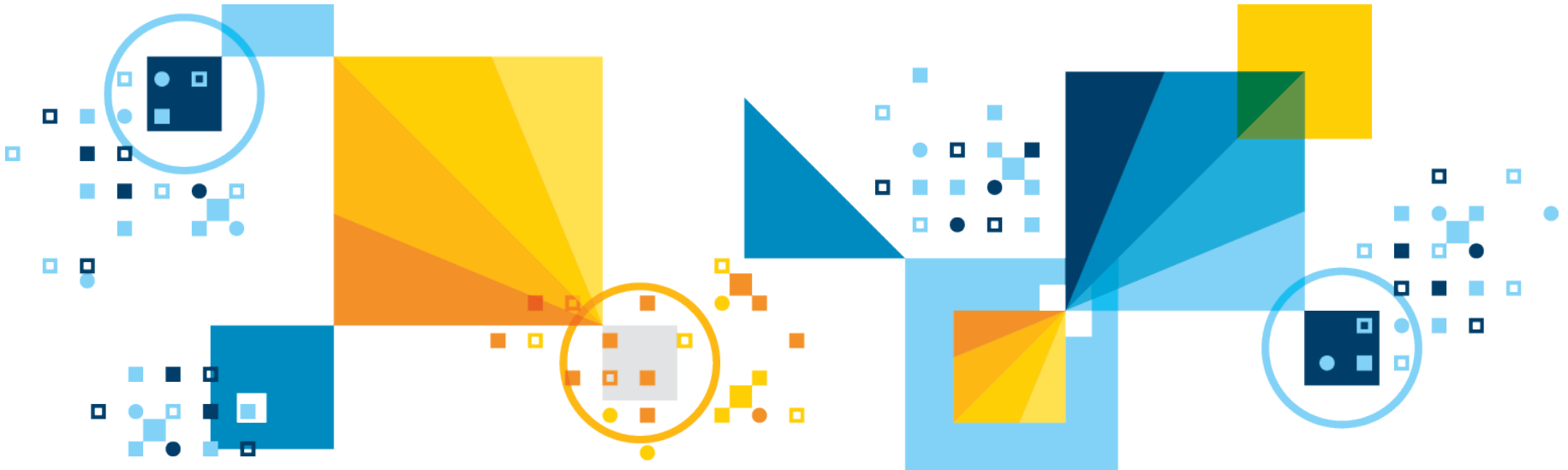
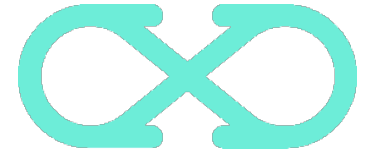


IBM IoT Analytics in the Cloud

Steve Geringer, Data Science Solutions Architect

Steve.Geringer@IBM.com

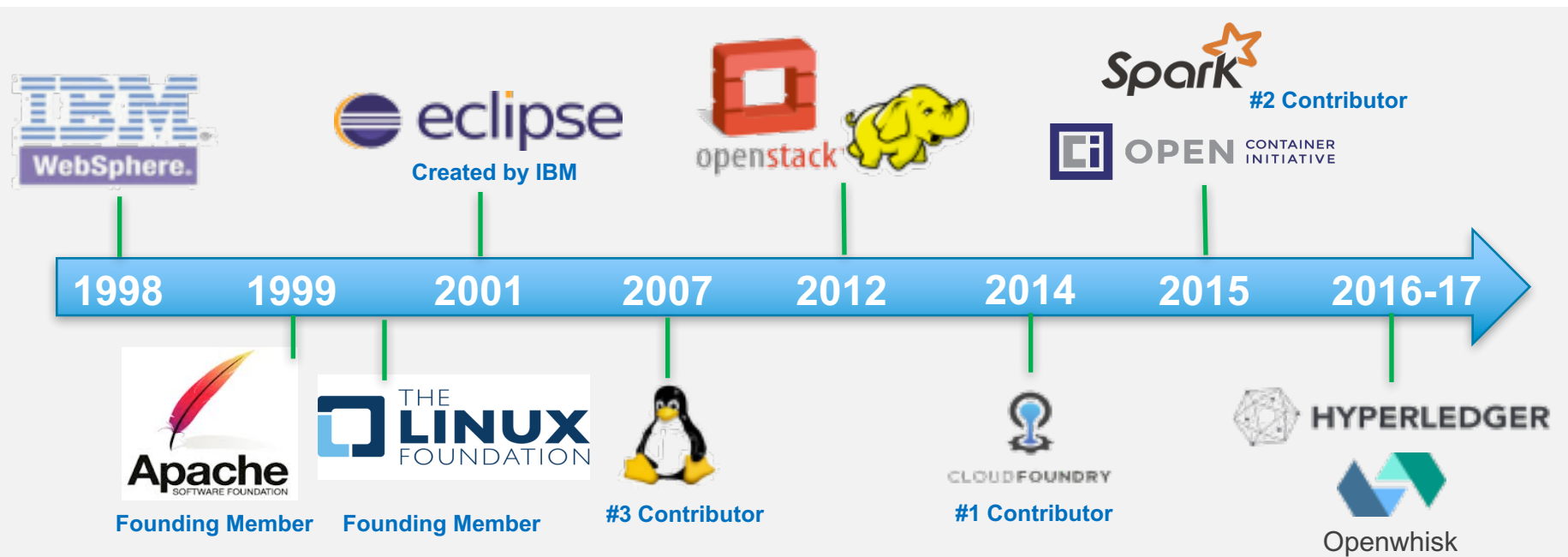


Background

▪ About Me:

- Data Science Solutions Architect
- IBM Analytics team covering
 - Healthcare, Life Sciences and State/Local Government.
- Achieved the "Kaggle Competitions Expert" Designation
 - Earned two Silver Medals in Kaggle Machine Learning Competitions.
- Steve.Geringer@ibm.com

IBM Has a Rich History with Open Source



IBM and Open Source:

Today companies have lots of options

Open Source Only



**Significant
Assembly**

Open Plus



**Enterprise Ready
Innovation**

Proprietary

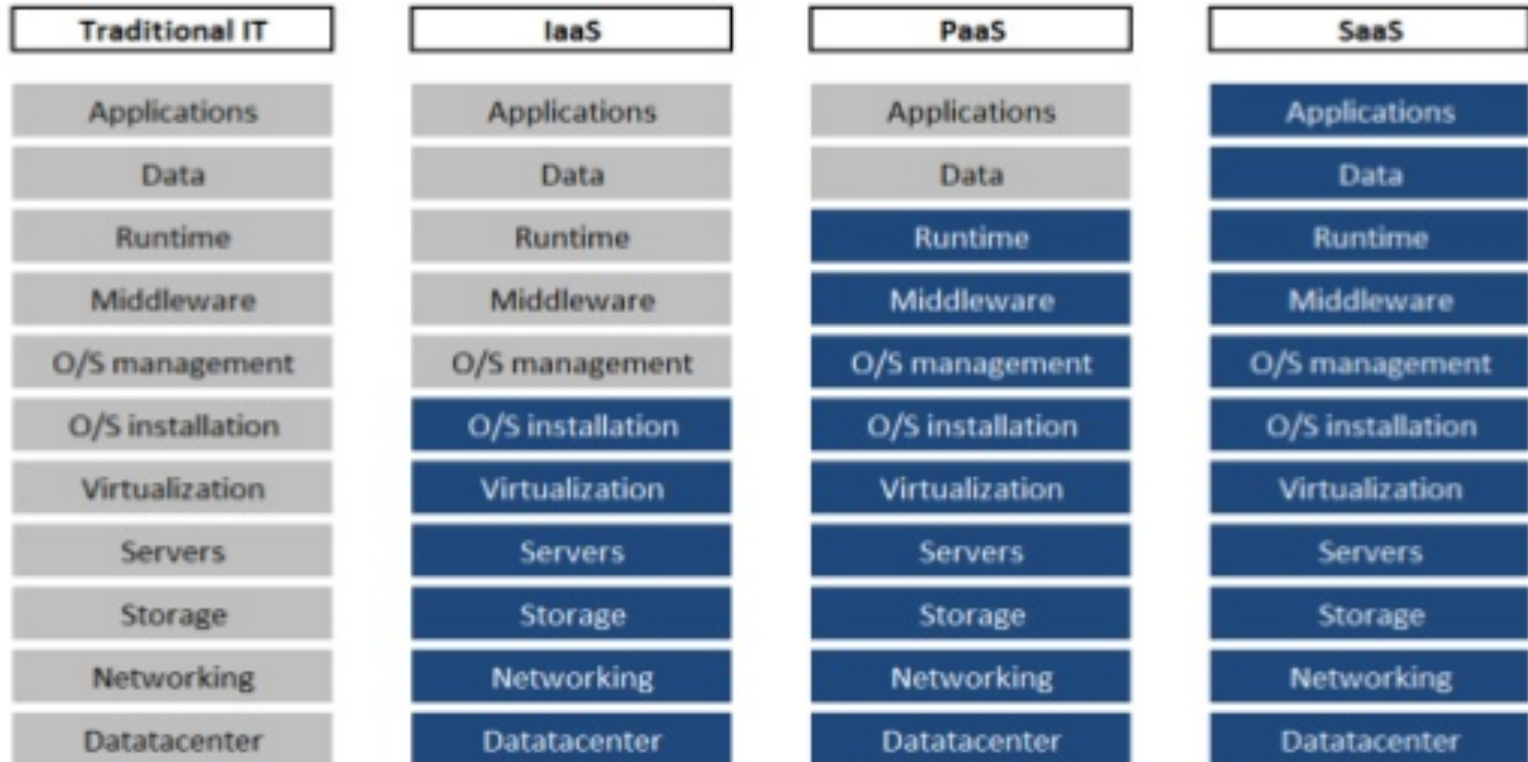


**Vendor
Lock-in**



More about Service

BlueMix is a Platform as a Service (PaaS)



