SPARK SUMMIT 2017

Taking Jupyter Notebooks and Apache Spark to the next level with PixieDust

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IBM Watson Data Platform, Developer Advocacy
@DTAIEB55

WHY ARE YOU HERE?

- More companies making bet-the-business data driven decisions
  - Good news: they are drowning in Data
  - Bad news: they are drowning in Data
- Solving the Data problems of tomorrow cannot be done by data scientists alone.
- Developers are getting more involved with Data Science, moving from stovepipe applications to “data pipelines” that integrate data and analytics.

How do we blur the lines between developers and data scientists?

Let’s start with a story… we all know too well.

Disclaimer: All characters and events depicted in this story are entirely fictitious. Any similarity to actual use cases, events or persons is actually intentional.

MEET BEN

THE DEVELOPER

- Hold a master degree in computer science
- 10 year experience, 6 years with the company
- Languages of choice: Java, Node.js, HTML5/CSS3
- Data: No SQL (Cloudant, Mongo), relational
- No major experience with Big Data

"The best line of code is the one I didn't have to write!"

MEET NATASHA

THE DATA SCIENTIST

- Hold a PHD in data science
- 5 year experience, 2 years with the company
- Experienced in Python and R
- Expert in Machine Learning and Data visualization
- Software engineering is not her thing

> “In God we trust. All others bring data.”
>
> — W. Edwards Deming

SURPRISE MEETING

With the VP of Development

“We have an urgent need for our marketing department to build an application that can provide real-time sentiment analysis on Twitter data.”

https://unsplash.com/search/meeting?photo=3fPXt37X6UQ

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KEY CONSTRAINTS

- You only have 6 weeks to build the application
- Target consumer is the business-focused user
  - Must be easy to use even for non technical people
- It must scale out of the box
  - I want you to look at Apache Spark

SOME LEARNING TO DO…

> “What exactly is Apache Spark?”
>
> — NATASHA

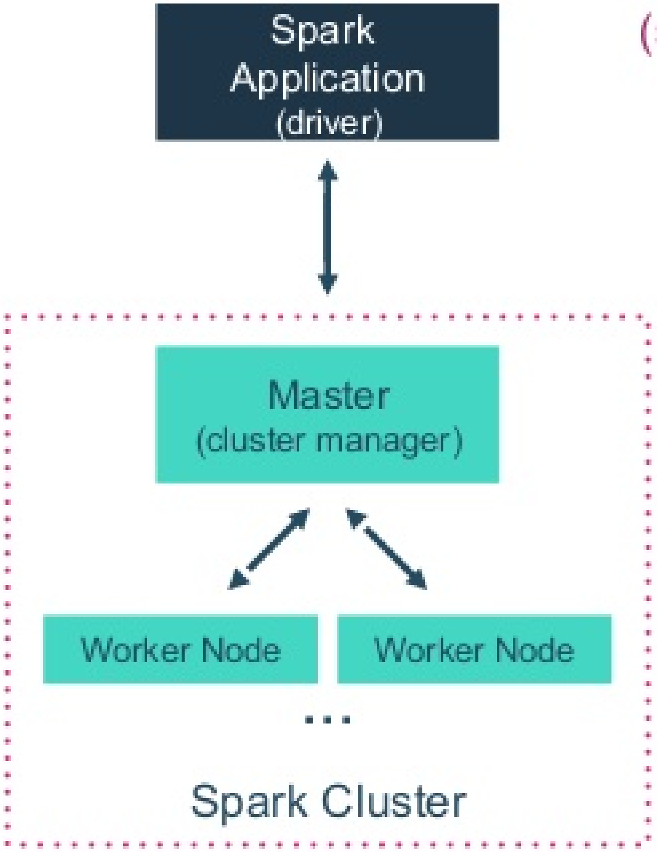
Great Question Natasha!

Best way to answer it is to arrange a ticket to the Spark Summit for you to find out

SPARK SUMMIT 2017
DATA SCIENCE AND ENGINEERING AT SCALE
JUNE 5 – 7, 2017 | SAN FRANCISCO
SPARK SUMMIT

CONSUMING SPARK

Batch Job
(spark-submit)

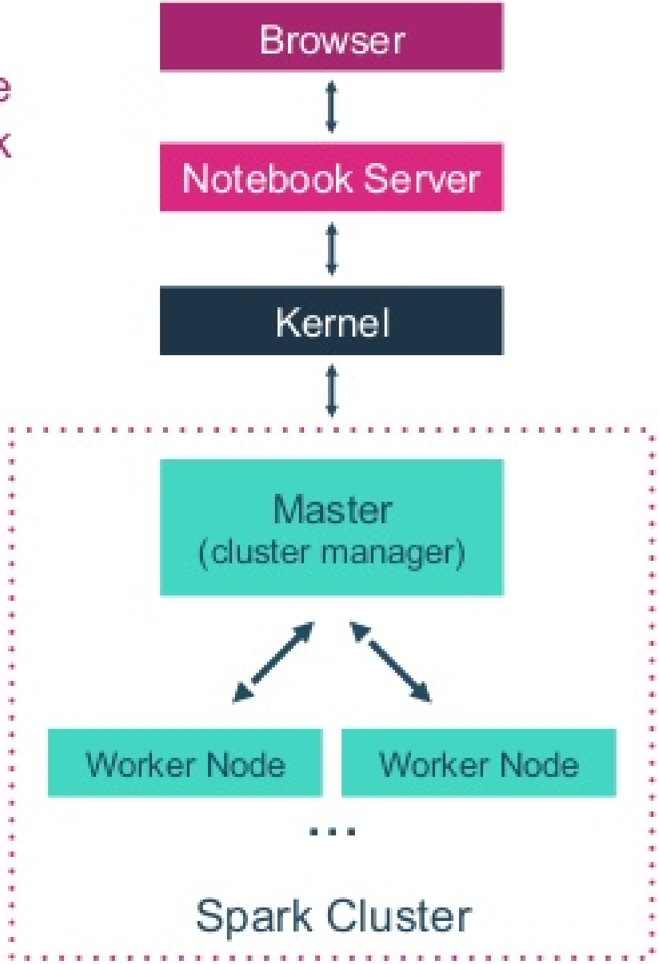


RDD Partitioning

Task packaging and dispatching

Worker node scheduling

Interactive
Notebook



CAN WE COLLABORATE USING NOTEBOOKS?

“What exactly is a Notebook?”

— NATASHA

— BEN

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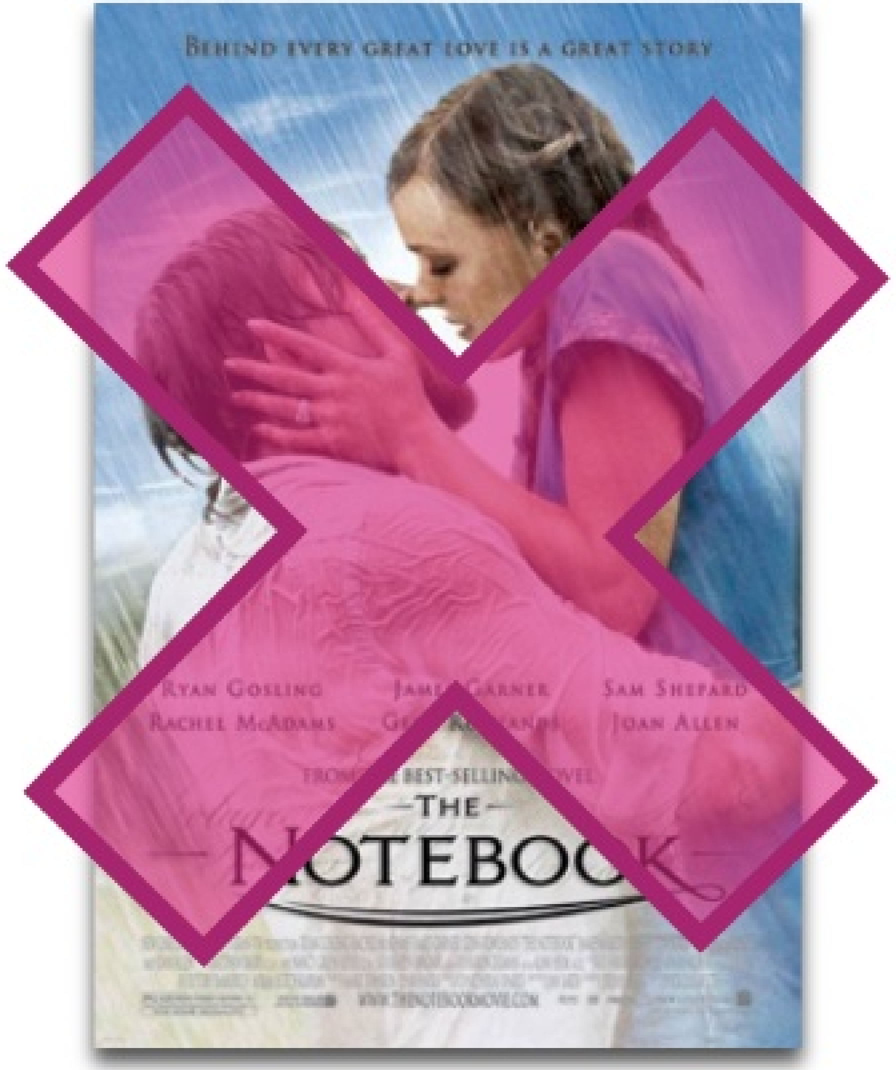
RYAN GOSLING MOVIE?



