Hands on Introduction to IBM's Data Science Experience

Power of data. Simplicity of design. Speed of innovation.

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Agenda

Time	Description
8:30 AM - 9:00 AM	**Registration and Coffee**
9:00 AM - 10:00 AM	**Overview of the Watson Data Platform and IBM Data Science Experience (DSX)**
10:00 AM - 11:30 AM	**Lab 1 - Setting Up Your First DSX Notebook**
11:30 AM - 12:30 PM	**Lab 2 - Machine Learning with Spark ML**
12:30 PM - 1:30 PM	**Lunch Provided**
1:30 PM - 2:30 PM	**Lab 3 - R, Shiny, and GUI Interfaces**
2:30 PM - 4:00 PM	**Lab 4 - Choose From Two Options**
4:00 PM - 4:30 PM	**Questions and Wrap Up**

Participant Background

Open Source

- R/Python/Scala
- Jupyter Notebook
- Spark
- Hadoop

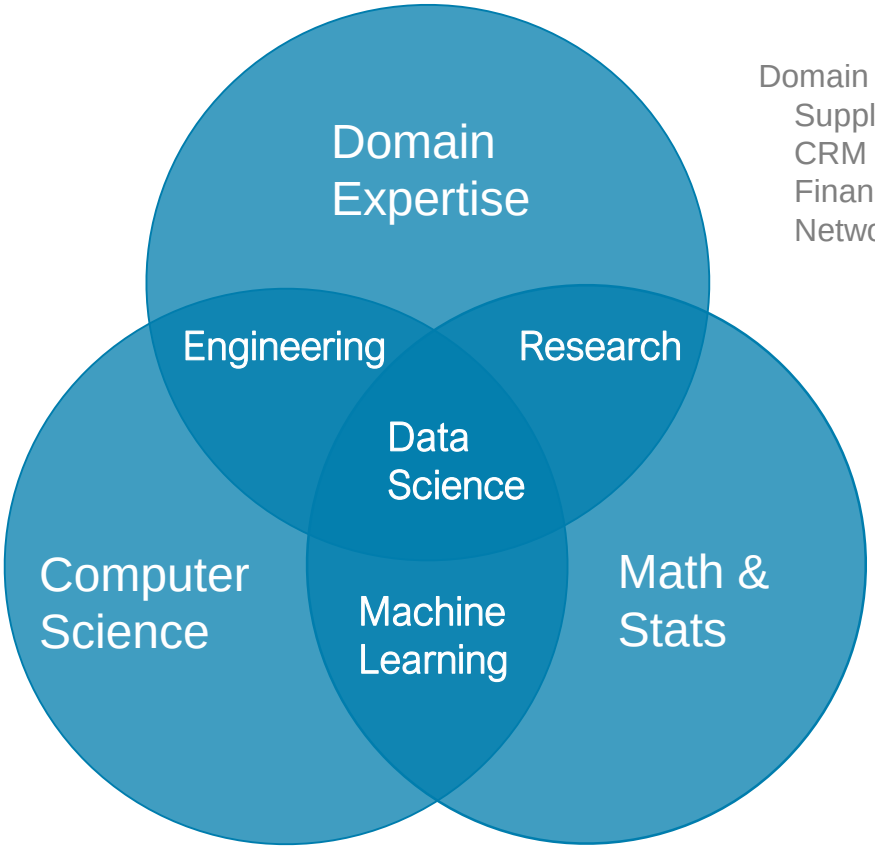
IBM

- Bluemix

Outline

- Data Science Introduction
- Watson Data Platform
- Data Science Experience
- Lab Overview

What is Data Science?



Domain Knowledge
- Supply Chain
- CRM
- Financials
- Networking

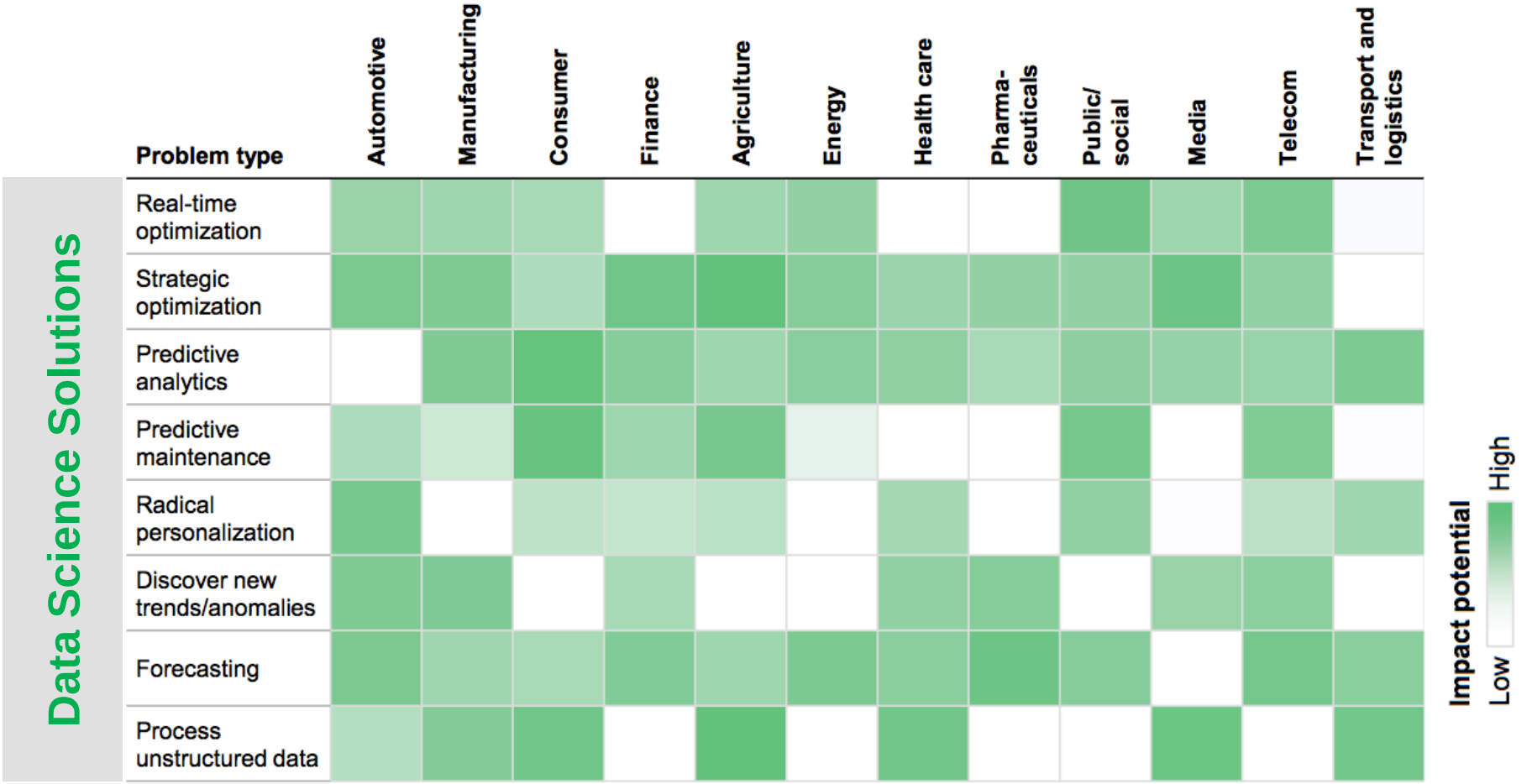
Scripting, SQL
Python, R Scala
Data Pipelines
Big Data/ Apache Spark

Mathematics
Computational

Data Science Projects Require Multiple Skills

Data Science Impact Across Industries and Use Cases

$10s of Billions in each industry and use case



SOURCE: McKinsey Global Institute analysis

Challenges in delivering value with Data Science

Data

- Data resides in silos and difficult to access
- Detailed data was never stored
- Unstructured and external data wasn't considered

Governance

- Self-service isn't a reality, if the data isn't secure
- Understanding lineage and getting to a system of truth

Skills

- Data Science skills are in low supply and high demand
- Nurturing new data professionals is challenging

Infrastructure

- Need an environment that enables collaboration and deployment to production
- Discrete tools present barriers to progress

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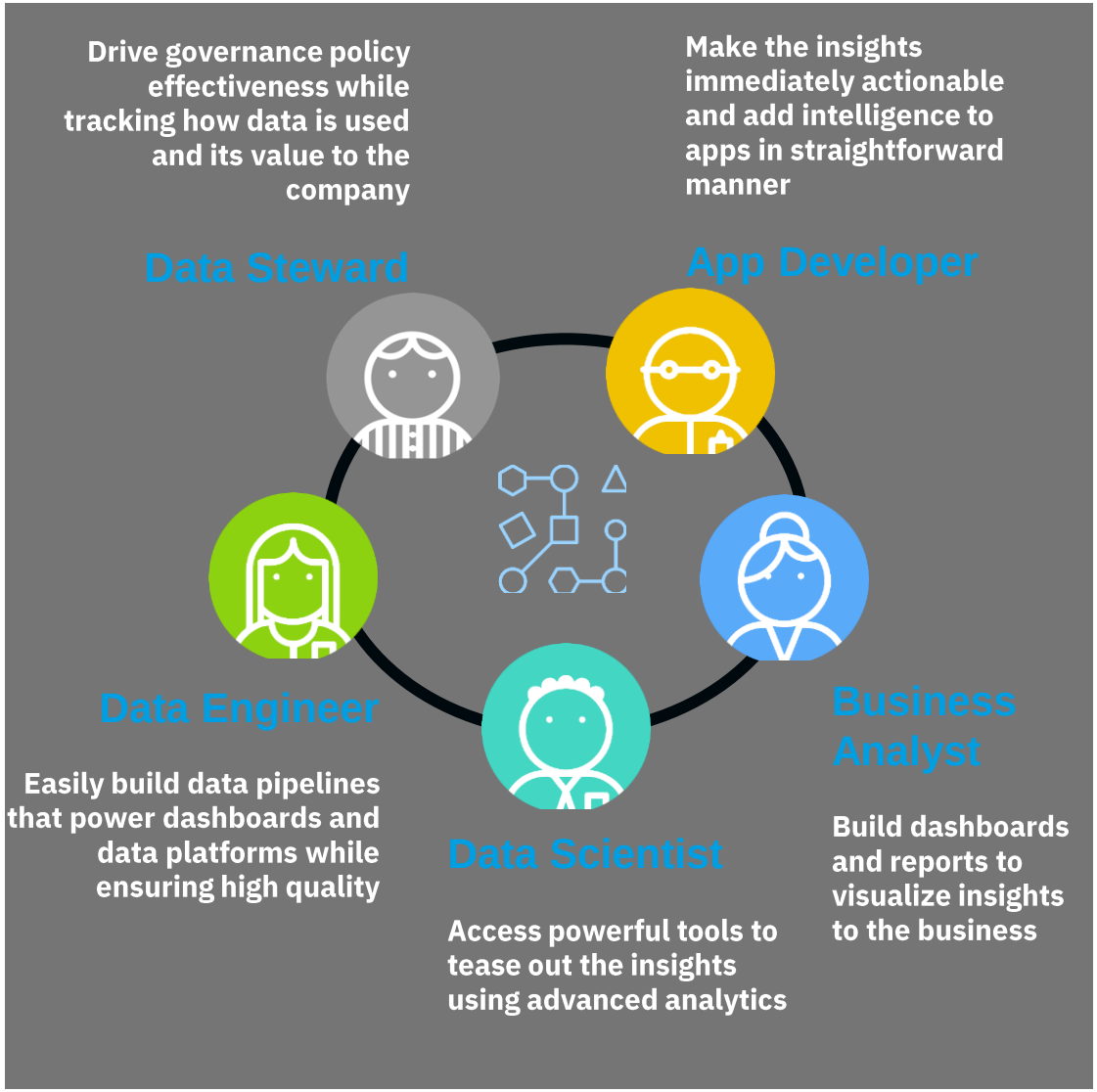
Watson Data Platform