Managed by you
 Managed by IBM

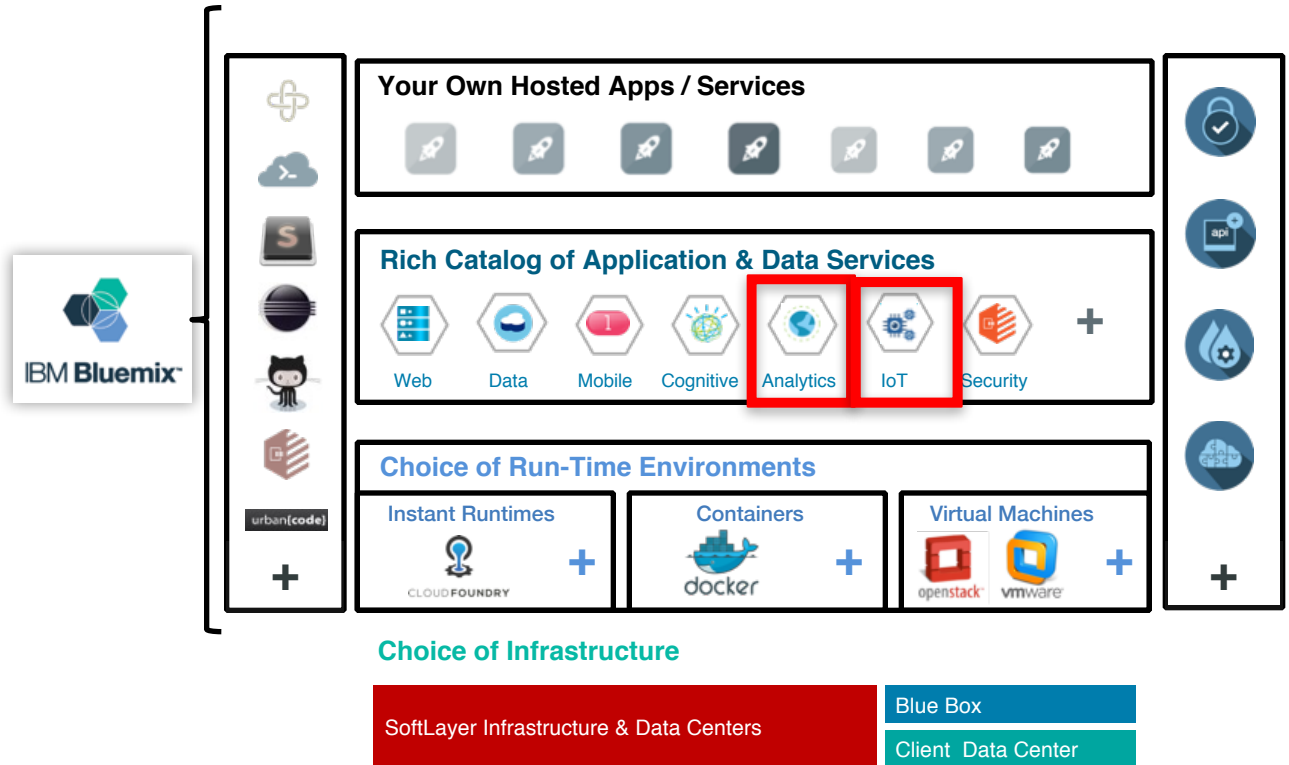
IBM Softlayer
 Amazon EC2
 Azure Infrastructure

IBM BlueMix
 Google App Engine
 Amazon Elastic Beanstalk

Guiding Principles Define the IBM Cloud Platform

IBM Cloud
Guiding Principles

- DevOps Productivity
- Hybrid Integration
- Powerful, Accessible Data and Analytics
- Cognitive Solutions
- Choice with Consistency



Comprehensive

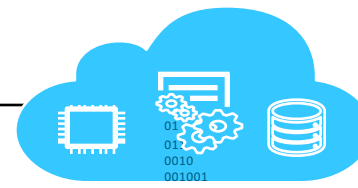
- Broadest selection of data and analytics services
- Seamless integrations
- Open-source leadership

Trusted

- Fully managed environment 24 x 7
- Secure infrastructure
- No installation, configuration, maintenance required

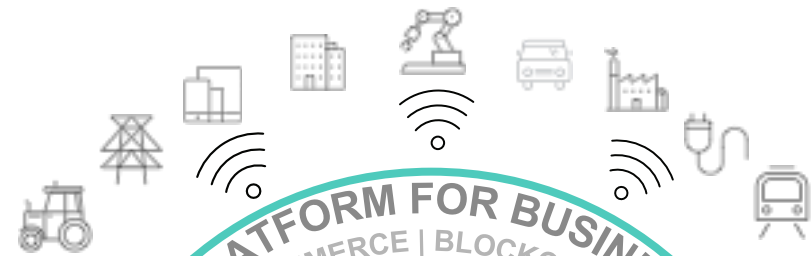
Flexible

- Cloud, on-premises & hybrid support
- No vendor lock-in
- Subscription pricing

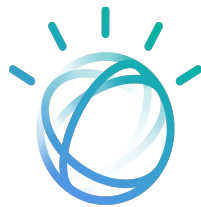


IBM Watson IoT Platform

Make sense of data to optimize operations, manage assets, rethink products and services, and transform customer experience.



Discover



Retrieve & Rank

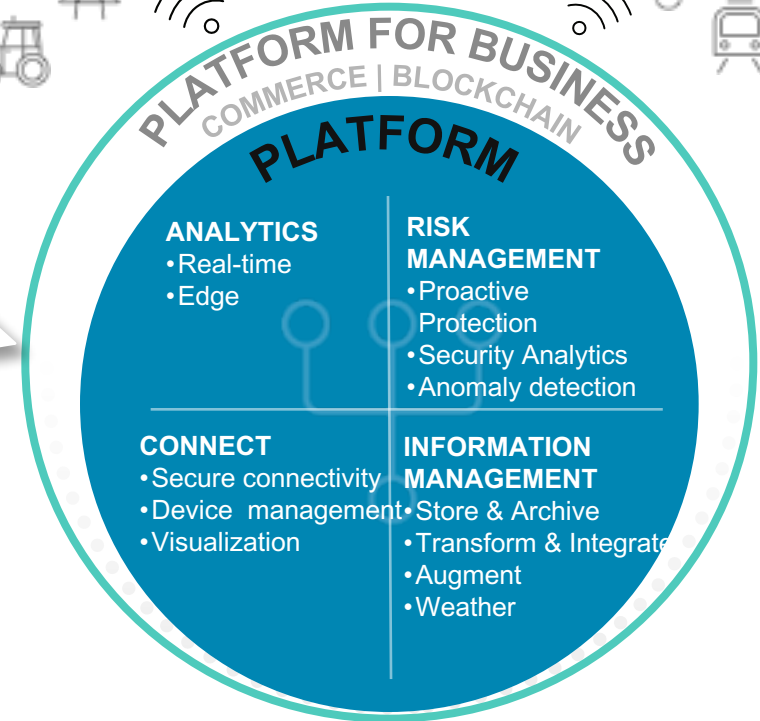
Video and Image Analytics



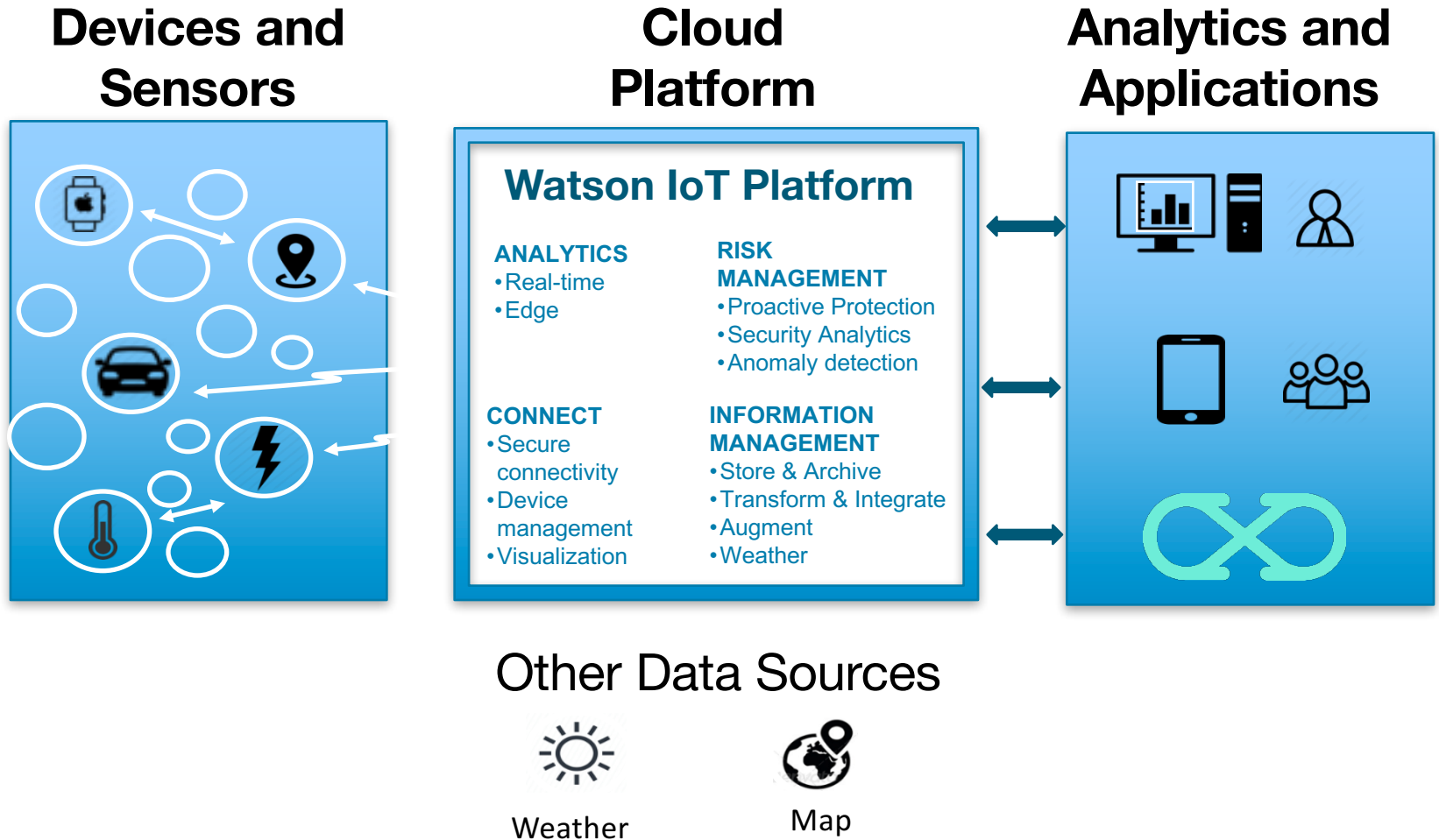
Streaming Analytics



Machine Learning



IBM Watson IoT Platform



MQTT – The Protocol for IoT Messaging



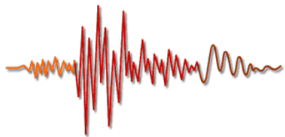
Analogue electrical power meter



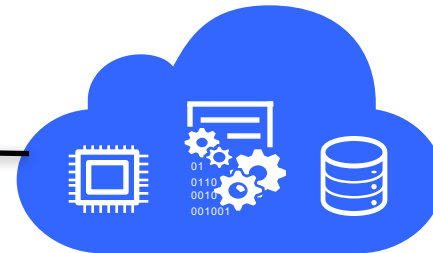
Analogue temperature gauge



Analogue vibration sensor (accelerometer)



IBM Watson IoT Platform



Applications



MQTT is a publish and subscribe, extremely simple and lightweight messaging protocol, designed for low-bandwidth, high-latency or unreliable networks.



