

# Prerequisites for IBM Watson Deep Learning as a Service (DLaaS)

This tutorial outlines the steps needed to setup the required services to run deep learning experiments using Watson Machine Learning via Jupyter notebooks in Watson studio.

## Overview

Leveraging the IBM Watson Deep Learning capabilities requires the following IBM Cloud services.

- 1- [IBM Watson Studio](#)
- 2- [IBM Watson Machine Learning \(WML\)](#)
- 3- [IBM Cloud Object Storage \(COS\)](#)

Figure 1 illustrates how these services interact to deliver the capability for data scientists to run machine learning and deep learning training jobs. Typically, in an enterprise environment, the account admin manages the cloud object storage instances including creation of buckets and assigning the correct permissions to enterprise users including data scientists. In a personal environment, the data scientist would be the account admin as well and he/she will manage the access permissions to cloud object storage instances and buckets.

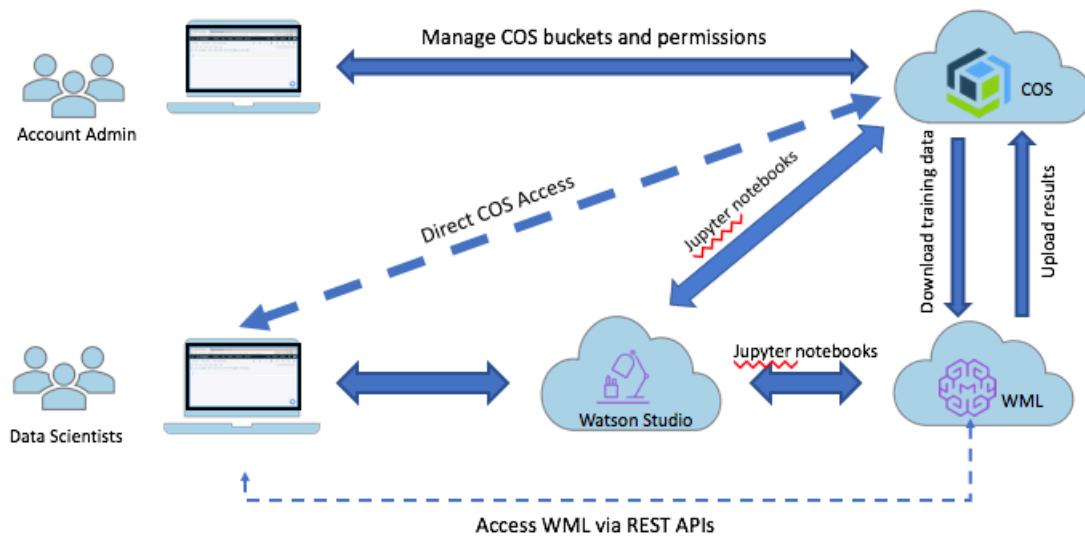


Figure 1: Interaction across IBM Cloud Services required for DLaaS

Once cloud object storage (COS) and the associated buckets are created with the correct permissions, data scientists can run deep learning experiments as follows:

- 1- Upload training data directly to their COS buckets.

In a personal environment, or for experimentation, data scientists would typically upload training data to their COS buckets. However, in a team environment, it is typical

for data scientists to run different deep learning experiments against the same data. In that scenario, one team member can upload the training data to a COS bucket which all team members have read access to.

For more details on access permissions, check the [IBM Cloud Object Storage documentation page](#).

2- Setup the COS buckets to store experiment training results.

As the deep learning experiment is run, training results get generated and they need to be saved to a cloud object storage (COS) bucket. It is important to set the permissions for the buckets correctly. While it is sufficient to get read access to the COS buckets that hold the training data, it is necessary to get read/write access to the COS buckets that hold the training results.

3- Setup deep learning (DL) experiments.

Jupyter notebooks are popular for data scientists to write code for loading, evaluating, and shaping data as well as training machine learning models. Jupyter notebooks are fully supported in Watson Studio and enable data scientists to work as a team by being collaborators in the same project.

Additionally, Watson Studio supports [Neural Network Modeler](#) which offers a user interface (UI) with drag-and-drop functionality to design deep neural networks.

Once deep learning network is defined, a training definition is created in Watson Machine Learning service.