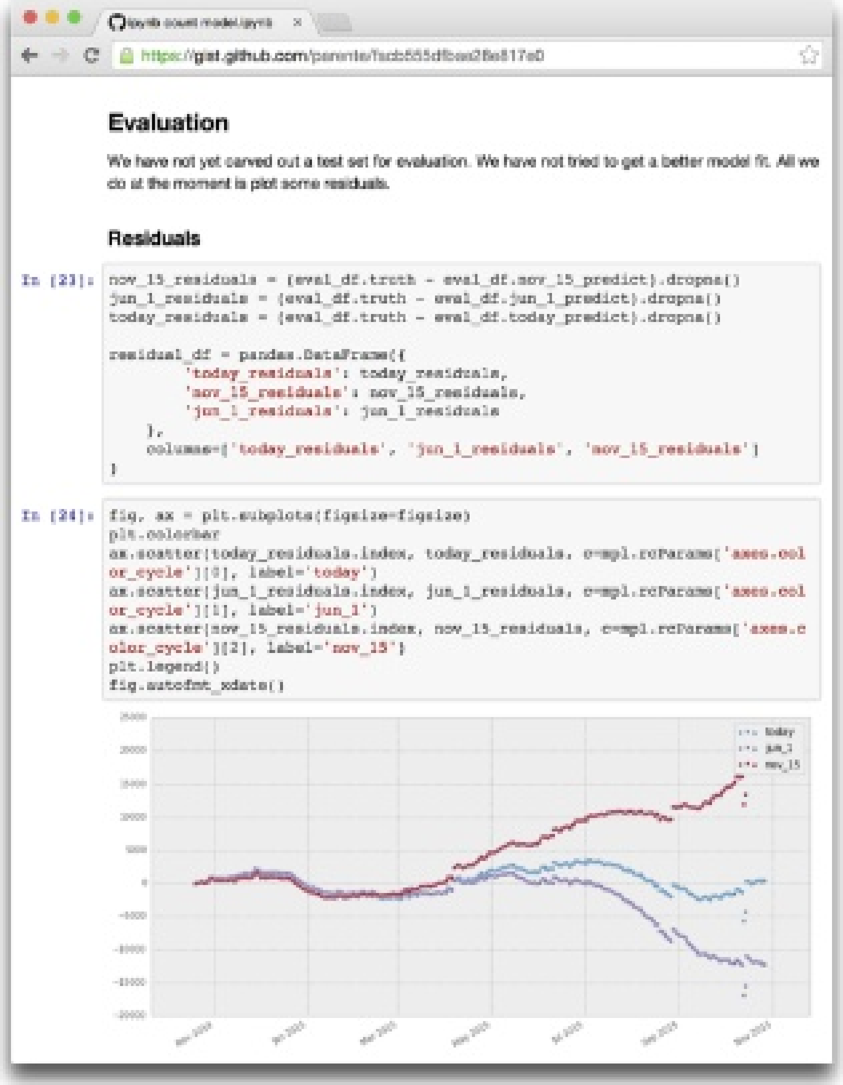
http://ia.media-imdb.com/images/M/MV5BMTk3OTM5Njg5M15BMI5BanBnXkFtZTYwMzA0ODI3._V1_SX640_SY720_.jpg

WHAT IS A NOTEBOOK?

Text
Annotations

Code
Data

Visualizations
Widgets
Output



Evaluation

We have not yet carved out a test set for evaluation. We have not tried to get a better model fit. All we do at the moment is plot some residuals.

Residuals

```
In [23]: nov_15_residuals = (eval_df.truth - eval_df.nov_15_predict).dropna()
         jun_1_residuals = (eval_df.truth - eval_df.jun_1_predict).dropna()
         today_residuals = (eval_df.truth - eval_df.today_predict).dropna()

         residual_df = pandas.DataFrame({
                 'today_residuals': today_residuals,
                 'nov_15_residuals': nov_15_residuals,
                 'jun_1_residuals': jun_1_residuals
             },
             columns=['today_residuals', 'jun_1_residuals', 'nov_15_residuals']
         )
```

```
In [24]: fig, ax = plt.subplots(figsize=figsize)
         plt.colorbar
         ax.scatter(today_residuals.index, today_residuals, c=mpl.rcParams['axes.col
         or_cycle'][0], label='today')
         ax.scatter(jun_1_residuals.index, jun_1_residuals, c=mpl.rcParams['axes.col
         or_cycle'][1], label='jun_1')
         ax.scatter(nov_15_residuals.index, nov_15_residuals, c=mpl.rcParams['axes.c
         olor_cycle'][2], label='nov_15')
         plt.legend()
         fig.autofmt_xdate()
```

- Web based UI for running Apache Spark console commands
- Easy, no install spark accelerator
- Best way to start working with spark
- Multiple flavors
  - Jupyter
  - Zeppelin
- Local or cloud hosted
  - IBM Data Science Experience
  - Databricks

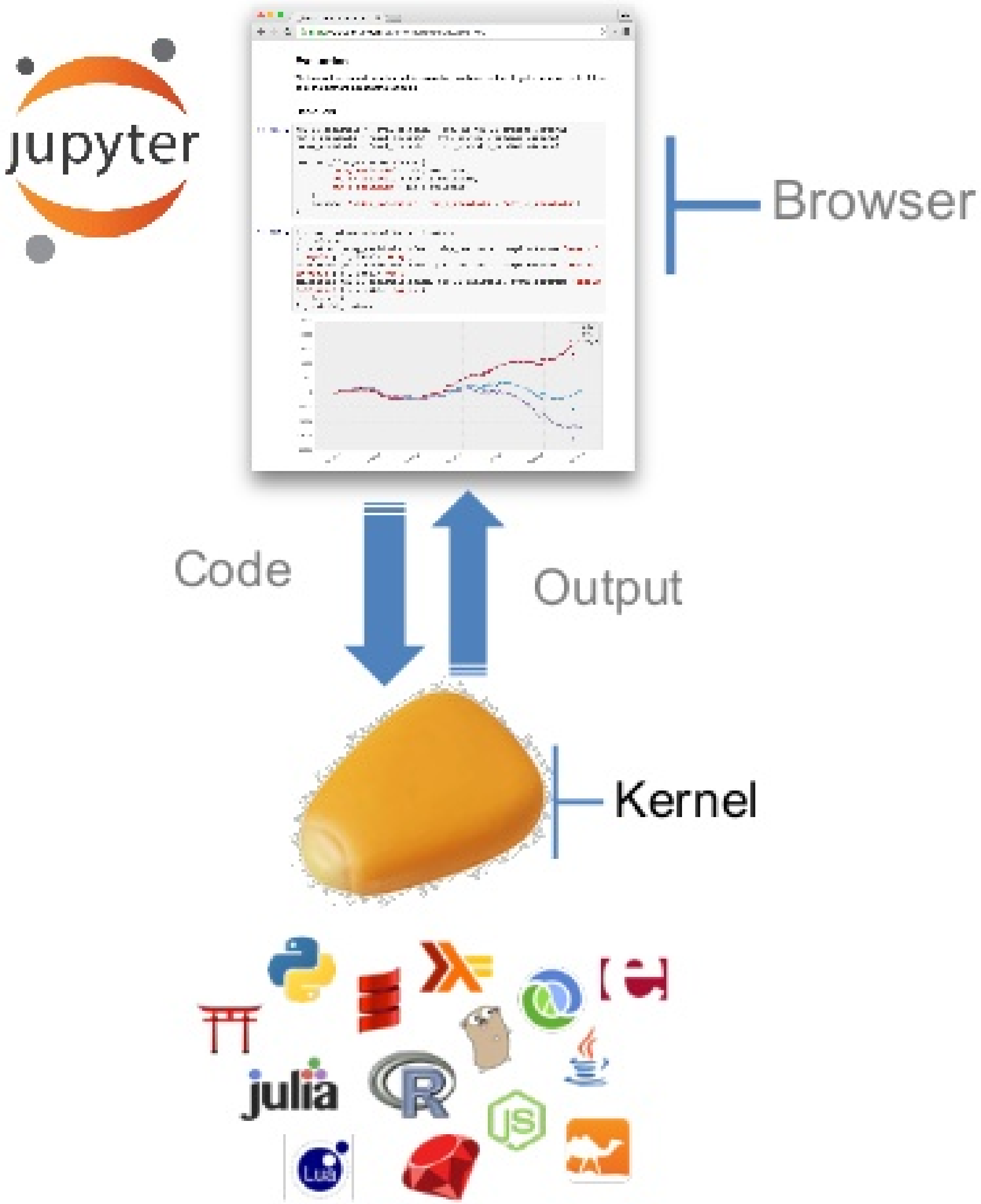
What is Jupyter?

"Open source, interactive data science and scientific computing"

- –Formerly IPython
- –Large, open, growing community and ecosystem

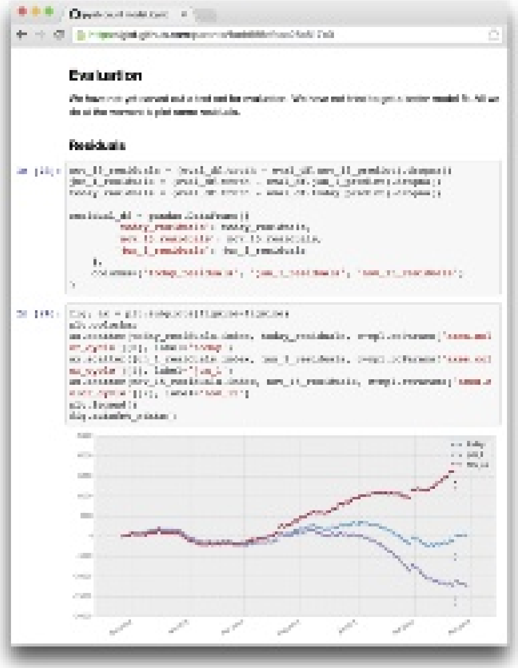
Very popular

- –"~2 million users for IPython" [1]
- –$6m in funding in 2015 [3]
- –200 contributors to notebook subproject alone [4]
- –275,000 public notebooks on GitHub [2]