Platform

Everything you need to innovate with IoT



Connect

Attach: MQTT, HTTPS
Visualize
Collect & Organize
Device Management
Users



Information Management

Parsing Unstructured Data
Storage & Archiving
Metadata Management
Reporting
Streaming Information



Risk Management

Proactive Protection



Analytics

Predictive
Cognitive
Realtime Performance
Contextual

Product Family

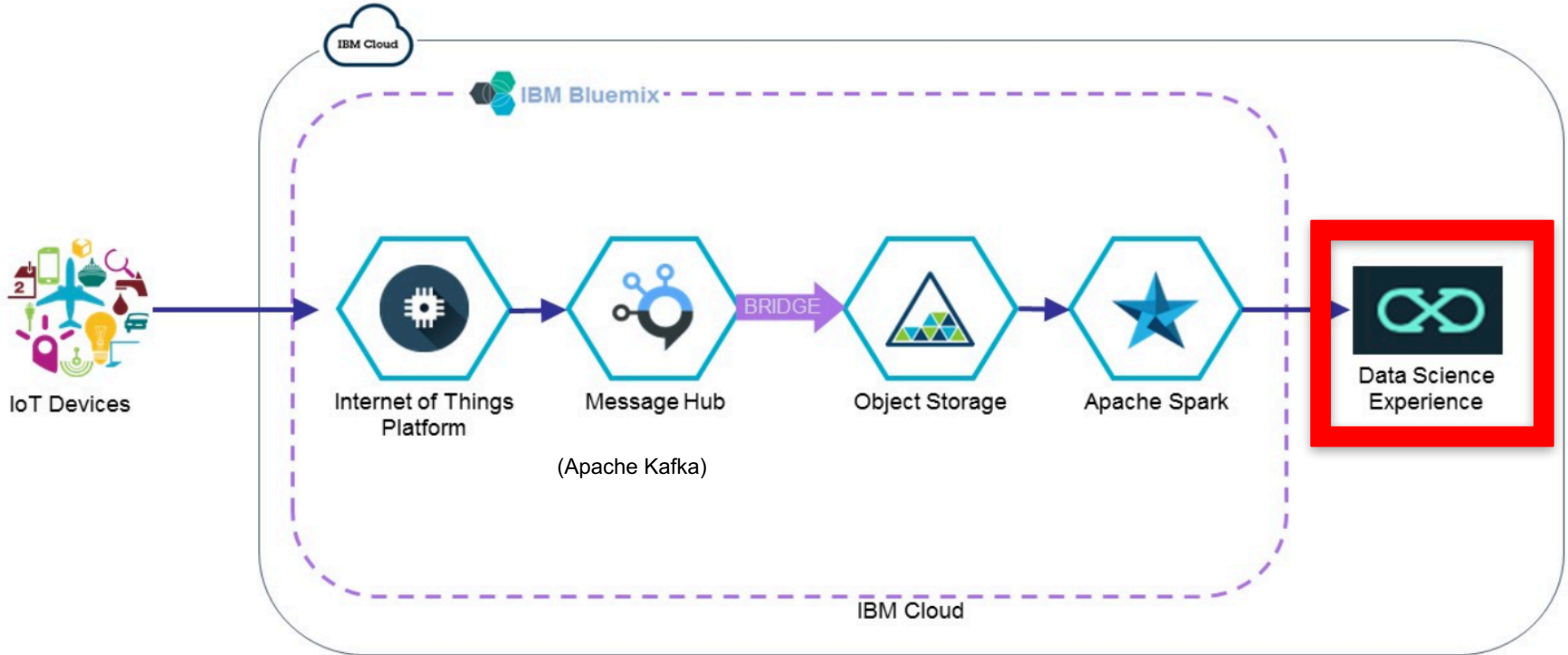
Watson IoT Platform
Continuous Engineering

Bluemix Open Standards Based Services

Full Development Lifecycle
DevOps Services
IBM Security

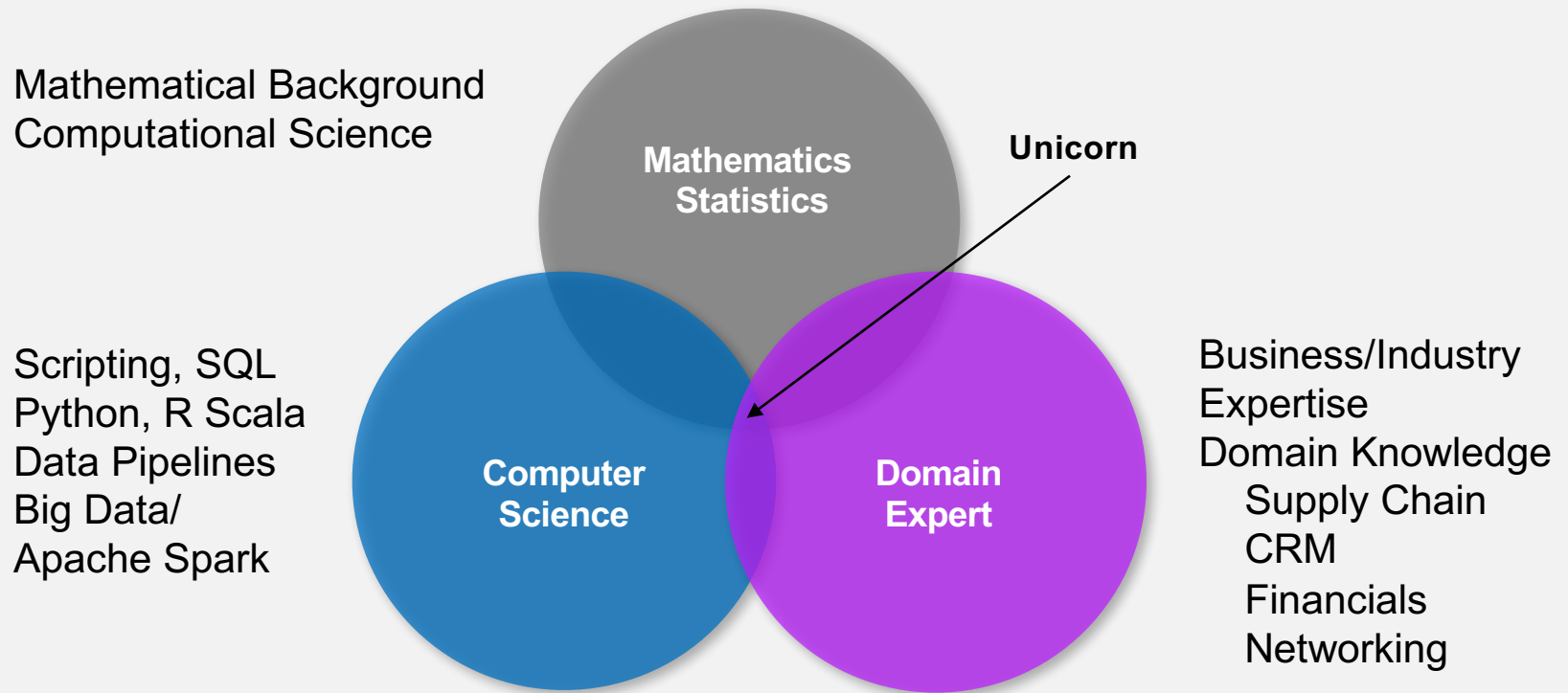


End-to-End IoT Data Pipeline



Data Science Professional

Data Scientists combine skills across areas of Expertise

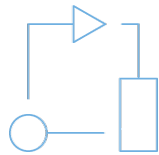


Data Science Is a Team Sport



Introducing IBM Watson Data Platform

An Integrated Data Science Environment in the Cloud



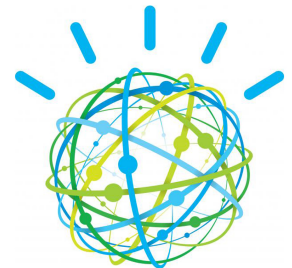
Platform.



Method.