Creating training definitions is a critical step for running deep learning experts whether those are created using Neural Network modeler or via python scripts.

4- Run and monitor DL experiments using Watson Machine Learning service.

Once the training definition is created, use the WML Python client to run and monitor the DL experiments.

5- Visualize experiment results.

Once the training is complete, it is important to be able to visualize the results so data scientists can get a better appreciation on what worked, what didn't and also inspire next steps.

6- Deploy ML/DL models.

Once a machine learning or deep learning model is trained with good performance results, it is important to deploy those models to a REST api so developers can leverage in their applications.

The rest of this tutorial outlines the steps required to setup your account and get it ready for running [Deep Learning experiments](#) via Jupyter notebooks in Watson Studio.

After completing the setup, you can run the Deep Learning Experiments notebook in Watson Studio to run a sample experiment for recognizing handwritten digits using the MNIST data set as training data. The notebook leverages Tensorflow as the deep learning framework.

The same notebook can be modified to run deep learning experiments for other use cases using different data sets.

## Setup

To start, there are some setup activities required to have access to the components and services needed to be able to train a deep learning network using IBM Watson DLaaS.

### Setup IBM Cloud Account

IBM Watson DLaaS is offered on the IBM Cloud and to access its capabilities, users need to have an IBM Cloud account. To setup an IBM Cloud Account, follow these steps:

#### 1- Sign In or Sign up to your IBM Cloud account.

In your browser, paste the following url: <https://ibm.com/cloud>

For a list of supported web browsers, check the [prerequisites](#).

Click on the Cloud sign-up/log-in link as shown in Figure 2. Then follow the instruction to sign up for an account if you don't have an account already.

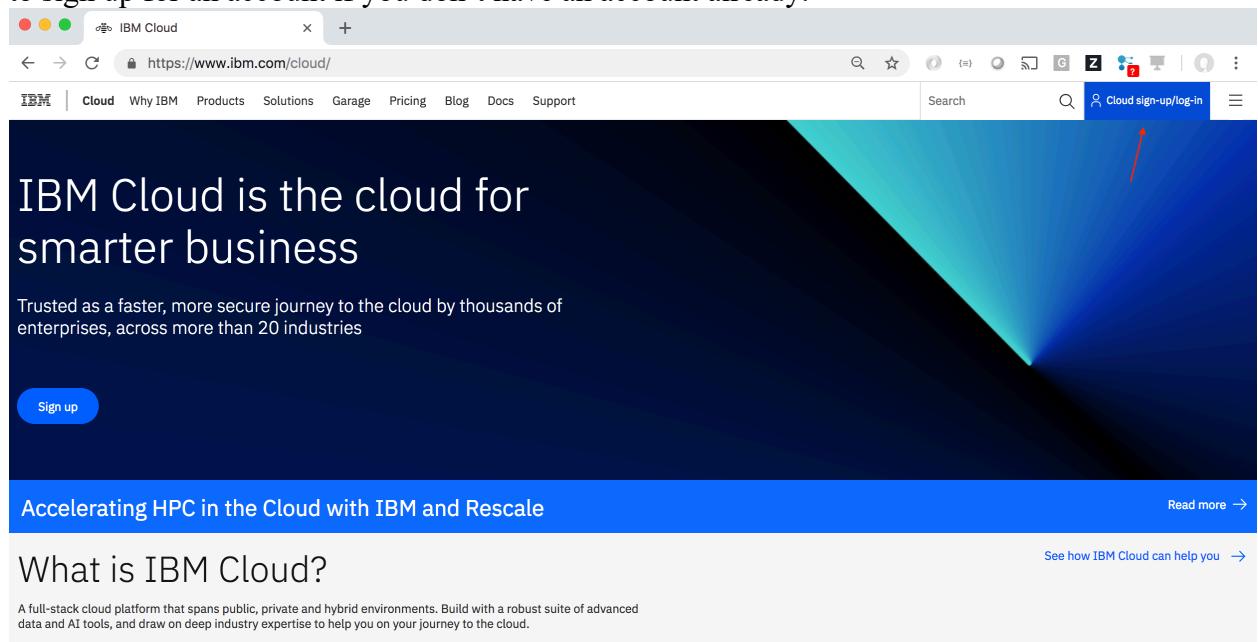


Figure 2: IBM Cloud Sign up

If you do have an IBM Cloud account, click on **Log in** link as shown in Figure 3.

