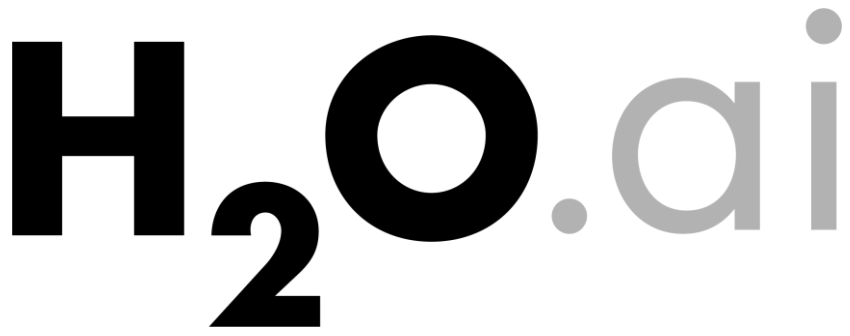
Latest Developments in H_2O



Jo-fai (Joe) Chow

Data Scientist

joe@h2o.ai

@matlabulous

Data Science for IoT Meetup – London

9th March, 2017

What's New

- From Kaggle to H_2O
  - Joe's Story
- ODSC Masterclass Summit
  - Training Materials on GitHub
- Stacked Ensembles
- Automatic Machine Learning
- Time Series
- Sparkling Water
- Deep Water
- H_2O + xgboost
- Community Events
- Discussions
  - H_2O on ARM
- Other News

From Kaggle to H_2O

The true story of a civil engineer turned data geek

About Me

- Civil (Water) Engineer

  2010 – 2015

  - Consultant (UK)
    - Utilities
    - Asset Management
    - Constrained Optimization
  - Industrial PhD (UK)
    - Infrastructure Design Optimization
    - Machine Learning + Water Engineering
    - Discovered H_2O in 2014

- Data Scientist

  2015

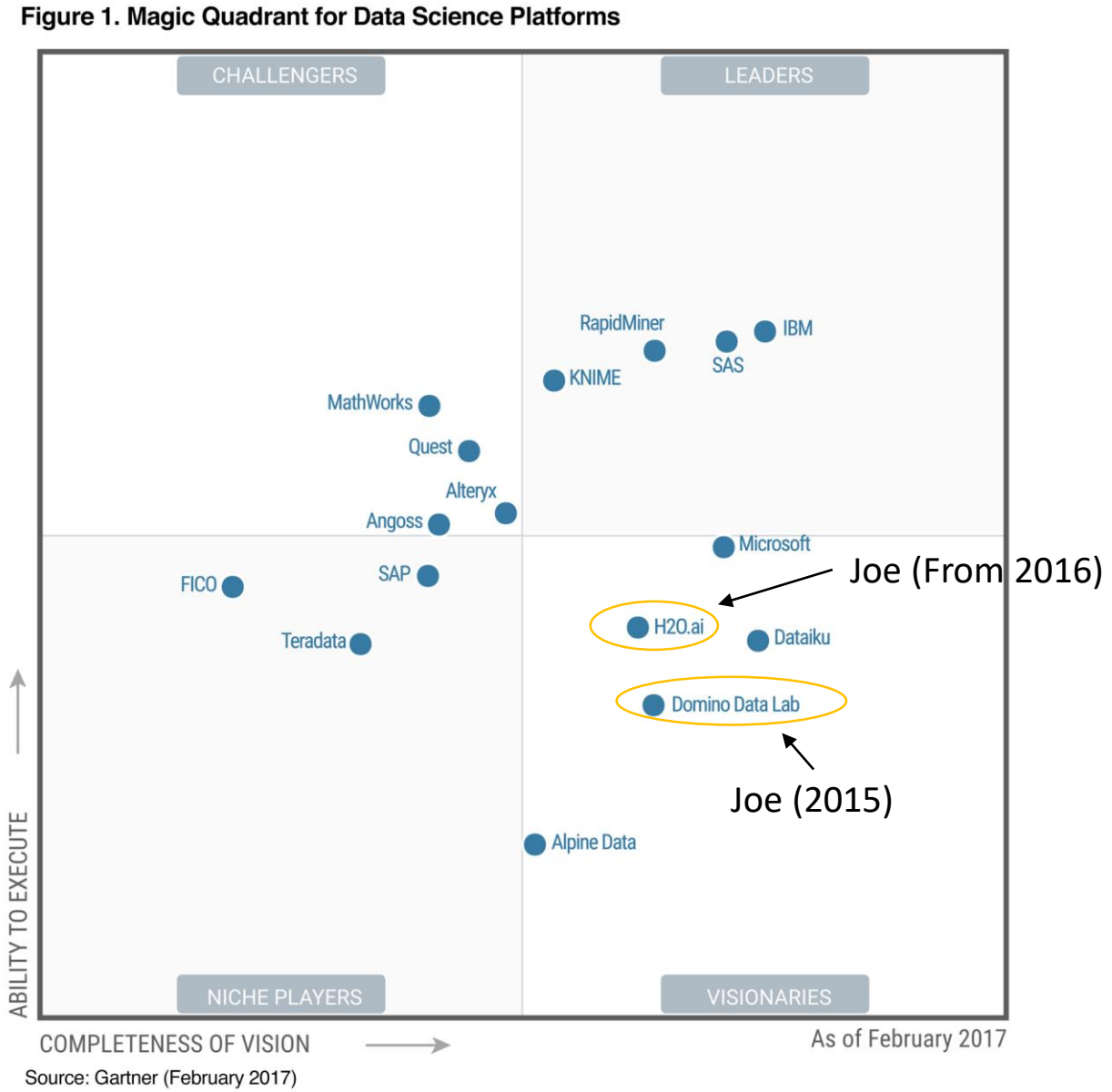
  - Virgin Media (UK)
  - Domino Data Lab (Silicon Valley)

  2016 – Present

  - H_2O.ai (Silicon Valley)

Joe the Outlier

- Slides
  - https://github.com/h2oai/h2o-meetups/blob/master/2017_02_28_SV_BigData_Science/2017_02_28_SVBDS_Kaggle_Story.pdf



Joe (Water Engineer)

http://www.h2o.ai/gartner-magic-quadrant/

H2O.ai

ODSC Masterclass Summit

Introduction to Machine Learning & Deep Learning with H_2O

New Training Materials

- In both Python and R
  - Based on Oxford IoT Course
- Machine Learning with H_2O
  - Basic Extract, Transform and Load (ETL)
  - Supervised Learning
  - Parameters Tuning
  - Stacking
- Deep Learning with H_2O
  - MNIST Example
  - Outlier Detection

- Materials
  - https://github.com/h2oai/h2o-meetups/tree/master/2017_03_01_ODSC_Masterclass_Summit

H2O.ai

Improving Model Performance (Step-by-Step)

Model Settings	MSE (CV)	MSE (Test)
GBM with default settings	N/A	0.4551
GBM with manual settings	N/A	0.4433
Manual settings + cross-validation	0.4502	0.4433
Manual + CV + early stopping	0.4429	0.4287
CV + early stopping + full grid search	0.4378	0.4196
CV + early stopping + random grid search	0.4227	0.4047
Stacking best two from random grid search	N/A	0.3997

