H₂O.ai

@h2oai & @mmalohlava
presents

Sparkling Water

Meetup

Spark + H_2O

SPARKLING
WATER

Spark

User-friendly API for data transformation

Large and active community

Platform components - SQL

Multitenancy

H_2O

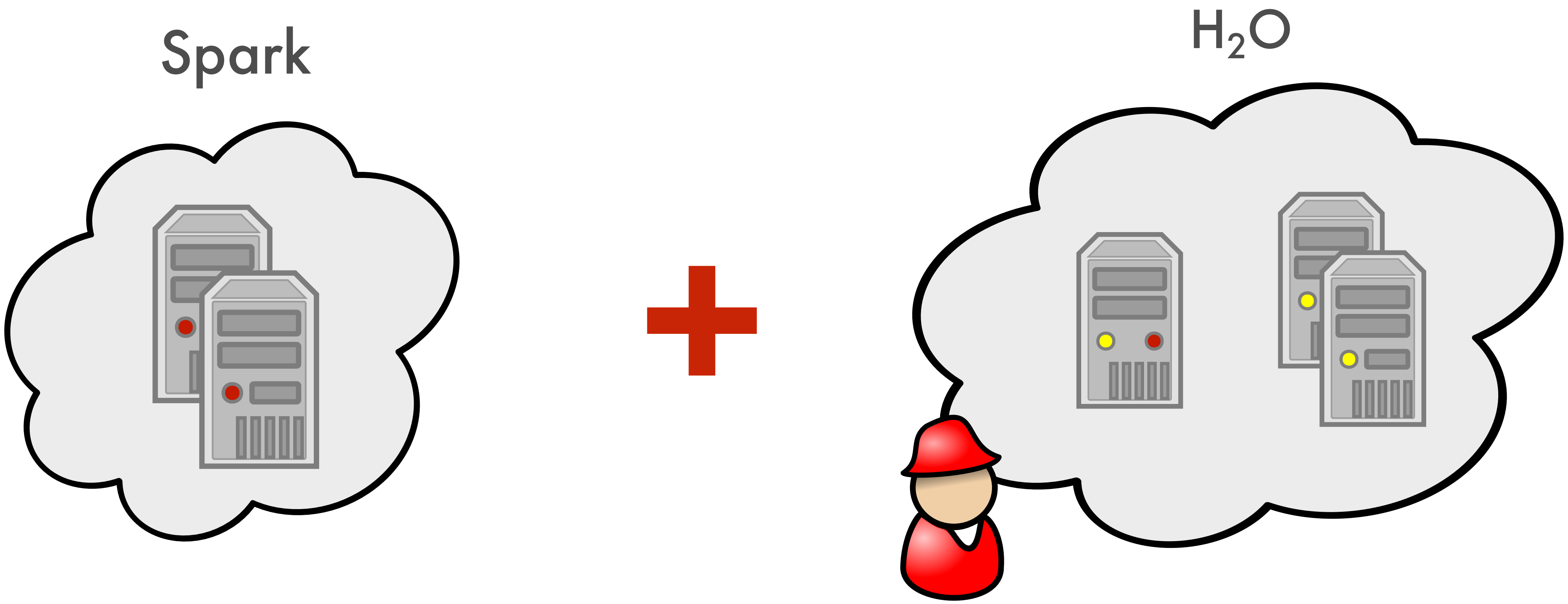
Memory efficient

Performance of computation

Machine learning algorithms

Parser, GUI, R-interface

Sparkling Water



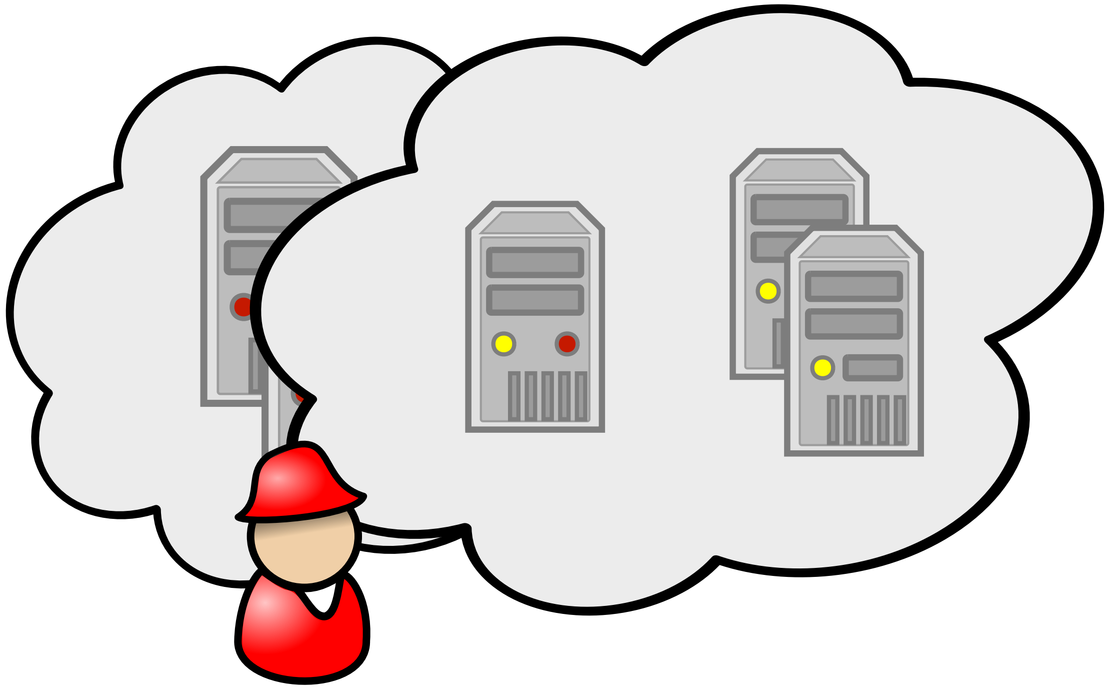
Spark

H_2O

RDD
immutable
world

DataFrame
mutable
world

Sparkling Water



Spark

H_2O

`RDD`

`DataFrame`

Sparkling Water

Provides

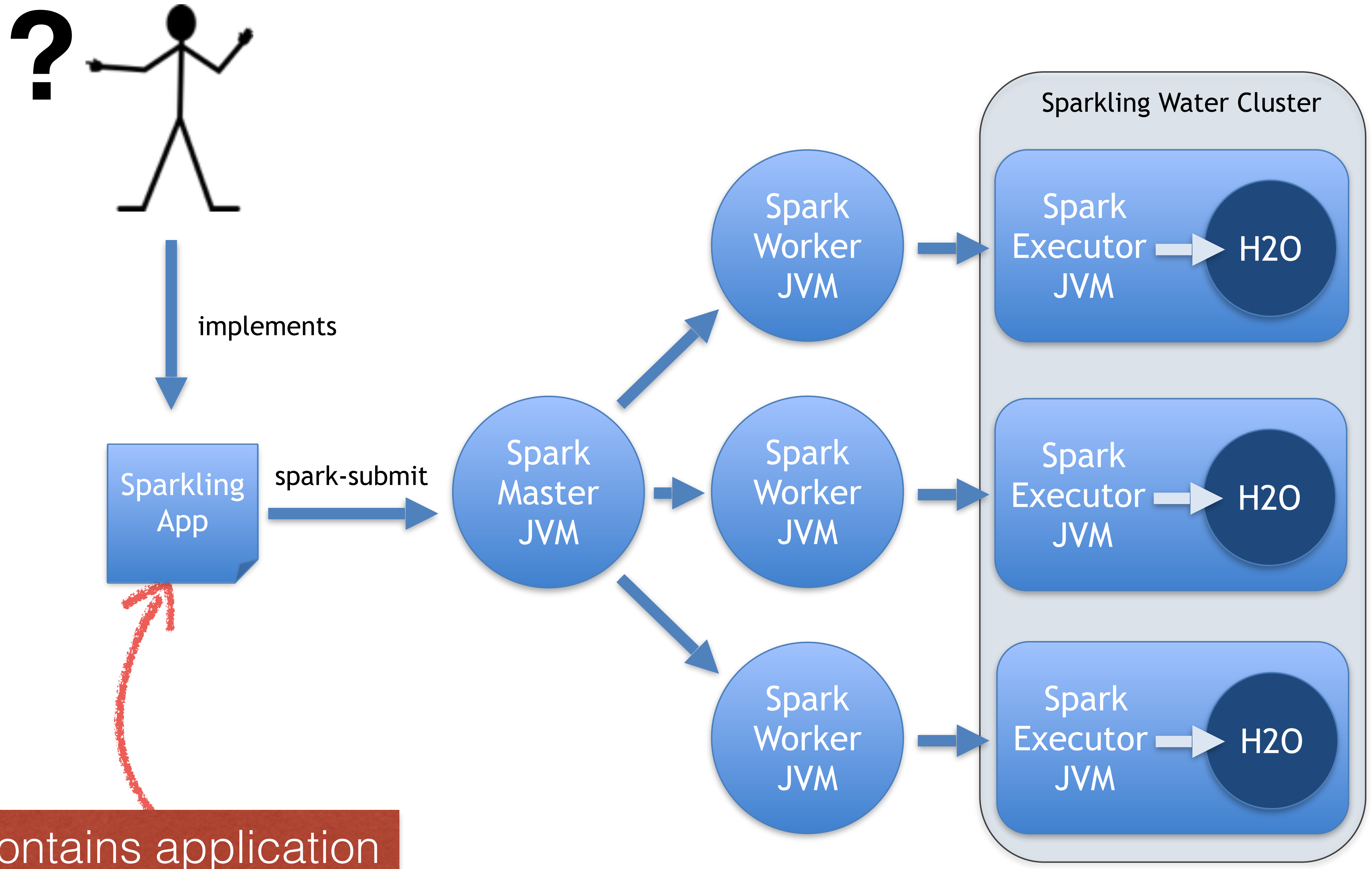
Transparent integration into Spark ecosystem