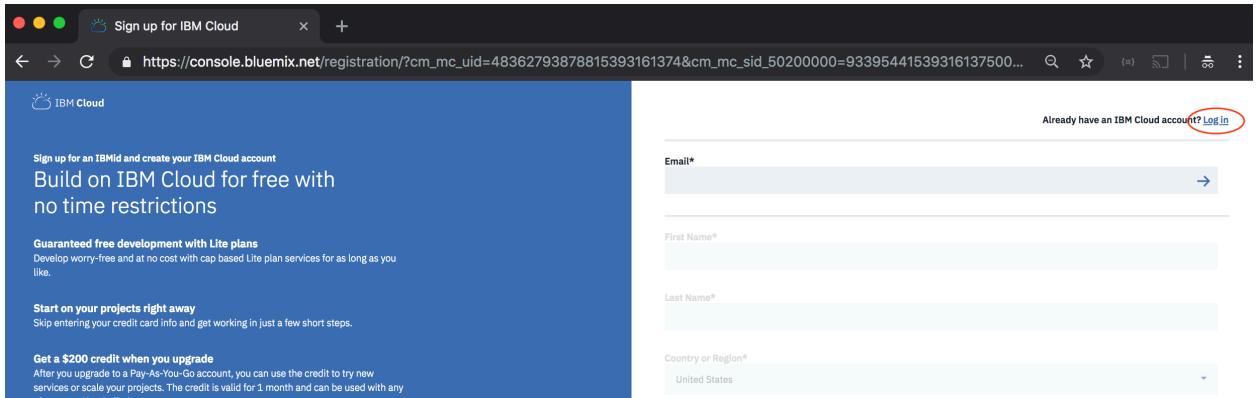


Figure 3: IBM Cloud Sign in

Authenticate by providing your IBM Cloud account credentials (username and password).

### Create Required Services

As explained earlier, training deep learning networks using IBM Watson DLaaS requires the following services to be created:

- 1- [IBM Cloud Object Storage](#) (COS)
- 2- [IBM Watson Machine Learning](#) (WML)
- 3- [IBM Watson Studio](#)

Once you've authenticated to your IBM Cloud account, select **Catalog** as shown in Figure 4. The Catalog shows all the IBM Cloud services and offerings available to you.

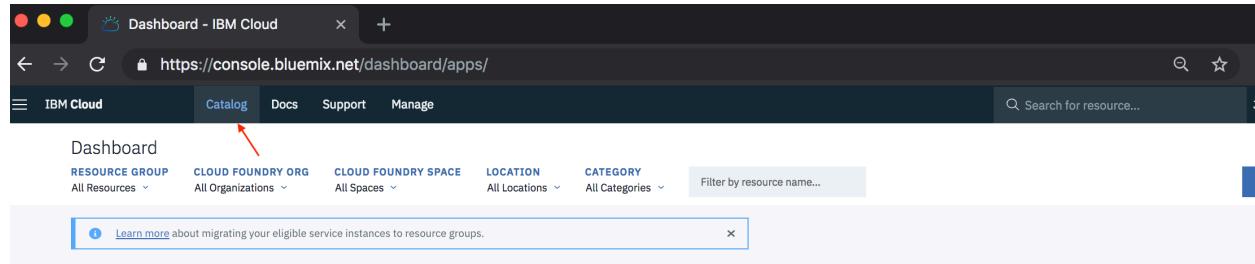


Figure 4: IBM Cloud Catalog

### [Cloud Object Storage](#)

On the page that loads, click on Storage in the left navigation column and then click on **Object Storage** as shown in Figure 5.

IBM Cloud Catalog Docs Support Manage

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

Catalog

label:lite

All Categories (51)

- Compute (10)
- Containers (1)
- Networking
- Storage (1) >**
- AI (13)
- Analytics (4)
- Databases (2)
- Developer Tools (6)
- Integration (2)
- Internet of Things (1)
- Security and Identity (2)
- Starter Kits (5)
- Web and Mobile (3)
- Web and Application (1)

**Storage**

**Object Storage**  
Lite + IBM

Provides flexible, cost-effective, and scalable cloud storage for unstructured data.