https://www.bluetrack.com/uploads/items_images/kernel-of-corn-stress-balls1_th

BIG DATA ANALYSIS

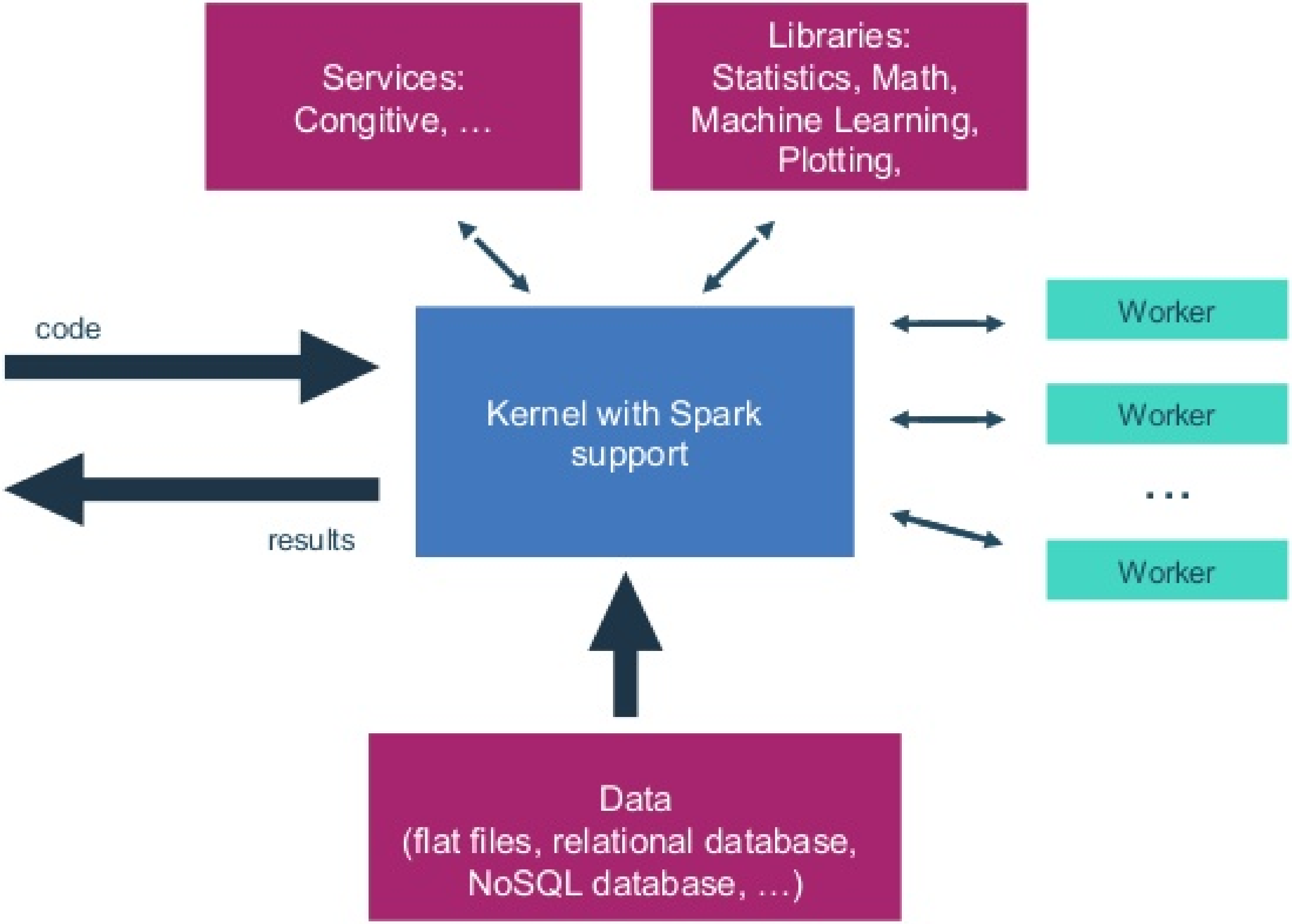


Evaluation

[illegible]

Residuals

```
[illegible]
```



NOTEBOOKS ARE POWERFUL TOOLS FOR DATA SCIENTISTS

> “But they seem complicated for developers like me”

— BEN

ENTER PIXIEDUST

Open Source Python helper library for Jupyter Notebooks

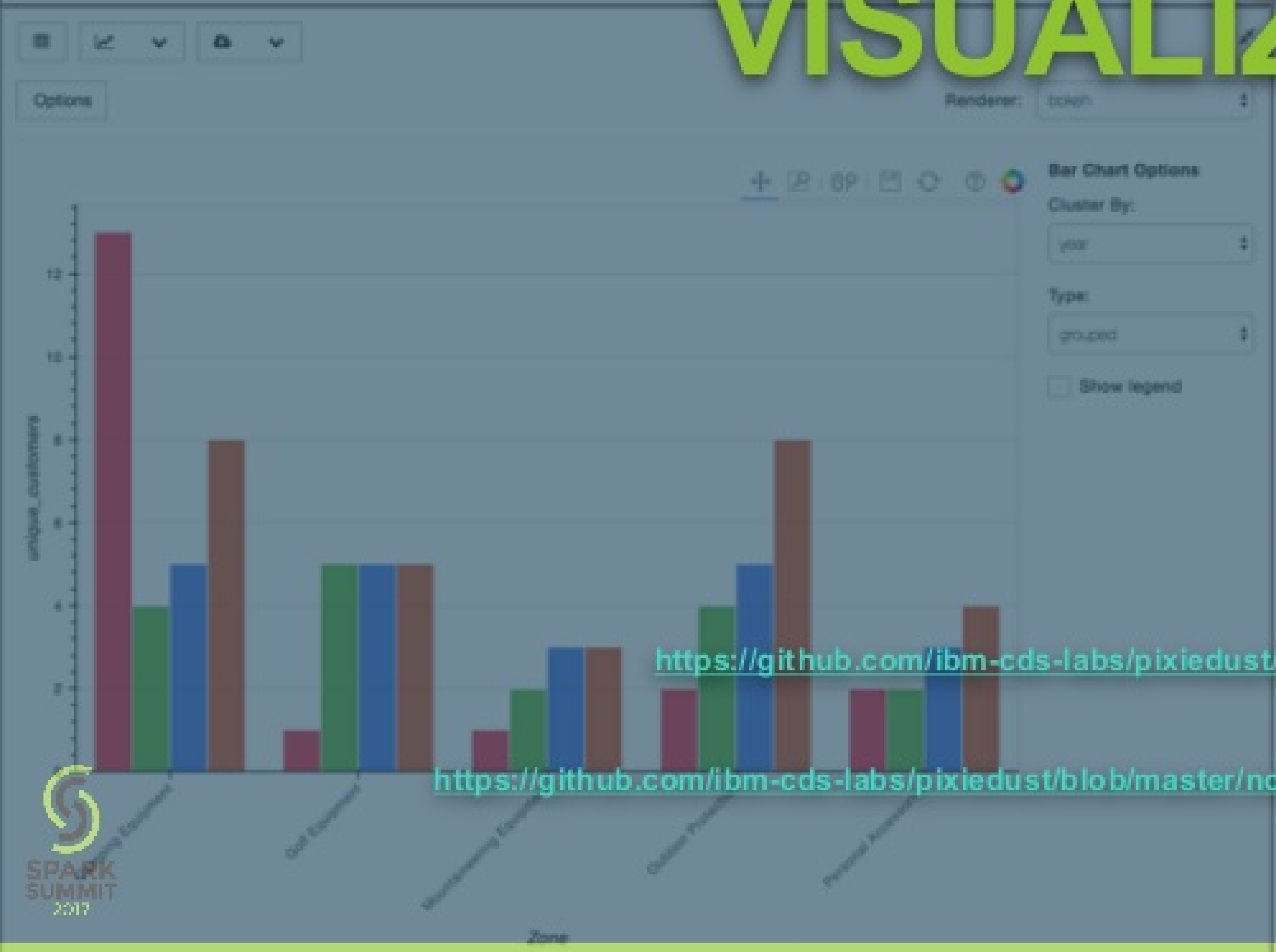
- Visualize data (e.g., Table, Charts, Map, etc)
- Data Management with PixieApps
- Download/export data (e.g., File, Cloudant, etc.)
- Use Scala directly in a Python notebook
- Install Spark packages into Python notebook
- Spark job progress monitor
- Extensible