Stacked Ensembles

Stacked Ensembles in H2O

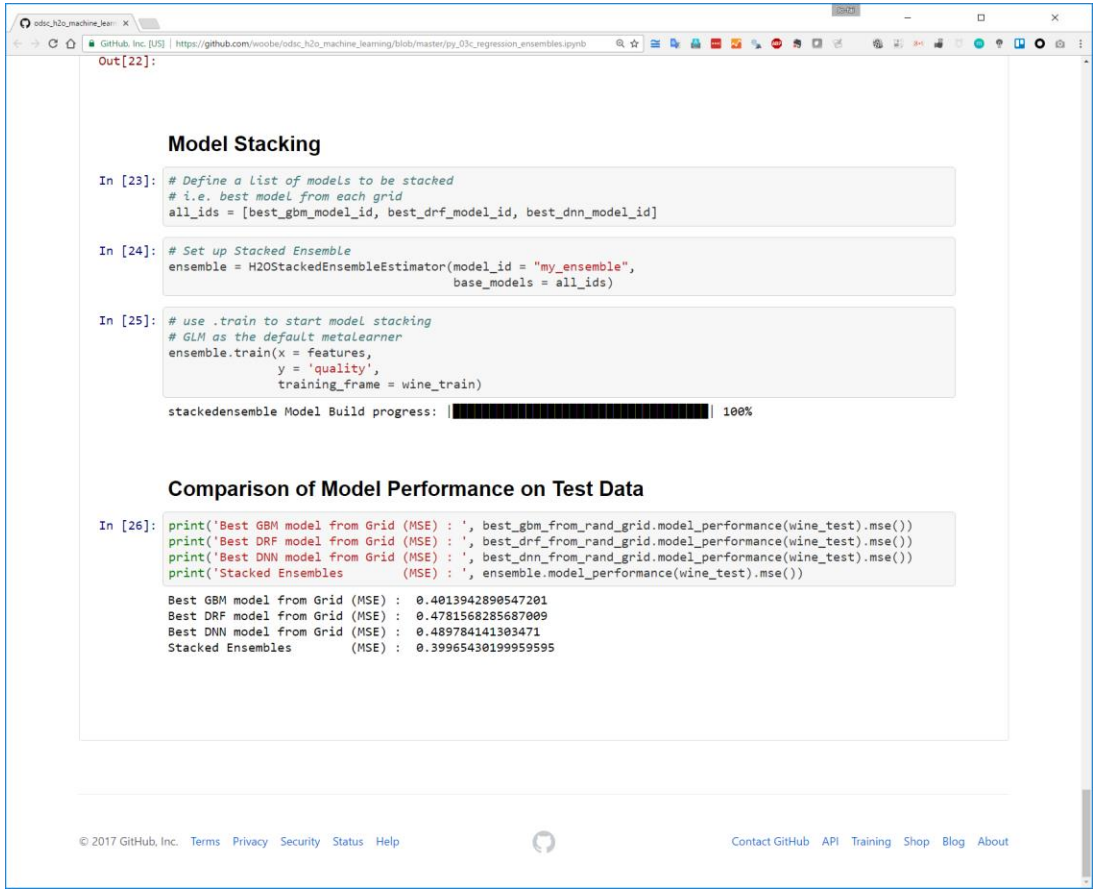
https://github.com/h2oai/h2o-meetups/blob/master/2017_02_23_Metis_SF_Stacked_Ensembles_Deep_Water/stacked_ensembles_in_h2o_feb2017.pdf

February 2017

Erin LeDell Ph.D.
Machine Learning Scientist

H2O.ai

Available in both Python and R



Out[22]:

Model Stacking

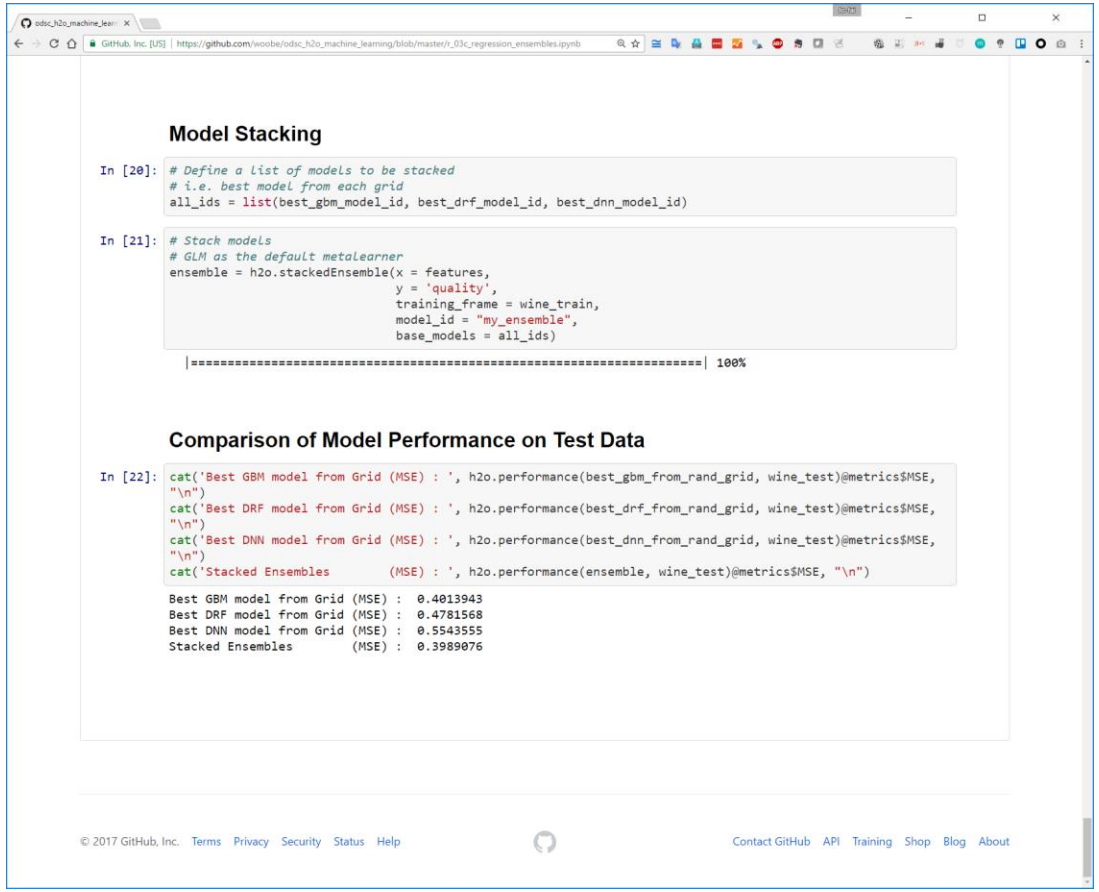
```
In [23]: # Define a list of models to be stacked
         # i.e. best model from each grid
         all_ids = [best_gbm_model_id, best_drf_model_id, best_dnn_model_id]

In [24]: # Set up Stacked Ensemble
         ensemble = H2OStackedEnsembleEstimator(model_id = "my_ensemble",
                                                base_models = all_ids)

In [25]: # use .train to start model stacking
         # GLM as the default metalearner
         ensemble.train(x = features,
                        y = 'quality',
                        training_frame = wine_train)
```

stackedensemble Model Build progress: |████████████████████████████████| 100%

Comparison of Model Performance on Test Data

```
In [26]: print('Best GBM model from Grid (MSE) : ', best_gbm_from_rand_grid.model_performance(wine_test).mse())
         print('Best DRF model from Grid (MSE) : ', best_drf_from_rand_grid.model_performance(wine_test).mse())
         print('Best DNN model from Grid (MSE) : ', best_dnn_from_rand_grid.model_performance(wine_test).mse())
         print('Stacked Ensembles        (MSE) : ', ensemble.model_performance(wine_test).mse())
```

```
Best GBM model from Grid (MSE) :  0.4013942890547201
Best DRF model from Grid (MSE) :  0.4781568285687009
Best DNN model from Grid (MSE) :  0.489784141303471
Stacked Ensembles        (MSE) :  0.39965430199959595
```

