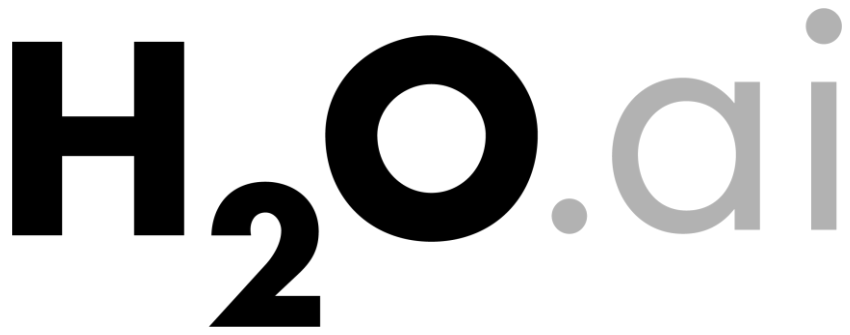
H_2O Deep Water

Making Deep Learning Accessible to Everyone



Jo-fai (Joe) Chow

Data Scientist

joe@h2o.ai

@matlabulous

Köln R at Eyeo GmbH

17th March, 2017

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
  - From 2015
  - Virgin Media (UK)
  - Domino Data Lab (Silicon Valley)
  - H_2O.ai (Silicon Valley)

Figure 1. Magic Quadrant for Data Science Platforms

Source: Gartner (February 2017)

H2O.ai recognized for completeness of vision and ability to execute

We are thrilled to be named a Visionary among the 16 vendors included in Gartner's 2017 Magic Quadrant for Data Science Platforms. As a Visionary we believe we are positioned highest in Ability to Execute for companies of our size and scale.

Since 2011, our mission has been to democratize data science through open source AI and deep learning. Today, H2O.ai is focused on bringing AI to enterprises with a growing community of more than 8,500 organizations that depend on H2O for mission critical applications. H2O.ai was recently named CB Insights AI 100 and is used by 107 of the Fortune 500 companies.

Disclaimer: This graphic was published by Gartner, Inc. as part of a larger research document and should be evaluated in the context of the entire document. The Gartner document is available upon request from H2O.ai.

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

H2O.ai

Agenda

- About H_2O.ai
  - Company
  - Machine Learning Platform
- Deep Learning Tools
  - TensorFlow, MXNet, Caffe, H_2O
- Deep Water
  - Motivation
  - Benefits
  - Interfaces
  - Demo
- Conclusions

About H_2O.ai

Company Overview

Founded	2011 Venture-backed, debuted in 2012
Products	• H_2O Open Source In-Memory AI Prediction Engine • Sparkling Water • Steam
Mission	Operationalize Data Science, and provide a platform for users to build beautiful data products
Team	70 employees • Distributed Systems Engineers doing Machine Learning • World-class visualization designers
Headquarters	Mountain View, CA




H_2O Machine Learning Platform

Algorithms Overview

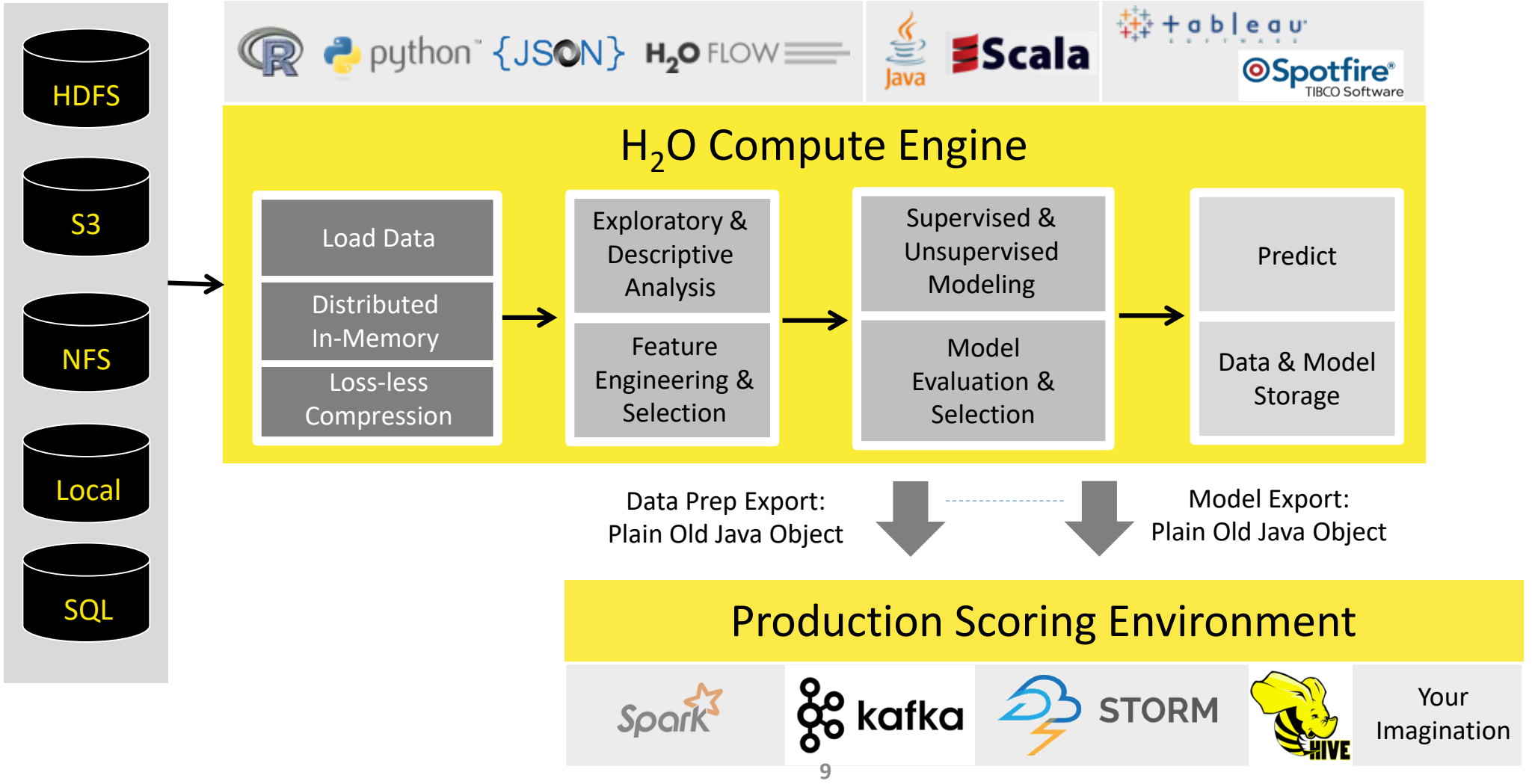
Supervised Learning

Statistical Analysis	• **Generalized Linear Models**: Binomial, Gaussian, Gamma, Poisson and Tweedie • **Naïve Bayes**
Ensembles	• **Distributed Random Forest**: Classification or regression models • **Gradient Boosting Machine**: Produces an ensemble of decision trees with increasing refined approximations
Deep Neural Networks	• **Deep learning**: Create multi-layer feed forward neural networks starting with an input layer followed by multiple layers of nonlinear transformations

Unsupervised Learning

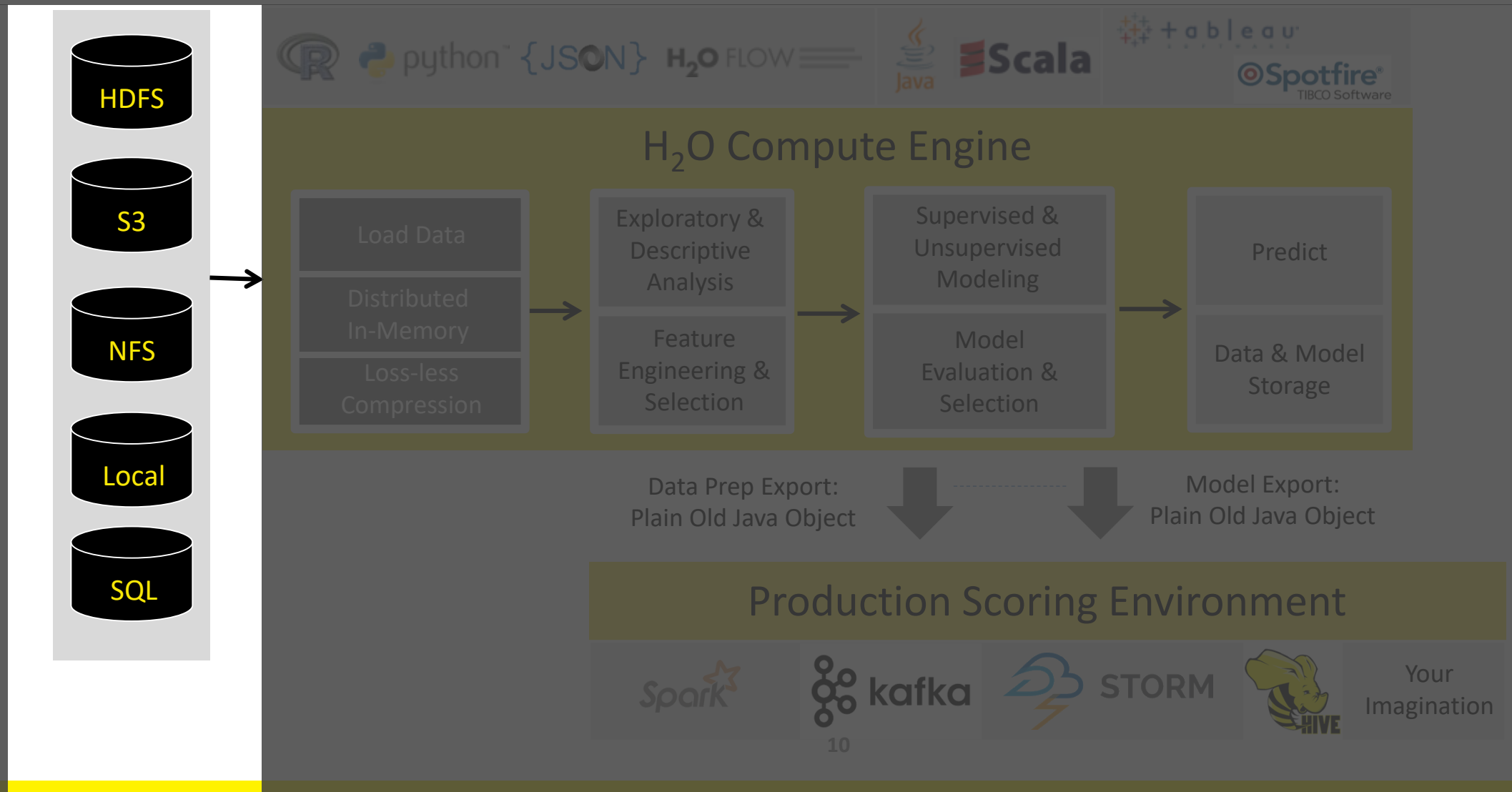
Clustering	• **K-means**: Partitions observations into k clusters/groups of the same spatial size. Automatically detect optimal k
Dimensionality Reduction	• **Principal Component Analysis**: Linearly transforms correlated variables to independent components • **Generalized Low Rank Models:** extend the idea of PCA to handle arbitrary data consisting of numerical, Boolean, categorical, and missing data
Anomaly Detection	• **Autoencoders**: Find outliers using a nonlinear dimensionality reduction using deep learning