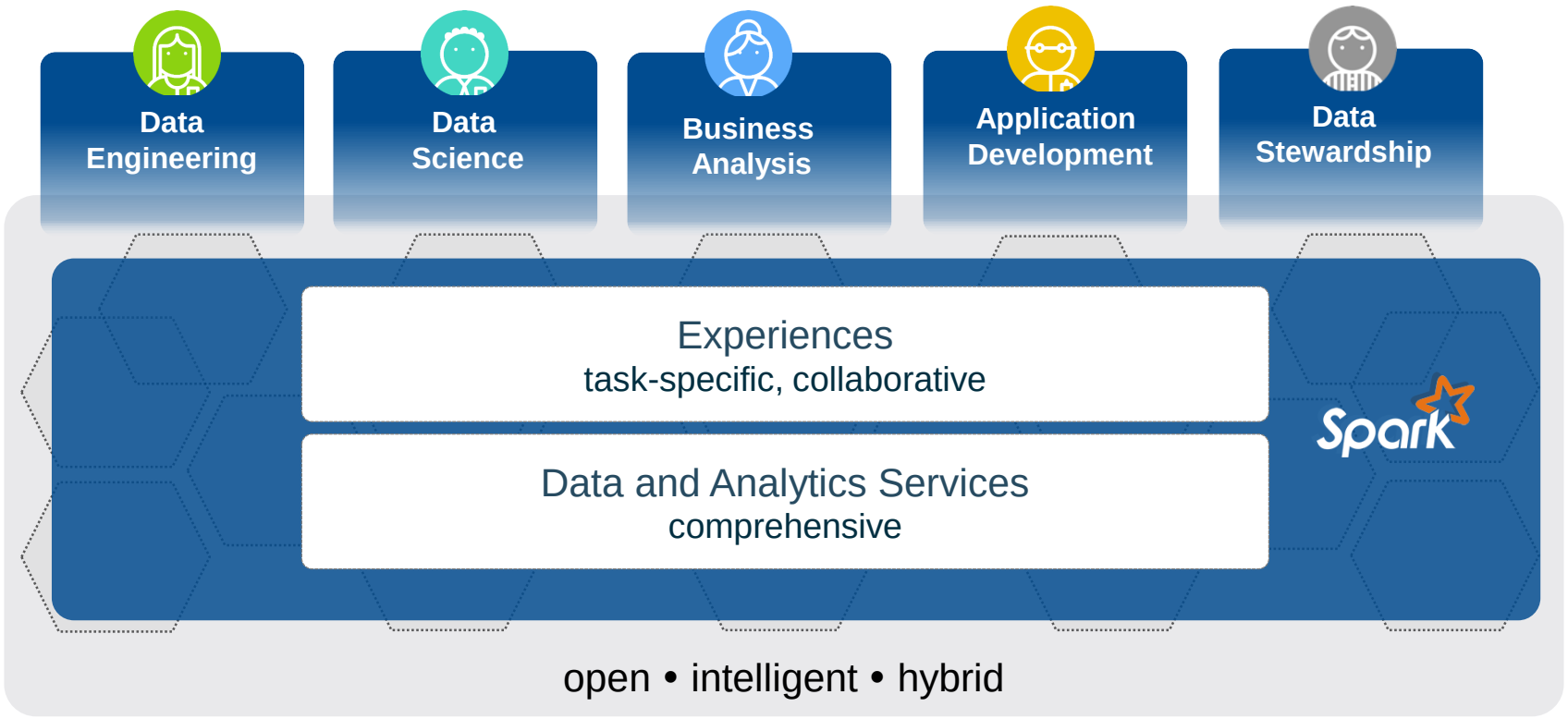
IBM Watson Data Platform

An integrated platform of tools, services, and data that help companies or agencies accelerate their shift to be data-driven organizations



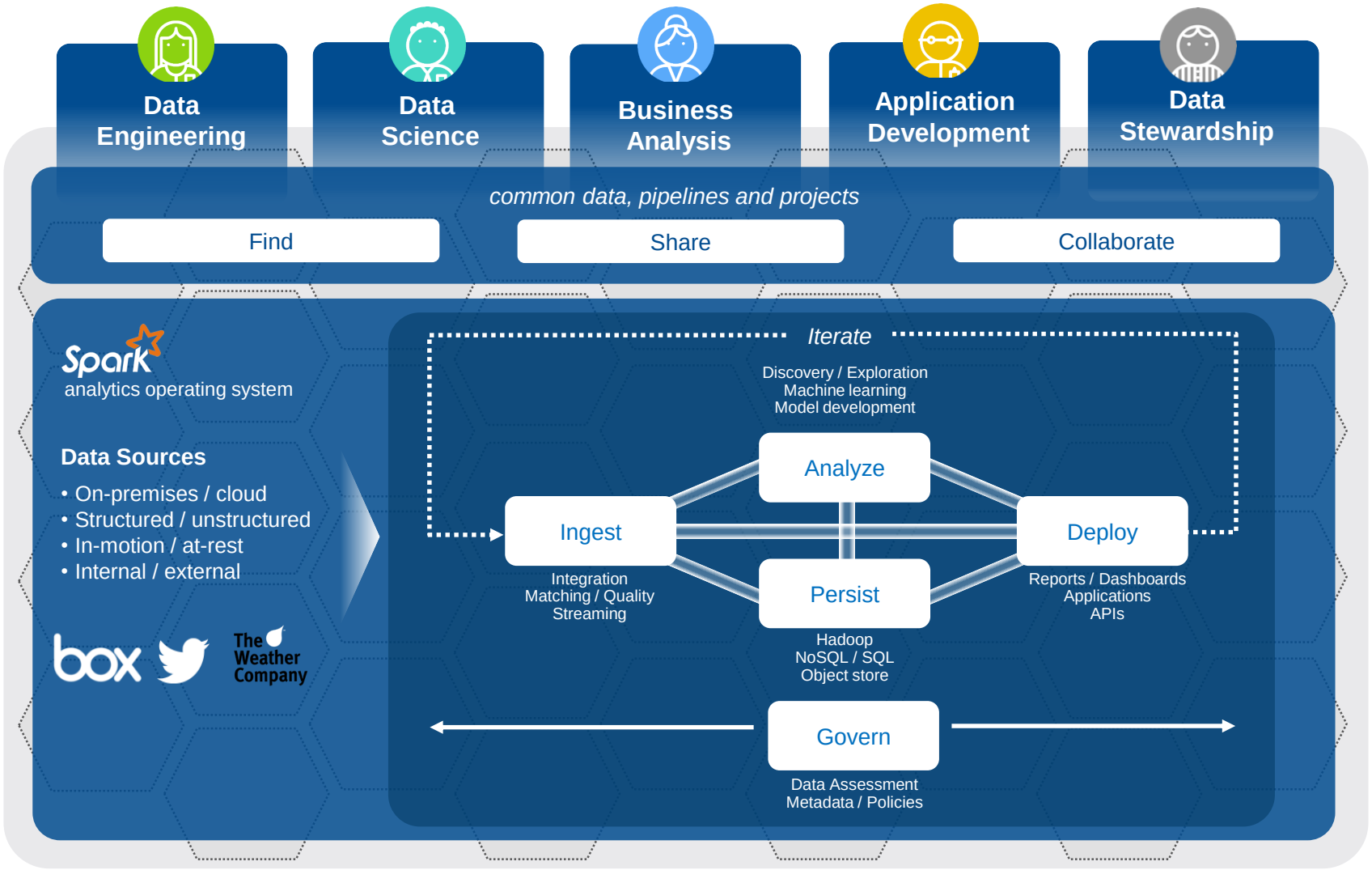
IBM Watson Data Platform

Experience New Ways To Put Data To Work



IBM Watson Data Platform

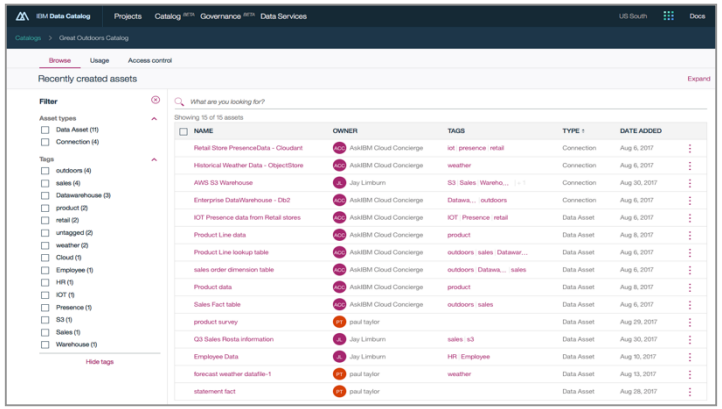
Connects Users to Data and Analytics

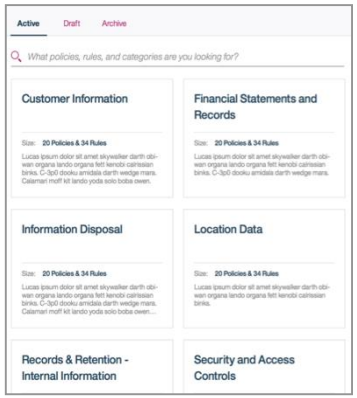


Data Catalog

Unlock tribal knowledge to unleash your data professionals

Data Steward





Discover

Intelligent discovery of data with advanced classification and profiling to provide context

Catalog

A rich metadata index of all data with social collaboration and enhanced findability

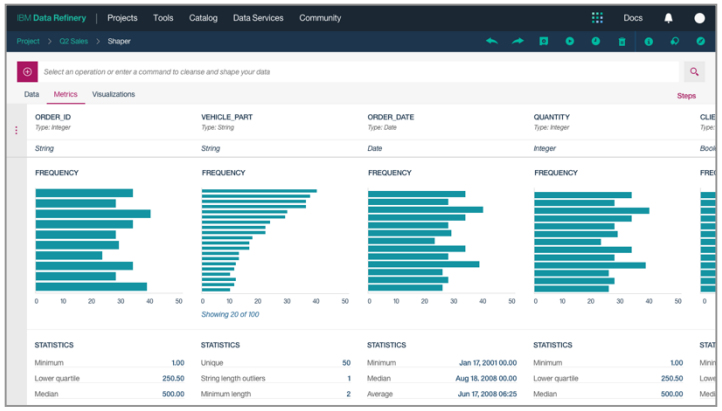
Govern

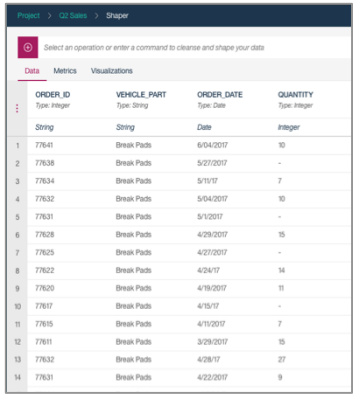
Powerful governance tools to control and protect access to data with visibility to data use

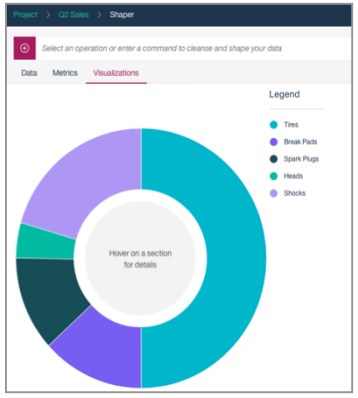
Data Refinery – Open Beta

A Breakthrough Approach to Explore and Prepare Data

Data Engineer







Wrangle

Interactively explore, resolve quality issues, enrich, standardize, and summarize data.