Model Stacking

```
In [20]: # Define a list of models to be stacked
         # i.e. best model from each grid
         all_ids = list(best_gbm_model_id, best_drf_model_id, best_dnn_model_id)

In [21]: # Stack models
         # GLM as the default metalearner
         ensemble = h2o.stackedEnsemble(x = features,
                                        y = 'quality',
                                        training_frame = wine_train,
                                        model_id = "my_ensemble",
                                        base_models = all_ids)
```

|==========| 100%

Comparison of Model Performance on Test Data

```
In [22]: cat('Best GBM model from Grid (MSE) : ', h2o.performance(best_gbm_from_rand_grid, wine_test)@metrics$MSE,
         "\n")
         cat('Best DRF model from Grid (MSE) : ', h2o.performance(best_drf_from_rand_grid, wine_test)@metrics$MSE,
         "\n")
         cat('Best DNN model from Grid (MSE) : ', h2o.performance(best_dnn_from_rand_grid, wine_test)@metrics$MSE,
         "\n")
         cat('Stacked Ensembles        (MSE) : ', h2o.performance(ensemble, wine_test)@metrics$MSE, "\n")
```

```
Best GBM model from Grid (MSE) :  0.4013943
Best DRF model from Grid (MSE) :  0.4781568
Best DNN model from Grid (MSE) :  0.5543555
Stacked Ensembles        (MSE) :  0.3989076
```


https://github.com/woobe/odsc_h2o_machine_learning

H2O.ai

Automatic Machine Learning (AutoML)

H2O AutoML

- AutoML stands for "Automatic Machine Learning"
- The idea here is to remove most (or all) of the parameters from the algorithm, as well as automatically generate derived features that will aid in learning.
- Single algorithms are tuned automatically using a carefully constructed random grid search.
- Optionally, a Stacked Ensemble can be constructed.

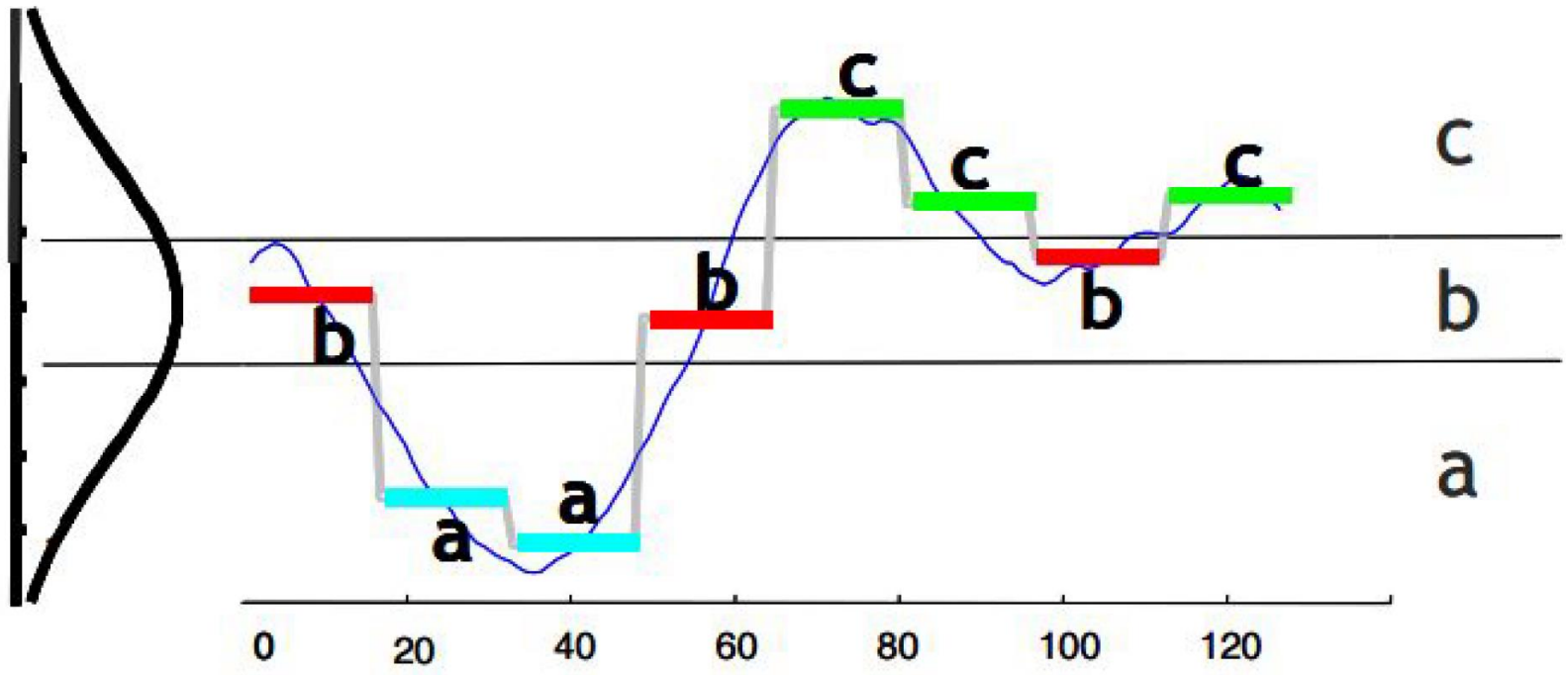
Public code coming soon!

Time Series in H_2O

ISAX

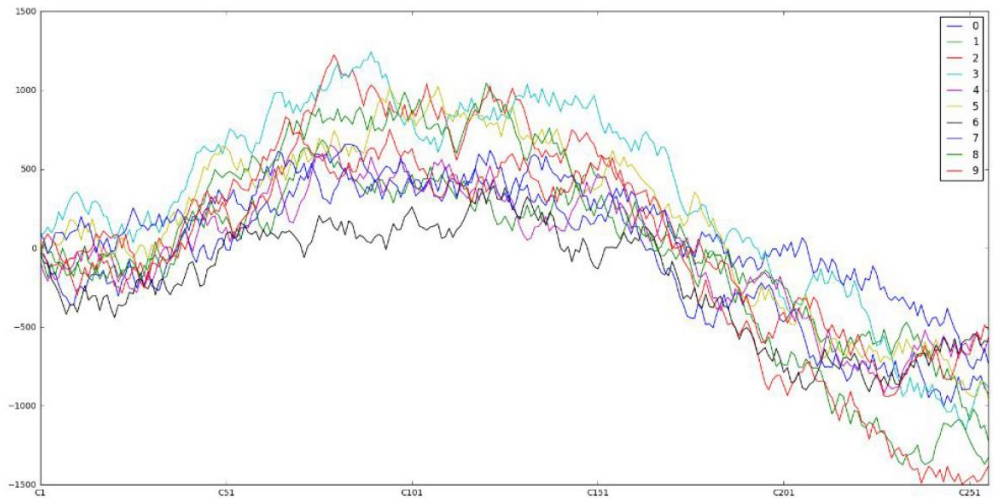
- Time series data compression algorithm, implemented on H2O's distributed architecture
- Find groups of similar time series patterns in one billion
  - http://blog.h2o.ai/2016/11/indexing-1-billion-time-series-with-h2o-and-isax/
- ISAX applied to fields such as IoT, Finance, BioInformatics,Image/Sound processing.
  - http://www.cs.ucr.edu/~eamonn/SAX.htm
- Compress your time series data and run:
  - Clustering
  - Classification
  - Anomaly Detection
  - Predictive analytics

ISAX



ISAX

- Highly scalable, tested on 2TB of data, 1Billion time series w/ 256 points (columns)
  - Leverages H2O's MapReduce framework
- Accessible from R or Python
- Image below, a group of similar time series was found from 1 Billion. Search took ~5 minutes. Indexing took 10 minutes.