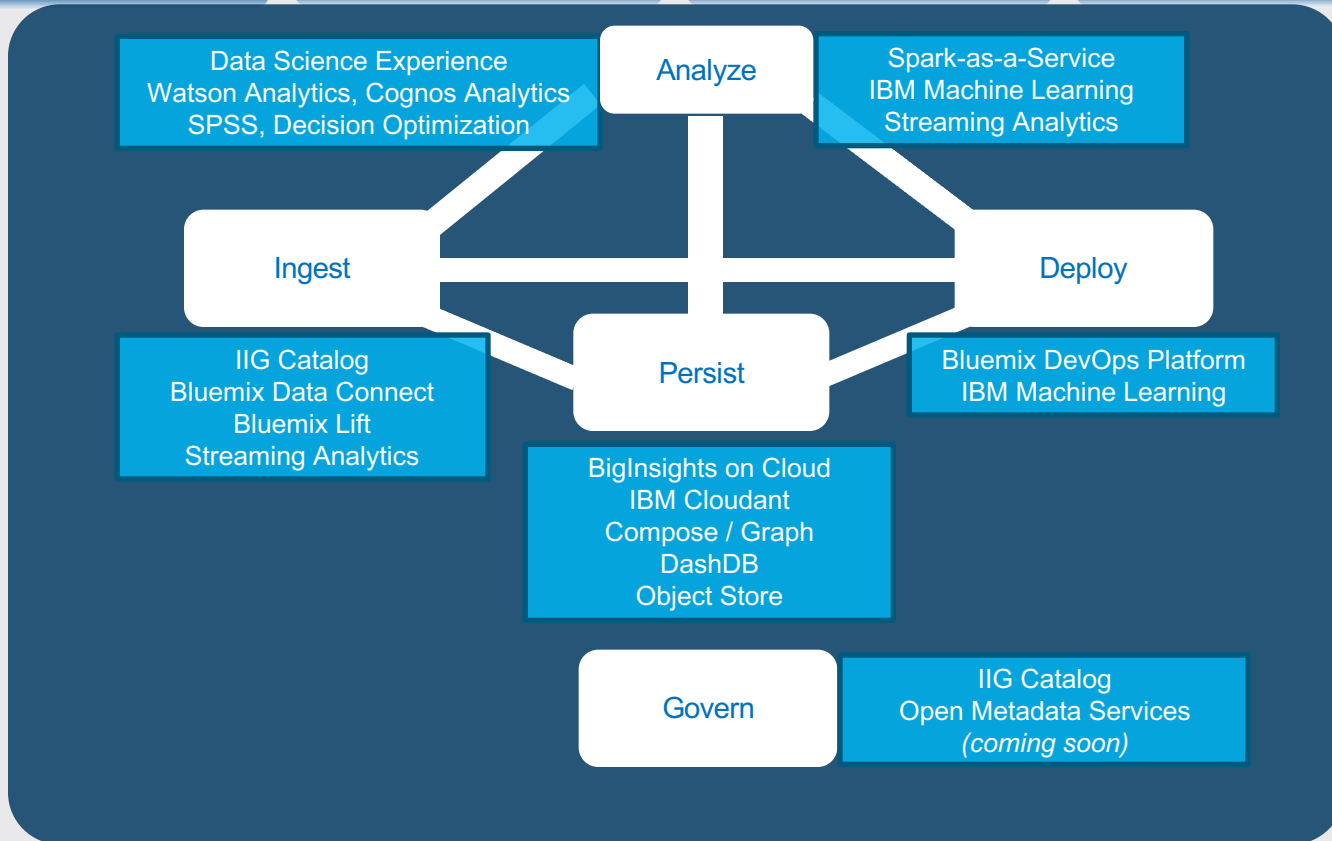
Ecosystem.



<http://ibm.co/makedatasimple>

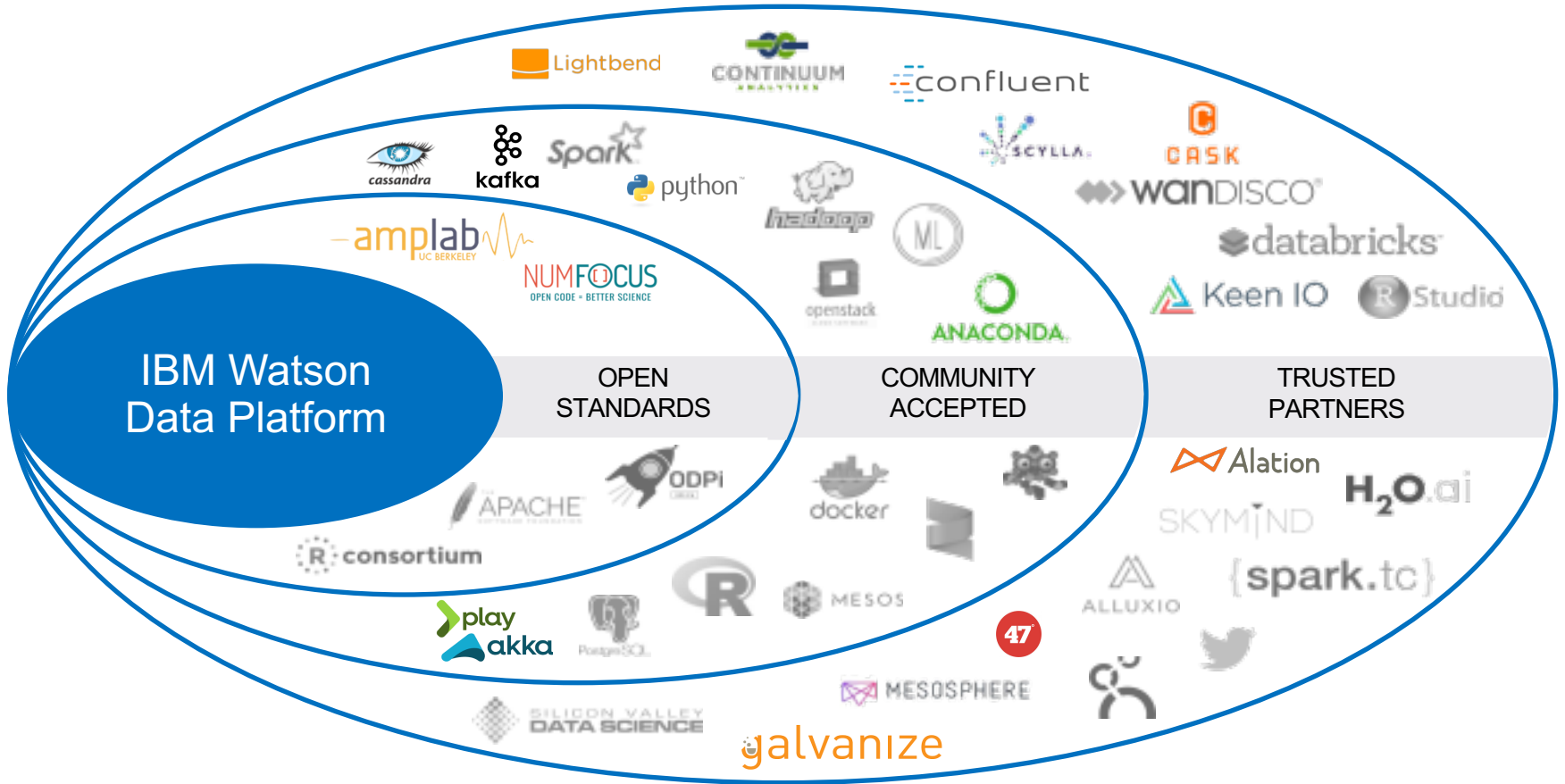
IBM Watson Data Platform

A closer look at what makes up the platform



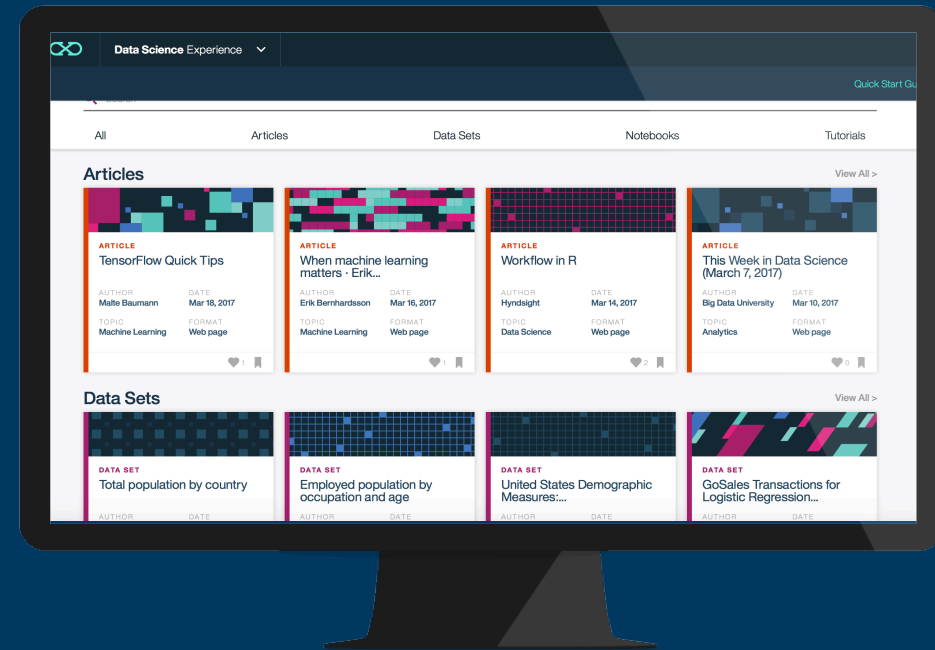
IBM Watson Data Platform Partner Ecosystem

The Open Community To Innovate Faster With Data



Data Science Experience

IBM Data Science Experience is an environment that brings together everything that a Data Scientist needs. It includes the most popular **Open Source tools** such as Code in Scala/Python/R/SQL, Jupyter Notebooks, RStudio IDE and Shiny apps, Apache Spark and IBM unique value-add functionalities with **community** and **social features**, integrated as a first class citizen to make Data Scientists more successful.



Data Science Experience: Centralizes Open Source



Deep Learning for Image Classification

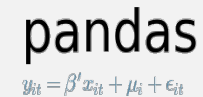
- Given a set of images of handwritten digits, we build a classification model that maps these images into its corresponding numerical digit
- Adapted from: <http://www.pyimagesearch.com/2014/09/22/getting-started-deep-learning-python/>
- Image taken from wolfram.com

7 → 7 5 → 5
 8 → 8 3 → 3
 2 → 2 4 → 4

Install the nolearn deep learning python library if you haven't

```
In [1]: #!pip install --user nolearn
```

```
In [ ]: import warnings
warnings.filterwarnings("ignore")
from sklearn.cross_validation import train_test_split
```



Core Attributes of the Data Science Experience



IBM Data Science Experience

Community

- Find tutorials and datasets
- Connect with Data Scientists
- Ask questions
- Read articles and papers
- Fork and share projects

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 - DOpplexcloud
- Projects and Version Control
- Managed Spark Service

Powered by IBM **Watson Data Platform**

* Closed beta

IBM Data Science Experience Brings Together Visual and Programmatic Worlds

Collaborate Using Projects

The screenshot shows the 'Data Science Experience' interface. At the top, there are tabs for 'Overview', 'Analytics Assets', 'Data Assets', 'Bookmarks', 'Collaborators', and 'Settings'. Below these, there are three main sections:

- Notebooks:** A table with columns 'NAME', 'SHARED', 'STATUS', and 'LANGUAGE'. It lists 'Retail Sales Analysis v2' (Python 2.7) and 'Machine Learning using R' (R 3.3.0).
- Data Assets:** A table with columns 'NAME' and 'TYPE'. It lists 'Great Outdoors Orders for BBST Parks' (Catalog File), 'ghon-daily-by-year-format.rtf' (RTF), and 'Presence Data (Cloudant NoSQL)' (Connection).
- Bookmarks:** A section with a 'view all (3)' link, showing a list of saved items with their names and dates.

