

LDAP port

636

Domain search user*The LDAP user that performs user lookups***Domain search password***The password for the search user***Domain base**

ou=bluepages,o=ibm.com

User Search Field

emailAddress

 Auto-Signup (Automatically approve all sign-up requests from users)**Username for testing**

<valid LDAP user>@ibm.com

Password for testing

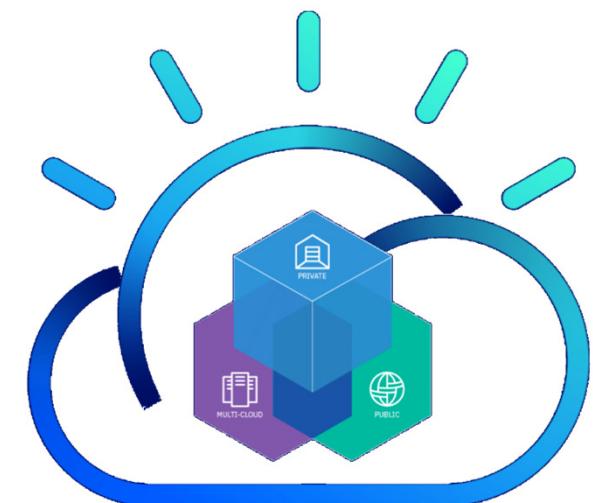
[Cancel](#)[Test LDAP](#)[Set up LDAP](#)

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Manage Users – LDAP Server

- To verify that your LDAP connection works, type in an existing LDAP user in the Username for testing and Password for testing fields, then click the Test LDAP button
- When finished, click the Set up LDAP button
- If the LDAP setup succeeds, WSL no longer displays password fields whenever you sign up a new user in the admin dashboard
- Because the WSL user credentials are stored in the external LDAP server, only the LDAP administrator can perform LDAP user password resets and changes

Watson Studio Local Administration Manage Nodes



Monitor Cluster Nodes

- Your IBM Watson Studio Local deployment consists of up to three types of nodes
 - *Control/Storage/Compute Nodes (required)*
 - *Additional Compute Nodes (optional)*
 - *Additional Deployment Nodes (optional)*
- The cluster requires a minimum of three machines—set up as Control/Storage/Compute “master” nodes in the minimum three machine configuration—for ensuring platform high availability
- Storage is always part of the master nodes. In current versions of WSL, there are no independent storage nodes
- Additional node machines can be added to provide greater compute and deployment capability

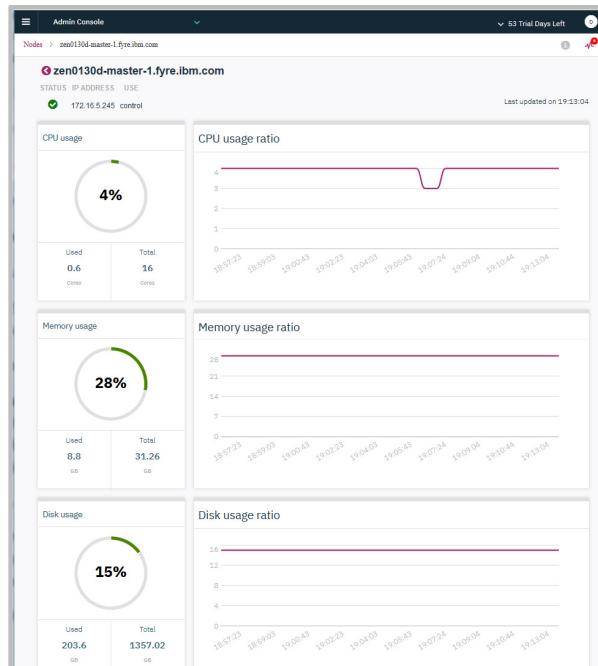
Manage Cluster Nodes

- You can check whether cluster nodes are running from the Nodes page
- You can access the Nodes page from the menu icon (
- For each node in the cluster, you can see:
 - The IP address of the node
 - Whether the node is running or down
 - How many CPU cores the node is using
 - The GB of memory the node is using
 - The GB of storage (disk) the node is using

Control plane nodes						Last updated on 00:57:26
NAME	IP ADDRESS	STATUS	CPU USED (CORES)	MEMORY USED (GB)	DISK USED (GB)	
> 3nodeautomated-master-1. 			0.5 / 16 (3%)	10.45 / 31.26 (33%)	42.73 / 245.87 (17%)	
> 3nodeautomated-master-2. 			0.7 / 16 (4%)	8.92 / 31.26 (29%)	42.56 / 245.87 (17%)	
> 3nodeautomated-master-3. 			1.2 / 16 (8%)	9.77 / 31.26 (31%)	52.98 / 245.87 (22%)	

Manage Cluster Nodes

- What if you need more detailed information?
- If you click the node name, you can see the CPU, storage, and memory consumption for the node over the last 20 minutes
 - For example, if we would have clicked on the a specific node from the previous screen this is what we would have seen



Manage Cluster Nodes

- Lets “zoom out” and go back to our high level view where you can see all the nodes
- If you expand the node name (ie clicking the arrow to the left of the node), you can see the operating system partition and disk partition where the node is running.
 - For example, in the below image you can see the size of the partition and how much of the partition is in use

Control plane nodes						Last updated on 19:15:04
NAME	IP ADDRESS	STATUS	CPU USED (CORES)	MEMORY USED (GB)	DISK USED (GB)	
PARTITION	USAGE		CAPACITY	RATIO		
zen0130d-master-1.fyre.ibm.com	172.16.5.245	✓	0.7 / 16 (4%)	8.77 / 31.26 (28%)	203.65 / 1357.02 (15%)	
/dev/mapper/rhel-root	2.05 GB		240.88 GB	1%		
/dev/vdal	207.69 MB		1014 MB	20%		
/dev/vdb1	152.76 GB		599.71 GB	25%		
/dev/vdc1	48.63 GB		499.75 GB	10%		
shm	0 Byte		64 MB	0%		
tmpfs	0 Byte		15.68 GB	0%		
zen0130d-master-2.fyre.ibm.com	172.16.11.13	✓	0.6 / 16 (4%)	8.36 / 31.26 (27%)	131.02 / 1356.96 (10%)	
zen0130d-master-3.fyre.ibm.com	172.16.11.14	✓	0.6 / 16 (4%)	9.12 / 31.26 (29%)	82.52 / 1356.96 (6%)	

Manage Cluster Nodes

- Kubernetes is designed to handle node outages, so you can still use WSL even if some of your nodes are down
- However, if a node is down, you must attempt to diagnose and resolve the problem to avoid outages if other nodes fail
- Contact IBM Software Support if you cannot determine why the node failed or how to restart the node
- Also, down the road if you want to expand the usage / resources for WSL you can add additional compute or deployment nodes
 - **Restriction:** WSL does not support adding additional nodes with GPU

Monitor Cluster Nodes

- Your WSL deployment consists of three types of nodes:

1. Control Nodes:

- Nodes that manage your Kubernetes cluster and your DSX Local deployment
- By default, the cluster has three control nodes. If you notice that a node is down, attempt to restore it to prevent outages.
- The cluster can continue to run if one node fails. However, if two nodes fail, your cluster fails.

Monitor Cluster Nodes

2. Storage Nodes: (Combine with Control node in latest version)

- Nodes where WSL metadata and any data that you load into WSL is stored
- By default, the cluster has three storage nodes. The data on these nodes is replicated across each node, so that if a node fails, you can still access the data. WSL can continue to run if two nodes fail
- **Tip:** If you run out of space on your storage nodes, add XFS-formatted disks to each node and extend the Logical Volume Management (LVM) partition to include the disks. If possible, ensure that the disks are the same size.

Monitor Cluster Nodes

3. Compute Nodes:

- Nodes where WSL services, such as Spark, run
- Unlike storage nodes, compute nodes are not replicated. When a new process starts, Kubernetes determines which node has sufficient capacity to run the process.
- WSL can continue to run when multiple compute nodes fail. However, you might notice that performance decreases when multiple nodes are down
- Additionally, if a node fails, Kubernetes attempts to bring any active processes up on another node. While Kubernetes attempts to bring up the processes, you might experience an outage
 - **If Kubernetes cannot bring the processes up on another node and the outage continues, contact IBM Software Support**

Monitor Cluster Nodes

4. Deployment Nodes: (Optional**)

- Deployment nodes are production versions of the compute nodes
- Asset deployment requires at least one deployment node.
- If the deployment nodes fail all the deployments will go offline and remain offline until nodes are repaired or replaced.

**Recommended
configuration examples**

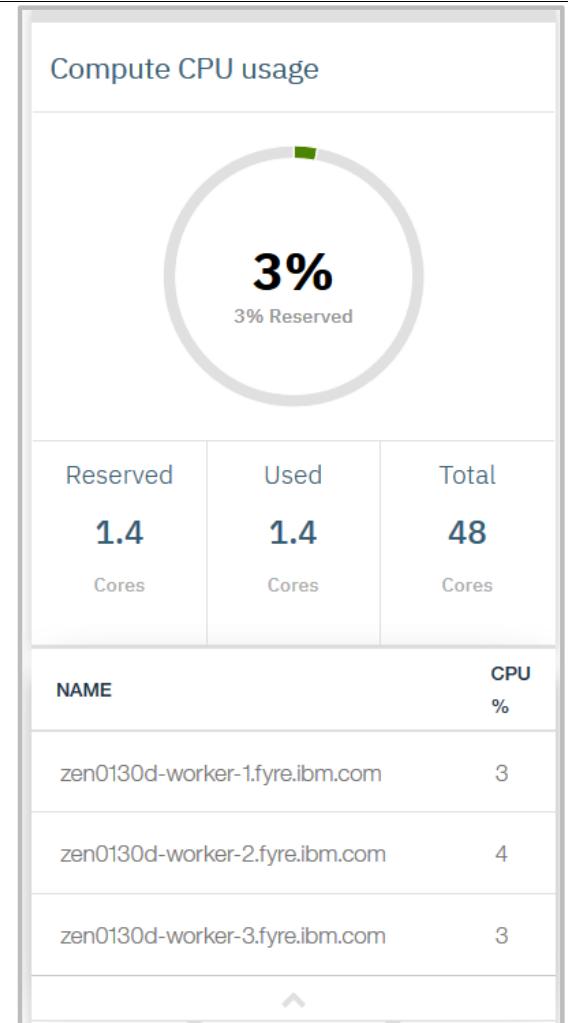
Cluster type	# node breakdown	Notes
3 nodes	3 shared control/compute	Unable to deploy assets.
4 nodes	3 shared control/compute + 1 deploy	
5 nodes	3 shared control/compute + 2 deploy	
7 nodes	3 control + 3 compute + 1 deploy	
8 nodes	3 control + 3 compute + 2 deploy	
11 nodes	3 control + 6 compute + 2 deploy	

Node Health

- If you want a high-level overview of the status of your cluster, you can monitor the health of your cluster nodes from the Dashboard page
- You can access the Dashboard page from the menu icon ()
- Specifically, you can monitor:
 - CPU Usage
 - Memory Usage
 - Disk Usage

Node Health

- For compute nodes, the usage of CPU and memory is measured against the CPU and memory that the WSL users reserved
- Each card on the Dashboard page shows the average usage across all of the nodes.
- However, you can expand the cards to see the specific usage for each node.

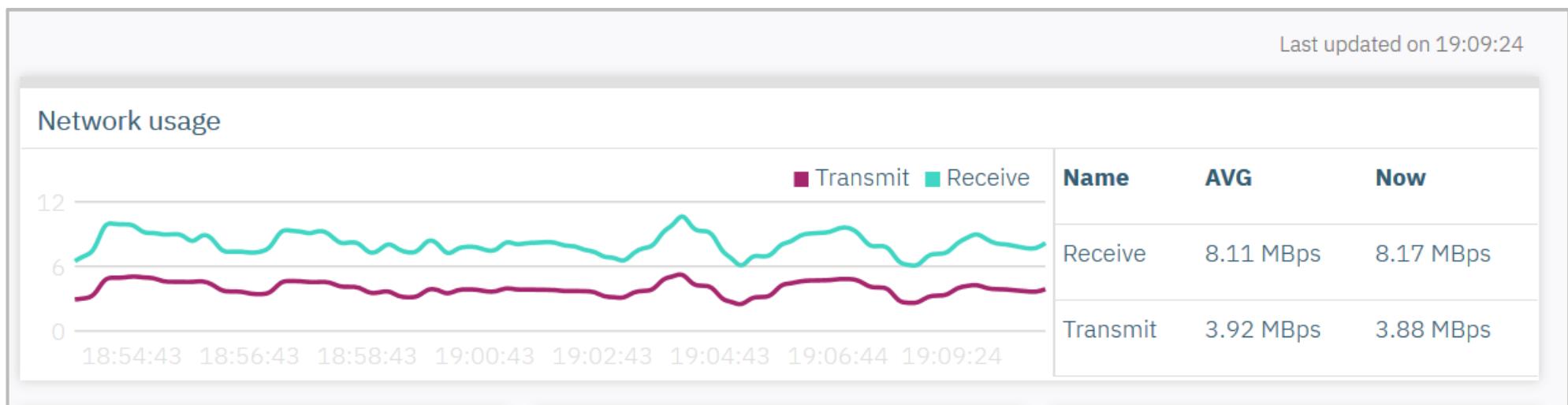


Node Health

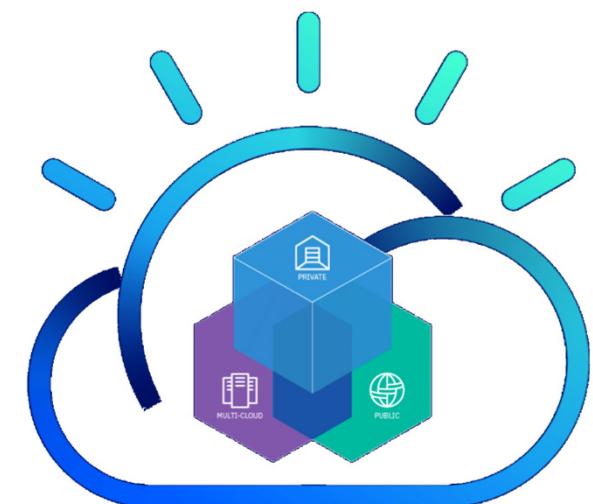
- Data is refreshed every 10 seconds
- By default, Kubernetes attempts to balance the load across servers
- Contact IBM Software Support if you notice that all of the nodes in a group are overloaded for extended time
 - Nodes are overloaded when they run above 90% usage
- Nodes can become overloaded when:
 - You have more users than your cluster configuration can handle
 - For example, your cluster doesn't have sufficient CPU, memory, or storage
 - A node fails and other nodes need to handle requests that would normally be handled by that node.

Monitor Network Usage

- If you encounter an issue with WSL, you can view the recent network traffic in your cluster on the Dashboard page
- You can view the number of megabytes that were sent and received across the nodes of the cluster over the last 20 minutes



Watson Studio Local Administration Manage Services



Manage Services

- Watson Studio Local is composed of multiple processes that run in a set of distributed pods.
- Watson Studio Local uses services to enable communication between pods.
- You can view the list of services that are used in your WSL deployment from the **Services page**
- You can access the Services page from the menu icon ()

Manage Services

- **Click the service name to see:**

- The list of pods that the service communicates with
- The status of each pod
- The nodes where each pod is deployed

Services				
NAME	DESCRIPTION	STATUS	PODS	IMAGE
Access load balancer	The load balancer for the Watson Studio client.		3	privatecloud-nginx-repo:v3.13.74-x86_64
Admin console APIs	The REST APIs for retrieving the data that is displayed in the administration console.		3	dashboard-backend:1.8.7-x86_64
Admin console UI	The user interface for the administration console.		3	dashboard-frontend:1.8.7-x86_64
Admin console metrics	Aggregates and calculates the metrics that are displayed in the administration console.		1	dashboard-metric-calc:11.7-x86_64
Cloudant DB	The distributed database for Watson Studio. This database contains user ID and the metadata for Watson Studio services.		1	privatecloud-cloudant-repo:v3.13.141-x86_64

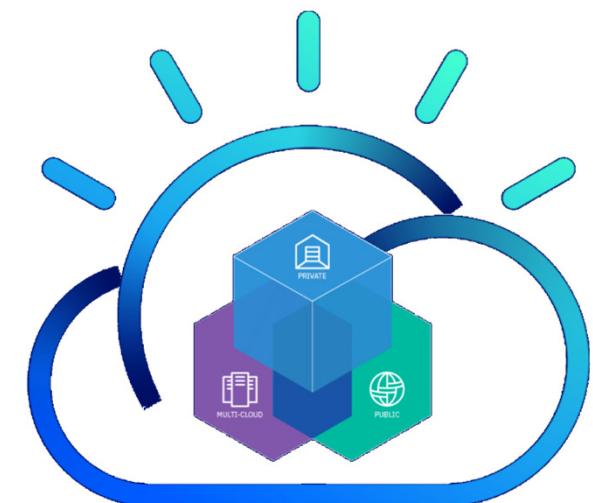
Manage Services

- You can also click each pod name to get more details about each pod

Services		
Name	Access load balancer	Kubernetes service name ibm-nginx-svc
Description	The load balancer for the Watson Studio client.	
NAME		
ibm-nginx-dfb988cbf-5bm9h	✓	zen0130d-master-3.fyre.ibm.com
ibm-nginx-dfb988cbf-c9pln	✓	zen0130d-master-2.fyre.ibm.com
ibm-nginx-dfb988cbf-qjf7l	✓	zen0130d-master-1.fyre.ibm.com

- If you encounter an issue with any of the services in WSL, contact IBM Software Support for assistance with resolving the issue

Watson Studio Local Administration Manage Pods



Manage Pods

- In Kubernetes, a *pod* is a process that is running on your Kubernetes cluster
- A pod is a runnable unit of work, which can be either a stand-alone application or a microservice
- In Watson Studio Local, if a process needs to run on multiple nodes, more pods are created and deployed for extra users or extra notebook servers and IDEs.
 - For example, Spark is deployed as a cluster with at least one pod in each compute node.

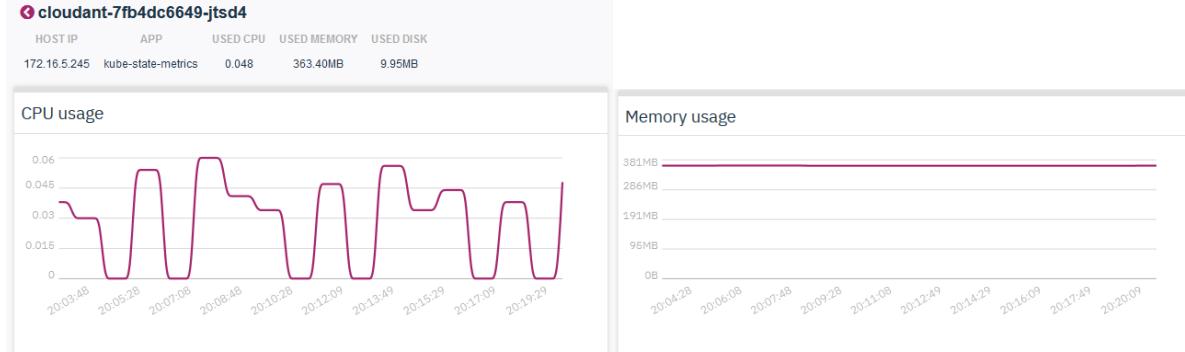
Manage Pods

- You can view the list of pods that are used in your Watson Studio Local deployment from the **Pods** page
- You can access the **Pods** page from the Menu icon (≡)
- From the **Pods** page you can see:
 - The names of the pods
 - The status of the pods
 - The node where each pod is deployed
 - The CPU, memory, and disk usage for each pod

Pod list						
POD NAME	STATUS	NODE NAME	USED CPU	USED MEMORY	USED DISK	REDEPLOY
cloudant-7fb4dc6649-jtsd4	✓	zen0130d-master-1.fyre.ibm.com	0.00	363MB	10MB	
dash-back-deploy-795b65d87c-f4mmd	✓	zen0130d-worker-1.fyre.ibm.com	0.00	111MB	3MB	

Manage Pods

- Additionally, you can click on the name of each pod to see:
 - The IP address of the host where the pod is deployed
 - The name of the service that is running on the pod
 - The amount of CPU the pod is using and a graph of the CPU usage over the last 15 minutes
 - The amount of memory that the pod is using and a graph of the memory usage over the last 15 minutes
 - The amount of disk space that the pod is using and a graph of the disk space usage over the last 15 minutes



Pod Status

- Typically, all of the pods in your environment are running
- However, you might notice that the pods in your environment are in one of the following states:
 - **Pending** (): The Kubernetes cluster is creating the Container images that are included in the pod
 - **Succeeded** (): All of the Containers in the pod stopped successfully. The Containers are not restarted
 - **Failed** (): All of the Containers in the pod stopped successfully, but at least one Container stopped with an error or was stopped by Kubernetes
 - **Unknown** (): The state of the pod cannot be determined, which typically occurs when there is a communication issue with the node where the pod is deployed
 - **Running** (): The pod is deployed on a node. At least one Container is running or is in the process of starting or restarting.

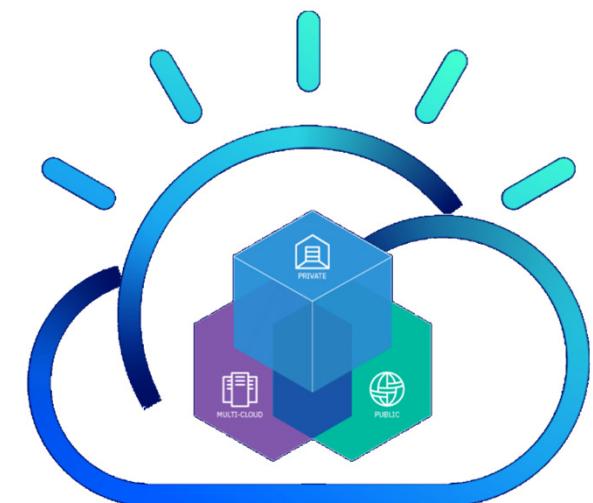
Pod Status

- If you encounter an issue with a service, you might need to redeploy the pod
- You can redeploy the pod by clicking the redeploy button
- If you cannot successfully redeploy a pod from the Pods page, contact IBM Software Support for assistance with resolving the issue

Pod List						
POD NAME	STATUS	NODE NAME	USED CPU	USED MEMORY	USED DISK	REDEPLOY
cdsx-data-api-1789792843-s2rpd		skeleton-storage-1. 	0.00	949MB	56MB	
cloudant-repo-3127452009-w94hw		skeleton-storage-2. 	0.08	1GB	633MB	
dap-notebooks-ui-347150342-3wct2		skeleton-storage-3. 	0.00	1GB	82MB	

Watson Studio Local Administration

View Alerts



View Alerts

- IBM Watson Studio Local automatically notifies you when a node or pod goes down or when you’re at risk of overloading a resource.
- By default, WSL issues alerts when:
 - CPU usage on a node goes above 90%
 - Memory usage on a node goes above 90%
 - Disk usage on a node goes above 90%
 - A node in the cluster goes down
 - A pod fails
 - A pod is not running or is in an unknown state for more than 5 minutes
- If you want to change the threshold at which alerts are issued, you can configure them on the [Settings page](#).

View Alerts

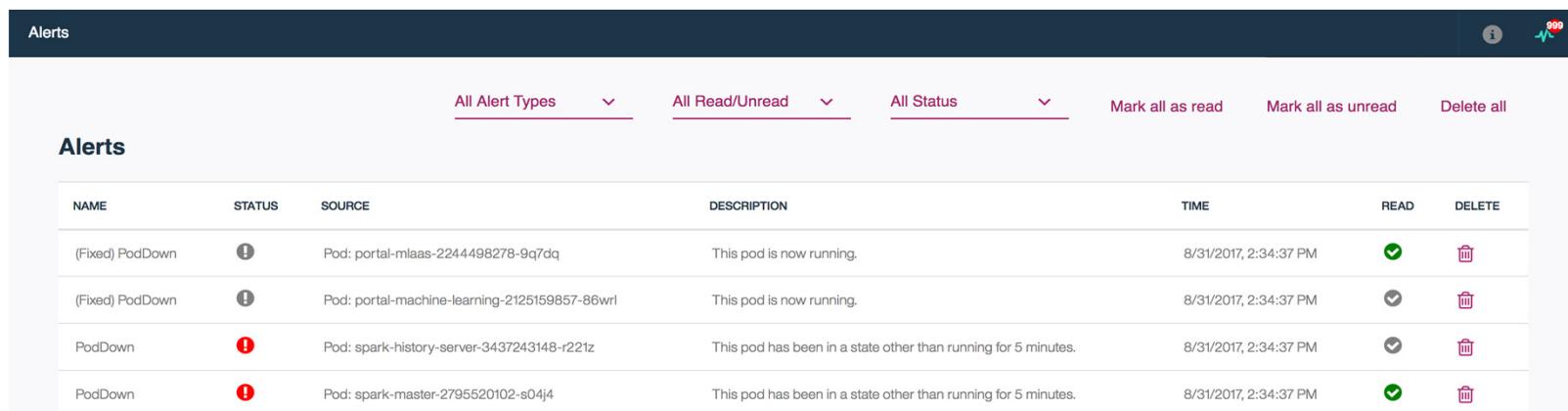
- When you have alerts, the alert icon displays the number of unread alerts in your queue:



- You can access alerts in either of the following ways:
 - If you want a quick peek at your alerts, click the alert icon in the menu bar ()
 - If you want to manage your alerts, you can access the Alerts page from the menu icon ()
- **Tip:** When you delete an alert, you can't access it again. Make sure that you don't need it before you delete it

View Alerts

- From the Alerts page you can:
 - Filter alerts by type
 - Filter alerts based on whether they were read or not
 - Filter alerts by status
 - Mark alerts as read or unread
 - Delete alerts



The screenshot shows the 'Alerts' page with the following interface elements:

- Header:** 'Alerts' tab, three small icons (info, chart, 99+), and a search bar.
- Filtering:** 'All Alert Types' dropdown, 'All Read/Unread' dropdown, 'All Status' dropdown, 'Mark all as read', 'Mark all as unread', and 'Delete all' buttons.
- Section Header:** 'Alerts'.
- Table:** A grid showing five alert entries with columns: NAME, STATUS, SOURCE, DESCRIPTION, TIME, READ, and DELETE.

NAME	STATUS	SOURCE	DESCRIPTION	TIME	READ	DELETE
(Fixed) PodDown		Pod: portal-mlaas-2244498278-9q7dq	This pod is now running.	8/31/2017, 2:34:37 PM		
(Fixed) PodDown		Pod: portal-machine-learning-2125159857-86wrl	This pod is now running.	8/31/2017, 2:34:37 PM		
PodDown		Pod: spark-history-server-3437243148-r221z	This pod has been in a state other than running for 5 minutes.	8/31/2017, 2:34:37 PM		
PodDown		Pod: spark-master-2795520102-s04j4	This pod has been in a state other than running for 5 minutes.	8/31/2017, 2:34:37 PM		

Change alert threshold

- In the Watson Studio Local client, an administrator can optionally adjust when alerts are generated, how long log files and metrics are stored, and how frequently the metrics on the dashboard are refreshed.
- To configure refresh and retention settings:
 1. From the Admin user profile icon, select Settings
 2. In the Refresh and alert settings, adjust the appropriate settings

Log retention (days) – the number of days to keep logs before they are automatically deleted. **Default is 10 days.**

Metrics retention (days) – the number of days to keep metrics history. **Default is 1 day.**

Dashboard refresh (seconds) – the frequency with which the data in the dashboard is refreshed. **Default is 10 seconds.**

Alert threshold (%) – the usage threshold at which an alert is triggered. **Default is 90%.**

Alert warning threshold (%) – the usage threshold at which a warning is triggered and the node color changes to yellow.
Default is 70%.

3. Click Save

Change alert threshold

Refresh and alert settings

Log retention (days)

10

Metric retention (days)

1

CPU alert threshold (%)

95

CPU alert warning threshold (%)

75

Memory alert threshold (%)

95

Memory alert warning threshold (%)

75

Disk alert threshold (%)

95

Disk alert warning threshold (%)

75

Alert length threshold (minutes)

5

Dashboard refresh (seconds)

10

Watson Studio Local Administration Security



IBM Watson Studio Local (WSL) – Security

Network security

- WSL is exposed via 443 port (SSL is supported by default)
- All REST APIs require bearer token or model deployment Token
- WSL supports firewall (vyatta) around cluster, not around individual nodes
- SSO is not yet supported

Data security

- WSL supports full disk encryption via LUKS (must be done prior to install)
- WSL encrypts the credentials for external data sources (AES 256)
- WSL hashes all the user passwords stored in Cloudant

Authentication

- LDAP/AD(See Compatibility Reports for supported LDAP servers)

Authorization

- Pre-defined roles: Administrator, Deployment Administrator, User
- Project roles: Administrator, Editor, Viewer

IBM Watson Studio Local (WSL) – Security

Watson Studio Local comes equipped with an array of security features you can use. Including:

- SAML
 - An administrator can setup SAML2.0 to redirect WSL users to sign in securely through your identity provider's login page
- SSH
 - You can install WSL using a private SSH key file for the credentials
 - A WSL administrator can enable SSHD so that users (using a public SSH key pair) can ssh directly to the WSL cluster through a secure port.
- SSL
- Tokens
- Authentication
- Authorization
- Data

Audit Log

- WSL logs an audit record of user login attempts (either from the sign in page or using the validateAuth REST API) to the WSL cluster
- The record is stored as JSON, and contains the following information about each login attempt:

Template:

```
{  
  "DSX_AUDIT_RECORD": {  
    "version": "1.0",  
    "event": "user_auth",  
    "timestamp": Request timestamp in ISO8601 DateTime with  
    Timeszone format  
    "user_auth_object": {  
      "user_auth_object_version": "1.0",  
      "uri": Request URI  
      "username": The user name used to attempt the login,  
      "status": Result Status code (e.g. 200: OK, 401:  
      Authorization failure)  
    }  
  }  
}
```

Example:

```
{  
  "DSX_AUDIT_RECORD": {  
    "version": "1.0",  
    "event": "user_auth",  
    "timestamp": "2018-03-08T06:38:00+00:00",  
    "user_auth_object": {  
      "user_auth_object_version": "1.0",  
      "uri": "\/v1\/preauth\/validateAuth",  
      "username": "admin",  
      "status": 200  
    }  
  }  
}
```

Audit Records

- All audit records are retained for a default of 10 days before they are automatically deleted
- The WS administrator can modify the log retention settings by clicking Settings from the admin user profile icon and under Refresh and alert settings, typing in a new duration in the Log retention (days) field
- **Tip:** The admin could download the user login audit records using the REST API periodically, before they are automatically deleted for long term storage

IBM Watson Studio Local (WSL) – Security

Get User Bearer Tokens

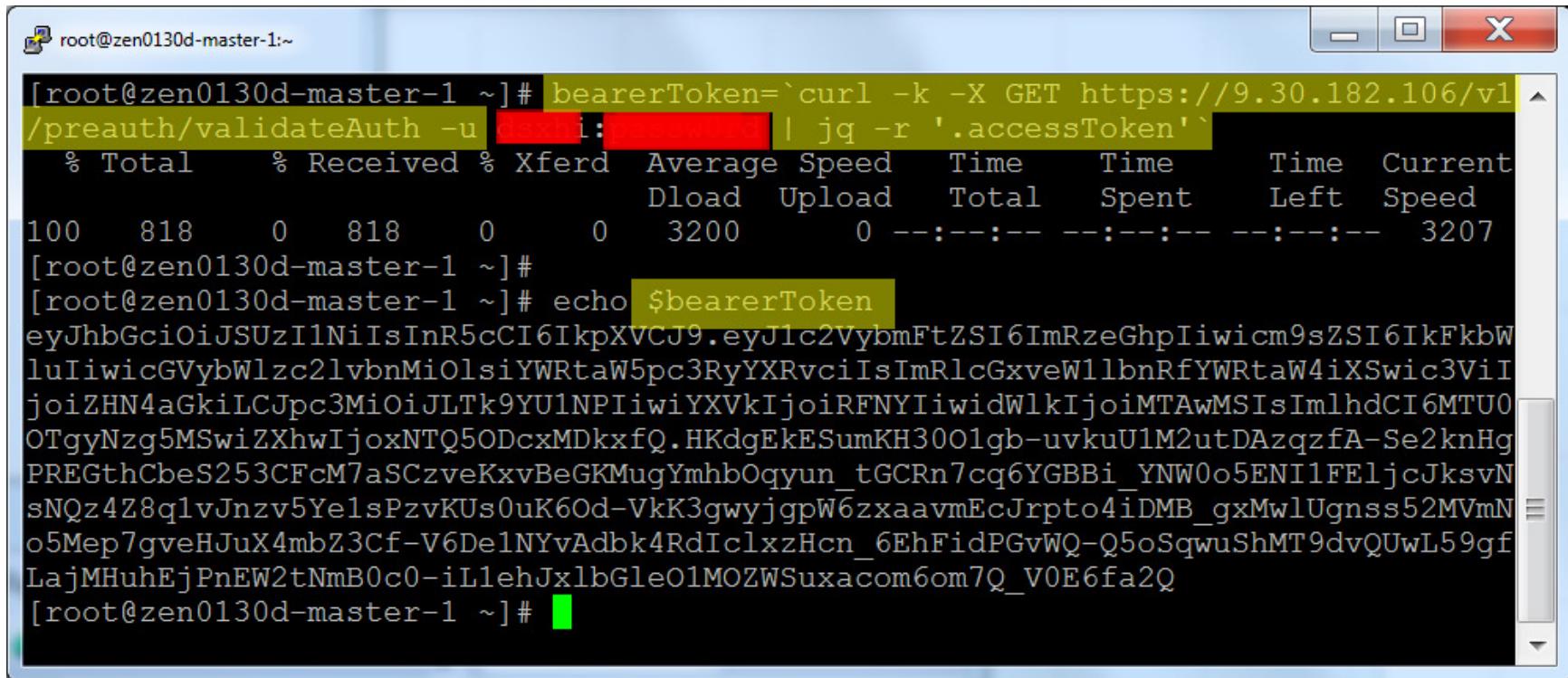
- WSL requires a bearer token to authenticate the user calling the REST APIs.
- The token lasts for 13 hours. The following example shows how to retrieve and set a bearer token from the user management service:

Example

```
# bearerToken=`curl -k -X GET <WSL_URL>/v1/preauth/validateAuth -u <uid>:<password> | jq -r '.accessToken'
```

IBM Watson Studio Local (WSL) – Security

Get User Bearer Tokens



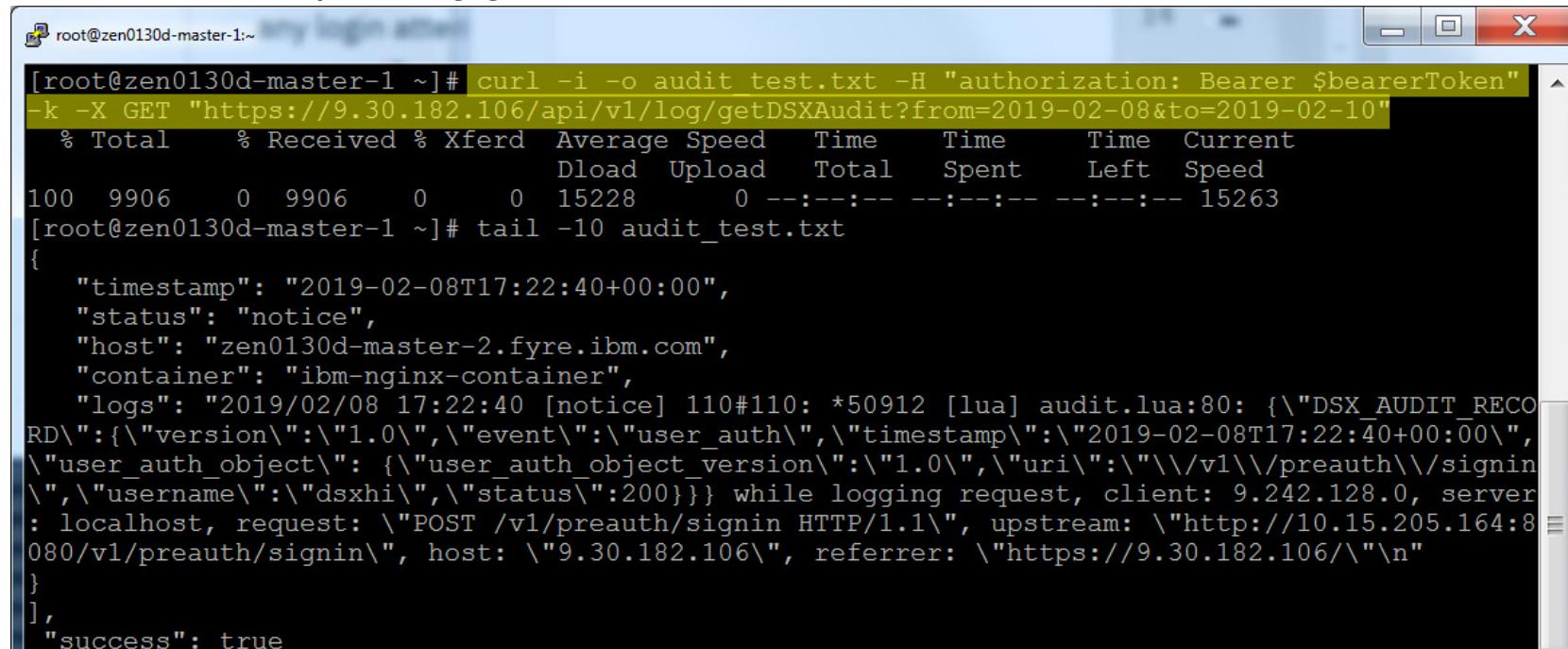
```
root@zen0130d-master-1:~]# bearerToken=`curl -k -X GET https://9.30.182.106/v1/preauth/validateAuth -u [REDACTED]:[REDACTED] | jq -r '.accessToken'`  
% Total    % Received % Xferd  Average Speed   Time     Time      Current  
          Dload  Upload   Total  Spent  Left  Speed  
100  818    0  818    0    0  3200      0 --:--:-- --:--:-- --:--:-- 3207  
[root@zen0130d-master-1 ~]#  
[root@zen0130d-master-1 ~]# echo $bearerToken  
eyJhbGciOiJSUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VybmcFtZSI6ImRzeGhpIiwicm9sZSI6IkFkbWluIiwicGVybWlzc2lvbnMiOlsiYWRtaW5pc3RyYXRvciiSImRlcGxveW1lbnRfYWRtaW4iXSwic3ViIjoiZHN4aGkiLCJpc3MiOiJLTk9YU1NPIiwiYXVkIjoiRFNYIiwidWlkIjoiMTAwMSIsImhdCI6MTU0OTgyNzg5MSwiZXhwIjoxNTQ5ODcxMDkxfQ.HKdgEkESumKH3001gb-uvkuU1M2utDAzqzfA-Se2knHgPREGthCbes253CFcM7aSCzveKxvBeGKMugYmhboqyuu_tGCRn7cq6YGBBi_YNW0o5ENI1FE1jcJksvNsNQz4Zq1vJnzb5Ye1sPzvKUs0uK6Od-VkK3gwyjgpW6zxaavmEcJrpto4iDMB_gxMwlUgnss52MVmNo5Mep7gveHJuX4mbZ3Cf-V6De1NYvAdbk4RdIclxzHcn_6EhFidPGvWQ-Q5oSqwuShMT9dvQUwL59gfLajMHuhEjPnEW2tNmB0c0-iL1ehJxlbgLe01MOZWSuxacom6om7Q_V0E6fa2Q  
[root@zen0130d-master-1 ~]#
```