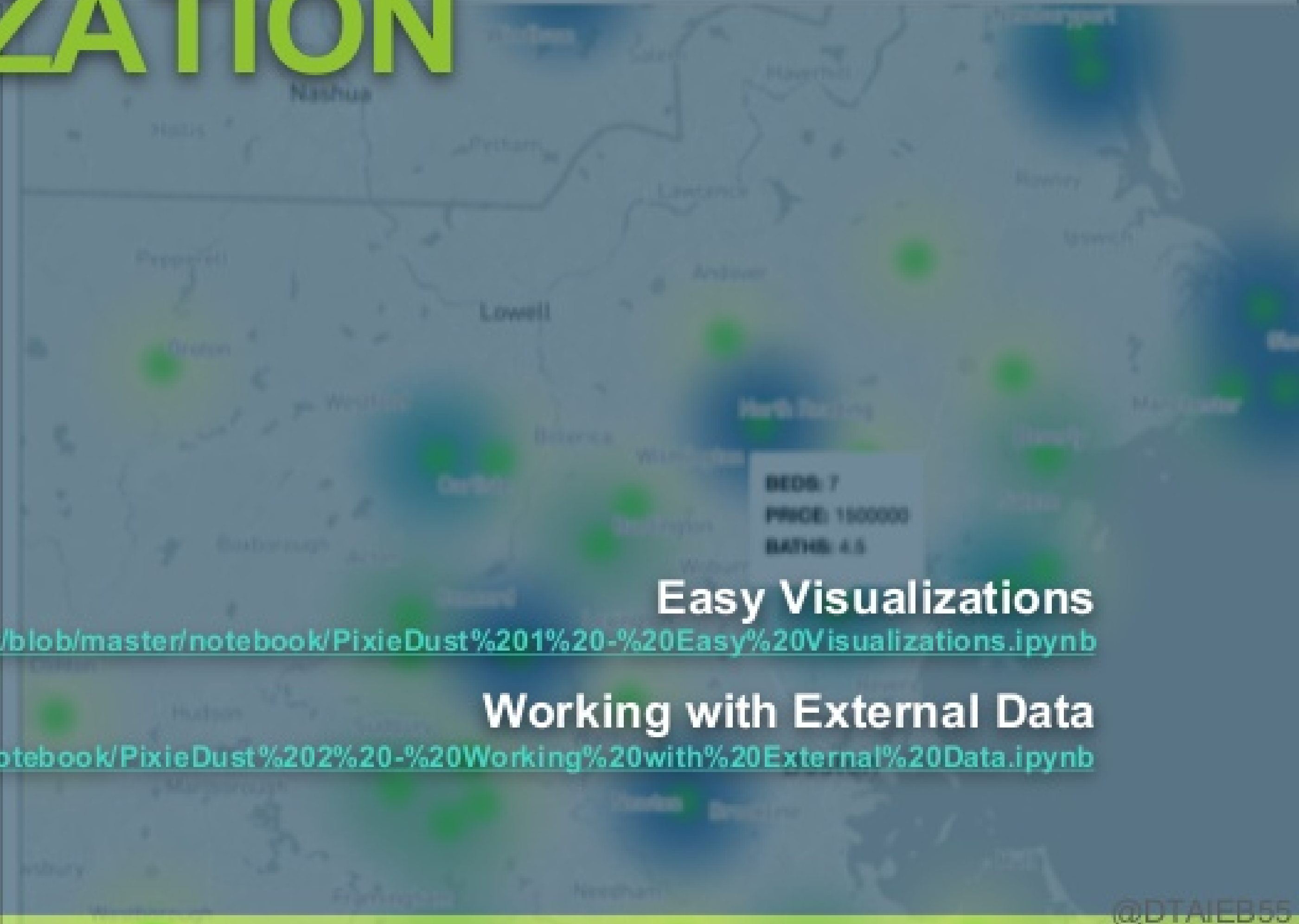
PixieDust

https://github.com/ibm-cds-labs/pixiedust

DEMO: PIXIEDUST DATA VISUALIZATION

```
import pixiedust
d1 = sqlContext.createDataFrame(
[(2010, 'Camping Equipment', 3, 200),(2010, 'Camping Equipment', 10, 200),(2010, 'Golf Equipment', 1, 240),
 (2010, 'Mountaineering Equipment', 1, 348),(2010, 'Outdoor Protection',2,200),(2010, 'Personal Accessories', 2, 200),
 (2011, 'Camping Equipment', 4, 489),(2011, 'Golf Equipment', 5, 234),(2011, 'Mountaineering Equipment',2, 123),
 (2011, 'Outdoor Protection', 4, 654),(2011, 'Personal Accessories', 2, 234),(2012, 'Camping Equipment', 5, 876),
 (2012, 'Golf Equipment', 5, 200),(2012, 'Mountaineering Equipment', 3, 156),(2012, 'Outdoor Protection', 5, 200),
 (2012, 'Personal [illegible]45),(2013, 'Camping Equipment', [illegible]87),(2013, 'Golf Equipment', 5, 434),
 (2013, 'Mountaineering Equipment', 3, 27[illegible]),(2013, 'Outdoor Protection', 8, 13[illegible]),(2013, 'Personal Accessories',4, 200)],
["year","zone","unique_customers", "revenue"])
display(d1)
```





Easy Visualizations

https://github.com/ibm-cds-labs/pixiedust/blob/master/notebook/PixieDust%201%20-%20Easy%20Visualizations.ipynb

Working with External Data

https://github.com/ibm-cds-labs/pixiedust/blob/master/notebook/PixieDust%202%20-%20Working%20with%20External%20Data.ipynb

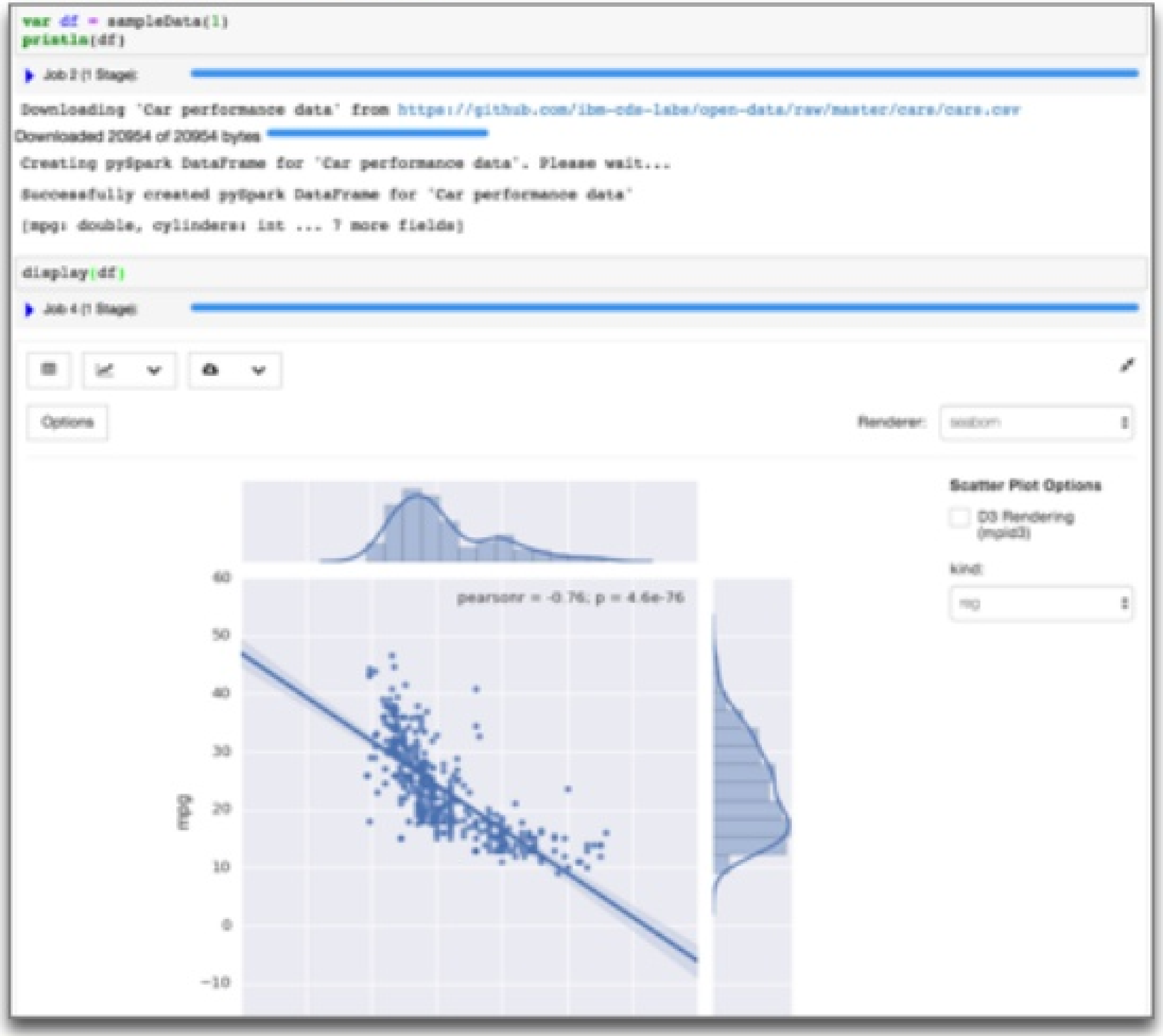
I AM OK TO USE PYTHON

"But I am really more comfortable with Scala"

— BEN

SCALA NOTEBOOKS

PixieDust also works with Scala Notebooks



```
var df = sampleData(1)
println(df)
```

▸ Job 2 (1 Stage)

```
Downloading 'Car performance data' from https://github.com/ibm-cds-labs/open-data/raw/master/cars/cars.csv
Downloaded 20954 of 20954 bytes
Creating pySpark DataFrame for 'Car performance data'. Please wait...
Successfully created pySpark DataFrame for 'Car performance data'
[mpg: double, cylinders: int ... 7 more fields]
```

```
display(df)
```

▸ Job 4 (1 Stage)

Renderer: seaborn

Scatter Plot Options

□ D3 Rendering (mpld3)

kind: reg

pearsonr = -0.76; p = 4.6e-76

Same PixieDust Scala APIs as in Python

WHAT ABOUT THE LINE OF BUSINESS USER?

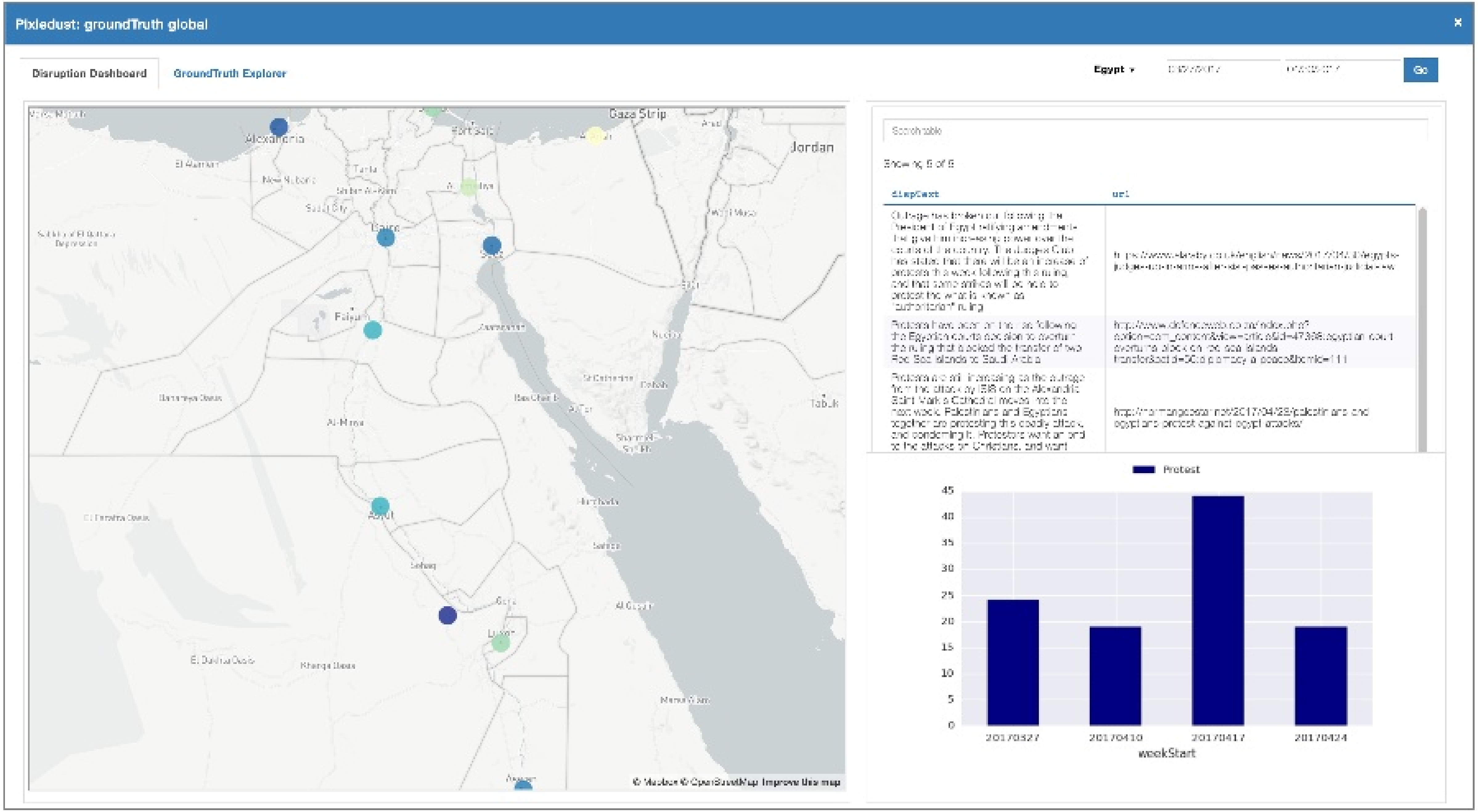
> “Expressing everything in code is nice but LOB users will not be able to linearly run large number of cells”