Pure H2ORDD encapsulating H_2O DataFrame

Transparent use of H_2O data structures and algorithms with Spark API

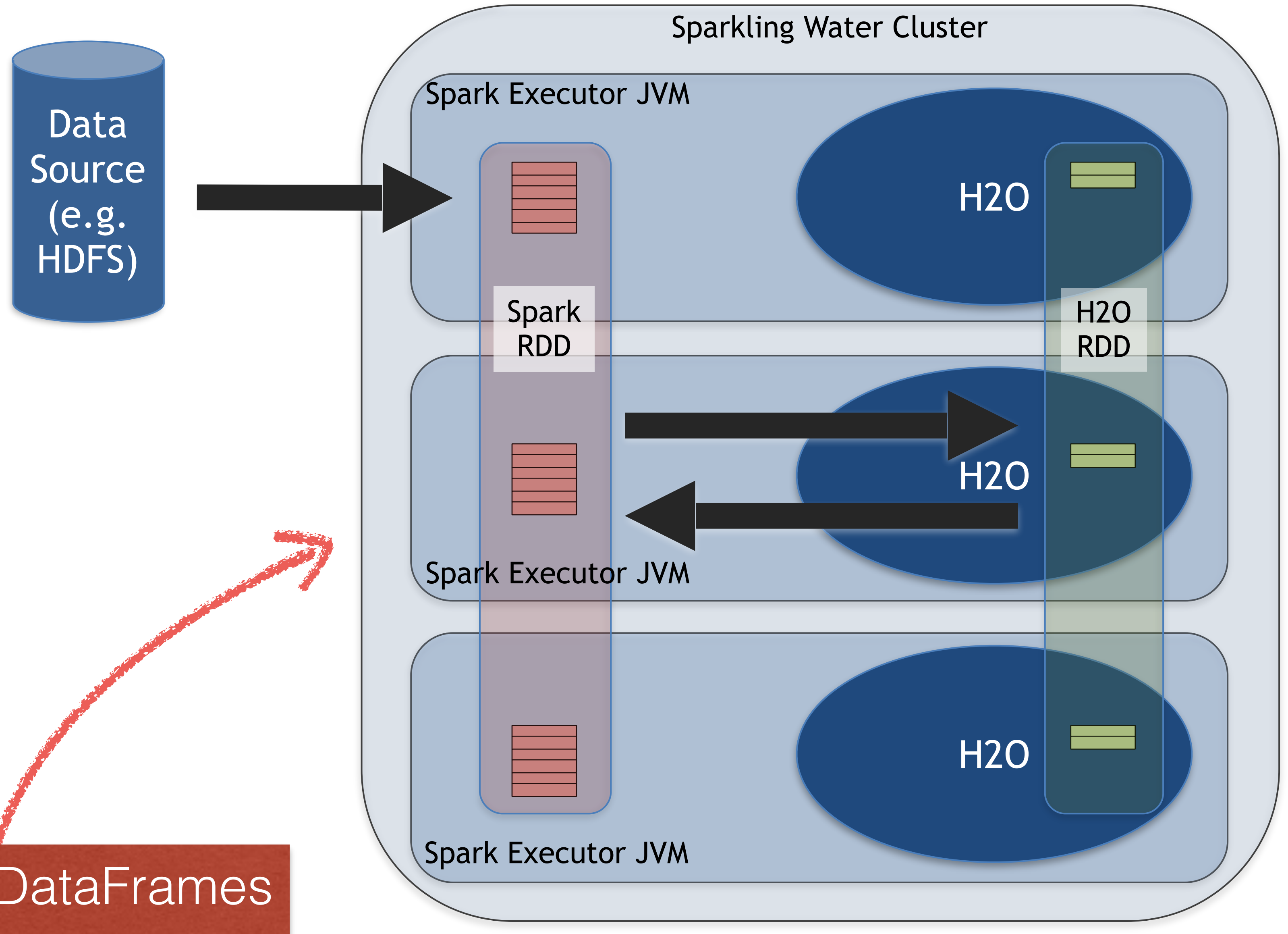
Excels in Spark workflows requiring advanced Machine Learning algorithms

Sparkling Water Design



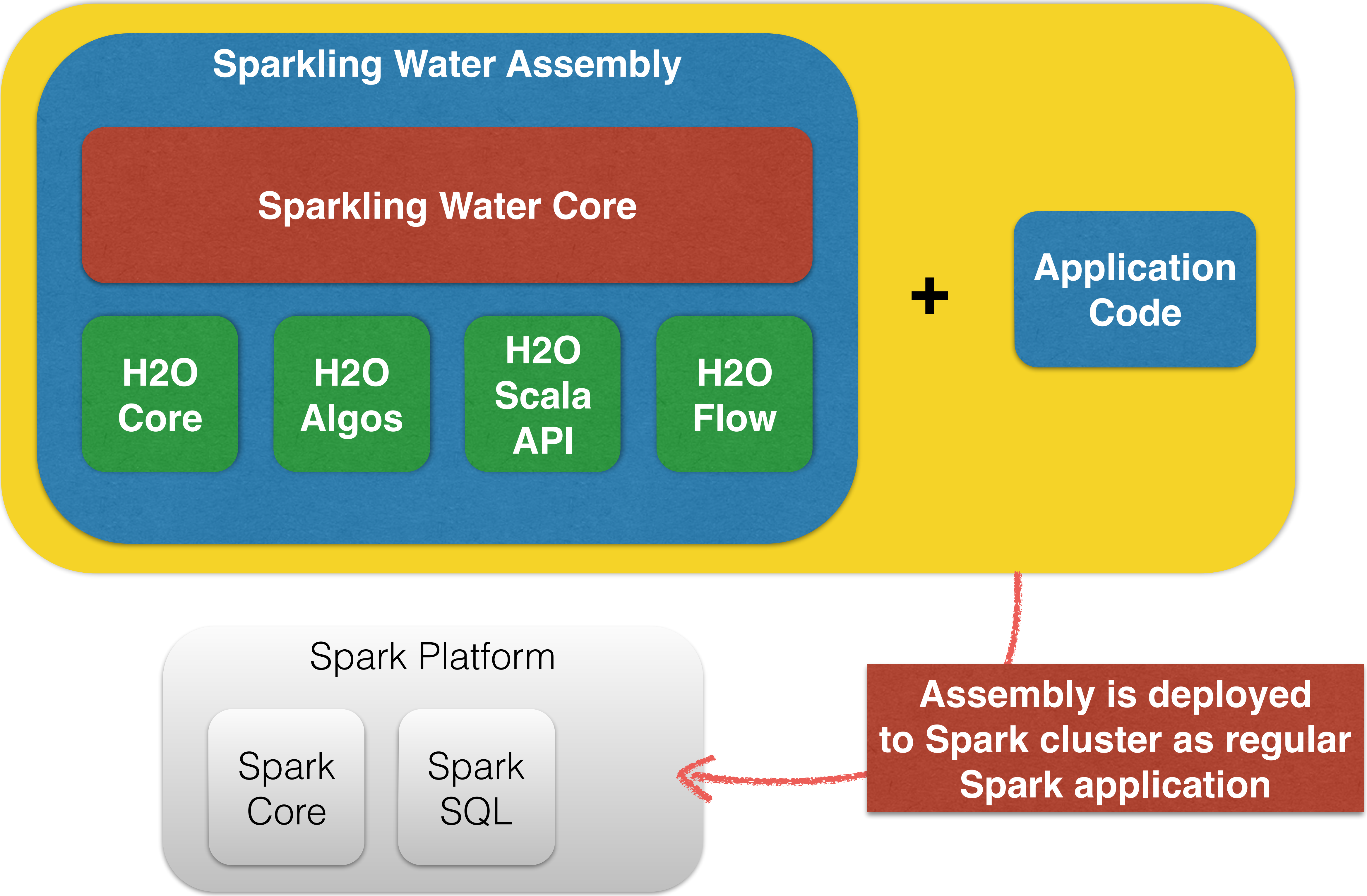
Contains application and Sparkling Water classes