Figure 5: IBM Cloud Object Storage

On Cloud Object Storage (COS) service page, select a unique name for your service, choose the **Lite** plan and click **Create** button.

The **Lite** plan is a free plan which allows you to experiment and evaluate the offerings on the IBM Cloud.

Please note that Lite plan services are deleted after 30 days of inactivity.

IBM Cloud Catalog Docs Support Manage

View all

Cloud Object Storage

Looking for our infrastructure or Swift Object Storage offerings? Compare Versions

Service name: cos-dltutorial

Select a resource group: Default

IBM Cloud Object Storage is a highly scalable cloud storage service, designed for high durability, resiliency and security. Store, manage and access your data via our self-service portal and RESTful APIs. Connect applications directly to Cloud Object Storage use other IBM Cloud Services with your data.

AUTHOR IBM  
PUBLISHED 06/25/2018  
TYPE Service

View Docs Terms

Features

- Storage for the IBM Cloud**  
IBM Cloud Object Storage provides unstructured data storage for cloud applications. Libraries and SDKs support a common set of S3 API functions for connecting new applications to scalable cloud storage and integrating your data into other services on the IBM Watson and Cloud Platform.
- Encryption management**  
All data is encrypted at-rest and in-flight by default. Keys are automatically managed by default, but can optionally be self-managed or managed using IBM Key Protect. (\*Key Protect is only available for buckets created in the US South (Dallas) and EU GB (London) regions.)
- Data storage classes for Active, Less Active, Archive and Dynamic workloads**  
Choose storage classes for frequently accessed data, occasionally accessed data and long-term data retention with Standard, Vault, and Cold Vault. Or, choose Flex class for dynamic data access needs that fluctuate month to month.
- IAM Policies - Bucket level access management**  
IBM Identity and Access Management (IAM) integration allows for granular access control at the bucket level using role-based policies.
- Regional and Cross Region resiliency options**  
Select the best resiliency option for your data. Choose "Cross Region" to store unstructured data across three regions, or choose "Regional" resiliency to store your data within a single region.
- Lite and pay-as-you-go plans**

Pricing Plans

PLAN	FEATURES	PRICING
Lite	<b>1 COS Service Instance</b> Storage up to 25 GB/mo. Up to 20,000 GET requests/mo. Up to 2,000 PUT requests/mo. Up to Data Retrieval 10 GB/mo. Up to 5GB Public Outbound Applies to aggregate total across all storage bucket classes	Free

The Lite service plan for Cloud Object Storage includes Regional and Cross Regional resiliency, flexible data classes, and built in security.

Lite plan services are deleted after 30 days of inactivity.

Need Help?  
Contact IBM Cloud Sales...  
Estimate Monthly Cost  
Cost Calculator

Create

Figure 6: Cloud Object Storage instance creation

Once the COS service is created, we need to record the credentials needed to access COS through APIs.

Click on Endpoint in the left navigation column and copy the us-geo public endpoint. This is the value you specify for the service endpoint in the notebook.

The screenshot shows the IBM Cloud Storage interface. In the left sidebar, the 'Endpoint' link is highlighted with a red arrow. The main content area displays the 'Endpoints' section for the 'cos-dltutorial' bucket. Under 'Service endpoints', there are two tabs: 'Public' and 'Private'. The 'Public' tab is selected, showing a table of endpoints. One row for 'us-geo' is circled in red, and its value, 's3-api.us-geo.objectstorage.softlayer.net', is highlighted.

	Public	Private
us-geo:	s3-api.us-geo.objectstorage.softlayer.net	s3-api.us-geo.objectstorage.service.networklayer.com
Dallas:	s3-api.dal-us-geo.objectstorage.softlayer.net	s3-api.dal-us-geo.objectstorage.service.networklayer.com
Washington:	s3-api.wdc-us-geo.objectstorage.softlayer.net	s3-api.wdc-us-geo.objectstorage.service.networklayer.com
San Jose:	s3-api.sjc-us-geo.objectstorage.softlayer.net	s3-api.sjc-us-geo.objectstorage.service.networklayer.com

Figure 7:Cloud Object Storage Endpoint

Figure 8 illustrates how to get the cos\_hmac\_keys. Specifically:

- Click on the **Service credentials** in the left navigation column
- Then press **New credential** button
- In the **Add new credential** window, type `{"HMAC":true}` in the **Add Inline Configuration Parameters** box.
- Press **Add** button.