High Level Architecture



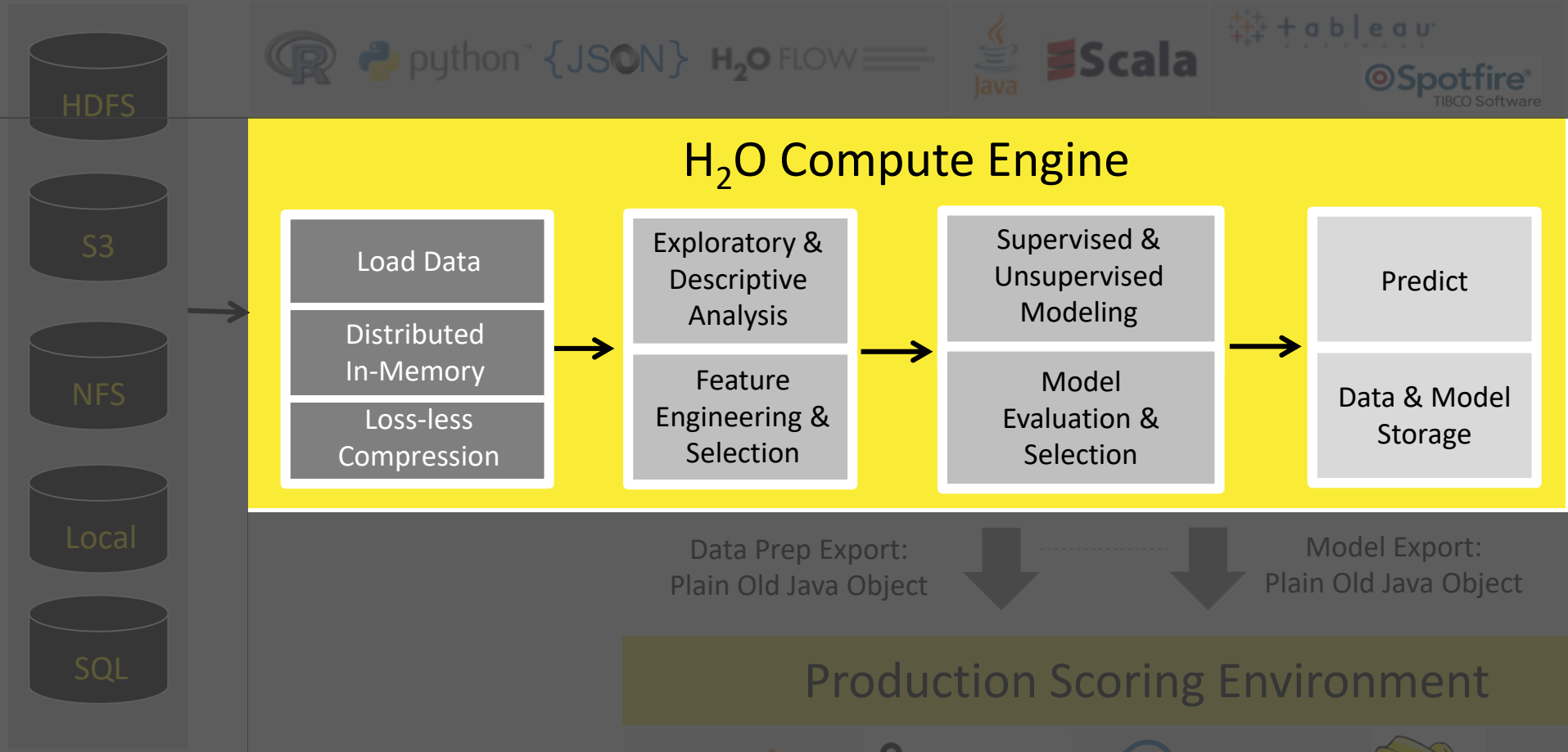
High Level Architecture

Import Data from Multiple Sources



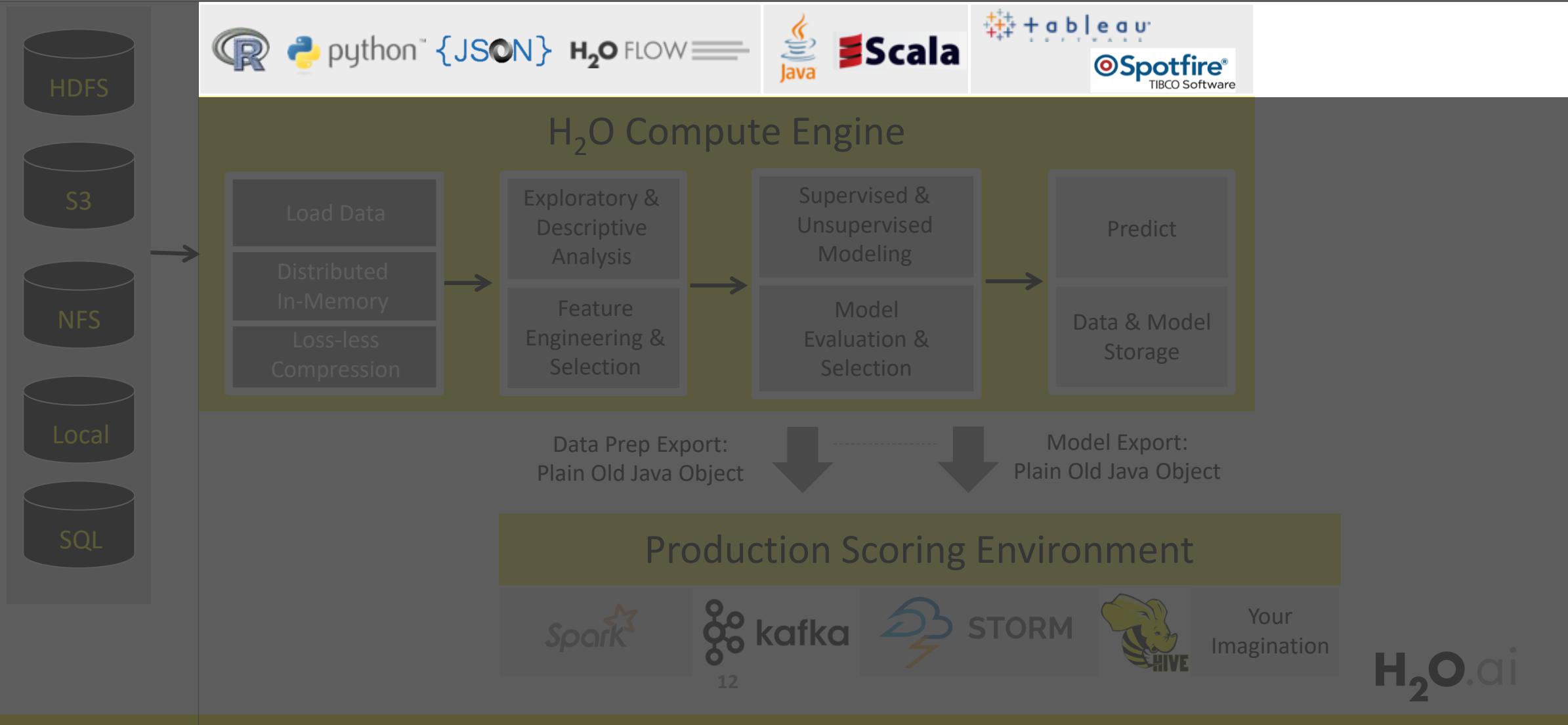
High Level Architecture

Fast, Scalable & Distributed Compute Engine Written in Java



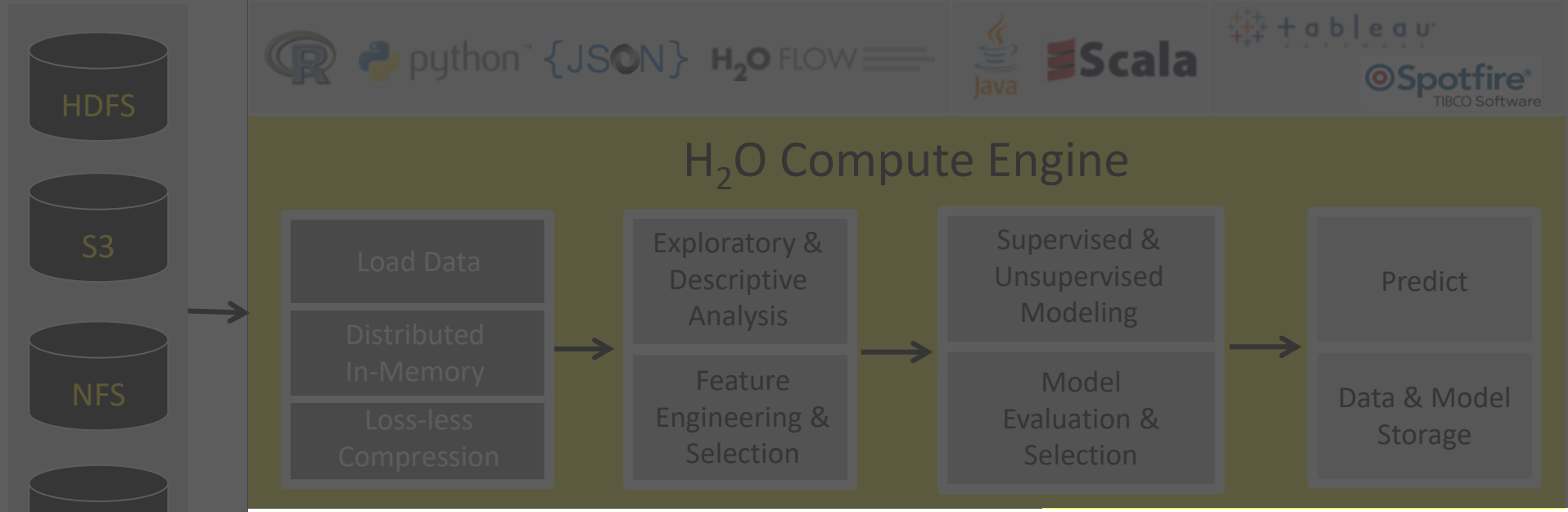
High Level Architecture

Multiple Interfaces



High Level Architecture

Export Standalone Models for Production



Data Prep Export:
Plain Old Java Object

Model Export:
Plain Old Java Object

Production Scoring Environment

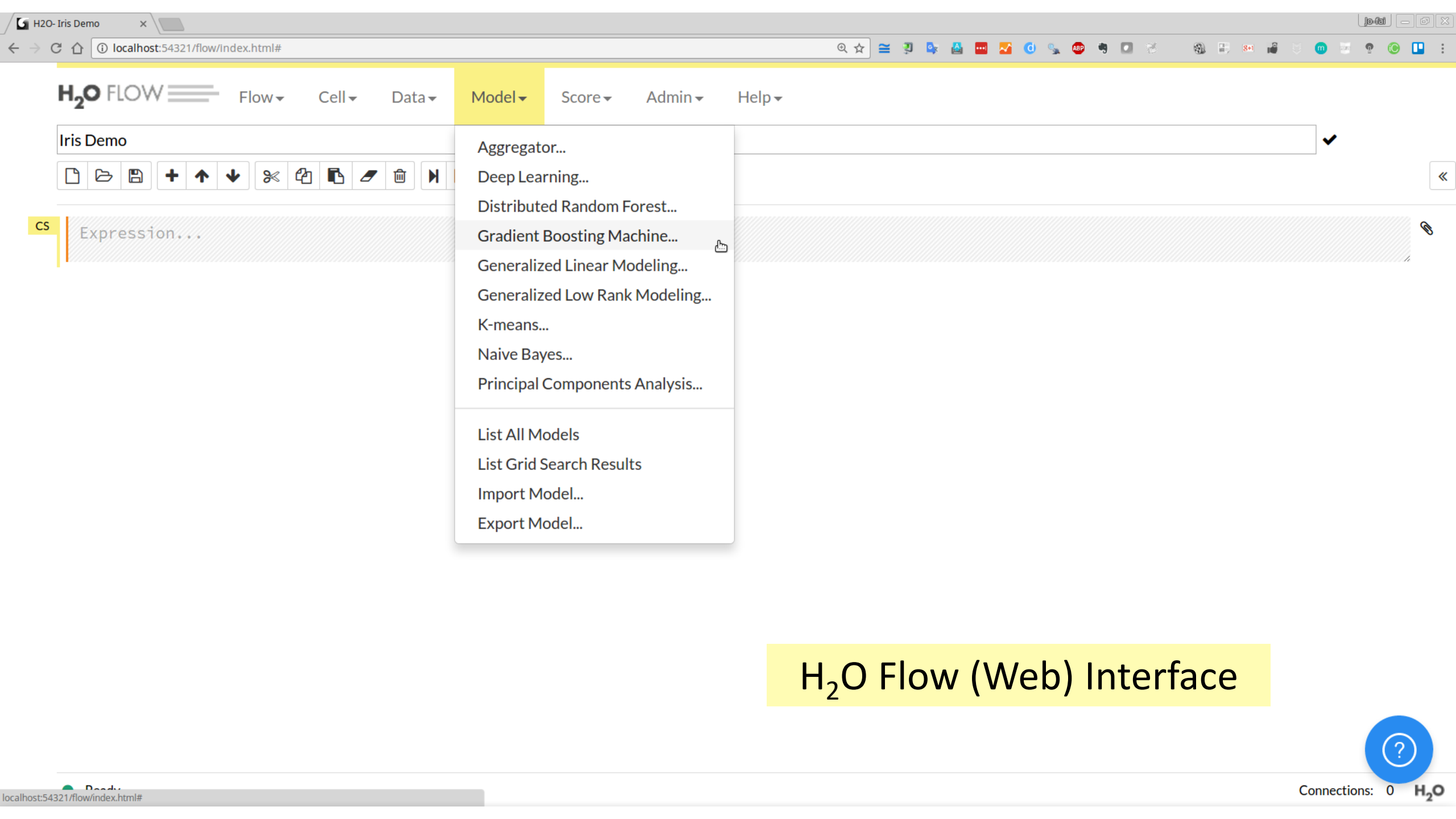
Spark | kafka | STORM | HIVE | Your Imagination

H_2O + R

h2o_iris_demo.R

Source on Save | Run | Source

```r
# ------------------------------------------------------------------------------
# Build a simple classification model using iris dataset
# ------------------------------------------------------------------------------

# Start and connect to a local H2O cluster
library(h2o)
h2o.init(nthreads = -1)

# Import data from a R data frame
data(iris)
d_iris <- as.h2o(iris)

# Define Targets and Features
target <- "Species"
features <- setdiff(colnames(d_iris), c("Species"))

# ------------------------------------------------------------------------------
# Train a H2O Model
# ------------------------------------------------------------------------------

# Train three basic H2O models
model_drf <- h2o.randomForest(x = features,
                              y = target,
                              model_id = "iris_random_forest",
                              training_frame = d_iris)

model_gbm <- h2o.gbm(x = features,
                     y = target,
                     model_id = "iris_gbm",
                     training_frame = d_iris)

model_dnn <- h2o.deeplearning(x = features,
                              y = target,
                              model_id = "iris_deep_learning",
                              training_frame = d_iris)
```



H_2O Flow (Web) Interface

docs.h2o.ai

Languages

R

- Quick Start Video - R
- R Package Docs
- R Booklet
- Examples and Demos
- R FAQ
- Ensemble R Package Readme
- RSparkling Readme
- Migrating from H2O-2

Python