Code Algorithms in Python, R and Scala: Automatic Model Visualization

The screenshot shows a Jupyter Notebook interface with a Python code cell and a visualization panel. The code cell contains the following Python code:

```

In [ ]: from pyspark.sql import SQLContext
sqlContext = SQLContext(sc)

# This function includes credentials to your Object Storage.
# You might want to remove those credentials before you share your notebook.
def set_hadoop_config_with_credentials_4fc230cb6994d18b495e1f707d00f96(name):
    """This function sets the Hadoop configuration so it is possible to
    access data from Amazon Object Storage S3 using Spark"""

    prefix = "s3.amazonaws.com" + name
    hconf = sc._jsc.hadoopConfiguration()
    hconf.set(prefix = ".auth.url", "https://identity.open.softlayer.com*/v3/auth/tokens")
    hconf.set(prefix = ".auth.endpoint.prefix", ".endpoint")
    hconf.set(prefix = ".tenant", "b144484742943b082b983e8b9495e38")
    hconf.set(prefix = ".username", "915704255484092918f202e4e3a33da")
    hconf.set(prefix = ".password", "IDS-A7?-b=7BCF/d")
    hconf.set(prefix = ".http.port", 8080)
    hconf.setBoolean(prefix + ".public", True)

# you can choose any name
name = "keycloak"

set_hadoop_config_with_credentials_4fc230cb6994d18b495e1f707d00f96(name)

df_data_1 = sqlContext.read.format("com.databricks.spark.csv") \
    .options(header="true", inferSchema="true") \
    .load("s3://notebooks-" + name + "/Demographic_Statistics_By_Zip_Code.csv")
df_data_1.take(5)
    
```

The visualization panel on the right shows 'Predictor Importance' for the target 'SALARY'. It includes a bar chart of importance scores, a table of asset statistics, and a residual histogram.

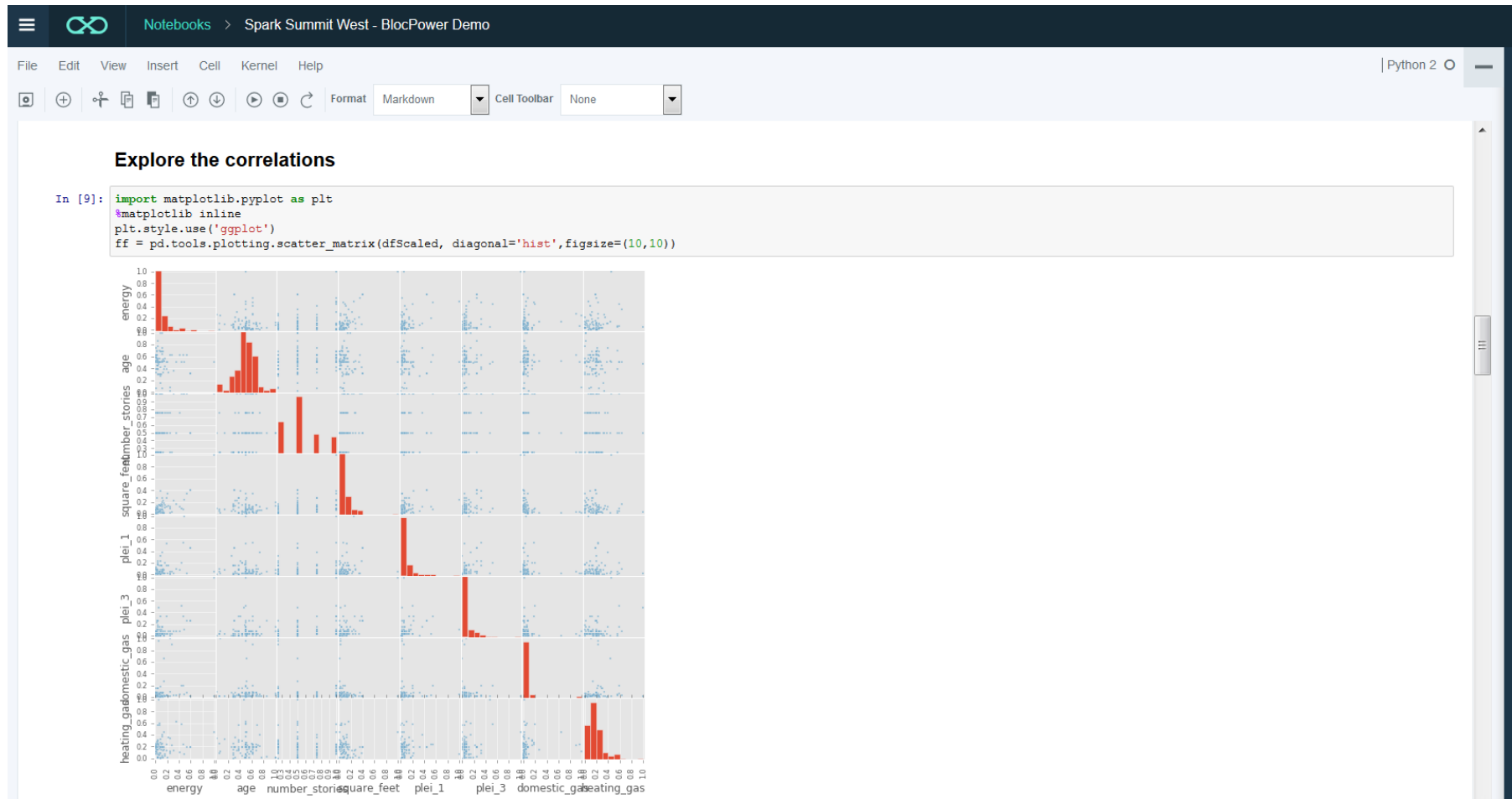
Statistic	Value	Count
Mean	141	5
Std Dev	237	21
N	27	10
Skewedness	642	35
Kurtosis	834	11
Order	560	458
Sk	25	42
Amst	17	145
Sked	8	1
CrashRate	241	17

Model Deployment (batch, streaming and real-time)

The screenshot shows the 'Monitor' tab in the 'Data Science Experience' interface. It displays two main sections:

- Scheduled Jobs:** A table with columns 'NAME', 'NOTEBOOK', 'START', 'END', and 'STATUS'. It lists jobs like 'Retrain Flight Delay Model' (Scheduled), 'Weekly Executive KPIs' (Finished), 'Business Impact by Weather' (Scheduled), 'Evaluate Business Impact' (Scheduled), and 'SF Traffic Delay Platform' (Running).
- Deployments:** A table with columns 'NAME', 'PIPELINE', 'ENDPOINT', and 'STATUS'. It lists deployments like 'Awesome Deployment' (Active), 'Weekly Executive KPIs' (Active), and 'Business Impact by Weather' (Offline).

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

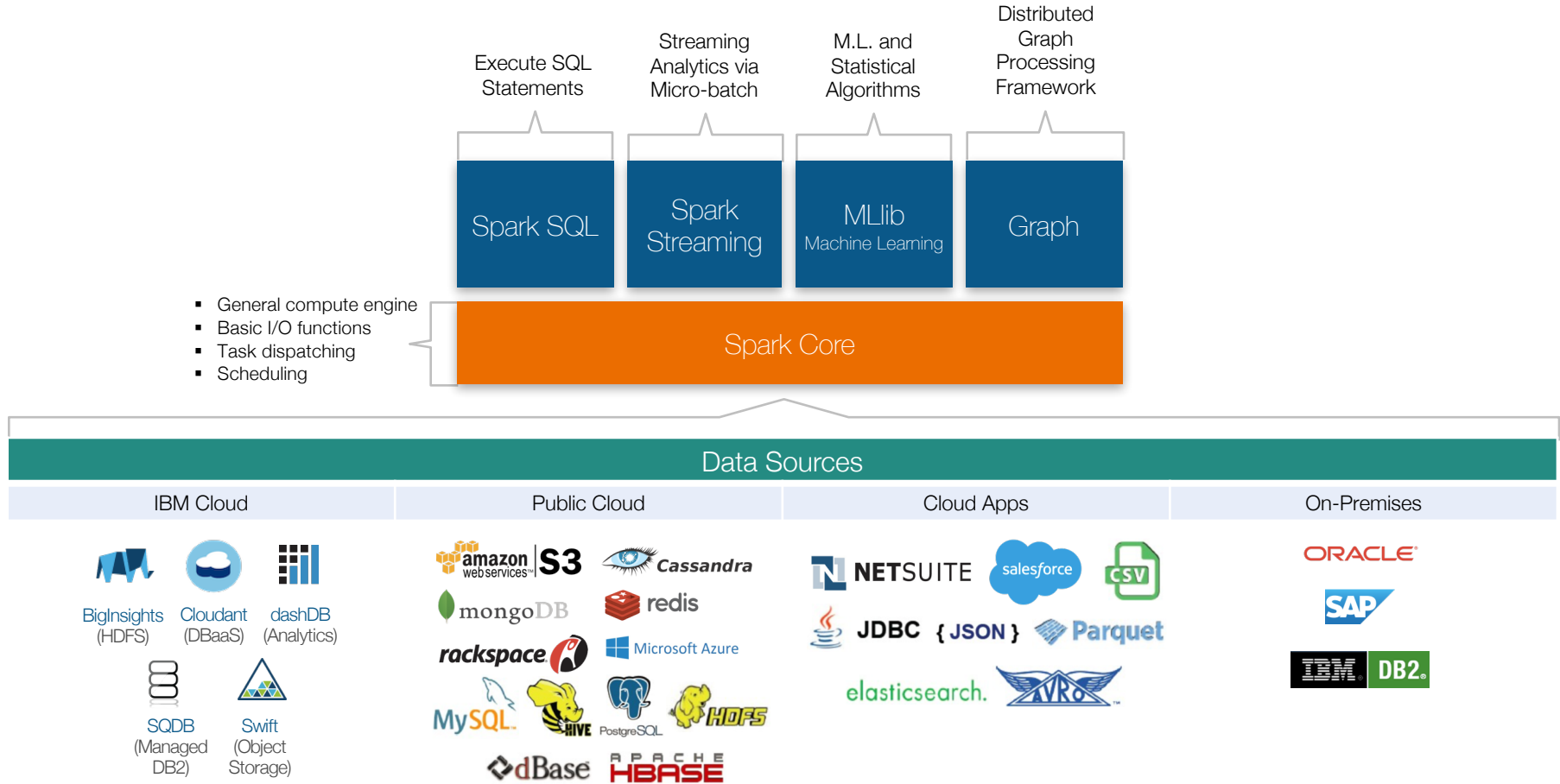


The screenshot displays a Jupyter Notebook interface with the following elements:

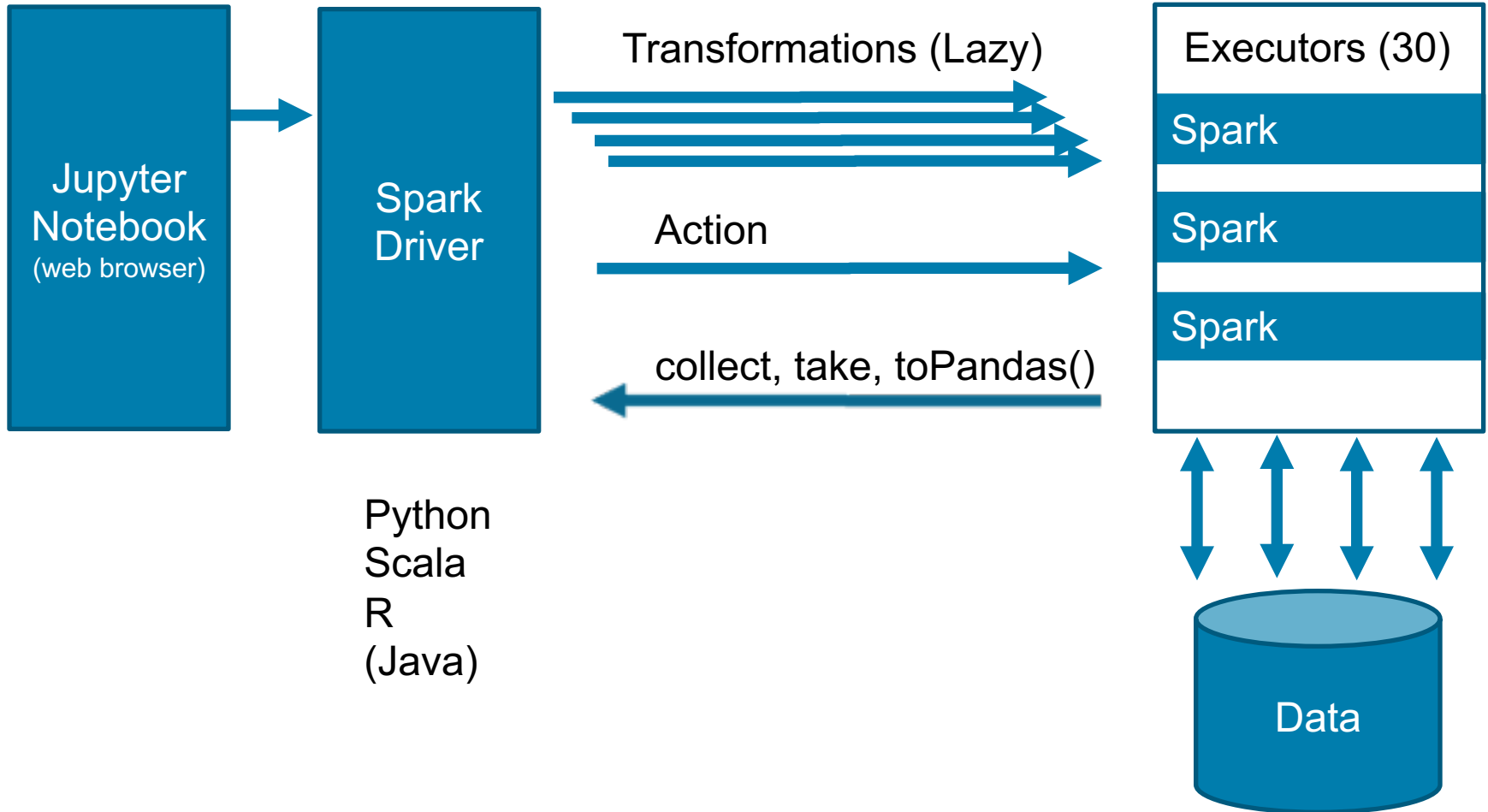
- Header:** "Notebooks > Spark Summit West - BlocPower Demo"
- Menu:** File, Edit, View, Insert, Cell, Kernel, Help
- Toolbar:** Includes icons for home, refresh, undo, redo, and a "Format" dropdown set to "Markdown".
- Code Cell:** Contains the following Python code:

```
In [9]: import matplotlib.pyplot as plt
import matplotlib inline
plt.style.use('ggplot')
ff = pd.tools.plotting.scatter_matrix(dfScaled, diagonal='hist', figsize=(10,10))
```
- Figure:** A scatter matrix plot for variables: energy, age, number_stories, square_feet, plei_1, plei_3, domestic_gas, and seating_gas. The diagonal elements are histograms, and the off-diagonal elements are scatter plots showing pairwise relationships between variables.

IBM's Managed Apache Spark Service in DSX



DSX - Spark Architecture



Collaborate Using Projects

Notebooks [view all \(2\)](#)

NAME	SHARED	STATUS	LANGUAGE
Retail Sales Analysis v2		○	Python 2.7
Machine Learning using R			R 3.3.0

Data Assets [view all \(23\)](#)

NAME	TYPE
Great Outdoors Orders for BBBT Ritika	Catalog File
Great Outdoors Orders for BBBT Ritika	Catalog File
ghc-daily-by_year-format.rtf	RTF
Presence Data (Cloudant NoSQL)	Connection
Sales Data (dashDB)	Connection

Bookmarks [view all \(3\)](#)

ARTICLE

From Machine Learning to Learning M...

Nov 10, 2016

NOTEBOOK

Use deep learning for image classifica...

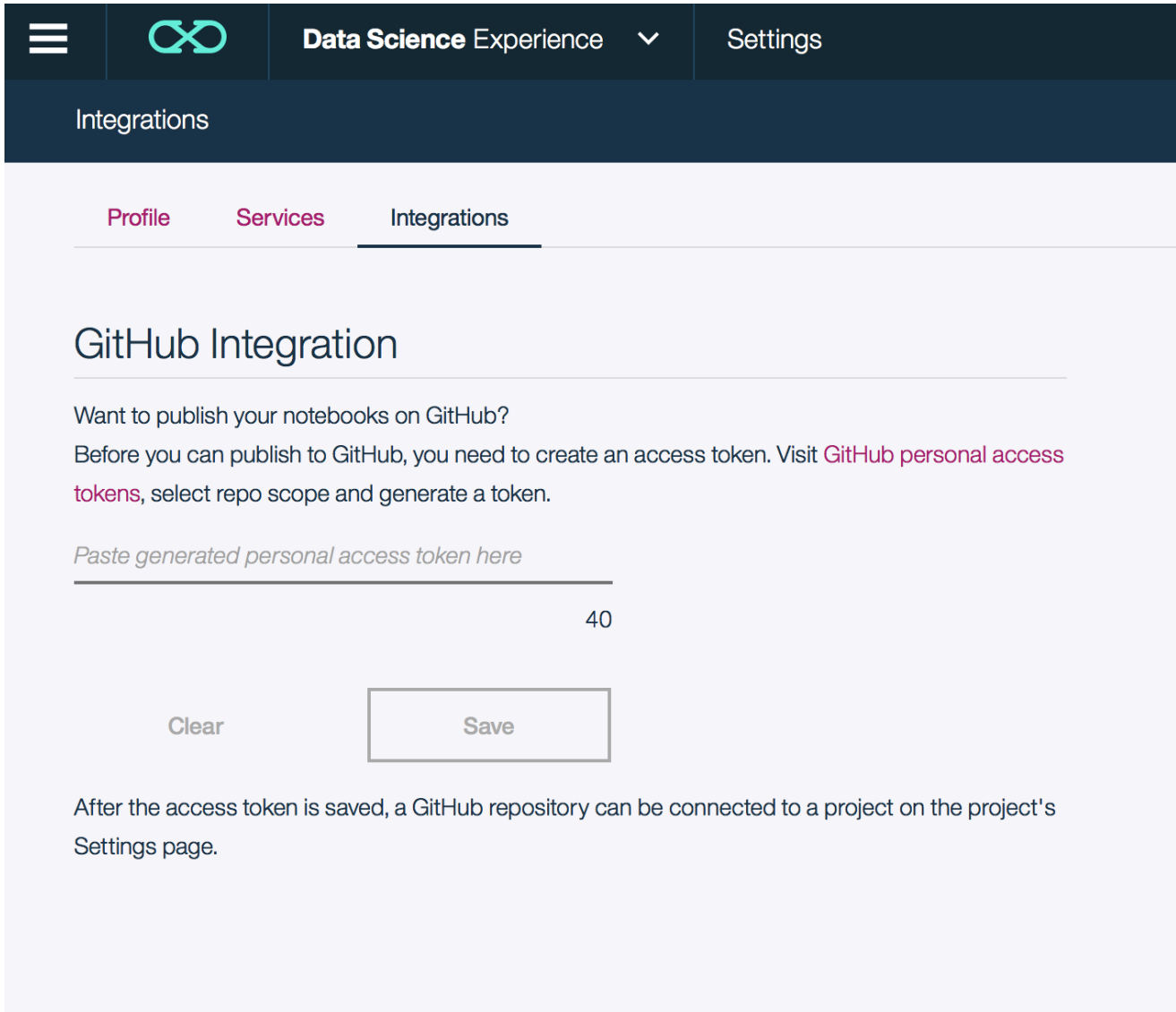
Oct 4, 2016

TUTORIAL

Analyze open data sets using pandas ...