Flow

Create data flows visually, schedule for repeatability, monitor and notify

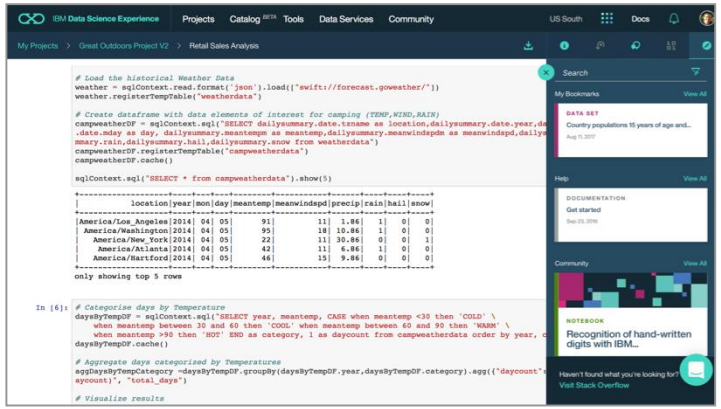
Adapt

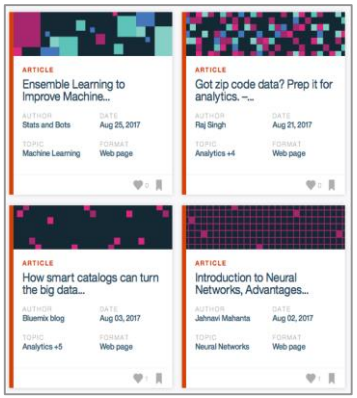
Connect to 30+ cloud and on-premises stores and scale on demand with cataloging and governance

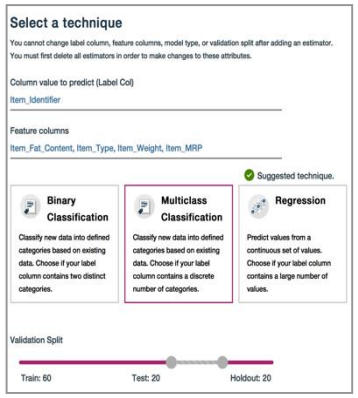
Data Science Experience

Data Scientist

Brings together everything a Data Scientist needs to be successful







Learn

Built-in learning to get started or go the distance with advanced tutorials

Create

The best of open source and IBM value-add to create state-of-the-art data products

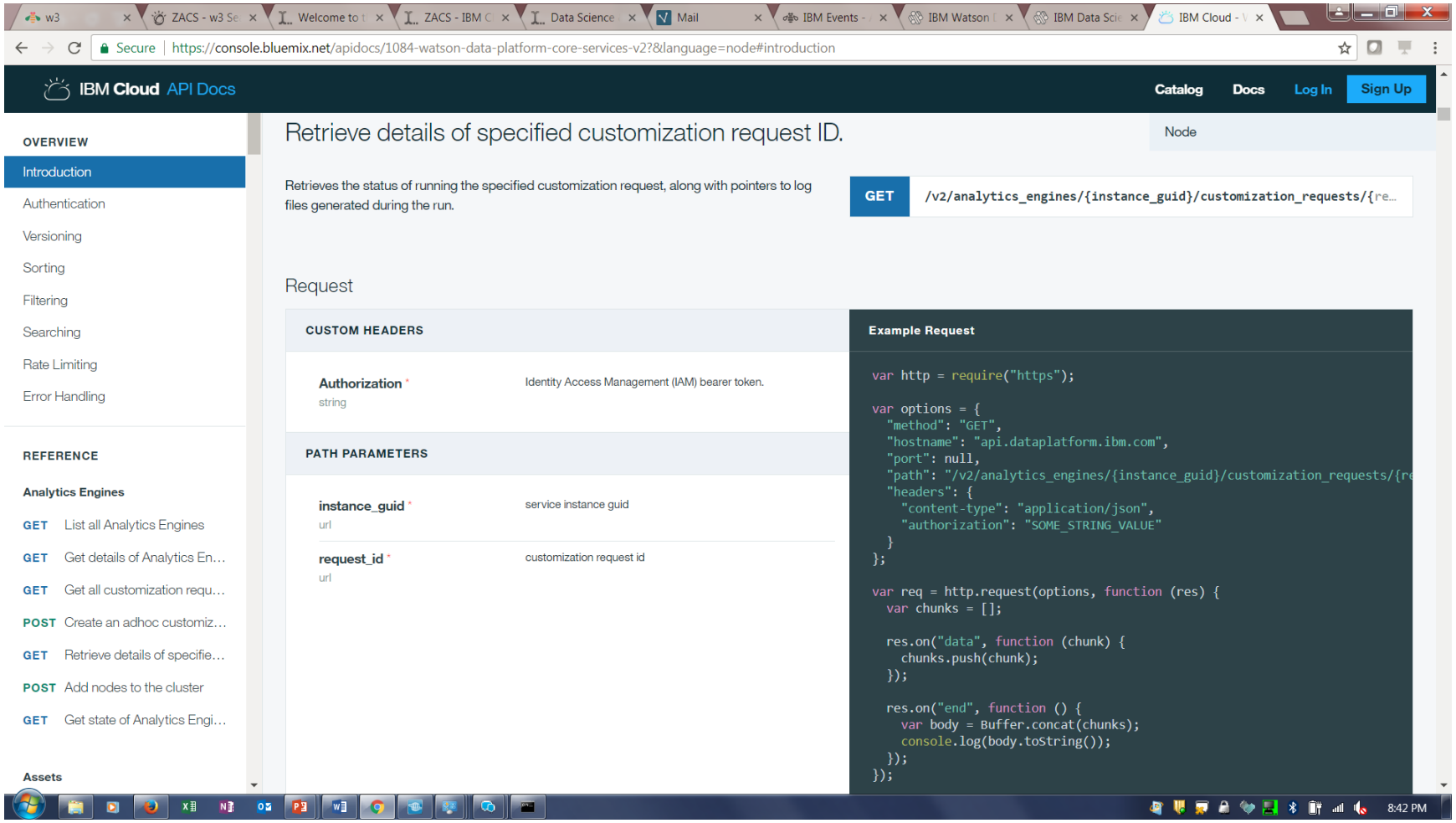
Collaborate

Data and Analytic assets are contained within projects which can be shared with other users.

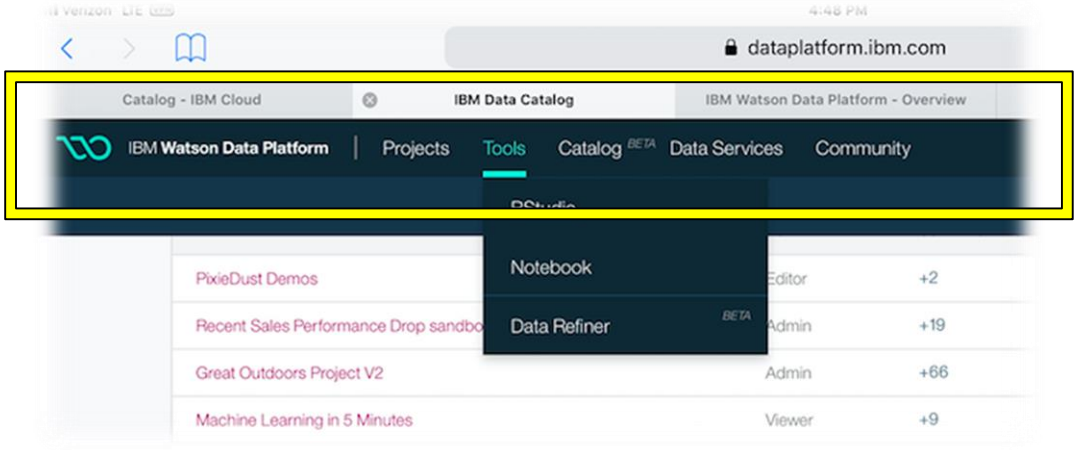
IBM Cloud PaaS

Rich Platform and Service APIs for your developers

Application Developer



Intelligent data fabric provides consistent platform experience



This fabric remains consistent throughout the Watson Data Platform experience – regardless if you are ingesting data, shaping data, building algorithms, deploying models and more…

How does WDP help fulfill the promise of your data?

Data

Puts every important data source at the fingertips of the teams that need it wherever resides

Governance

Enforces your policies without getting in the way of delivering insights

Skills

Makes the most of the data professionals you have and helps them grow and learn from each other as a team

Infrastructure

Brings all the tools in one place. Collaboration capabilities enables Data Science as a team sport.

Data Science Experience

Core Attributes of the Data Science Experience

IBM Data Science Experience

Community

- Find tutorials and datasets
- Read articles and papers
- Connect with Data Scientists
- Share comments
- Copy and share notebooks

Open Source

- Code in Scala/Python/R/SQL
- Jupyter Notebooks
- RStudio IDE and Shiny
- Apache Spark
- Your favorite libraries

IBM Added Value

- IBM Machine Learning
- SPSS Modeler Canvas
- Prescriptive Analytics - DOcplexcloud
- Projects and Version Control
- Managed Spark Service