The screenshot shows the 'Add new credential' dialog box. In the left sidebar, the 'Service credentials' link is highlighted with a red arrow. The dialog box has 'Add new credential' at the top. It includes fields for 'Name' (set to 'Service credentials-1'), 'Role' (set to 'Writer'), and 'Select Service ID (Optional)'. Below these is a section for 'Add Inline Configuration Parameters (Optional)' with a text input field containing the JSON object `{"HMAC":true}`. At the bottom are 'Cancel' and 'Add' buttons, with the 'Add' button highlighted by a red arrow.

Figure 8: Creating COS HMAC Credentials

Click on **View Credentials** and copy the COS credentials as shown in Figure 9. Copy these credentials as you'll need them in the Jupyter notebook to access your COS instance. For more details, check the [Using HMAC credentials](#) page.

Service credentials		
<b>KEY NAME</b>	<b>DATE CREATED</b>	<b>ACTIONS</b>
Service credentials-1	JUL 28, 2018 - 03:23:57 PM	<a href="#">View credentials</a> <span style="color: red;">access_key_id:</span> <span style="color: red;">secret_access_key:</span>

Figure 9: COS HMAC Keys

### Watson Machine Learning

To create a Watson Machine Learning (WML) service, click on Catalog tab in the top navigation bar, then click on the AI category in the left navigation column and then select the Machine Learning service as shown in Figure 10.

All Categories (51)	AI
Compute (10) Containers (1) Networking Storage (1) <b>AI (13)</b>	<div style="border: 1px solid #ccc; padding: 10px;"> <b>Watson Assistant (formerly Conversation)</b> Lite • IBM Add a natural language interface to your application to automate interactions with your end users. Common applications...         </div> <div style="border: 1px solid #ccc; padding: 10px;"> <b>Discovery</b> Lite • IBM Unlock hidden value in data to find answers, monitor trends and surface patterns with the world's most advanced cloud-native insight...         </div> <div style="border: 1px solid #ccc; padding: 10px;"> <b>Knowledge Catalog</b> Lite • IBM Discover, catalog, and securely share enterprise data.         </div> <div style="border: 1px solid #ccc; padding: 10px;"> <b>Knowledge Studio</b> Lite • IBM Build custom models to teach Watson the language of your domain.         </div> <div style="border: 1px solid #ccc; padding: 10px;"> <b>Language Translator</b> Lite • IBM Translate text from one language to another, adapt translation models to your custom domain.         </div> <div style="border: 1px solid #ccc; padding: 10px;"> <b>Machine Learning</b>  Lite • IBM IBM Watson Machine Learning - make smarter decisions, solve tough problems, and improve user outcomes.         </div> <div style="border: 1px solid #ccc; padding: 10px;"> <b>Natural Language Understanding</b> Lite • IBM Analyze text to extract meta-data from content such as concepts, entities, emotion, relations, sentiment and more.         </div> <div style="border: 1px solid #ccc; padding: 10px;"> <b>Personality Insights</b> Lite • IBM The Watson Personality Insights derives insights from transactional and social media data to identify psychological traits         </div> <div style="border: 1px solid #ccc; padding: 10px;"> <b>Speech to Text</b> Lite • IBM Low-latency, streaming transcription         </div> <div style="border: 1px solid #ccc; padding: 10px;"> <b>Text to Speech</b> Lite • IBM Synthesizes natural-sounding speech from text.         </div> <div style="border: 1px solid #ccc; padding: 10px;"> <b>Tone Analyzer</b> Lite • IBM Tone Analyzer uses linguistic analysis to detect three types of tones from communications: emotion, social, and...         </div> <div style="border: 1px solid #ccc; padding: 10px;"> <b>Watson Studio</b> Lite • IBM Embed AI and machine learning into your business. Create custom models using your own data.         </div>

Figure 10: IBM Cloud AI Services

On the Watson Machine Learning service page, select a unique name for your service, choose the **Lite** plan and click **Create** button as shown in Figure 11.