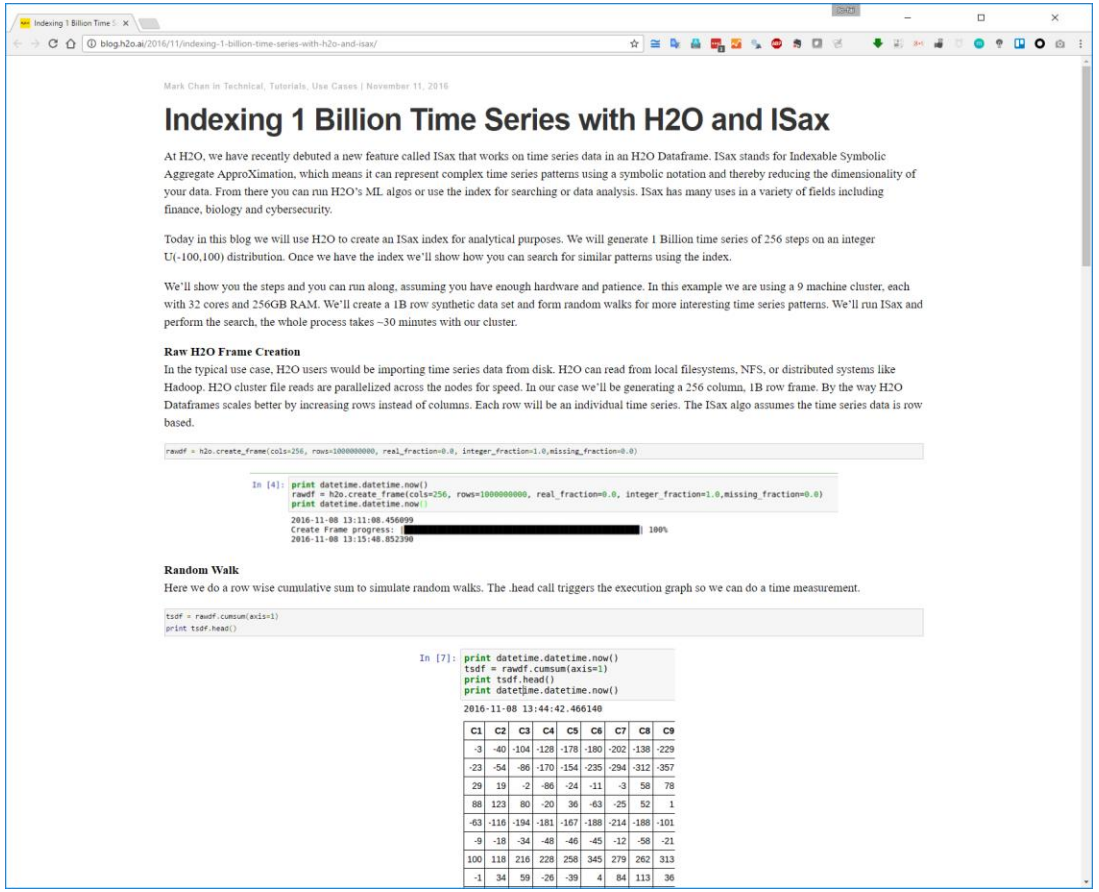


Time Series at H2O

- More time series features are coming to H2O soon. Keep checking back!
  - Pivoting
  - Rolling Window

Blog Post

http://blog.h2o.ai/2016/11/indexing-1-billion-time-series-with-h2o-and-isax/



Mark Chan in Technical, Tutorials, Use Cases | November 11, 2016

Indexing 1 Billion Time Series with H2O and ISax

At H2O, we have recently debuted a new feature called ISax that works on time series data in an H2O Dataframe. ISax stands for Indexable Symbolic Aggregate ApproXimation, which means it can represent complex time series patterns using a symbolic notation and thereby reducing the dimensionality of your data. From there you can run H2O's ML algos or use the index for searching or data analysis. ISax has many uses in a variety of fields including finance, biology and cybersecurity.

Today in this blog we will use H2O to create an ISax index for analytical purposes. We will generate 1 Billion time series of 256 steps on an integer U(-100,100) distribution. Once we have the index we'll show how you can search for similar patterns using the index.

We'll show you the steps and you can run along, assuming you have enough hardware and patience. In this example we are using a 9 machine cluster, each with 32 cores and 256GB RAM. We'll create a 1B row synthetic data set and form random walks for more interesting time series patterns. We'll run ISax and perform the search, the whole process takes ~30 minutes with our cluster.

Raw H2O Frame Creation

In the typical use case, H2O users would be importing time series data from disk. H2O can read from local filesystems, NFS, or distributed systems like Hadoop. H2O cluster file reads are parallelized across the nodes for speed. In our case we'll be generating a 256 column, 1B row frame. By the way H2O Dataframes scales better by increasing rows instead of columns. Each row will be an individual time series. The ISax algo assumes the time series data is row based.

```
rawdf = h2o.create_frame(cols=256, rows=1000000000, real_fraction=0.0, integer_fraction=1.0,missing_fraction=0.0)
```

```
In [4]: print datetime.datetime.now()
        rawdf = h2o.create_frame(cols=256, rows=1000000000, real_fraction=0.0, integer_fraction=1.0,missing_fraction=0.0)
        print datetime.datetime.now()

        2016-11-08 13:11:08.456099
        Create Frame progress: [##################################################] 100%
        2016-11-08 13:15:48.852390
```