IBM Watson Studio Local (WSL) – Security

Get Server Audit Logs

Example

```
# curl -i -o audit_test.txt -H "authorization: Bearer $bearerToken" -k -X GET  
“<WSL_URL>/api/v1/log/getDSXAudit?from=2019-02-08&to=2019-02-10”
```



The screenshot shows a terminal window with the following content:

```
[root@zen0130d-master-1 ~]# curl -i -o audit_test.txt -H "authorization: Bearer $bearerToken" -k -X GET "https://9.30.182.106/api/v1/log/getDSXAudit?from=2019-02-08&to=2019-02-10"  
% Total    % Received % Xferd  Average Speed   Time     Time      Time  Current  
          Dload  Upload   Total Spent  Left Speed  
100  9906     0  9906     0      0  15228       0 --:--:-- --:--:-- --:--:-- 15263  
[root@zen0130d-master-1 ~]# tail -10 audit_test.txt  
{  
  "timestamp": "2019-02-08T17:22:40+00:00",  
  "status": "notice",  
  "host": "zen0130d-master-2.fyre.ibm.com",  
  "container": "ibm-nginx-container",  
  "logs": "2019/02/08 17:22:40 [notice] 110#110: *50912 [lua] audit.lua:80: {\"DSX_AUDIT_RECO  
RD\":{\"version\":\"1.0\",\"event\":\"user_auth\",\"timestamp\":\"2019-02-08T17:22:40+00:00\",  
\"user_auth_object\": {\"user_auth_object_version\":\"1.0\",\"uri\":\"\\v1\\preauth\\signin\",  
\"username\":\"dsxhi\",\"status\":200}}} while logging request, client: 9.242.128.0, server:  
localhost, request: \"POST /v1/preauth/signin HTTP/1.1\", upstream: \"http://10.15.205.164:8  
080/v1/preauth/signin\", host: \"9.30.182.106\", referrer: \"https://9.30.182.106/\\n\"  
}  
],  
  "success": true
```

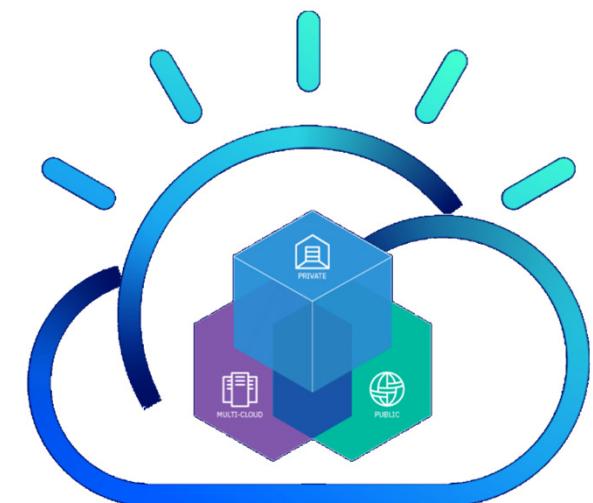
IBM Watson Studio Local (WSL) – Security

Usage Report

- Every day at 1AM (machine time) WSL creates and stores a report of users signing into the system.
- To retrieve these usage report files, run the script “/wdp/utils/get_usage_reports.sh” on any one of the master nodes.
- The script saves zipped usage reports in the ws_usage_reports directory.
- Each usage report is a comma delimited CSV file with the column: Username, Login timestamp.
- Example report:

```
test_user_1_36, 2018-12-12T18:04:23+00:00
test_user_1_29, 2018-12-12T18:04:23+00:00
test_user_1_62, 2018-12-12T18:04:22+00:00
test_user_1_2, 2018-12-12T18:04:22+00:00
test_user_1_83, 2018-12-12T18:04:21+00:00
test_user_1_3, 2018-12-12T18:04:21+00:00
test_user_1_46, 2018-12-12T18:04:20+00:00
```

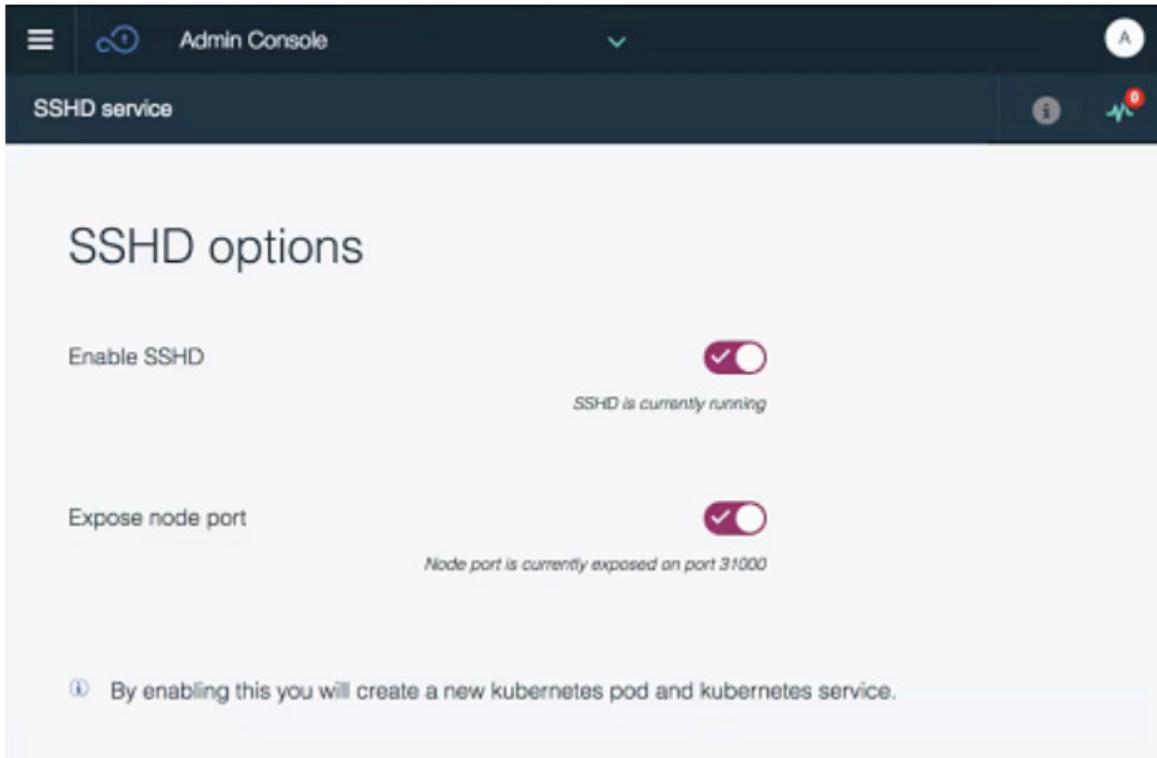
Watson Studio Local Administration SSHD



SSHD Service

- SSH connection to Watson Studio Local is disabled by default. To enable the connection, do the following steps:
 - In the Admin Console, click the menu icon (≡) and click SSHD service. The SSHD options window opens.
 - For Enable SSHD, switch SSHD on. A new kubernetes pod and service starts.
 - For Expose node port switch the node port on to expose a secure kubernetes port.

Enable SSHD Service



The screenshot shows the IBM Admin Console interface for managing the SSHD service. The top navigation bar includes icons for navigation, search, and user authentication, followed by the text "Admin Console". Below the navigation is a header bar with the title "SSHD service" and several status indicators: a blue circle with an "i", a green circle with a heart rate monitor icon, and a red circle with the number "0".

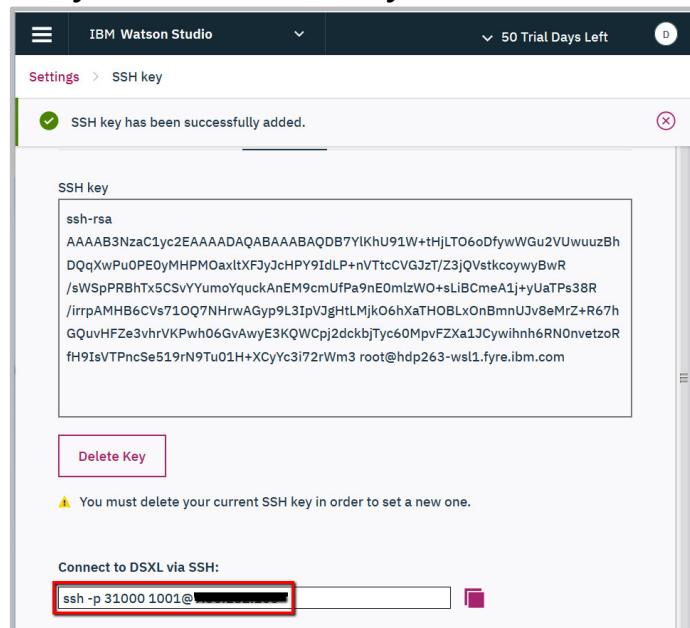
The main content area is titled "SSHD options". It contains two configuration sections:

- Enable SSHD**: A toggle switch is set to the "on" position, indicated by a checkmark inside the circle. Below the switch, the text "SSHD is currently running" is displayed.
- Expose node port**: A toggle switch is set to the "on" position. Below the switch, the text "Node port is currently exposed on port 31000" is displayed.

A note at the bottom left states: "By enabling this you will create a new kubernetes pod and kubernetes service."

Configure the SSH key in Watson Studio Local

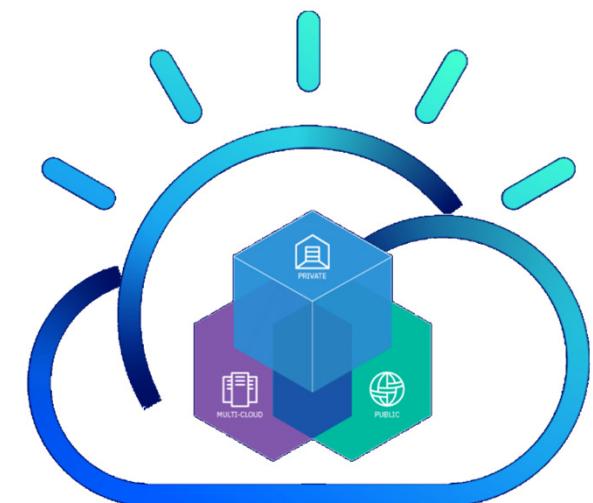
- To setup an SSH connection to WSL, a WSL user must complete the following steps:
 - In the WSL client, go to **Settings** and click the **SSH** key tab.
 - In the SSH key field, paste in the public SSH key. Click the Add Key button. The public SSH key is automatically saved in the user's home directory on the WSL cluster.



- In the Connection via SSH field, copy the ssh command and paste it into the SSH client.
- WSL user can then ssh to the Watson Studio Local cluster through the secure port.

Tip: To upload large files, place them in /user-home/_global_/libraryProjects/<YourLibrary>/datasets.

Watson Studio Local Administration Replace Nodes



Replace Nodes – Master Node

- If a master or compute node fails, a WSL administrator can manually replace it at the command line
- The process to do so is quite involved for any of the nodes, so it will not be covered here; the URL where the process is documented is found below:
 - https://content-dsxlocal.mybluemix.net/docs/content/SSAS34_current/local/replacenodes.html

Watson Studio Local Administration Manage Library & Package



Install Custom or 3rd Party Library – Notebooks

- You can add processing capabilities to Apache Spark in WSL by installing external or third-party libraries
- WSL includes many pre-installed libraries
- Before you install a library, check the list of preinstalled libraries. Run the appropriate command from a notebook cell:

- Python: `!pip list --isolated`
- R: `installed.packages()`

- If the library you want to use is not listed, then you can use the commands on the following slides to install it

Install Local Python Library – Notebooks

- Use the Python pip package installer command to install Python libraries to your notebook
 - For example, using the command “*!pip install prettyplotlib*” installs the prettyplotlib library into a pod’s conda and removes the package once the pod is terminated
 - Or using the command “*!pip install –user prettyplotlib*” installs the prettyplotlib library in your user home and the package exists even after the pod is terminated
- Use the Python import command to import the library components
 - Going off our example above, you would then use the command “*import prettyplotlib as ppl*”
- Restart the kernel

Install Global Library & Package

- A WSL administrator can install Python or R packages in global directories. These packages are then made available to all users
- To install a global Python library:
 - Log in to WSLL as admin and create a Python notebook
 - Use the Python pip package installer command to install Python libraries to your notebook for example see the image below:

```
!pip install --target  
/user-home/_global_/python-2.7 prettyplotlib
```

- The installed packages can be used by all notebook users that use the same Python version in the Spark service
- Notebook users can now use the Python import command to import the library components.
 - For example, users can run the following command in a code cell:

```
import prettyplotlib as ppl
```

Install Global Library & Package

- To install a global R package:
 - Log in to WSL as admin and create an R notebook
 - Use the R `install.packages()` function to install new R packages. For example, running the following command would install the `ggplot2` package

```
install.packages("ggplot2")
```

- The imported package can be used by all R notebooks that are running in the Spark service
- Now, users can use the R `library()` function to load the installed package
 - For example, a user can run the following command in a code cell:

```
library("ggplot2")
```

Manage Packages

▪ Administrator

A WSL administrator can install Python or R packages in global directories. These packages are available to all users on the cluster

- **Add a global Spark JAR file**

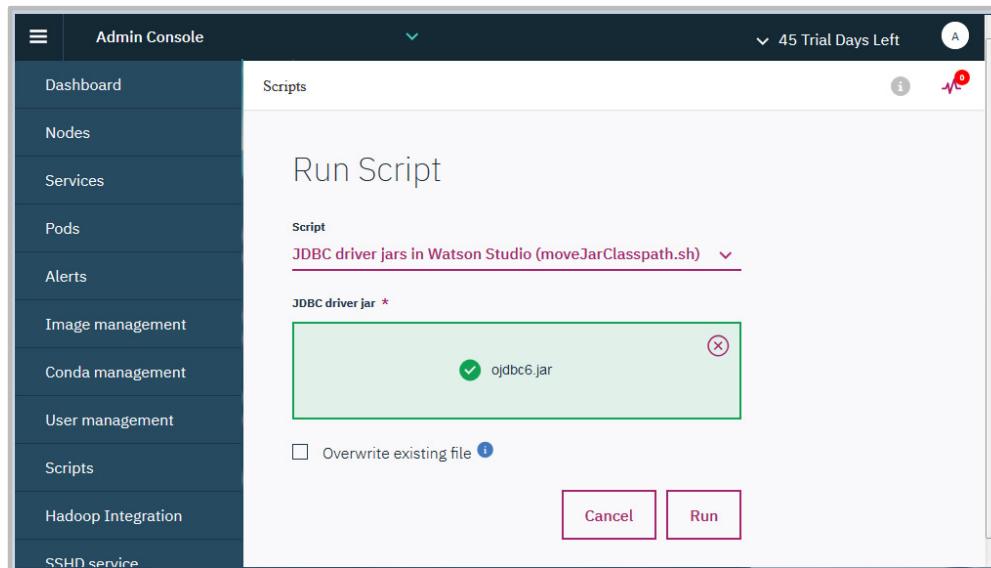
- In the Scripts panel of the Admin console, an administrator can select “Add Spark jars in Watson Studio (moveJarClasspath.sh) to upload JAR files to the /user-home/_global_/spark/jars/ directory for use with Spark.

Manage Packages

▪ Administrator

- Add a JDBC driver

- In the Admin Console, click the menu icon (≡) and click Scripts.
- In the Scripts pull-down menu, select JDBC driver jars in Watson Studio (moveJarClasspath.sh), and click add jar.



Manage Packages

▪ Administrator

- **Install a global Python package**

- Log in to WSL as the default administrator (ie. Admin) and create a Python notebook.
- Use the Python pip package installer command to install Python libraries in the Python notebook.

Example:

```
!pip install --target /user-home/_global_/python-2.7 prettyplotlib
```
- Once the package is installed, it can be used by all notebook users. Example from above installation, users can then use the library simply do: Ex: import prettyplotlib as ppl

Manage Packages

▪ WSL Local User

- Local users can add additional packages to a base image, which can then be reused by other users.
- WSL includes many preinstalled libraries. Check the [list](#) before you install a library. (or type command: “pip list” for Python, “installed.packages()” for R.)

• Install a Python library

- Use the Python conda install. Ex: !conda install prettyplotlib

- Use custom functions/libraries in Python scripts

- **Example:**

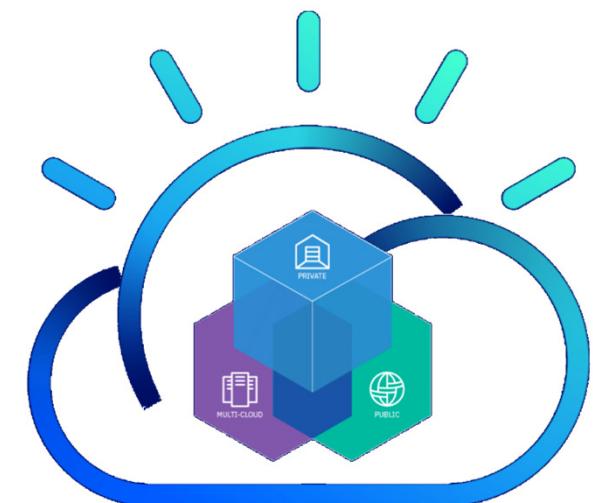
```
sys.path.insert(0, ‘..scripts/’)
from your_custom_script import *
```

• Install a R library

- Example: install.packages(“ggplot2”)

Watson Studio Local

Administration Hadoop Integration



Objective Overview

- Hadoop infrastructure is a huge investment but the tools in the ecosystem are not intuitive for business analyst and users. Most of your data is probably available within your HDFS along with your huge compute capacity but access to it is difficult.
- Build machine learning and analytics on Watson Studio that provides variety of open source libraries and frameworks such as Spark, R, Keras, TensorFlow, Scikit-learn as a service within a kubernetes based platform behind your firewall. Along with cloud agility the platform provides end-end data management and analytics capability with collaboration and lifecycle management functions.
- Hadoop connector provides seamless access to compute power available along with easy access to hdfs data.
- Accelerate your machine learning deployments in hours as oppose to months. Build quick to market business decision making Artificial Intelligence systems easily and quickly.

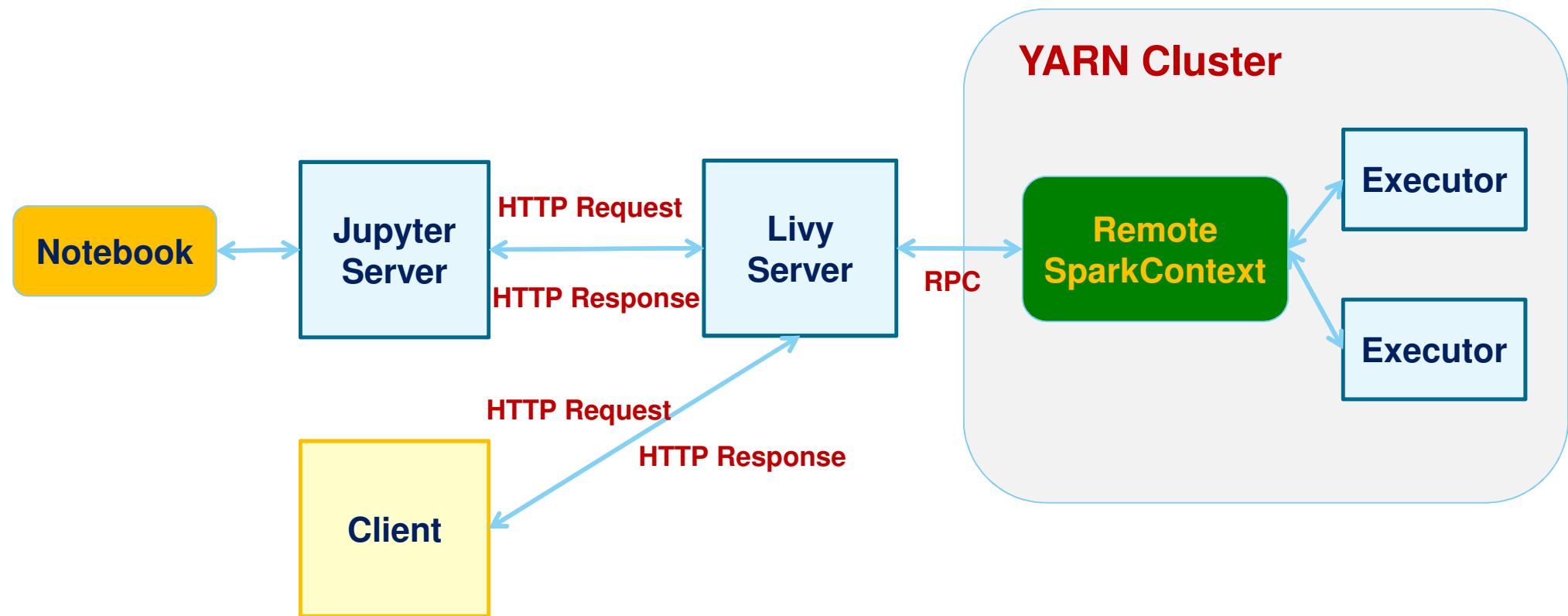
Hadoop Integration – Overview

- The Watson Studio Local Hadoop Integration Service is a registration service that can be installed on a Hadoop edge node.
- WSL Version 1.2 or later clusters can securely access data residing on the Hadoop cluster, submit interactive Spark jobs, build models, and schedule jobs that run as a YARN application.

Important: Your Hadoop admin must install the Hadoop registration service on a Hadoop cluster, add the Watson Studio Local cluster to the Hadoop registration to be managed, and provide the Hadoop registration service user ID and the URLs.

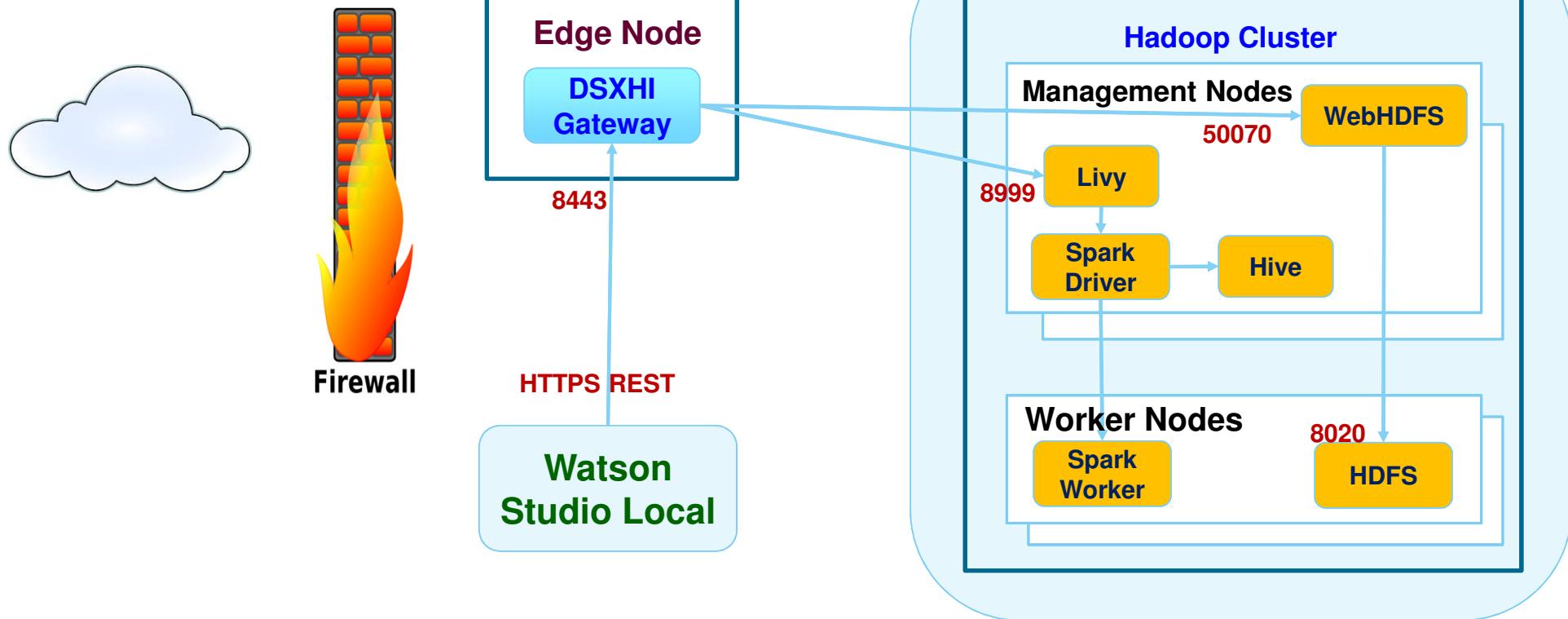
Livy Interface with Spark

Architecture I



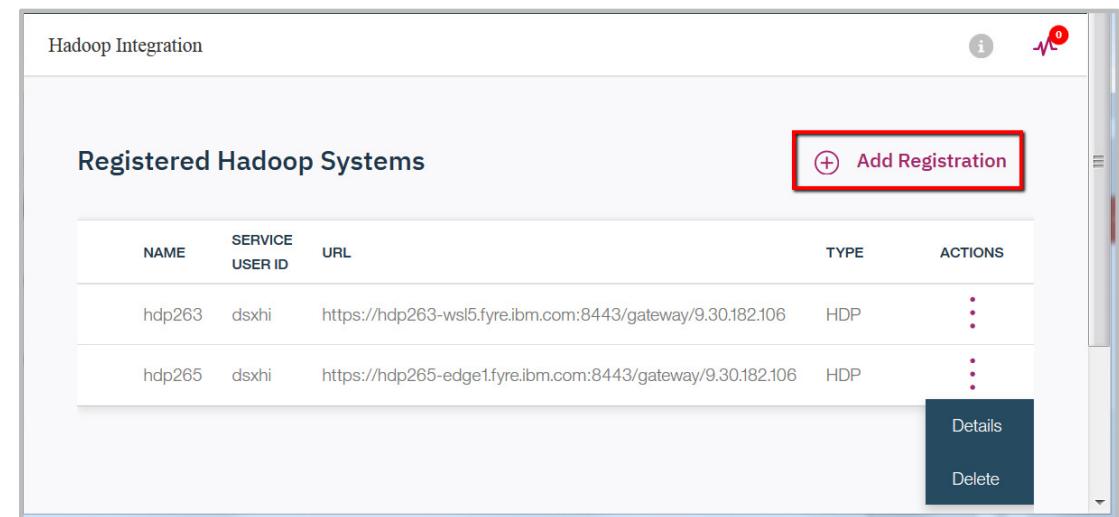
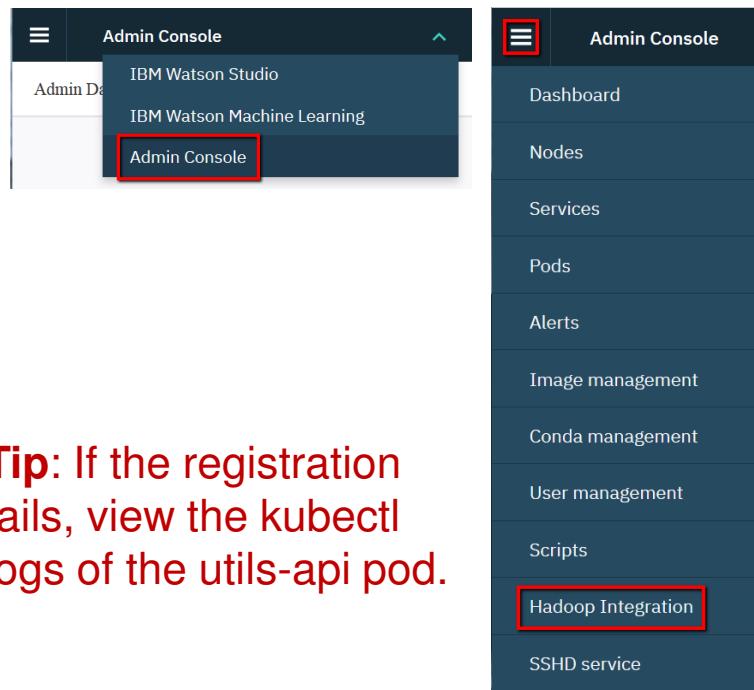
Hadoop Connector Installation & Setup

Architecture



Hadoop Integration – Register a Hadoop Cluster

- In the Admin Console, click the menu icon (☰) and click **Hadoop Integration**.
- HDFS and Hive data sources are automatically created when a Hadoop registration service is registered in WSL admin console.



The image shows the 'Hadoop Integration' page. It displays a table of 'Registered Hadoop Systems' with two entries:

NAME	SERVICE USER ID	URL	TYPE	ACTIONS
hdp263	dsxhi	https://hdp263-wsl5.fyre.ibm.com:8443/gateway/9.30.182.106	HDP	⋮
hdp265	dsxhi	https://hdp265-edge1.fyre.ibm.com:8443/gateway/9.30.182.106	HDP	⋮

A red box highlights the '+ Add Registration' button in the top right corner. A tooltip for the 'Delete' action on the second row is visible.

Tip: If the registration fails, view the kubectl logs of the utils-api pod.

Hadoop Integration – View details about the registered Hadoop cluster

If Livy for Spark and/or Livy for Spark2 services are exposed, WSL users can list these endpoints through `dsx_core_utils` and `dsxCoreUtilsR`, and use them as defined Livy endpoint in Jupyter, RStudio and Zeppelin notebooks.

Python syntax:

```
%python
import dsx_core_utils;
dsx_core_utils.list_dsxhi_livy_endpoints();
```

R syntax:

```
library('dsxCoreUtilsR');
dsxCoreUtilsR::listDSXHILivyEndpoints()
```

Hadoop Integration

FYI. When a Watson Studio Local administrator pushes a custom image to a registered Hadoop system, a notebook can initialize a remote Spark Livy session which runs within an environment associated with that remote custom image:

```
import dsx_core_utils
%load_ext sparkmagic.magics

# Retrieve a list of registered Hadoop Integration systems.
DSXHI_SYSTEMS = dsx_core_utils.get_dsxhi_info(showSummary=True)

Available Hadoop systems:

systemName    LIVYSPARK   LIVYSPARK2  imageId
0      hdp263  livyspark  livyspark2
1      hdp265  livyspark  livyspark2
```

```
session_name = 'spark2_0205'
livy_endpoint = HI_CONFIG['LIVY']
webhdfs_endpoint = HI_CONFIG['WEBHDFS']
%spark add -s $session_name -l python -u $livy_endpoint
```

Starting Spark application

ID	YARN Application ID	Kind	State	Spark UI	Driver log	Current session?
12	application_1549042673081_0016	pyspark	idle	Link	Link	✓

Hadoop Integration – Hadoop Gateway Installation & Setup

Installation

- **Pre-req**

- Install Hadoop clients on an edge node (**Recommended) or a node that will host gateway service
- Create a gateway service id on all Hadoop cluster nodes & edge node
 - ✓ Ex. # useradd -u 3001 -g hdfs dsxhi (all Hadoop cluster nodes**)
- Create HDFS directories
 - ✓ Ex. # su - hdfs -c 'hdfs dfs -mkdir -p /user/dsxhi/environments'
 - ✓ # su - hdfs -c 'hdfs dfs -chown -R dsxhi:hdfs /user/dsxhi'
- Collect port information for HDFS, WebHDFS, Livy** (ex. 8020, 50070, 8999)

Hadoop Integration – Hadoop Gateway Installation & Setup

Installation

- **Pre-req**

- Add Hadoop service parameters for gateway service id (listed in below)

- ✓ 1. HDFS custom core-site

hadoop.proxyuser.<service_id>.groups=*

hadoop.proxyuser.<service_id>.hosts=*

- ✓ 2. Hive custom webhcat-site

webhcat.proxyuser. <service_id>.hosts=*

webhcat.proxyuser.<service_id>.groups=*

- ✓ 3. Spark2 custom livy2-conf

livy.superusers=<service_id>

Hadoop Integration – Hadoop Gateway Installation & Setup

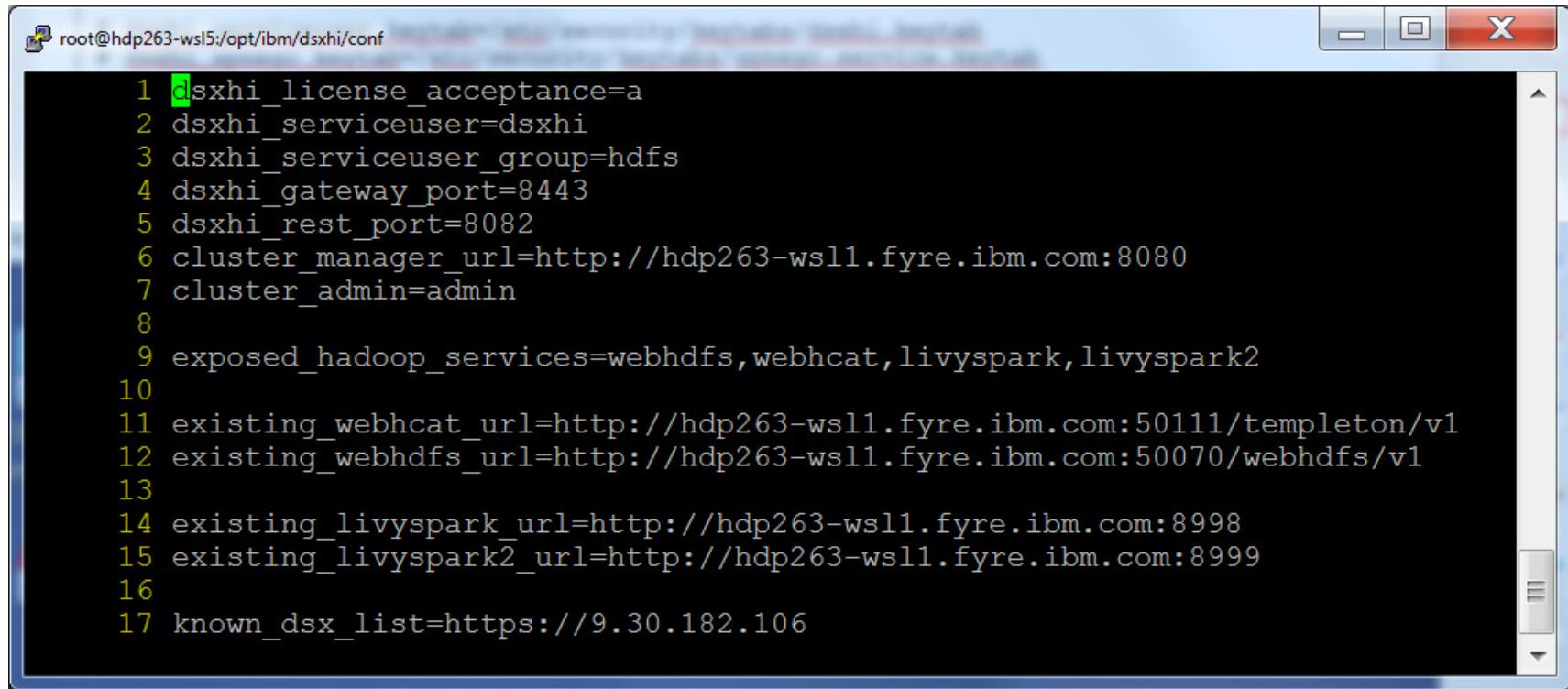
Installation

- **Install Livy connector (dsxhi) rpm package**
 - Download connector rpm file from Passport Advantage
 - Install rpm file (Ex. rpm -ivh dsxhi-icp4data-dsp-1.1.1.0-64.noarch.rpm)
- **Configure Livy connector**
 - Modify configuration files
 - ✓ # cp /opt/ibm/dsxhi/conf/dsxhi_install.conf.template.HDP
/opt/ibm/dsxhi/conf/dsxhi_install.conf
 - ✓ # vi /opt/ibm/dsxhi/conf/dsxhi_install.conf