Data Distribution



RDDs and DataFrames share same memory space

Devel Internals



Sparkling Water Assembly

Sparkling Water Core

H2O Core

H2O Algos

H2O Scala API

H2O Flow

+

Application Code

Spark Platform

Spark Core

Spark SQL

Assembly is deployed to Spark cluster as regular Spark application

Hands-On #1
Sparkling Shell

Sparkling Water Requirements

Linux or Mac OS X

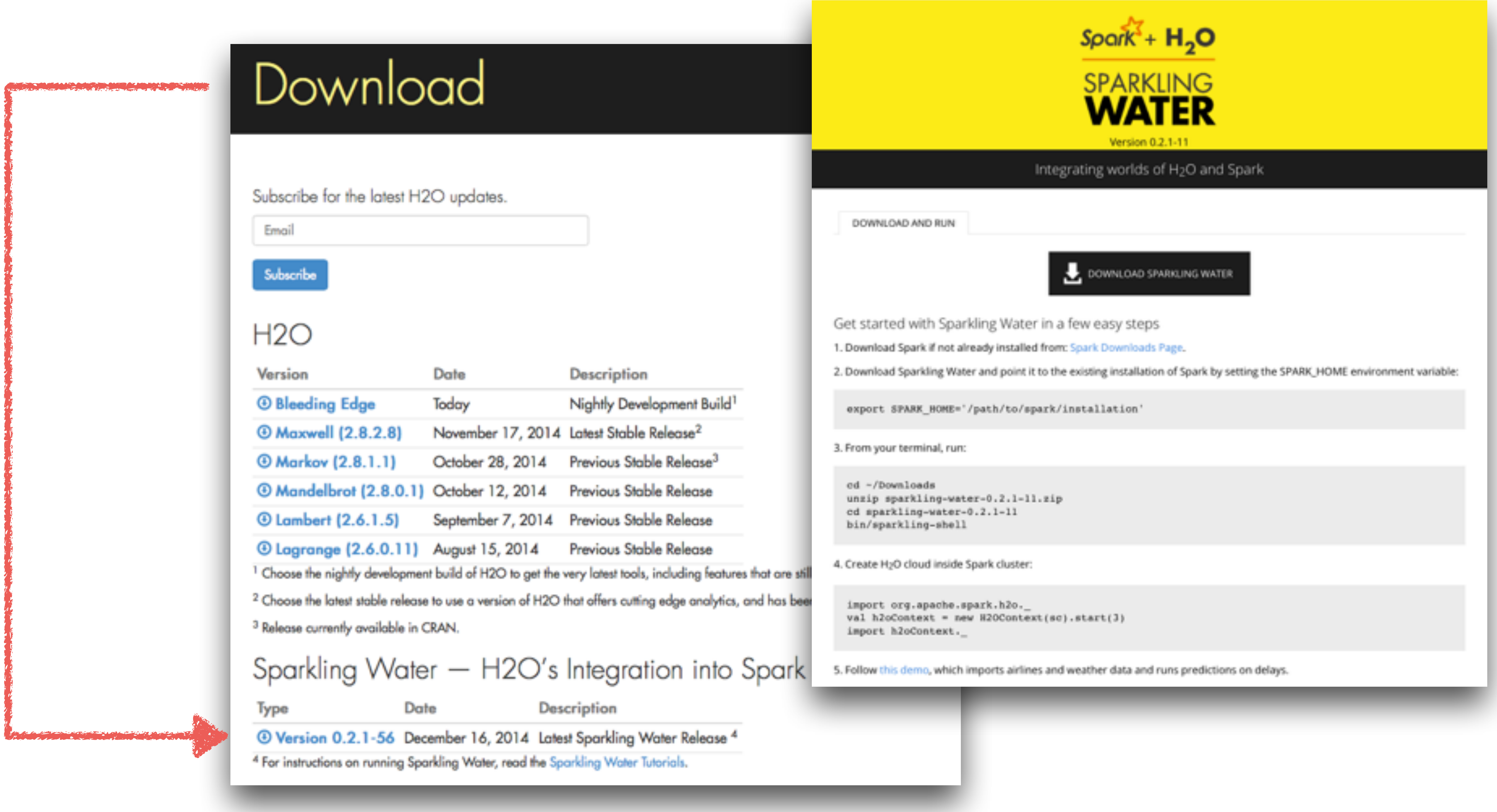
Oracle Java 1.7+

Spark 1.1.0

Provided on USB stick or download from http://meetups.h2o.ai/sw.zip

Sparkling Water Download

http://h2o.ai/download/



Download

Subscribe for the latest H2O updates.

Email

Subscribe

H2O

Version	Date	Description
Bleeding Edge	Today	Nightly Development Build[1]
Maxwell (2.8.2.8)	November 17, 2014	Latest Stable Release[2]
Markov (2.8.1.1)	October 28, 2014	Previous Stable Release[3]
Mandelbrot (2.8.0.1)	October 12, 2014	Previous Stable Release
Lambert (2.6.1.5)	September 7, 2014	Previous Stable Release
Lagrange (2.6.0.11)	August 15, 2014	Previous Stable Release

[1] Choose the nightly development build of H2O to get the very latest tools, including features that are still

[2] Choose the latest stable release to use a version of H2O that offers cutting edge analytics, and has been

[3] Release currently available in CRAN.

Sparkling Water — H2O's Integration into Spark

Type	Date	Description
Version 0.2.1-56	December 16, 2014	Latest Sparkling Water Release [4]

[4] For instructions on running Sparkling Water, read the Sparkling Water Tutorials.

Spark + H_2O

SPARKLING WATER

Version 0.2.1-11

Integrating worlds of H_2O and Spark

Get started with Sparkling Water in a few easy steps

1. Download Spark if not already installed from: Spark Downloads Page.

2. Download Sparkling Water and point it to the existing installation of Spark by setting the SPARK_HOME environment variable:

```
export SPARK_HOME='/path/to/spark/installation'
```

3. From your terminal, run:

```
cd ~/Downloads
unzip sparkling-water-0.2.1-11.zip
cd sparkling-water-0.2.1-11
bin/sparkling-shell
```

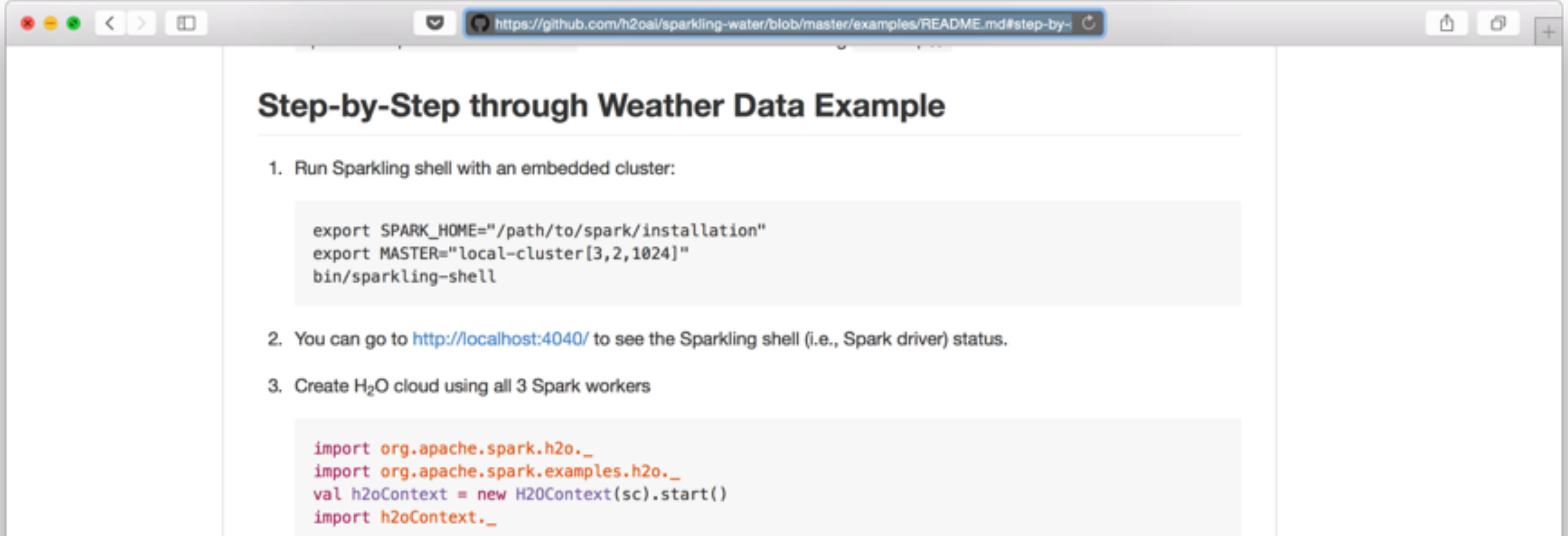
4. Create H_2O cloud inside Spark cluster:

```
import org.apache.spark.h2o._
val h2oContext = new H2OContext(sc).start(3)
import h2oContext._
```

5. Follow this demo, which imports airlines and weather data and runs predictions on delays.

Where is the code?

https://github.com/h2oai/sparkling-water/blob/master/examples/scripts/


https://github.com/h2oai/sparkling-water/blob/master/examples/README.md#step-by-

Step-by-Step through Weather Data Example

1. Run Sparkling shell with an embedded cluster:

```
export SPARK_HOME="/path/to/spark/installation"
export MASTER="local-cluster[3,2,1024]"
bin/sparkling-shell
```

2. You can go to http://localhost:4040/ to see the Sparkling shell (i.e., Spark driver) status.

3. Create H_2O cloud using all 3 Spark workers

```
import org.apache.spark.h2o._
import org.apache.spark.examples.h2o._
val h2oContext = new H2OContext(sc).start()
import h2oContext._
```

Flight delays prediction

“Build a model using weather and flight data to predict delays of flights arriving to Chicago O’Hare International Airport”

Example Outline

Load & Parse CSV data from 2 data sources

Use Spark API to filter data, do SQL query for join

Create regression models

Use models to predict delays

Graph residual plot from R

Install and Launch

Unpack zip file

and

Point SPARK_HOME to your Spark 1.2.0 installation

It is on USB stick

and

Launch bin/sparkling-shell

What is Sparkling Shell?

Standard spark-shell

With additional Sparkling Water classes

Spark Master address

```
export MASTER=“local-cluster[3,2,1024]”

spark-shell \
    --jars sparkling-water.jar
```

JAR containing Sparkling Water

Lets play with Sparkling shell...