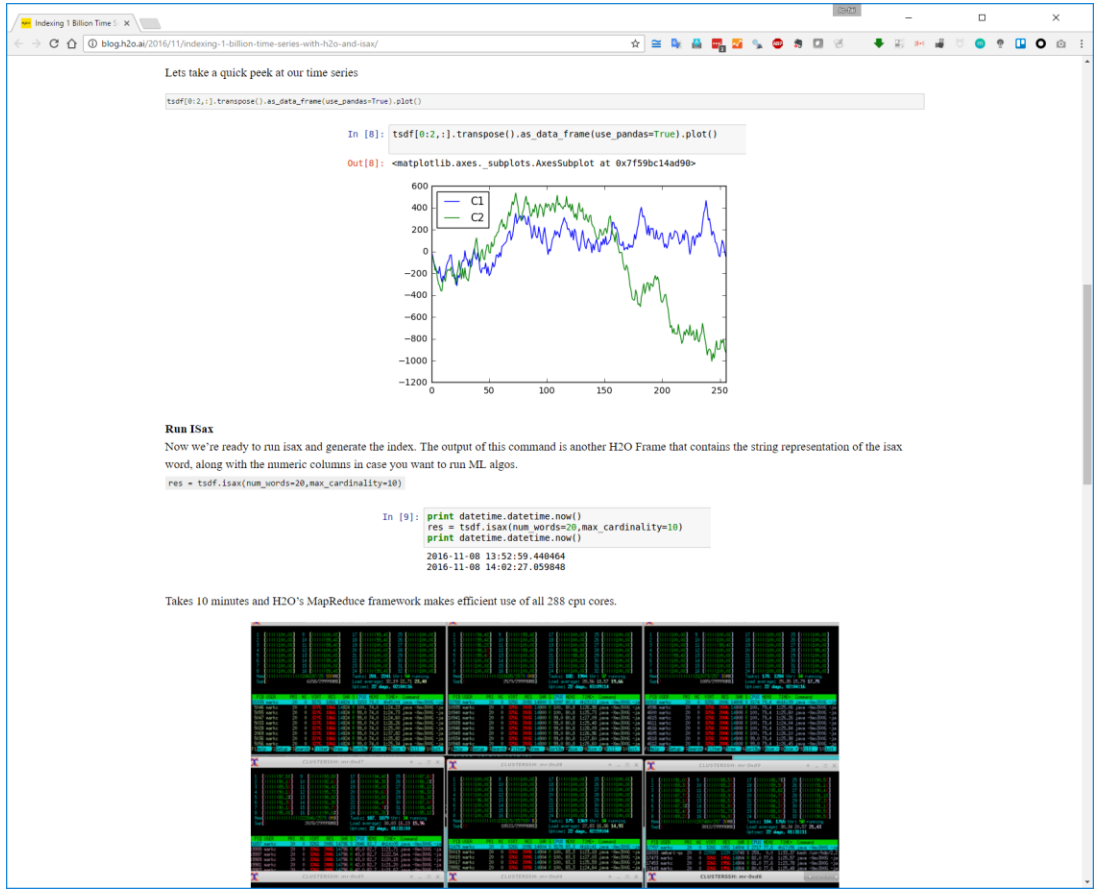
Random Walk

Here we do a row wise cumulative sum to simulate random walks. The .head call triggers the execution graph so we can do a time measurement.

```
tsdf = rawdf.cumsum(axis=1)
print tsdf.head()
```

```
In [7]: print datetime.datetime.now()
        tsdf = rawdf.cumsum(axis=1)
        print tsdf.head()
        print datetime.datetime.now()

        2016-11-08 13:44:42.466140
```

C1	C2	C3	C4	C5	C6	C7	C8	C9
-3	-40	-104	-128	-178	-180	-202	-138	-229
-23	-54	-86	-170	-154	-235	-294	-312	-357
29	19	-2	-86	-24	-11	-3	58	78
88	123	80	-20	36	-63	-25	52	1
-63	-116	-194	-181	-167	-188	-214	-188	-101
-9	-18	-34	-48	-46	-45	-12	-58	-21
100	118	216	228	258	345	279	262	313
-1	34	59	-26	-39	4	84	113	36



Lets take a quick peek at our time series

```
tsdf[0:2,:].transpose().as_data_frame(use_pandas=True).plot()
```

```
In [8]: tsdf[0:2,:].transpose().as_data_frame(use_pandas=True).plot()

Out[8]: <matplotlib.axes._subplots.AxesSubplot at 0x7f59bc14ad90>
```


Run ISax

Now we're ready to run isax and generate the index. The output of this command is another H2O Frame that contains the string representation of the isax word, along with the numeric columns in case you want to run ML algos.

```
res = tsdf.isax(num_words=20,max_cardinality=10)
```

```
In [9]: print datetime.datetime.now()
        res = tsdf.isax(num_words=20,max_cardinality=10)
        print datetime.datetime.now()

        2016-11-08 13:52:59.440464
        2016-11-08 14:02:27.059848
```

Takes 10 minutes and H2O's MapReduce framework makes efficient use of all 288 cpu cores.

H2O.ai

More Slides & Code Examples

- https://github.com/h2oai/h2o-meetups/tree/master/2017_02_16_TimeSeries_Meetup

- https://github.com/h2oai/h2o-3/blob/master/h2o-core/src/main/java/water/rapids/ast/prims/reducers/AstCumu.java

- https://github.com/h2oai/h2o-3/blob/master/h2o-core/src/main/java/water/rapids/ast/prims/timeseries/AstIsax.java