Hadoop Integration – Hadoop Gateway Installation & Setup

Installation

- ✓ Example:



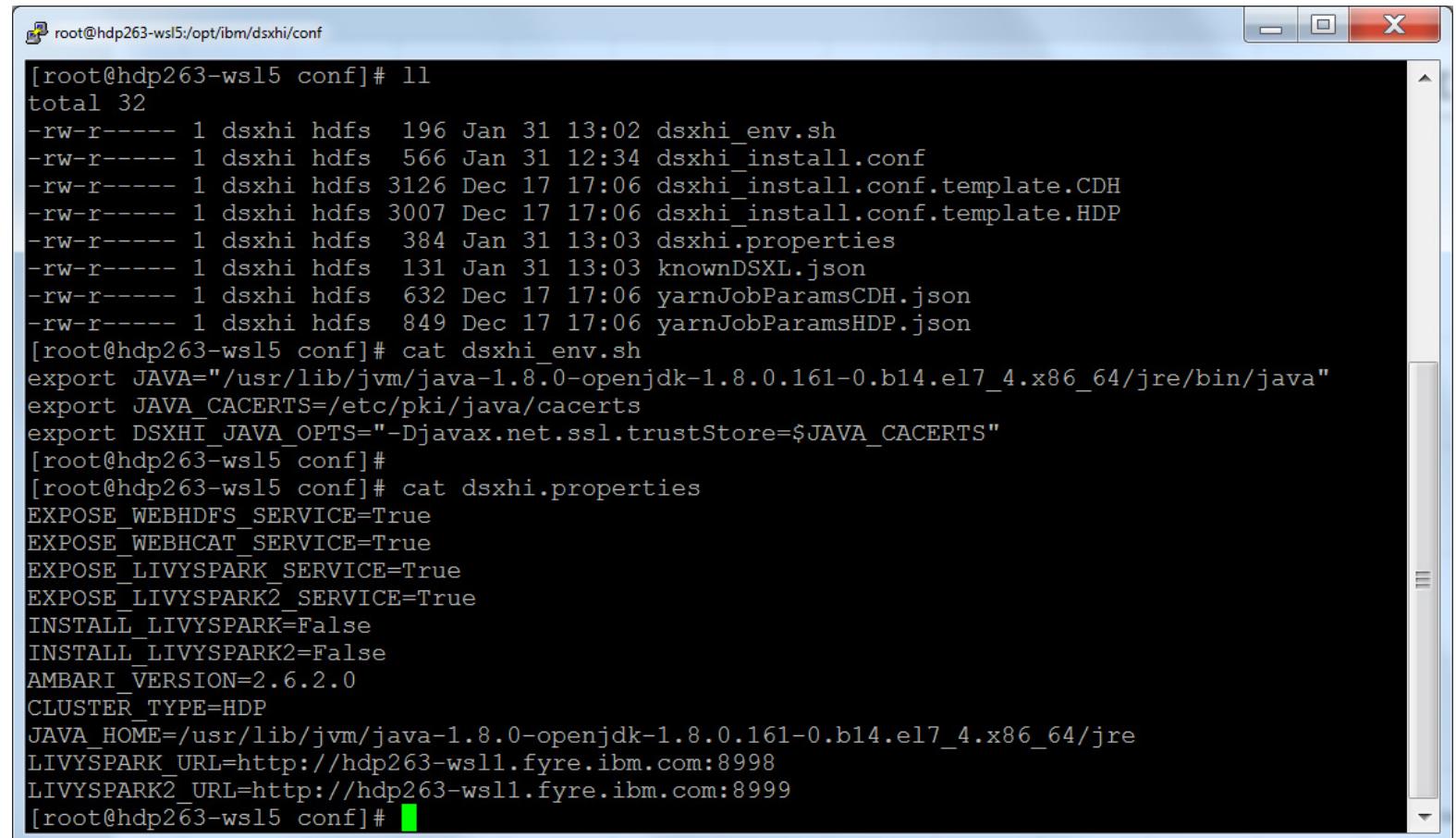
A screenshot of a terminal window titled "root@hdp263-ws15:/opt/ibm/dsxhi/conf". The window displays a configuration file with the following content:

```
1 dsxhi_license_acceptance=a
2 dsxhi_serviceuser=dsxhi
3 dsxhi_serviceuser_group=hdfs
4 dsxhi_gateway_port=8443
5 dsxhi_rest_port=8082
6 cluster_manager_url=http://hdp263-ws11.fyre.ibm.com:8080
7 cluster_admin=admin
8
9 exposed_hadoop_services=webhdfs,webhcatt,livyspark,livyspark2
10
11 existing_webhcatt_url=http://hdp263-ws11.fyre.ibm.com:50111/templeton/v1
12 existing_webhdfs_url=http://hdp263-ws11.fyre.ibm.com:50070/webhdfs/v1
13
14 existing_livyspark_url=http://hdp263-ws11.fyre.ibm.com:8998
15 existing_livyspark2_url=http://hdp263-ws11.fyre.ibm.com:8999
16
17 known_dsx_list=https://9.30.182.106
```

Hadoop Integration – Hadoop Gateway Installation & Setup

Installation

✓ Example:



The screenshot shows a terminal window titled "root@hdp263-ws15: /opt/ibm/dsxhi/conf". The window displays the contents of several configuration files and environment variables. It includes the output of the "ll" command, the content of "dsxhi_env.sh", "dsxhi.properties", and "dsxhi.conf". The "dsxhi_env.sh" script sets JAVA_HOME and JAVA_CACERTS. The "dsxhi.properties" file contains various service configurations like EXPOSE_WebHDFS_SERVICE=True and CLUSTER_TYPE=HDP.

```
[root@hdp263-ws15 conf]# ll
total 32
-rw-r----- 1 dsxhi hdfs 196 Jan 31 13:02 dsxhi_env.sh
-rw-r----- 1 dsxhi hdfs 566 Jan 31 12:34 dsxhi_install.conf
-rw-r----- 1 dsxhi hdfs 3126 Dec 17 17:06 dsxhi_install.conf.template.CDH
-rw-r----- 1 dsxhi hdfs 3007 Dec 17 17:06 dsxhi_install.conf.template.HDP
-rw-r----- 1 dsxhi hdfs 384 Jan 31 13:03 dsxhi.properties
-rw-r----- 1 dsxhi hdfs 131 Jan 31 13:03 knownDSXL.json
-rw-r----- 1 dsxhi hdfs 632 Dec 17 17:06 yarnJobParamsCDH.json
-rw-r----- 1 dsxhi hdfs 849 Dec 17 17:06 yarnJobParamsHDP.json
[root@hdp263-ws15 conf]# cat dsxhi_env.sh
export JAVA="/usr/lib/jvm/java-1.8.0-openjdk-1.8.0.161-0.b14.el7_4.x86_64/jre/bin/java"
export JAVA_CACERTS=/etc/pki/java/cacerts
export DSXHI_JAVA_OPTS="-Djavax.net.ssl.trustStore=$JAVA_CACERTS"
[root@hdp263-ws15 conf]#
[root@hdp263-ws15 conf]# cat dsxhi.properties
EXPOSE_WEBHDFS_SERVICE=True
EXPOSE_WEBHCAT_SERVICE=True
EXPOSE_LIVYSPARK_SERVICE=True
EXPOSE_LIVYSPARK2_SERVICE=True
INSTALL_LIVYSPARK=False
INSTALL_LIVYSPARK2=False
AMBARI_VERSION=2.6.2.0
CLUSTER_TYPE=HDP
JAVA_HOME=/usr/lib/jvm/java-1.8.0-openjdk-1.8.0.161-0.b14.el7_4.x86_64/jre
LIVYSPARK_URL=http://hdp263-ws11.fyre.ibm.com:8998
LIVYSPARK2_URL=http://hdp263-ws11.fyre.ibm.com:8999
[root@hdp263-ws15 conf]#
```

Hadoop Integration – Hadoop Gateway Installation & Setup

Installation

- **Install Livy connector (dsxhi)**

- Install connector

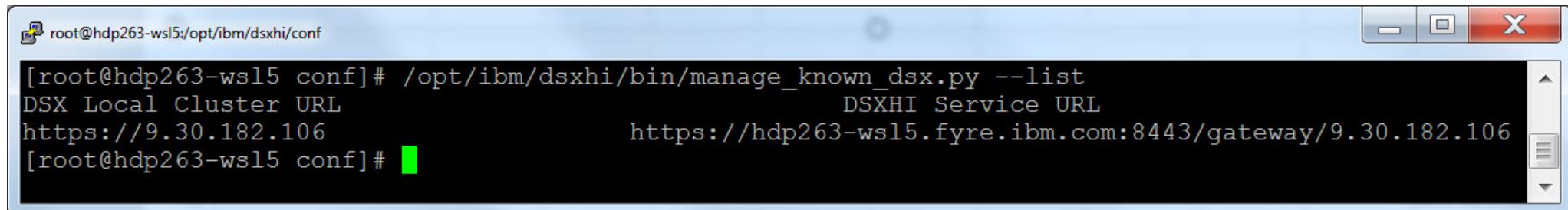
```
# /opt/ibm/dsxhi/bin/install.py --dsxhi_gateway_master_password=<password> --  
password=<password>
```

```
IBM Data Science Experience Hadoop Integration Service  
-----  
Terms and Conditions: http://www14.software.ibm.com/cgi-  
bin/weblap/lap.pl?la_formnum=&li_formnum=L-KLSY-  
AVZW2D&title=IBM+Data+Science+Experience+Hadoop+Integration&l=en  
  
--Determining properties  
--Running the prechecks  
  
--Install Livy for Spark / Spark 2  
--Configure gateway  
--Create template for gateway  
--Setting up known DSX Local clusters  
--Install dsxhi_rest  
--Start all services  
--Install finished. Check status in /var/log/dsxhi/dsxhi.log
```

Hadoop Integration – Hadoop Gateway Installation & Setup

Verify Installation

- **Livy connector process status check**
 - /opt/ibm/dsxhi/bin/status.py
- **List registered WSL cluster(s)**
 - /opt/ibm/dsxhi/bin/manage_known_dsx.py –list
- **Register/Add new WSL cluster**
 - /opt/ibm/dsxhi/bin/manage_known_dsx.py --add https://<WSL_FQDN>



```
[root@hdp263-ws15:/opt/ibm/dsxhi/conf]# /opt/ibm/dsxhi/bin/manage_known_dsx.py --list
DSX Local Cluster URL                               DSXHI Service URL
https://9.30.182.106                                https://hdp263-ws15.fyre.ibm.com:8443/gateway/9.30.182.106
[root@hdp263-ws15 conf]#
```

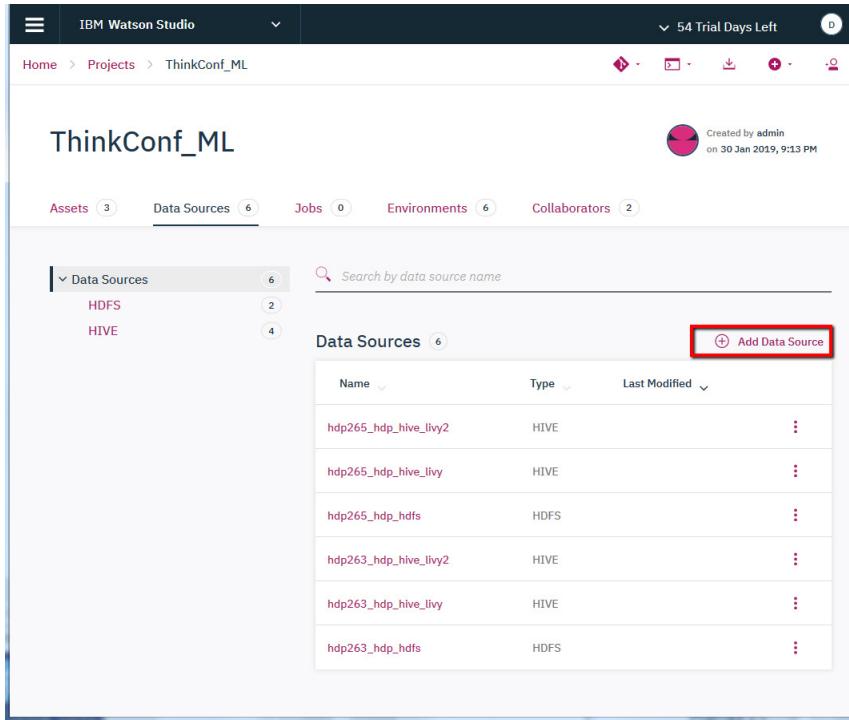
Hadoop Integration – Hadoop Gateway Testing & Troubleshoot

- Retrieve data from HDFS file system
- Access to Hive database table data
- Push down Spark job/task to the remote Spark2 server on Hadoop cluster

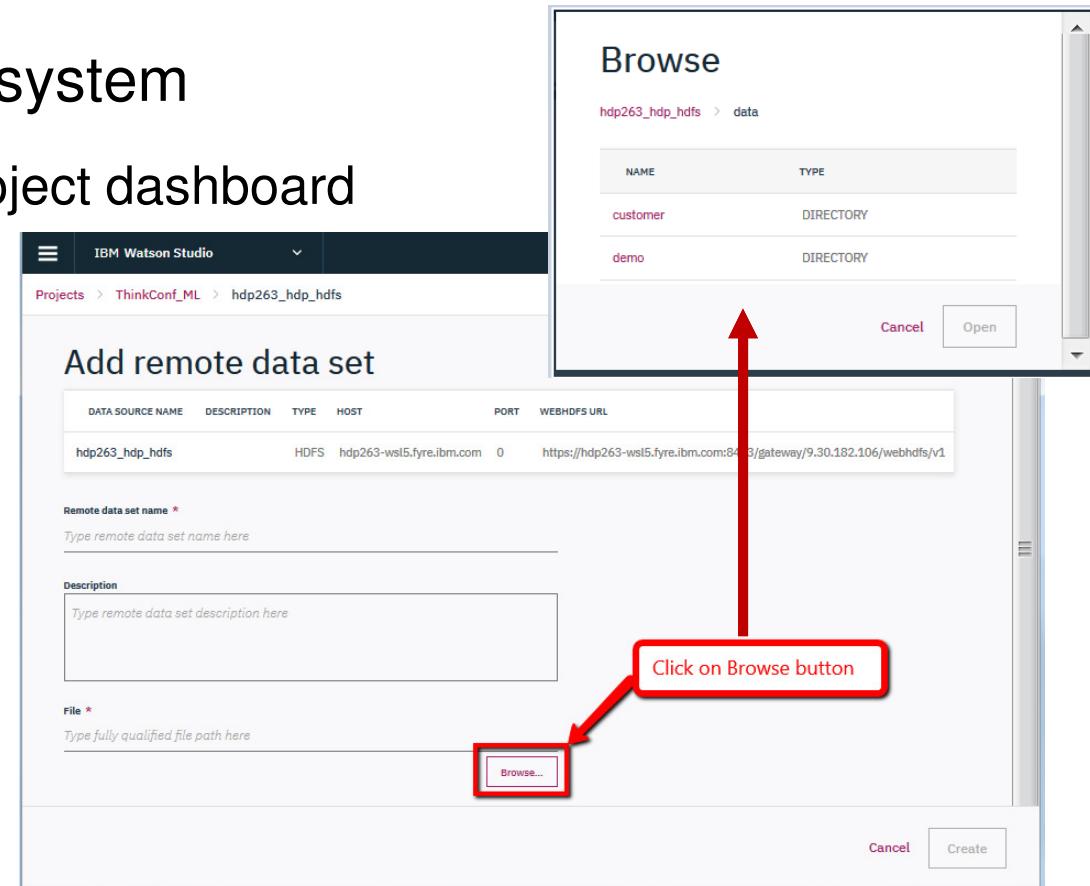
Hadoop Integration – Hadoop Gateway Testing & Troubleshoot

1. Retrieving data from HDFS file system

- Add a remote data source from project dashboard



The screenshot shows the IBM Watson Studio interface for a project named "ThinkConf_ML". In the top navigation bar, there are tabs for Home, Projects, ThinkConf_ML, and several status indicators like Trial Days Left (54). Below the navigation, there are sections for Assets, Data Sources (6), Jobs (0), Environments (6), and Collaborators (2). The "Data Sources" section is expanded, showing two categories: HDFS (2) and HIVE (4). A search bar is present above the list of data sources. A red box highlights the "Add Data Source" button at the top right of the list.



The screenshot shows the "Add remote data set" dialog box. It includes fields for DATA SOURCE NAME (hdp263_hdp_hdfs), DESCRIPTION, TYPE (HDFS), HOST (hdp263-wsl5.fyre.ibm.com), PORT (0), and WEBHDFS URL (https://hdp263-wsl5.fyre.ibm.com:843/gateway/9.30.182.106/webhdfs/v1). Below these, there are fields for Remote data set name, Description, and File. A red box highlights the "Browse..." button next to the File field. A red arrow points from this highlighted button to a separate "Browse" dialog box shown on the right.

Hadoop Integration – Hadoop Gateway Testing & Troubleshoot

2. Use added remote HDFS data source in Notebooks

- Click on icon () and select the Remote data source created from previous instruction; then select “Insert Spark DataFrame in Python”.

```
In [1]: import platform
print(platform.python_version())
3.5.5

In [2]: import dateutil
import requests
os, io
import unicodedata
from requests import Session
from spark import SparkSession
# Add access from remote connection
if __name__ == "__main__":
    datasets = dax_core_utils.get_remote_data_set_info("remote_esh_customer")
    dataSource = dax_core_utils.get_data_source_info(dataSource="datasource")
    sparkSession = SparkSession.builder.getOrCreate()
    # Access HDFS dataset using S3C port with hdfs protocol
    if ("HDFS" in dataSource["type"] and not dataSource["URL"]):
        url = "http://10.10.10.10:9000" + dataSource["path"]
        fileFullPath = url + datasets["file"]
        headers = {"X-SECURITY-PORT": "true", "inferSchema": "true"}
        df = sparkSession.read.csv(fileFullPath, header="true", **headers)
        # Access S3C dataset using S3C port with a suffix .orc
    elif ("HDFS" in dataSource["type"] and dataSource["URL"]):
        url = "http://10.10.10.10:9000" + dataSource["path"]
        headers = {"X-SECURITY-PORT": "true", "inferSchema": "true"}
        df = sparkSession.read.csv(url, header="true", **headers)
    else:
        raise Exception("Unknown data source type")
    # Access CSV dataset using S3C port
    if ("CSV" in dataSource["type"] and not dataSource["URL"]):
        url = "http://10.10.10.10:9000" + dataSource["path"]
        headers = {"X-SECURITY-PORT": "true", "inferSchema": "true", "sep": "\t", "header": "true", "maxRows": 10, "maxColumns": 10, "lineSep": "\n", "allowRedirections": "true"}
        response = requests.request("GET", url, headers=headers, timeout=10, verify=False)
        df = pd.read_csv(pd.compat.StringIO(response.text), sep="\t", header="true", max_rows=10, max_columns=10, line_sep="\n")
        raise Exception("df.read_csv(url, **headers) * returned when sending a request to " + url + " *")
    else:
        if not datasets["file"].endswith("json") or not datasets["file"].endswith("txt")):
            raise Exception("Invalid file type that is not txt or json")
        count = 5
        reader = csv.reader(response.text.encode("utf-8"), encoding="utf-8"))
        formattedData = []
        for row in reader:
            if len(row) <= 1:
                continue
            rdd = sc.parallelize(formattedData)
            headers = rdd.first()
            df1 = rdd.filter(lambda row : row != headers).toDF(headers)
            df1.show(5)
```

Hadoop Integration – Hadoop Gateway Testing & Troubleshoot

3. Load HDFS dataset via remote Spark session

- Example code:

```
import dsx_core_utils, requests, jaydebeapi, os, io, sys
import pandas as pd
url = 'https://hdp263-
wsl5.fyre.ibm.com:8443/gateway/9.30.182.106/webhdfs/v1/data/demo/customer/enhanced_customer.csv?OP=OPEN'
headers = {'Authorization': os.environ.get('DSX_TOKEN')}
response = requests.request("GET", url, headers=headers, timeout=10, verify=False, allow_redirects=True)
df = pd.read_csv(io.StringIO(response.text, newline=None), sep=',')
df.head()
```

```
In [6]: import dsx_core_utils, requests, jaydebeapi, os, io, sys
import pandas as pd
url = 'https://hdp263-wsl5.fyre.ibm.com:8443/gateway/9.30.182.106/webhdfs/v1/data/demo/customer/enhanced_customer.csv?OP=OPEN'
headers = {'Authorization': os.environ.get('DSX_TOKEN')}
response = requests.request("GET", url, headers=headers, timeout=10, verify=False, allow_redirects=True)
df = pd.read_csv(io.StringIO(response.text, newline=None), sep=',')
df.head()
```

Out [6]:

	PHASE	ID	LONGDISTANCE	INTERNATIONAL	LOCAL	DROPPED	PAYMETHOD	LOCALBILLTYPE	LONGDISTANCEBILLTYPE	USAGE	RATEPLAN	GENDER
0	Adult	1	23	0	206	0	CC	Budget	Intl_discount	229	3	F
1	Adult	11	26	0	32	1	CC	Budget	Standard	59	1	M
2	Adult	14	5	0	23	0	CH	Budget	Intl_discount	28	1	F
3	Adult	17	12	0	46	4	CC	FreeLocal	Standard	58	1	M
4	Adult	21	20	0	13	0	CC	Budget	Standard	34	3	M

Hadoop Integration – Hadoop Gateway Testing & Troubleshoot

4. Load HDFS dataset via “PyWebHdfs” package

```
import json
from pywebhdfs.webhdfs import PyWebHdfsClient
headers = {'Authorization': os.environ.get('DSX_TOKEN')}
url = 'https://hdp263-wsl5.fyre.ibm.com:8443/gateway/9.30.182.106/webhdfs/v1'
hdfs = PyWebHdfsClient(base_uri_pattern=url, request_extra_opts={'verify': False}, request_extra_headers=headers)
print(json.dumps(hdfs.list_dir('/'), indent=1))
```

```
In [19]: import json
from pywebhdfs.webhdfs import PyWebHdfsClient
headers = {'Authorization': os.environ.get('DSX_TOKEN')}

url = 'https://hdp263-wsl5.fyre.ibm.com:8443/gateway/9.30.182.106/webhdfs/v1'
hdfs = PyWebHdfsClient(base_uri_pattern=url, request_extra_opts={'verify': False}, request_extra_headers=headers)
print(json.dumps(hdfs.list_dir('/'), indent=1))

{
  "FileStatuses": [
    "FileStatus": [
      {
        "group": "hadoop",
        "modificationTime": 1548968993029,
        "permission": "777",
        "pathSuffix": "app-logs",
        "type": "DIRECTORY",
        "fileId": 16396,
        "blockSize": 0,
        "accessTime": 0,
        "storagePolicy": 0,
        "owner": "yarn",
        "length": 0,
        "replication": 0,
        "childrenNum": 4
      },
      {
        "group": "hadoop",
        "modificationTime": 1548968993029,
        "permission": "777",
        "pathSuffix": "app-logs",
        "type": "DIRECTORY",
        "fileId": 16397,
        "blockSize": 0,
        "accessTime": 0,
        "storagePolicy": 0,
        "owner": "yarn",
        "length": 0,
        "replication": 0,
        "childrenNum": 4
      }
    ]
  ]
}
```

Hadoop Integration – Hadoop Gateway Testing & Troubleshoot

5. Access Hive data

- %%spark -s <session_name> -c sql -o <local_dataframe>
select gender, count(gender) from ext_customer group by gender order by gender
print(type(df_ex_cust_local))
print(df_ex_cust_local)

```
In [9]: %%spark -s $session_name -c sql
show tables
```

```
Out[9]:


|   | database | tableName    | isTemporary |
|---|----------|--------------|-------------|
| 0 | default  | del2         | False       |
| 1 | default  | ext_customer | False       |


```

```
In [12]: %%spark -s $session_name -o df_ex_cust_local -c sql
select gender, count(gender) from ext_customer group by gender order by gender
```

```
Out[12]:


|   | gender | count(gender) |
|---|--------|---------------|
| 0 | F      | 1316          |
| 1 | GENDER | 1             |
| 2 | M      | 750           |


```

```
In [15]: print(type(df_ex_cust_local))
print(df_ex_cust_local)
```

```
<class 'pandas.core.frame.DataFrame'>
   gender  count(gender)
0        F          1316
1    GENDER          1
2        M          750
```

Hadoop Integration – Hadoop Gateway Testing & Troubleshoot

6. Push down Spark processing

```
In [25]: import dsx_core_utils
%load_ext sparkmagic.magics
# Retrieve a list of registered Hadoop Integration systems.
DSXHI_SYSTEMS = dsx_core_utils.get_dsxhi_info(showSummary=True)

The sparkmagic.magics extension is already loaded. To reload it, use:
%reload_ext sparkmagic.magics
Available Hadoop systems:

systemName    LIVYSPARK   LIVYSPARK2 imageId
0      hdp263  livyspark  livyspark2
1      hdp265  livyspark  livyspark2
```

```
In [26]: # Set up sparkmagic to connect to the selected registered HI systemName above.
myConfig={
    "queue": "default",
    "driverMemory": "512M",
    "numExecutors": 1,
    "executorMemory": "512M"
}
HI_CONFIG = dsx_core_utils.setup_livy_sparkmagic(
    system="hdp263",
    livy="livyspark2",
    imageId=None,
    addlConfig=myConfig)
# (Re-)load spark magic to apply the new configs.
%reload_ext sparkmagic.magics
```

sparkmagic has been configured to use <https://hdp263-wsl5.fyre.ibm.com:8443/gateway/9.30.182.106/livy2/v1>
success configuring sparkmagic livy.

Hadoop Integration – Hadoop Gateway Testing & Troubleshoot

6. Push down Spark processing

```
In [27]: %spark cleanup
session_name = 'spark2_0205a'
livy_endpoint = HI_CONFIG['LIVY']
webhdfs_endpoint = HI_CONFIG['WEBHDFS']
%spark add -s $session_name -l python -u $livy_endpoint
```

Starting Spark application

ID	YARN Application ID	Kind	State	Spark UI	Driver log	Current session?
4	application_1549042673081_0007	pyspark	idle	Link	Link	✓

SparkSession available as 'spark'.

```
In [28]: %spark info
```

```
Info for running Spark:
Sessions:
  Name: spark2_0205a    Session id: 4    YARN id: application_1549042673081_0007 Kind: pyspark    State: idle
  Spark UI: http://hdp263-ws12.fyre.ibm.com:8088/proxy/application\_1549042673081\_0007/
  Driver Log: http://hdp263-ws15.fyre.ibm.com:8042/node/containerlogs/container\_e02\_1549042673081\_0007\_01\_000001/dsxhi
Session configs:
  {'conf': {'spark.yarn.appMasterEnv.HI_UTILS_PATH': '/user/dsxhi/environments/pythonAddons/hi_core_utils.zip'}, 'proxyUser': 'dsxhi', 'numExecutors': 1, 'queue': 'default', 'driverMemory': '512M', 'executorMemory': '512M'}
```

Hadoop Integration – Hadoop Gateway Testing & Troubleshoot

6. Push down Spark processing

```
In [29]: %%spark -s $session_name
import socket
print("Remote livy session driver: {}".format(socket.gethostname()))

Remote livy session driver: hdp263-wsl5.fyre.ibm.com

In [30]: %%spark -s $session_name
import socket
print("Remote livy session driver: {}".format(socket.gethostname()))

Remote livy session driver: hdp263-wsl5.fyre.ibm.com

In [32]: %%spark

file_customer = "hdfs:///data/demo/customer/enhanced_customer.csv"
df_cust = spark.read.format("org.apache.spark.sql.execution.datasources.csv.CSVFileFormat").option("header", "true").option("inferSchema", "true").load(file_customer)
df_cust.printSchema()

print("Total number of customer dataset row count: {}\n".format(df_cust.count()))

root
|-- PHASE: string (nullable = true)
|-- ID: integer (nullable = true)
|-- LONGDISTANCE: integer (nullable = true)
|-- INTERNATIONAL: integer (nullable = true)
|-- LOCAL: integer (nullable = true)
|-- DROPPED: integer (nullable = true)
|-- PAYMETHOD: string (nullable = true)
|-- LOCALBILLTYPE: string (nullable = true)
|-- LONGDISTANCEBILLTYPE: string (nullable = true)
|-- USAGE: integer (nullable = true)
|-- RATEPLAN: integer (nullable = true)
|-- GENDER: string (nullable = true)
|-- STATUS: string (nullable = true)
|-- CHILDREN: integer (nullable = true)
|-- ESTINCOME: double (nullable = true)
|-- CAROWNER: string (nullable = true)
|-- AGE: double (nullable = true)

Total number of customer dataset row count: 2066
```

Hadoop Integration – Hadoop Gateway Testing & Troubleshoot

6. Push down Spark processing – Review the remote Spark application

loop

FINISHED Applications

Cluster Metrics

Apps Submitted	Apps Pending	Apps Running	Apps Completed	Containers Running	Memory Used	Memory Total	Memory Reserved	VCores Used	VCores Total	
20	0	0	20	0	0 B	10 GB	0 B	0	12	0

Scheduler Metrics

Scheduler Type	Scheduling Resource Type	Minimum Allocat
Capacity Scheduler	[MEMORY]	<memory:1536, vCores:1>

Show 20 entries

ID	User	Name	Application Type	Queue	Application Priority	StartTime	FinishTime	State
application_1549042673081_0015	dsxhi	DSXHI	YARN	default	0	Thu Feb 7 08:44:24 -0800 2019	Thu Feb 7 08:44:31 -0800 2019	FINISHED
application_1549042673081_0014	dsxhi	batch-score-a8f0d693-460b-40a4-bf2cf65b9da79847	SPARK	default	0	Thu Feb 7 08:10:42 -0800 2019	Thu Feb 7 08:12:06 -0800 2019	FINISHED
application_1549042673081_0013	dsxhi	livy-session-10	SPARK	default	0	Wed Feb 6 21:55:08 -0800 2019	Wed Feb 6 22:14:26 -0800 2019	FINISHED
application_1549042673081_0012	dsxhi	batch-score-789e5bc2-21dd-43ec-9667-d0be6488c7aa	SPARK	default	0	Wed Feb 6 21:43:47 -0800 2019	Wed Feb 6 21:50:54 -0800 2019	FINISHED

Hadoop Integration – Hadoop Gateway Testing & Troubleshoot

Delete the remote Spark session**

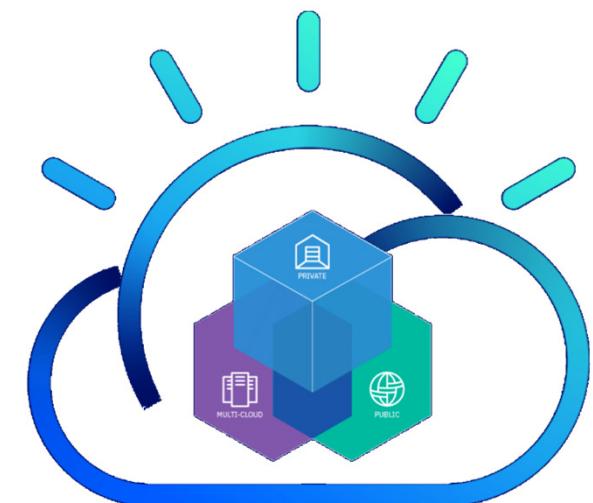
- %spark delete -s <session_name>

```
In [38]: %spark delete -s $session_name
```

```
In [23]: %spark cleanup
```

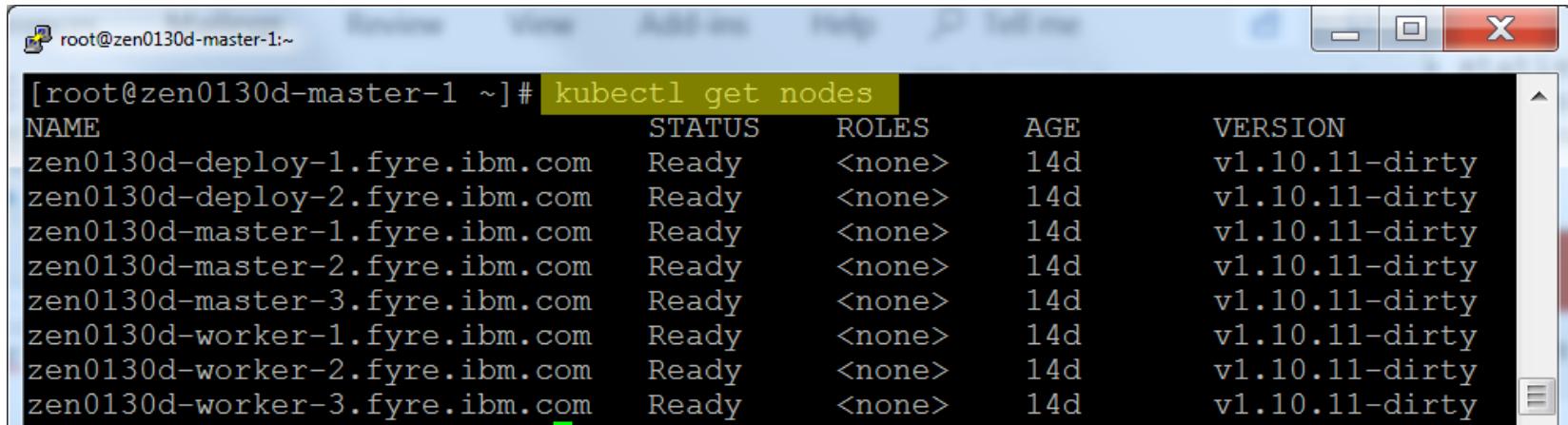
```
In [*]: %%javascript  
Jupyter.notebook.session.delete();
```

Watson Studio Local Administration Health Check



Health Check

- Services need to be up and running on all cluster nodes
 - docker, kubelet, glusterd (ex. # systemctl enable docker; systemctl start docker)
- Verify gluster peer status (make sure communication among cluster nodes is working)
 - # gluster peer status
- Verify all cluster nodes status
 - # kubectl get nodes (FYI. Cluster has issues If any cluster node status is not shown “Ready”)



```
[root@zen0130d-master-1 ~]# kubectl get nodes
NAME           STATUS   ROLES      AGE    VERSION
zen0130d-deploy-1.fyre.ibm.com   Ready    <none>    14d   v1.10.11-dirty
zen0130d-deploy-2.fyre.ibm.com   Ready    <none>    14d   v1.10.11-dirty
zen0130d-master-1.fyre.ibm.com   Ready    <none>    14d   v1.10.11-dirty
zen0130d-master-2.fyre.ibm.com   Ready    <none>    14d   v1.10.11-dirty
zen0130d-master-3.fyre.ibm.com   Ready    <none>    14d   v1.10.11-dirty
zen0130d-worker-1.fyre.ibm.com  Ready    <none>    14d   v1.10.11-dirty
zen0130d-worker-2.fyre.ibm.com  Ready    <none>    14d   v1.10.11-dirty
zen0130d-worker-3.fyre.ibm.com  Ready    <none>    14d   v1.10.11-dirty
```

Health Check

- Verify if Pods are all up and running
 - Verify from Admin Console GUI
 - OR via command line: # kubectl get [pods | po] --all-namespaces

Tip: If a pod is not “Running”, you can:

- Delete the Pod (it will auto create a new instance).

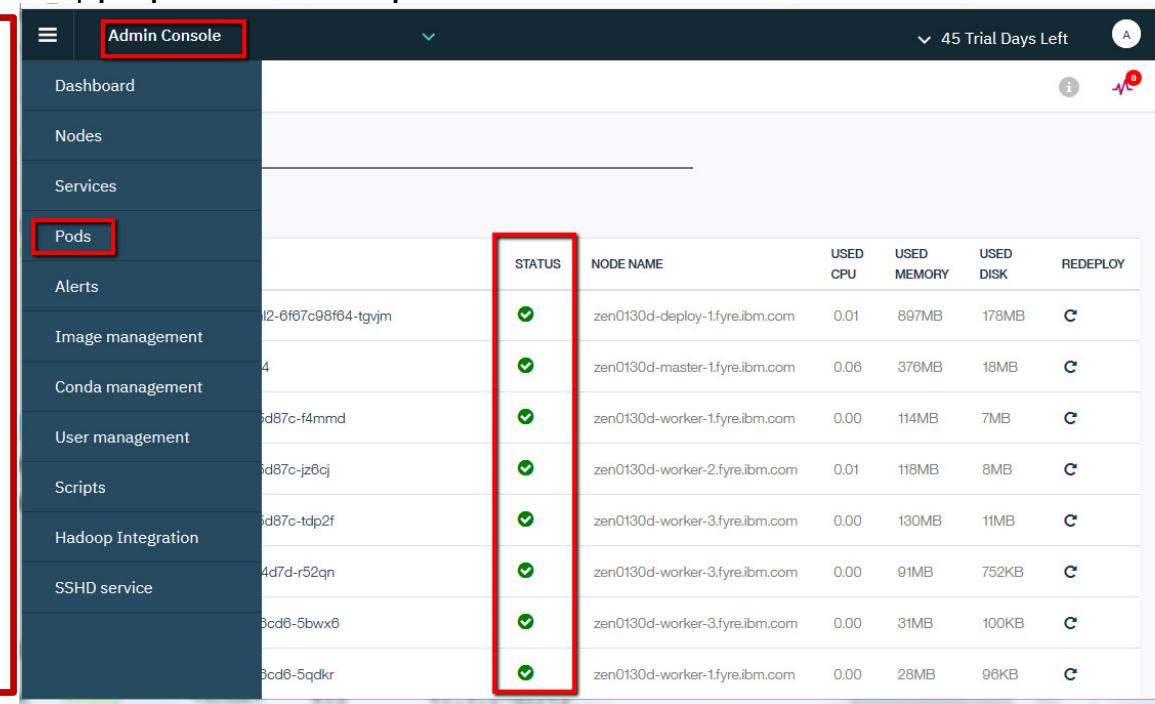
Ex. kubectl delete po [--force] -n <namespace>
<pod>

- Run describe command to review more detail

Ex. kubectl describe po <pod> -n <namespace>

- Review Pod logs to investigate errors.