IBM Watson Machine Learning is a full-service IBM Cloud offering that makes it easy for developers and data scientists to work together to integrate predictive capabilities with their applications. The Machine Learning service is a set of REST APIs that you can call from any programming language to develop applications that make smarter decisions, solve tough problems, and improve user outcomes.

[View Docs](#) [Terms](#)

AUTHOR IBM  
PUBLISHED 07/25/2018  
TYPE Service

Service name: wml-ditutorial

Choose a region/location to deploy in: US South Select a resource group: Default

Features

- Machine Learning features
- Integration with Watson Studio
- Wide choice of interfaces

Images

Pricing Plans Monthly prices shown for country or region: United States

PLAN	FEATURES	PRICING
Lite	Service instance (5 models per instance) 5,000 predictions 50 capacity unit-hours: Compute Tier: k80 = 2 capacity units for 1 training hour Compute Tier: k80x2 = 4 capacity units for 1 training hour Compute Tier: k80x4 = 8 capacity units for 1 training hour Otherwise 1 capacity unit for 1 computation hour Max 8 k80 GPUs (Deep Learning Training)	Free

The lite plan instance of the IBM Watson Machine Learning service provides you with a maximum of 5 deployed models, 5,000 predictions per month.

Need Help? [Contact IBM Cloud Sales](#) Estimate Monthly Cost [Cost Calculator](#) [Create](#)

Figure 11: Watson Machine Learning Service Page

Once the WML service is created, create credentials for the service by clicking on the **Service credentials** link in the left navigation column and pressing the **New credential** button. To view the generated credentials, click the **View credentials** button and copy the credentials for use in the notebook.

## Watson Studio

To create a Watson Machine Learning (WML) service, click on Catalog tab in the top navigation bar, then click on the AI category in the left navigation column and then select the **Watson Studio** service as shown in Figure 12.

All Categories (51) AI

- Compute (10)
- Containers (1)
- Networking
- Storage (1)
- AI (13) >
- Analytics (4)
- Databases (2)
- Developer Tools (6)
- Integration (2)
- Internet of Things (1)
- Security and Identity (2)
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- Web and Mobile (3)
- Web and Application (1)

Watson Assistant (formerly Conversation) Lite + IBM Add a natural language interface to your application to automate interactions with your end users. Common applications...

Discovery Lite + IBM Unlock hidden value in data to find answers, monitor trends and surface patterns with the world's most advanced cloud-native insights...

Knowledge Catalog Lite + IBM Discover, catalog, and securely share enterprise data.

Knowledge Studio Lite + IBM Build custom models to teach Watson the language of your domain.

Language Translator Lite + IBM Translate text from one language to another; adapt translation models to your custom domain.

Machine Learning IBM Watson Machine Learning - make smarter decisions, solve tough problems, and improve user outcomes.

Natural Language Understanding Lite + IBM Analyze text to extract meta-data from content such as concepts, entities, emotion, relations, sentiment and more.

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Speech to Text Lite + IBM Low-latency, streaming transcription

Text to Speech Lite + IBM Synthesizes natural-sounding speech from text.

Tone Analyzer Lite + IBM Tone Analyzer uses linguistic analysis to detect three types of tones from communications: emotion, social, and...

Watson Studio Lite + IBM Embed AI and machine learning into your business. Create custom models using your own data.

Figure 12: IBM Cloud AI Services

On Watson Studio service page, select a unique name for your Watson Studio service, choose the **Lite** plan and click **Create** button.

The screenshot shows the Watson Studio service page in the IBM Cloud catalog. A red arrow points to the 'Service name' input field, which contains 'watsonstudio-tutorial'. Another red arrow points to the 'PLAN' section in the 'Pricing Plans' table, specifically highlighting the 'Lite' plan row. The table provides details for the Lite plan:

PLAN	FEATURES	PRICING
<b>Lite</b>	1 authorized user 50 capacity unit-hours monthly limit 1 free small compute environment with 1 vCPU and 4 GB RAM (does not require capacity unit-hours)	Free
Standard v1	1 authorized user + unlimited viewer collaborators 50 capacity unit-hours included monthly (additional capacity available) Unlimited elastic compute environments	\$99.00 USD/Instance \$0.50 USD/Capacity Unit-Hour \$99.00 USD/Authorized User

At the bottom right of the page is a large blue 'Create' button.