Create H_2O Client

Contains implicit utility functions

Demo specific classes

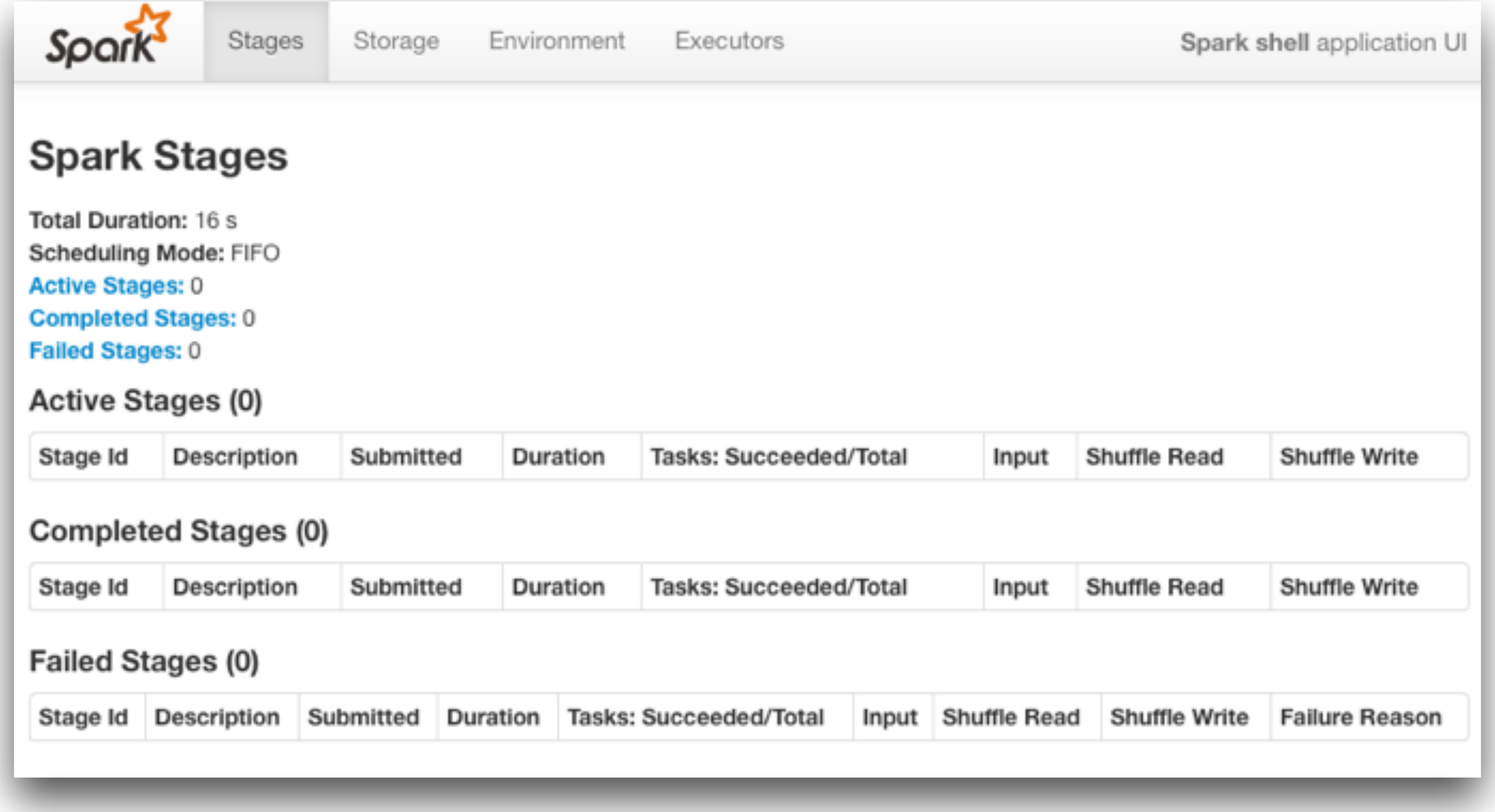
Size of demanded H_2O cloud

```
import org.apache.spark.h2o._
import org.apache.spark.examples.h2o._

val h2oContext = new H2OContext(sc).start()
import h2oContext._
```

Regular Spark context provided by Spark shell

Is Spark Running?

Go to http://localhost:4040



Spark Stages

Total Duration: 16 s
Scheduling Mode: FIFO
Active Stages: 0
Completed Stages: 0
Failed Stages: 0

Active Stages (0)

Stage Id	Description	Submitted	Duration	Tasks: Succeeded/Total	Input	Shuffle Read	Shuffle Write

Completed Stages (0)

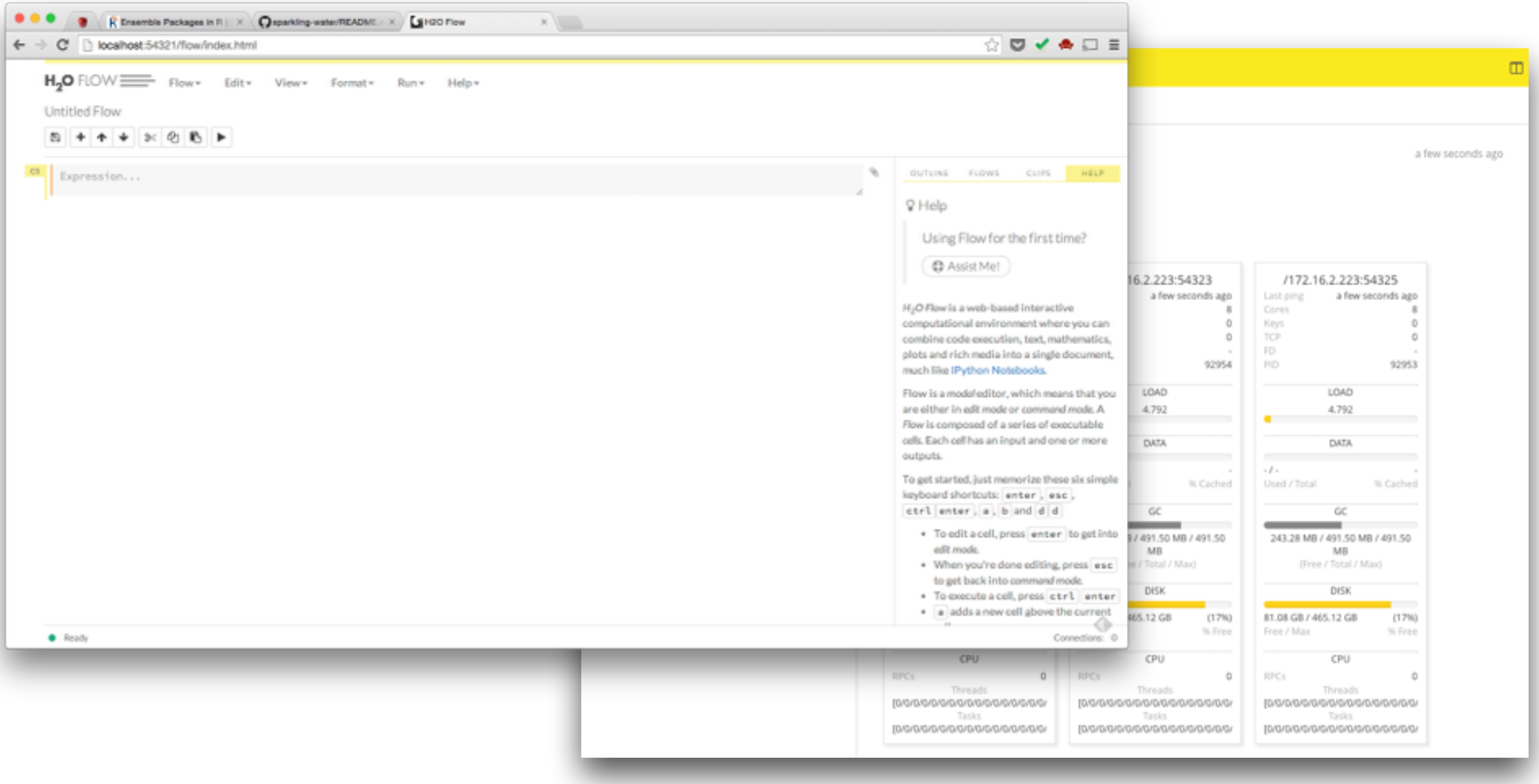
Stage Id	Description	Submitted	Duration	Tasks: Succeeded/Total	Input	Shuffle Read	Shuffle Write

Failed Stages (0)

Stage Id	Description	Submitted	Duration	Tasks: Succeeded/Total	Input	Shuffle Read	Shuffle Write	Failure Reason

Is H_2O running?

http://localhost:54321/flow/index.html



Using Flow for the first time?

H₂O Flow is a web-based interactive computational environment where you can combine code execution, text, mathematics, plots and rich media into a single document, much like IPython Notebooks.

Flow is a *modal* editor, which means that you are either in *edit mode* or *command mode*. A *Flow* is composed of a series of executable *cells*. Each *cell* has an input and one or more outputs.

To get started, just memorize these six simple keyboard shortcuts: `enter`, `esc`, `ctrl` `enter`, `a`, `b` and `d` `d`

- To edit a cell, press `enter` to get into *edit mode*.
- When you're done editing, press `esc` to get back into *command mode*.
- To execute a cell, press `ctrl` `enter`
- `a` adds a new cell above the current

/172.16.2.223:54325

Last ping	a few seconds ago
Cores	8
Keys	0
TCP	0
FD	-
PID	92953

LOAD

4.792

DATA

-/- -

Used / Total % Cached

GC

243.28 MB / 491.50 MB / 491.50 MB

(Free / Total / Max)

DISK

81.08 GB / 465.12 GB (17%)

Free / Max % Free

CPU

RPCs 0

Threads

[0/0/0/0/0/0/0/0/0/0/0/0/0/0/0/0/0/

Tasks

[0/0/0/0/0/0/0/0/0/0/0/0/0/0/0/0/0/

Load Data #1

Load weather data into RDD

```
val weatherDataFile =
  “examples/smalldata/
Chicago_Ohare_International_Airport.csv"

val wrawdata = sc.textFile(weatherDataFile,3)
                        .cache()

val weatherTable = wrawdata
     .map(_.split(“,"))
     .map(row => WeatherParse(row))
     .filter(!_.isWrongRow())
```

Regular Spark API

Ad-hoc Parser

Weather Data

```
case class Weather( val Year   : Option[Int],
                    val Month  : Option[Int],
                    val Day    : Option[Int],
                    val TmaxF  : Option[Int],   // Max temperatur in F
                    val TminF  : Option[Int],   // Min temperatur in F
                    val TmeanF : Option[Float], // Mean temperatur in F
                    val PrcpIn : Option[Float], // Precipitation (inches)
                    val SnowIn : Option[Float], // Snow (inches)
                    val CDD    : Option[Float], // Cooling Degree Day
                    val HDD    : Option[Float], // Heating Degree Day
                    val GDD    : Option[Float]) // Growing Degree Day
```