- Quick Start Video - Python
- Python Module Docs
- Python Booklet
- Examples and Demos
- Python FAQ
- PySparkling Readme 2.0 | 1.6
- skutil Docs

Java

- POJO and MOJO Model Javadoc
- H2O Core Javadoc
- H2O Algorithms Javadoc

Scala

Sparkling Water API	2.0	1.6
Sparkling Water Scaladoc	2.0	1.6
H2O Scaladoc	2.11	2.10

Tutorials, Examples, & Presentations

Tutorials and Blogs

- H2O Tutorials HTML | PDF
- H2O Blogs
- H2O University

Use Case Examples

Chicago crime prediction	R	Python	ScalaSW	PySW
Airlines delays prediction	R	Python	ScalaSW	PySW
Lending Club loan prediction	R	Python	ScalaSW	PySW
Ham or Spam	R	Python	ScalaSW	PySW
Prediction with prostate dataset	R	Python	ScalaSW	PySW

Presentations

- H2O Meetups
- H2O World 2014 Videos
- H2O World 2015 Videos
- Open Tour Chicago Videos
- Open Tour NYC Videos
- Open Tour Dallas Videos

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

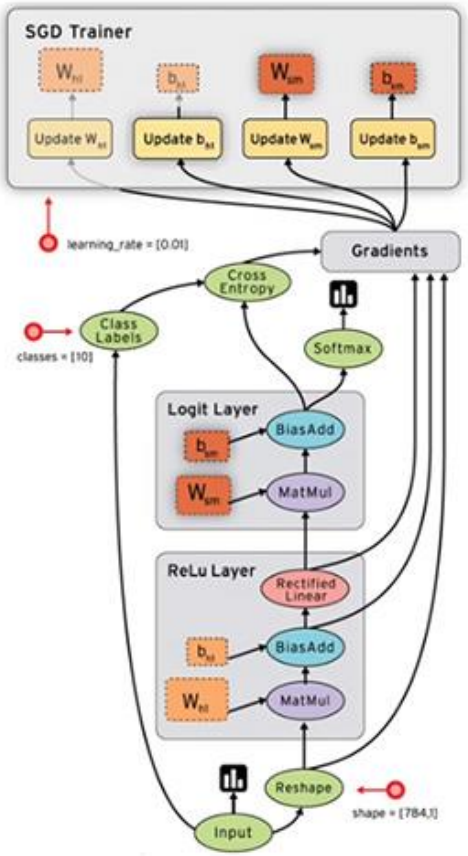
H2O.ai

Open-Source Deep Learning Tools

TensorFlow, mxnet, Caffe and H_2O Deep Learning

TensorFlow

- Open source machine learning framework by Google
- Python / C++ API
- TensorBoard
  - Data Flow Graph Visualization
- Multi CPU / GPU
  - v0.8+ distributed machines support
- Multi devices support
  - desktop, server and Android devices
- Image, audio and NLP applications
- **HUGE** Community
- Support for Spark, Windows …



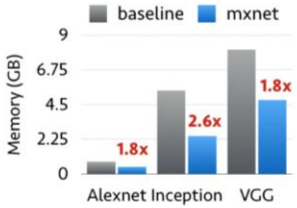
https://github.com/tensorflow/tensorflow

dmlc mxnet for Deep Learning

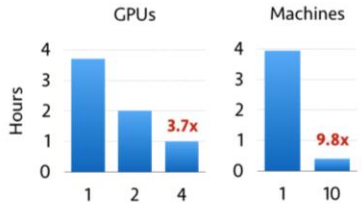
build passing | docs latest | license Apache 2.0

Portable

Efficient



Scalable



MXNet is a deep learning framework designed for both *efficiency* and *flexibility*. It allows you to ***mix*** the flavours of symbolic programming and imperative programming to ***maximize*** efficiency and productivity. In its core, a dynamic dependency scheduler that automatically parallelizes both symbolic and imperative operations on the fly. A graph optimization layer on top of that makes symbolic execution fast and memory efficient. The library is portable and lightweight, and it scales to multiple GPUs and multiple machines.