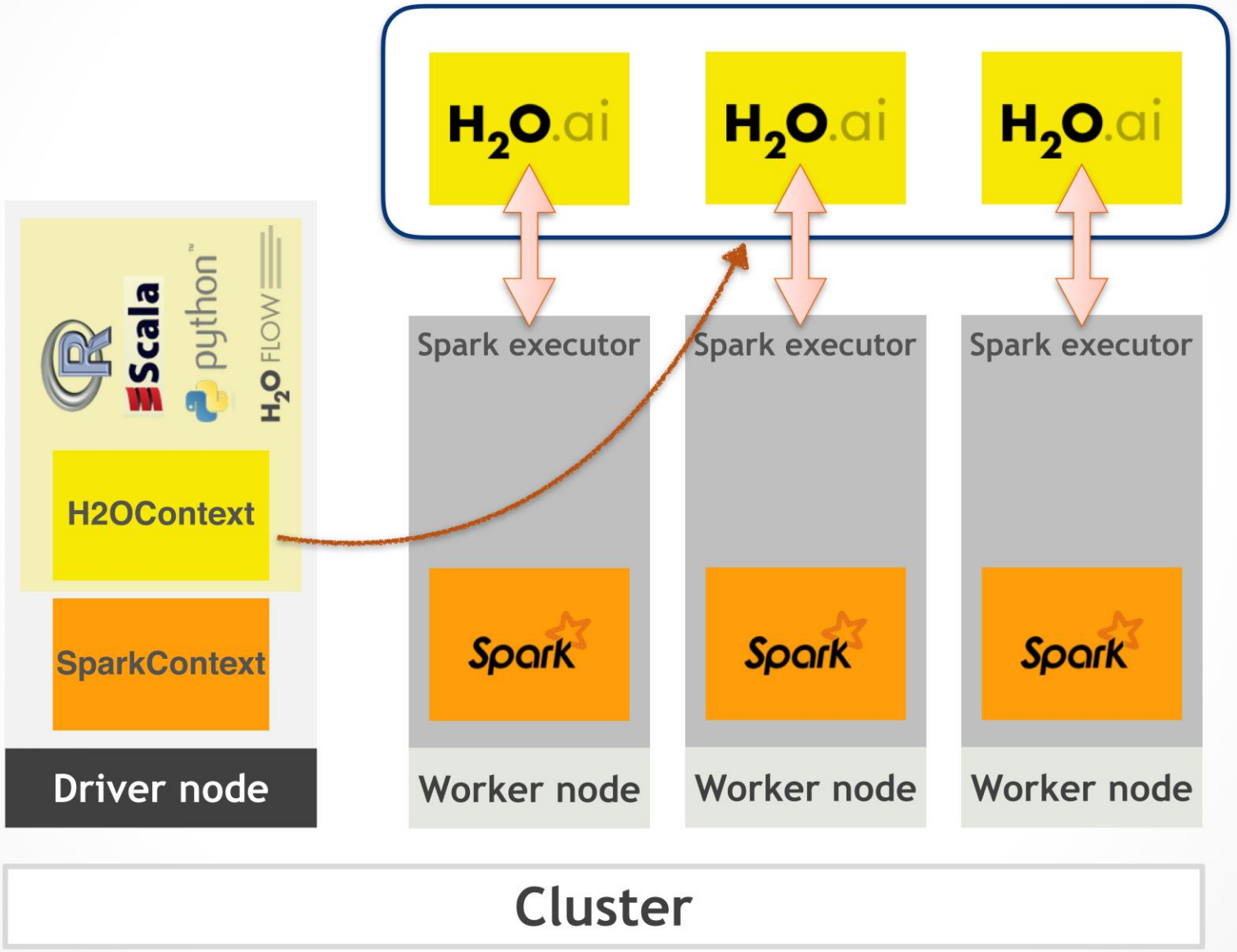
Sparkling Water

H_2O's integration with Spark – latest developments

External H_2O Backend for Sparkling Water

- High Availability Mode
  - Separating Spark and H_2O
  - while preserving same API
- Advantages
  - H_2O does not crash when Spark executor goes down
  - Better resource management since resources can be planned per tool
- Disadvantages
  - Transfer overhead between Spark and H_2O processes
  - Under measurement with cooperation of a customer
- Links
  - https://github.com/h2oai/sparkling-water/blob/master/doc/backends.md

High Availability



Deep Water

H_2O's integration with TensorFlow, MXNet and Caffe – latest developments

Latest in Deep Water

- MXNet
  - Works on most stuff
- TensorFlow
  - Works on most stuff
- Caffe
  - Works on Multi-GPU
  - Does not score yet

- Latest deepwater branch in h2o-3
  - https://github.com/h2oai/h2o-3/tree/deepwater

H_2O + xgboost

Brand-new: H2O XGBoost Integration (Gradient Boosting)

Why XGBoost?

Competitive **accuracy** and **speed** (great for Kaggle)

GPU support (for small/medium data)

Efficient on **sparse** data

Why integrate into H2O?

Ease of use (**Flow** GUI, R/Py APIs)

Real-time model status (var imp, metrics)

Efficient **data preprocessing** (sparse, categorical)

Integration into **H2O ecosystem** (modeling, deployment, support)

Live Demo of GPU Gradient Boosting in H2O

Build a Model

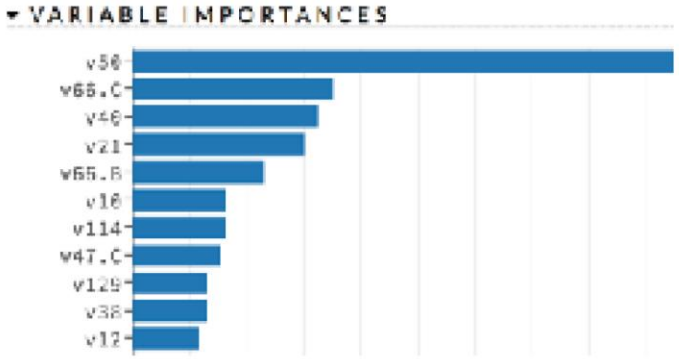
Select an algorithm: XGBoost

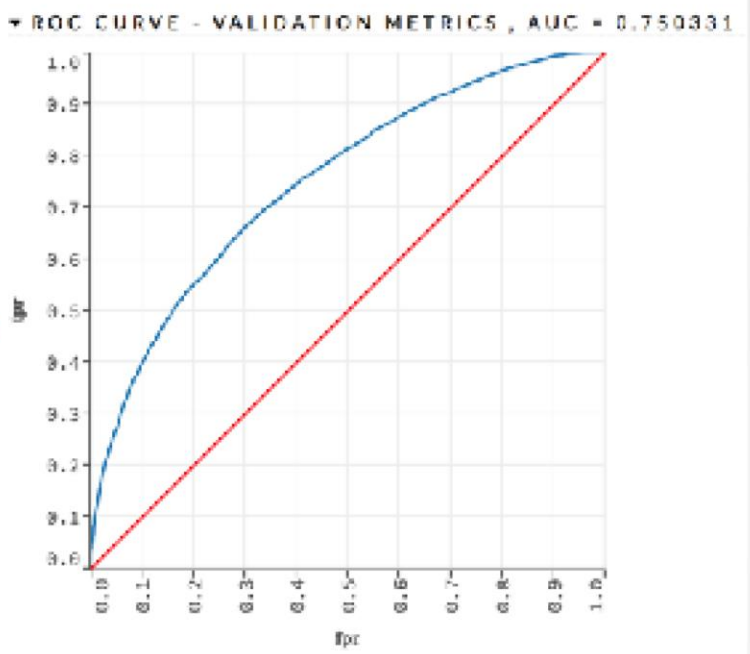
booster gbtree

reg_lambda 1

reg_alpha (Choose...)

backend auto / gpu / cpu






```
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 375.20                 Driver Version: 375.20                    |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|===============================+======================+======================|
|   0  GeForce GTX 1080    Off  | 0000:02:00.0     On |                  N/A |
| 27%   43C    P2    83W / 180W |   2040MiB /  8145MiB |     94%      Default |
+-------------------------------+----------------------+----------------------+
```

```
gbm = h2o.get_model("h2o-gbm")
xgb = h2o.get_model("h2o-xgboost")
print("H2O GBM:      Validation AUC=%r" % gbm.auc(valid=True))
print("H2O XGBoost: Validation AUC=%r" % xgb.auc(valid=True))
```