Oct 19, 2016

GitHub Integration



The screenshot shows the IBM Analytics user interface. At the top, there is a dark navigation bar with a hamburger menu icon, a teal infinity symbol, the text "Data Science Experience" with a dropdown arrow, and "Settings". Below this is a dark blue header with the word "Integrations". The main content area has three tabs: "Profile", "Services", and "Integrations" (which is selected). The "GitHub Integration" section contains the following text: "Want to publish your notebooks on GitHub? Before you can publish to GitHub, you need to create an access token. Visit [GitHub personal access tokens](#), select repo scope and generate a token." Below this is a text input field with the placeholder text "Paste generated personal access token here" and a character count of "40". At the bottom of the input field are two buttons: "Clear" and "Save". A final paragraph states: "After the access token is saved, a GitHub repository can be connected to a project on the project's Settings page."

Community Cards provide in-context learning for users

<p>ARTICLE</p> <p>How can data scientists collaborate to build...</p> <p>SOURCE IBM</p> <p>DATE Jun 24, 2016</p>	<p>ARTICLE</p> <p>What is machine learning?</p> <p>SOURCE IBM</p> <p>DATE Jun 24, 2016</p>	<p>NOTEBOOK</p> <p>Insights from Twitter data about car makers</p> <p>SOURCE IBM</p> <p>DATE Jun 22, 2016</p>
<p>NOTEBOOK</p> <p>Insights from New York car accident reports</p> <p>SOURCE IBM</p> <p>DATE Jun 16, 2016</p>	<p>DATA SET</p> <p>Country Surface Area (sq. km)</p> <p>SOURCE IBM</p> <p>DATE Jun 16, 2016</p>	<p>NOTEBOOK</p> <p>Improved Flight delay prediction</p> <p>SOURCE IBM</p> <p>DATE Jun 06, 2016</p>
<p>NOTEBOOK</p> <p>Load data from different sources</p> <p>SOURCE IBM</p> <p>DATE Jun 02, 2016</p>	<p>NOTEBOOK</p> <p>Learn basics about notebooks and Apache Spark</p> <p>SOURCE IBM</p> <p>DATE Jun 02, 2016</p>	<p>NOTEBOOK</p> <p>Analyze precipitation data</p> <p>SOURCE IBM</p> <p>DATE Jun 02, 2016</p>

Supported Data Sources for DSX via on-premises and cloud **Connections**



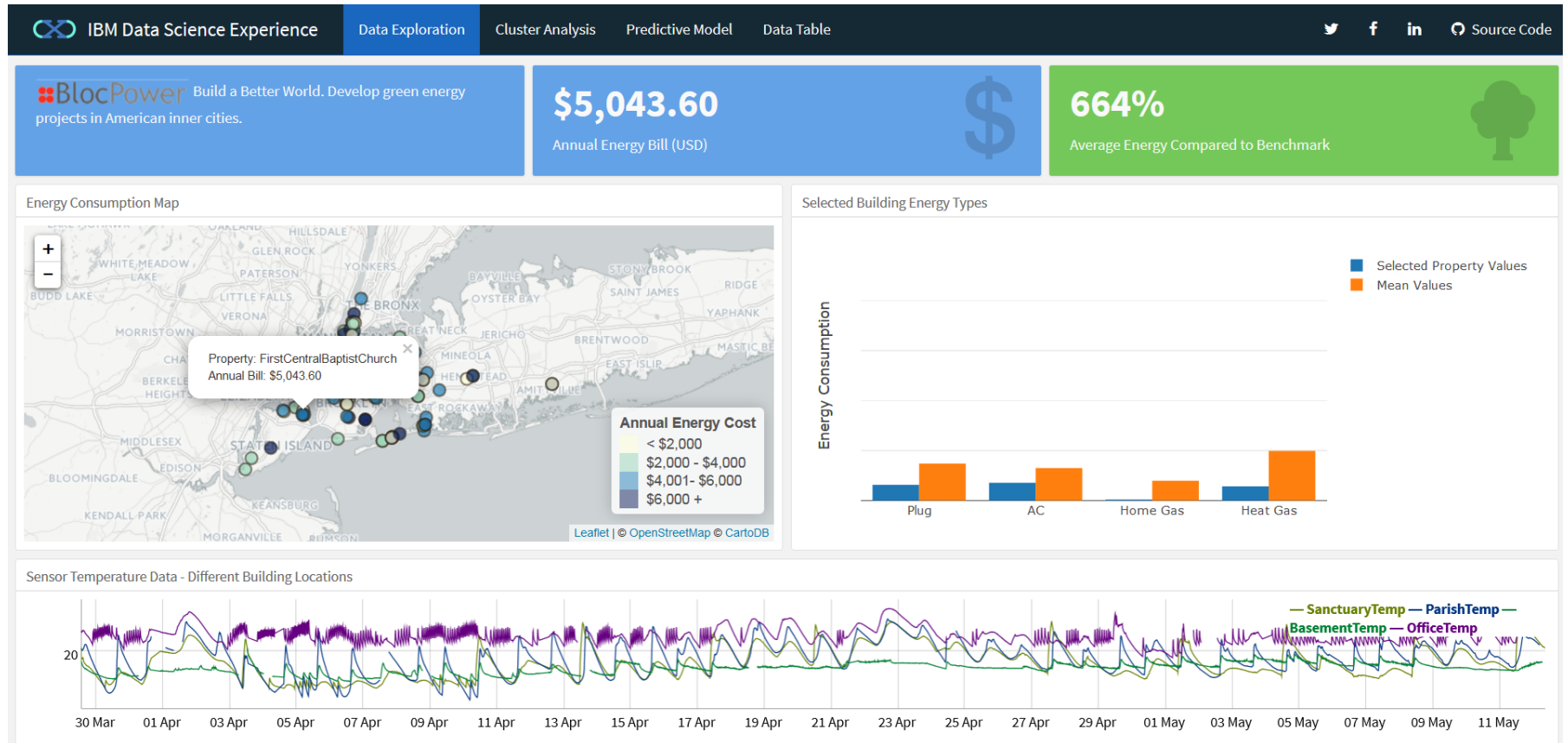
Cloud Sources	On-Premises Sources	Cloud Targets	On-Premises Targets
Amazon Redshift	Apache Hive	Amazon S3	IBM DB2® LUW
Amazon S3	Cloudera Impala	Bluemix Object Storage	IBM Pure Data for Analytics®
Apache Hive	IBM DB2® LUW	IBM Cloudant™	Teradata
Bluemix Object Storage	IBM Informix®	IBM dashDB	
IBM BigInsights™ on Cloud	IBM Pure Data for Analytics®	IBM BigInsights™ on Cloud	
IBM Cloudant™	Microsoft SQL Server	IBM DB2® on Cloud	
IBM dashDB	MySQL Enterprise Edition	IBM SQL Database	
IBM DB2® on Cloud	Oracle	IBM Watson™ Analytics	
IBM SQL Database	Pivotal Greenplum	PostgreSQL on Compose	
Microsoft Azure	PostgreSQL	SoftLayer Object Storage	
PostgreSQL on Compose	Sybase		
Salesforce	Sybase IQ		
SoftLayer Object Storage	Teradata		

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

The screenshot displays the RStudio environment with the following components:

- Source Editor:** Contains R code for loading data from a KML file, summarizing it, and creating various plots (smooth trend, polar plot, and calendar plot).
- Console:** Shows the execution output, including a warning message about data ratification and a data frame listing variables like date1, date2, nox, no2, o3, so2, co, pm10_raw, pm10, pm25, and site.
- Workspace:** Lists the 'bloomsbury' dataset with 50804 observations and 18 variables.
- Plots Panel:** Displays a calendar heatmap titled 'O₃ in 2006', showing daily values for each month from January to December. A color scale on the right indicates values from 20 to 100.
- Annotation Panel:** A tooltip for the 'annotate' function explains that it controls daily plot content, with options for 'date', 'wd', and 'ast'.

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



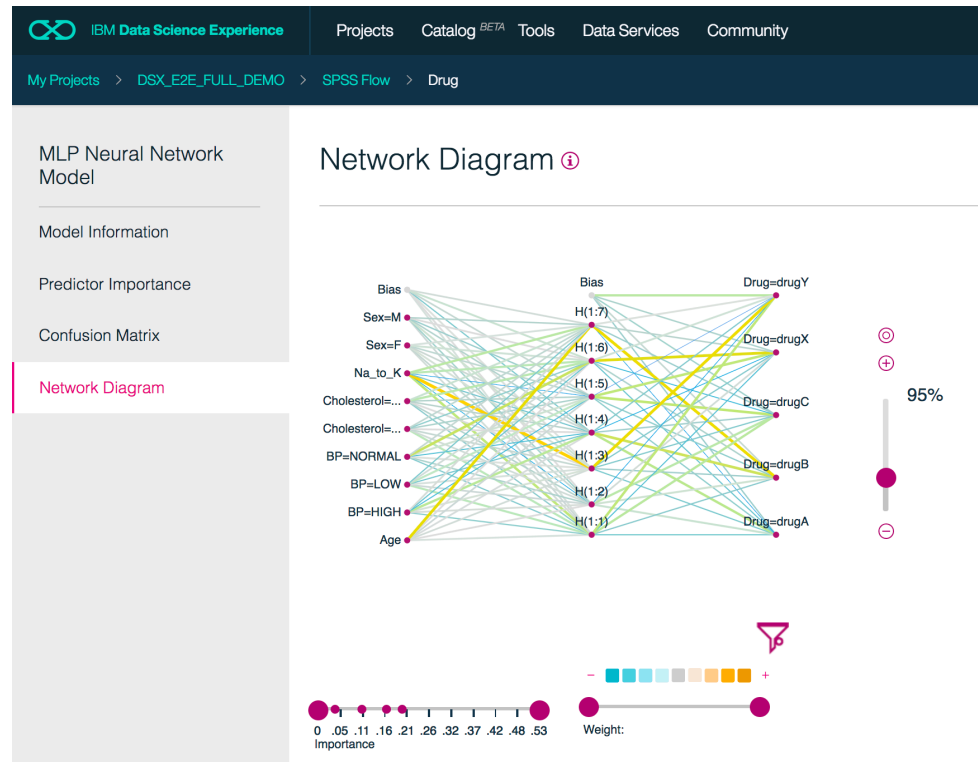
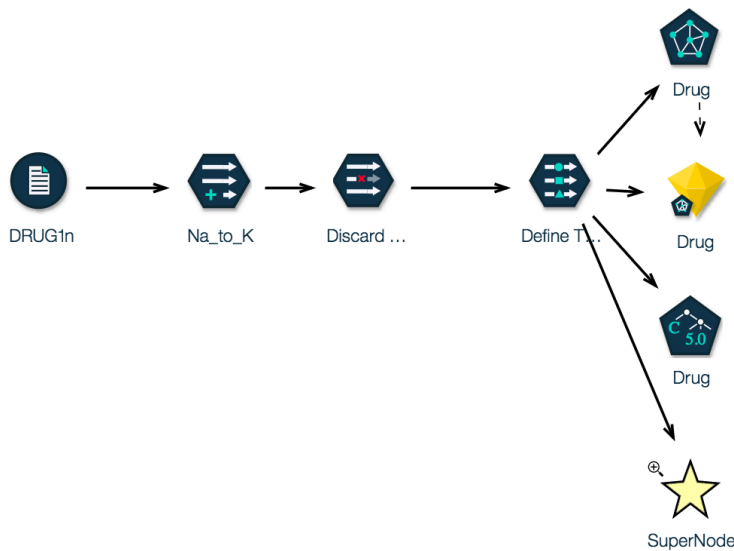
IBM Watson Machine Learning in Data Science Experience