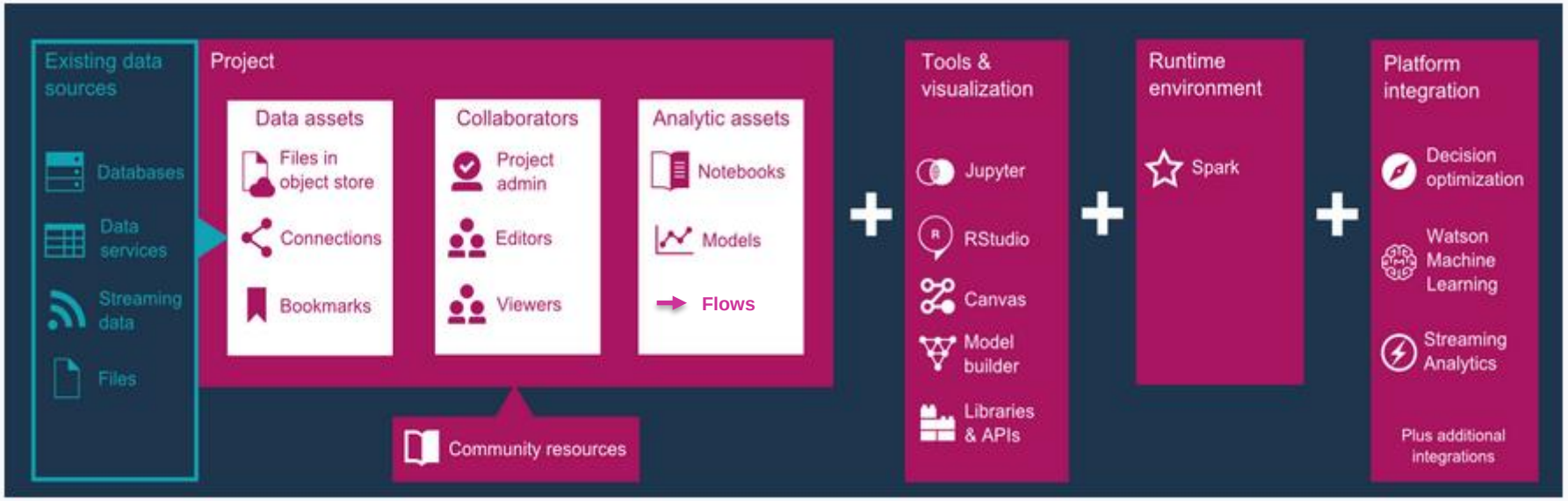
Powered by IBM Watson Data Platform

DSX Architecture

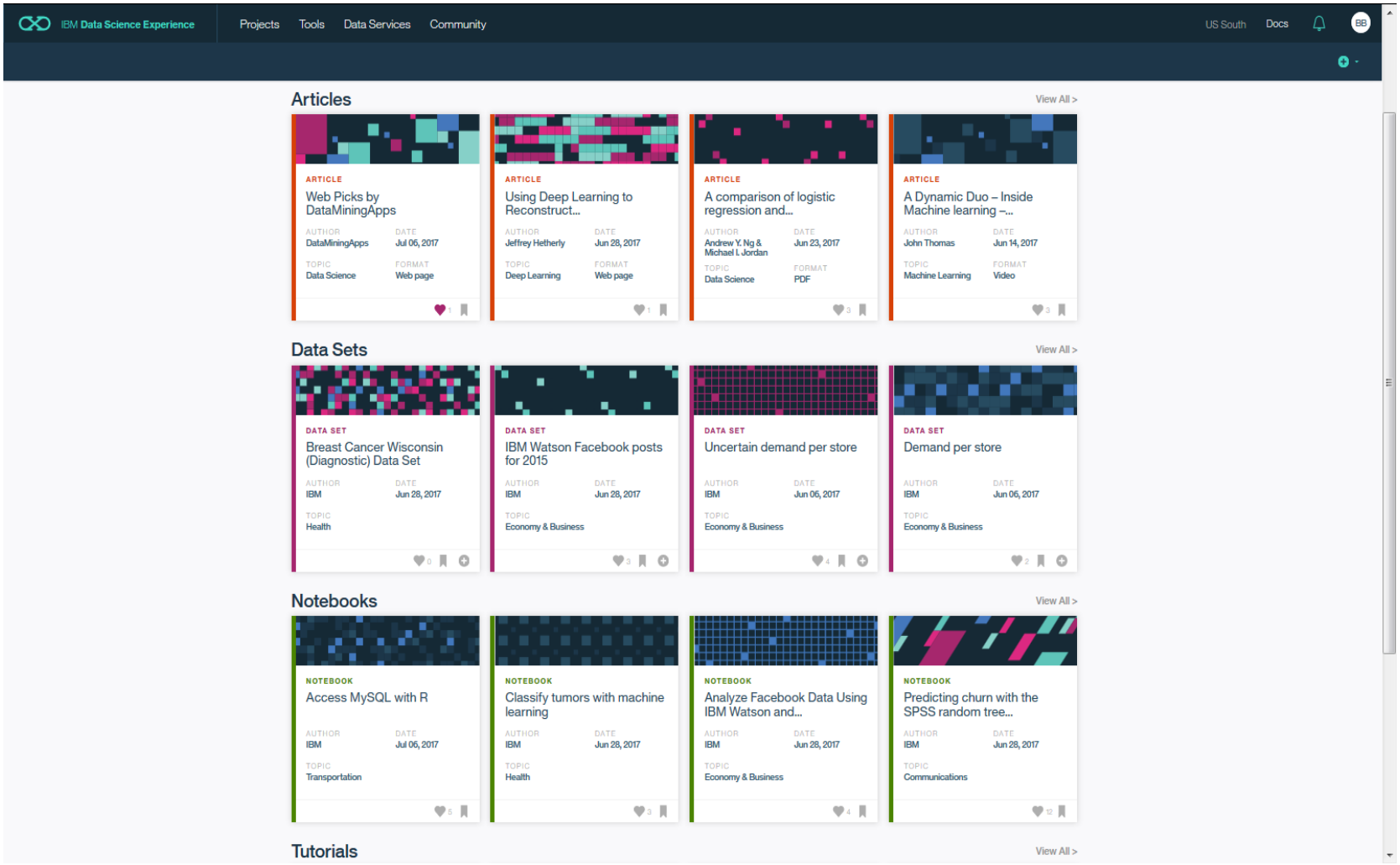
DSX architecture

Last updated: June 27, 2017

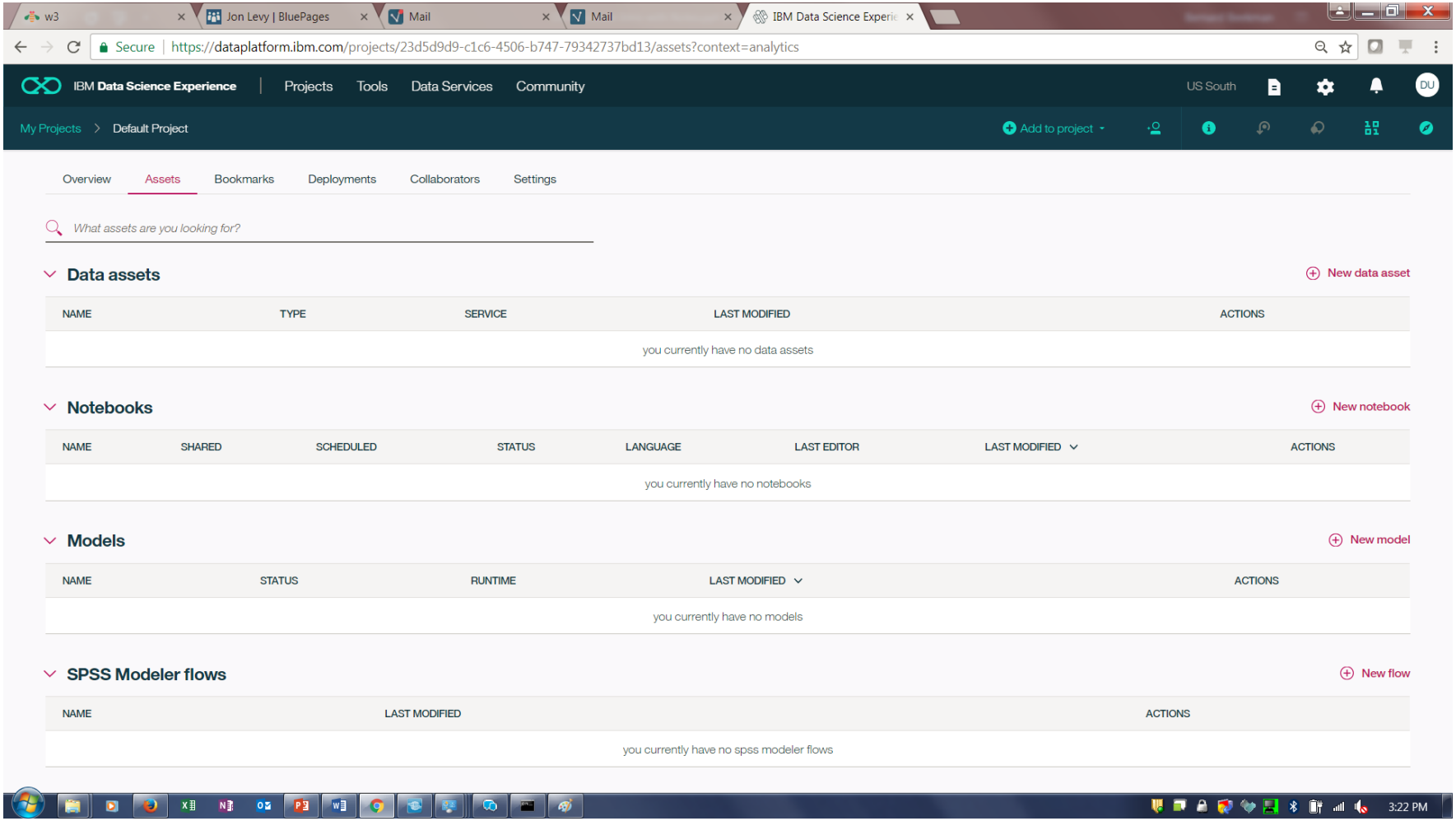
DSX provides you with the environment and tools to solve your business problems by collaboratively analyzing data. This illustration shows how the architecture of DSX is centered around the project. A project is how you organize your resources for solving a business problem.



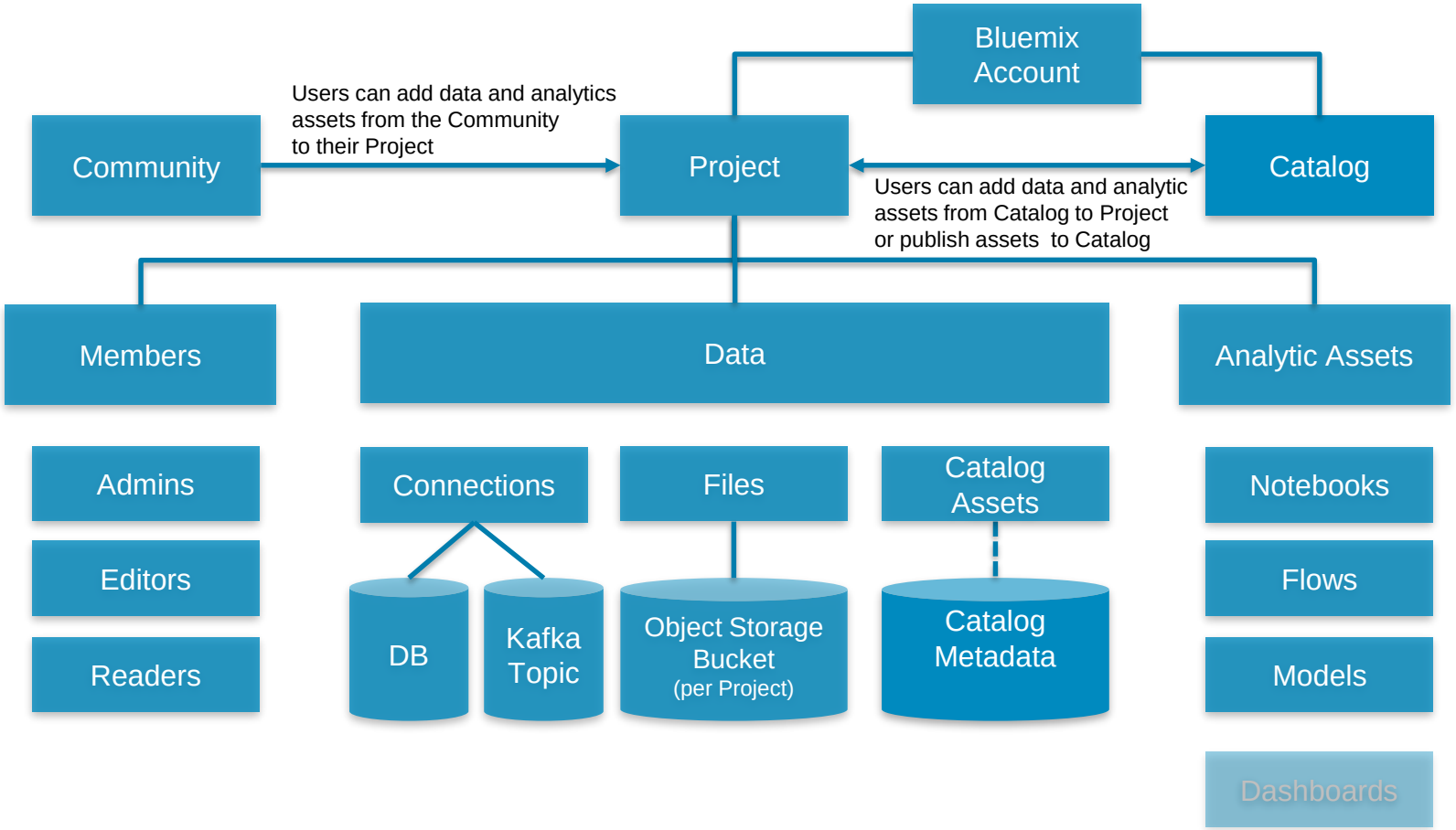
Community Cards provide in-context learning