— NATASHA

Enter PixieApps

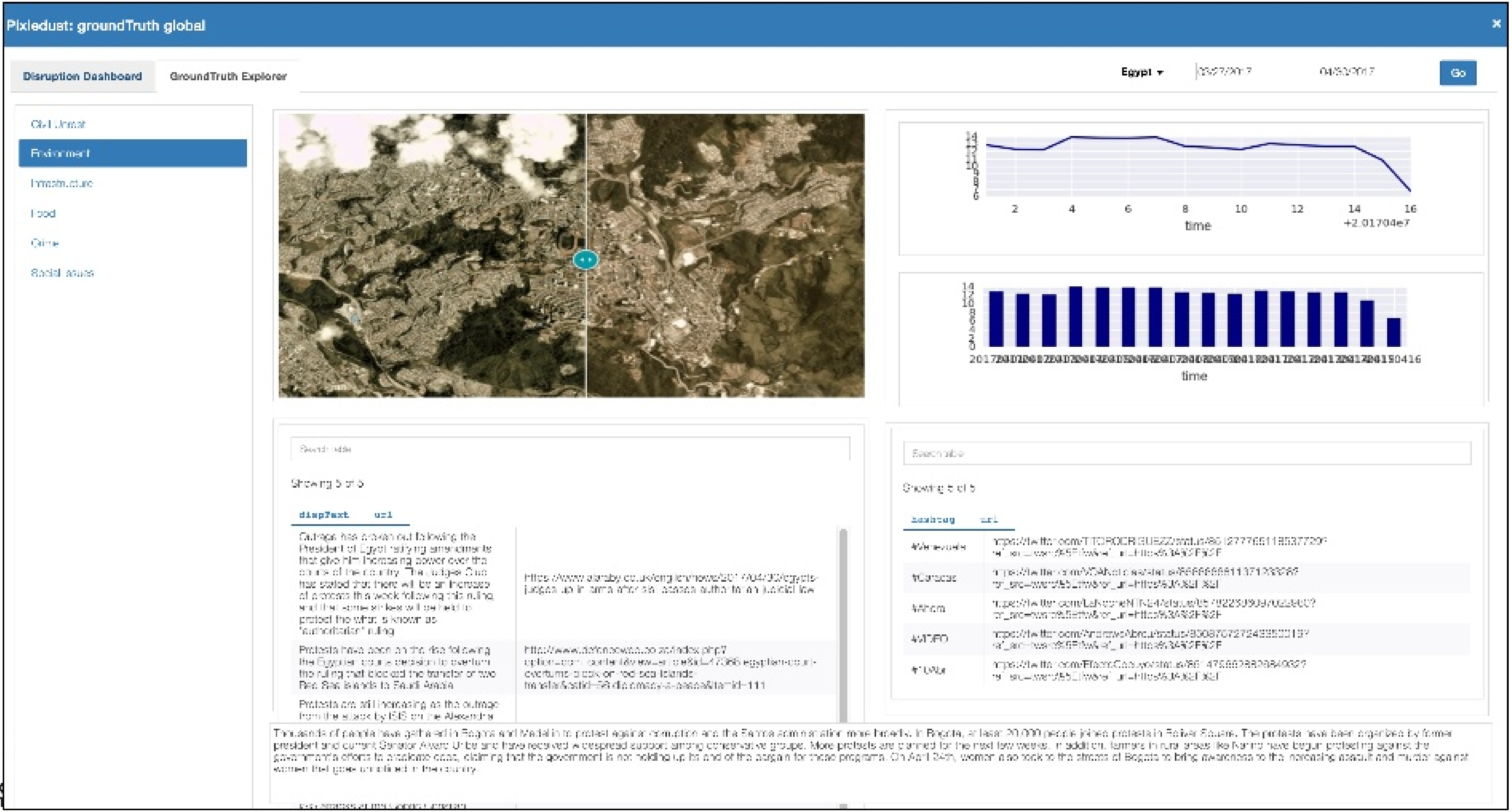
- PixieApps are Python classes used to write UI for your analytics that runs directly in a Jupyter Notebook
- Easy to build: mostly HTML and CSS with some custom attributes (micro-format style)
- Leverage PixieDust Display visualization for charting
- With PixieApps you can:
    - Create different html views with routes to invoke them
    - Invoke Python Scripts from user interactions
    - Run in the notebook cell output or in a Dialog
    - and much more…
- Use cases:
    - Dashboards
    - Data Browsers
    - Data Pipeline Management

Demo: PeaceTech GroundTruth Global Dashboard



dispText	url
Outrage has broken out following the President of Egypt ratifying amendments that give him increasing power over the courts of the country. The Judges Club has stated that there will be an increase of protests this week following this ruling and that some strikes will be held to protest the what is known as "authoritarian" ruling	https://www.alaraby.co.uk/english/news/2017/4/28/egypts-judges-[illegible]
Protests have been on the rise following the Egyptian courts decision to overturn the ruling that blocked the transfer of two Red Sea islands to Saudi Arabia	http://www.defenceweb.co.za/index.php?option=com_content&view=article&id=47368:egyptian-court-overturns-block-on-red-sea-islands-transfer&catid=56:diplomacy-a-peace&Itemid=111
Protests are still increasing as the outrage from the attack by ISIS on the Alexandria Saint Mark's Cathedral moves into the next week. Palestinians and Egyptians together are protesting this deadly attack and condemning it. Protestors want an end to the attacks on Christians, and want	http://[illegible]/2017/04/28/palestinians-and-egyptians-protest-against-egypt-attacks/

Demo: PeaceTech GroundTruth Global Dashboard



Showing 5 of 5

dispText	url
Outrage has broken out following the President of Egypt ratifying amendments that give him increasing power over the courts of the country. The Judges Club has stated that there will be an increase of protests this week following this ruling, and that some strikes will be held to protest the what is known as "authoritarian" ruling	https://www.alaraby.co.uk/english/news/2017/04/30/egypts-judges-up-in-arms-after-sisi-passes-authoritarian-judicial-law
Protests have been on the rise following the Egyptian court's decision to overturn the ruling that blocked the transfer of two Red Sea Islands to Saudi Arabia	http://www.defenceweb.co.za/index.php?option=com_content&view=article&id=47366:egyptian-court-overturns-block-on-red-sea-islands-transfer&catid=56:diplomacy-a-peace&Itemid=111
Protests are still increasing as the outrage from the attack by ISIS on the Alexandria	

Showing 5 of 5

hashtag	url
#Venezuela	https://twitter.com/TITORODRIGUEZ2/status/861277765118537729?ref_src=twsrc%5Etfw&ref_url=https%3A%2F%2F
#Caracas	https://twitter.com/VOANoticias/status/[illegible]?ref_src=twsrc%5Etfw&ref_url=https%3A%2F%2F
#Ahora	https://twitter.com/LaNoticiaNTN24/status/[illegible]?ref_src=twsrc%5Etfw&ref_url=https%3A%2F%2F
#VIDEO	https://twitter.com/AndrewsAbreu/status/[illegible]?ref_src=twsrc%5Etfw&ref_url=https%3A%2F%2F
#10Abr	https://twitter.com/[illegible]/status/[illegible]?ref_src=twsrc%5Etfw&ref_url=https%3A%2F%2F

Thousands of people have gathered in Bogota and Medellin to protest against corruption and the Santos administration more broadly. In Bogota, at least 20,000 people joined protests in Bolivar Square. The protests have been organized by former president and current Senator Alvaro Uribe and have received widespread support among conservative groups. More protests are planned for the next few weeks. In addition, farmers in rural areas like Narino have begun protesting against the government's efforts to eradicate coca, claiming that the government is not holding up its end of the bargain for these programs. On April 24th, women also took to the streets of Bogota to bring awareness to the increasing assault and murder against women that goes unpunished in the country.

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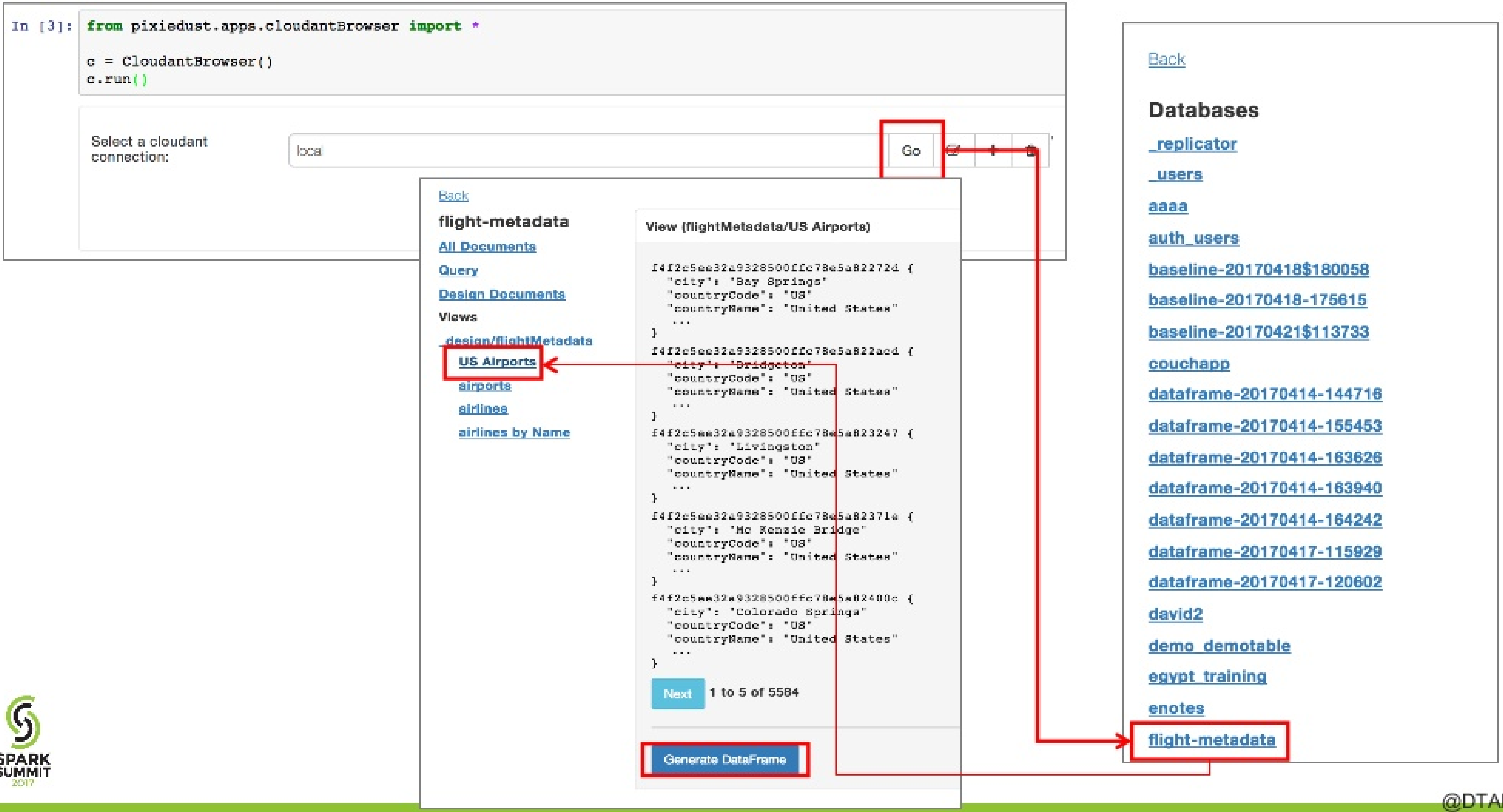
@DTAIEB55