Data Scientist

Flows

Open Beta



Create Advanced Models without coding

Advanced Model Visualization: Easy to understand their performance

DSX is *The Power Tool for Today's Data Scientist*

- **Fully Configured and Managed Data Science Environment**
 - Running on Powerful IBM Cloud Servers
 - Integrated Apache Spark – 30 Executors
- **Built on Open Source Tools**
 - Maximum Innovation
 - Choice of Languages, Libraries and Visualization Tools
- **Easily Deploy Machine Learning Models to Production**
- **Part of IBM's Comprehensive Big Data Cloud Story**

BlocPower Demo

Analyze energy consumption in NYC buildings

Modelling Energy Usage in NYC – BlocPower



BlocPower

— Tooraji Arvajah,
Chief Engineering Officer,
BlocPower

"BlocPower operation is diverse from outreach and targeting, origination of investment-grade clean energy projects to financing projects through our crowdfunding marketplace. Data is the underlying tool of our operation and IBM's Data Science Experience will facilitate a closer integration across it and help our business scale up faster. "

Use Shiny apps to share your analysis with business users

BlocPower Demo v3 - Blue X

https://apsx-dev.stage1.ng.bluemix.net/analytics/

BlocPower Demo v3

```
credentials_1['filename'] = 'LDD-HUD-Feat
dfCH = pd.read_csv(get_file_content(cred
```

1. Energy Usage (kWh) M

Clean and Prepare Data

In [8]: `sc.addPyFile("https://raw.githubusercontent.com/ies.py")
import utilities as ut`

In [9]: `# energy usage in (kwh)
energy, age, num_stories, sq_feet, plei

domestic and heating gas
domestic_gas = np.asarray(dfHDD['domesti
heating_gas = np.asarray(dfHDD['heating_`

Build Feature Matrix, Fill Miss

In [10]: `matrix = np.transpose(np.matrix([energy,
domestic_gas,heating_gas]))
cols = ['energy_usage','age','number_sto
mestic_gas','heating_gas']
feat = pd.DataFrame(data=matrix)
fill missing values with average
feat = feat.fillna(feat.mean())
scale data
scaler = preprocessing.MaxAbsScaler()
feat = scaler.fit_transform(feat)
dfScaled = pd.DataFrame(feat,columns=col`

Explore Correlations

In [11]: `plt.style.use('ggplot')
ff = pd.tools.plotting.scatter_matrix(df`

Data & Analytics Portal | IBM Data Science Experie

https://apsnginxstudio.stage1.mybluemix.net/node1/rstudio40008/p/4456/shinyDemo.Rmd#data-explora

IBM Data Science Experience | Data Exploration | Cluster Analysis | Predictive Model | Data Table | Source Code

BlocPower Build a Better World.
Develop green energy projects in American inner cities.

23643
Annual Energy Use (kwh)

\$4,255.74
Annual Energy Bill (USD)

Energy Consumption Map

Location Values

Category	Selected Property Values	Mean Values
Plug Load	~0.18	~0.15
AC Cooling	~0.15	~0.12
Domestic	~0.08	~0.05
Heating Gas	~0.60	~0.20

Sensor Temperature Data - Different Building Locations

Interactively explore the analysis of your data science team

BlocPower Demo v3 - Blue X

https://apxs-dev.stage1.ng.bluemix.net/analytic

BlocPower Demo v3

Plugged Equipment Inefficiency

The clustering model help us identify inefficient buildings.

- Note in the above figure that most buildings are efficient
- Buildings that are part of the brown, yellow and orange clusters are inefficient
- Labels are re-coded into a binary variable where 1 indicates inefficient (purple cluster) and 0 otherwise (purple cluster)

```
In [19]: # binary variable to identify inefficient buildings
label_binary = []
for v in labels:
    label_binary.append(0 if (v == 0) else 1)
label_binary = np.asarray(label_binary)
```

Classification Model Identify Inefficient Buildings

```
In [20]: # train classifier
log = linear_model.LogisticRegression(tol = 1e-6)
log.fit(feats_reduced, label_binary)
accuracy = log.score(feats_reduced, label_binary)
y_pred = log.predict(feats_reduced)
```

```
In [21]: print "Model Accuracy: ", accuracy
Model Accuracy: 0.893203883495
```

```
In [22]: def plot_confusion_matrix(cm, title='Confusion Matrix', cmap=plt.cm.binary):
plt.imshow(cm, interpolation='nearest', cmap=cmap)
plt.title(title)
plt.colorbar()
tick_marks = np.arange(2)
plt.xticks(tick_marks, ['efficient', 'inefficient'], rotation=45)
plt.yticks(tick_marks, ['efficient', 'inefficient'], rotation=45)
plt.tight_layout()
plt.ylabel('True label')
plt.xlabel('Predicted label')
```

Data & Analytics Portal | IBM Data Science Experience

https://apsginxrstudio.stage1.mybluemix.net/node1/rstudio40008/p/4456/shinyDemo.Rmd#cluster-analysis

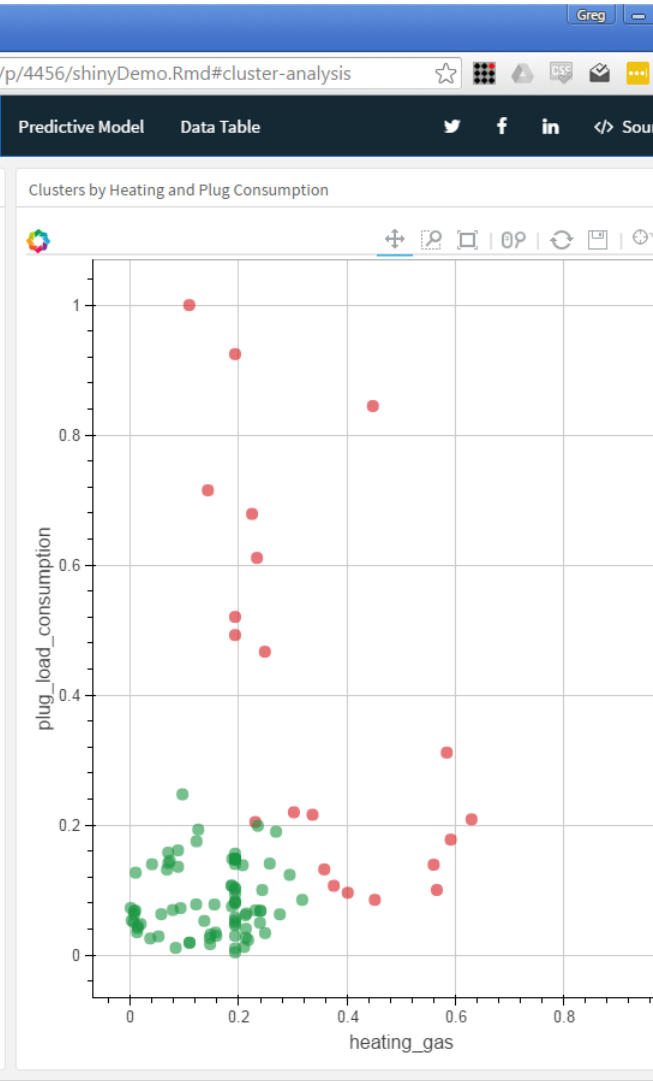
IBM Data Science Experience | Data Exploration | Cluster Analysis | Predictive Model | Data Table

Energy Consumption Map

Cluster Labels

- Efficient
- Inefficient

Leaflet | © OpenStreetMap © CartoDB



Adjust parameters on-the-fly and visualize model predictions

BlocPower Demo v3 - BlueMix

https://apxs-dev.stage1.ng.bluemix.net/analyt...

BlocPower Demo v3

Linear Regression Model.

Hypothesis: energy usage (kWh) can be predicted based on the following characteristics:

- age of the building
- square feet
- number of stories
- number of plugged equipment, ...

```
In [12]: features = dfScaled.columns.tolist()
response = ['energy_usage']
features.remove(response[0])
# prepare data for regression
lr = linear_model.LinearRegression(fit_intercept=True)
y = np.asarray(dfScaled[response])
X = dfScaled[features]
# run regression
regr = lr.fit(X,y)
coeffs = regr.coef_[0]
# collect regression results
dataRegQ = []
dataRegQ.append(('Intercept', regr.intercept_))
for i in range(len(features)):
    dataRegQ.append((features[i], coeffs[i]))
yh = regr.predict(X)
print 'R-Squared: ', r2_score(y,yh)
pd.DataFrame(dataRegQ, columns=['feature_name', 'coefficient'])
```

R-Squared: 0.725632741591

```
Out[12]:
```

	feature_name	coefficient
0	Intercept	-0.092789
1	age	0.139789
2	number_stories	0.059749
3	square_feet	0.734468
4	plug_equipment	0.330050
5	domestic_gas	0.208283
		0.105810

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Data Exploration | Cluster Analysis | **Predictive Model** | Data Table | Source Code

Predict Energy Use and Cost for New Property

Enter Age of Property:

Enter number of Stories:

Enter Property Square Footage:

Enter Age of Property:

Predicted Annual Energy Bill (USD @ \$0.18/kwh)

43.7K\$

Predicted Annual Energy (kwh)

242.8K

Regression Results: Actual Vs. Predicted Values

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