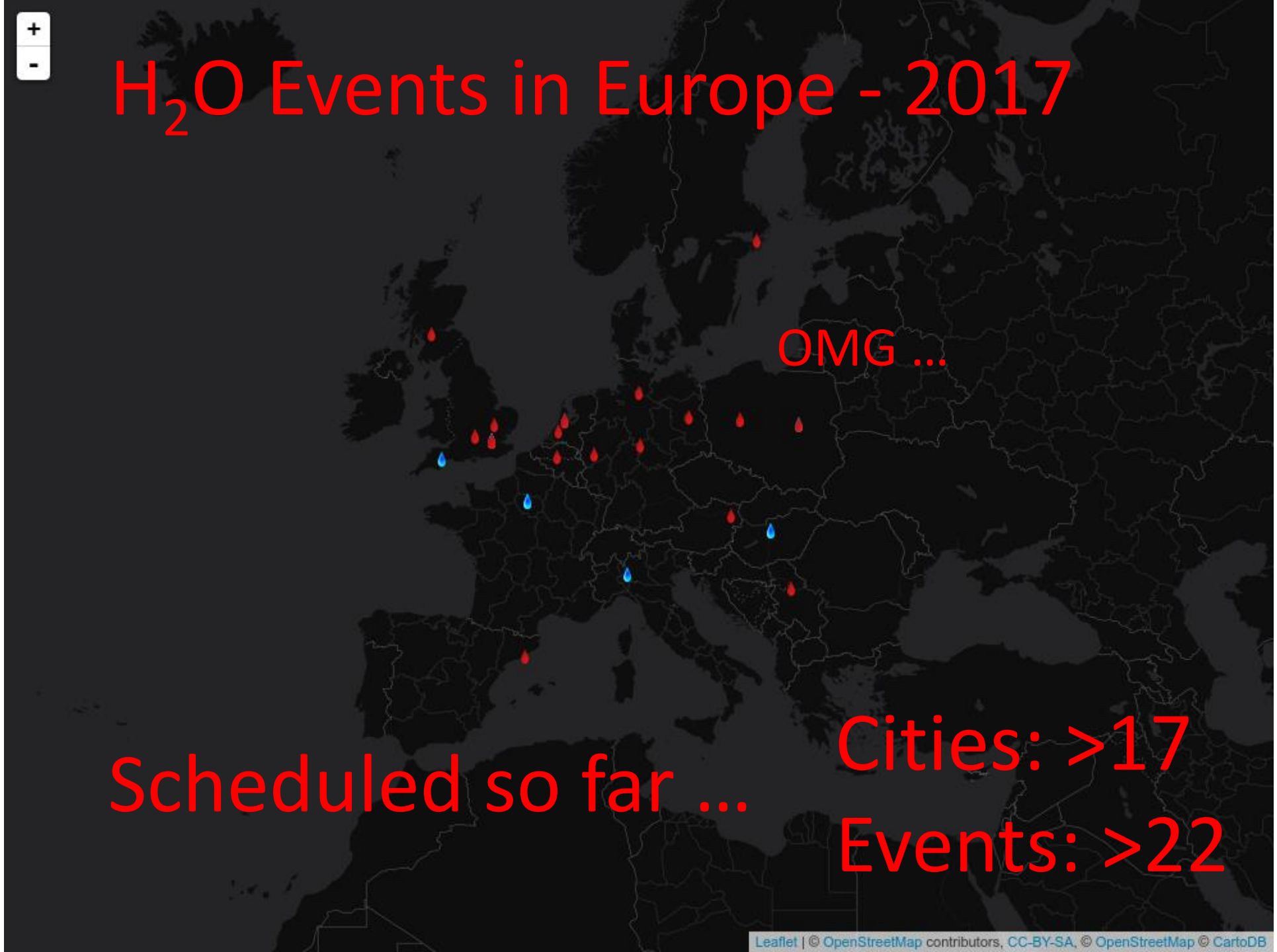
```
H2O GBM:      Validation AUC=0.7517126133633125
H2O XGBoost: Validation AUC=0.750331001716736
```

H2O.ai

Kaggle dataset: BNP Paribas Cardif Claims Management

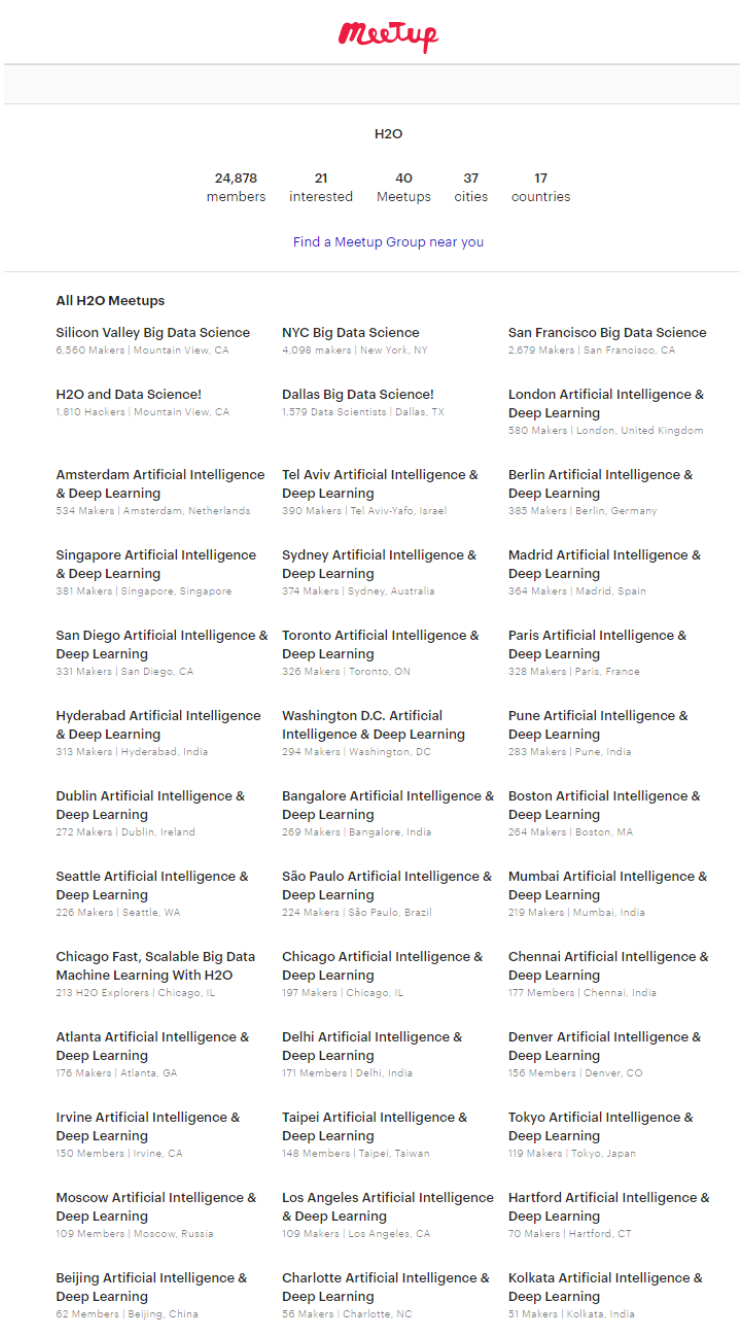
Community Events in Europe


+
-
H_2O Events in Europe - 2016
London: 13
Amsterdam: 1
Exeter: 1
Warsaw: 1
Paris: 3
Budapest: 2
Milan: 1
Cities: 7
Events: 22
Leaflet | © OpenStreetMap contributors, CC-BY-SA, © OpenStreetMap © CartoDB


+
-
H_2O Events in Europe - 2017
OMG …
Scheduled so far …
Cities: >17
Events: >22
Leaflet | © OpenStreetMap contributors, CC-BY-SA, © OpenStreetMap © CartoDB