Demo: Data Browser for Cloudant/CouchDB



```
In [3]: from pixiedust.apps.cloudantBrowser import *

        c = CloudantBrowser()
        c.run()
```

Select a cloudant connection: local

Back

Databases

- _replicator
- _users
- aaaa
- auth_users
- baseline-20170418$180058
- baseline-20170418-175615
- baseline-20170421$113733
- couchapp
- dataframe-20170414-144716
- dataframe-20170414-155453
- dataframe-20170414-163626
- dataframe-20170414-163940
- dataframe-20170414-164242
- dataframe-20170417-115929
- dataframe-20170417-120602
- david2
- demo_demotable
- egypt_training
- enotes
- flight-metadata

Back

flight-metadata

- All Documents
- Query
- Design Documents
- Views
  - _design/flightMetadata
    - US Airports
    - airports
    - airlines
    - airlines by Name

View (flightMetadata/US Airports)

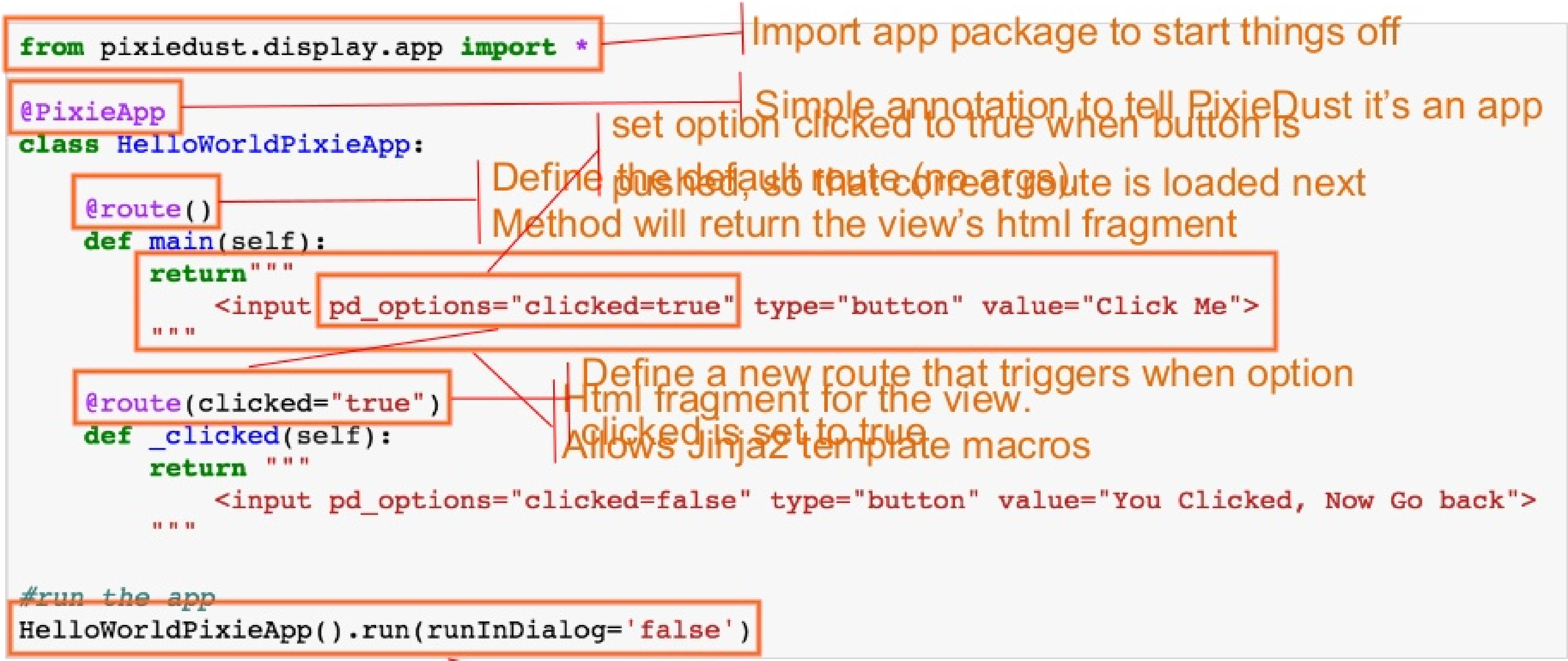
```
f4f2c5ee32a9328500ffc78e5a82272d {
  "city": "Bay Springs"
  "countryCode": "US"
  "countryName": "United States"
   ...
}
f4f2c5ee32a9328500ffc78e5a822acd {
  "city": "Bridgeton"
  "countryCode": "US"
  "countryName": "United States"
   ...
}
f4f2c5ee32a9328500ffc78e5a823247 {
  "city": "Livingston"
  "countryCode": "US"
  "countryName": "United States"
   ...
}
f4f2c5ee32a9328500ffc78e5a82371e {
  "city": "Mc Kenzie Bridge"
  "countryCode": "US"
  "countryName": "United States"
   ...
}
f4f2c5ee32a9328500ffc78e5a82400c {
  "city": "Colorado Springs"
  "countryCode": "US"
  "countryName": "United States"
   ...
}
```

1 to 5 of 5584

WHAT DOES IT TAKE TO BUILD A PIXIEAPP?

> “Do I need to learn yet another framework?”
>
> — BEN

PIXIEAPP HELLO WORLD



```
from pixiedust.display.app import *

@PixieApp
class HelloWorldPixieApp:

    @route()
    def main(self):
        return"""
            <input pd_options="clicked=true" type="button" value="Click Me">
        """

    @route(clicked="true")
    def _clicked(self):
        return """
            <input pd_options="clicked=false" type="button" value="You Clicked, Now Go back">
        """


#run the app
HelloWorldPixieApp().run(runInDialog='false')
```

Import app package to start things off

Simple annotation to tell PixieDust it's an app

set option clicked to true when button is pushed, so that correct route is loaded next

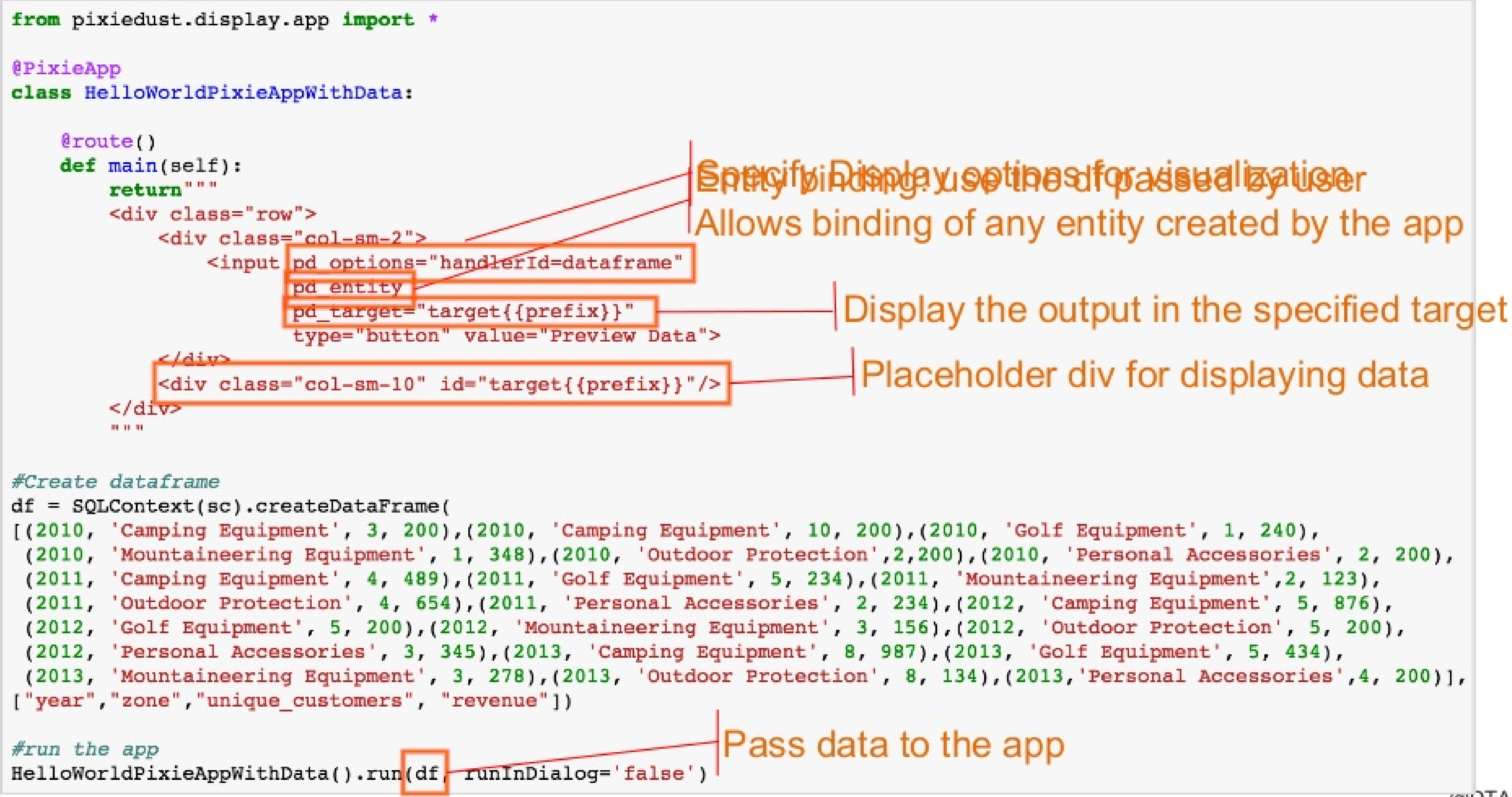
Define the default route (no args)
Method will return the view's html fragment