Ex. kubectl logs <pod> -n <namespace>



STATUS	NODE NAME	USED CPU	USED MEMORY	USED DISK	REDEPLOY
Running	zen0130d-deploy-1.fyre.ibm.com	0.01	897MB	178MB	C
Running	zen0130d-master-1.fyre.ibm.com	0.06	376MB	18MB	C
Running	zen0130d-worker-1.fyre.ibm.com	0.00	114MB	7MB	C
Running	zen0130d-worker-2.fyre.ibm.com	0.01	118MB	8MB	C
Running	zen0130d-worker-3.fyre.ibm.com	0.00	130MB	11MB	C
Running	zen0130d-worker-3.fyre.ibm.com	0.00	91MB	752KB	C
Running	zen0130d-worker-3.fyre.ibm.com	0.00	31MB	100KB	C
Running	zen0130d-worker-1.fyre.ibm.com	0.00	28MB	96KB	C
Running	zen0130d-worker-1.fyre.ibm.com	0.00	28MB	96KB	C

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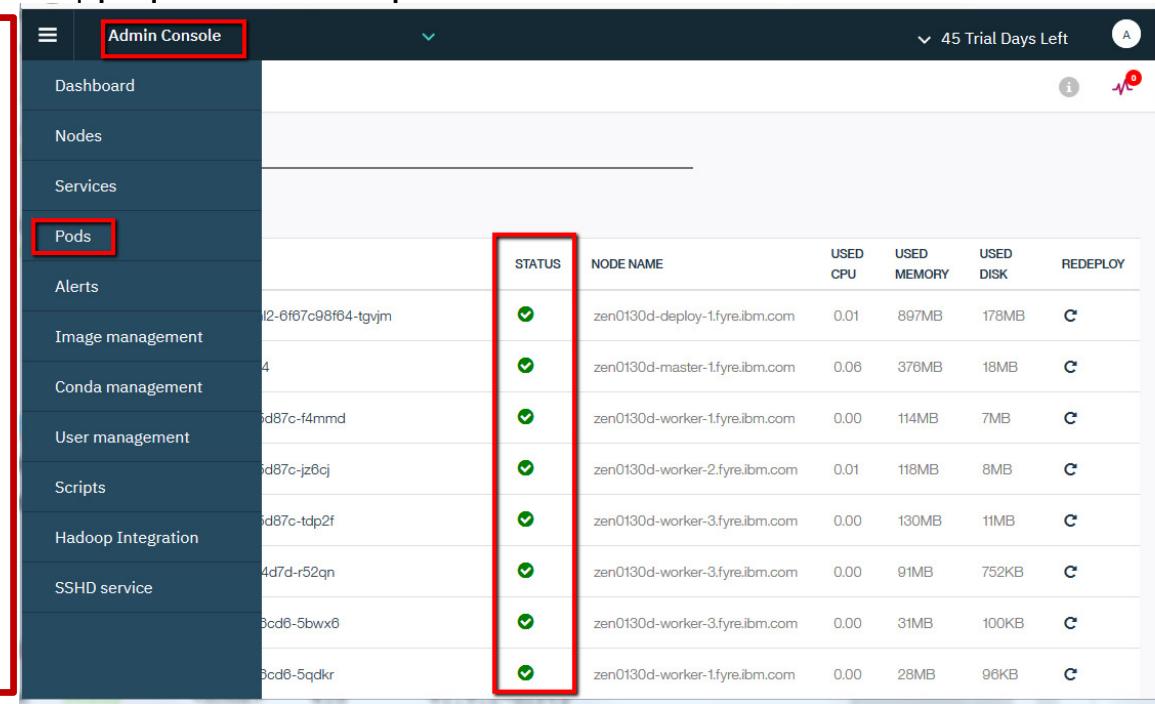
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Running	zen0130d-worker-3.fyre.ibm.com	0.00	130MB	11MB	C
Running	zen0130d-worker-3.fyre.ibm.com	0.00	91MB	752KB	C
Running	zen0130d-worker-3.fyre.ibm.com	0.00	31MB	100KB	C
Running	zen0130d-worker-1.fyre.ibm.com	0.00	28MB	96KB	C
Running	zen0130d-worker-1.fyre.ibm.com	0.00	28MB	96KB	C

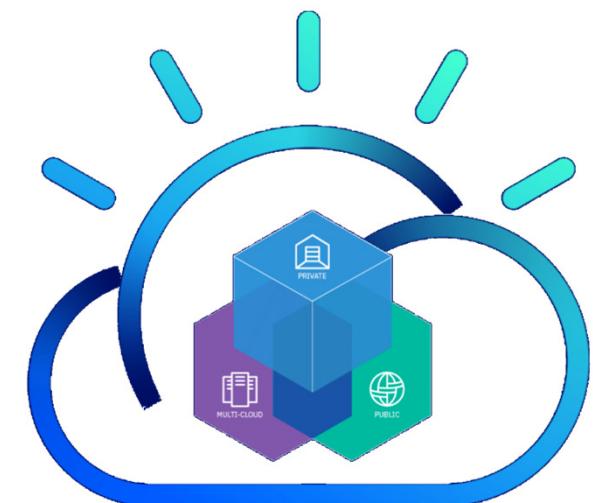
Health Check

▪ Admin utility scripts

- Automatically troubleshoot and repair common problems in your Watson Studio Local cluster:
 - `/wdp/utils/cluster_repair_utility.sh [-h]`
- Troubleshoot and print out results in a zipped tar file:
 - `/wdp/utils/admin-utils.sh --user <username> --password --port <port> --key-pair <ssh_key_pair_file>`

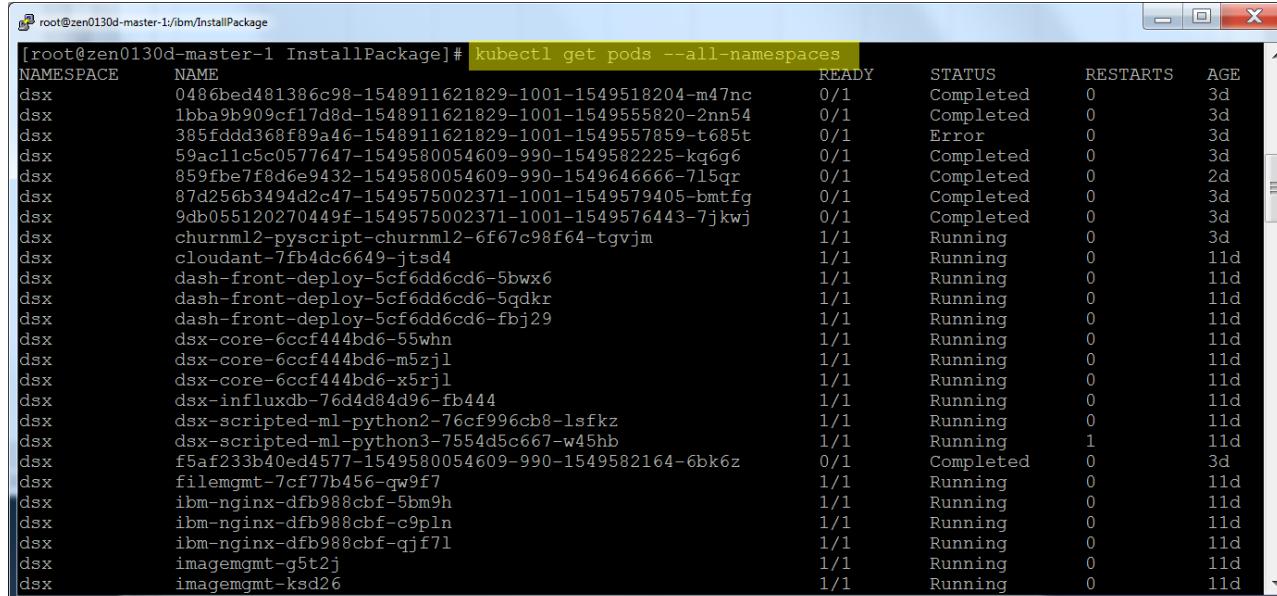
`Ex. /wdp/utils/admin-utils.sh --user root --password --key-pair /root/.ssh/id_rsa`

Watson Studio Local Administration Troubleshoots



Access Pods

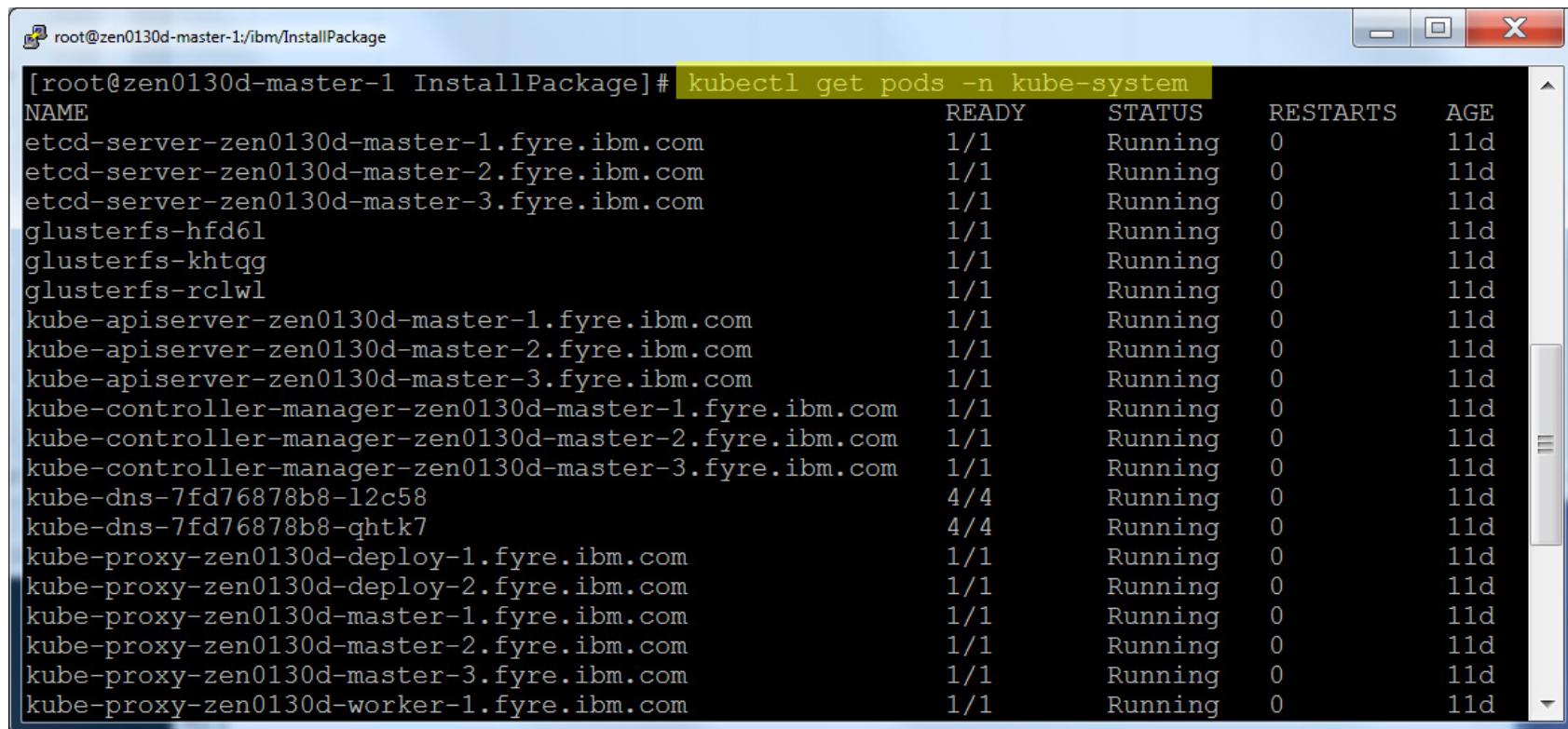
- List all Pods in the cluster
 - \$ kubectl get pods --all-namespaces



NAME	READY	STATUS	RESTARTS	AGE
0486bed481386c98-1548911621829-1001-1549518204-m47nc	0/1	Completed	0	3d
1bba9b909cf17d8d-1548911621829-1001-1549555820-2nn54	0/1	Completed	0	3d
385fddd368f89a46-1548911621829-1001-1549557859-t685t	0/1	Error	0	3d
59ac11c5c0577647-1549580054609-990-1549582225-kq6g6	0/1	Completed	0	3d
859fbe7f8d6e9432-1549580054609-990-1549646666-7l5qr	0/1	Completed	0	2d
87d256b3494d2c47-1549575002371-1001-1549579405-bmtfg	0/1	Completed	0	3d
9db055120270449f-1549575002371-1001-1549576443-7jkwj	0/1	Completed	0	3d
churnml2-pyscript-churnml2-6f67c98f64-tgvjm	1/1	Running	0	3d
cloudant-7fb4dc6649-jtsd4	1/1	Running	0	11d
dash-front-deploy-5cf6dd6cd6-5bwx6	1/1	Running	0	11d
dash-front-deploy-5cf6dd6cd6-5qdkr	1/1	Running	0	11d
dash-front-deploy-5cf6dd6cd6-fbj29	1/1	Running	0	11d
dsx-core-6ccf444bd6-55whn	1/1	Running	0	11d
dsx-core-6ccf444bd6-m5zjl	1/1	Running	0	11d
dsx-core-6ccf444bd6-x5rjl	1/1	Running	0	11d
dsx-influxdb-76d4d84d96-fb444	1/1	Running	0	11d
dsx-scripted-ml-python2-76cf996cb8-lsfkz	1/1	Running	0	11d
dsx-scripted-ml-python3-7554d5c667-w45hb	1/1	Running	1	11d
f5af233b40ed4577-1549580054609-990-1549582164-6bk6z	0/1	Completed	0	3d
filemgmt-7cf77b456-qw9f7	1/1	Running	0	11d
ibm-nginx-dfb988cbf-5bm9h	1/1	Running	0	11d
ibm-nginx-dfb988cbf-c9pln	1/1	Running	0	11d
ibm-nginx-dfb988cbf-qjf71	1/1	Running	0	11d
imagemgmt-g5t2j	1/1	Running	0	11d
imagemgmt-ksd26	1/1	Running	0	11d

Access Pods

- List all Pods in the cluster based on namespace
 - \$ kubectl get pods -n kube-system



```
[root@zen0130d-master-1 InstallPackage]# kubectl get pods -n kube-system
NAME                               READY   STATUS    RESTARTS   AGE
etcd-server-zen0130d-master-1.fyre.ibm.com   1/1     Running   0          11d
etcd-server-zen0130d-master-2.fyre.ibm.com   1/1     Running   0          11d
etcd-server-zen0130d-master-3.fyre.ibm.com   1/1     Running   0          11d
glusterfs-hfd61                         1/1     Running   0          11d
glusterfs-khtqg                         1/1     Running   0          11d
glusterfs-rclwl                         1/1     Running   0          11d
kube-apiserver-zen0130d-master-1.fyre.ibm.com 1/1     Running   0          11d
kube-apiserver-zen0130d-master-2.fyre.ibm.com 1/1     Running   0          11d
kube-apiserver-zen0130d-master-3.fyre.ibm.com 1/1     Running   0          11d
kube-controller-manager-zen0130d-master-1.fyre.ibm.com 1/1     Running   0          11d
kube-controller-manager-zen0130d-master-2.fyre.ibm.com 1/1     Running   0          11d
kube-controller-manager-zen0130d-master-3.fyre.ibm.com 1/1     Running   0          11d
kube-dns-7fd76878b8-12c58                  4/4     Running   0          11d
kube-dns-7fd76878b8-qhtk7                  4/4     Running   0          11d
kube-proxy-zen0130d-deploy-1.fyre.ibm.com   1/1     Running   0          11d
kube-proxy-zen0130d-deploy-2.fyre.ibm.com   1/1     Running   0          11d
kube-proxy-zen0130d-master-1.fyre.ibm.com   1/1     Running   0          11d
kube-proxy-zen0130d-master-2.fyre.ibm.com   1/1     Running   0          11d
kube-proxy-zen0130d-master-3.fyre.ibm.com   1/1     Running   0          11d
kube-proxy-zen0130d-worker-1.fyre.ibm.com   1/1     Running   0          11d
```

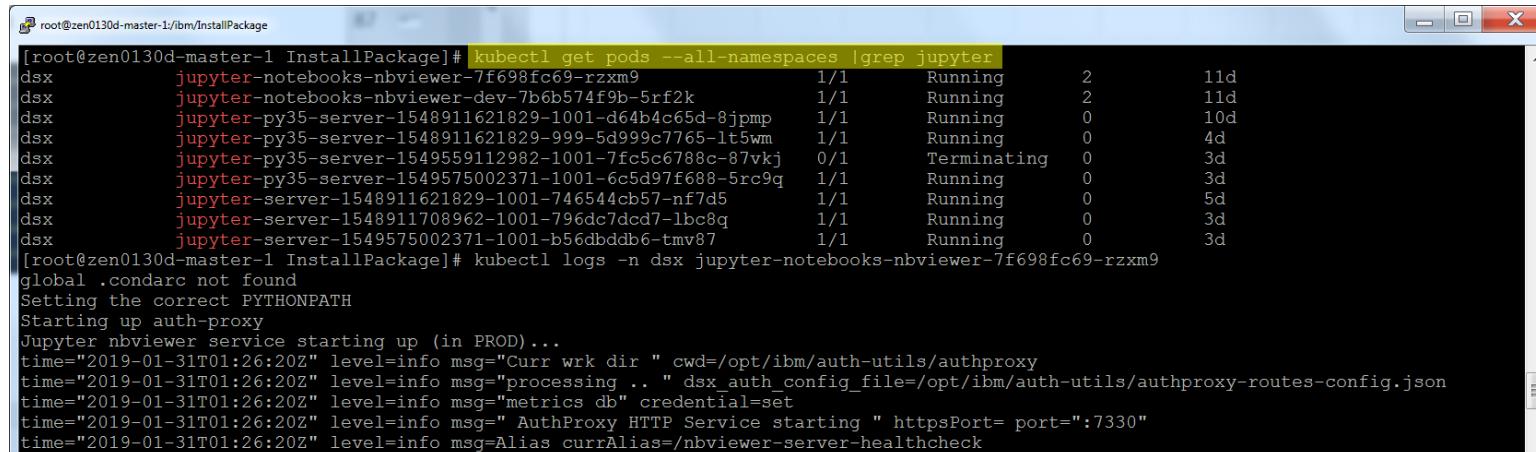
Access Pods

- Log in to a Pod with shell
 - \$ kubectl exec -it -n <namespace> <pod_name> [bash|sh]

Example: \$ kubectl exec -it -n kube-system glusterfs-hfd6l bash

- Access Pod's logs
 - \$ kubectl logs -n <namespace> <pod-name>
- Restart a Pod
 - \$ kubectl delete pod -n <namespace> <pod_name>

Example: \$ kubectl delete pod -n dsx jupyter-notebooks-nbviewer-7f698fc69-rzxm9



The screenshot shows a terminal window with the following command and output:

```
[root@zen0130d-master-1 InstallPackage]# kubectl get pods --all-namespaces |grep jupyter
dsx      jupyter-notebooks-nbviewer-7f698fc69-rzxm9          1/1     Running   2      11d
dsx      jupyter-notebooks-nbviewer-dev-7b6b574f9b-5rf2k       1/1     Running   2      11d
dsx      jupyter-py35-server-1548911621829-1001-d64b4c65d-8jmpm 1/1     Running   0      10d
dsx      jupyter-py35-server-1548911621829-9999-5d999c7765-1t5wm 1/1     Running   0      4d
dsx      jupyter-py35-server-1549559112982-1001-7fc5c6788c-87vkj  0/1     Terminating 0      3d
dsx      jupyter-py35-server-1549575002371-1001-6c5d97f688-5rc9q  1/1     Running   0      3d
dsx      jupyter-server-1548911621829-1001-746544cb57-nf7d5       1/1     Running   0      5d
dsx      jupyter-server-1548911708962-1001-796dc7ddc7-lbc8q       1/1     Running   0      3d
dsx      jupyter-server-1549575002371-1001-b56dbddb6-tmv87        1/1     Running   0      3d
[root@zen0130d-master-1 InstallPackage]# kubectl logs -n dsx jupyter-notebooks-nbviewer-7f698fc69-rzxm9
global .condarc not found
Setting the correct PYTHONPATH
Starting up auth-proxy
Jupyter nbviewer service starting up (in PROD)...
time="2019-01-31T01:26:20Z" level=info msg="Curr wrk dir " cwd=/opt/ibm/auth-utils/authproxy
time="2019-01-31T01:26:20Z" level=info msg="processing .. " dsx_auth_config_file=/opt/ibm/auth-utils/authproxy-routes-config.json
time="2019-01-31T01:26:20Z" level=info msg="metrics db" credential=set
time="2019-01-31T01:26:20Z" level=info msg=" AuthProxy HTTP Service starting " httpsPort= port=":7330"
time="2019-01-31T01:26:20Z" level=info msg=Alias currAlias=/nbviewer-server-healthcheck
```

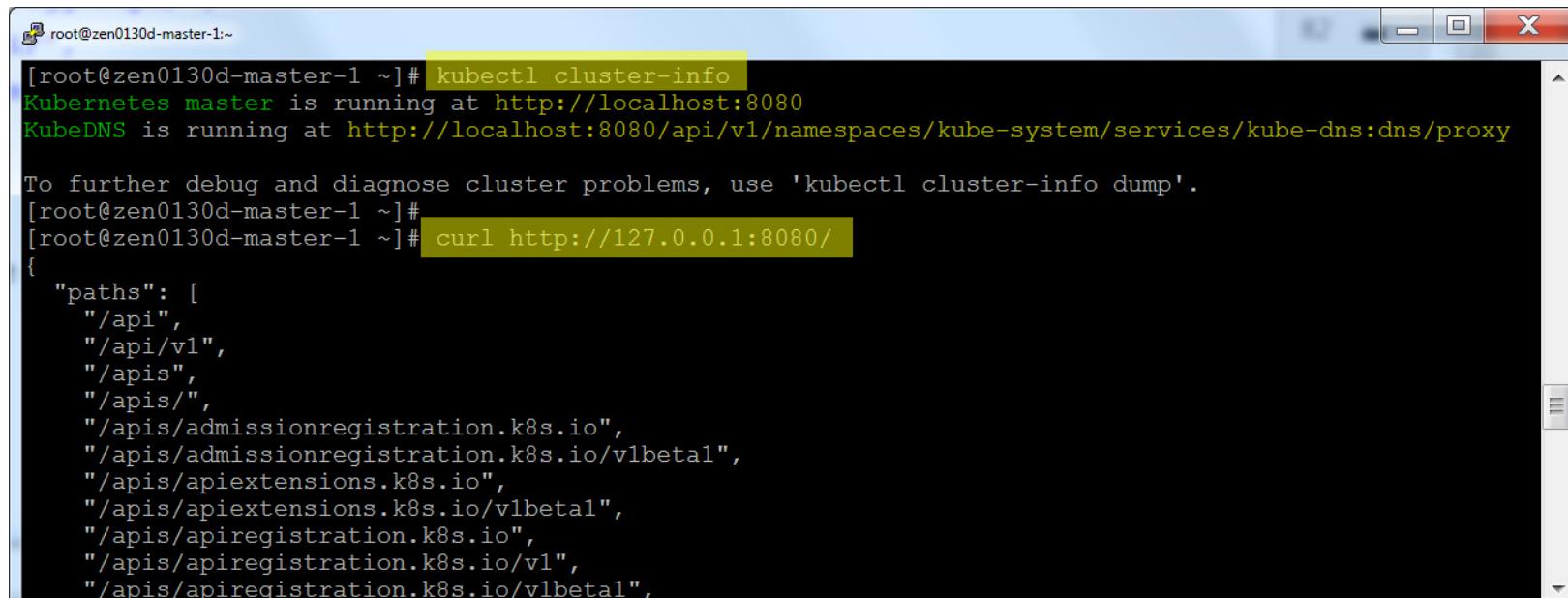
Docker 101

- Docker image vs container
 - A docker container is the runtime instance of an image
- Useful Docker commands
 - \$ docker images → list all images that are locally stored with the Docker
 - \$ docker rmi <image_name> → delete an image from the local image store
 - \$ docker kill <container> → kill a running container
 - \$ docker ps → list all “running” docker containers
 - \$ docker ps -a → list all containers (running and not running)
 - \$ docker inspect <container_id> → list detailed info about a docker container
 - \$ docker logs <container_id> → show logs of a given container
 - \$ docker build -t <image_name> . → build an image from the Dockerfile in the current directory and tag the image
 - \$ docker [start | stop | rm] <container> → start: Launch a container previously stopped.
 - \$ docker run <image> → create a new container of an image, and execute the container.
 - \$ docker exec -it <container> [command] → ex. docker exec -it jupyter-notebooks-nbviewer-

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Cluster information

- Show cluster information
 - \$ kubectl cluster-info
- List all API endpoint
 - \$ curl http://localhost:8080/



```
root@zen0130d-master-1:~ [root@zen0130d-master-1 ~]# kubectl cluster-info
Kubernetes master is running at http://localhost:8080
KubeDNS is running at http://localhost:8080/api/v1/namespaces/kube-system/services/kube-dns:dns/proxy

To further debug and diagnose cluster problems, use 'kubectl cluster-info dump'.
[root@zen0130d-master-1 ~]#
[root@zen0130d-master-1 ~]# curl http://127.0.0.1:8080/
{
  "paths": [
    "/api",
    "/api/v1",
    "/apis",
    "/apis/",
    "/apis/admissionregistration.k8s.io",
    "/apis/admissionregistration.k8s.io/v1beta1",
    "/apis/apiextensions.k8s.io",
    "/apis/apiextensions.k8s.io/v1beta1",
    "/apis/apiregistration.k8s.io",
    "/apis/apiregistration.k8s.io/v1",
    "/apis/apiregistration.k8s.io/v1beta1",
```

Cluster / Pod information

- List all namespaces in the cluster
 - \$ kubectl get namespaces
- Look at a Pod's details
 - \$ kubectl describe pod <pod_name> -n <namespace>

```
root@zen0130d-master-1:~]# kubectl get namespaces
NAME        STATUS   AGE
default     Active  11d
dsx         Active  11d
kube-public Active  11d
kube-system Active  11d
sysibm-adm  Active  11d
[root@zen0130d-master-1 ~]#
```

```
root@zen0130d-master-1:~]# kubectl get pods --all-namespaces | grep spark
dsx      spark-history-server-8db797c7c-6vhpc    1/1    Running   0      11d
dsx      spark-master-855585f76-vplz6          1/1    Running   0      11d
dsx      spark-master221-6f99c4fbc7-gnqf4        1/1    Running   0      11d
dsx      spark-worker-bqn2l                     1/1    Running   0      11d
dsx      spark-worker-g6nv2                     1/1    Running   0      11d
dsx      spark-worker-gv5zq                     1/1    Running   0      11d
dsx      spark-worker221-csgdj                  1/1    Running   0      11d
dsx      spark-worker221-fwtm8                  1/1    Running   0      11d
dsx      spark-worker221-r8b5s                  1/1    Running   0      11d
dsx      sparkaas-api-deploy-644f997f-51vnj    1/1    Running   0      11d
dsx      sparkaas-api-deploy-644f997f-1hs8r    1/1    Running   0      11d
dsx      sparkaas-api-deploy-644f997f-vngp4    1/1    Running   0      11d
dsx      sparkgxm-764bcf8f8-thkp2             3/3    Running   0      11d
[root@zen0130d-master-1 ~]#
[root@zen0130d-master-1 ~]# kubectl describe pod spark-master-855585f76-vplz6 -n dsx
Name:           spark-master-855585f76-vplz6
Namespace:      dsx
Node:           zen0130d-worker-2.fyre.ibm.com/172.16.11.42
Start Time:     Wed, 30 Jan 2019 17:25:49 -0800
Labels:          app=spark
                 chart=ibm-dsx-prod
                 component=spark-master
                 heritage=tiller
                 pod-template-hash=411141932
                 release=dsx
                 run=spark-master-deployment-pod
Annotations:    productID=IBMWatsonStudio_123_perpetual_00000
                 productName=IBM Watson Studio
```

Troubleshooting

- Watson Studio Local provides various methods, scripts, and support for troubleshooting your cluster
- The areas we are going to cover include:
 - Troubleshoot common problems
 - Troubleshoot your system performance
 - Troubleshoot your system with administration utilities

Troubleshoot Common Problems

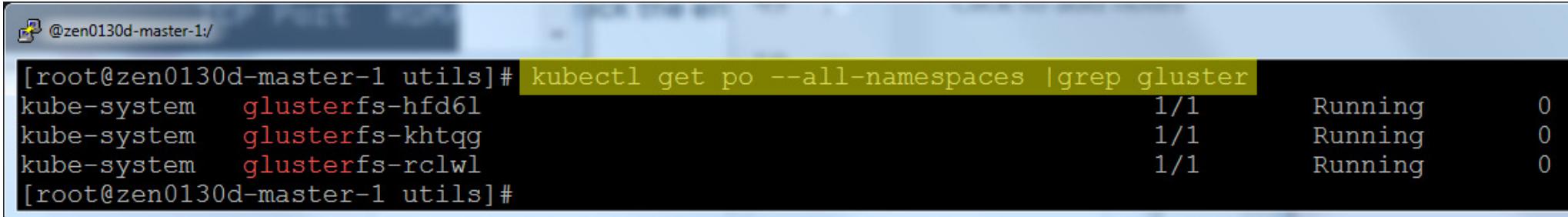
- **Symptom:**

- Watson Studio Local does not start, pods stuck creating or crashing, due to glusterfs in read-only or offline

- **Diagnostic Procedure:**

- 1. Verify glusters bricks are online by using the following command:

```
kubectl get po --all-namespaces | grep gluster
```



```
[root@zen0130d-master-1:/] [root@zen0130d-master-1 utils]# kubectl get po --all-namespaces |grep gluster
kube-system    glusterfs-hfd61                           1/1        Running      0
kube-system    glusterfs-khtqg                           1/1        Running      0
kube-system    glusterfs-rclwl                           1/1        Running      0
[root@zen0130d-master-1 utils]#
```

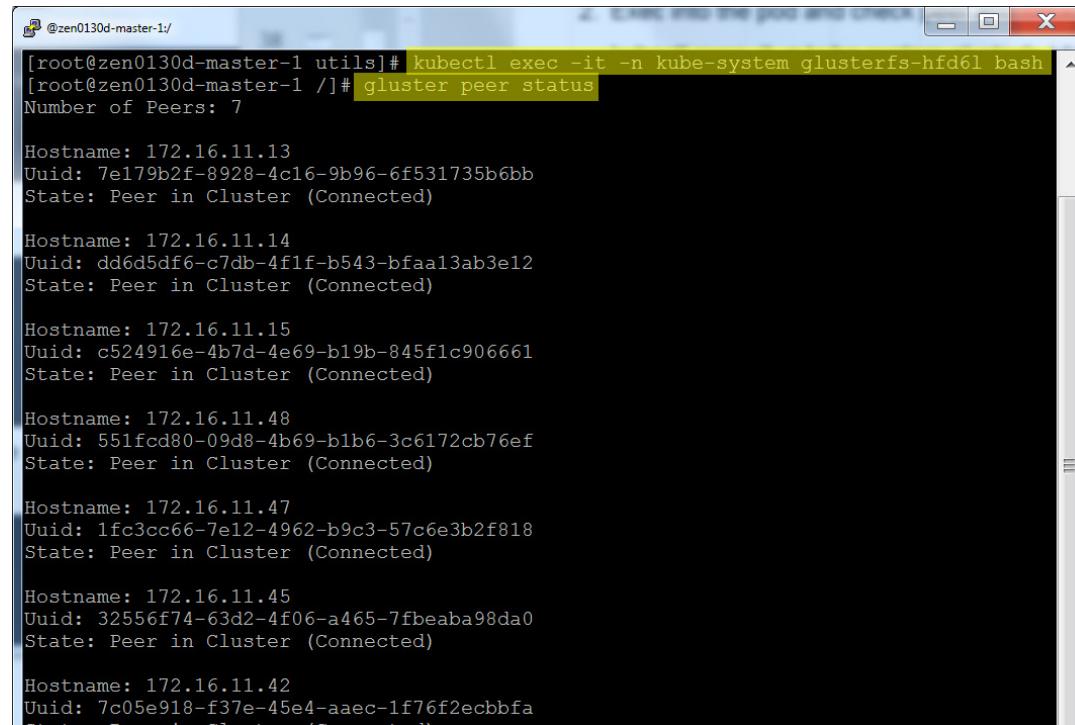
Troubleshoot Common Problems

- **Diagnostic Procedure (cont):**

2. Exec into the pod and check peer and brick status using the following command:

```
kubectl exec -it -n kube-system glusterfs-hfd6l bash
```

```
gluster peer status
```



```
[root@zen0130d-master-1 utils]# kubectl exec -it -n kube-system glusterfs-hfd6l bash
[root@zen0130d-master-1 /]# gluster peer status
Number of Peers: 7

Hostname: 172.16.11.13
Uuid: 7e179b2f-8928-4c16-9b96-6f531735b6bb
State: Peer in Cluster (Connected)

Hostname: 172.16.11.14
Uuid: dd6d5df6-c7db-4f1f-b543-bfaa13ab3e12
State: Peer in Cluster (Connected)

Hostname: 172.16.11.15
Uuid: c524916e-4b7d-4e69-b19b-845f1c906661
State: Peer in Cluster (Connected)

Hostname: 172.16.11.48
Uuid: 551fcfd80-09d8-4b69-b1b6-3c6172cb76ef
State: Peer in Cluster (Connected)

Hostname: 172.16.11.47
Uuid: 1fc3cc66-7e12-4962-b9c3-57c6e3b2f818
State: Peer in Cluster (Connected)

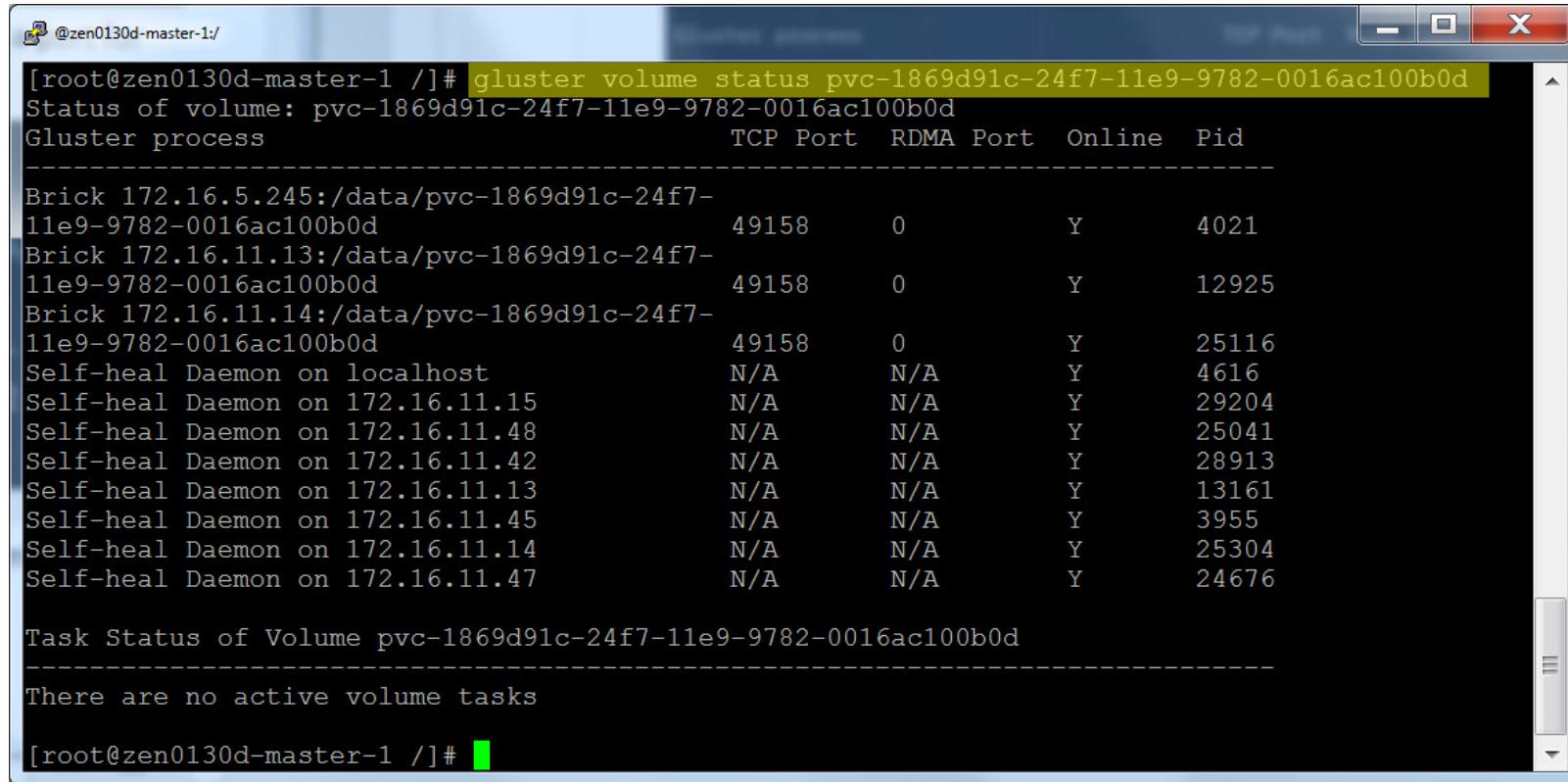
Hostname: 172.16.11.45
Uuid: 32556f74-63d2-4f06-a465-7fbeaba98da0
State: Peer in Cluster (Connected)

Hostname: 172.16.11.42
Uuid: 7c05e918-f37e-45e4-aaec-1f76f2ecbbfa
State: Peer in Cluster (Connected)
```

Troubleshoot Common Problems

- **Diagnostic Procedure (cont):**

3. Enter gluster volume status. Verify that you see 3 bricks and show a port for the brick that is online:



```
[root@zen0130d-master-1 /]# gluster volume status pvc-1869d91c-24f7-11e9-9782-0016ac100b0d
Status of volume: pvc-1869d91c-24f7-11e9-9782-0016ac100b0d
Gluster process          TCP Port  RDMA Port  Online  Pid
-----
Brick 172.16.5.245:/data/pvc-1869d91c-24f7-11e9-9782-0016ac100b0d      49158     0       Y      4021
Brick 172.16.11.13:/data/pvc-1869d91c-24f7-11e9-9782-0016ac100b0d      49158     0       Y      12925
Brick 172.16.11.14:/data/pvc-1869d91c-24f7-11e9-9782-0016ac100b0d      49158     0       Y      25116
Self-heal Daemon on localhost           N/A      N/A       Y      4616
Self-heal Daemon on 172.16.11.15      N/A      N/A       Y      29204
Self-heal Daemon on 172.16.11.48      N/A      N/A       Y      25041
Self-heal Daemon on 172.16.11.42      N/A      N/A       Y      28913
Self-heal Daemon on 172.16.11.13      N/A      N/A       Y      13161
Self-heal Daemon on 172.16.11.45      N/A      N/A       Y      3955
Self-heal Daemon on 172.16.11.14      N/A      N/A       Y      25304
Self-heal Daemon on 172.16.11.47      N/A      N/A       Y      24676

Task Status of Volume pvc-1869d91c-24f7-11e9-9782-0016ac100b0d
-----
There are no active volume tasks

[root@zen0130d-master-1 /]#
```

Troubleshoot Common Problems

- **Diagnostic Procedure (cont):**

4. If you do not, then run the following to attempt to connect the volumes that are not online:

```
gluster volume stop <volume name>
```

5. Select Y to stop the volume

6. Enter gluster volume start <volume name>

7. Verify with gluster volume status, correct for all the volumes and then WSL should recover

Troubleshoot Common Problems

- **Symptom:**

- Kubectl get no returns the following ‘The connection to the server localhost:8080 was refused – did you specify the right host or port?’