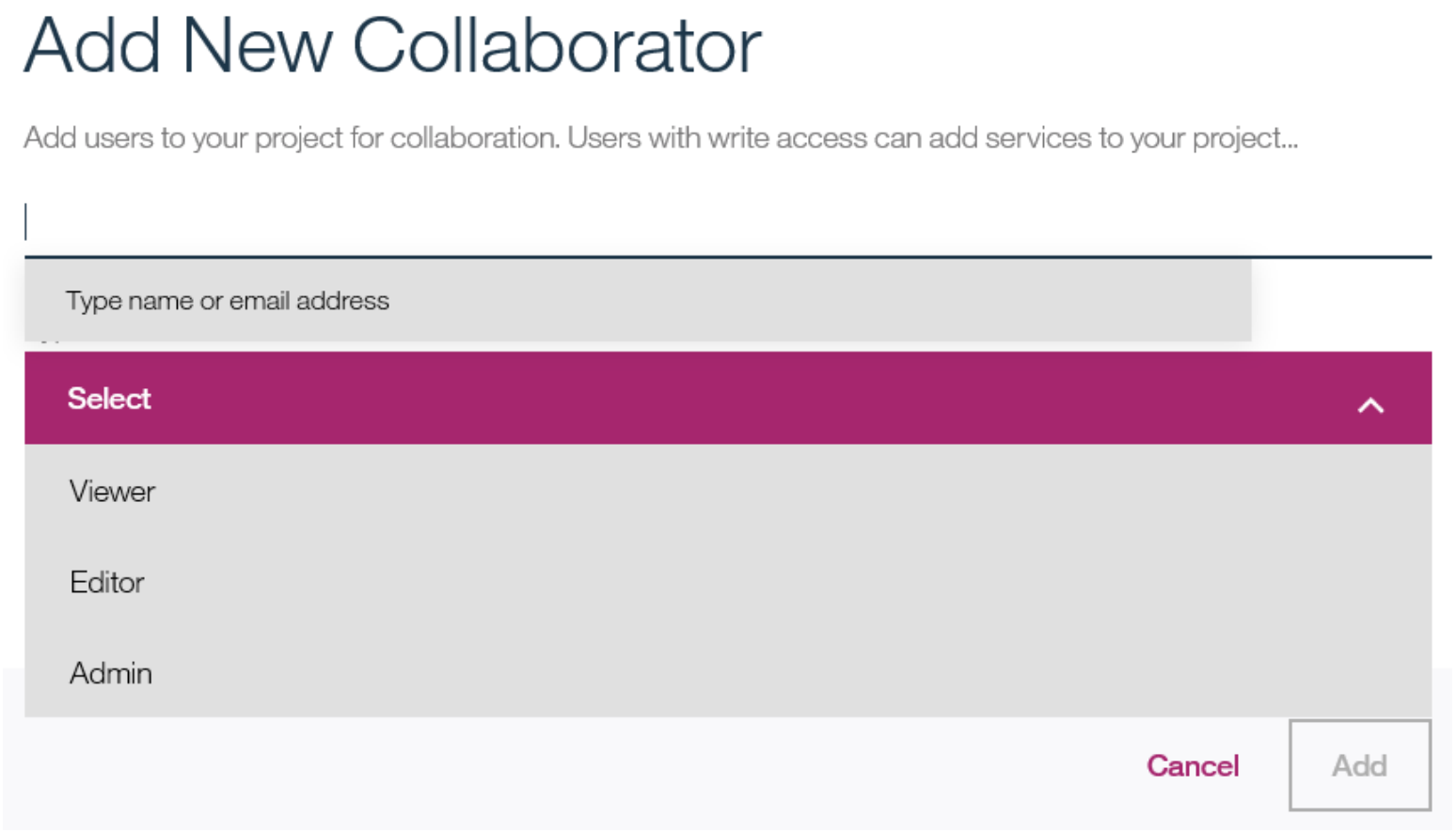
Collaborate Using Projects



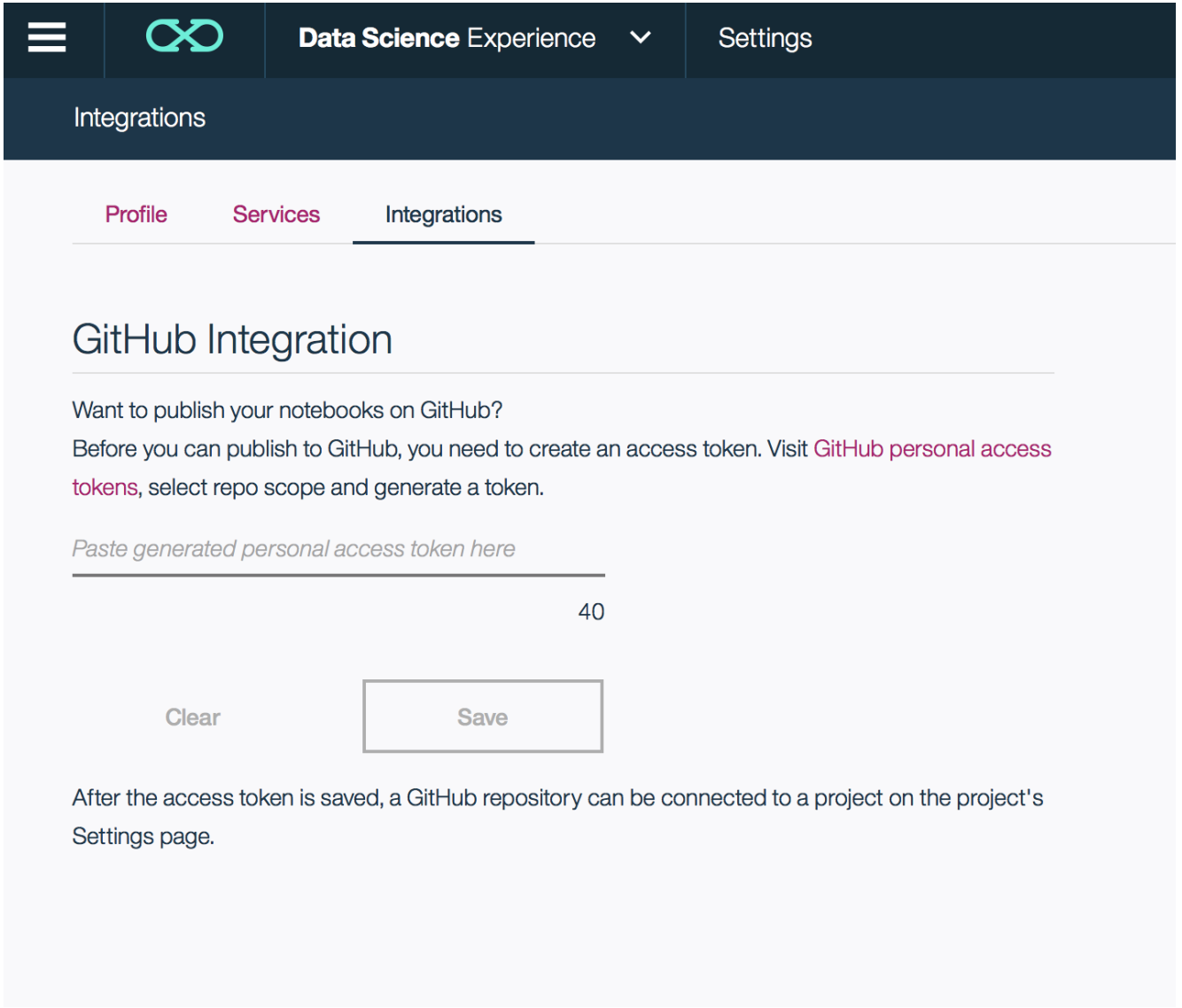
Projects allow users to work and collaborate



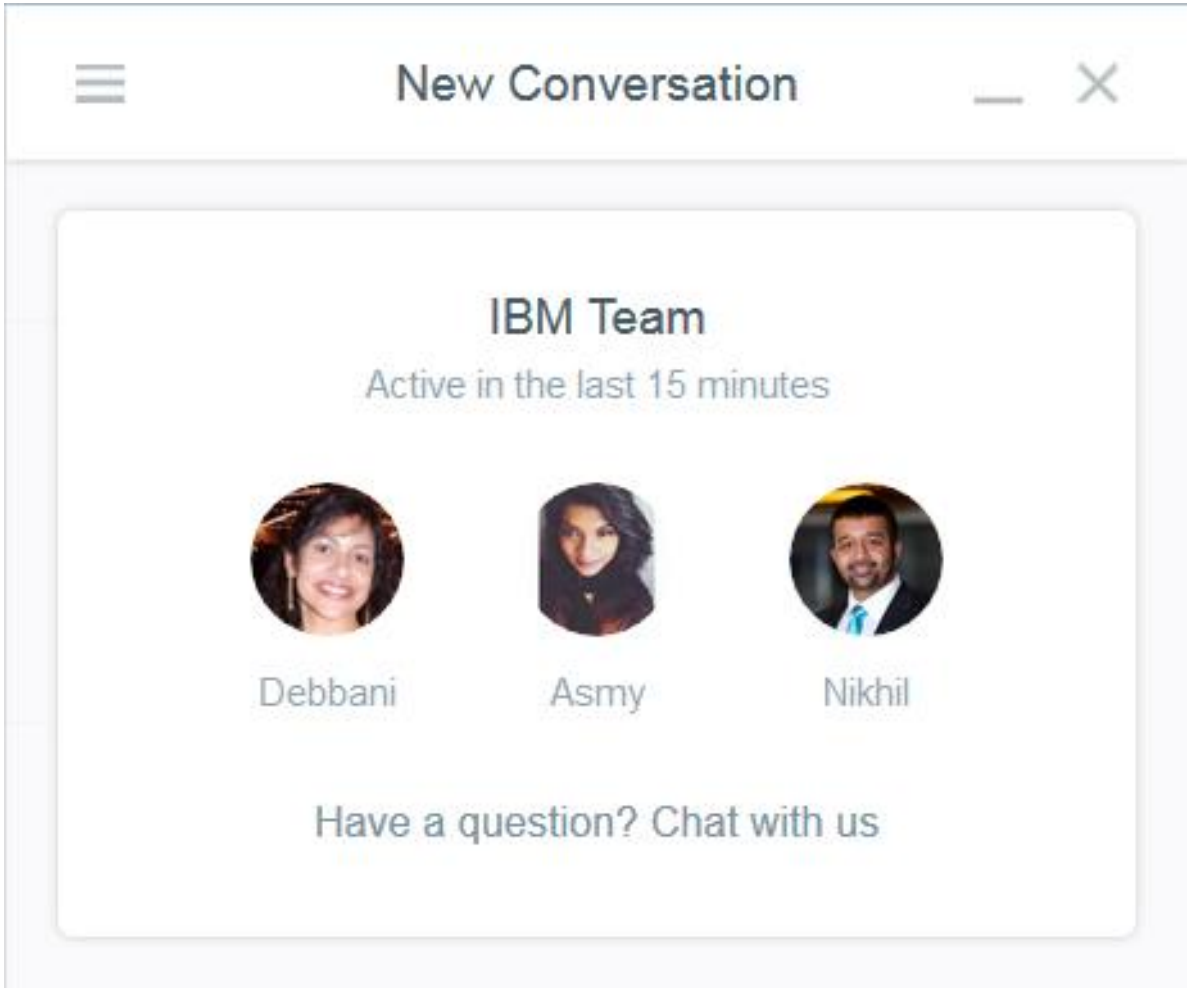
Add Collaborators to a Project



GitHub Integration



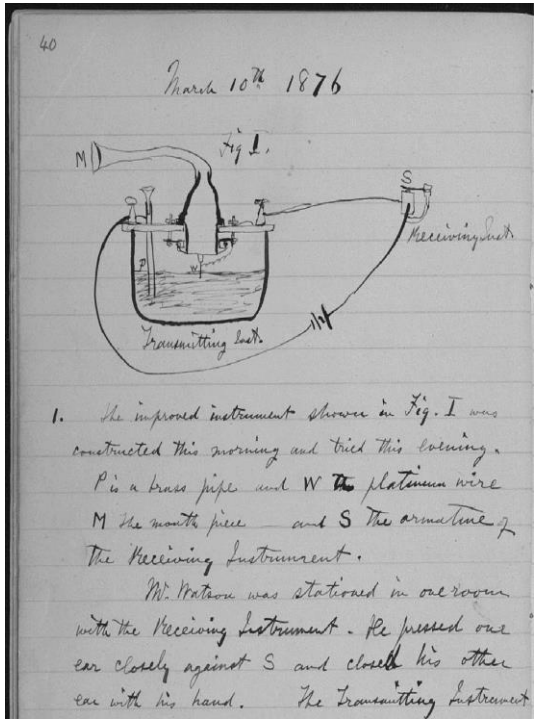
Live chat on Intercom for support from the IBM team and to provide your feedback on how we can improve



What is a “Notebook”?

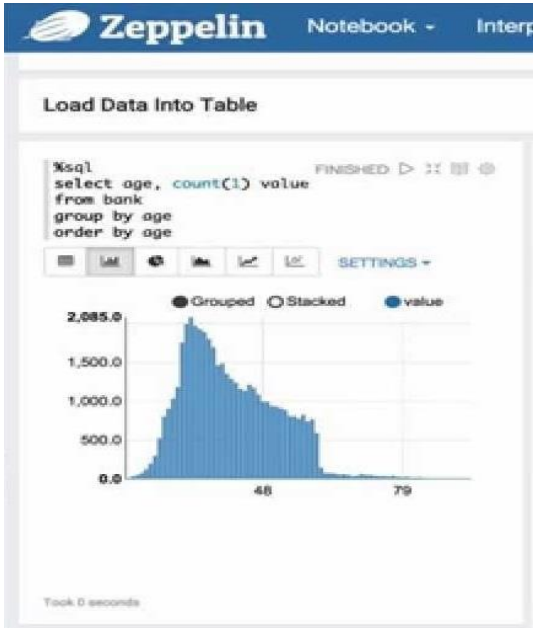
Pen and Paper

- **Pen and paper has long provided the rich experience that scientists need to document progress through notes and drawings:**
  - Expressive
  - Cumulative
  - Collaborative



Notebooks

- **Notebooks are the digital equivalent of the “pen and paper” lab notebook, enabling data scientists to document reproducible analysis:**
  - Markdown and visualization
  - Iterative exploration
  - Easy to share



Integrated Jupyter Notebooks for interactive and collaborative development - seamless execution on Spark