Define a new route that triggers when option clicked is set to true

Html fragment for the view.
Allows Jinja2 template macros

Import app package to start things off

PIXIEAPP HELLO WORLD WITH DATA



```
from pixiedust.display.app import *

@PixieApp
class HelloWorldPixieAppWithData:

    @route()
    def main(self):
        return"""
        <div class="row">
            <div class="col-sm-2">
                <input pd_options="handlerId=dataframe"
                       pd_entity
                       pd_target="target{{prefix}}"
                       type="button" value="Preview Data">
            </div>
            <div class="col-sm-10" id="target{{prefix}}"/>
        </div>
        """

#Create dataframe
df = SQLContext(sc).createDataFrame(
[(2010, 'Camping Equipment', 3, 200),(2010, 'Camping Equipment', 10, 200),(2010, 'Golf Equipment', 1, 240),
 (2010, 'Mountaineering Equipment', 1, 348),(2010, 'Outdoor Protection',2,200),(2010, 'Personal Accessories', 2, 200),
 (2011, 'Camping Equipment', 4, 489),(2011, 'Golf Equipment', 5, 234),(2011, 'Mountaineering Equipment',2, 123),
 (2011, 'Outdoor Protection', 4, 654),(2011, 'Personal Accessories', 2, 234),(2012, 'Camping Equipment', 5, 876),
 (2012, 'Golf Equipment', 5, 200),(2012, 'Mountaineering Equipment', 3, 156),(2012, 'Outdoor Protection', 5, 200),
 (2012, 'Personal Accessories', 3, 345),(2013, 'Camping Equipment', 8, 987),(2013, 'Golf Equipment', 5, 434),
 (2013, 'Mountaineering Equipment', 3, 278),(2013, 'Outdoor Protection', 8, 134),(2013,'Personal Accessories',4, 200)],
["year","zone","unique_customers", "revenue"])

#run the app
HelloWorldPixieAppWithData().run(df, runInDialog='false')
```

Specify Display options for visualization

Entity binding: use the df passed by user

Allows binding of any entity created by the app

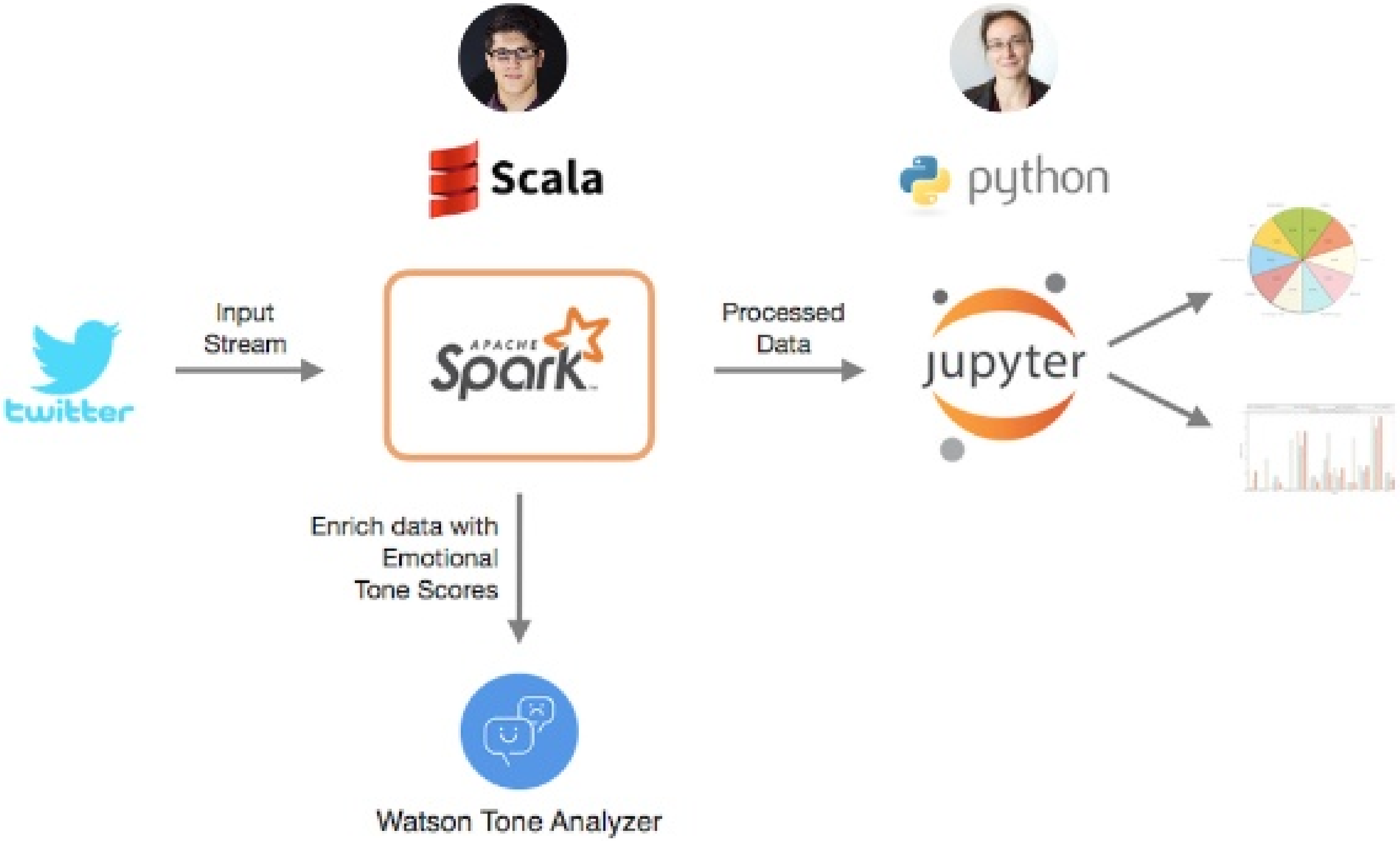
Display the output in the specified target

Placeholder div for displaying data

Pass data to the app

OK, I'M SOLD…

LET'S AGREE ON THE ARCHITECTURE



BEN and NATASHA

START BRAINSTORMING

- I'll work on data acquisition from Twitter and enrichment with sentiment analysis scores using Spark Streaming
- I know Java very well, but I don't have time to learn Python.
- However, I am willing to learn Scala if that helps improve my productivity

I'll need to do some data exploration too.

- I'll perform the data exploration and analysis
- I know Python and R, but I am not familiar enough with Java or Scala
- I like pandas and numpy. I'm ok to learn Spark but expect the same level of apis
- I need to work iteratively with the data

I'll need APIs to access my data.

BEN and NATASHA

DIVIDING THE TASKS

- Implement a Spark Streaming connector to Twitter
- Call Watson Tone Analyzer for each tweets
- Return a Spark DataFrame with the tweets enriched with Tone scores
- Code written in Scala, delivered as a Jar

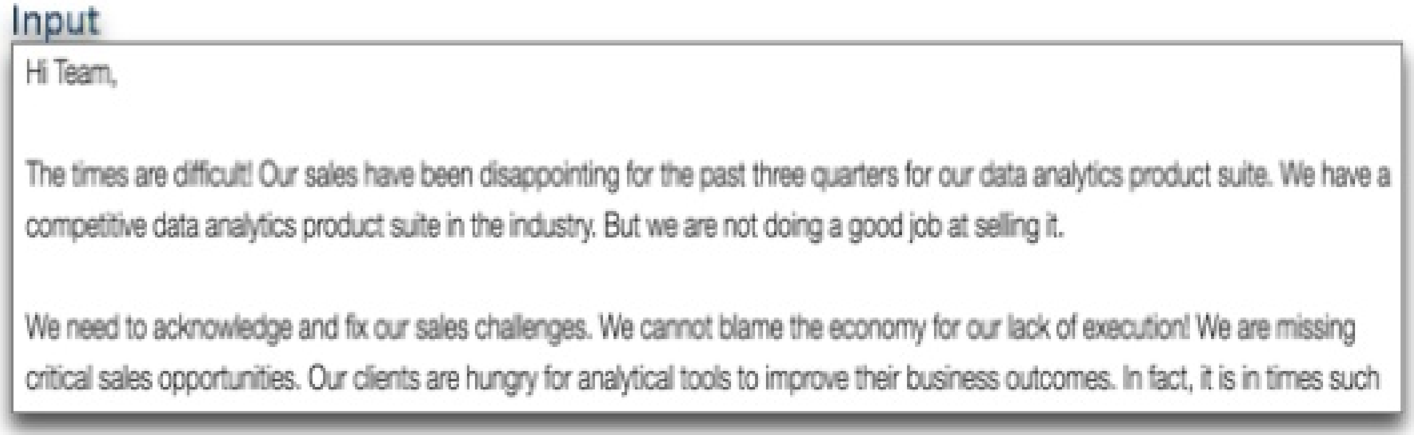
- Works in a Python Notebook
- Using PixieDust PackageManager, install the Scala library delivered by Ben to load the twitter data with Tone scores
- Using PixieDust display() api, perform the data exploration and analysis: trending hashtags and sentiments
- Produce visualizations to LOB Users

WATSON TONE ANALYZER

http://www.ibm.com/watson/developercloud/tone-analyzer.html

- Uses linguistic analysis to detect 3 types of tones
  - Emotion
  - Social Tendencies
  - Language Styles
- Available as a cloud service on IBM Bluemix