H_2O Meetup Groups

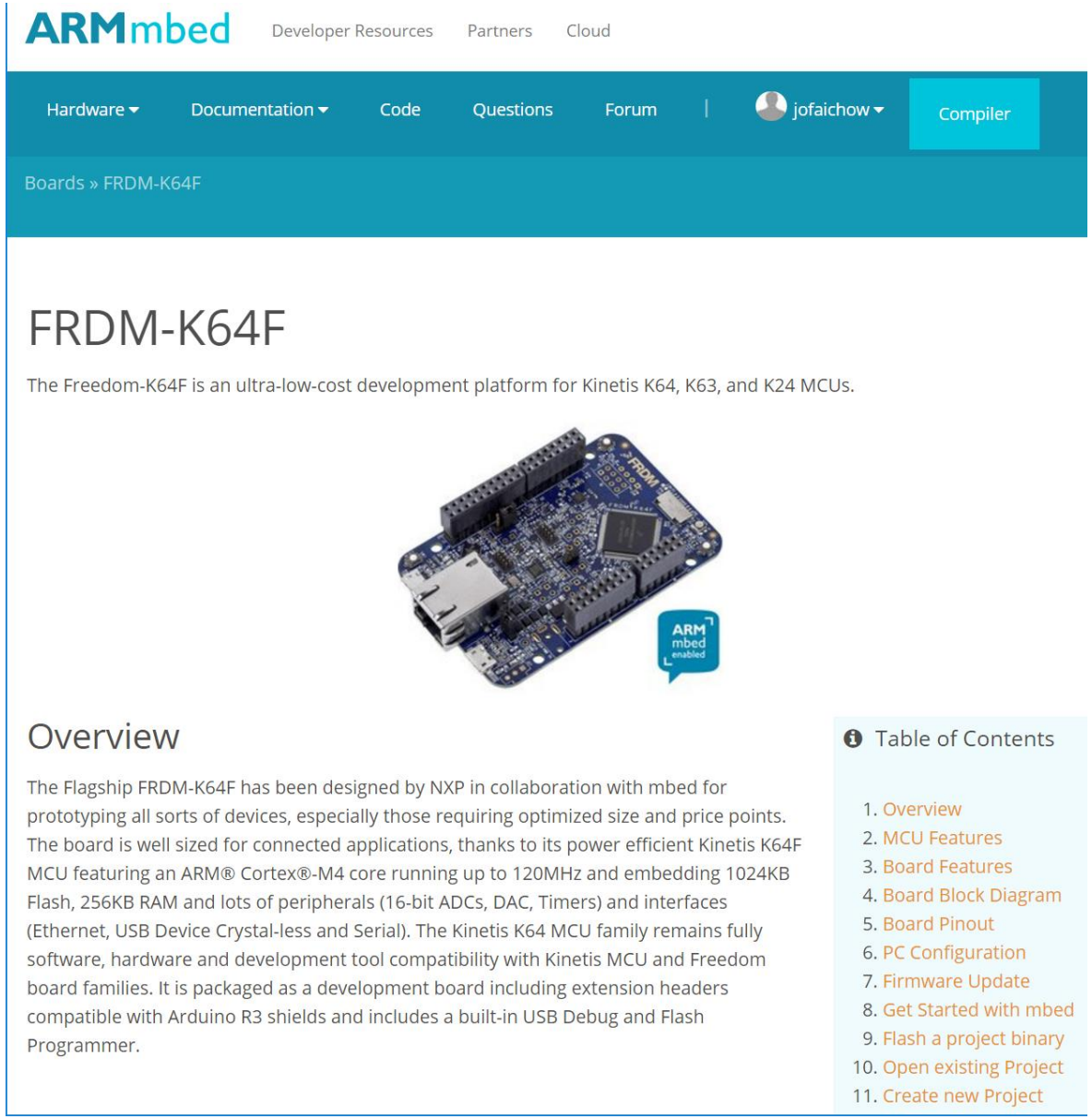
- www.meetup.com/topics/h2o/all/
- Need your help ☺



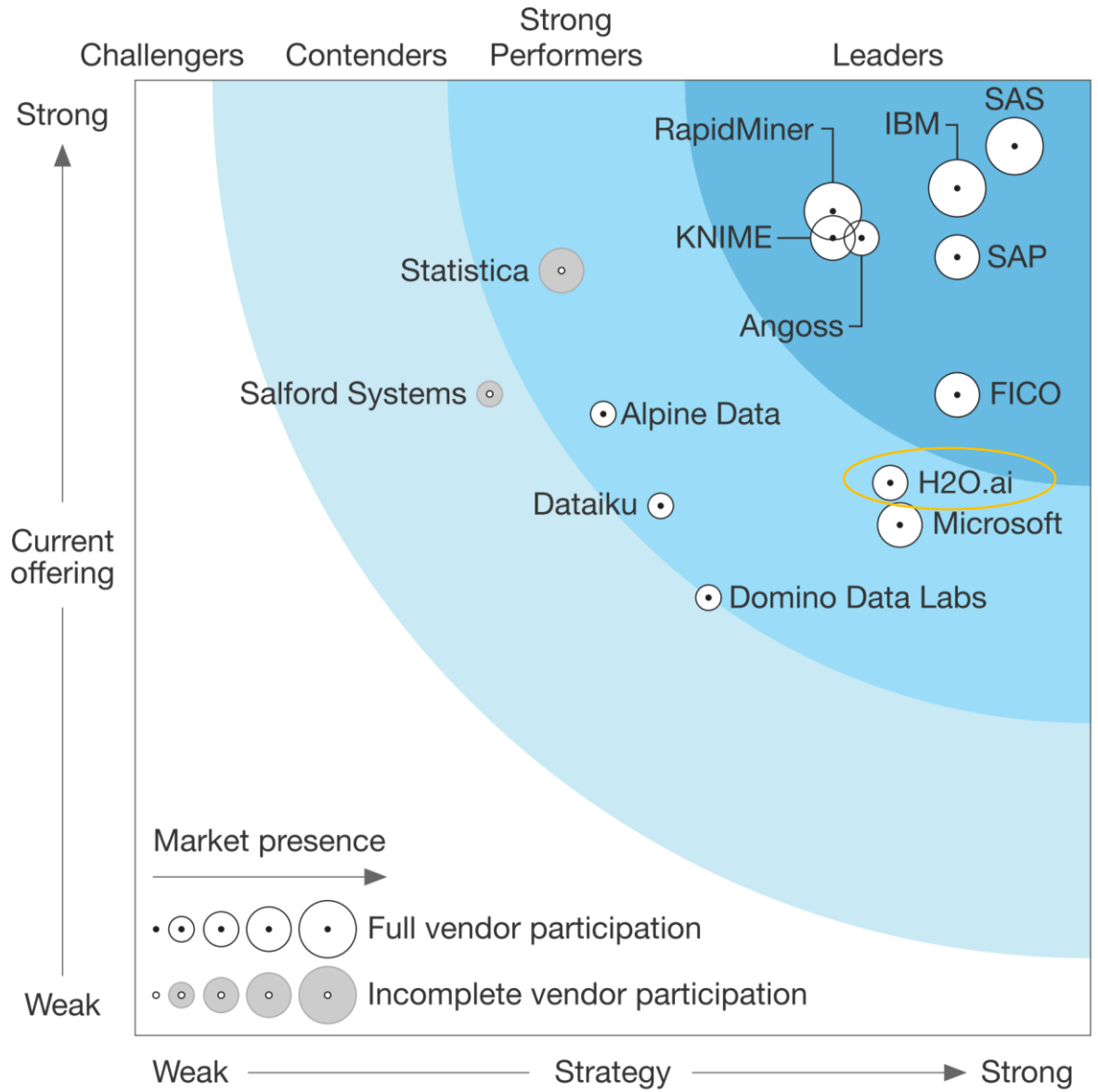
H_2O on ARM

H_2O on ARM

- New Challenge
  - Use ARM device for MOJO (scoring only – not model training)
  - C++ instead of Java
- Discussion
  - Data Collection
  - Inputs? (IoT Applications)
  - Outputs? (How to represent)



Other News



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129452

107 OF THE FORTUNE 500 ♥ H2O

8 OF TOP 10 BANKS

7 OF TOP 10 INSURANCE COMPANIES

4 OF TOP 10 HEALTHCARE COMPANIES

Thanks!

- Slides
  - bit.ly/h2o_meetups
- Contact
  - joe@h2o.ai
  - @matlabulous
  - github.com/woobe

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Making Machine Learning Accessible to Everyone

Photo credit: Virgin Media