MXNet is also more than a deep learning project. It is also a collection of blue prints and guidelines for building deep learning system, and interesting insights of DL systems for hackers.

MXNet now chosen by Amazon as Deep Learning Framework

By Geneva Clark | 2016-11-24 ♡19 💬0

Share this magazine

Amazon has announced that it has chosen MXNet as its deep learning framework of choice for its web services(AWS). Amazon extensively uses machine learning in areas like fraud detection, abusive review detection, and book classification. Amazon also uses it in application areas such as text and speech recognition, autonomous drones etc...

https://github.com/dmlc/mxnet
https://www.zeolearn.com/magazine/amazon-to-use-mxnet-as-deep-learning-framework

H2O.ai

Caffe

- **C**onvolution **A**rchitecture **F**or **F**eature **E**xtraction (CAFFE)
- Pure C++ / CUDA architecture for deep learning
- Command line, Python and MATLAB interface
- Model Zoo
  - Open collection of models

https://docs.google.com/presentation/d/1UeKXVgRvvxg9OUdh_UiC5G71UMscNPlvArsWER41PsU/

H_2O Deep Learning

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Both TensorFlow and H_2O are widely used

The usage of Hadoop/Big Data tools grew to 39%, up from 29% in 2015 (and 17% in 2014), driven by Apache Spark, MLlib (Spark Machine Learning Library) and H2O.
See also

- KDnuggets interview with Spark Creator Matei Zaharia
- KDnuggets interview with Arno Candel, H2O.ai on How to Quick Start Deep Learning with H2O

http://www.kdnuggets.com

H2O and TensorFlow are tied

usage of Deep Learning tools in past year

Deep Learning Tools & Platforms: Caffe (63)	0%
Cuda-convnet (22)	0%
Convnet.js (8)	0%
carch (2)	0%
Deeplearning4j (46)	0%
H2O (190)	1%
MATLAB Deep Learning Toolbox (57)	0%
Microsoft CNTK (25)	0%
mxnet (16)	0%
Nervana (2)	0%
Tensorflow (190)	1%
Theano ecosystem including Keras, Lasagne, Pylearn2 (140)	1%
Torch (28)	0%
Veles (2)	0%
Other Deep Learning Tools (104)	1%

H_2O.ai

TensorFlow , MXNet, Caffe and H_2O democratize the power of deep learning.

H_2O platform democratizes artificial intelligence & big data science.

There are other open source deep learning libraries like Theano and Torch too.

Let’s have a party, this will be fun!

H_2O.ai


H2O.ai
Products
Industries
Customers
Community
Documentation
Download
Deep Water
H2O.ai
Caffe
mxnet
TensorFlow

Deep Water

Next-Gen Distributed Deep Learning with H_2O

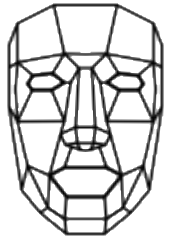
One Interface - GPU Enabled - Significant Performance Gains

Inherits All H_2O Properties in Scalability, Ease of Use and Deployment

TensorFlow Caffe H_2O.ai mxnet

Deep Water

H_2O integrates with existing GPU backends for significant performance gains



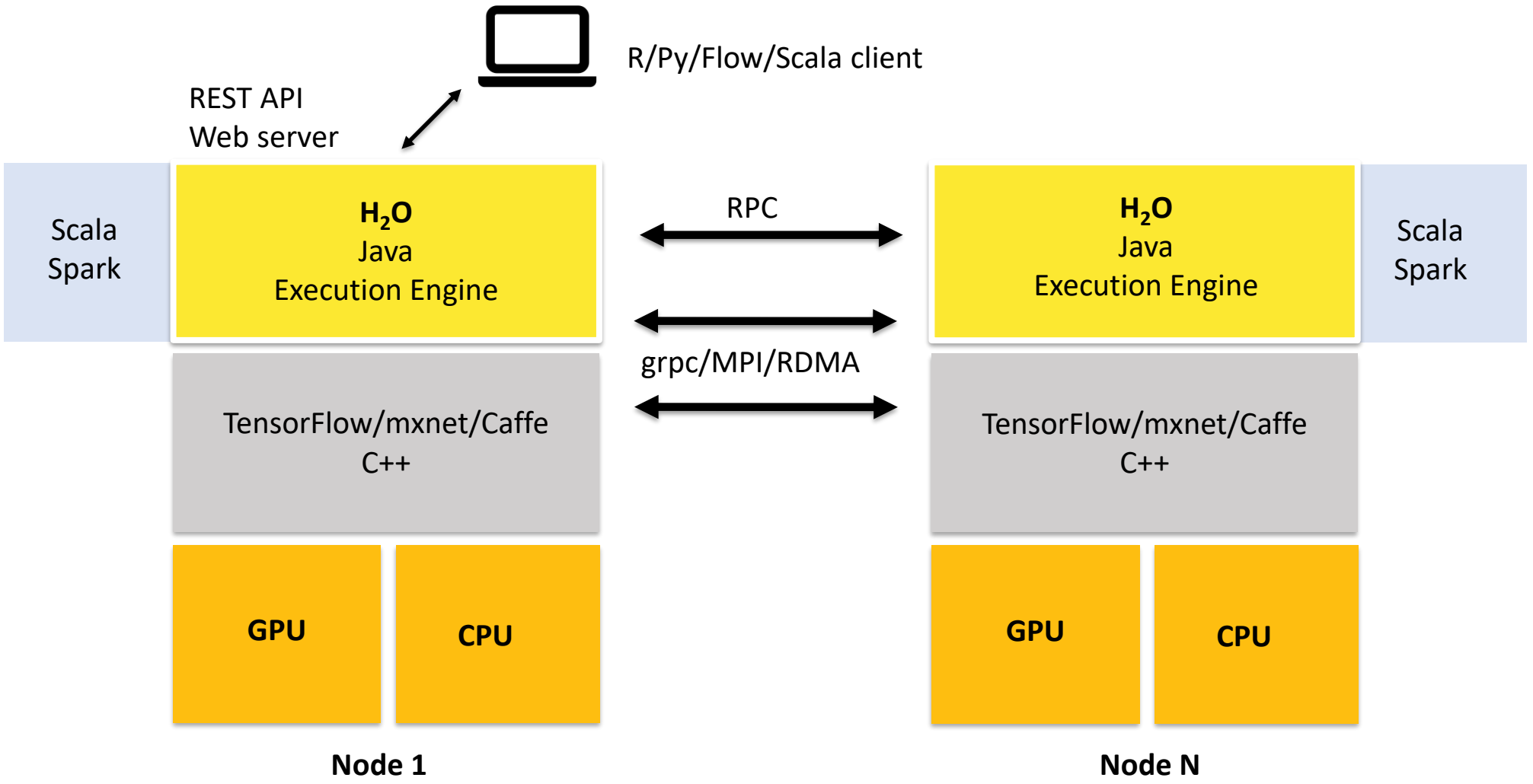
Convolutional Neural Networks enabling **Image, video, speech recognition**

Recurrent Neural Networks enabling **natural language processing, sequences, time series,** and more

Hybrid Neural Network Architectures enabling **speech to text translation, image captioning, scene parsing** and more

H_2O.ai

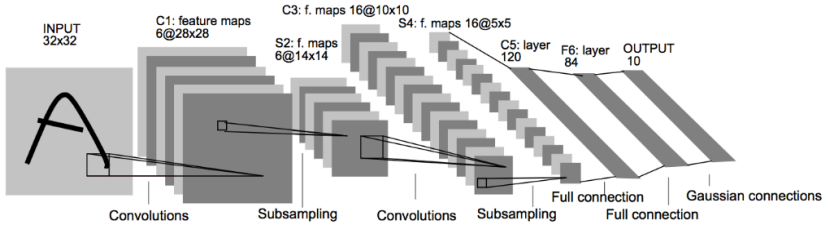
Deep Water Architecture



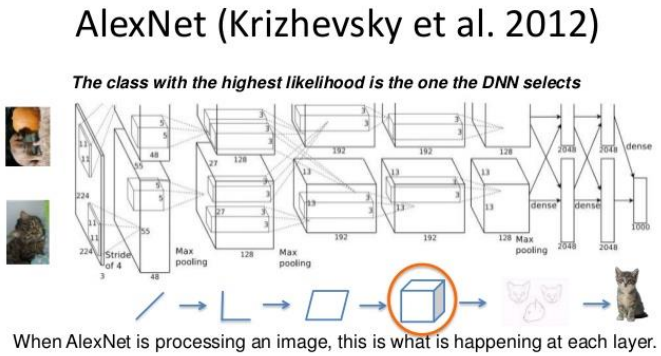
H2O.ai

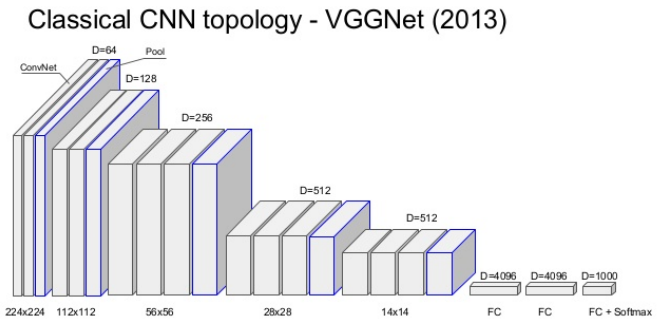
Available Networks in Deep Water

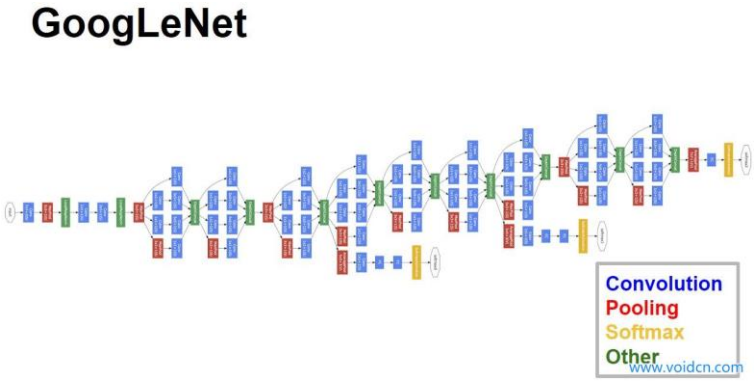
- LeNet
- AlexNet
- VGGNet
- Inception (GoogLeNet)
- ResNet (Deep Residual Learning)
- Build Your Own