Input

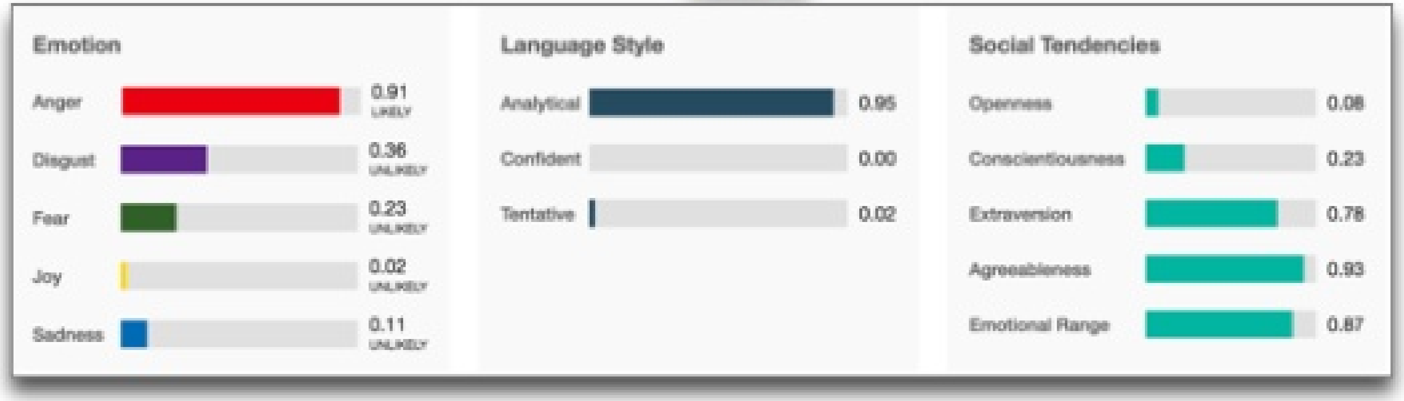


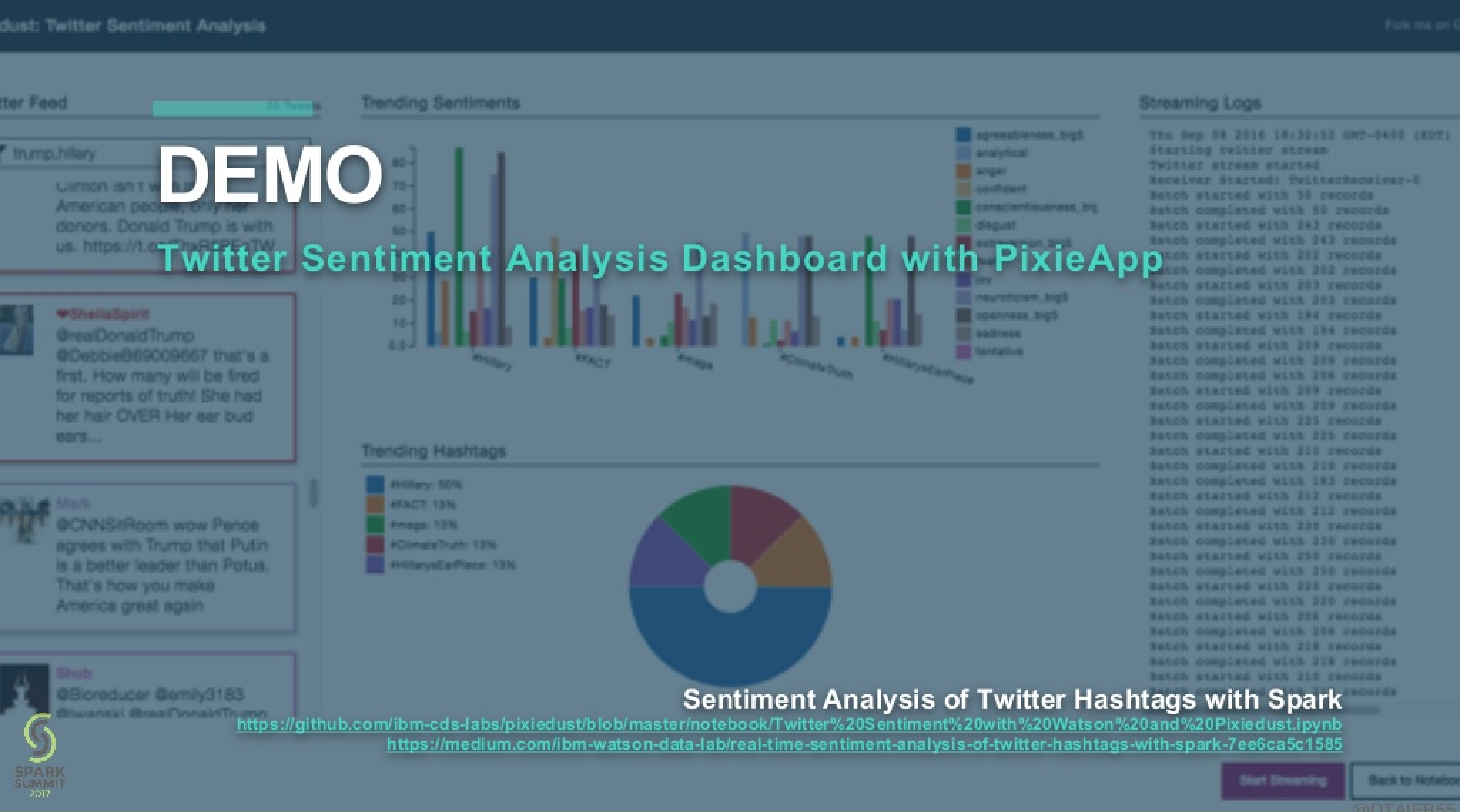
Hi Team,

The times are difficult! Our sales have been disappointing for the past three quarters for our data analytics product suite. We have a competitive data analytics product suite in the industry. But we are not doing a good job at selling it.

We need to acknowledge and fix our sales challenges. We cannot blame the economy for our lack of execution! We are missing critical sales opportunities. Our clients are hungry for analytical tools to improve their business outcomes. In fact, it is in times such

Results





Clinton isn't w... American people, only her donors. Donald Trump is with us. https://t.co/...

❤SheilaSpirit
@realDonaldTrump @Debbie869009667 that's a first. How many will be fired for reports of truth! She had her hair OVER Her ear bud ears...

Mark
@CNNSitRoom wow Pence agrees with Trump that Putin is a better leader than Potus. That's how you make America great again

Shub
@Bioreducer @emily3183 @lwanski @realDonaldTrump

```
Thu Sep 08 2016 18:32:52 GMT-0400 (EDT)
Starting twitter stream
Twitter stream started
Receiver Started: TwitterReceiver-0
Batch started with 50 records
Batch completed with 50 records
Batch started with 243 records
Batch completed with 243 records
Batch started with 202 records
Batch completed with 202 records
Batch started with 203 records
Batch completed with 203 records
Batch started with 194 records
Batch completed with 194 records
Batch started with 209 records
Batch completed with 209 records
Batch completed with 206 records
Batch started with 209 records
Batch completed with 209 records
Batch started with 225 records
Batch completed with 225 records
Batch started with 210 records
Batch completed with 210 records
Batch completed with 183 records
Batch started with 212 records
Batch completed with 212 records
Batch started with 230 records
Batch completed with 230 records
Batch started with 250 records
Batch completed with 250 records
Batch started with 220 records
Batch completed with 220 records
Batch started with 206 records
Batch completed with 206 records
Batch started with 218 records
Batch completed with 218 records
Batch started with 210 records
```

DEMO

Twitter Sentiment Analysis Dashboard with PixieApp

Sentiment Analysis of Twitter Hashtags with Spark

https://github.com/ibm-cds-labs/pixiedust/blob/master/notebook/Twitter%20Sentiment%20with%20Watson%20and%20Pixiedust.ipynb

https://medium.com/ibm-watson-data-lab/real-time-sentiment-analysis-of-twitter-hashtags-with-spark-7ee6ca5c1585

MEETING WITH THE VP

“SUCCESS!!”

https://unsplash.com/search/meeting?photo=3fPXt37X6UQ

What’s next for PixieDust

- Support Visualization for Streaming data
  - Start with Structured Streaming and IBM Streams
- Ability to publish/embed PixieApps into Web Application (Nodejs to begin with)
- PixieDust visualization enhancements
  - Custom colors
  - Custom GeoJSON layers for maps
  - Sorting/filtering
  - More renderers: Brunel, ArcGIS, etc.
  - …
- Ability to run Node.js code to load and visualize data
- Support for Jupyter Labs and Jupyter Hub

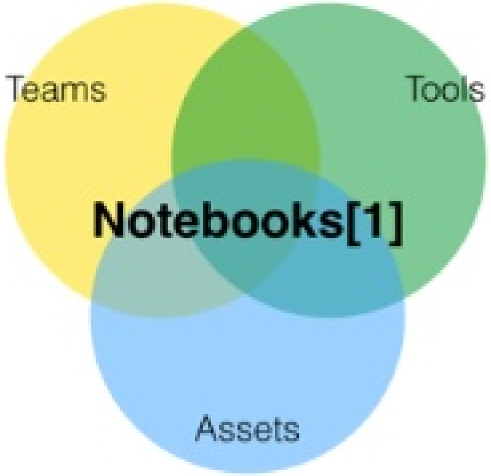
As always…

We look forward for your feedback
and pull requests on GitHub

https://github.com/ibm-cds-labs/pixiedust

CONCLUSION

- Solving the Data problems of tomorrow cannot be done by data scientists alone.
- Notebooks, considered by most to be the domain of data scientists, can help break down traditional silos and help team of all types who are working on data problems



[1] Not just for data scientists

Try it for yourself today:

- IBM Data Science Experience
  http://datascience.ibm.com/
- Locally using PixieDust automated installer
  https://ibm-cds-labs.github.io/pixiedust/install.html

RESOURCES

- https://github.com/ibm-cds-labs/pixiedust
- https://ibm-cds-labs.github.io/pixiedust
- https://medium.com/ibm-watson-data-lab/i-am-not-a-data-scientist-efe7ca6ceba2
- https://spark.apache.org
- https://www.ibm.com/us-en/marketplace/spark-as-a-service
- http://datascience.ibm.com
- https://www.ibm.com/watson/developercloud/tone-analyzer.html
- https://medium.com/ibm-watson-data-lab/real-time-sentiment-analysis-of-twitter-hashtags-with-spark-7ee6ca5c1585
- https://ibm.biz/pixiedustvis
- https://ibm.biz/pixiedustlab

Questions

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謝謝
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mercé
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তোমাকে ধন্যবাদ
감사합니다
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merci