- **Diagnostic Procedure:**

1. Verify that at least two master nodes are online
2. Check the status of docker:
3. Check the status of kubelet:
4. Check that the kube-apiserver is running: docker ps | grep kube-apiserver
5. If not shown: docker ps -a | grep kube-apiserver, then check the logs: docker logs <api server container>
6. If the logs look fine, check to verify that there is adequate space in the installer partition: df -lh
7. Check logs for etcd container, and verify that you don't see messages about the time being out of sync

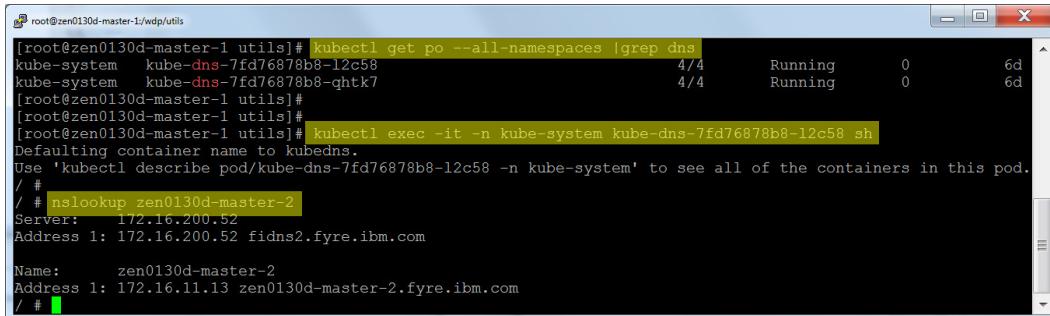
Troubleshoot Common Problems

- **Symptom:**

- ibm-nginx pods CrashLoopBack/Error

- **Diagnostic Procedure:**

1. Check logs for kubedns.kube-system.svc.cluster.local or usermgmt-svc.dsx.svc.cluster.local
2. Check logs of kubedns pods / restart kubedns
3. On the host, check the kubedns: nslookup <cluster_node>
4. Exec into dsx-core pod, and check dns resolution in the pod:



```
[root@zen0130d-master-1:~/wdp/utils]# kubectl get po --all-namespaces |grep dns
kube-system kube-dns-7fd76878b8-12c58 4/4 Running 0 6d
kube-system kube-dns-7fd76878b8-qhtk7 4/4 Running 0 6d
[root@zen0130d-master-1 utils]#
[root@zen0130d-master-1 utils]#
[root@zen0130d-master-1 utils]# kubectl exec -it -n kube-system kube-dns-7fd76878b8-12c58 sh
Defaulting container name to kubedns.
Use 'kubectl describe pod/kube-dns-7fd76878b8-12c58 -n kube-system' to see all of the containers in this pod.
/ #
/ # nslookup zen0130d-master-2
Server: 172.16.200.52
Address 1: 172.16.200.52 fidns2.fyre.ibm.com

Name: zen0130d-master-2
Address 1: 172.16.11.13 zen0130d-master-2.fyre.ibm.com
/ #
```

5. If resolving names doesn't work, check /etc/resolv.conf setting; and confirm that outside DNS lookups work: nslookup <hostname on network>

Troubleshoot Common Problems

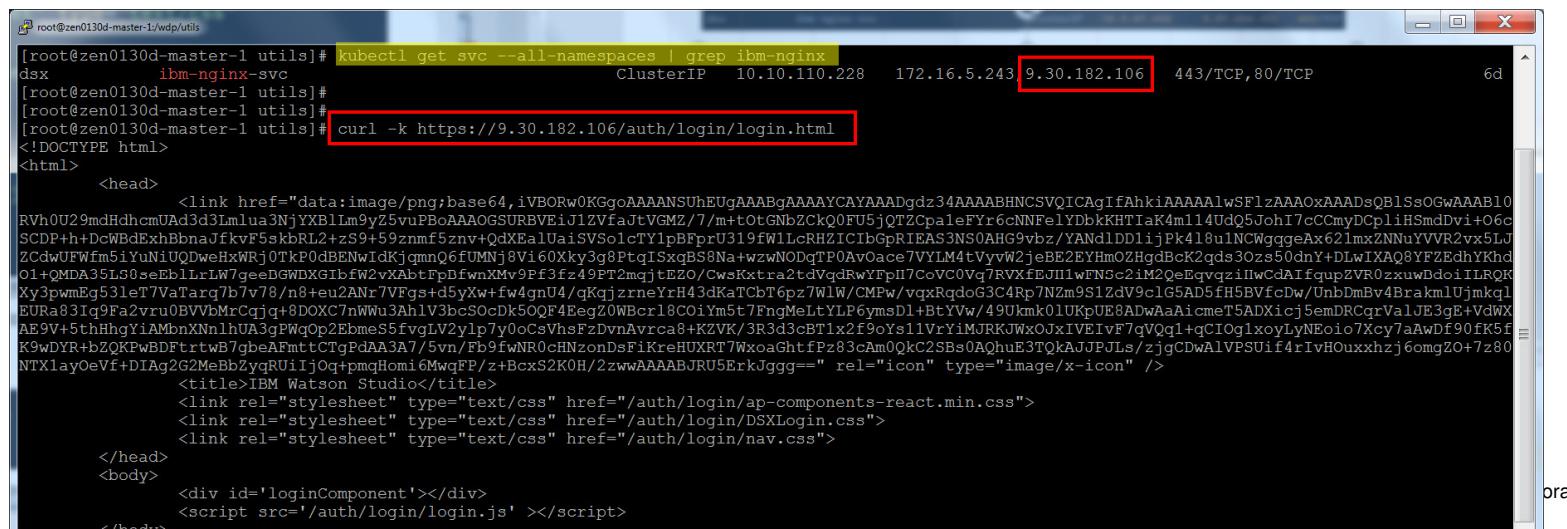
▪ Symptom:

- Connecting to WSL from browser fails but ALL pods show as running

▪ Diagnostic Procedure:

1. Verify that you can ping the proxy IP or hostname
2. Connect to one of the nodes and attempt to connect to the site internally

3. Verify site IP:



```
[root@zen0130d-master-1 ~]# curl -k https://9.30.182.106/auth/login/login.html
<!DOCTYPE html>
<html>
  <head>
    <link href="data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAABqAAAAACAYAAADgdz34AAAAABHNC SVQICAgI fAhkiAAAAAlwSFlzAAAoxAAADsQB1ssOGwAAAB1oR
Vh0U29mdHdcmUAd3d3LmLua3NjYXBB1Lm9yZ5vuPBoAAAOGSURBVEiJ1ZVfaJtVGMZ//7/m+t0tGnbZCkQ0FU5jQTZCpaleFYr6cNNFe1YDbkKHTiaK4m114UdQ5Johi7cCCmyDCpliHSmdDvi+O6c
SCDP+h+DcWBdExhBbnaJfkvF5skbRL2+zS9+59znmf5znv+QdXEa1Ua1SVSo1cTY1pBFprU319fW1LcRHZICIB6PRIEAS3NS0AHG9vbz/YANd1DD1ijPk418u1NCWgggeAx62lmxZNnuYVVR2vx5LJ
ZCdWUFWmQdKj0uN1QDweHxWRjOTkP0dBNw1dKj0mmn6fUMNj8Vi60Xky3g3PtqISxqBS8Na+wzwNODqTP0Av0ace7YLM4tVvv2jeBE2EYHm0ZHgdbck2qds30z50dnY+DlwIXA08YFZE dhYKhd
O1+QMda35LS0seEb1LrLw7geeBGwdxG1bfw2vxAbtPpEfwnXMv9PF3fz49PT2mcjtEZo/CwsKxtra2tdVqdRwYpII7CoVc0Vq7RVxfEJH1wFN5c2iM2QeEgvqzilwcd4IfqupZVR0zxuwBdoiiLRQK
Xy3pwEg53leT7VaTaRq7b7v78/n8+eu2ANr7VFgs+d5yXw+fw4gnU4/qKqjzrneYrH43dKaTCb76pz7wlW/CMPw/vqxRqdoG3C4Rp7Nzm951Zdv9c1G5AD5fH5BVfcDw/UnbdmBv4BrakmlUjmql
EURa831q9Fa2vru0BVVbMrCqjq+8DOXC7nWwU3Ah1V3bcSOCdk50QF4EegZOBcr18CoiYm5t7FnqMeLtYLP6ymsDl+BtYWW/49Ukmk01UKpUE8ADwhaaAicmeT5ADXicj5emDRcqrValJE3g+EvdWX
AE9V+5thlhqYiAMbnXNnlhuA3gPWqop2EbmesS5fvqLV2ylp7y0oCsVhsFzDvnAvrcab+KZVK/3R3d3cBT1x2f9oYs11VrYiMURKJWxOjxIVEIvF7qVqg1+qCIog1xoyLyNEcioi7xcy7aAwDf90fk5f
K9wDYR+bZQKfwBDfttwB7gbeAFmttCTqPdAA3A7/5vn/Fb9fwNR0cHNzonDsFIKreHUXRT7WxoAGhtfpz83cAm0QkC2SBs0AqhB3TqKAJJPLs/zjgCDwA1VPSUif4rIvHoUxxhzj6omgZO+7z80
NTX1ayOeVf+DIAg2G2MeBbZyqRUiIjoq+pmqHomie6MwqFP/z+BCsX2K0H/2zwAAAABJRU5ErkJgg==" rel="icon" type="image/x-icon" />
  <title>IBM Watson Studio</title>
  <link rel="stylesheet" type="text/css" href="/auth/login/ap-components-react.min.css">
  <link rel="stylesheet" type="text/css" href="/auth/login/DSXLLogin.css">
  <link rel="stylesheet" type="text/css" href="/auth/login/nav.css">
</head>
<body>
  <div id='loginComponent'></div>
  <script src='/auth/login/login.js' ></script>
</body>
```

Troubleshoot Common Problems

- **Diagnostic Procedure (cont):**

If the page comes up as previous screenshot, Watson Studio Local works internally.

4. Check if firewalls are enabled:

`systemctl status firewalld`

`Systemctl status iptables`

Verify that there are no firewalls, proxies, or blocked 443 port from the system.

Troubleshoot System Performance

- If performance slows for computing jobs, or stalls to the point where no new projects or assets can be created anymore, reserve more CPU and memory for your runtime in the Environments page
- Additionally, you can stop the runtime environment for idle notebooks to free up more resource

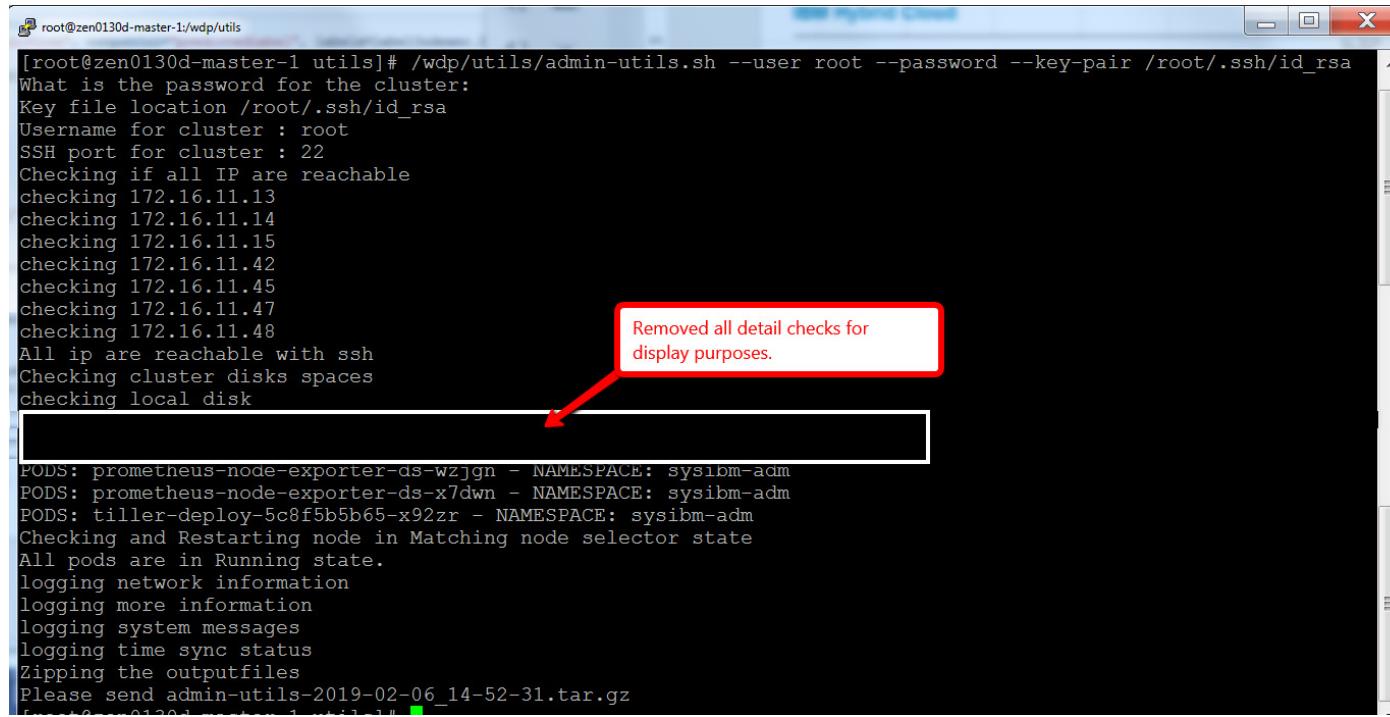
```
In [10]: %spark cleanup
```

```
In [ ]: %%javascript  
Jupyter.notebook.session.delete();
```

Troubleshoot using Administration Utilities

- To automatically troubleshoot your entire WSL cluster, run the `/wdp/utils/admin-utils.sh` script by entering the following command:

```
/wdp/utils/admin-utils.sh --user <userid> --password <--port port_number> --key-pair <ssh_key_file>
```



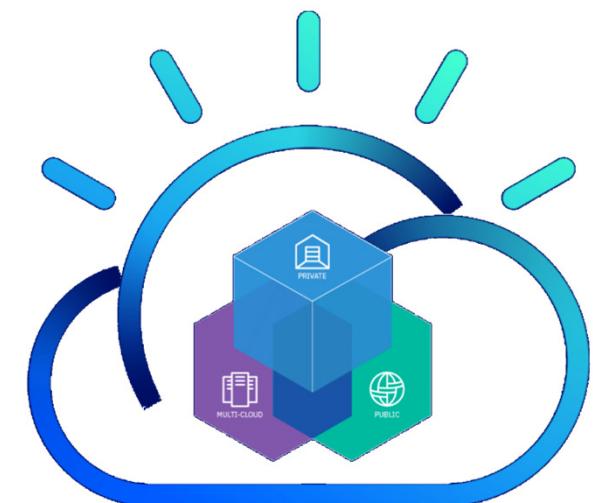
```
[root@zen0130d-master-1 wdp/utils]# /wdp/utils/admin-utils.sh --user root --password --key-pair /root/.ssh/id_rsa
What is the password for the cluster:
Key file location /root/.ssh/id_rsa
Username for cluster : root
SSH port for cluster : 22
Checking if all IP are reachable
checking 172.16.11.13
checking 172.16.11.14
checking 172.16.11.15
checking 172.16.11.42
checking 172.16.11.45
checking 172.16.11.47
checking 172.16.11.48
All ip are reachable with ssh
Checking cluster disks spaces
checking local disk
PODS: prometheus-node-exporter-ds-wzjgn - NAMESPACE: sysibm-adm
PODS: prometheus-node-exporter-ds-x7dwn - NAMESPACE: sysibm-adm
PODS: tiller-deploy-5c8f5b5b65-x92zr - NAMESPACE: sysibm-adm
Checking and Restarting node in Matching node selector state
All pods are in Running state.
logging network information
logging more information
logging system messages
logging time sync status
Zipping the outputfiles
Please send admin-utils-2019-02-06_14-52-31.tar.gz
```

Removed all detail checks for display purposes.

Troubleshoot using Administration Utilities

- The command performs the following tasks:
 - Checks whether all nodes are up and accessible with SSH
 - Checks free disk space on all nodes
 - Checks whether the Docker and Kubelet are running
 - Checks whether Gluster is installed and the volumes are up
- If all of the checks pass, then the script automatically logs everything that is not in the state ‘Ready’ or ‘Running’ into the following compressed file:
 - `/wdp/utils/admin-utils-<timestamp>.tar.gz`
- You can then send this file to IBM Support to diagnose or you can take a look for yourself

Watson Studio Local Administration Image Management



Manage Images

- WSL administrator can create an image that everyone in the cluster can use.
- Images contain a specific runtime (for example, a Jupyter notebook, RStudio, or Zeppelin notebook) and a set of packages and libraries
- In the Admin Console, click the menu icon (≡) and click Image Management to augment the runtime images that Watson Studio Local users can get started from.
- When the WSL administrator deploys them, users can conveniently select them from the Environments page of their project without having to upload any of the packages and libraries themselves
 - Alternatively, you can have your admin install packages globally which we covered in a previous training session

Manage Images

Complete the following steps to customize an image:

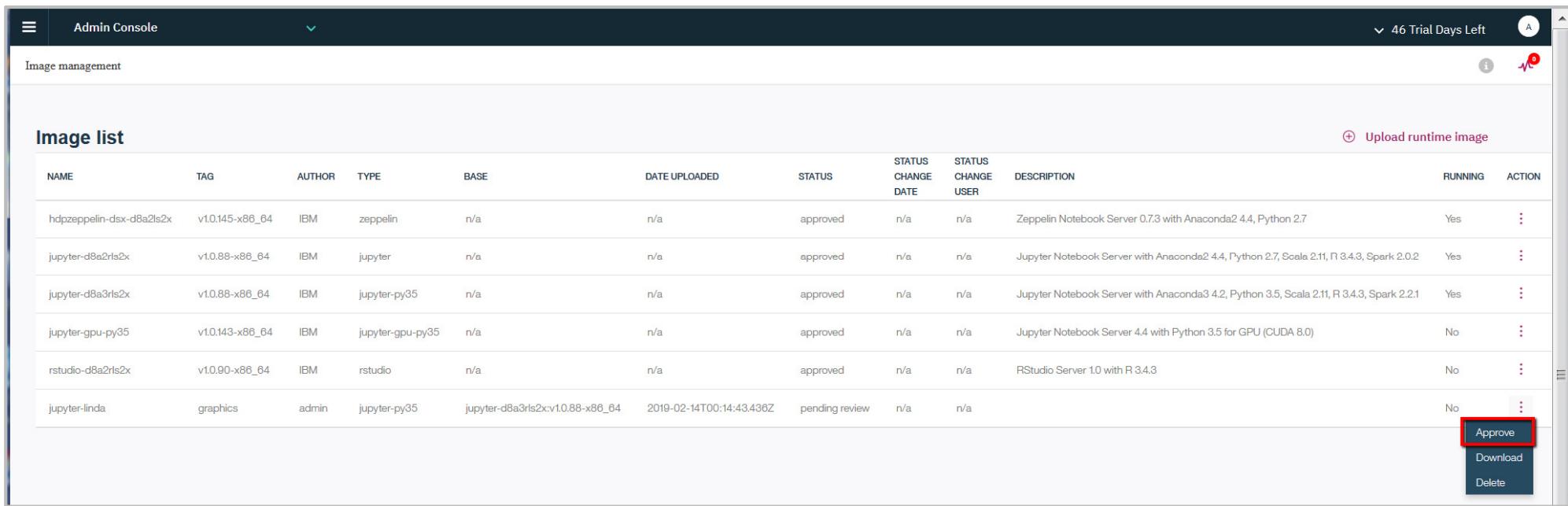
1. Download an existing image
2. Modify the existing image
3. Upload the customized image
4. Approve the customized image
5. Delete the customized image

Tip: you can only delete a non-IBM image (that is NOT running) by clicking Delete next to it. If you do NOT see the Delete button for a non-IBM image, that means the image is currently in use by at least one user. To stop a runtime environment from using the image, go to the project's environment page, find the environment that is using the image, and click the Stop icon (■) on it.

Manage Images

Download an existing Image

- In the Image Management page, go to the Image List and click Download next to the runtime image you want to customize.



NAME	TAG	AUTHOR	TYPE	BASE	DATE uploaded	STATUS	STATUS CHANGE DATE	STATUS CHANGE USER	DESCRIPTION	RUNNING	ACTION
hdpzeppelin-dsx-d8a2ls2x	v1.0.145-x86_64	IBM	zeppelin	n/a	n/a	approved	n/a	n/a	Zeppelin Notebook Server 0.7.3 with Anaconda2 4.4, Python 2.7	Yes	⋮
jupyter-d8a2rls2x	v1.0.88-x86_64	IBM	jupyter	n/a	n/a	approved	n/a	n/a	Jupyter Notebook Server with Anaconda2 4.4, Python 2.7, Scala 2.11, R 3.4.3, Spark 2.0.2	Yes	⋮
jupyter-d8a3rls2x	v1.0.88-x86_64	IBM	jupyter-py35	n/a	n/a	approved	n/a	n/a	Jupyter Notebook Server with Anaconda3 4.2, Python 3.5, Scala 2.11, R 3.4.3, Spark 2.2.1	Yes	⋮
jupyter-gpu-py35	v1.0.143-x86_64	IBM	jupyter-gpu-py35	n/a	n/a	approved	n/a	n/a	Jupyter Notebook Server 4.4 with Python 3.5 for GPU (CUDA 8.0)	No	⋮
rstudio-d8a2rls2x	v1.0.90-x86_64	IBM	rstudio	n/a	n/a	approved	n/a	n/a	RStudio Server 1.0 with R 3.4.3	No	⋮
jupyter-linda	graphics	admin	jupyter-py35	jupyter-d8a3rls2x:v1.0.88-x86_64	2019-02-14T00:14:43.436Z	pending review	n/a	n/a		No	⋮

Manage Images

Modify the downloaded Image

- Install Docker if not already. [Download Docker Community Edition](#) for details.
- Change the working directory to the folder with downloaded image.
- Load the image with command: # docker load -i <image_name>.tar.gz
- Create a file named Dockerfile and use the loaded image as the base image. Then add/customize with your need. **Example:**

```
[root@hdp265-edge1 p2]# docker load -i jupyter-d8a3rls2x_v1.0.88-x86_64.tar.gz
Loaded image: idp-registry.sysibm-adm.svc.cluster.local:31006/jupyter-d8a3rls2x:v1.0.88-x86_64
[root@hdp265-edge1 p2]#
[root@hdp265-edge1 p2]#
[root@hdp265-edge1 p2]# cat Dockerfile
FROM idp-registry.sysibm-adm.svc.cluster.local:31006/jupyter-d8a3rls2x:v1.0.88-x86_64
RUN apt-get update
RUN apt-get install -y graphviz
RUN pip install pydot
[root@hdp265-edge1 p2]# docker build -t idp-registry.sysibm-adm.svc.cluster.local:31006/jupyter-d8a3rls2x:v1.0.88-x86_64-Linda .
Sending build context to Docker daemon 3.613 GB
```

Manage Images

Modify the downloaded Image

- Build the image with a new identifier. **Example:**

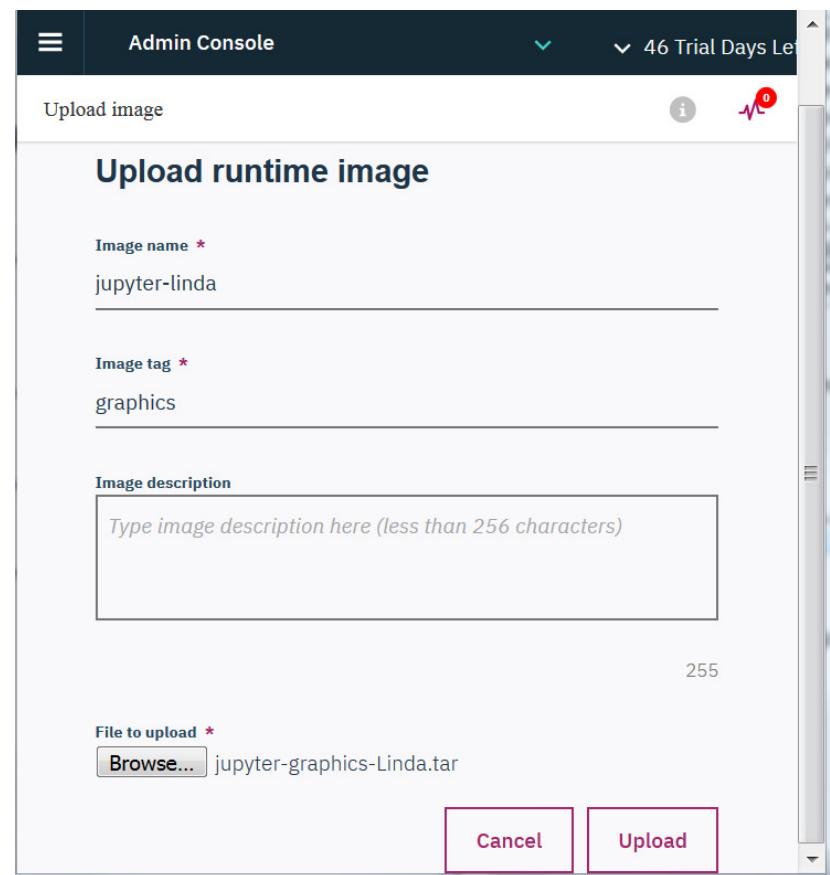
```
[root@hdp265-edge1 p2]# docker load -i jupyter-d8a3rls2x_v1.0.88-x86_64.tar.gz
Loaded image: idp-registry.sysibm-adm.svc.cluster.local:31006/jupyter-d8a3rls2x:v1.0.88-x86_64
[root@hdp265-edge1 p2]#
[root@hdp265-edge1 p2]#
[root@hdp265-edge1 p2]# cat Dockerfile
FROM idp-registry.sysibm-adm.svc.cluster.local:31006/jupyter-d8a3rls2x:v1.0.88-x86_64
RUN apt-get update
RUN apt-get install -y graphviz
RUN pip install pydot
[root@hdp265-edge1 p2]# docker build -t idp-registry.sysibm-adm.svc.cluster.local:31006/jupyter-d8a3rls2x:v1.0.88-x86_64-Linda .
Sending build context to Docker daemon 3.613 GB
```

- Save the image and compress it as a tar file. **Example:** # docker save <modified_img_name> | gzip > <modified_name>.tar.gz

Manage Images

Upload the customized image

- In the Admin console Image Management page, click Upload runtime image. **Example:**
- Type in a new image name, tag, and description.
- From the browse button, select the TAR.GZ file to be uploaded and click the Upload button.

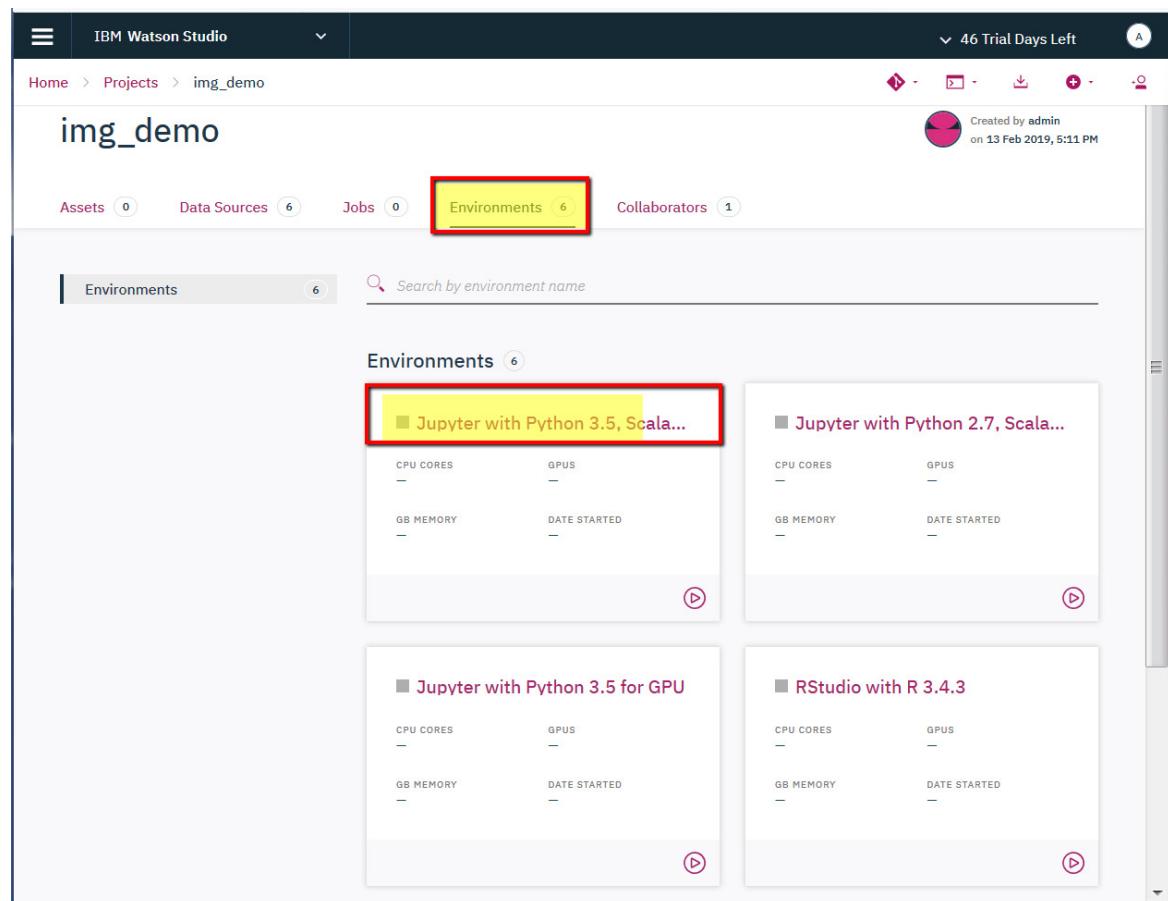


The screenshot shows the 'Admin Console' interface with a '46 Trial Days Left' notification. The main area is titled 'Upload image' and contains a sub-section titled 'Upload runtime image'. It includes fields for 'Image name *' (set to 'jupyter-linda'), 'Image tag *' (set to 'graphics'), and 'Image description' (with a placeholder 'Type image description here (less than 256 characters)'). Below these is a 'File to upload *' field with a 'Browse...' button, which has 'jupyter-graphics-Linda.tar' selected. At the bottom are 'Cancel' and 'Upload' buttons.

Manage Images

Edit Environment

- From the project **Edit Environment** page, the newly uploaded image should display “Pending” status.
- To stop a runtime environment from using the image, click the Stop icon from the environment page. (■)

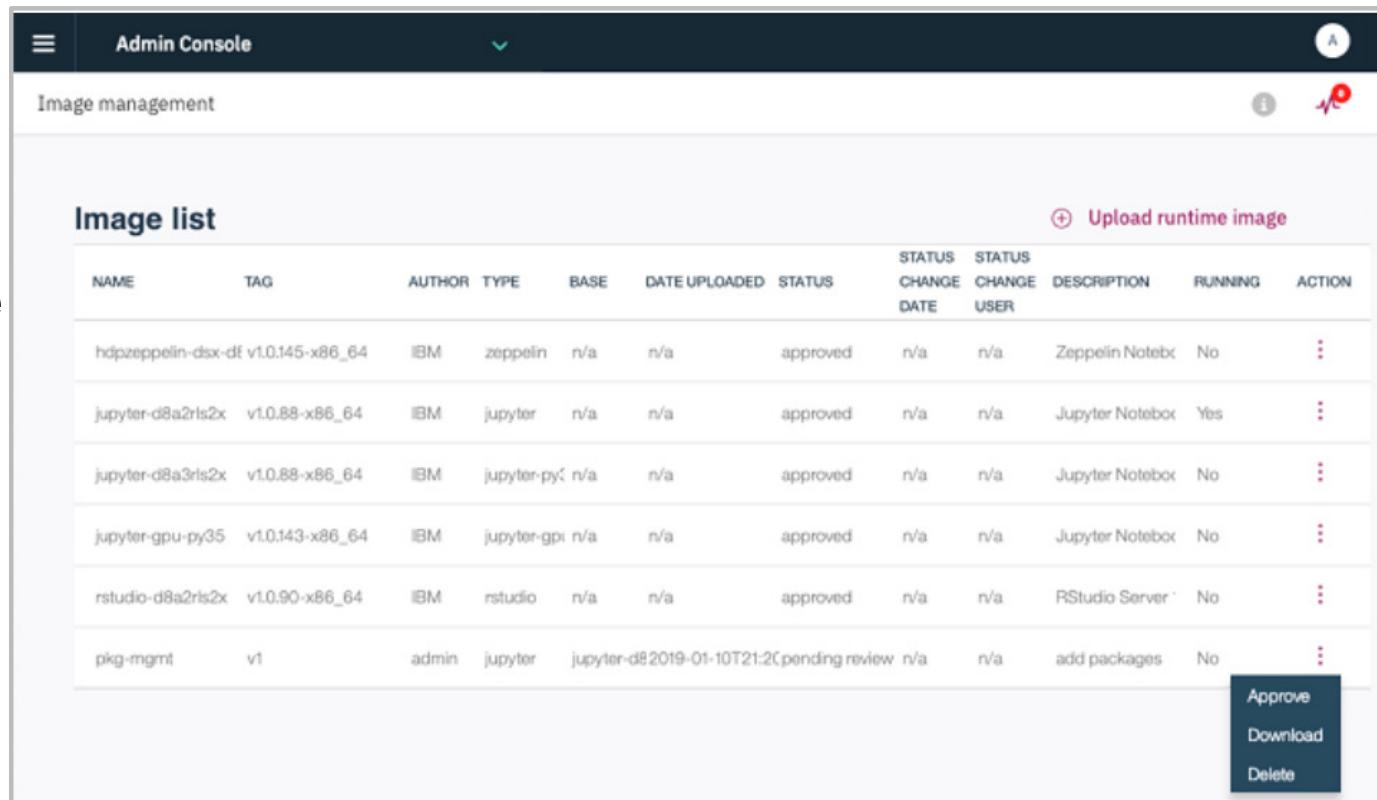


The screenshot shows the IBM Watson Studio interface. At the top, there's a navigation bar with 'IBM Watson Studio' and a '46 Trial Days Left' message. Below it, the project name 'img_demo' is displayed. The main area has tabs for 'Assets' (0), 'Data Sources' (6), 'Jobs' (0), 'Environments' (6), and 'Collaborators' (1). A red box highlights the 'Environments' tab. Below this, there's a search bar labeled 'Search by environment name'. The 'Environments' section shows six environment cards. The first card, 'Jupyter with Python 3.5, Scala...', is highlighted with a red box. Each card displays resource details: CPU CORES, GPUS, GB MEMORY, and DATE STARTED. To the right of each card is a circular icon with a play symbol.