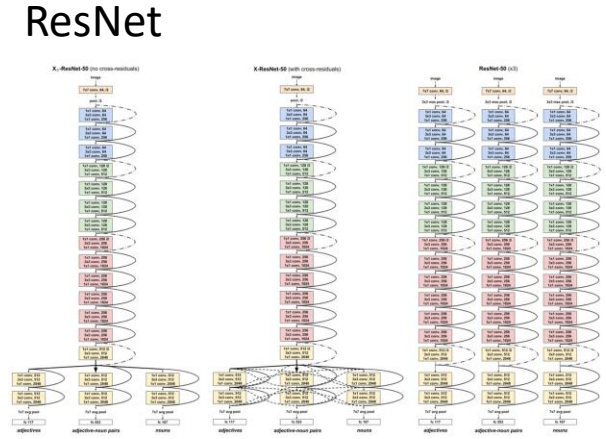


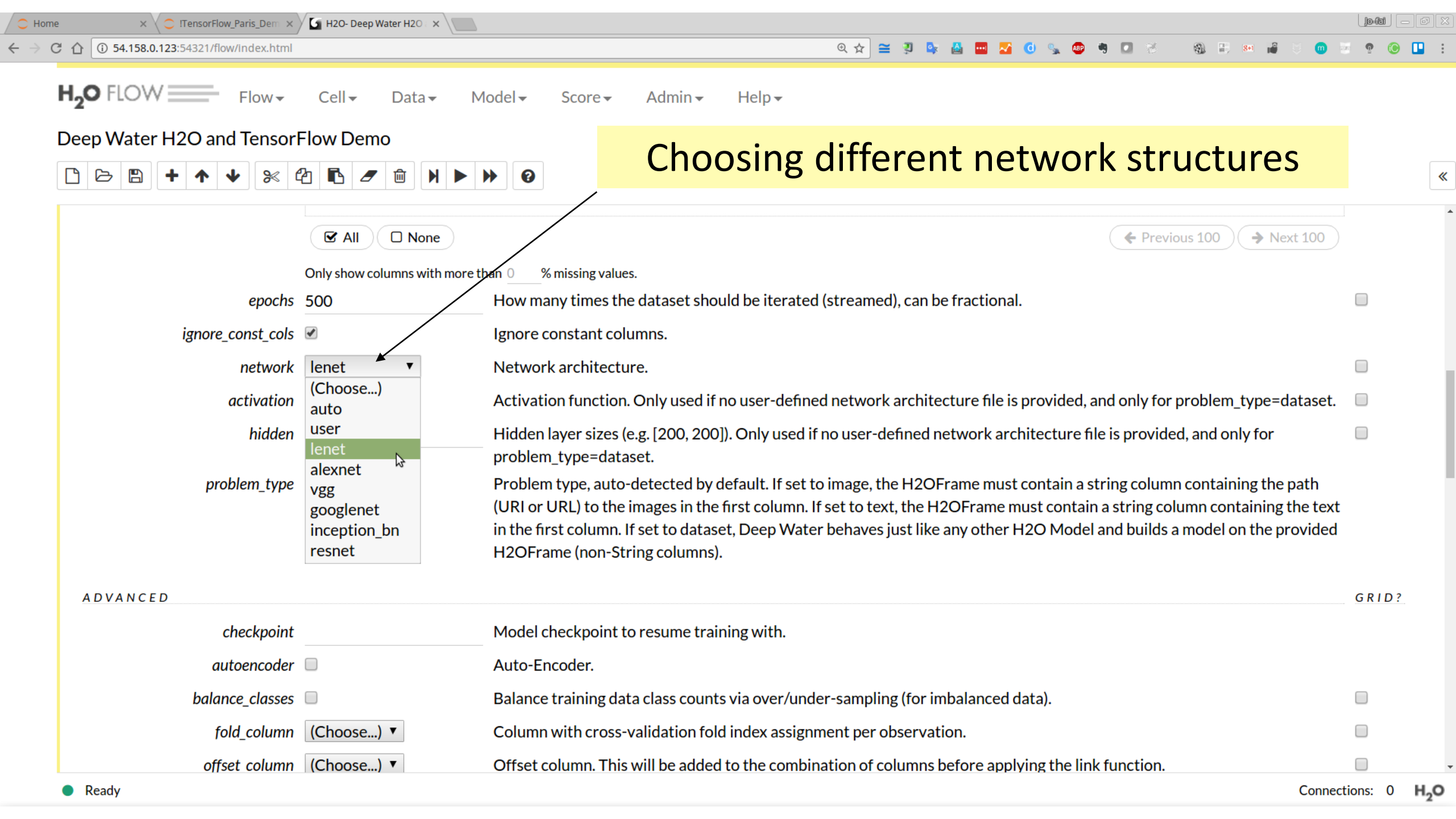
CNN called LeNet by Yann LeCun (1998)

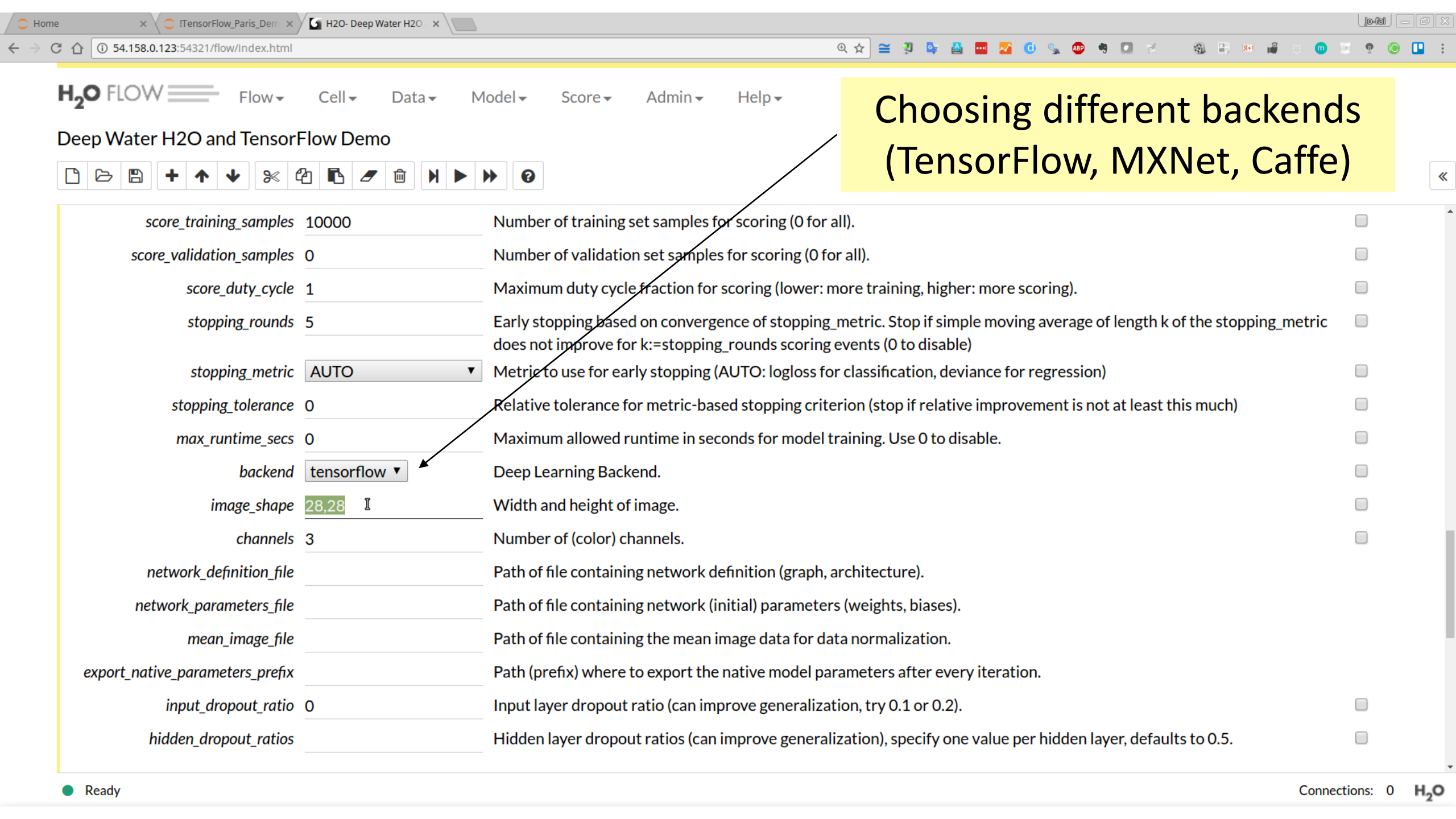









Home
ITensorFlow_Paris_Dem
H2O- Deep Water H2O
54.158.0.123:54321/flow/index.html
H2O FLOW
Flow
Cell
Data
Model
Score
Admin
Help
Deep Water H2O and TensorFlow Demo
Choosing different network structures
All
None
Previous 100
Next 100
Only show columns with more than 0 % missing values.
epochs
500
How many times the dataset should be iterated (streamed), can be fractional.
ignore_const_cols
Ignore constant columns.
network
lenet
Network architecture.
activation
Activation function. Only used if no user-defined network architecture file is provided, and only for problem_type=dataset.
hidden
Hidden layer sizes (e.g. [200, 200]). Only used if no user-defined network architecture file is provided, and only for problem_type=dataset.
problem_type
Problem type, auto-detected by default. If set to image, the H2OFrame must contain a string column containing the path (URI or URL) to the images in the first column. If set to text, the H2OFrame must contain a string column containing the text in the first column. If set to dataset, Deep Water behaves just like any other H2O Model and builds a model on the provided H2OFrame (non-String columns).
(Choose...)
auto
user
lenet
alexnet
vgg
googlenet
inception_bn
resnet
ADVANCED
GRID?
checkpoint
Model checkpoint to resume training with.
autoencoder
Auto-Encoder.
balance_classes
Balance training data class counts via over/under-sampling (for imbalanced data).
fold_column
(Choose...)
Column with cross-validation fold index assignment per observation.
offset_column
(Choose...)
Offset column. This will be added to the combination of columns before applying the link function.
Ready
Connections: 0