Figure 13: Watson Studio Instance Creation

On the page that loads, click Get Started button to launch Watson Studio as shown in Figure 7.

The screenshot shows the Watson Studio landing page. A red circle highlights the 'Get Started' button, which is located below the 'Welcome to Watson Studio. Let's get started!' message. The page also includes sections for 'Documentation' and 'Community'.

Figure 14: Launch Watson Studio

After this initial setup, for future logging into Watson Studio, you can paste the following url into your browser, provide your credentials and you're logged into IBM Watson landing page:  
<https://dataplatform.ibm.com/>

## Deep Learning Experiments in Jupyter notebooks

Once logged into Watson Studio, you need to create a project where you'll be working. A project in Watson Studio is a wrapper that includes all relevant assets including data, code, models, ... for your project.

### Create Project in Watson Studio

Create a new project in Watson Studio by clicking the New project link as shown in Figure 15

The screenshot shows the IBM Watson Studio interface at the URL <https://dataplatform.cloud.ibm.com/home?context=wdp>. The top navigation bar includes links for Projects, Tools, Catalog, Community, Services, Manage, Support, and Docs. Below the navigation is a section titled "Recently updated projects" with a "View all (52)" link. A table lists two projects: "testCatalog" and "Default Project". To the right of the table is a blue button labeled "+ New project" with a red arrow pointing to it.

Figure 15: New Project in Watson Studio

If prompted for which project tile, select Complete and press OK.

Provide a project name, a short description (optional) and select the cloud object service you had created earlier and then press the Create button as shown in Figure 16.

The screenshot shows the "Create New Project" dialog box. On the left, under "Define project details", the "Name" field contains "Dlproject" and the "Description" field contains "Project description". On the right, under "Storage", there is a dropdown menu showing "cosjik". Under "Choose project options", there is a checked checkbox for "Restrict who can be a collaborator". At the bottom, a note states "Project will include integration with Cloud Object Storage for storing project assets." A red arrow points to the "Create" button at the bottom right of the dialog.

Figure 16: Create New Project

## Create Notebook

Once your project is created, navigate to the Assets tab and click on New notebook as shown in Figure 17. The project Assets tab shows all the assets associated with the project like data assets, the machine learning models, experiment flows, notebooks, and dashboards.

The screenshot shows the 'Assets' tab selected in the navigation bar. Below it, there's a search bar and a list of asset categories: Data assets, Models, Notebooks, and Streams flows. Each category has a table showing its details. In the 'Notebooks' section, there is a 'New notebook' button, which is circled in red. The 'Streams flows' section also has a 'New streams flow' button.

Figure 17: Project Assets tab

On the New notebook pop-up window, fill out the information as shown in Figure 18. Select the **From URL** tab to specify a notebook URL to copy into your space.

Provide a name for your notebook.

For the Notebook URL field, copy the following value into that field:

<https://github.com/joe4k/deeplearningutils/blob/master/notebooks/DeepLearningExperiments.ipynb>

For the runtime, select the **Default Python 3.5 Free** runtime.

Press the **Create Notebook** button at the bottom of the page to create the notebook.

New notebook

Blank From file From URL

Name\*  
DLexp 45 Characters Remaining

Description  
Type your Description here

Notebook URL\*  
<https://github.com/oe4k/deeplearningutils/blob/master/notebooks/DeepLearningExperiments.ipynb>

Select runtime\* Includes notebook environments ⓘ

- Default Spark Python 3.5 XS (Driver with 1 vCPU and 4 GB RAM, 2 executors with 1 vCPU and 4 GB RAM each)
- Default Python 3.5 Free (1 vCPU and 4 GB RAM) **(This option is highlighted with a red circle)**
- Default Python 3.5 XS (2 vCPU and 8 GB RAM)
- Default Python 3.5 S (4 vCPU and 16 GB RAM)
- Default R 3.4 S (4 vCPU and 16 GB RAM)

Cancel **Create Notebook**

Figure 18: New Notebook Creation

Now that you have setup the required services, you can setup and run deep learning experiments by following the instructions in the [Deep Learning Experiments notebook](#).