Simple POJO to hold one row of weather data

Load Data #2

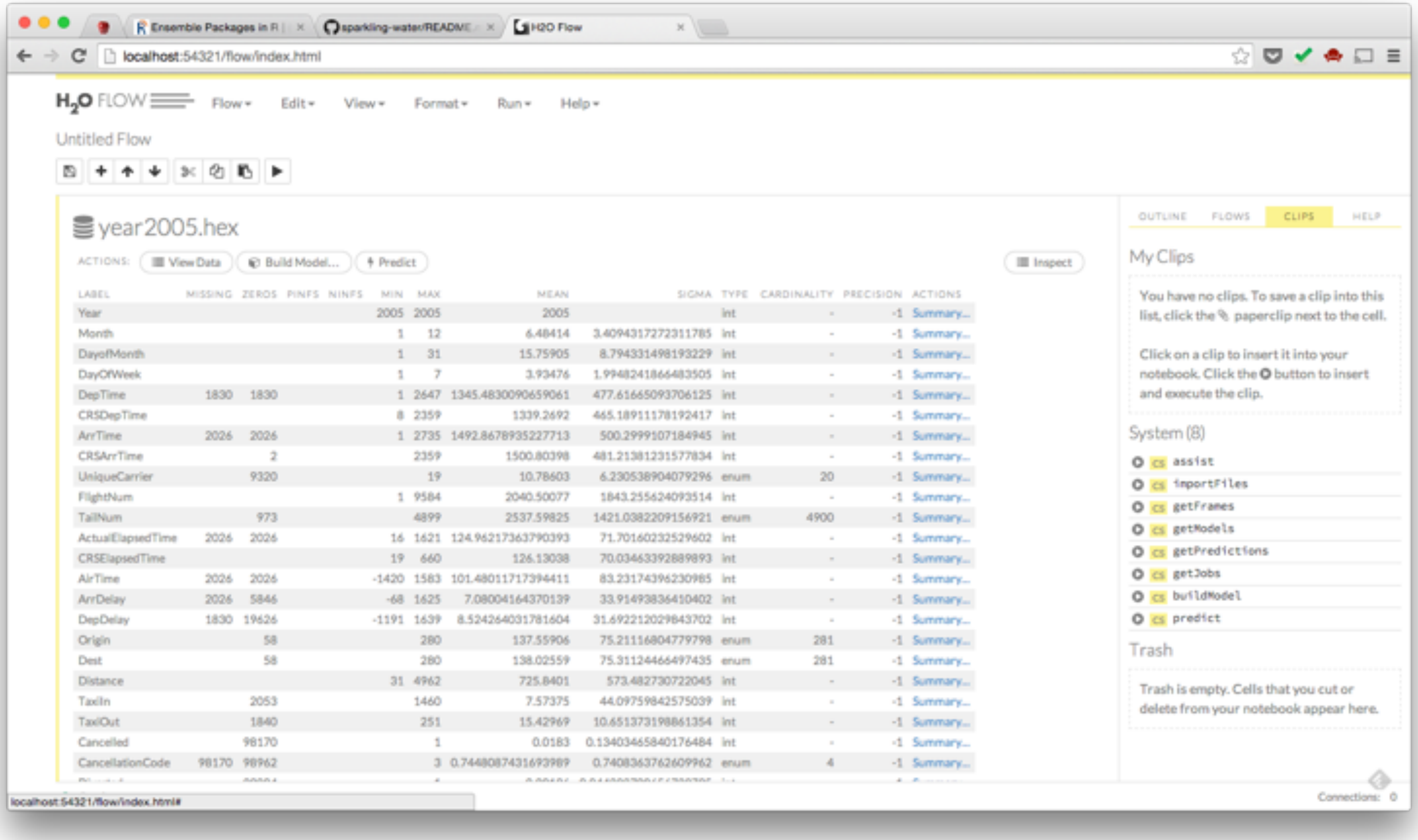
Load flights data into H2O frame

```
import java.io.File

val dataFile =
  “examples/smalldata/year2005.csv.gz"

val airlinesData = new DataFrame(new File(dataFile))
```

Shortcut for data load and parse

Where is the data?

Go to http://localhost:54321/flow/index.html



year2005.hex

LABEL	MISSING	ZEROS	PINFS	NINFS	MIN	MAX	MEAN	SIGMA	TYPE	CARDINALITY	PRECISION	ACTIONS
Year					2005	2005	2005		int	-	-1	Summary...
Month					1	12	6.48414	3.40943172723117785	int	-	-1	Summary...
DayofMonth					1	31	15.75905	8.794331498193229	int	-	-1	Summary...
DayOfWeek					1	7	3.93476	1.9948241866483505	int	-	-1	Summary...
DepTime	1830	1830			1	2647	1345.4830090659061	477.61665093706125	int	-	-1	Summary...
CRSDepTime					8	2359	1339.2692	465.18911178192417	int	-	-1	Summary...
ArrTime	2026	2026			1	2735	1492.8678935227713	500.2999107184945	int	-	-1	Summary...
CRSArrTime		2				2359	1500.80398	481.21381231577834	int	-	-1	Summary...
UniqueCarrier		9320				19	10.78603	6.230538904079296	enum	20	-1	Summary...
FlightNum					1	9584	2040.50077	1843.255624093514	int	-	-1	Summary...
TailNum		973				4899	2537.59825	1421.0382209156921	enum	4900	-1	Summary...
ActualElapsedTime	2026	2026			16	1621	124.96217363790393	71.70160232529602	int	-	-1	Summary...
CRSElapsedTime					19	660	126.13038	70.03463392889893	int	-	-1	Summary...
AirTime	2026	2026			-1420	1583	101.48011717394411	83.23174396230985	int	-	-1	Summary...
ArrDelay	2026	5846			-68	1625	7.08004164370139	33.91493836410402	int	-	-1	Summary...
DepDelay	1830	19626			-1191	1639	8.524264031781604	31.692212029843702	int	-	-1	Summary...
Origin		58				280	137.55906	75.21116804779798	enum	281	-1	Summary...
Dest		58				280	138.02559	75.31124466497435	enum	281	-1	Summary...
Distance					31	4962	725.8401	573.482730722045	int	-	-1	Summary...
TaxiIn		2053				1460	7.57375	44.09759842575039	int	-	-1	Summary...
TaxiOut		1840				251	15.42969	10.651373198861354	int	-	-1	Summary...
Cancelled		98170				1	0.0183	0.13403465840176484	int	-	-1	Summary...
CancellationCode	98170	98962				3	0.7448087431693989	0.7408363762609962	enum	4	-1	Summary...

My Clips

You have no clips. To save a clip into this list, click the paperclip next to the cell.

Click on a clip to insert it into your notebook. Click the ● button to insert and execute the clip.

System (8)

- cs assist
- cs importFiles
- cs getFrames
- cs getModels
- cs getPredictions
- cs getJobs
- cs buildModel
- cs predict

Trash

Trash is empty. Cells that you cut or delete from your notebook appear here.

Use Spark API for Data Filtering

Create a cheap wrapper around H_2O DataFrame

```
// Create RDD wrapper around DataFrame
val airlinesTable : RDD[Airlines]
                = asRDD[Airlines](airlinesData)

// And use Spark RDD API directly
val flightsToORD = airlinesTable
    .filter( f => f.Dest == Some(“ORD") )
```

Regular Spark RDD call

Use Spark SQL to Data Join

```
import org.apache.spark.sql.SQLContext
// We need to create SQL context
implicit val sqlContext = new SQLContext(sc)
import sqlContext._

flightsToORD.registerTempTable("FlightsToORD")
weatherTable.registerTempTable("WeatherORD")
```

Make context implicit to share it with h2oContext

Join Data based on Flight Date

```
val joinedTable = sql(
  """SELECT
    | f.Year,f.Month,f.DayofMonth,
    | f.CRSDepTime,f.CRSArrTime,f.CRSElapsedTime,
    | f.UniqueCarrier,f.FlightNum,f.TailNum,
    | f.Origin,f.Distance,
    | w.TmaxF,w.TminF,w.TmeanF,
    | w.PrcpIn,w.SnowIn,w.CDD,w.HDD,w.GDD,
    | f.ArrDelay
    | FROM FlightsToORD f
    | JOIN WeatherORD w
    | ON f.Year=w.Year AND f.Month=w.Month
    |   AND f.DayofMonth=w.Day""".stripMargin)
```

Split data

```
import hex.splitframe.SplitFrame
import hex.splitframe.SplitFrameModel.SplitFrameParameters

val sfParams = new SplitFrameParameters()
sfParams._train = joinedTable
sfParams._ratios = Array(0.7, 0.2)
val sf = new SplitFrame(sfParams)

val splits = sf.trainModel().get._output._splits
val trainTable = splits(0)
val validTable = splits(1)
val testTable  = splits(2)
```

Result of SQL query is implicitly converted into H2O DataFrame

Launch H_2O Algorithms

```
import hex.deeplearning._
import hex.deeplearning.DeepLearningModel
        .DeepLearningParameters

// Setup deep learning parameters
val dlParams = new DeepLearningParameters()
dlParams._train = trainTable
dlParams._response_column = 'ArrDelay
dlParams._valid = validTable
dlParams._epochs = 100
dlParams._reproducible = true
dlParams._force_load_balance = false


// Create a new model builder
val dl = new DeepLearning(dlParams)

val dlModel = dl.trainModel.get
```

Blocking call

Make a prediction

```
// Use model to score data
val dlPredictTable = dlModel.score(testTable)(‘predict)

// Collect predicted values via RDD API
val predictionValues = asSchemaRDD(dlPredictTable)
                            .collect
                            .map (row =>
      if (row.isNullAt(0))
         Double.NaN
      else
         row(0)
```

Hands-On #2

Can I access results from R?

YES!