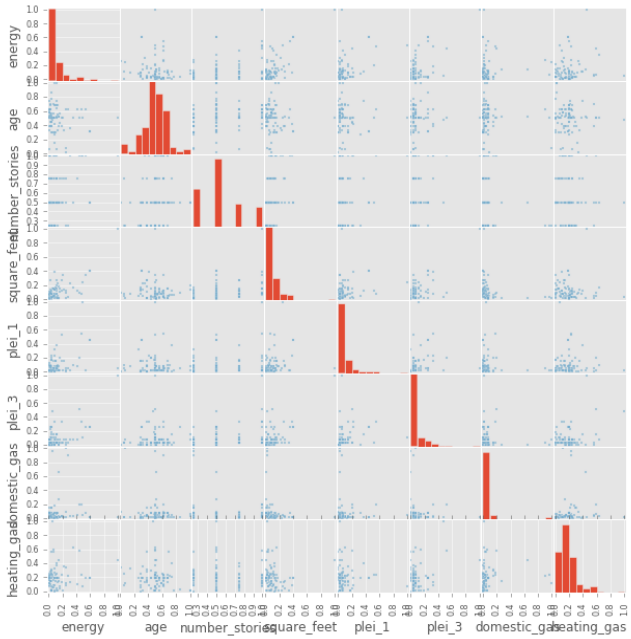
Notebooks > Spark Summit West - BlocPower Demo

File Edit View Insert Cell Kernel Help Python 2

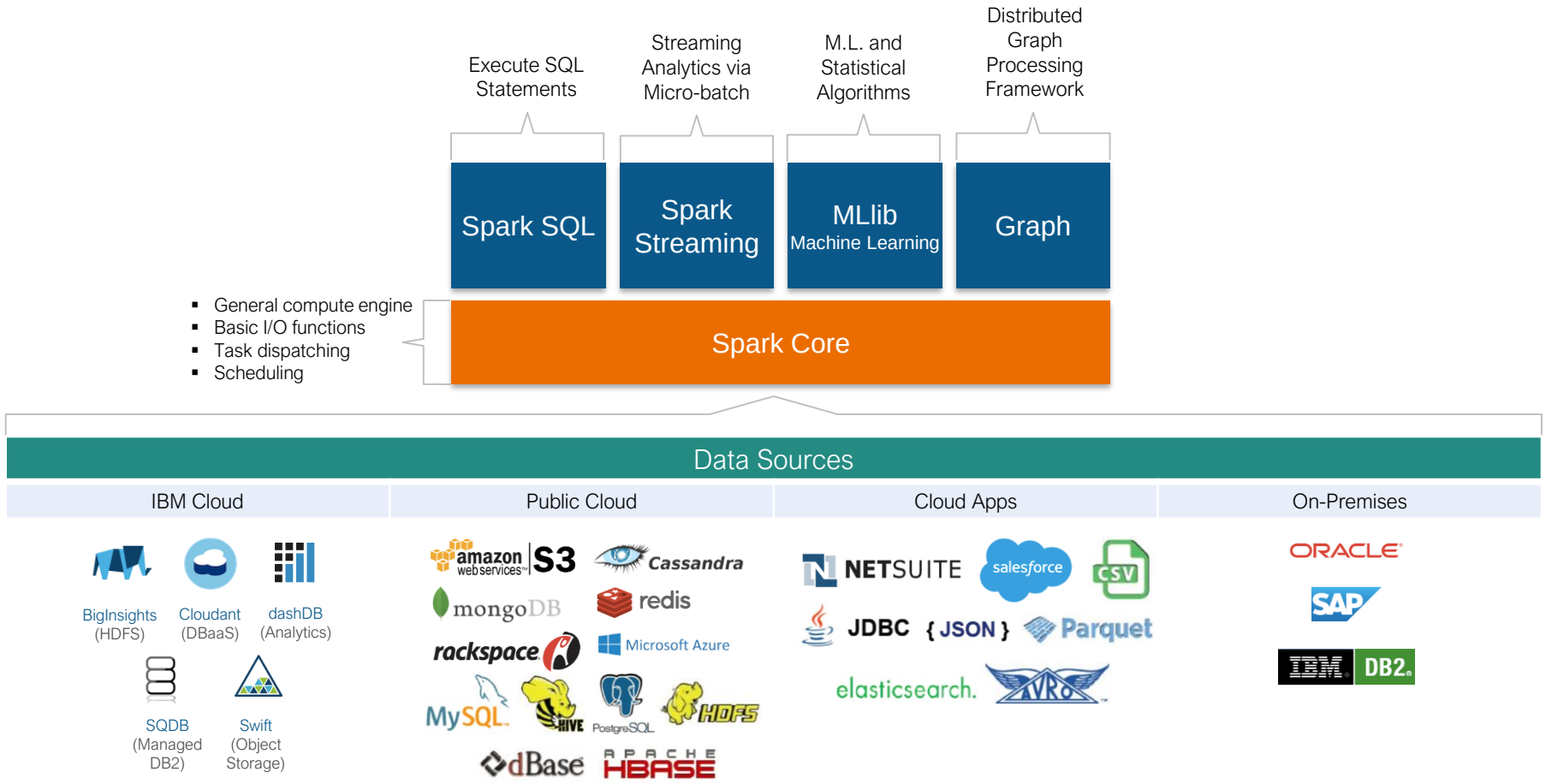
Format Markdown Cell Toolbar None

Explore the correlations

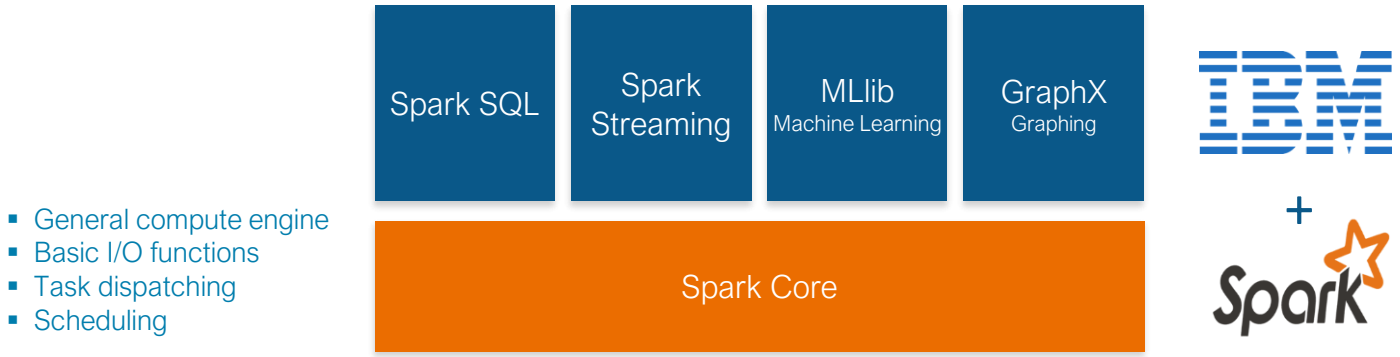
In [9]:
```
import matplotlib.pyplot as plt
%matplotlib inline
plt.style.use('ggplot')
ff = pd.tools.plotting.scatter_matrix(dfScaled, diagonal='hist',figsize=(10,10))
```



From a Notebook in DSX you can use IBM's managed Spark Service to blend multiple data types, sources, and workloads