Manage Images

Approve / Un-approve / Delete an Image

- A WSL administrator can click **Approve / Up-approve** / **Delete** next to the newly uploaded image.
- If you do not see the Delete in the dropdown list for a non-IBM image, that means the image is currently in use by at least one user.



NAME	TAG	AUTHOR	TYPE	BASE	DATE UPLOADED	STATUS	STATUS	DESCRIPTION	RUNNING	ACTION
							CHANGE DATE			
hdpzeppelin-dsx-df	v1.0.145-x86_64	IBM	zeppelin	n/a	n/a	approved	n/a	n/a	Zeppelin Notebo	No
jupyter-d8a2rls2x	v1.0.88-x86_64	IBM	jupyter	n/a	n/a	approved	n/a	n/a	Jupyter Notebo	Yes
jupyter-d8a3rls2x	v1.0.88-x86_64	IBM	jupyter-py3	n/a	n/a	approved	n/a	n/a	Jupyter Notebo	No
jupyter-gpu-py35	v1.0.143-x86_64	IBM	jupyter-gpu	n/a	n/a	approved	n/a	n/a	Jupyter Notebo	No
rstudio-d8a2rls2x	v1.0.90-x86_64	IBM	rstudio	n/a	n/a	approved	n/a	n/a	RStudio Server	No
pkg-mgmt	v1	admin	jupyter	jupyter-d82019-01-10T21:2Cpending review	n/a	n/a	n/a	add packages	No	Approve Download Delete

Manage Images

Approve / Un-approve / Delete an Image

- A WSL administrator can click **Approve** / **Up-approve** / **Delete** next to the newly uploaded image.
- If you do not see the **Delete** in the dropdown list for a non-IBM image, that means the image is currently in use by at least one user.

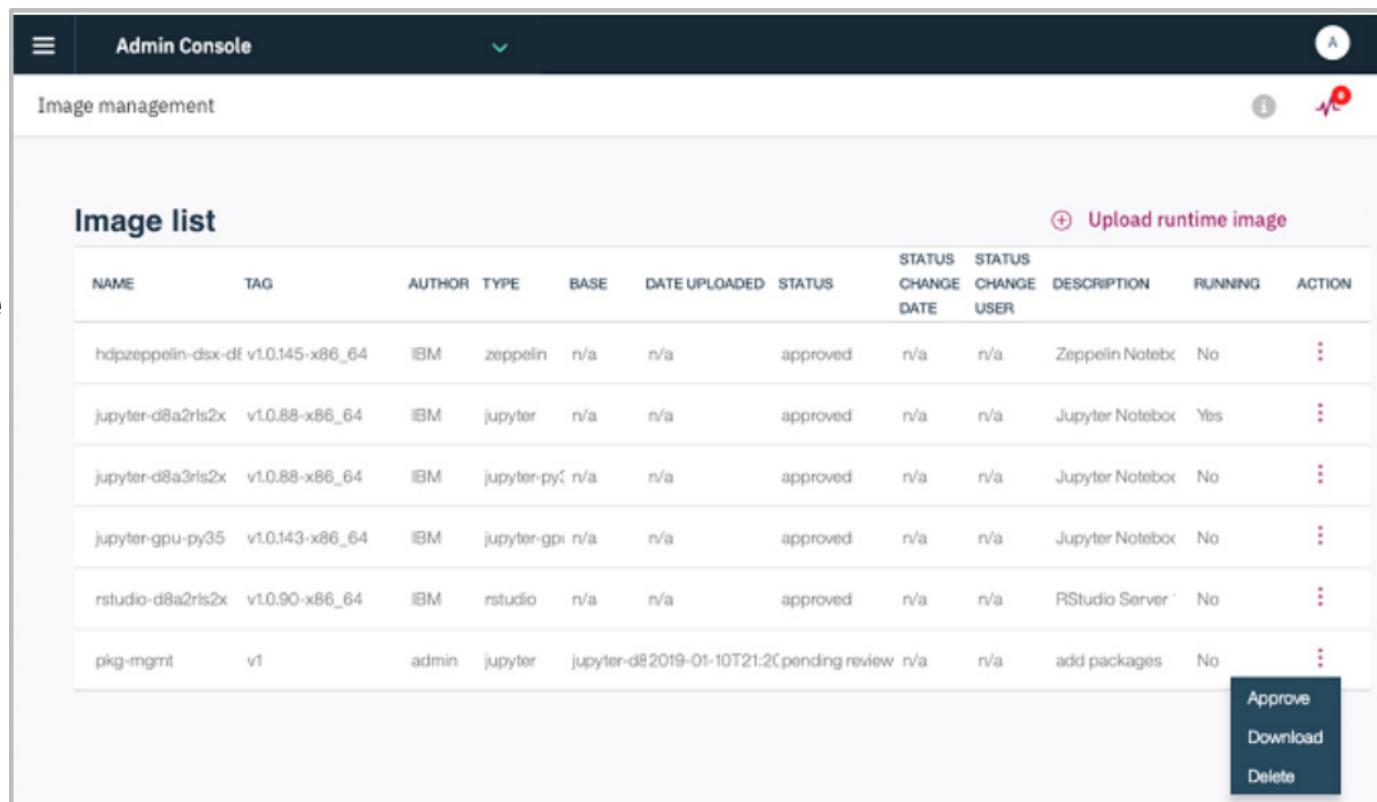


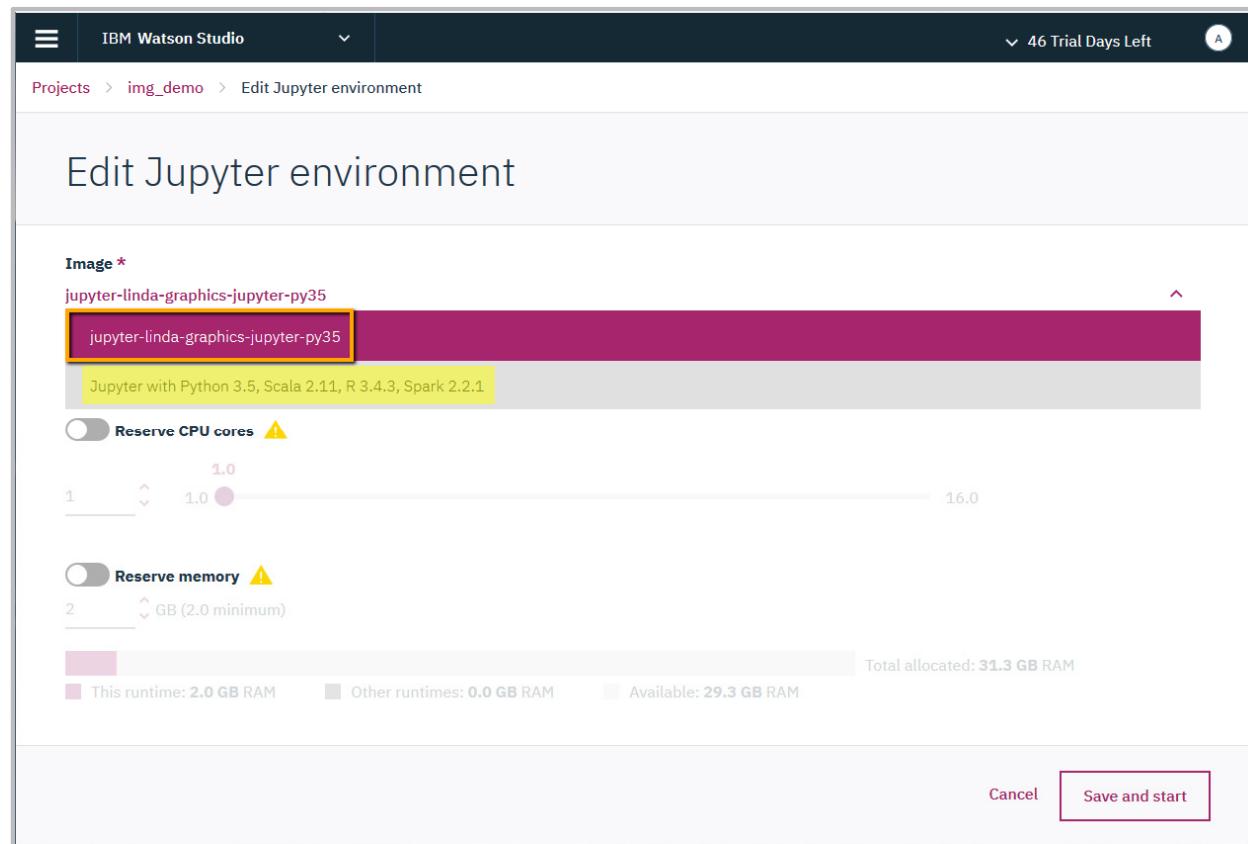
Image list											Upload runtime image
NAME	TAG	AUTHOR	TYPE	BASE	DATE UPLOADED	STATUS	STATUS CHANGE DATE	STATUS CHANGE USER	DESCRIPTION	RUNNING	ACTION
hdpzeppelin-dsx-df	v1.0.145-x86_64	IBM	zeppelin	n/a	n/a	approved	n/a	n/a	Zeppelin Notebo	No	⋮
jupyter-d8a2rls2x	v1.0.88-x86_64	IBM	jupyter	n/a	n/a	approved	n/a	n/a	Jupyter Notebo	Yes	⋮
jupyter-d8a3rls2x	v1.0.88-x86_64	IBM	jupyter-py3	n/a	n/a	approved	n/a	n/a	Jupyter Notebo	No	⋮
jupyter-gpu-py35	v1.0.143-x86_64	IBM	jupyter-gpu	n/a	n/a	approved	n/a	n/a	Jupyter Notebo	No	⋮
rstudio-d8a2rls2x	v1.0.90-x86_64	IBM	rstudio	n/a	n/a	approved	n/a	n/a	RStudio Server	No	⋮
pkg-mgmt	v1	admin	jupyter	jupyter-d82019-01-10T21:2Cpending review	n/a	n/a	n/a	n/a	add packages	No	⋮

[Approve](#)
[Download](#)
[Delete](#)

Manage Images

Use custom image

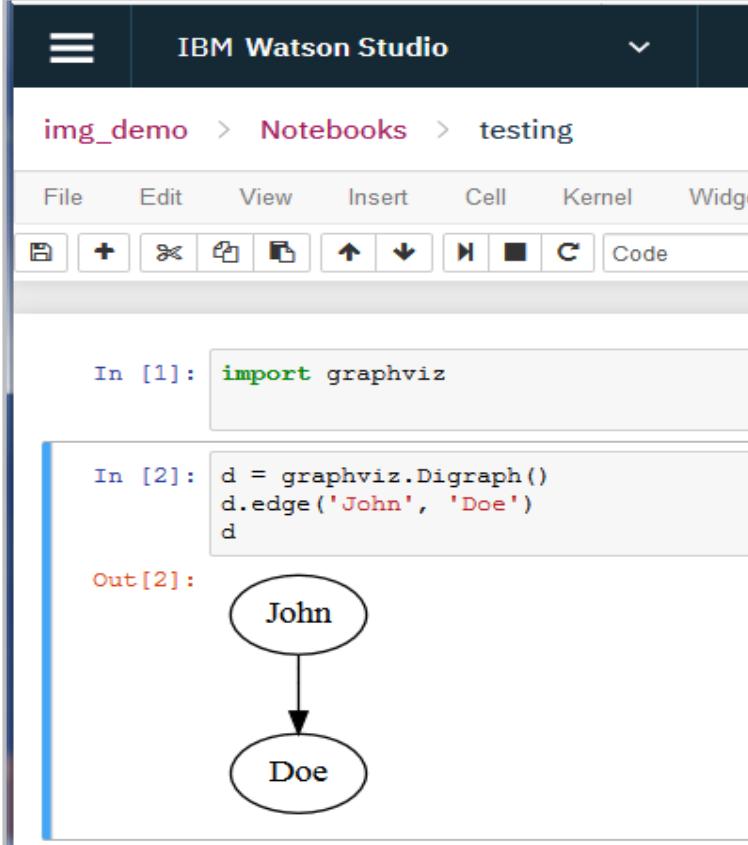
- In your project **Environment** page, click the environment name to edit.
- For Image, select the custom image and click the Save and restart button.



Manage Images

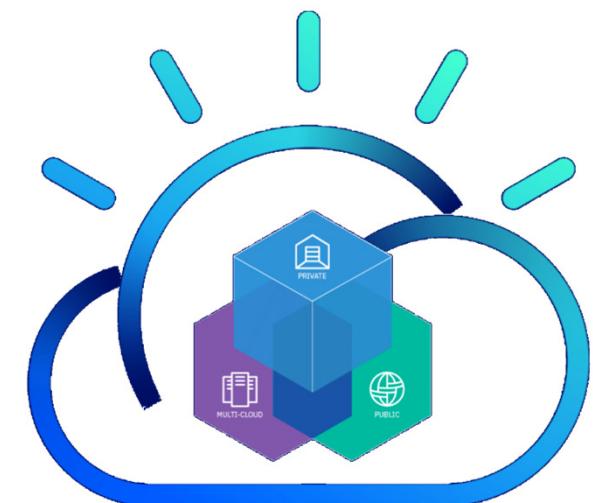
Use custom image

- Go to your project **Assets** page, click **Notebooks**, and click **Add Notebook** button.
- Start using the new customized image. **Example:**



The screenshot shows a Jupyter-style notebook interface in IBM Watson Studio. The top navigation bar includes 'IBM Watson Studio' and a dropdown menu. The path 'img_demo > Notebooks > testing' is visible. The toolbar below has buttons for file operations, cell types (including 'Image'), and other notebook controls. The code cell 'In [1]' contains the command 'import graphviz'. The next cell, 'In [2]', contains Python code to create a directed graph: 'd = graphviz.Digraph()', 'd.edge('John', 'Doe')', and 'd'. The output 'Out[2]' shows a directed graph with two nodes: 'John' at the top and 'Doe' at the bottom, connected by a downward-pointing arrow.

Watson Studio Local Administration Model Management & Deployment



Model Management and Deployment in Watson Studio Local

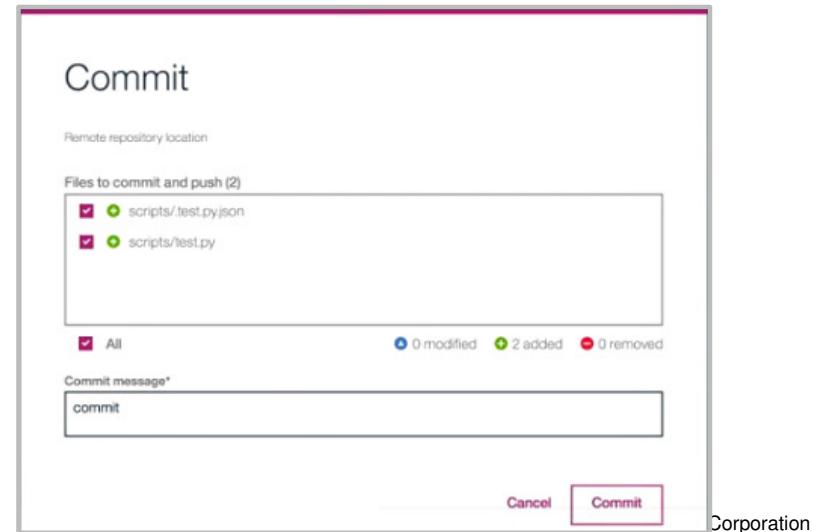
- To expose a checkpoint of assets to outside users, a Deployment Admin can create a project release and deploy the assets within it.
- A project release represents a project tag that can be launched as a production environment within Watson Studio Local.
- The Watson Machine Learning client requires Deployment Admin permissions to create a project release.
- Only the WSL administrator can assign **Deployment Admin** permissions to a WSL user.
- **Prerequisite:** At least one WSL deployment node must be installed and available for a project release to launch successfully. If no deployment node was installed, the WSL administrator can add a new deployment node (that meets the software requirements) from the Nodes page of the Admin Console.

Model Management and Deployment in Watson Studio Local

- The Watson Machine Learning client provides the following tasks:
 - Creating a Project Release
 - Assign Members
 - Deploy Assets
 - Launch a Project Release
 - Manage a Project Release
 - Manage Deployments
 - View Data Sources
 - View Active Environments
 - Edit workers
- We will go over each of these tasks in the following slides

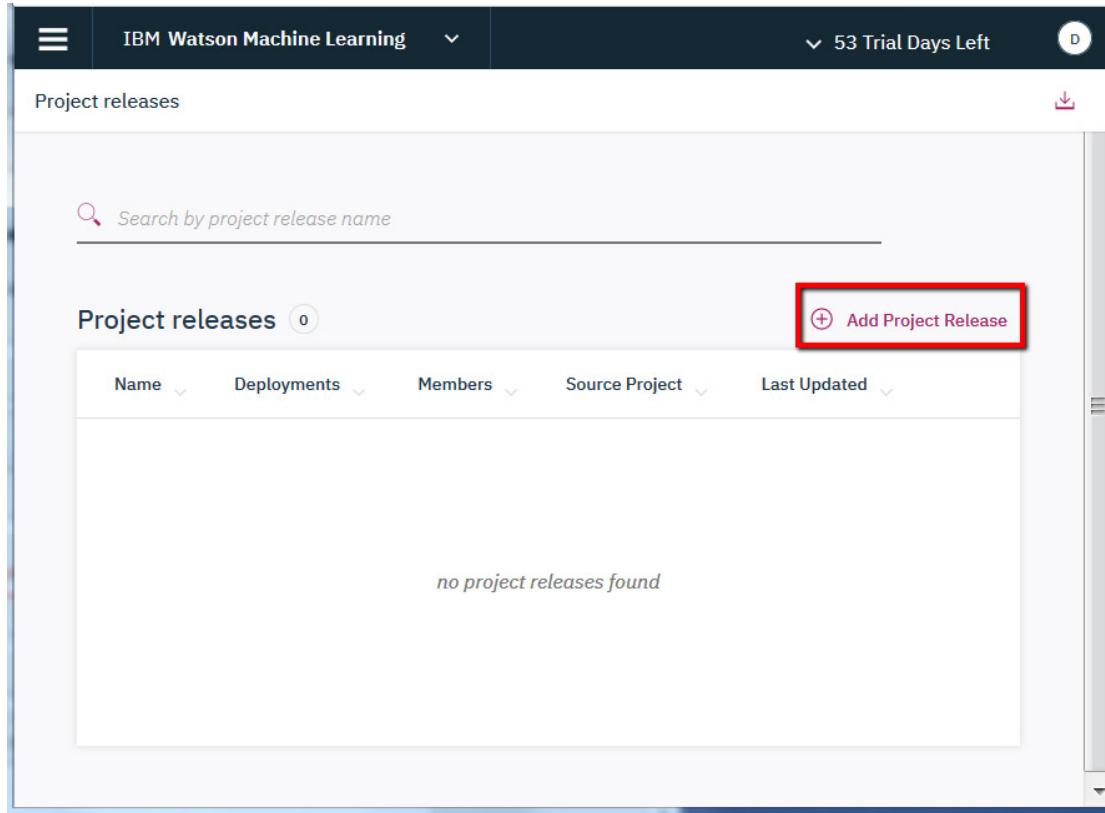
Model Management & Deployment – Create a Project Release

- This is the first step required when wanting to deploy an asset
- A Deployment Admin creates a project release out of the state of a project at a given point in time as denoted by a user-defined tag.
- After the project release is created, assets within this project release can then be deployed
- If you create a project release from a Watson Studio Local source project, this source project must have a tag (specified from the Commit and push window)



Model Management & Deployment – Create a Project Release

1. In the Watson Machine Learning client, go to the Project releases page and click Add Project Release.

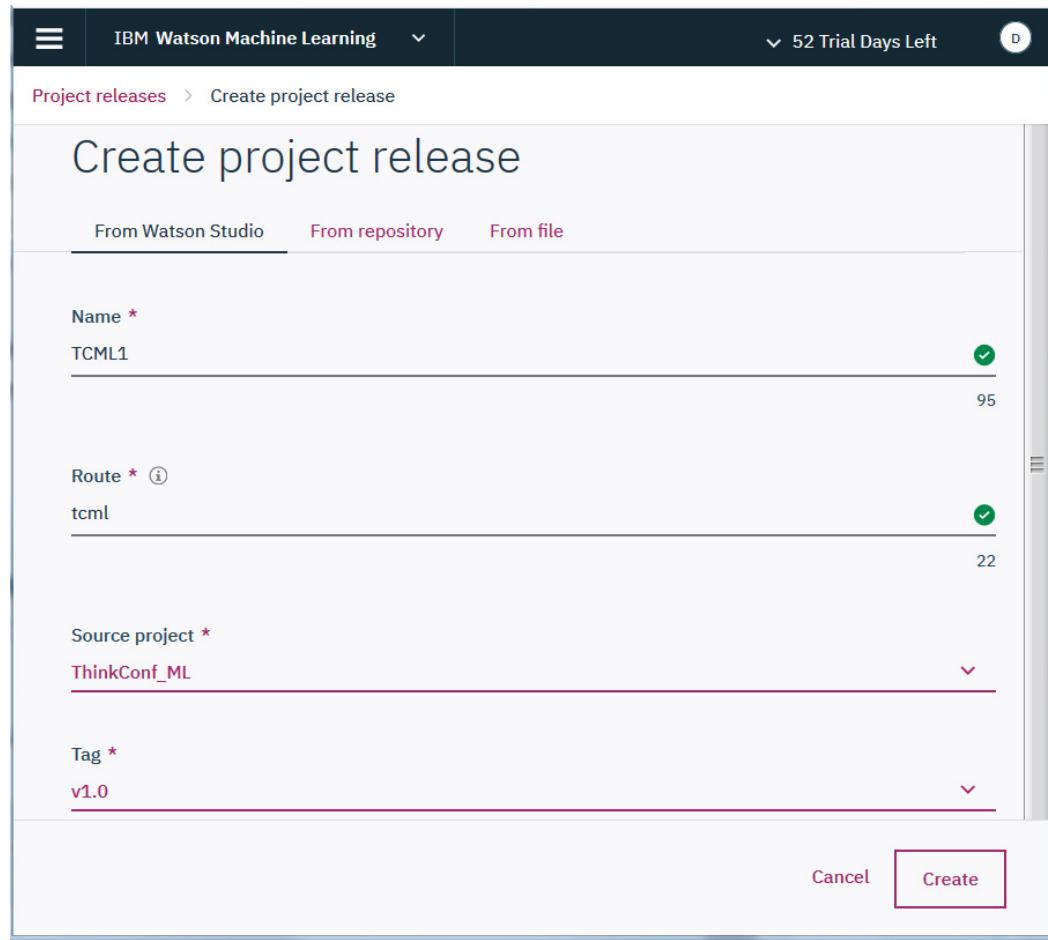


The screenshot shows the 'Project releases' page in the IBM Watson Machine Learning interface. At the top, there is a search bar labeled 'Search by project release name'. Below the search bar, the heading 'Project releases' is followed by a small circular icon with the number '0'. To the right of this, there is a red-bordered button with a plus sign and the text 'Add Project Release'. The main area of the page displays a table header with columns: Name, Deployments, Members, Source Project, and Last Updated. Below the table, a message reads 'no project releases found'.

Model Management & Deployment – Create a Project Release

2. Click **From Watson Studio Local** and select a source project and tag in WSL to associate the release to. Click **From repository** to import a release from a Git repo (a personal access token is required). Click **From file** to import a pre-existing project from your local device (note that the file must be an exported project). Ensure the file name and release name do not contain a space.
3. Type in a name that is descriptive and unique. The name can contain hyphens but not special characters such as a period (.).
4. Type the route to use. The route is the unique ID for the project release, and is used within the deployments' REST paths and URLs. It can contain at least 2 and at most 26 lowercase alphanumeric characters and hyphens, and must start with a letter and end with a letter or number
5. Click Create
6. Watson Machine Learning creates an offline release, unlocked for editing.

Model Management & Deployment – Create a Project Release



The screenshot shows the 'Create project release' form in the IBM Watson Machine Learning interface. The top navigation bar includes the IBM Watson Machine Learning logo and a trial days counter (52 Trial Days Left). The main title is 'Create project release'. Below it, there are three tabs: 'From Watson Studio' (selected), 'From repository', and 'From file'. The form fields are as follows:

- Name ***: TCML1 (highlighted with a red border)
- Route ***: tcml
- Source project ***: ThinkConf_ML
- Tag ***: v1.0

At the bottom right are 'Cancel' and 'Create' buttons.

Model Management & Deployment – Deploy Assets

- An Admin can deploy an asset into a project release
- The deployment action creates a read-only snapshot of the asset
- The following types of assets can be deployed:

Asset	Job	Web service	App	Notes
Notebooks	Y	N	Y	Only Jupyter notebooks can be deployed. Zeppelin and H2O Flows are not supported by Watson Machine Learning.
Models	N	Y	N	Requires that you associate a batch scoring script with it. You cannot deploy Custom Batch models as a web service (must be Custom Online).
R Shiny	N	N	Y	Deploys the R code inside of an R pod.
Flows	Y	N	N	Flows from SPSS Modeler.
Decision Optimization Models	N	Y	N	Provides a REST API to submit and execute optimization jobs.
Scripts	Y	Y	N	
Model groups	N	Y*	N	* Can be deployed as a web service group.

Model Management & Deployment – Deploy Assets

- When the project release launches, each enabled deployment automatically generates either a permalink URL or REST API endpoint where the asset can be accessed:
 - **Job:** Generates a REST API endpoint to start, stop, and get status for that job. The job can be scheduled (but not unscheduled), and is visible to authenticated users only
 - **Web Service:** Generates a REST API endpoint for an external application to call. The web service is visible to authenticated users only

Model Management & Deployment – Deploy Assets

- **Web Service Group:** Generates a REST API endpoint for an external application to call. The web service group is visible to authenticated users only. In the Edit test settings page, you can set the leader and enable the following routing configurations:
 - **Leader:** Allows API requests to the leader of the group. The Routing-Option header in the API request must be set to leader. This is the default.
 - **Specific Model:** Allows API requests to a specific model version in the group. The Routing-Option header in the API request must be set to specific.
 - **Random Model:** Allows API requests to a randomly selected model version in the group. The Routing-Option header in the API request must be set to random.
 - **All Models:** Allows requests to every enabled model version in the group. The Routing-Option header in the API request must be set to all.

Model Management & Deployment – Deploy Assets

- **App:** Generates a URL that runs the asset code as an interactive UI session. You can specify the Shared with setting to be either:
 - **Anyone with the link:** Anyone outside person can view it
 - **Any authenticated user:** Only signed users can view it
 - **Deployment Admin:** Only the creator of the project release can view it.

Model Management & Deployment – Deploy Assets

A web service generates a REST API endpoint for an external application to call.

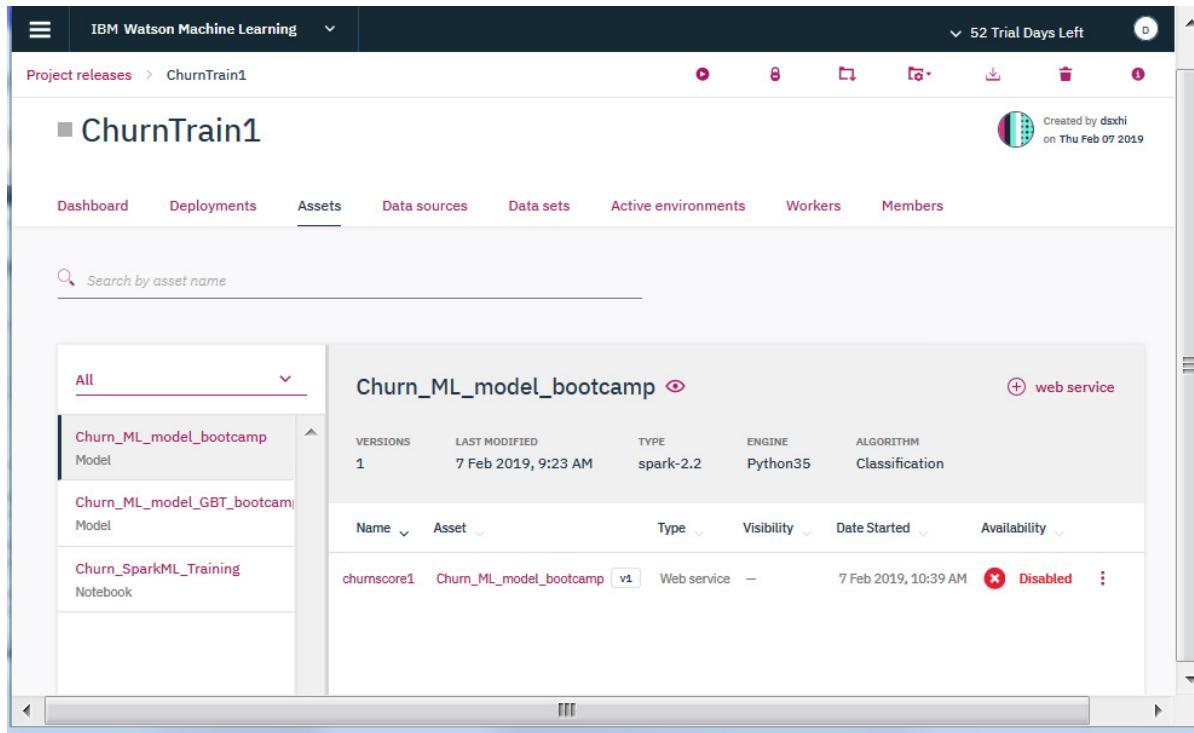
The following asset types can be deployed as a web services:

- Models
- Scripts

Restriction: You cannot deploy custom batch models as web service (must be custom online)

Model Management & Deployment – Deploy Assets

- To deploy an asset, complete the following steps:
 1. In the Watson Machine Learning client, go to your project release and click the **Assets** tab.



The screenshot shows the Watson Machine Learning interface. The top navigation bar includes 'IBM Watson Machine Learning' and a dropdown for 'Project releases'. Below it, the path 'Project releases > ChurnTrain1' is shown. The main area displays the 'ChurnTrain1' project. The 'Assets' tab is selected, indicated by a pink underline. A search bar at the top of the assets section contains the placeholder 'Search by asset name'. On the left, a sidebar lists assets: 'All' (selected), 'Churn_ML_model_bootcamp' (Model), 'Churn_ML_model_GBT_bootcamp' (Model), and 'Churn_SparkML_Training' (Notebook). The main content area shows a detailed view of the 'Churn_ML_model_bootcamp' asset. It lists one version (v1) created on '7 Feb 2019, 9:23 AM' using 'spark-2.2' engine and 'Python35' algorithm. This asset is categorized as a 'Classification' model and is currently a 'web service'. A table below shows deployment details: 'churnscore1' was deployed as a 'Web service' on '7 Feb 2019, 10:39 AM' but is marked as 'Disabled'.

Model Management & Deployment – Deploy Assets

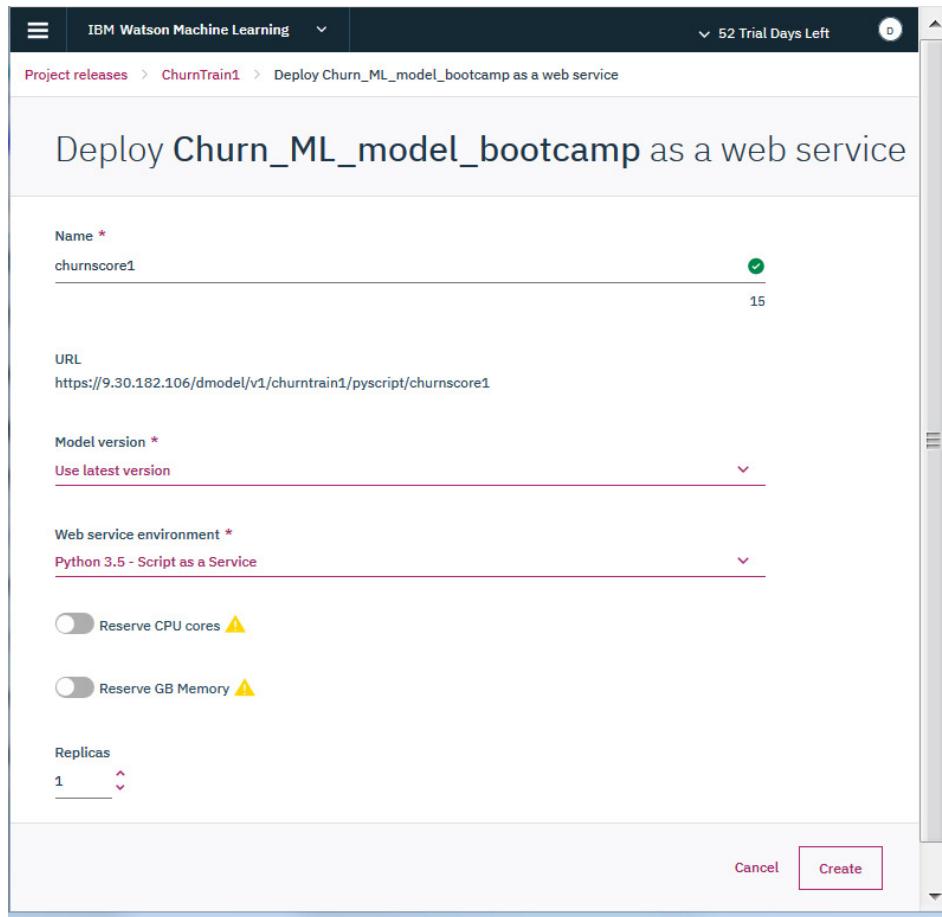
2. Select a model from the left side of the assets table, and then, in the right side, click the button to create a web service. The Create web service deployment window opens.

You are prompted with the following fields:

- Name – Specify a name for the asset that will be deployed. Use only lowercase alphanumeric characters and hyphens, up to 26 characters.
- URL – View the generated URL for the web service.
- Model version – Select from available versions. The latest is the default.
- Web service environment – Select from one of the generated scripts, or select Custom for a custom script that you generate.
- Reserve resources
- Replicas

3. Click the **Create** button

Model Management & Deployment – Deploy Assets



The screenshot shows the 'Deploy Churn_ML_model_bootcamp as a web service' configuration page. Key fields include:

- Name ***: churnscore1
- URL**: <https://9.30.182.106/dmodel/v1/churntrain1/pyscript/churnscore1>
- Model version ***: Use latest version
- Web service environment ***: Python 3.5 - Script as a Service
- Reserve CPU cores**: (warning icon)
- Reserve GB Memory**: (warning icon)
- Replicas**: 1

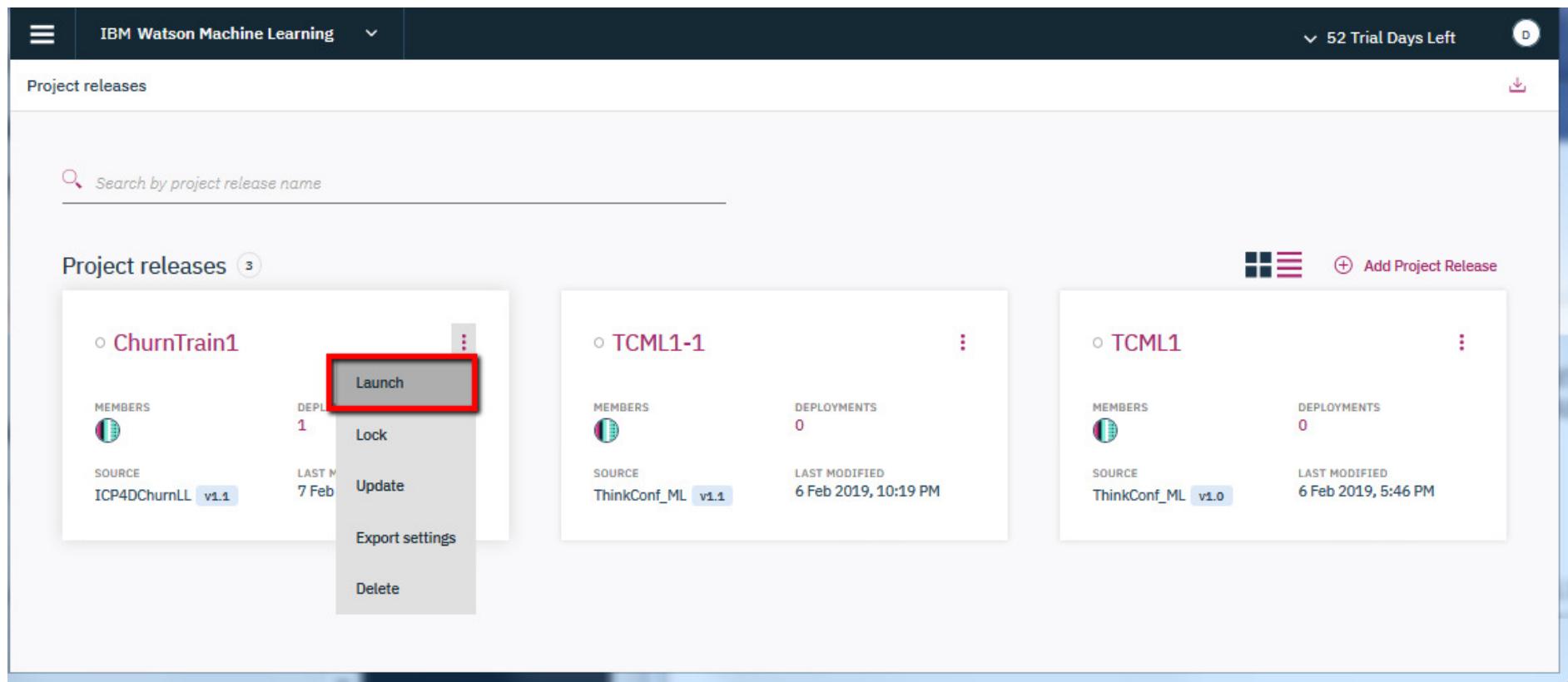
At the bottom right are 'Cancel' and 'Create' buttons.