Requirements

R 3.1.2+

RStudio

H2O R package

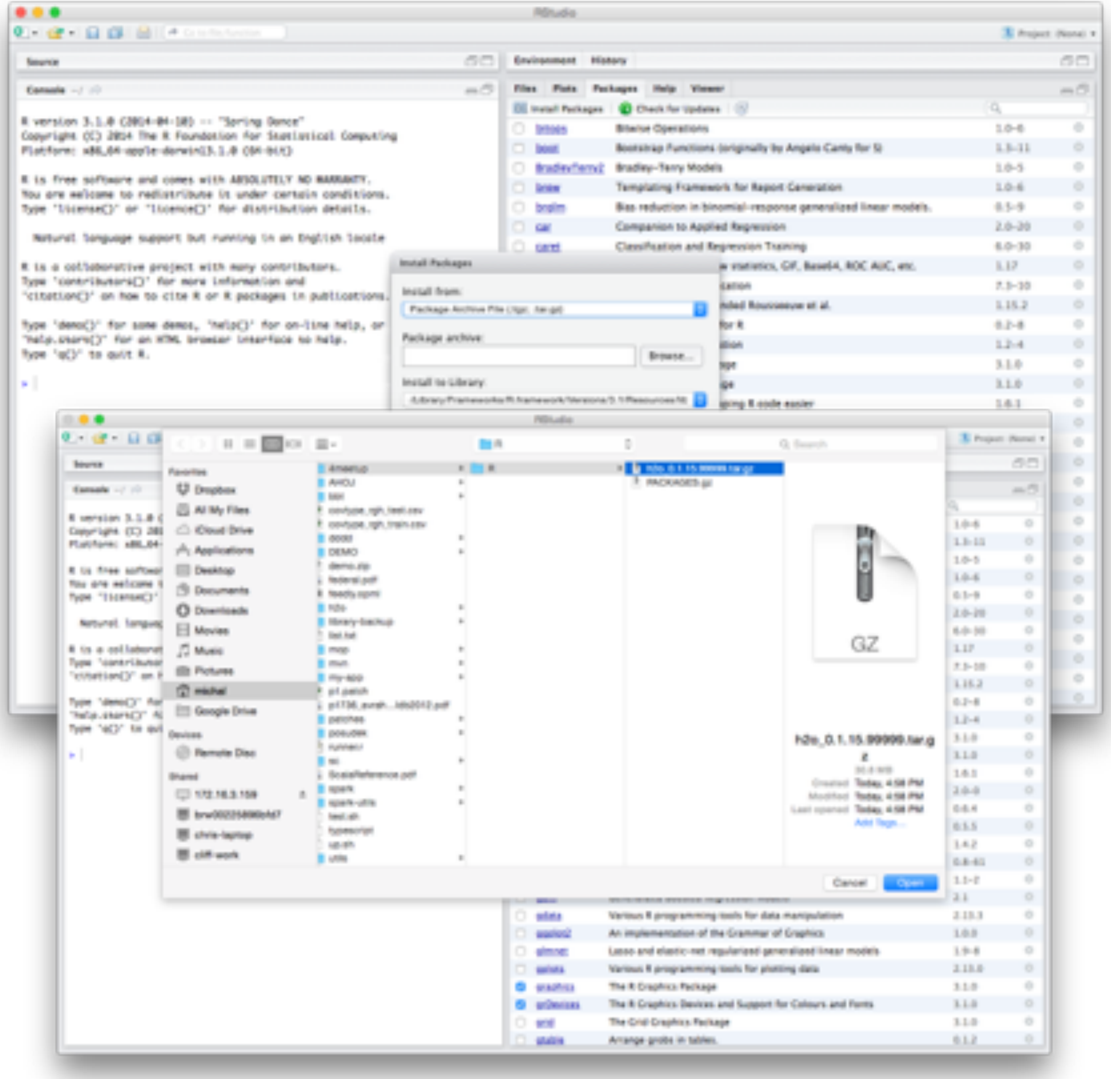
Install R package

You can find R package on USB stick

1. **Open RStudio**

2. **Click on "Install Packages"**

3. **Select h2o_0.1.22.99999.tar.gz file from USB**



```
R version 3.1.0 (2014-04-10) -- "Spring Dance"
Copyright (C) 2014 The R Foundation for Statistical Computing
Platform: x86_64-apple-darwin13.1.0 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

>
```

Install Packages

Install from: Package Archive File (.tgz; .tar.gz)

Package archive:

Install to Library: /Library/Frameworks/R.framework/Versions/3.1/Resources/library

□	bitops	Bitwise Operations	1.0-6
□	boot	Bootstrap Functions (originally by Angelo Canty for S)	1.3-11
□	BradleyTerry2	Bradley-Terry Models	1.0-5
□	brew	Templating Framework for Report Generation	1.0-6
□	brglm	Bias reduction in binomial-response generalized linear models.	0.5-9
□	car	Companion to Applied Regression	2.0-20
□	caret	Classification and Regression Training	6.0-30
□	gdata	Various R programming tools for data manipulation	2.13.3
□	ggplot2	An implementation of the Grammar of Graphics	1.0.0
□	glmnet	Lasso and elastic-net regularized generalized linear models	1.9-8
□	gplots	Various R programming tools for plotting data	2.13.0
☑	graphics	The R Graphics Package	3.1.0
☑	grDevices	The R Graphics Devices and Support for Colours and Fonts	3.1.0
□	grid	The Grid Graphics Package	3.1.0
□	gtable	Arrange grobs in tables.	0.1.2

```
install.packages("sparkling-water-meetup/R/h2o_0.1.22.99999.tar.gz", repos = NULL, type = "source")
```

Generate R code

In Sparkling Shell:

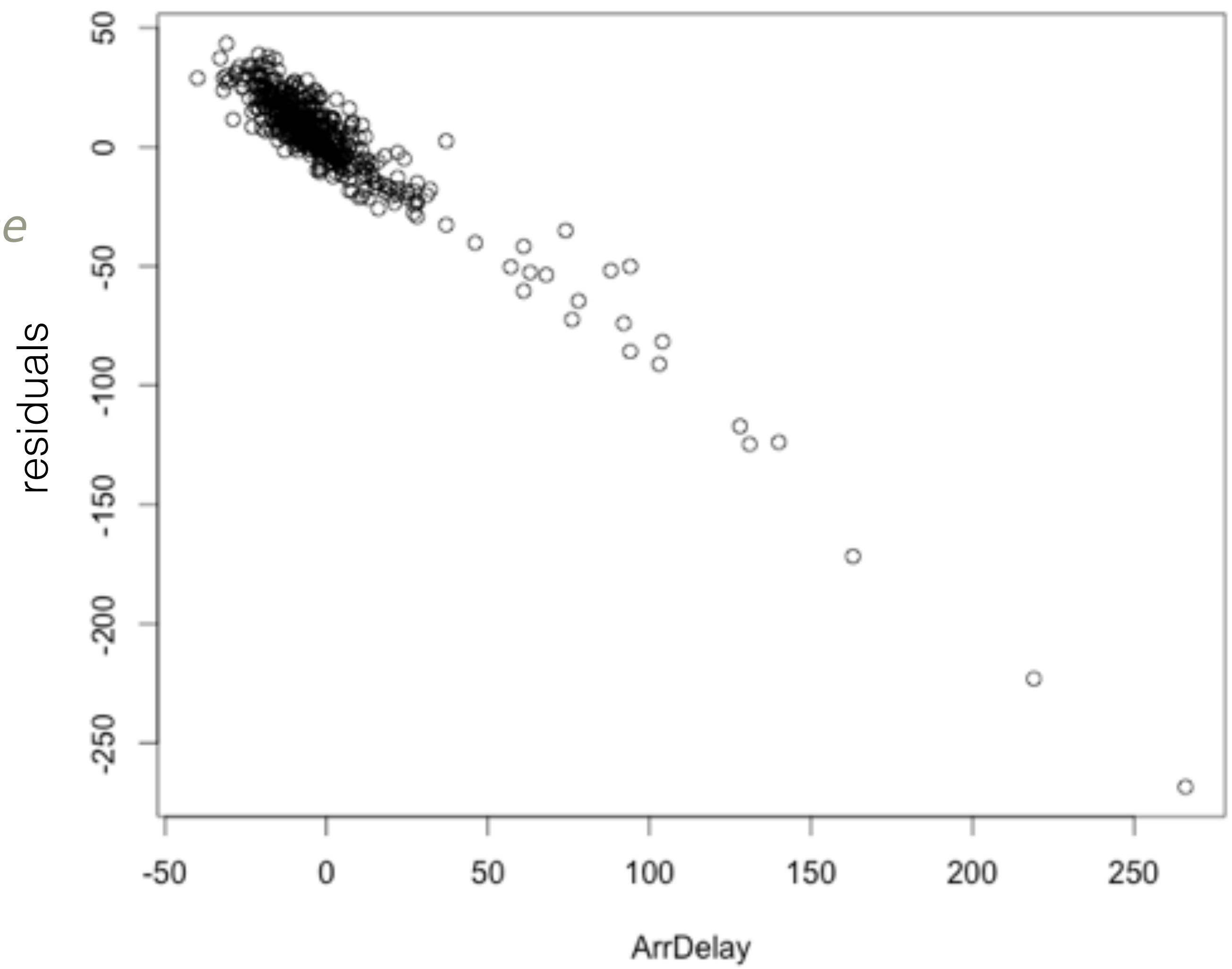
```
import org.apache.spark.examples.h2o.DemoUtils.residualPlotRCode

residualPlotRCode(
   predictionH2OFrame, 'predict,
   testFrame, 'ArrDelay)
```