Home
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H2O- Deep Water H2O
54.158.0.123:54321/flow/index.html
H2O FLOW
Flow
Cell
Data
Model
Score
Admin
Help
Deep Water H2O and TensorFlow Demo
Choosing different backends
(TensorFlow, MXNet, Caffe)
score_training_samples 10000 Number of training set samples for scoring (0 for all).
score_validation_samples 0 Number of validation set samples for scoring (0 for all).
score_duty_cycle 1 Maximum duty cycle fraction for scoring (lower: more training, higher: more scoring).
stopping_rounds 5 Early stopping based on convergence of stopping_metric. Stop if simple moving average of length k of the stopping_metric does not improve for k:=stopping_rounds scoring events (0 to disable)
stopping_metric AUTO Metric to use for early stopping (AUTO: logloss for classification, deviance for regression)
stopping_tolerance 0 Relative tolerance for metric-based stopping criterion (stop if relative improvement is not at least this much)
max_runtime_secs 0 Maximum allowed runtime in seconds for model training. Use 0 to disable.
backend tensorflow Deep Learning Backend.
image_shape 28,28 Width and height of image.
channels 3 Number of (color) channels.
network_definition_file Path of file containing network definition (graph, architecture).
network_parameters_file Path of file containing network (initial) parameters (weights, biases).
mean_image_file Path of file containing the mean image data for data normalization.
export_native_parameters_prefix Path (prefix) where to export the native model parameters after every iteration.
input_dropout_ratio 0 Input layer dropout ratio (can improve generalization, try 0.1 or 0.2).
hidden_dropout_ratios Hidden layer dropout ratios (can improve generalization), specify one value per hidden layer, defaults to 0.5.
Ready
Connections: 0
H2O

Unified Interface for TF, MXNet and Caffe

```
model <- h2o.deepwater(x=path, y=response,
                       training_frame=df, epochs=50,
                       learning_rate=1e-3, network = "lenet")
model
```

Example: Deep Water + R
Choosing different network structures

Easy Stacking with other H_2O Models

Model Stacking

Now we have three different models, we are ready to carry out model stacking.

In [47]:
```
# Create a list to include all the models for stacking
models <- list(model_dw, model_gbm, model_drf)
```

In [48]:
```
# Define a metalearner (one of the H2O supervised machine learning algorithms)
metalearner <- "h2o.glm.wrapper"
```

In [49]:
```
# Use h2o.stack() to carry out metalearning
stack <- h2o.stack(models = models,
                   response_frame = h_train$medv,
                   metalearner = metalearner)
```

```
[1] "Metalearning"
```

In [50]:
```
# Finally, we evaluate the predictive performance on the ensemble as well as individual models.
h2o.ensemble_performance(stack, newdata = h_test)
```

```
Base learner performance, sorted by specified metric:
        learner      MSE
1 h2o_deepwater 8.377644
2       h2o_gbm 8.106541
3       h2o_drf 7.443517


H2O Ensemble Performance on <newdata>:
----------------
Family: gaussian

Ensemble performance (MSE): 5.80436983051916
```

Ensemble of Deep Water, Gradient Boosting Machine & Random Forest models

H2O, Sparkling Water, Steam, & Deep Water Documentation

Getting Started | Data Science Algorithms | Languages | Tutorials, Examples, & Presentations | For Developers | For the Enterprise

docs.h2o.ai

Getting Started

H2O

What is H2O?
H2O User Guide
H2O Book (O'Reilly)
Recent Changes
Open Source License (Apache V2)

Quick Start Video - Flow Web UI
Quick Start Video - R
Quick Start Video - Python

Download H2O

Sparkling Water

What is Sparkling Water?
Sparkling Water Booklet
PySparkling Readme 2.0 | 1.6
RSparkling Readme
Open Source License (Apache V2)

Quick Start Video - Scala
Quick Start Video - Python

Download Sparkling Water

Steam

What is Steam?
Steam User Guide
Recent Changes
Open Source License (AGPL)

Download Steam

Deep Water (preview)

Deep Water Readme
Deep Water AMI Guide
Open Source License (Apache V2)

Launch Deep Water AMI
(choose g2.2xlarge)

Q & A

FAQ
Community Forum
h2ostream Google Group
Issue Tracking (JIRA)
Gitter
Stack Overflow
Cross Validated

For Supported Enterprise Customers

Enterprise Support Web | Email

Branch: master ▾ h2o-3 / examples / deeplearning / notebooks / Create new file | Upload files | Find file | History

mstensmo changing the name of deeplearning_credit_card_default_risk_prediction... ... Latest commit 5568350 11 days ago

..		
images	Add cat/dog/mouse lenet example.	3 months ago
README.md	Update README.md	2 months ago
deeplearning_anomaly_detection.ip...	Update notebooks, introduce local paths to ~/h2o-3/	3 months ago
deeplearning_benchmark_mnist.ipynb	Update lenet test to remove all. Update MNIST benchmark with comments.	3 months ago
deeplearning_cat_dog_mouse_incep...	Add credit card default risk model, update other notebooks.	
deeplearning_cat_dog_mouse_lenet....	Add credit card default risk model, update other notebooks.	
deeplearning_cat_dog_mouse_lenet...	Add back model.plot() and scoring history.	
deeplearning_cifar10_vgg.ipynb	Rename notebooks.	
deeplearning_credit_card_default_ri...	changing the name of deeplearning_credit_card_default_risk_prediction...	
deeplearning_ensemble_boston_ho...	Ensemble demo using GBM, DRF and Deep Water (#676)	17 days ago
deeplearning_grid_iris.ipynb	Add two new notebooks: Lenet for R and iris grid for python	3 months ago
deeplearning_grid_iris_R.ipynb	Update R py notebook.	3 months ago
deeplearning_image_reconstruction...	Update notebooks, introduce local paths to ~/h2o-3/	3 months ago
deeplearning_mnist_convnet.ipynb	Update notebooks, introduce local paths to ~/h2o-3/	3 months ago
deeplearning_mnist_introduction.ip...	Add missing file.	3 months ago
deeplearning_tensorflow_cat_dog_...	Add tensorflow example (#529)	2 months ago
deeplearning_tensorflow_mnist.ipynb	Added MNIST example for TensorFlow	a month ago

Deep Water Example notebooks

https://github.com/h2oai/h2o-3/tree/master/examples/deeplearning/notebooks

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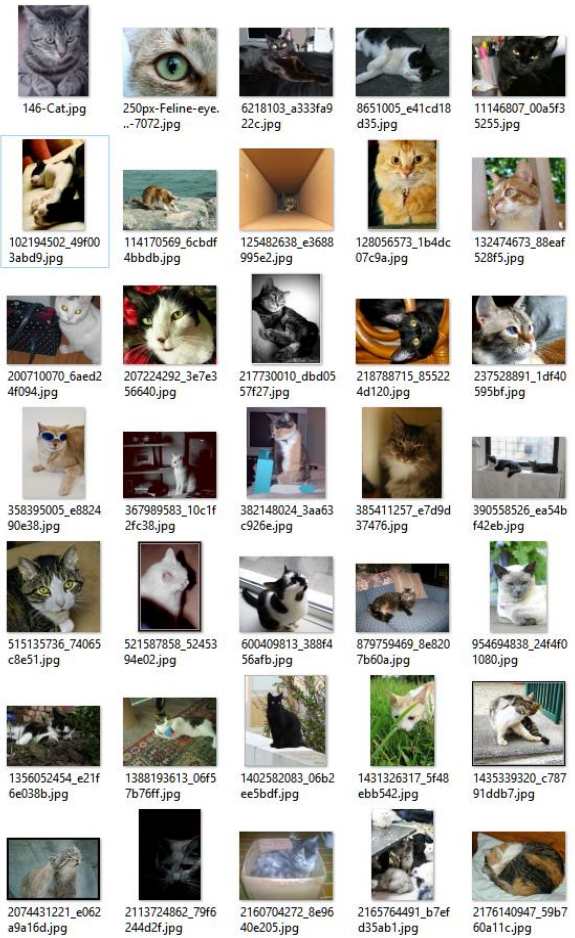
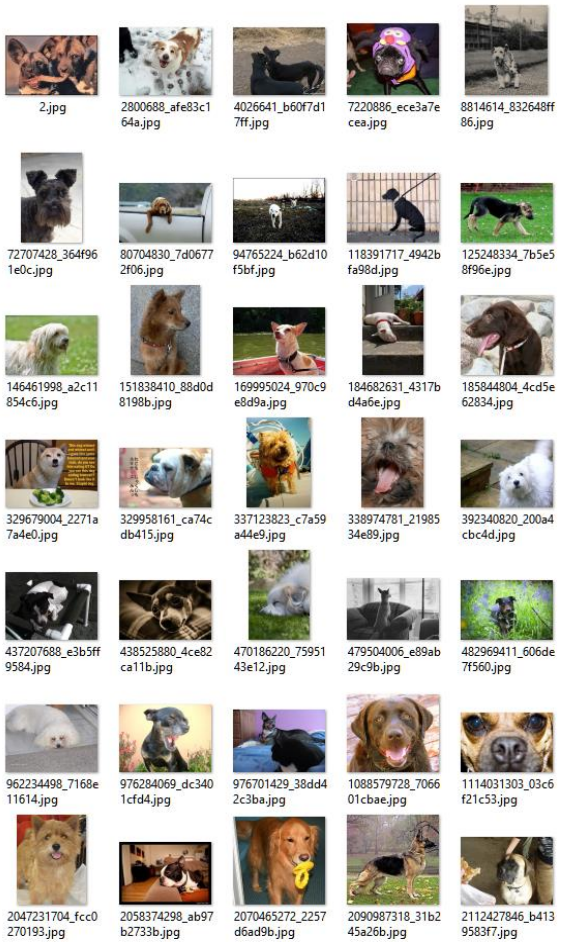
Deep Water Cat/Dog/Mouse Demo