- All deployments remain **disabled** until the project release is launched
- If the project release is already online, your newly created deployment starts immediately

Model Management & Deployment – Launch a Project Release

- An Admin can click the Launch icon to bring the release online
- Wait about a minute for the pods to start and each enabled deployment to activate (you can monitor the status in the Active environments panel) before you click any actions for the deployment
- You might also see a similar time delay when you stop or start a script for model deployment
- If you deployed a Job:
 - Click it to view the REST API endpoint for an external application or to run the job on demand
 - When the release is online, you can click the API tab and submit a request to Start, Stop, or get Status for the job
 - You can also click generate code to copy/paste the curl command with the deployment bearer token in it.
 - You cannot take a release offline; you can only delete the release

Model Management & Deployment – Launch a Project Release



The screenshot shows the IBM Watson Machine Learning interface for managing project releases. At the top, there's a navigation bar with the title "IBM Watson Machine Learning" and a "52 Trial Days Left" indicator. Below the navigation bar, the main area is titled "Project releases". A search bar is present with the placeholder "Search by project release name". On the right side, there's a button to "Add Project Release". The main content area displays three project releases:

- ChurnTrain1**: This release has 1 member, 1 deployment, and was last modified on 7 Feb. It has options to Launch, Lock, Update, Export settings, and Delete. The "Launch" option is highlighted with a red box.
- TCML1-1**: This release has 1 member and 0 deployments. It was last modified on 6 Feb 2019, 10:19 PM. It includes options to Members, Deployments, SOURCE (ThinkConf_ML v1.1), and LAST MODIFIED.
- TCML1**: This release has 1 member and 0 deployments. It was last modified on 6 Feb 2019, 5:46 PM. It includes options to Members, Deployments, SOURCE (ThinkConf_ML v1.0), and LAST MODIFIED.

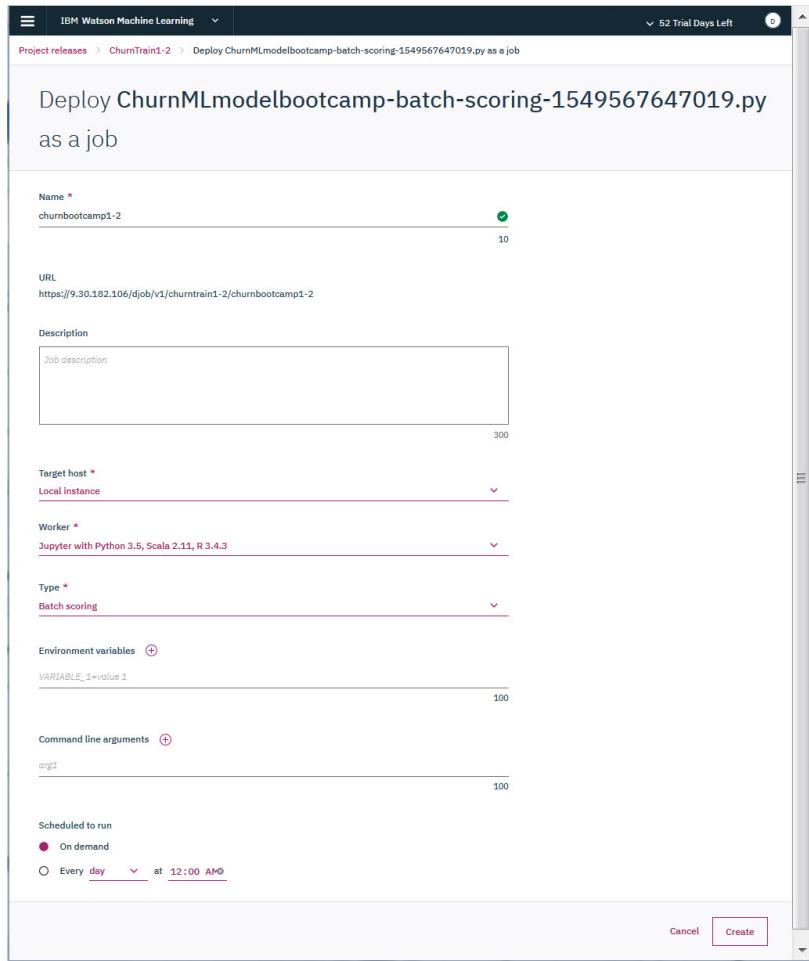
Model Management & Deployment – Launch a Project Release

- If you deployed a Job:
 - A job deployment generates a REST API endpoint to start, stop, and get status for that job. The job can be scheduled (but not unscheduled), and is visible to authenticated users only.
 - The following asset types can be deployed as a job:
 - Scripts
 - Notebooks

Model Management & Deployment – Launch a Project Release

- Deploy a job following this steps:
 - Open the Assets tab in the Project release details page. Select a script or notebook from the left side of the assets table, and then, in the right side, click the button to create a job. The Create job deployment window opens.
 - Specify a name for the job that contains lowercase alphanumeric characters and hyphens, up to 26 characters. Then specify other details for the job, including workers, job type, environment variables, and command line arguments. You can set up a schedule for the job.
 - After you create a job, you will see the job deployment in the deployments list.
 - To use the test API page in the Deployment details page, you must first bring the release online by clicking the Launch button from the Project release details page.

Model Management & Deployment – Launch a Project Release



The screenshot shows the 'Deploy ChurnMLmodelbootcamp-batch-scoring-1549567647019.py as a job' page in the IBM Watson Machine Learning interface. The page includes fields for Name (churnbootcamp1-2), URL (https://9.30.182.106/djob/v1/churntrain1-2/churnbootcamp1-2), Description (Job description), Target host (Local instance), Worker (Jupyter with Python 3.5, Scala 2.11, R 3.4.3), Type (Batch scoring), Environment variables (VARIABLE_1=value 1), Command line arguments (arg1), and Scheduled to run (On demand). A 'Create' button is at the bottom right.

- All deployments remain **disabled** until the project release is launched
- If the project release is already online, your newly created deployment starts immediately

Model Management & Deployment – Launch a Project Release

- If you deployed a Web Service:
 - It will have a REST API endpoint for an external application to call
 - From the deployment details API tab, you can submit a JSON request or click generate code to copy/paste the curl command with the deployment bearer token in it
 - For an R script, ensure RStudio environment is in running state before you run the curl command (otherwise you might receive a ‘502 Bad Gateway’ error)
 - You cannot take a release offline; you can only delete the release.

Model Management & Deployment – Launch a Project Release

- If you deployed a Job:
 - Click it to view the REST API endpoint for an external application or to run the job on demand
 - When the release is online, you can click the API tab and submit a request to Start, Stop, or get Status for the job
 - You can also click generate code to copy/paste the curl command with the deployment bearer token in it.
 - You cannot take a release offline; you can only delete the release

Model Management & Deployment – Manage a Project Release

- **Update:**

- To pull in the latest assets from the source project and update the deployments with them, click **Update** next to the release
 - This action only updates modified assets and adds new assets to the release. It does not delete assets from the release

- **Export:**

- To export the deployment settings of a release (for use in another release), click **Export deployment settings** next to it
 - You can then upload these same deployment setting into another offline release by clicking the Import deployment settings icon and dragging the settings file into the Input pane.
 - Click the **Validate File** button to compare these imported settings with the current settings for your release
 - If the **Differences** look acceptable, you can click **Submit** to update your release manifest accordingly. Existing settings will be updated, new settings will be added, and unaffected settings will remain unchanged

Model Management & Deployment – Manage a Project Release

- **Lock:**

- To lock a release so that no one can edit it, click **Lock** next to it
 - You can click **Unlock** to reopen the release for editing.

- **Delete:**

- To delete a release and all of its deployments, click **Delete** next to it
 - Alternatively, you can click the **Delete** icon from the release details page.

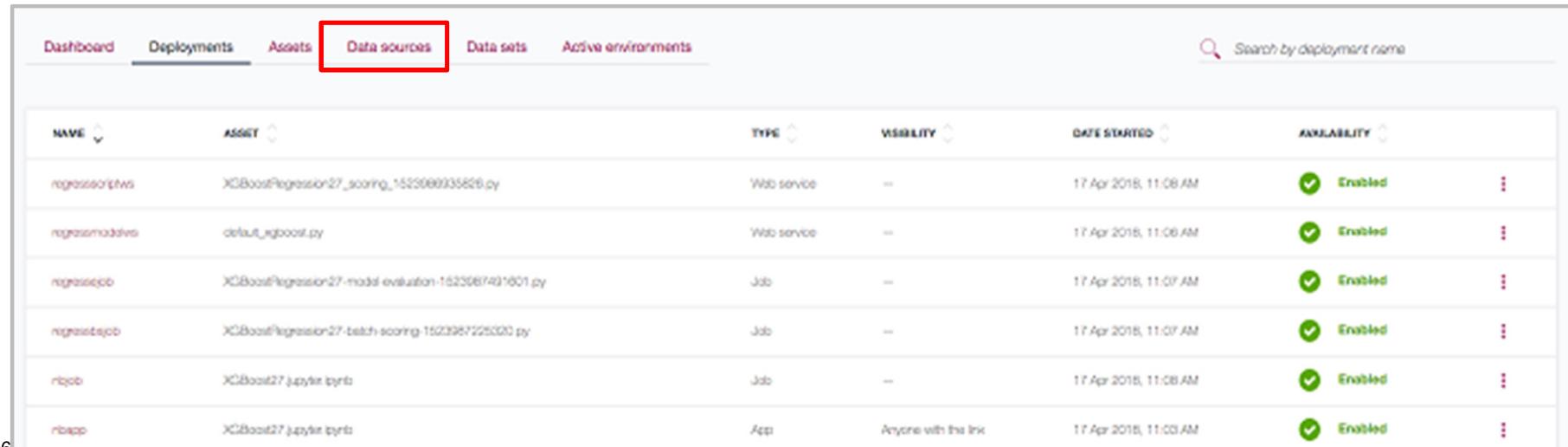
Model Management & Deployment – Manage Deployments

- From the Deployments tab of your project release, an Admin, Developer, or Viewer can click a deployment for an overview of its details including request metrics captured at the function level
- Only the Admin can start, stop, delete, or redeploy any deployment in the release. Note that if you redeploy a new version of any of the assets, the URL does not change
- For an app, the Admin can edit its settings, edit its visibility, and view its route

Dashboard	Deployments	Assets	Data sources	Data sets	Active environments	Search by deployment name
Name	Asset	Type	Visibility	Date Started	Availability	
regressoripws	XGBoostRegression27_scoring-152300035826.py	Web service	--	17 Apr 2018, 11:08 AM	Enabled	
regressormodels	default_xgboost.py	Web service	--	17 Apr 2018, 11:08 AM	Enabled	
regressorjob	XGBoostRegression27-model-evaluation-1523067491601.py	Job	--	17 Apr 2018, 11:07 AM	Enabled	
regressorjob	XGBoostRegression27-batch-scoring-1523987225302.py	Job	--	17 Apr 2018, 11:07 AM	Enabled	
rjob	XGBoost27_jupyter.ipynb	Job	--	17 Apr 2018, 11:08 AM	Enabled	
rjob	XGBoost27_jupyter.ipynb	App	Anyone with the link	17 Apr 2018, 11:00 AM	Enabled	

Model Management & Deployment – View Data Sources

- In the IBM Deployment Manager, click the Data sources to view your project data sources
- You can also edit the production data source connection string and credentials by clicking Edit credentials next to the data source
- Important: Database credentials must be input again after creating a project release. Otherwise, the data source might not work

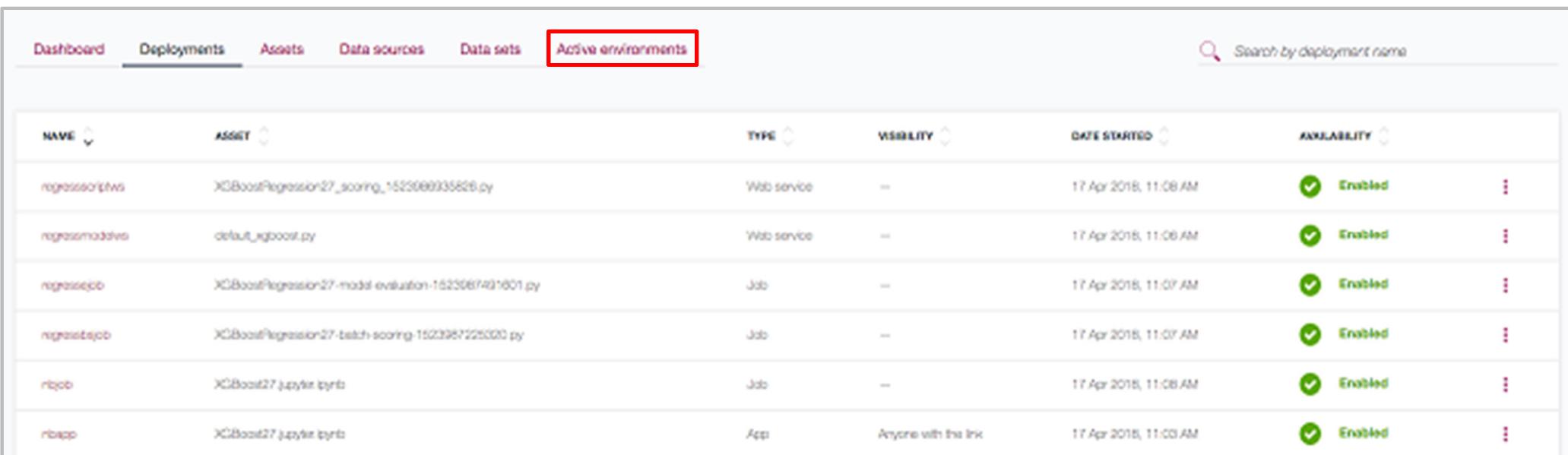


The screenshot shows the IBM Deployment Manager dashboard. The top navigation bar includes links for Dashboard, Deployments, Assets, **Data sources** (which is highlighted with a red box), Data sets, and Active environments. A search bar is located at the top right. Below the navigation is a table with deployment details. The columns are: NAME, ASSET, TYPE, VISIBILITY, DATE STARTED, and AVAILABILITY. The rows list various deployments, all of which are currently enabled.

NAME	ASSET	TYPE	VISIBILITY	DATE STARTED	AVAILABILITY
regressscriptws	XGBoostRegression27_scoring_1523060355826.py	Web service	--	17 Apr 2018, 11:08 AM	Enabled
regressmadditive	default_xgboost.py	Web service	--	17 Apr 2018, 11:06 AM	Enabled
regressjob	XGBoostRegression27-model-evaluation-1523067491601.py	Job	--	17 Apr 2018, 11:07 AM	Enabled
regressjob	XGBoostRegression27-batch-scoring-1523987225390.py	Job	--	17 Apr 2018, 11:07 AM	Enabled
rjob	XGBoost27_jupyter.ipynb	Job	--	17 Apr 2018, 11:08 AM	Enabled
rapp	XGBoost27_jupyter.ipynb	App	Anyone with the link	17 Apr 2018, 11:03 AM	Enabled

Model Management & Deployment – View Active Environments

- In the Watson Machine Learning client, click the **Active environments** tab to monitor all runtime environments, workers, and services to WSL
 - This is synonymous with using the menu icon to click on **All Active Environments**



The screenshot shows the 'Active environments' tab selected in the navigation bar. The table lists seven entries:

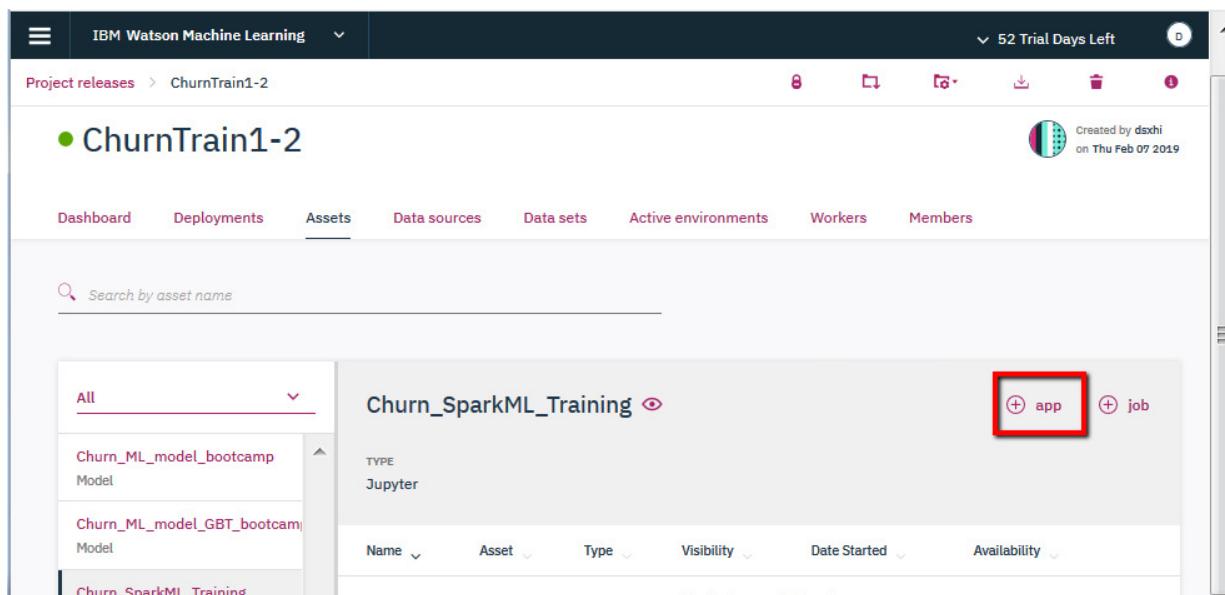
NAME	ASSET	TYPE	VISIBILITY	DATE STARTED	AVAILABILITY	⋮
regressor1ws	XGBoostRegression27_scoring_1523000035826.py	Web service	--	17 Apr 2018, 11:08 AM	Enabled	⋮
regressor2ws	default_xgboost.py	Web service	--	17 Apr 2018, 11:08 AM	Enabled	⋮
regressorjob	XGBoostRegression27-model-evaluation-15230067491001.py	Job	--	17 Apr 2018, 11:07 AM	Enabled	⋮
regressorjob	XGBoostRegression27-batch-scoring-1523987225000.py	Job	--	17 Apr 2018, 11:07 AM	Enabled	⋮
rjob	XGBoost27_jupyter.ipynb	Job	--	17 Apr 2018, 11:08 AM	Enabled	⋮
rapp	XGBoost27_jupyter.ipynb	App	Anyone with the link	17 Apr 2018, 11:03 AM	Enabled	⋮

Model Management & Deployment – Deploy Asset as an App

- An app deployment generates a URL that runs the asset code as an interactive UI session
- The following asset types can be deployed as an app:
 - Shiny Servers
 - Jupyter Notebooks

Model Management & Deployment – Deploy Notebook as an App

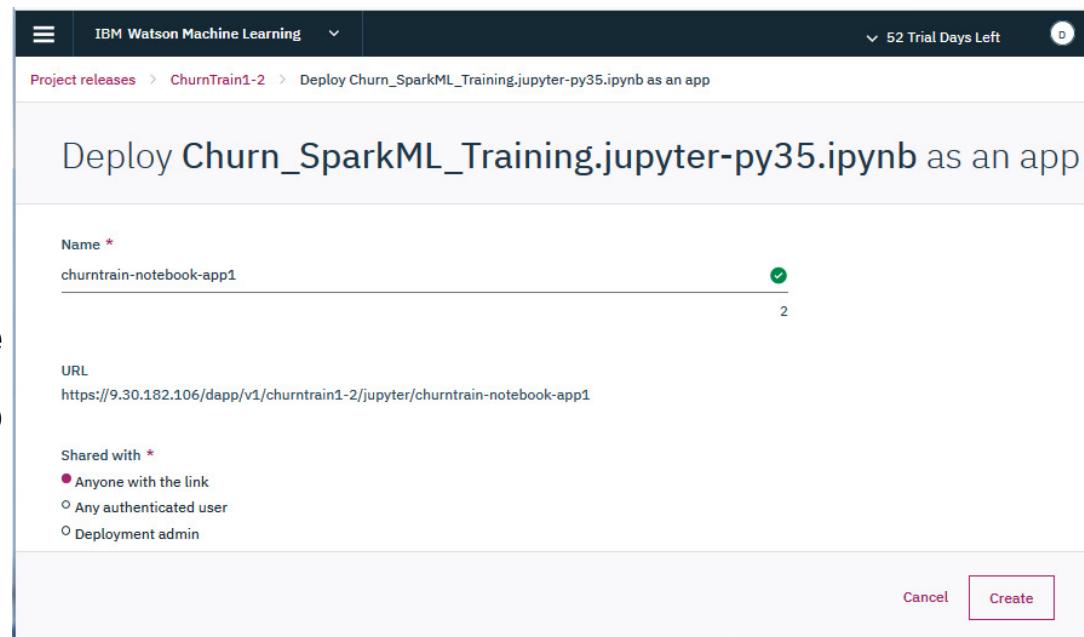
- **Requirement:** Ensure that you run your notebook before you deploy it as an app. Otherwise, cell results such as graphs do not appear
- You can navigate to the Assets tab in the Project release details page
- When a Jupyter notebook is selected in the left panel of the assets table, the right panel of the assets table provides the button to create an app, which brings you to the Create app deployment screen.



The screenshot shows the IBM Watson Machine Learning interface. At the top, there's a navigation bar with 'IBM Watson Machine Learning' and a dropdown showing 'Project releases > ChurnTrain1-2'. Below the navigation is a toolbar with icons for search, refresh, and other operations, followed by a message '52 Trial Days Left' and a user icon. The main area has tabs for 'Dashboard', 'Deployments', 'Assets' (which is selected), 'Data sources', 'Data sets', 'Active environments', 'Workers', and 'Members'. A search bar says 'Search by asset name'. On the left, a sidebar lists assets: 'All' (selected), 'Churn_ML_model_bootcamp Model', 'Churn_ML_model_GBT_bootcamp Model', and 'Churn_SparkML_Training'. The main content area displays 'Churn_SparkML_Training' with a 'TYPE' of 'Jupyter'. To the right of the asset details are two buttons: '+ app' (highlighted with a red box) and '+ job'. At the bottom of the asset list are filters for 'Name', 'Asset', 'Type', 'Visibility', 'Date Started', and 'Availability'.

Model Management & Deployment – Deploy Notebook as an App

- You are prompted with the following fields:
 - A **Name** for the asset to be deployed. It can contain lowercase alphanumeric characters and hyphens, up to 26 characters
 - A generated **URL** is shown
 - You can select the **Visibility** option from the radio group. Visibility determines who is app to interact with the app after it is deployed



The screenshot shows a deployment dialog in the IBM Watson Machine Learning interface. The title bar says "IBM Watson Machine Learning" and "52 Trial Days Left". The URL in the browser is "Project releases > ChurnTrain1-2 > Deploy Churn_SparkML_Training.jupyter-py35.ipynb as an app". The dialog form has the following fields:

- Name ***: churntrain-notebook-app1 (with a green checkmark icon)
- URL**: <https://9.30.182.106/dapp/v1/churntrain1-2/jupyter/churntrain-notebook-app1>
- Shared with ***:
 - Anyone with the link
 - Any authenticated user
 - Deployment admin

At the bottom right are "Cancel" and "Create" buttons, with "Create" being highlighted.

Model Management & Deployment – View App

- When an app deployment is created and the project is live, you can view the app by going to the Deployments tab on the Release details page
- You can click the name of the app deployment and are brought to the app page.

Model Management & Deployment – Deploy Asset as a Job

- A job generates a REST API endpoint to start, stop, and get status for that job
- The job can be scheduled (but not unscheduled), and is visible to authenticated users only
- The following asset types can be deployed as a job:
 - Scripts
 - Notebooks

Model Management & Deployment – Deploy Script or Notebook as a Job

- You can navigate to the Assets tab in the Project release details page
- When a script is selected in the left panel of the assets table, the right panel of the assets table provides the button to create a job, which brings you to the Create job deployment page.

Deploy Cars Model Python-model-evaluation-1522797324247.py as a job

Name *
cars-model-evaluation 5

URL
<https://9.30.140.31/djcb/v1/blg/cars-model-evaluation>

Description
Job description 300

Type *
Model evaluation

Worker *
Jupyter with Python 2.7, Scala 2.11, R 3.4.3

Target host *
Local instance

Environment variables ⊕
VARIABLE_1=value 1 100

Command line arguments ⊕
arg1 100

Scheduled to run
 On demand
 Every day ▼ at 12:00 AM ⌚

Model Management & Deployment – Deploy Script or Notebook as a Job

- You are prompted with the following fields:
 - A **Name** for the job to be deployed. It might contain lowercase alphanumeric characters and hyphens, up to 26 characters
 - A generated **URL** is shown
 - An optional **description** is shown
 - You are able to select the **Worker** from the pull-down of available images
 - You are able to select the **job type** from the pull-down for the various job types
 - You have the option to provide **environment variables** for the job and **command line arguments**
 - You have the option of providing a time for the job to be **scheduled to run**

Model Management & Deployment – Deploy Script or Notebook as a Job

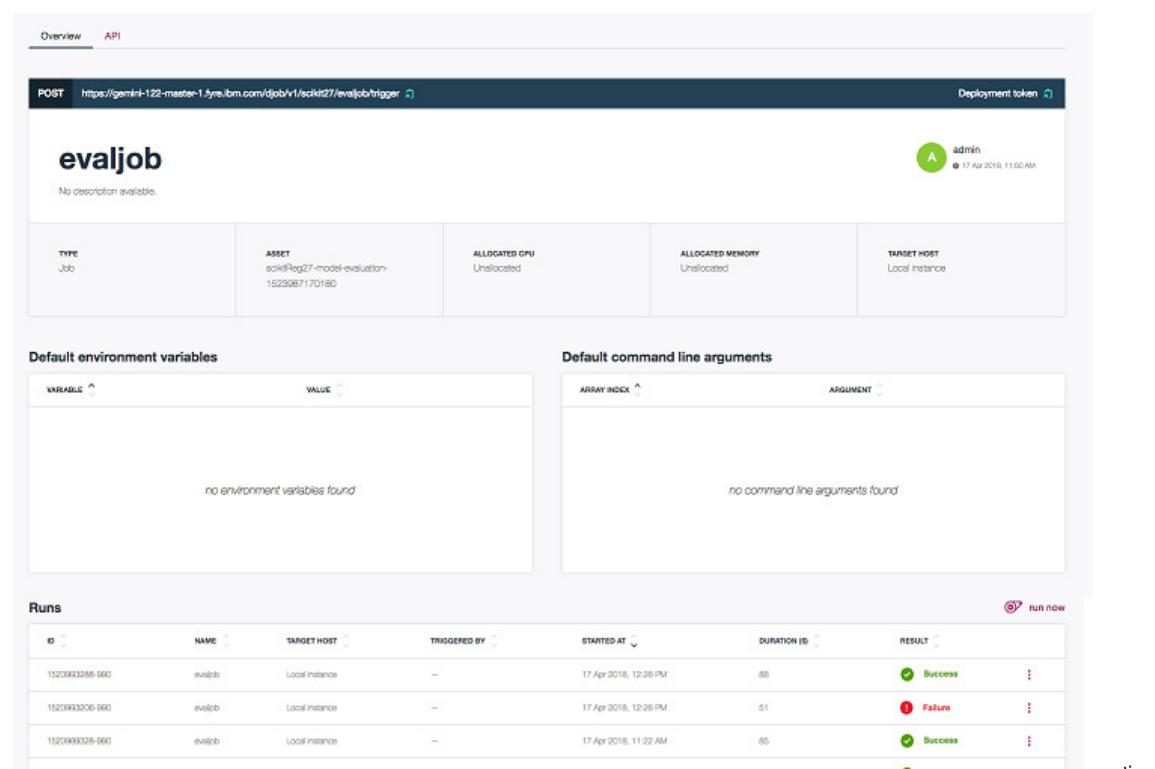
- After you create a job, you will see the job deployment in the deployments list
- To use the test API page in the deployment details page, you must first bring the release online by clicking the Launch button in the upper right of the Project release details page

Model Management & Deployment – Manage a Deployed Job

- After you create a job deployment and selecting a job deployment from the deployments page, Watson Studio Local displays a Deployment details page
- The Deployment details page has two tabs:
 - Overview
 - API
- **Important:** You cannot start, stop, or get the status of a job if the release is not live

Model Management & Deployment – Overview Tab

- A table of environments and arguments for the current job
- A table of all the runs for that particular job
- A button run now that triggers a job run



evaljob

No description available.

TYPE	ASSET	ALLOCATED GPU	ALLOCATED MEMORY	TARGET HOST
Job	ecelleReg27-model-evaluation-1522987170180	Unallocated	Unallocated	Local instance

Default environment variables

VARIABLE	VALUE
no environment variables found	

Default command line arguments

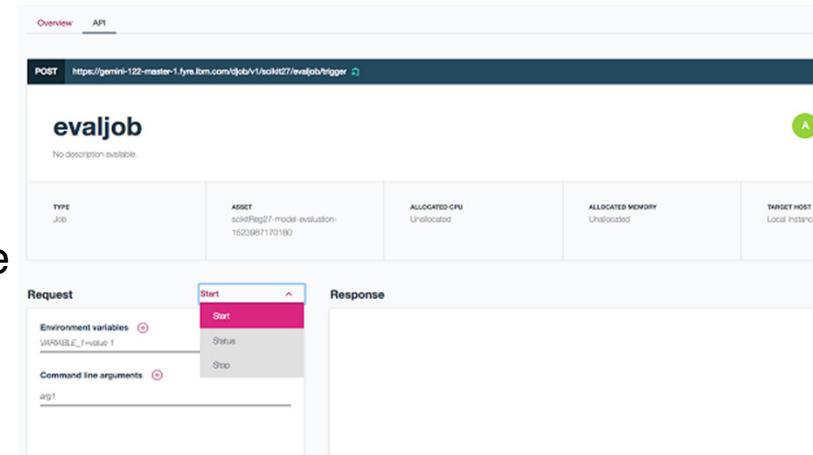
ARRAY INDEX	ARGUMENT
no command line arguments found	

Runs

ID	NAME	TARGET HOST	TRIGGERED BY	STARTED AT	DURATION (S)	RESULT
1523993386-980	evaljob	Local instance	—	17 Apr 2018, 12:28 PM	88	Success
1523993206-980	evaljob	Local instance	—	17 Apr 2018, 12:26 PM	81	Failure
1523993326-980	evaljob	Local instance	—	17 Apr 2018, 11:22 AM	85	Success

Model Management & Deployment – API Tab

- In the API tab, you have three options of API calls to interact with a job with the pull-down menu:
 - Start calls the **trigger** api call to start a job run
 - Stop calls the **cancel** api call to stop a job run
 - Status calls the **status** api call to get information about the status. Note if you do not supply a run ID in the text box when you call the status, the API call gets all the runs for the current job
- A **generate code** button, which displays the proper curl command based on the selected status and the data in the **input** box
- A result box that shows the **JSON** output from the API call

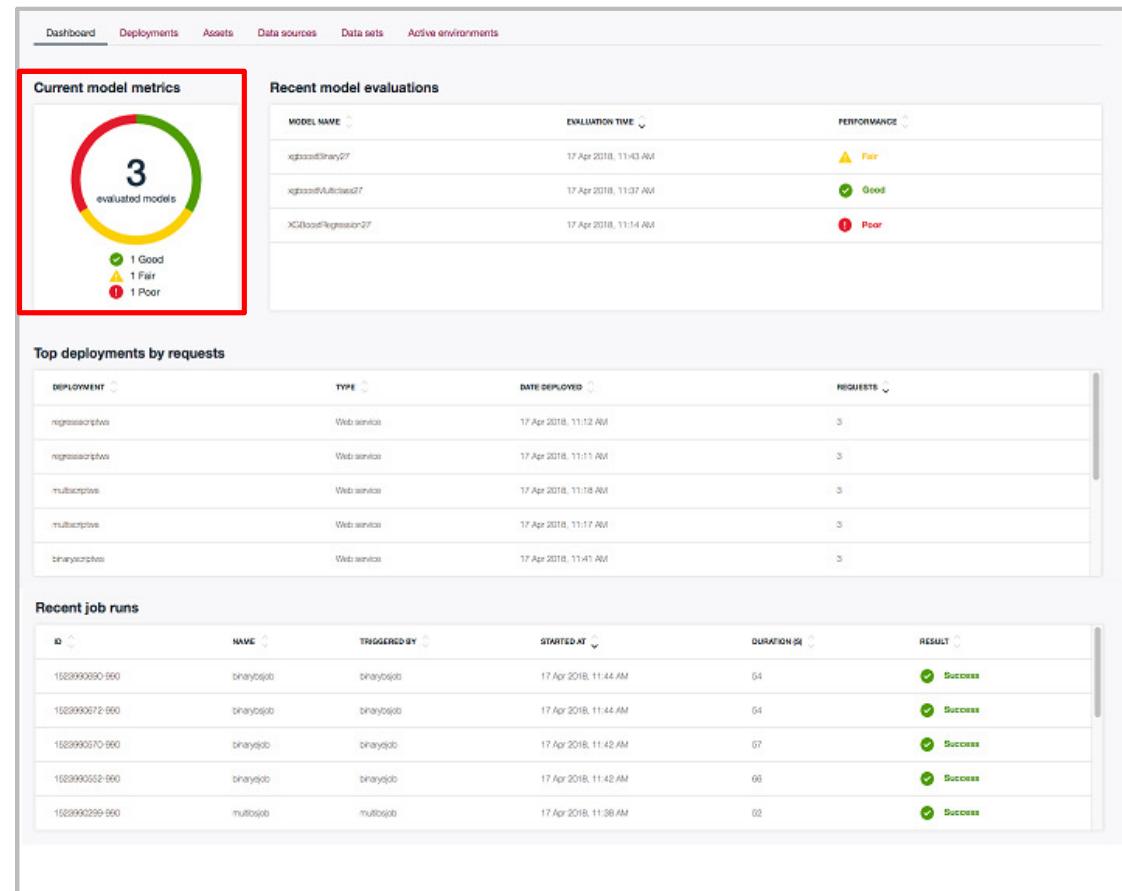


Model Management & Deployment – Project Release Dashboard

- Deployment dashboard provides an overview about the release
- It has five components:
 - Current Metrics
 - Recent Model Evaluations
 - Top Deployments by Requests
 - Recent Job Runs

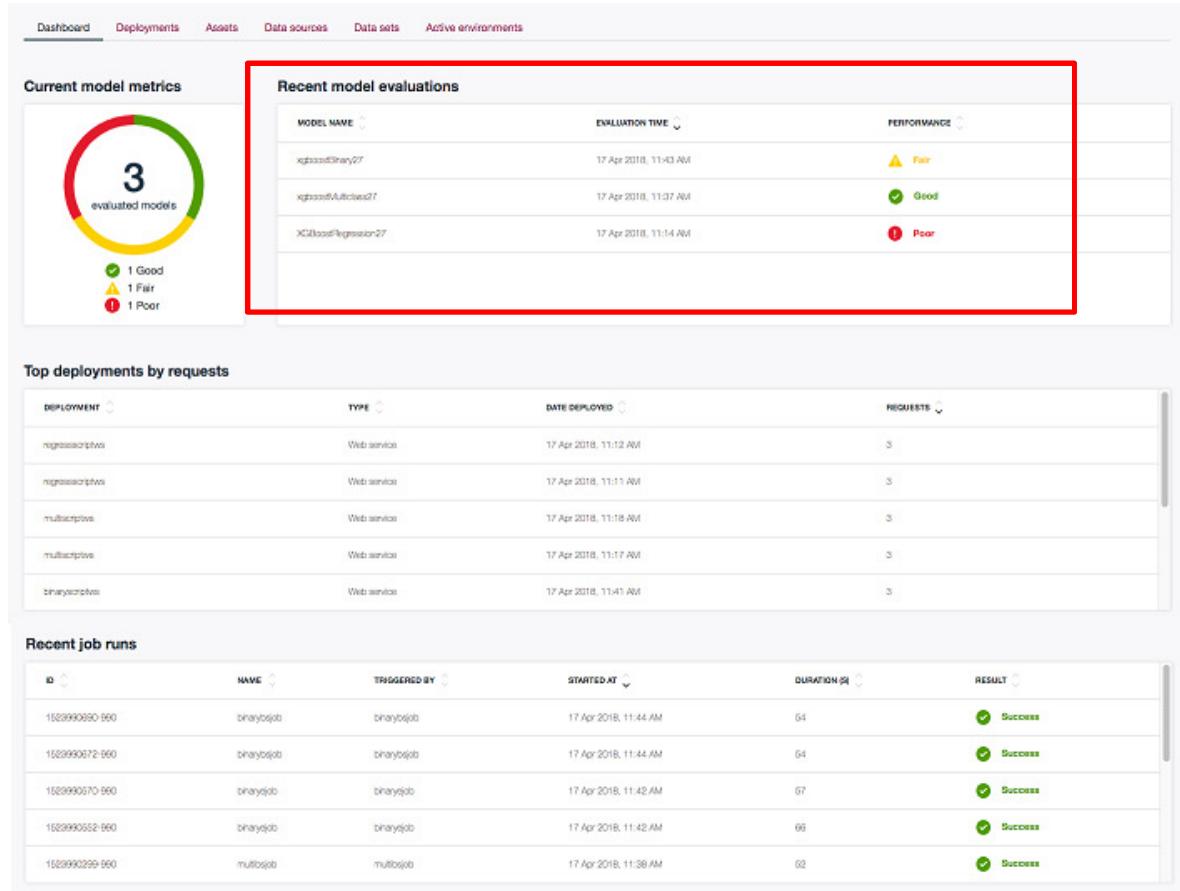
Model Management & Deployment – Current Model Metrics

- The performance of all models across the release. The model's performance is calculated on model's score and thresholds. There are three different types of performance:
 - Good
 - Green
 - Fair
 - Yellow
 - Poor
 - Red



Model Management & Deployment – Recent Model Evaluations

- This component shows five latest model's evaluations



The screenshot displays the IBM Model Management & Deployment interface. At the top, there is a navigation bar with tabs: Dashboard, Deployments, Assets, Data sources, Data sets, and Active environments. The 'Dashboard' tab is selected.