Utility generating R code to show residuals plot for predicted and actual values

Residuals Plot in R

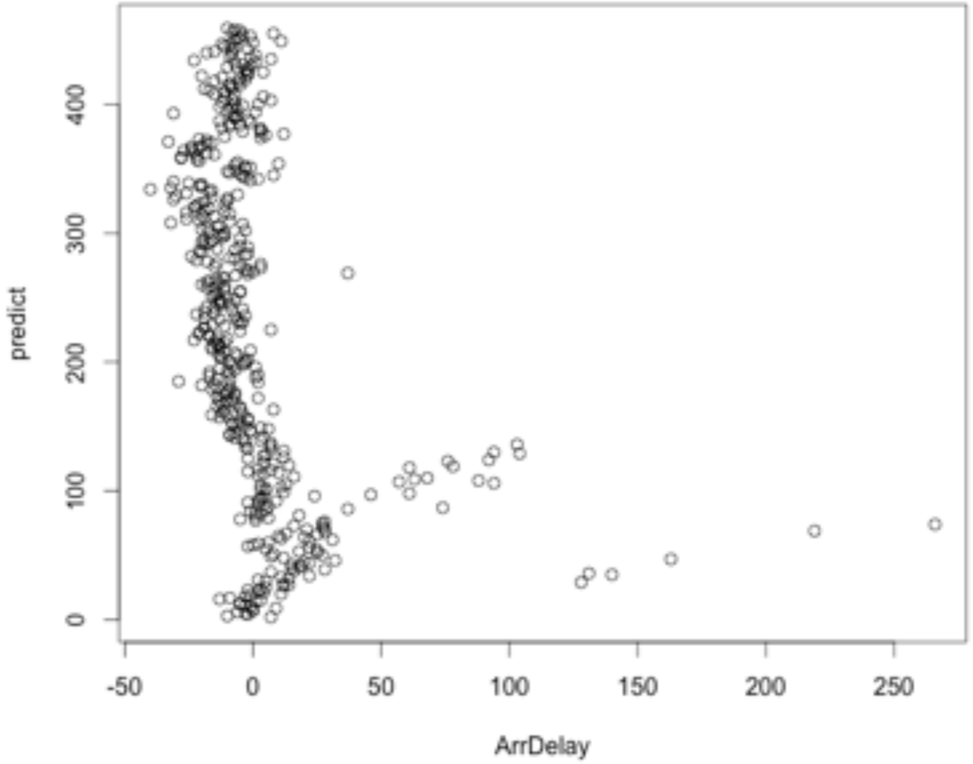
References of data

```r
# Import H2O library and initialize H2O client
library(h2o)

h = h2o.init()

# Fetch prediction and actual data, use remembered keys
pred = h2o.getFrame(h, "dframe_b5f449d0c04ee75fda1b9bc865b14a69")
act = h2o.getFrame (h, "frame_rdd_14_b429e8b43d2d8c02899ccb61b72c4e57")

# Select right columns
predDelay = pred$predict
actDelay = act$ArrDelay

# Make sure that number of rows is same
nrow(actDelay) == nrow(predDelay)

# Compute residuals
residuals = predDelay - actDelay

# Plot residuals
compare = cbind(
    as.data.frame(actDelay$ArrDelay),
    as.data.frame(residuals$predict))

plot( compare[,1:2] )
```



Warning!

If you are running R v3.1.0 you will see different plot:

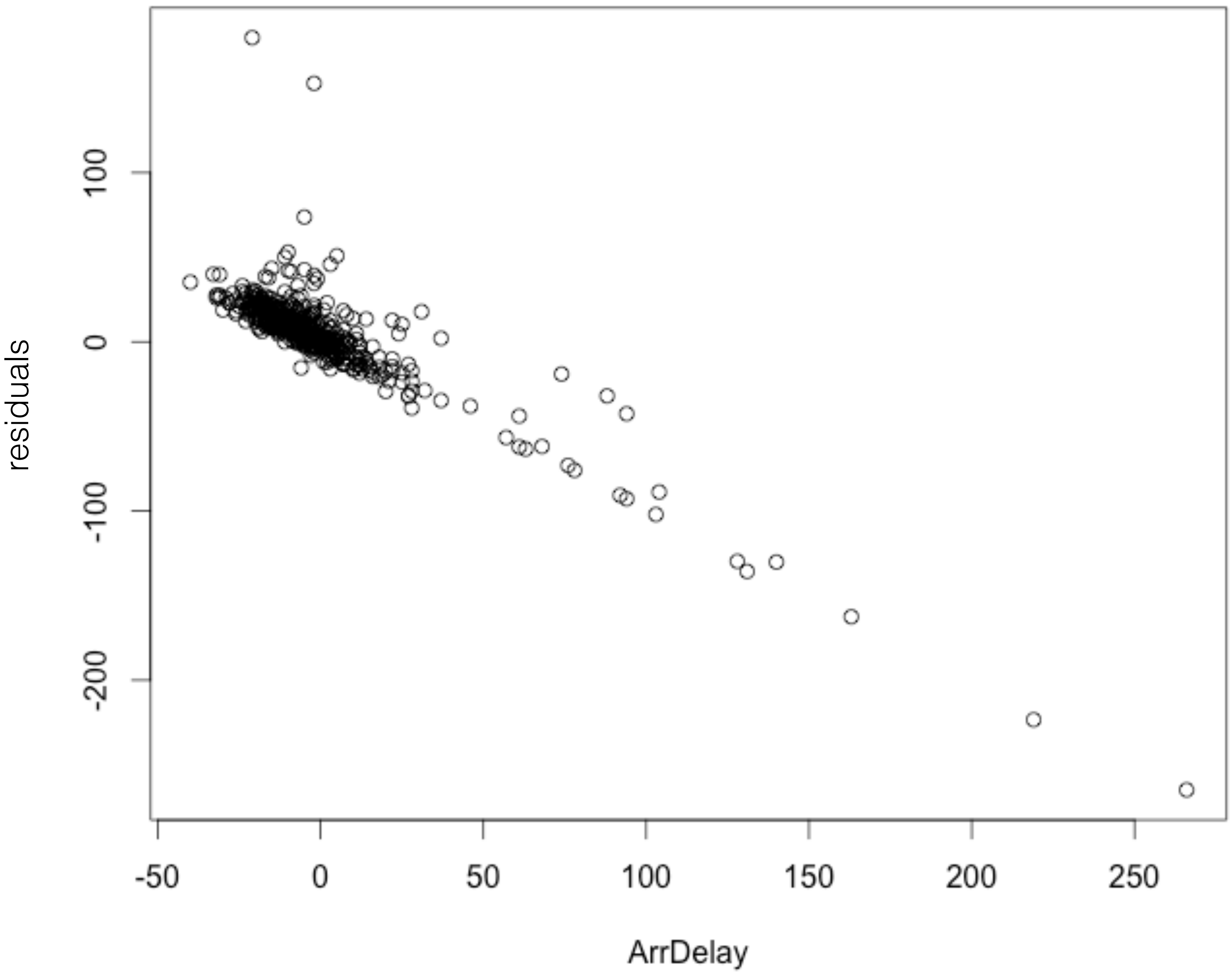


Why? Float number handling was changed in that version. Our recommendation is to upgrade your R to the newest version.

Try GBM Algo

```
import hex.tree.gbm.GBM
import hex.tree.gbm.GBMModel.GBMParameters

val gbmParams = new GBMParameters()
gbmParams._train = trainTable
gbmParams._response_column = 'ArrDelay
gbmParams._valid = validTable
gbmParams._ntrees = 100

val gbm = new GBM(gbmParams)
val gbmModel = gbm.trainModel.get

// Print R code for residual plot
val gbmPredictTable = gbmModel.score(testTable)('predict)
printf( residualPlotRCode(gbmPredictTable, 'predict, testTable,
'ArrDelay) )
```

Residuals plot for GBM prediction



Hands-On #3

How Can I Develop and Run Standalone App?

Requirements

Idea or Eclipse

Git

Use Sparkling Water Droplet

Clone H2O Droplets repository

```
git clone https://github.com/h2oai/h2o-droplets.git

cd h2o-droplets/sparkling-water-droplet/
```

Generate IDE project

For Idea

```
./gradlew idea
```

For Eclipse

```
./gradlew eclipse
```

... add import project into your IDE

Create An Application

```
object AirlinesWeatherAnalysis {

  /** Entry point */
  def main(args: Array[String]) {
    // Configure this application
    val conf: SparkConf = new SparkConf().setAppName("Flights Water")
    conf.setIfMissing("spark.master", sys.env.getOrElse("spark.master", "local"))

    // Create SparkContext to execute application on Spark cluster
    val sc = new SparkContext(conf)
    // Start H2O cluster only
    new H2OContext(sc).start()

    // User code
    // . . .
  }
}
```

Create
Spark Context

Create H2O context
and start H2O on top
of Spark

Build the Application

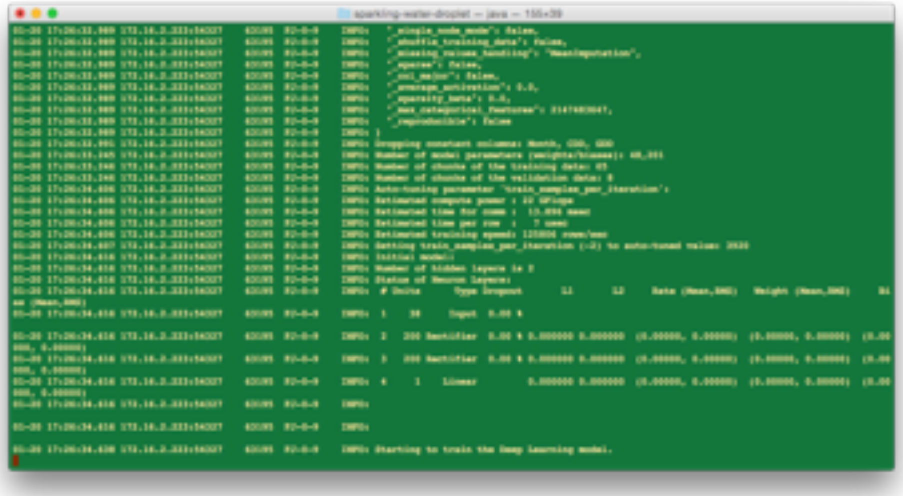
Build and test

```
./gradlew build shadowJar
```

Create an assembly which can be submitted to Spark cluster

Run code on Spark

```
#!/usr/bin/env bash

APP_CLASS=water.droplets.AirlineWeatherAnalysis
FAT_JAR_FILE=“build/libs/sparkling-water-droplet-app.jar”
MASTER=${MASTER:-"local-cluster[3,2,1024]"}
DRIVER_MEMORY=2g

$SPARK_HOME/bin/spark-submit "$@" \
  --driver-memory $DRIVER_MEMORY \
  --master $MASTER \
  --class "$APP_CLASS" $FAT_JAR_FILE
```



It is Open Source!