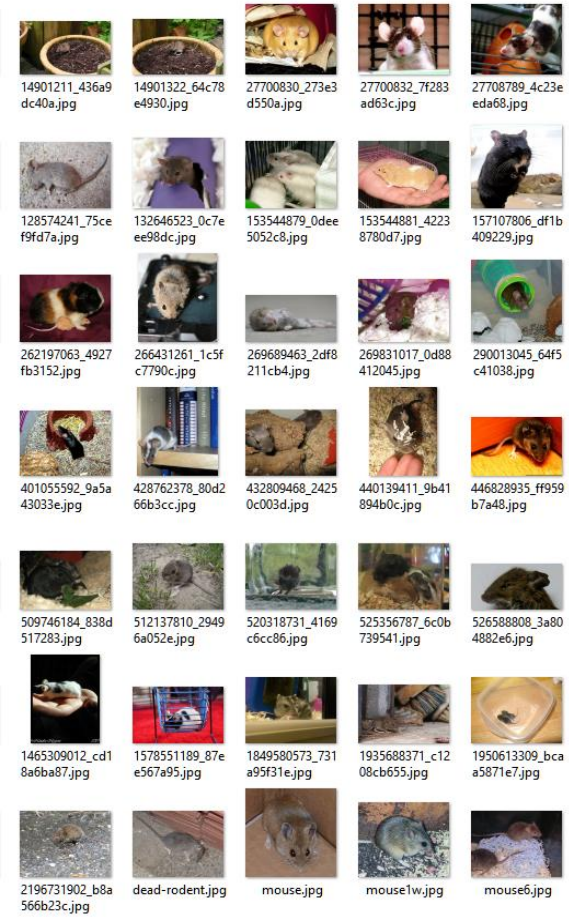
Deep Water H_2O + MXNet Demo

- H_2O + MXNet
  - Dataset – Cat/Dog/Mouse
  - MXNet as GPU backend
  - Train LeNet (CNN) models
  - R Demo (Jupyter Notebook)
    - Link
- Code and Data
  - github.com/h2oai/deepwater

Data – Cat/Dog/Mouse Images







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Data – CSV

	A	B
1	bigdata/laptop/deepwater/imagenet/cat/102194502_49f003abd9.jpg	cat
2	bigdata/laptop/deepwater/imagenet/cat/11146807_00a5f35255.jpg	cat
3	bigdata/laptop/deepwater/imagenet/cat/1140846215_70e326f868.jpg	cat
4	bigdata/laptop/deepwater/imagenet/cat/114170569_6cbdf4bbdb.jpg	cat
5	bigdata/laptop/deepwater/imagenet/cat/1217664848_de4c7fc296.jpg	cat
6	bigdata/laptop/deepwater/imagenet/cat/1241603780_5e8c8f1ced.jpg	cat
7	bigdata/laptop/deepwater/imagenet/cat/1241612072_27ececbdef.jpg	cat
8	bigdata/laptop/deepwater/imagenet/cat/1241613138_ef1d82973f.jpg	cat
9	bigdata/laptop/deepwater/imagenet/cat/1244562192_35becd66bd.jpg	cat
10	bigdata/laptop/deepwater/imagenet/cat/125482638_e3688995e2.jpg	cat
11	bigdata/laptop/deepwater/imagenet/cat/128056573_1b4dc07c9a.jpg	cat
12	bigdata/laptop/deepwater/imagenet/cat/12945197_75e607e355.jpg	cat
13	bigdata/laptop/deepwater/imagenet/cat/132474673_88eaf528f5.jpg	cat
14	bigdata/laptop/deepwater/imagenet/cat/1350530984_ecf3039cf0.jpg	cat
15	bigdata/laptop/deepwater/imagenet/cat/1351606235_c9fbebf634.jpg	cat
16	bigdata/laptop/deepwater/imagenet/cat/1356052454_e21f6e038b.jpg	cat
17	bigdata/laptop/deepwater/imagenet/cat/1388193613_06f57b76ff.jpg	cat

Deep Water – Basic Usage

Start and Connect to H2O Cluster

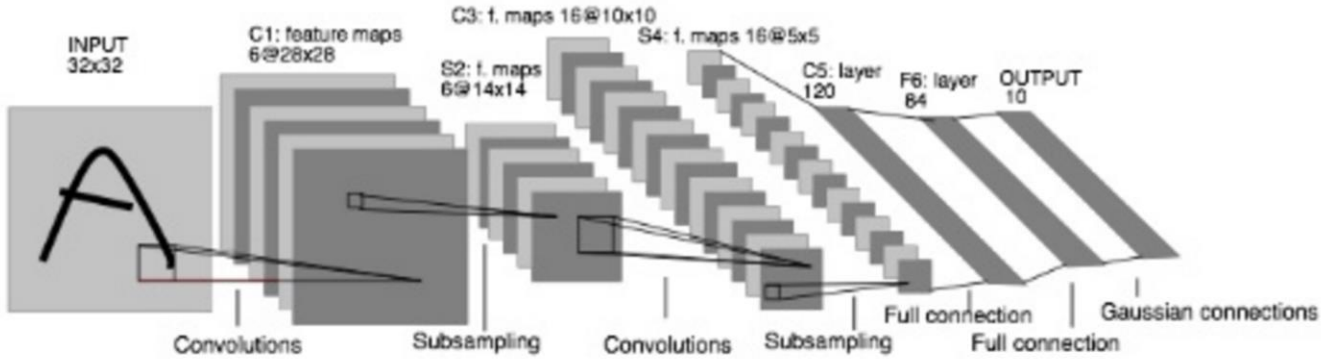
```
library(h2o)
h2o.init(nthreads=-1)
```

Import CSV

```
df <- h2o.importFile("/home/ubuntu/h2o-3/bigdata/laptop/deepwater/imagenet/cat_dog_mouse.csv")
print(head(df))
path = 1 ## must be the first column
response = 2
```

```
  |=============================================================| 100%
                                                          C1  C2
1  bigdata/laptop/deepwater/imagenet/cat/102194502_49f003abd9.jpg cat
2   bigdata/laptop/deepwater/imagenet/cat/11146807_00a5f35255.jpg cat
3 bigdata/laptop/deepwater/imagenet/cat/1140846215_70e326f868.jpg cat
4  bigdata/laptop/deepwater/imagenet/cat/114170569_6cbdf4bbdb.jpg cat
5 bigdata/laptop/deepwater/imagenet/cat/1217664848_de4c7fc296.jpg cat
6 bigdata/laptop/deepwater/imagenet/cat/1241603780_5e8c8f1ced.jpg cat
```

Train a CNN (LeNet) Model on GPU



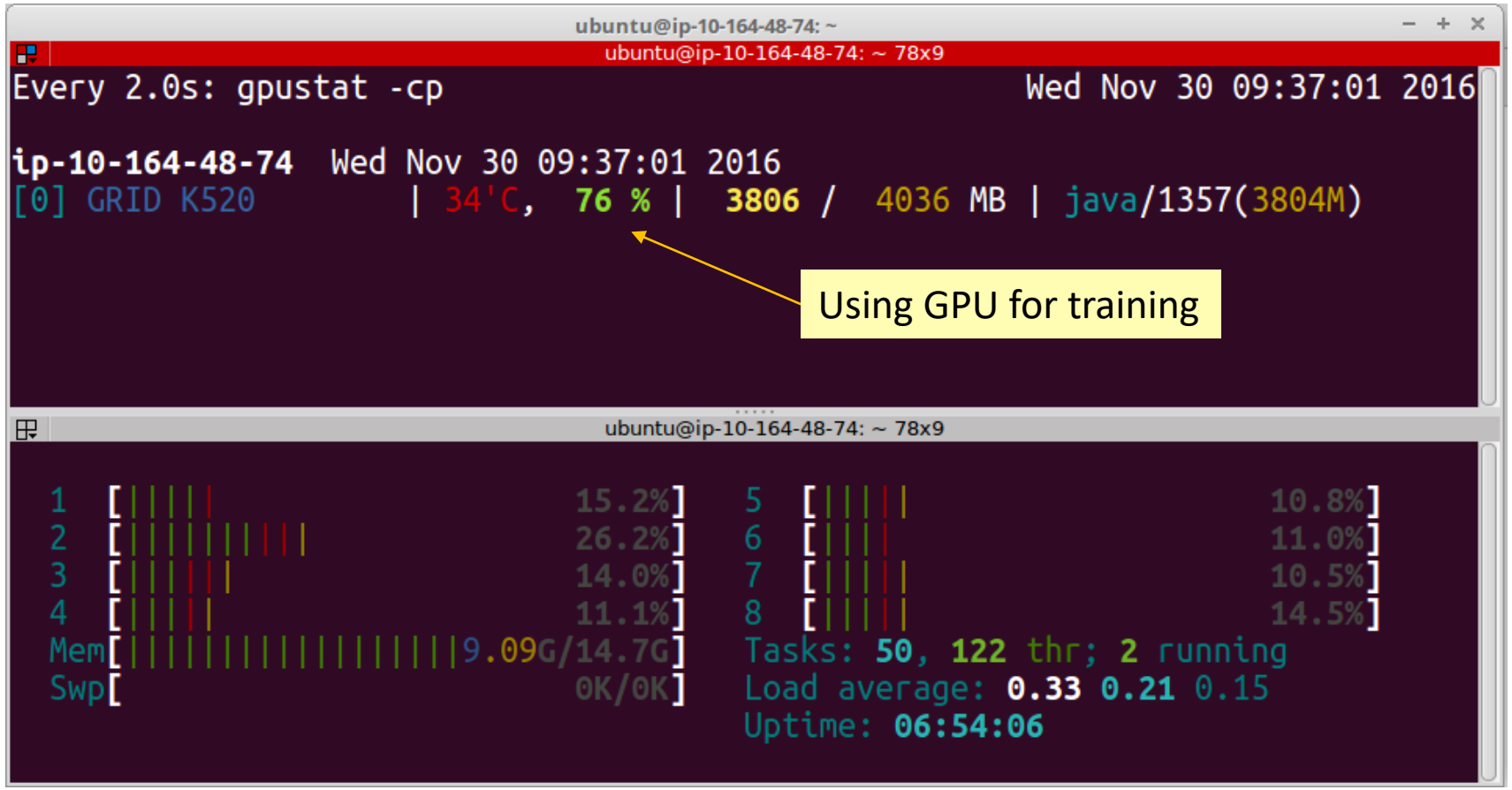
LeNet: a layered model composed of convolution and subsampling operations followed by a holistic representation and ultimately a classifier for handwritten digits. [Yann LeCun; LeNet]