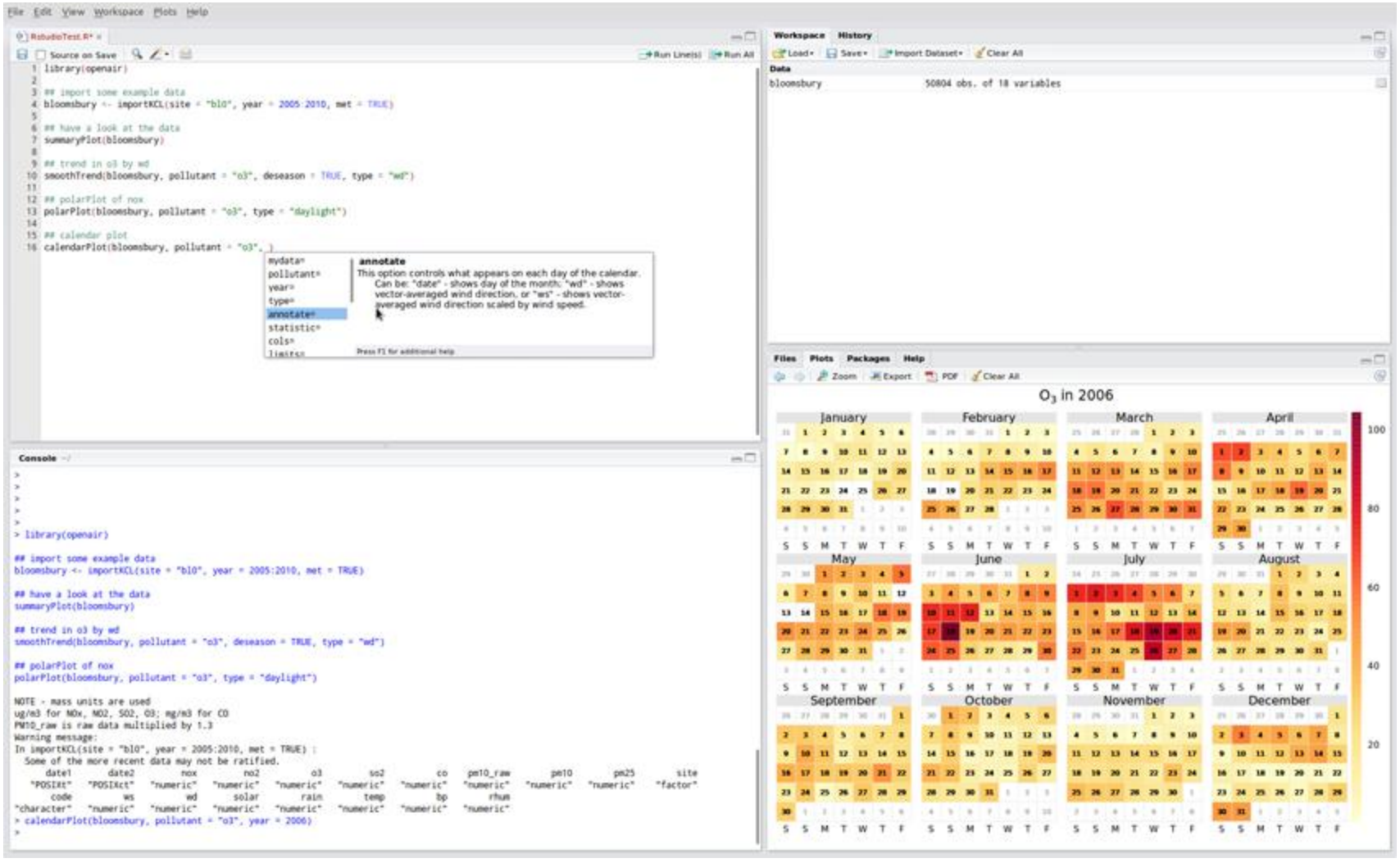


Benefits of Spark for Data Science

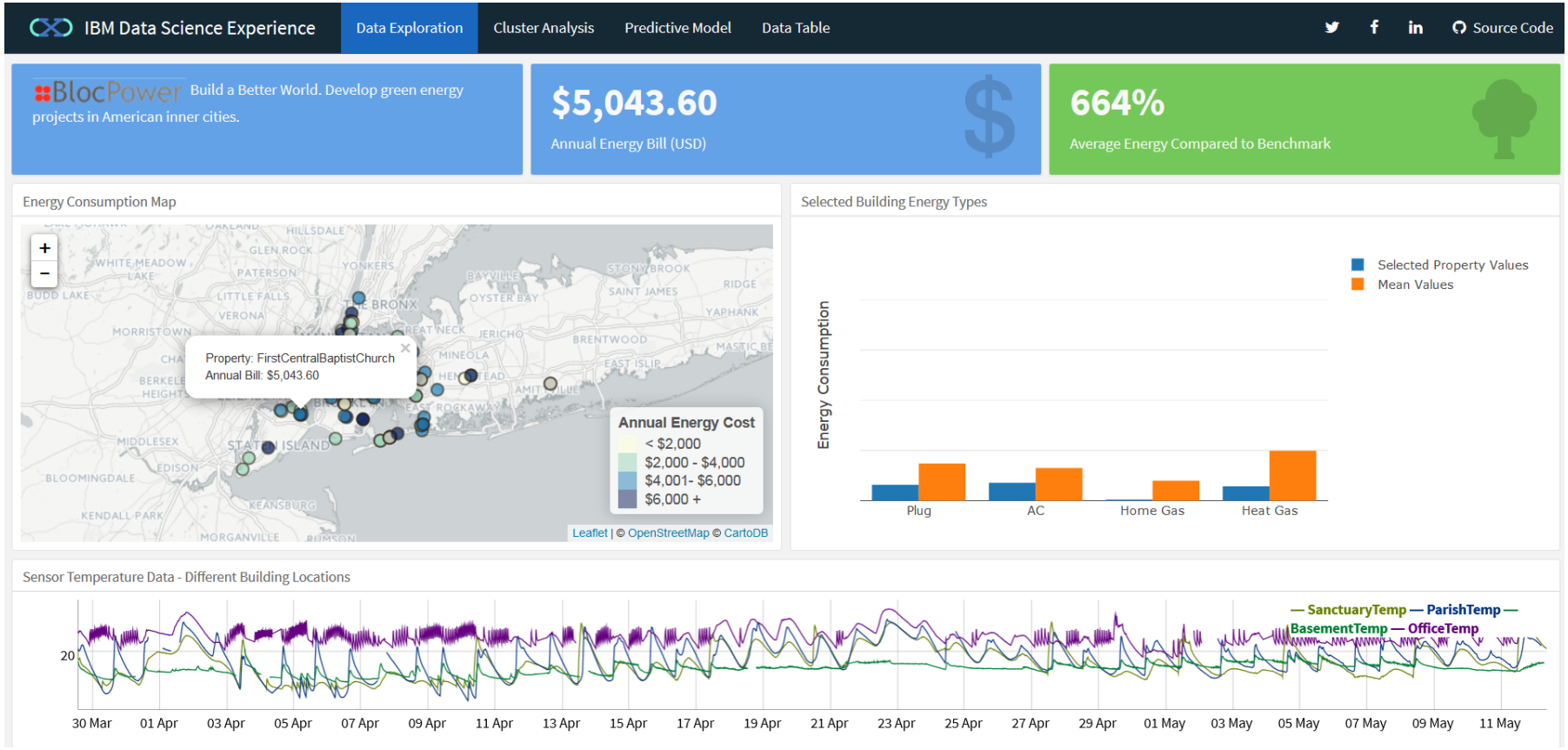


- Allows Data Scientists to code at scale
  - In-Memory processing that scales in a distributed architecture
- Supports multiple programing interfaces (Scala, Python, Java and R)
- Provides unified APIs (SQL, Streaming, Machine Learning, etc.)

DSX has RStudio built into the experience thanks to our strategic partnership



With RStudio you can create Shiny web applications to make your analysis accessible to the business



Operationalize insights with IBM Machine Learning

IBM Machine Learning

Data Access:

- Easily connect to Behind-the-Firewall and Public Cloud Data
- Catalogued and Governed Controls through Watson Data Platform

Creating Models:

- Single UI and API for creating ML Models on various Runtimes
- Auto-Modeling and Hyperparameter Optimization

Web Service:

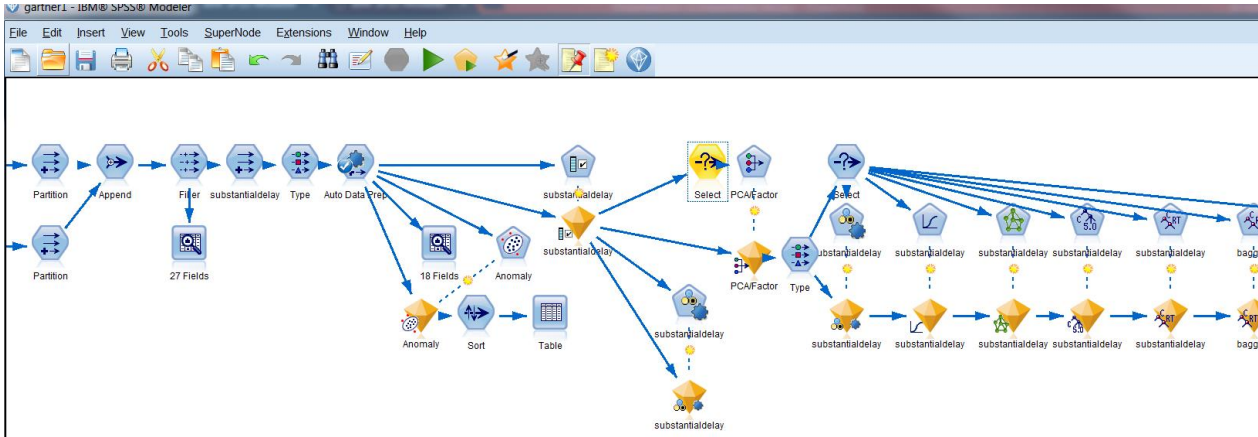
- Real-time, Streaming, and Batch Deployment
- Continuous Monitoring and Feedback Loop

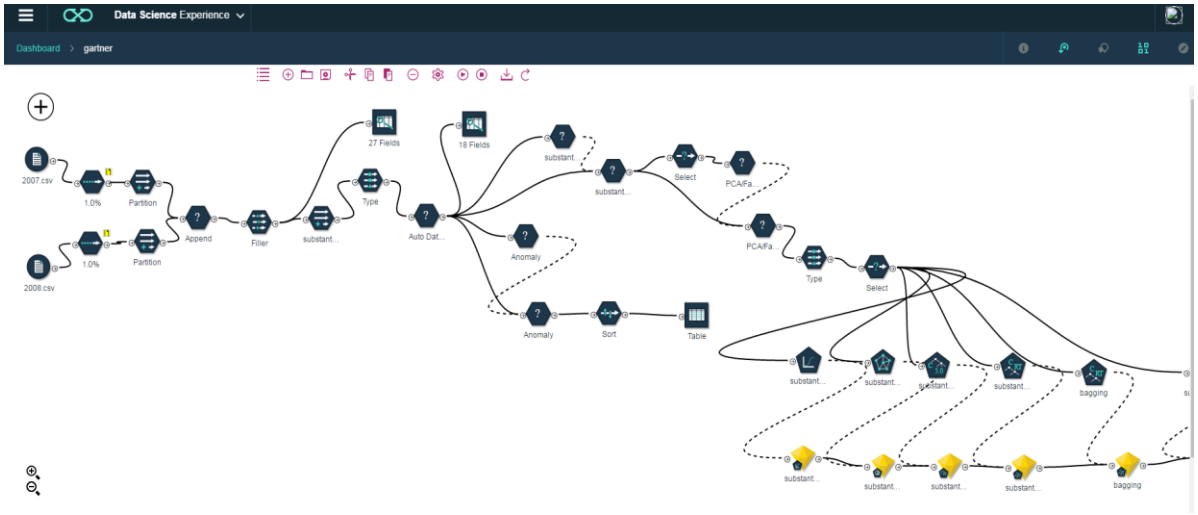
Intelligent Apps:

- Integrate ML models with apps, websites, etc.
- Continuously Improve and Adapt with Self-Learning

Use the DSX Canvas to Visually Create ML Flows

- DSX Canvas will have compatibility with legacy SPSS Modeler streams
- Multiple execution runtimes: SPSS Modeler, SparkML
- Planned support for R/Python/SQL code





- Pipeline deployment from DSX Canvas (left) via IBM Machine Learning

Stream Designer – Open Beta

- Characteristics of Stream Processing
  - Continuous processing
  - Multiple varied data sources
  - High data rates/ data volumens
  - Near-real time action
- DSX Stream Designer
  - Design stream flow with new Stream Designer
  - Executes in Streaming Analytics Service (based on IBM Streams)
  - Can invoke stream within Jupyter notebooks using Stream API

Supported Data Sources via on- premises and cloud Connectors

IBM services in IBM Cloud

- IBM Informix
- IBM Db2 for i
- Object Storage OpenStack Swift for IBM Cloud
- Object Storage OpenStack Swift (IaaS)
- PostgreSQL on Compose
- IBM Cloudant
- IBM Db2
- IBM PureData for Analytics
- MySQL on Compose
- Cloud Object Storage (IaaS)
- IBM BigInsights HDFS
- IBM Db2 for z/OS
- Cloud Object Storage
- IBM Db2 on Cloud
- IBM Db2 Hosted
- IBM Db2 Warehouse on Cloud

Third-party services

- Cloudera Impala
- Microsoft SQL Server
- Amazon S3
- Pivotal Greenplum
- Salesforce.com
- Sybase IQ
- MySQL
- Microsoft Azure SQL Database
- Apache Hive
- Sybase
- Hortonworks HDFS
- Amazon Redshift
- Oracle
- PostgreSQL

DSX Local

- **Very similar to the public cloud version of DSX**
- **Runs on hardware that is provided by the customer**
  - The DSX Local software and hardware are managed by the customer
- **DSX Local comes with all the software it needs to run, although it can integrate with existing customer systems such as**
  - Databases and HDFS storage
  - LDAP servers for authentication

IBM Data Science Experience

https://www.youtube.com/watch?v=1HjzkLRdP5k&t=29s

Labs

Lab Overview

Use IBM's Data Science Experience (DSX) and IBM cloud services to create a working cloud-based application from start to finish. Participants will be led through a series of four labs. The first three build upon one another so it is important that they are completed in order.

- Lab 1 - The first lab will begin with loading raw delimited data into DB2 Warehouse for Cloud and interacting with that data from a Jupyter notebook in DSX with python.
- Lab 2 - The second lab will leverage Spark machine learning (SparkML) on the loaded data to create categorical predictions using pyspark and a supervised learning model and store the results back to the database.
- Lab 3 - The third lab will guide participants in creating an R notebook and Shiny UI in DSX using RStudio.

Choose one of the two below:

- Lab-4a - This lab will use the Watson Machine Learning capability to create a machine learning model based on the Titanic data set. The model will be deployed in the IBM Cloud, and an application will be built that uses the deployed machine learning model to predict survivability given passenger characteristics.
- Lab 4b - The second lab will use the SPSS Modeler Flow designer to cleanse and prepare the Titanic data set for modeling. A Logistic Regression model will be trained and evaluated to predict survivability given passenger characteristics.

Lab 1

This lab will begin with loading raw delimited data into DB2 Warehouse for Cloud and interacting with that data from a Jupyter notebook in DSX with Python.

Objectives:

- Upon completing the lab, you will know how to:
  - Create a Jupyter IPython notebook from a URL
  - Establish a connection to DB2 Warehouse on Cloud
  - Use a dataframe to read and manipulate tables
  - Use SQL to query the database
  - Explore the data using techniques from earlier in the lab
  - Close the database connection

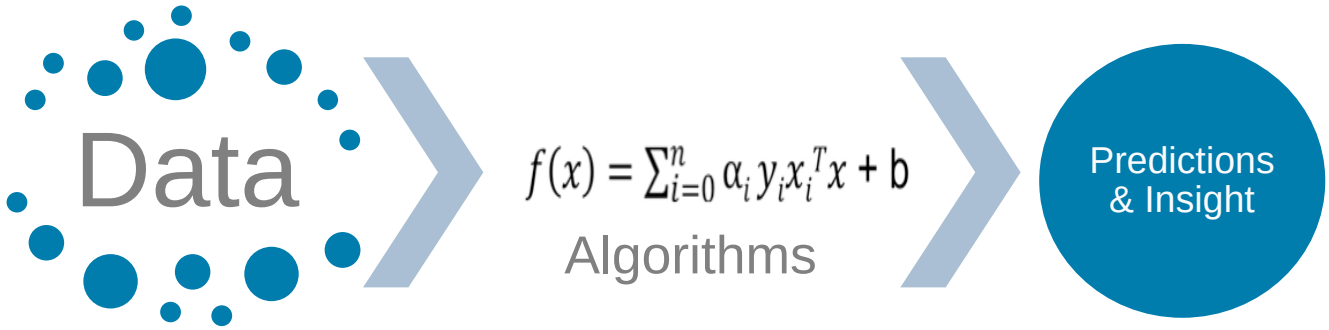
Lab 2

In this lab, you will use SparkML in IBM Data Science Experience to run generated travel data through a machine learning algorithm, automatically tune the algorithm, and load the data into a DB2 Warehouse database.

What is Machine Learning?