Current model metrics: A circular gauge indicating 3 evaluated models. Below it, a legend shows: 1 Good (green), 1 Fair (yellow), and 1 Poor (red).

Recent model evaluations: A table listing three recent evaluations. The columns are: MODEL NAME, EVALUATION TIME, and PERFORMANCE. The data is as follows:

MODEL NAME	EVALUATION TIME	PERFORMANCE
xgbboostBinary27	17 Apr 2018, 11:43 AM	Fair
xgbboostAutoclass27	17 Apr 2018, 11:37 AM	Good
XCBoostRegression27	17 Apr 2018, 11:14 AM	Poor

Top deployments by requests: A table listing five deployments. The columns are: DEPLOYMENT, TYPE, DATE DEPLOYED, and REQUESTS.

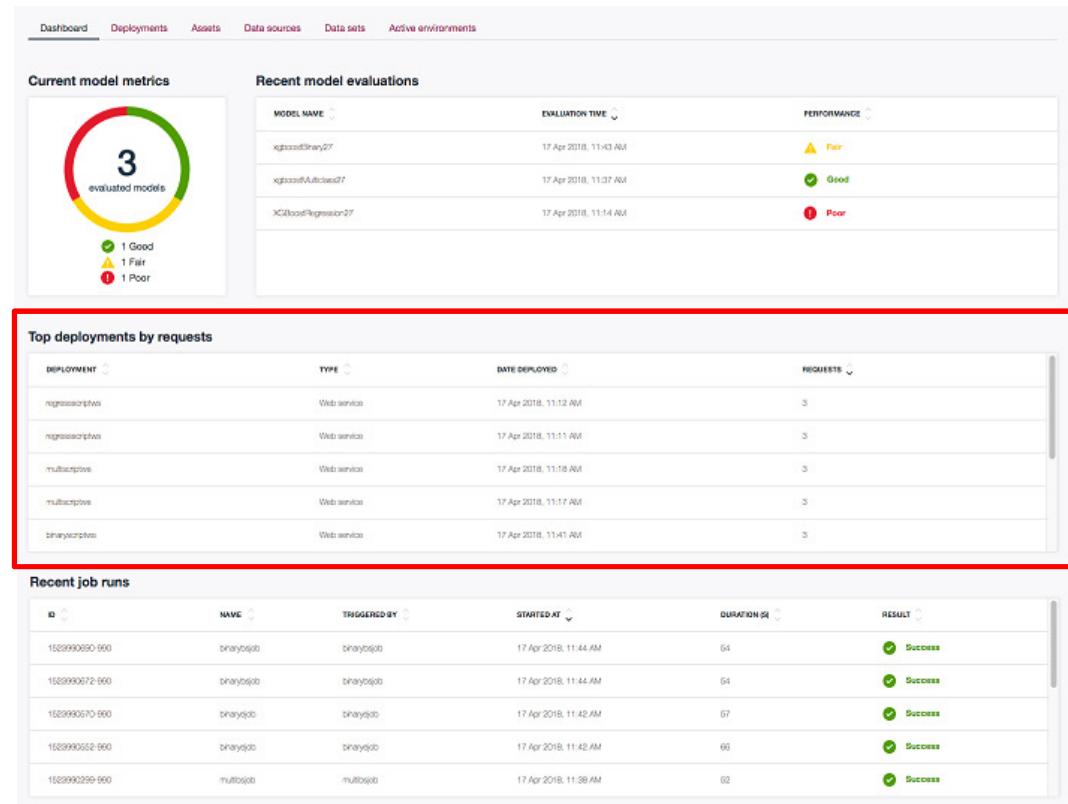
DEPLOYMENT	TYPE	DATE DEPLOYED	REQUESTS
regressionscripts	Web service	17 Apr 2018, 11:12 AM	3
regressionscripts	Web service	17 Apr 2018, 11:11 AM	3
multiscripts	Web service	17 Apr 2018, 11:18 AM	3
multiscripts	Web service	17 Apr 2018, 11:17 AM	3
binariescripts	Web service	17 Apr 2018, 11:11 AM	3

Recent job runs: A table listing six job runs. The columns are: ID, NAME, TRIGGERED BY, STARTED AT, DURATION [S], and RESULT.

ID	NAME	TRIGGERED BY	STARTED AT	DURATION [S]	RESULT
1529990990-990	binayjob	binayjob	17 Apr 2018, 11:44 AM	64	Success
1529990972-990	binayjob	binayjob	17 Apr 2018, 11:44 AM	64	Success
1529990970-990	binayjob	binayjob	17 Apr 2018, 11:42 AM	67	Success
1529990552-990	binayjob	binayjob	17 Apr 2018, 11:42 AM	66	Success
1529990299-990	multibjob	multibjob	17 Apr 2018, 11:39 AM	62	Success

Model Management & Deployment – Top Deployments by Requests

- This component shows five deployments that have the most number of requests
- There are three different types of deployments:
 - Job
 - Web Service
 - App



The screenshot displays the IBM Model Management & Deployment interface. At the top, there's a navigation bar with tabs: Dashboard, Deployments (which is selected), Assets, Data sources, Data sets, and Active environments.

Current model metrics: A circular gauge chart showing 3 evaluated models. Below it, a legend indicates 1 Good (green), 1 Fair (yellow), and 1 Poor (red).

Recent model evaluations: A table listing three evaluations:

MODEL NAME	EVALUATION TIME	PERFORMANCE
kgboostBinary27	17 Apr 2018, 11:43 AM	Fair
kgboostDecision27	17 Apr 2018, 11:07 AM	Good
XGBBoostRegression-27	17 Apr 2018, 11:14 AM	Poor

Top deployments by requests: A table listing five deployments:

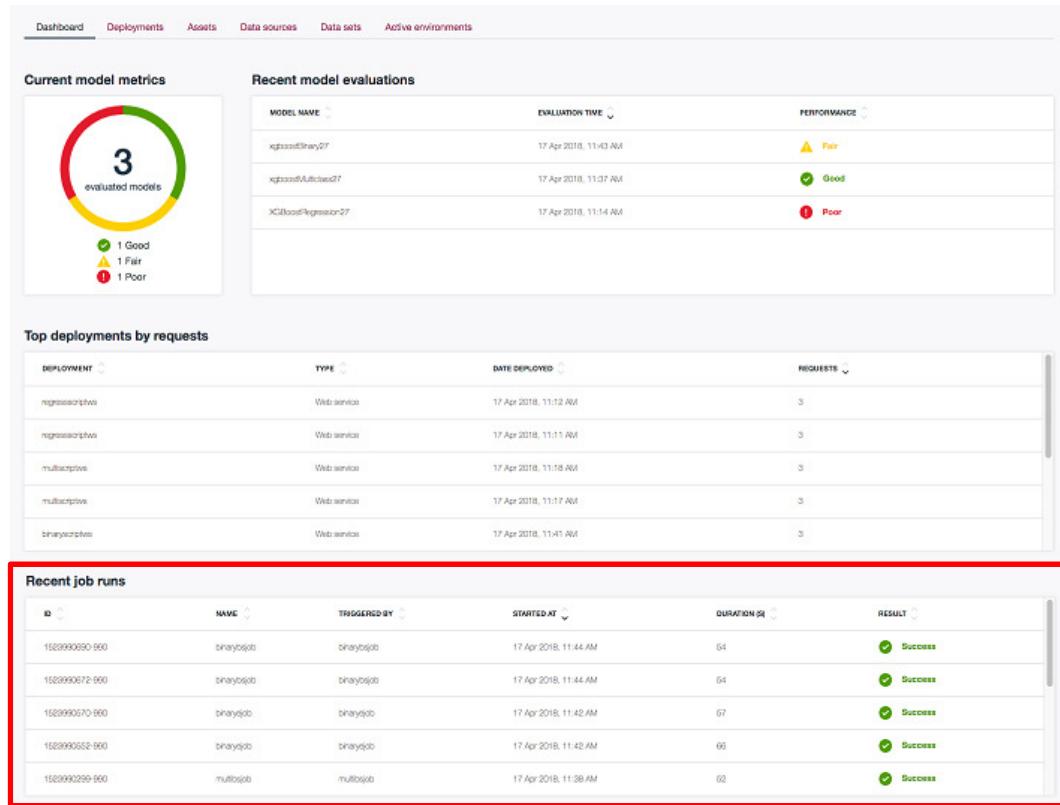
DEPLOYMENT	TYPE	DATE DEPLOYED	REQUESTS
regressionservice	Web service	17 Apr 2018, 11:12 AM	3
regressionservice	Web service	17 Apr 2018, 11:11 AM	3
multiclassservice	Web service	17 Apr 2018, 11:18 AM	3
multiclassservice	Web service	17 Apr 2018, 11:17 AM	3
binarieservice	Web service	17 Apr 2018, 11:41 AM	3

Recent job runs: A table listing five job runs:

ID	NAME	TRIGGERED BY	STARTED AT	DURATION (S)	RESULT
15289900690-960	binayjob0	binayjob0	17 Apr 2018, 11:44 AM	64	Success
15289900672-960	binayjob0	binayjob0	17 Apr 2018, 11:44 AM	64	Success
15289900670-960	binayjob0	binayjob0	17 Apr 2018, 11:42 AM	67	Success
15289900562-960	binayjob0	binayjob0	17 Apr 2018, 11:42 AM	66	Success
15289902299-960	multosjob0	multosjob0	17 Apr 2018, 11:38 AM	62	Success

Model Management & Deployment – Recent Job Runs

- This component shows five most recent job runs



The screenshot displays a dashboard for Model Management & Deployment. At the top, there are tabs for Dashboard, Deployments, Assets, Data sources, Data sets, and Active environments. The Dashboard tab is selected.

Current model metrics: A circular gauge showing 3 evaluated models. Below it, a legend indicates 1 Good (green), 1 Fair (yellow), and 1 Poor (red).

Recent model evaluations: A table listing three models with their evaluation times and performance scores (Fair, Good, Poor).

MODEL NAME	EVALUATION TIME	PERFORMANCE
kgboostBinary27	17 Apr 2018, 11:43 AM	Fair
kgboostMulticat27	17 Apr 2018, 11:07 AM	Good
XGBBoostRegression-27	17 Apr 2018, 11:14 AM	Poor

Top deployments by requests: A table listing five deployments based on request volume.

DEPLOYMENT	TYPE	DATE DEPLOYED	REQUESTS
regressionscriptsweb	Web service	17 Apr 2018, 11:12 AM	3
regressionscriptsweb	Web service	17 Apr 2018, 11:11 AM	3
multicatscriptsweb	Web service	17 Apr 2018, 11:18 AM	3
multicatscriptsweb	Web service	17 Apr 2018, 11:17 AM	3
binaryscriptsweb	Web service	17 Apr 2018, 11:41 AM	3

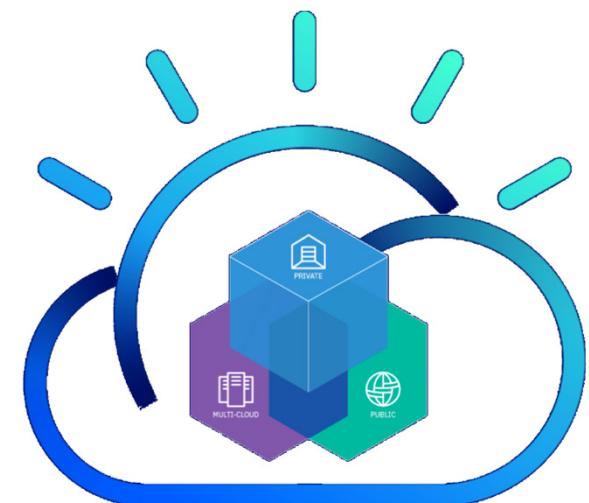
Recent job runs: A table listing five job runs, all of which are marked as successful.

ID	NAME	TRIGGERED BY	STARTED AT	DURATION (S)	RESULT
15289900690-960	binayjob0	binayjob0	17 Apr 2018, 11:44 AM	64	Success
15289900672-960	binayjob0	binayjob0	17 Apr 2018, 11:44 AM	64	Success
15289900670-960	binayjob0	binayjob0	17 Apr 2018, 11:42 AM	67	Success
15289900562-960	binayjob0	binayjob0	17 Apr 2018, 11:42 AM	66	Success
15289902699-960	multosjob0	multosjob0	17 Apr 2018, 11:38 AM	62	Success

Watson Studio Local Administration Additional Topics



Watson Studio Local Administration Kubernetes 101



Kubernetes 101

- What is Kubernetes?
 - Kubernetes is an open source orchestration tool developed by Google for managing microservices and containerized applications across a distributed cluster.
 - Kubernetes provides highly resilient infrastructure with zero downtime deployment capabilities, automatic rollback, scaling, and self-healing of containers.
 - The main objective of Kubernetes is to hide the complexity of managing a fleet of containers by providing REST APIs for the required functionalities.
 - Kubernetes is portable in nature, meaning it can run on various public or private cloud platforms such as AWS, Azure, OpenStack, Google Cloud, or Apache Mesos. It can also run on bare metal machines.

FYI. Kubernetes is a part of Cloud Native Computing Foundation (CNCF) project hosted by The Linux Foundation. <https://www.cncf.io>

Kubernetes 101

- What is K8s?
 - Developers are lazy and somewhere in the mid-late 80s they started abbreviating the words based on their first letter, last letter, and number of letters in between.
 - For example **i18n** is equivalent to **internationalization** and **I10n** for **localization**.
 - So K8s is Kubernetes. ☺

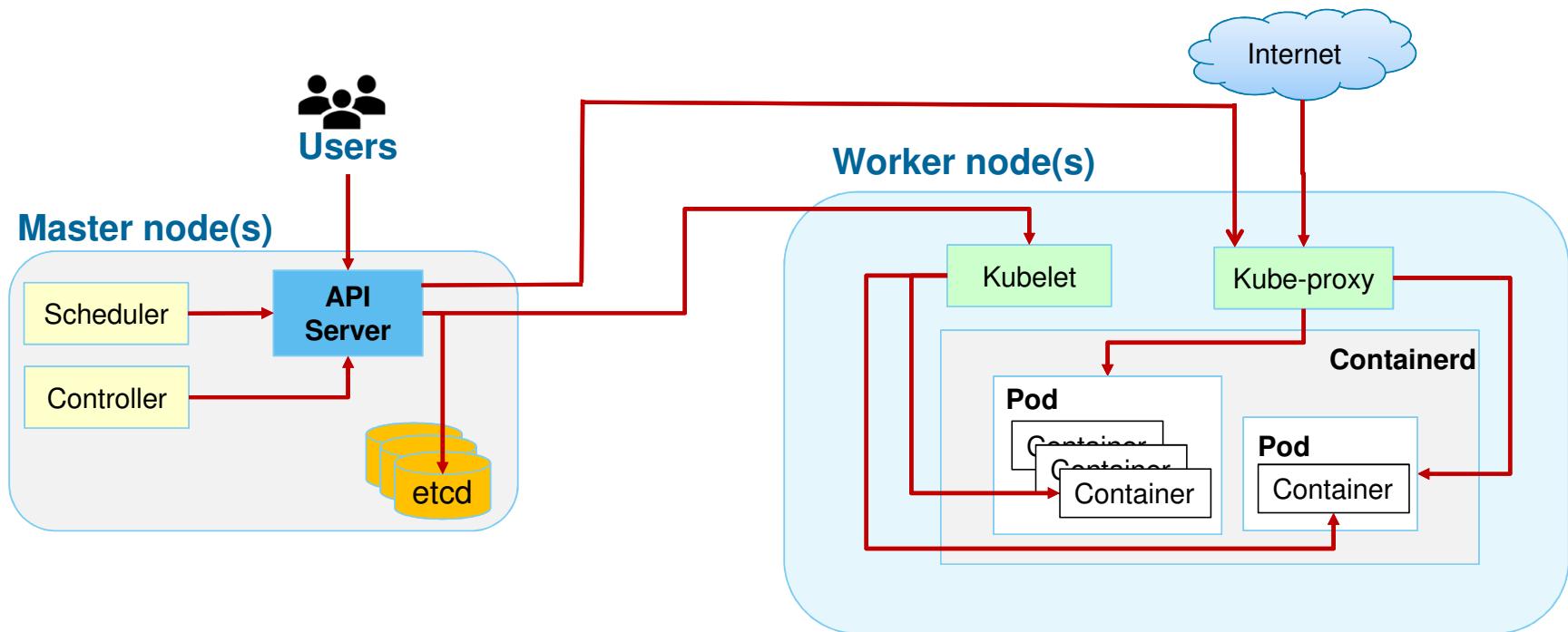
FYI. Kubernetes is an open source project written in Go language, and licensed under the Apache License Version 2.0. The current stable version is 1.9 (as of February 2018)

Kubernetes 101

- Most popular container orchestrators nowadays
 - Docker Swarm – provided by Docker, Inc. www.docker.com
 - Kubernetes – Cloud Native Computing Foundation. <https://www.cncf.io/>
 - Mesos Marathon – Apache Mesos. <http://mesos.apache.org/>
 - Amazon ECS – Amazon EC2 Container Service <https://aws.amazon.com/ecs/>
 - Hashicorp Nomad – provided by HashiCorp. <https://www.hashicorp.com/>

Kubernetes 101

- Kubernetes Components and Architecture
 - Kubernetes follows a client-server architecture. You can have multi-master setup (for HA).



Kubernetes 101

- Kubernetes Components and Architecture

- **Master node**

- The master node is responsible for the management of Kubernetes cluster.
 - The master node is the one taking care of orchestrating the worker nodes, where the actual services are running
 - We can communicate to the master node via the CLI, the GUI (Dashboard), or via APIs.
 - Only one of the master nodes would be the leader, performing all the operations. The others are followers.

Kubernetes 101

- Kubernetes Components and Architecture

- **Worker node**

A worker node is a machine which runs the applications using Pods and is controlled by the master node. Pods are scheduled on the worker nodes, which have the necessary tools. It's a logical collection of one or more containers which are always scheduled together.

- Docker

- Docker runtime (ie. Containerd) runs on each of the worker nodes, and runs the configured pods. It handles downloading the images and starting the containers

- Kubelet

- Kubelet is an agent which runs on each worker node and communicates with the master node. It gets the configuration of a pod from the API server and ensures that the described containers are up and running.

Kubernetes 101

- Kubernetes Components and Architecture

- Kube-proxy

- Kube-proxy acts as a network proxy and a load balancer for a service on a single worker node. It takes care of the network routing for TCP and UDP packets.
 - It listens to the API server for each Service endpoint creation/deletion. It setup the routes so that it can reach to it.

- Kubectl

- A command line tool to communicate with the API service and send commands to the master node.

Kubernetes 101

- Kubernetes Components and Architecture

- **API server**

- The API server is the entry point for all the REST commands used to control the cluster. It processes the REST requests, validates them, and executes the bound business logic.

- **Scheduler**

- The scheduler schedules the work to worker nodes.
 - The scheduler has the information regarding resources available on the members of the cluster, as well as the ones required for the configured service to run and hence is able to decide where to deploy a specific service.

Kubernetes 101

- Kubernetes Components and Architecture
 - **Controller-manager**

- A controller uses API server to watch the shared state of the cluster and make corrective changes to the current state to change it to the desired one.
- You may have multiple different kind of controllers, for example, the replication controller which takes care of number of pods in the system. Other examples like, endpoints controller, namespace controller, and service accounts controller, etc.

Kubernetes 101

- Kubernetes Components and Architecture
 - **Pod**

- Kubernetes targets the management of elastic applications that consist of multiple microservices communicating with each other. Often those microservices are tightly coupled forming a group of containers that would typically, in a non-containerized setup run together on one server. This group, the smallest unit that can be scheduled to be deployed through K8s is called a pod.
- This group of containers share storage, Linux namespaces, IP addresses. Containers reach each other via localhost.
- Pods are not intended to live long. They are created, destroyed and re-created on demand, based on the state of the server and the service.
- Pod is a scheduling unit in Kubernetes, they can contain one or more containers. Also they are distributed among nodes to provide high availability.

Kubernetes 101

- Kubernetes Components and Architecture

- **Service**

- As pods have a short lifetime, there is not guarantee about the IP address they are served on. This could make the communication of microservices difficult.
 - K8s has introduced the concept of a service, which is an abstraction on top of a number of pods, communicating with it via a Virtual IP address.
 - This is where you can configure load balancing for your numerous pods and expose them via a service.

Kubernetes 101

- Kubernetes Components and Architecture

- **etcd storage**

- etcd is a simple, distributed, consistent key-value store. It's mainly used for shared configuration and service discovery.
 - It provides a REST API for CRUD operations as well as an interface to register watchers on specific nodes, which enables a reliable way to notify the rest of the cluster about configuration changes.
 - An example of data stored by Kubernetes in etcd is jobs being scheduled, created and deployed, pod/service details and state, namespaces and replication information, etc.

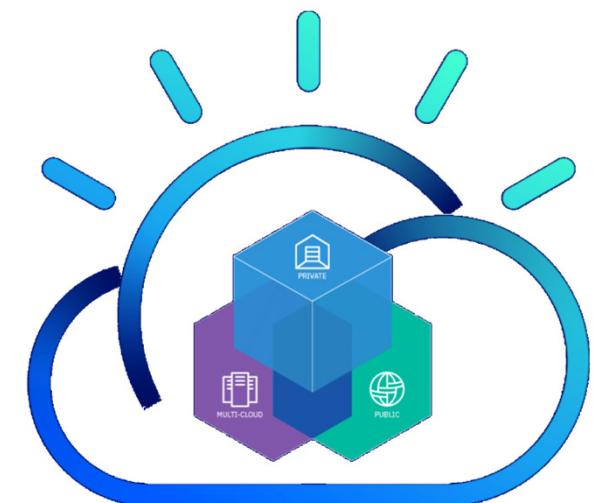
Kubernetes 101

- Kubernetes Components and Architecture

- **GlusterFS**

- Gluster is a scalable, distributed file system that aggregates disk storage resources from multiple servers into a single global namespace.
 - Advantages
 - Scales to several petabytes
 - Handles thousands of clients
 - POSIX compatible
 - Uses commodity hardware
 - Can use any ondisk filesystem that supports extended attributes
 - Accessible using industry standard protocols like NFS and SMB
 - Provides replication, quotas, geo-replication, snapshots and bitrot detection
 - Allows optimization for different workloads
 - Open source

Watson Studio Local Administration Best Practices



Best Practices

- **Access large amount of data – with relational databases**

When you load gigabytes of data from tables, no amount of memory you reserve will be adequate. For better practice, consider following

- You can load and process by batches. Instead of `fetchall()` use `batch` similar to the following example:

```
cur.execute('select * from table1')  
for row in cur:  
    print row  
    #perform processing...
```

Best Practices

- **Access large amount of data – with relational databases**

- Or add criteria in your query filter. Example

```
cur = conn.cursor()  
  
cur.execute("SELECT * FROM large_table WHERE geo = 'NA'")
```

- Using SparkSQL and DataFrame to provide faster data access compared to other database JDBC clients.
 - Consider letting RDBMS process data as much as possible, and extract only the subset.
 - Define stored procedures that can perform most of the filtering and processing on your relational database.

Best Practices

- **Access large amount of data – with Spark and Hadoop**
 - As a best practice, processing should be close to your data. If you need to use large amount of data in HDFS or Hive, It's best to use the Spark running on Hadoop cluster through Livy.
 - Take advantage of data localization, and avoids data transfer to speed up your processing.
 - All runtime environments in WSL (Jupyter, Zeppelin and RStudio) support accessing Hadoop Spark through Livy. More details refer to: [remote spark documentation](#)

Best Practices

▪ Performance Tuning

- Generally, WSL reads and writes to relational databases using JDBC and modules JayDeBeApi and RJDBC/SparkR.
- Using database vendor specific clients such as cx_Oracle and pymssql can provide comparable performance to SparkSQL.
- WSL writes database specific data frames using SQLAlchemy and database vendor specific adapters such as ibm_db_sa.
- WSL does NOT support ODBC at the moment.

Best Practices

▪ Performance Tuning – Tune Zeppelin notebook

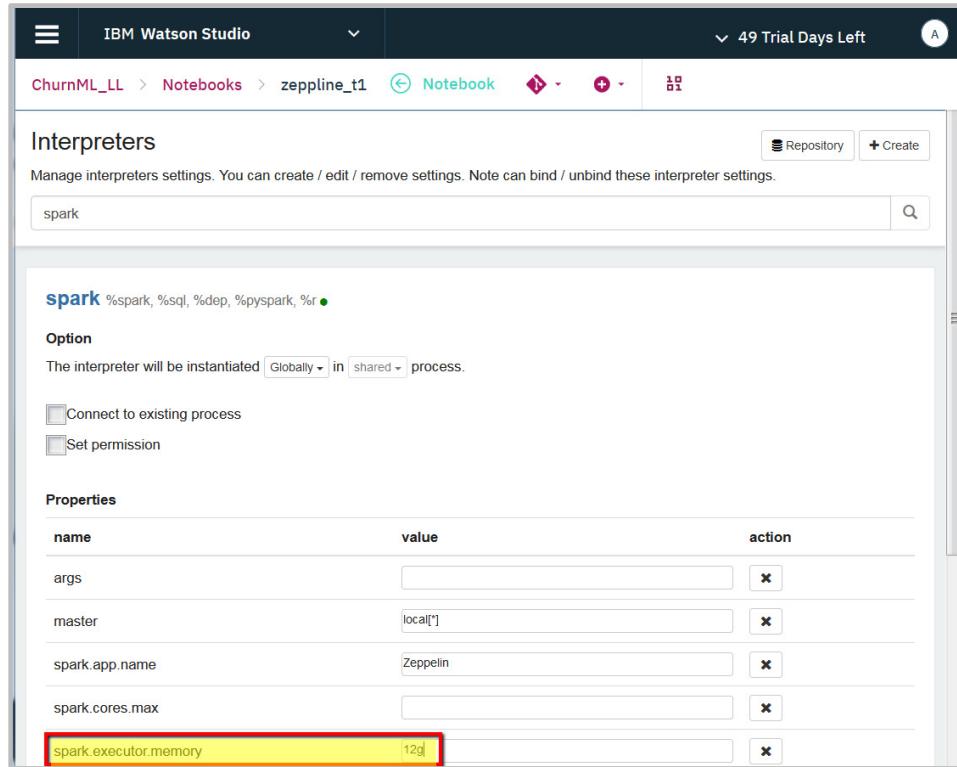
Set Zeppelin interpreter property and increase memory

- Go to the Zeppelin interpreters by clicking on the wheel at the right top of the Zeppelin notebook window.
- Click on the Interpreter link to open the Interpreter settings window.
- Search for spark and select edit on the upper right.
- Set spark.executor.memory to 12g for example. You might have to try increasing this as much possible to test.

Best Practices

▪ Performance Tuning – Tune Zeppelin notebook

Set Zeppelin interpreter property and increase memory



The screenshot shows the 'Interpreters' settings page in IBM Watson Studio. A search bar at the top contains the text 'spark'. Below it, a section titled 'spark' lists supported interpreters: %spark, %sql, %dep, %pyspark, %r. Under the 'Option' section, it says the interpreter will be instantiated 'Globally' in a 'shared' process. There are two unchecked checkboxes: 'Connect to existing process' and 'Set permission'. The 'Properties' section contains a table with the following rows:

name	value	action
args		x
master	local[*]	x
spark.app.name	Zeppelin	x
spark.cores.max		x
spark.executor.memory	12g	x

Best Practices

- **Performance Tuning – Tune Spark applications**
 - **Spark executor configuration – Change the resources for the Spark application**
 - Stop the pre-created spark context, and then create a new spark context with the proper resource configuration. For example:

```
sc.stop()
from pyspark import SparkConf, SparkContext
conf = (SparkConf()
         .set("spark.cores.max", "15")
         .set("spark.dynamicAllocation.initialExecutors", "3")
         .set("spark.executor.cores", "5")
         .set("spark.executor.memory", "6g"))
sc=SparkContext(conf=conf)
```

Best Practices

- **Performance Tuning – Tune Spark applications**
 - **Spark executor configuration – Change the resources for the Spark application**
 - Verify the new settings by running the following command in a cell using the new Spark context

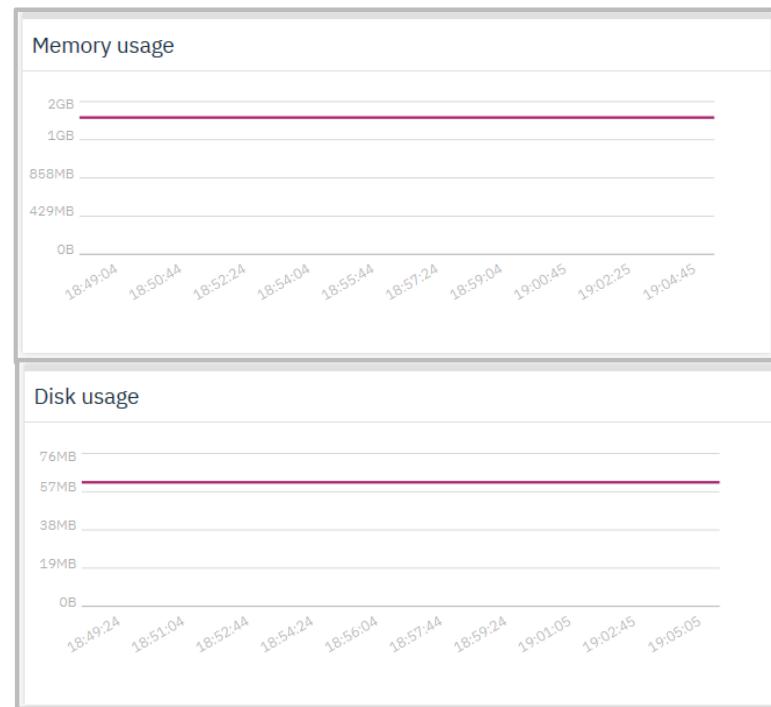
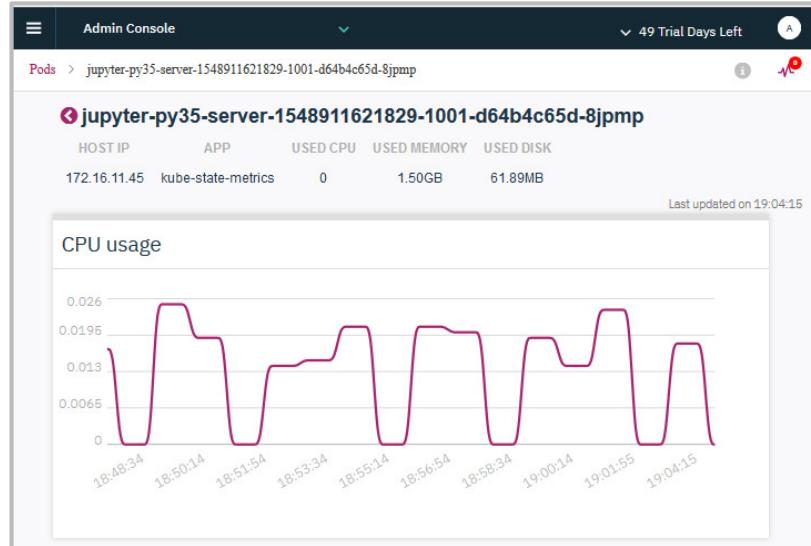
```
for item in sorted(sc._conf.getAll()): print(item)
```

Best Practices

▪ Performance Tuning – Tune Spark applications

– Monitoring

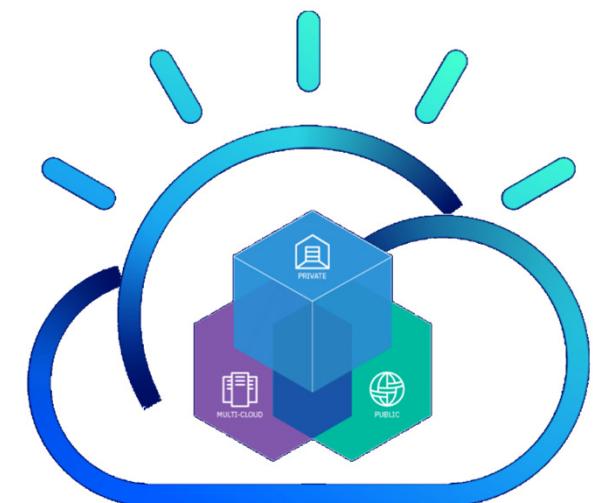
- You can monitor the per-pod CPU/memory/disk usage from the dashboard in the **Admin Console**.



Labs

1. **Lab #1** Instruction: WatsonStudio_Deployment.pdf
2. **Lab #2:** Use the same notebook developed in Lab #1 and convert the local Spark to remote Spark push down jobs.

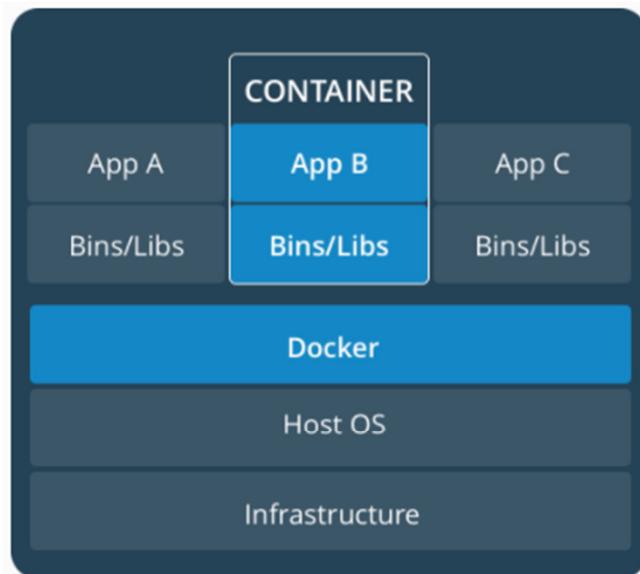
Watson Studio Local Administration Backup Slides



Docker 101

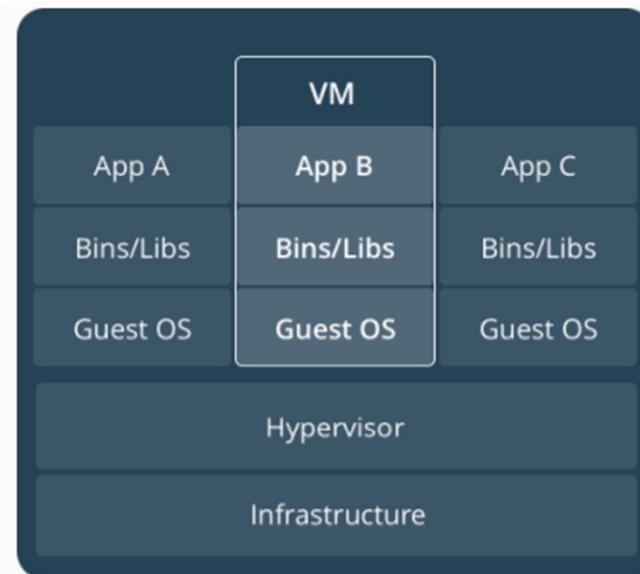
- Docker image vs container
 - A docker container is the runtime instance of an image
- Useful Docker commands
 - \$ docker images → list all images that are locally stored with the Docker
 - \$ docker rmi <image_name> → delete an image from the local image store
 - \$ docker kill <container> → kill a running container
 - \$ docker ps → list all “running” docker containers
 - \$ docker ps -a → list all containers (running and not running)
 - \$ docker inspect <container_id> → list detailed info about a docker container
 - \$ docker logs <container_id> → show logs of a given container
 - \$ docker build -t <image_name> . → build an image from the Dockerfile in the current directory and tag the image
 - \$ docker [start | stop | rm] <container> → start: Launch a container previously stopped.
 - \$ docker run <image> → create a new container of an image, and execute the container.
 - \$ docker exec -it <container> [command] → ex. docker exec -it jupyter-notebooks-nbviewer-

Docker vs VMs



CONTAINERS

Containers are an abstraction at the app layer that packages code and dependencies together. Multiple containers can run on the same machine and share the OS kernel with other containers, each running as isolated processes in user space. Containers take up less space than VMs (container images are typically tens of MBs in size), and start almost instantly.



VIRTUAL MACHINES

Virtual machines (VMs) are an abstraction of physical hardware turning one server into many servers. The hypervisor allows multiple VMs to run on a single machine. Each VM includes a full copy of an operating system, one or more apps, necessary binaries and libraries - taking up tens of GBs. VMs can also be slow to boot.

Docker (Docker Swarm) vs Kubernetes

- Containers and container platforms provide a lot more advantages over traditional virtualization.
- Docker is currently the most popular container platform.
- While Docker provided an open standard for packaging and distributing containerized applications; however, Docker doesn't handle the containers coordination, communication, scheduling, and scaling the container instances.
- Popular solutions for orchestrating containers are: Kubernetes, Mesos, and Docker Swarm. And Kubernetes is the market leader and the standardized means of orchestrating containers and deploying distributed applications.
- Kubernetes can be run on a public cloud service or on-premises.
- Docker is a platform and tool for building, distributing, and running Docker containers.
- Kubernetes is a container orchestration system for Docker containers to coordinate clusters of nodes at scale.