We'll use a GPU to train such a LeNet model in seconds

To build a LeNet image classification model in H2O, simply specify network = "lenet":

```
model <- h2o.deepwater(x=path, y=response,
                       training_frame=df, epochs=50,
                       learning_rate=1e-3, network = "lenet")
```

Train a CNN (LeNet) Model on GPU



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Model

```
Model Details:
==============

H2OMultinomialModel: deepwater
Model ID:  DeepWater_model_R_1477378862430_2
Status of Deep Learning Model: lenet, 1.6 MB, predicting C2, 3-class classif
s, mini-batch size 32
  input_neurons     rate momentum
1          2352 0.000986 0.990000


H2OMultinomialMetrics: deepwater
** Reported on training data. **
** Metrics reported on full training frame **

Training Set Metrics:
=====================

Extract training frame with `h2o.getFrame("cat_dog_mouse.hex_sid_95f8_1")`
MSE: (Extract with `h2o.mse`) 0.131072
RMSE: (Extract with `h2o.rmse`) 0.3620386
Logloss: (Extract with `h2o.logloss`) 0.4176429
Mean Per-Class Error: 0.1165104
Confusion Matrix: Extract with `h2o.confusionMatrix(<model>,train = TRUE)`)
========================================================================
Confusion Matrix: vertical: actual; across: predicted
       cat dog mouse  Error       Rate
cat     75   4    11 0.1667 =  15 / 90
dog      4  75     6 0.1176 =  10 / 85
mouse    3   3    86 0.0652 =   6 / 92
Totals  82  82   103 0.1161 = 31 / 267
```

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Deep Water – Custom Network

If you'd like to build your own LeNet network architecture, then this is easy as well. In this example script, we are using the 'mxnet' backend. Models can easily be imported/exported between H2O and MXNet since H2O uses MXNet's format for model definition.

In [5]:
```
get_symbol <- function(num_classes = 1000) {
  library(mxnet)
  data <- mx.symbol.Variable('data')
  # first conv
  conv1 <- mx.symbol.Convolution(data = data, kernel = c(5, 5), num_filter = 20)

  tanh1 <- mx.symbol.Activation(data = conv1, act_type = "tanh")
  pool1 <- mx.symbol.Pooling(data = tanh1, pool_type = "max", kernel = c(2, 2), stride = c(2, 2))

  # second conv
  conv2 <- mx.symbol.Convolution(data = pool1, kernel = c(5, 5), num_filter = 50)
  tanh2 <- mx.symbol.Activation(data = conv2, act_type = "tanh")
  pool2 <- mx.symbol.Pooling(data = tanh2, pool_type = "max", kernel = c(2, 2), stride = c(2, 2))
  # first fullc
  flatten <- mx.symbol.Flatten(data = pool2)
  fc1 <- mx.symbol.FullyConnected(data = flatten, num_hidden = 500)
  tanh3 <- mx.symbol.Activation(data = fc1, act_type = "tanh")
  # second fullc
  fc2 <- mx.symbol.FullyConnected(data = tanh3, num_hidden = num_classes)
  # loss
  lenet <- mx.symbol.SoftmaxOutput(data = fc2, name = 'softmax')
  return(lenet)
}
```

Configure custom network structure (MXNet syntax)

In [7]:
```
nclasses = h2o.nlevels(df[,response])
network <- get_symbol(nclasses)
cat(network$as.json(), file = "/tmp/symbol_lenet-R.json", sep = '')
```

Saving the custom network structure as a file

Train a Custom Network

```
model = h2o.deepwater(x=path, y=response, training_frame = df,
                      epochs=500, ## early stopping is on by default and might trigger before
                      network_definition_file="/tmp/symbol_lenet-R.json",  ## specify the model
                      image_shape=c(28,28),                                ## provide expected (or matchin
g) image size
                      channels=3)                                          ## 3 for color, 1 for monochrom
e
```

Model

```
Model Details:
==============

H2OMultinomialModel: deepwater
Model Key:  DeepWater_model_R_1477378862430_3
Status of Deep Learning Model: user, 1.6 MB, predicting C2, 3-class classifi
s, mini-batch size 32
  input_neurons     rate momentum
1          2352 0.004409 0.990000

H2OMultinomialMetrics: deepwater
** Reported on training data. **
** Metrics reported on full training frame **

Training Set Metrics:
=====================

Extract training frame with `h2o.getFrame("cat_dog_mouse.hex_sid_95f8_1")`
MSE: (Extract with `h2o.mse`) 0.03078524
RMSE: (Extract with `h2o.rmse`) 0.1754572
Logloss: (Extract with `h2o.logloss`) 0.1154222
Mean Per-Class Error: 0.03366487
Confusion Matrix: Extract with `h2o.confusionMatrix(<model>,train = TRUE)`)
=========================================================================
Confusion Matrix: vertical: actual; across: predicted
       cat dog mouse  Error      Rate
cat     88   2     0 0.0222 =  2 / 90
dog      2  82     1 0.0353 =  3 / 85
mouse    1   3    88 0.0435 =  4 / 92
Totals  91  87    89 0.0337 = 9 / 267
```

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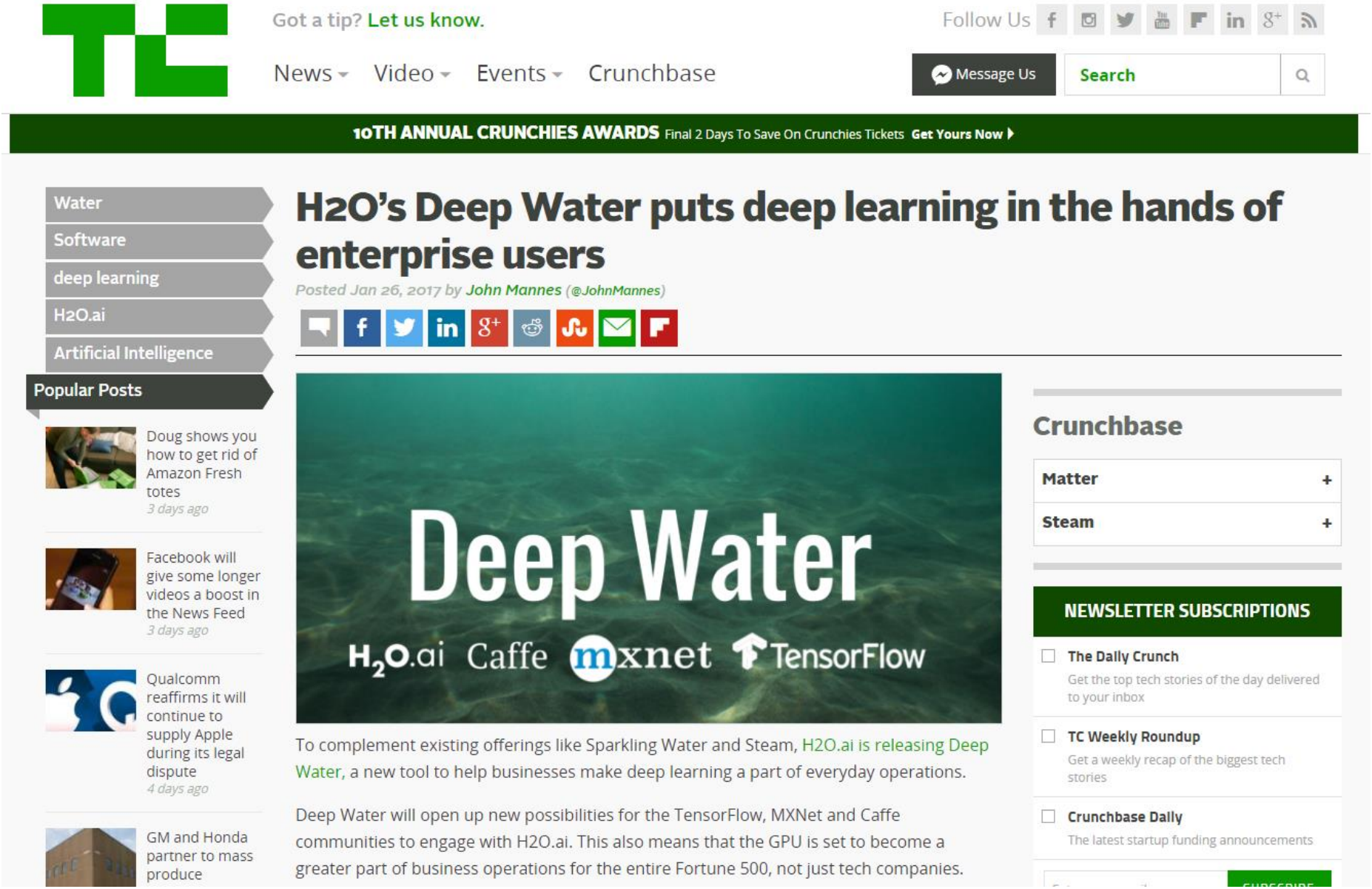
Conclusions

Project “Deep Water”

- H_2O + TF + MXNet + Caffe
  - a powerful combination of widely used open source machine learning libraries.
- All Goodies from H_2O
  - inherits all H_2O properties in scalability, ease of use and deployment.
- Unified Interface
  - allows users to build, stack and deploy deep learning models from different libraries efficiently.

- 100% Open Source
  - the party will get bigger!



https://techcrunch.com/2017/01/26/h2os-deep-water-puts-deep-learning-in-the-hands-of-enterprise-users/

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Thanks!

- Organizers & Sponsors
  - Köln R User Group
  - Eyeo GmbH
- Code, Slides & Documents
  - bit.ly/h2o_meetups
  - bit.ly/h2o_deepwater
  - docs.h2o.ai
- Contact
  - joe@h2o.ai
  - @matlabulous
  - github.com/woobe

- Please search/ask questions on **Stack Overflow**
  - Use the tag `**h2o**`
  - (remember it is not H2 zero)