"Computers that learn without being explicitly programmed"

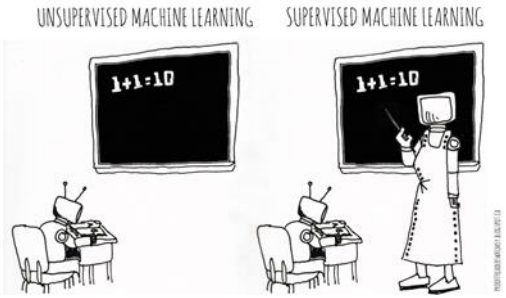
"Using algorithms to understand patterns in data"



Categories of Machine Learning

- **Supervised learning**
  - The program is “trained” on a pre-defined set of “training examples”, which then facilitate its ability to reach an accurate conclusion when given new data
  - The algorithm is presented with example inputs and their outcomes (labels)
  - The goal is to learn a general rule that maps inputs to outputs

- **Unsupervised learning**
  - No labels are given to the learning algorithm, leaving it on its own to find structure (patterns and relationships) in its input

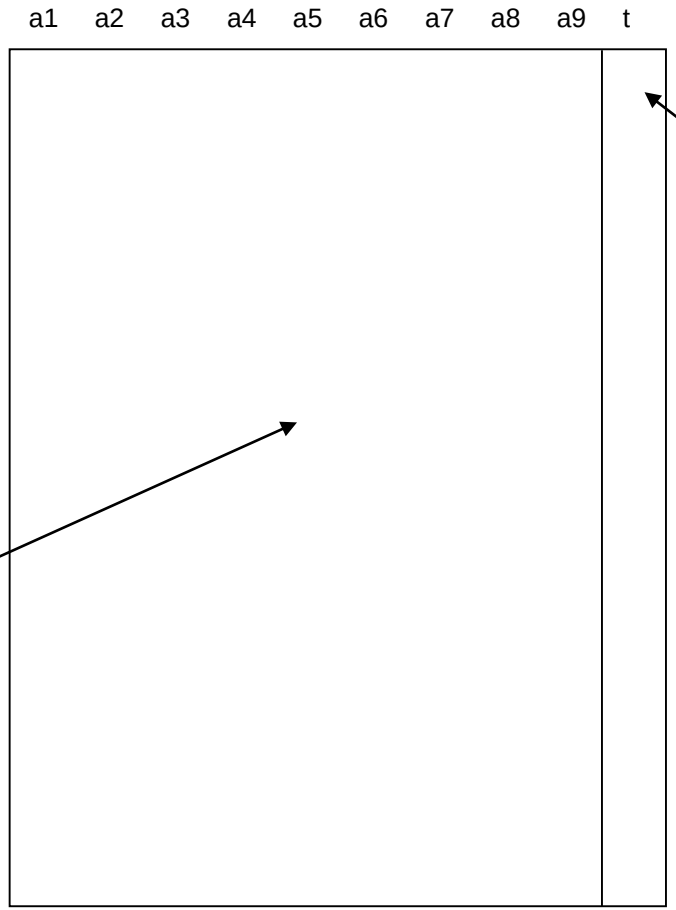


Categories of Machine Learning

Technique	Usage	Algorithms
Classification (or prediction)	• Used to predict group membership (e.g., will this employee leave?) or a number (e.g., how many widgets will I sell?)	• Decision Trees • Logistic Regression • Random Forests • **Naïve Bayes** • Linear Regression • Lasso Regression etc
Segmentation	• Used to classify data points into groups that are internally homogenous and externally heterogeneous. • Identify cases that are unusual	• K-means • Gaussian Mixture • Latent Dirichlet allocation etc
Association	• Used to find events that occur together or in a sequence (e.g., market basket)	• FP Growth

Preprocessing: Matrix for Machine Learning

Known as:
- Attributes
- Features
- Predictor variables
- Explanatory variables



Scale variables:
- Continuous variables, which can be measured on an interval scale or ratio scale
- ‘Weight’, ‘Temperature’, ‘Salary’, etc…

Categorical variables:
- Data with a limited number of distinct values or categories (nominal or ordinal)
- ‘Hair color’, ‘Gender’, ‘Grape varieties’, etc…

Known as:
- Label
- Target variable
- Dependent variable

Scale or Categorical

Training, testing, & validation sets

- **During the model development process, supervised learning techniques employ training and testing sets and sometimes a validation set.**
  - Historical data with known outcome
  - Data is randomly split into training, testing, and/or validation sets (mutually exclusive records)
- **Why?**
  - Training set
    - Build the model
    - Tune the parameters
  - Testing set
    - Assess model quality during training/tuning process
    - Avoid overfitting the model to the training set
  - Validation set
    - Estimate accuracy or error rate of model after tuning
    - Used to compare multiple models

Spark ML

- **Spark ML is Spark's machine learning (ML) library**
- **Goal is to make machine learning scalable and easy**
  - No need to understand the detailed math!
- **Divides into two packages:**
  - spark.mllib contains the original API built on top of RDDs
  - spark.ml provides higher-level API built on top of DataFrames for constructing ML pipelines
  - A pipeline is a series of stages where each stage either transforms, or runs through a machine learning algorithm.
- **Using spark.ml is recommended because with DataFrames the API is more versatile and flexible**
  - spark.mllib will continue to be supported

Spark ML Pipeline Terminology

Spark ML standardizes APIs for machine learning algorithms to make it easier to combine multiple algorithms into a single pipeline, or workflow

- **DataFrame**: Spark ML uses DataFrame from Spark SQL as an ML dataset, which can hold a variety of data types
- **Transformer**: A Transformer is an algorithm which can transform one DataFrame into another DataFrame
- **Estimator**: An Estimator is an algorithm which can be fit on a DataFrame to produce a Transformer
- **Pipeline**: A Pipeline chains multiple Transformers and Estimators together in a sequence to specify an ML workflow
- **Parameter**: All Transformers and Estimators share a common API for specifying parameters

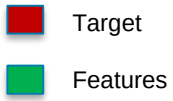
Lab 2 – Female Human Trafficking

- **Input**
  - Generated fake travel records based on incoming custom forms.
  - Subset of records were vetted as “high”, “medium”, or “low” risk for Female Human Trafficking by an analyst.

- **Goal is to train a model on the vetted data to be able to score the unvetted travel records into high, medium, or low categories.**

Lab 2 Data

Field	Description
UUID	Hash-based unique identifier
VETTING_LEVEL	Analyst vetting status : 100- PENDING, 10 – HIGH, 20 – MED, 10 - LOW
NAME	Person name
GENDER	Person Gender
AGE	Person age at time of travel
BIRTH_DATE	Person birth date
BIRTH_COUNTRY	Person full birth country
BIRTH_COUNTRY_CODE	Person ISO 2 country
OCCUPATION	Person occupation as declared on form
ADDRESS	Person US address
SSN	Person Social Security Number
PASSPORT_NUMBER	Person Passport Number
PASSPORT_COUNTRY	Person Passport Issuing Country
PASSPORT_COUNTRY_CODE	Person Passport Issuing Country ISO 2 Code
COUNTRYIES_VISITED	The countries visited as declared on form
COUNTRIES_VISITED_COUNT	The number of countries visited as declared on form
ARRIVAL_AIRPORT_COUNTRY_CODE	ARRIVAL Airport country code ISO2
AIRPORT_ARRIVAL_IATA	ARRIVAL Airport 3 character code
AIRPORT_ARRIVAL_MUNICIPALITY	ARRIVAL Airport Municipality Derived from Code
ARRIVAL_AIRPORT_REGION	ARRIVAL Airport Region Derived from Code
DEPARTURE_AIRPORT_COUNTRY_CODE	DEPARTURE Airport Country code ISO2
DEPARTURE_AIRPORT_IATA	DEPARTURE Airport 3 character code
DEPARTURE_AIRPORT_MUNICIPALITY	DEPARTURE Airport Municipality Derived from Code.



Lab 2 Flow

- **Read in dataset as a DataFrame from dashDB**
  - Connect to dashDB
  - Read in the data
- **Identify Labels**
  - Label the data (“VETTING_LEVEL”)
  - Select features
- **Feature Engineering (Transformation)**
  - StringIndexer (occupation, country, gender, birth year variables)
  - VectorAssembler
  - Normalizer
- **Define Model and Setup Pipeline**
  - Naïve Bayes
- **Train the Model**
  - Split input data into Training (70%) and Test (30%) DataFrames
  - Cache the resulting DataFrames
  - Fit the Pipeline to the Training data set

Lab 2 Flow (continued)

- **Evaluate the resulting predictions**
  - Area under the ROC curve
- **Tune the model (hyperparamaters)**
  - Build Parameter Grid
  - Cross-evaluate to find the best model
- **Score the unvetted records**
  - Use Best Model to Score unvetted records (VETTING LEVEL == 100)
  - Write results into DashDB table
- **Save the model in the Model Repository**
  - Model properties can be saved as well (e.g Area under the ROC curve)

Classification - Naïve Bayes

- **Two or more outcomes.**
- **Assumes independence among explanatory variables, which is rarely true (thus "naïve").**
- **Despite its simplicity, often performs very well… widely used.**
- **Significant use cases:**
  - Text categorization (spam vs. legitimate, sports or politics, etc.) using word frequencies as the features
  - Medical diagnosis (*e.g.*, automatic screening)

Lab 3

In this lab, you will learn some of the fundamentals of using RStudio and Shiny in DSX to work and interact with data in DB2 Warehouse and then to create a fully operational "reactive" web application that you can enhance further.

Objectives:

- Upon completing the lab, you will:
  - Create an RStudio project from a Git repository
  - Establish a connection to DB2 Warehouse using an ancillary file
  - Query, join, explore and visualize data in an R notebook
  - Derive categorical names from numerical levels in an R dataframe
  - Use ggplot2 to create bar plots of several of the columns in an R dataframe
  - Use a logarithmic scale when creating bar plots
  - Leverage shiny to create and run a web application
  - Interact with the shiny web application by running it externally

Lab 4a – Watson Machine Learning

In this lab, you will use IBM's Watson Machine Learning GUI to train, evaluate, and deploy a Watson Machine Learning model based on the Titanic dataset.

Objectives:

- Upon completing the lab, you will:
  - Become familiar with the Watson Machine Learning GUI.
  - Train/Evaluate a machine learning model
  - Deploy a machine learning model.
  - Deploy an application that invokes the machine learning model service.

Lab 4b – DSX SPSS Modeler

In this lab, you will use the Data Science Experience SPSS Modeler capability to explore, prepare, and model passenger data from the Titanic. The SPSS Modeler is a drag and drop capability to build machine learning pipelines.

Objectives:

- Upon completing the lab, you will:
  - Become familiar with the DSX SPSS Modeler capability
  - Profile the Titanic data set
  - Explore the Titanic data set with visualizations
  - Cleanse and Transform the data
  - Train/Evaluate a machine learning mode.

Demo Data - Titanic

Variable Descriptions:

survival	Survival
	(0 = No; 1 = Yes)
pclass	Passenger Class
	(1 = 1st; 2 = 2nd; 3 = 3rd)
name	Name
sex	Sex
age	Age
sibsp	Number of Siblings/Spouses Aboard
parch	Number of Parents/Children Aboard
ticket	Ticket Number
fare	Passenger Fare
cabin	Cabin
embarked	Port of Embarkation
	(C = Cherbourg; Q = Queenstown; S = Southampton)

PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cabin	Embarked
1	0	3	Braund, Mr. Owen Harris	male	22	1	0	A/5 21171	7.25		S
2	1	1	Cumings, Mrs. John Bradley (Florence Briggs Thayer)	female	38	1	0	PC 17599	71.2833	C85	C
3	1	3	Heikkinen, Miss. Laina	female	26	0	0	STON/O2. 3101282	7.925		S
4	1	1	Futrelle, Mrs. Jacques Heath (Lily May Peel)	female	35	1	0	113803	53.1	C123	S
5	0	3	Allen, Mr. William Henry	male	35	0	0	373450	8.05		S
6	0	3	Moran, Mr. James	male		0	0	330877	8.4583		Q
7	0	1	McCarthy, Mr. Timothy J	male	54	0	0	17463	51.8625	E46	S
8	0	3	Palsson, Master. Gosta Leonard	male	2	3	1	349909	21.075		S
9	1	3	Johnson, Mrs. Oscar W (Elisabeth Vilhelmina Berg)	female	27	0	2	347742	11.1333		S
10	1	2	Nasser, Mrs. Nicholas (Adele Achem)	female	14	1	0	237736	30.0708		C