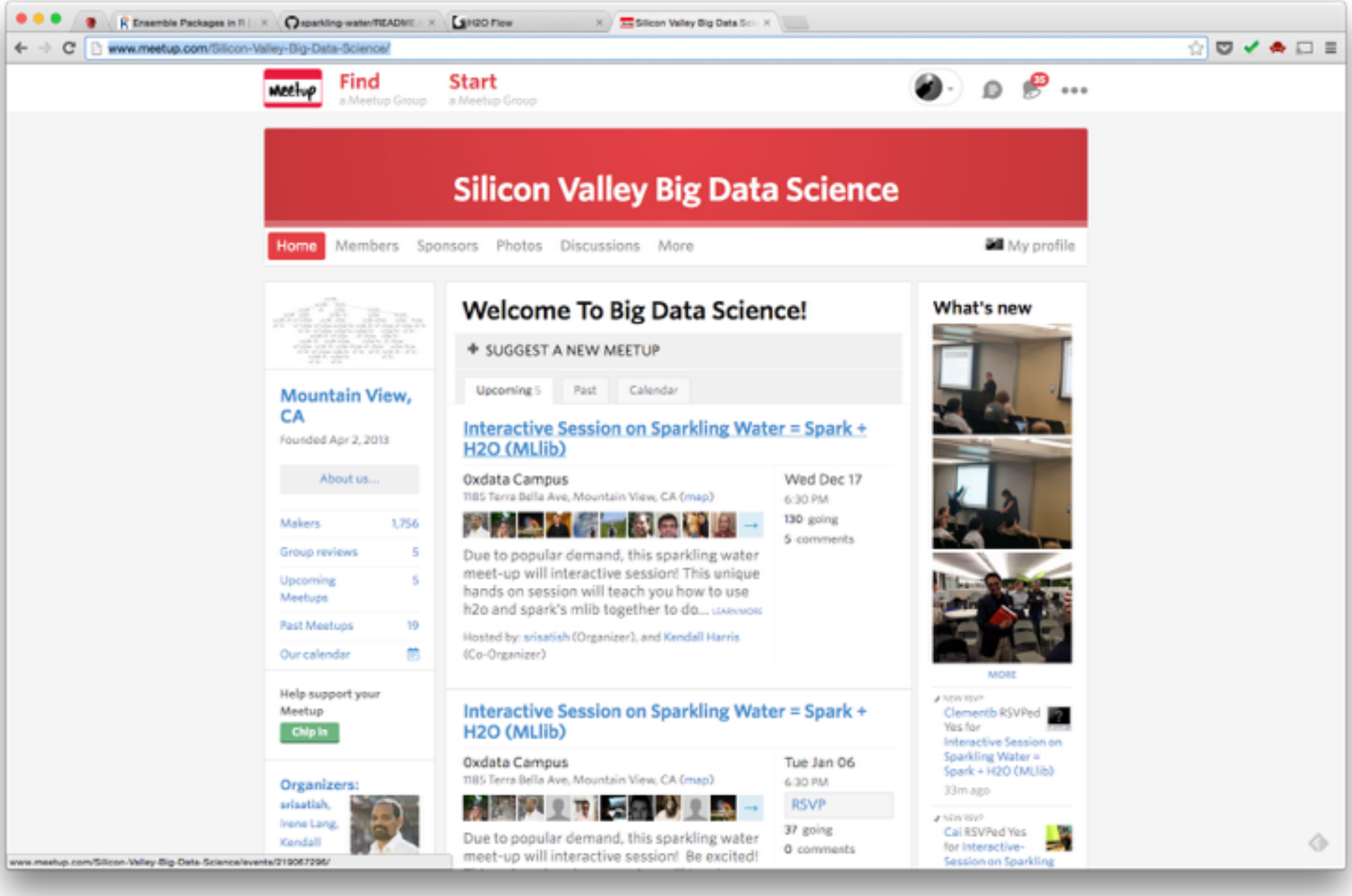
You can participate in

- **H2O Scala API**
- **Sparkling Water testing**
  - **Mesos, Yarn, workflows (PUBDEV-23,26,27,31-33)**
- **Spark integration**
  - **MLLib Pipelines**

Check out our JIRA at http://jira.h2o.ai

Come to Meetup

http://www.meetup.com/Silicon-Valley-Big-Data-Science/



Silicon Valley Big Data Science

Mountain View, CA

Founded Apr 2, 2013

Makers	1,756
Group reviews	5
Upcoming Meetups	5
Past Meetups	19
Our calendar	

Help support your Meetup

Organizers: srisatish, Irene Lang, Kendall

Welcome To Big Data Science!

+ SUGGEST A NEW MEETUP

Upcoming 5 | Past | Calendar

Interactive Session on Sparkling Water = Spark + H2O (MLlib)

0xdata Campus
1185 Terra Bella Ave, Mountain View, CA (map)

Wed Dec 17
6:30 PM
130 going
5 comments

Due to popular demand, this sparkling water meet-up will interactive session! This unique hands on session will teach you how to use h2o and spark's mlib together to do... LEARN MORE

Hosted by: srisatish (Organizer), and Kendall Harris (Co-Organizer)

Interactive Session on Sparkling Water = Spark + H2O (MLlib)

0xdata Campus
1185 Terra Bella Ave, Mountain View, CA (map)

Tue Jan 06
6:30 PM
37 going
0 comments

Due to popular demand, this sparkling water meet-up will interactive session! Be excited!

What's new

NEW RSVP
Clementb RSVPed Yes for Interactive Session on Sparkling Water = Spark + H2O (MLlib)
33m ago

NEW RSVP
Cai RSVPed Yes for Interactive-Session on Sparkling

More info

Checkout **H2O.ai** Training Books

http://learn.h2o.ai/

Checkout **H2O.ai** Blog for Sparkling Water tutorials

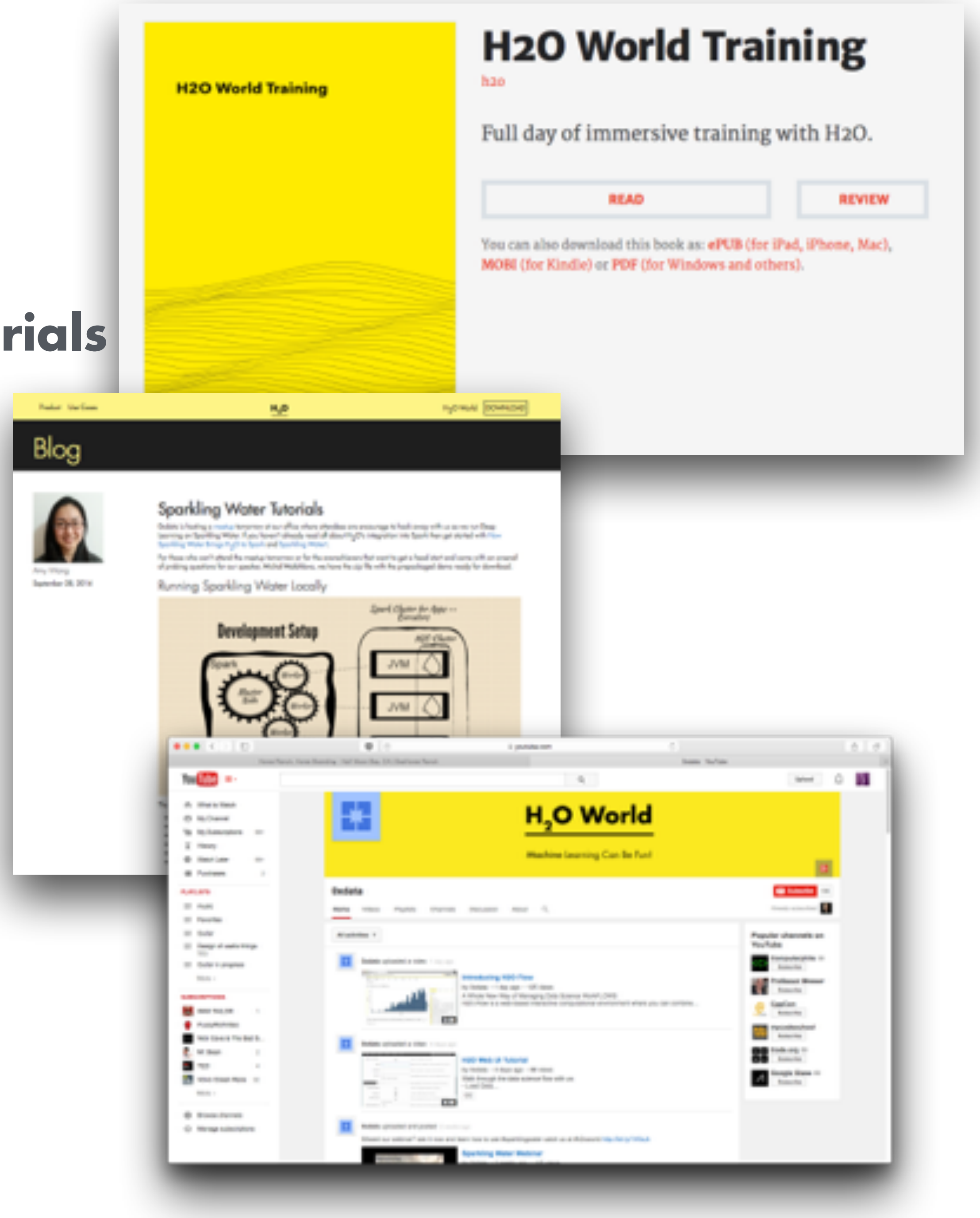
http://h2o.ai/blog/

Checkout **H2O.ai** Youtube Channel

https://www.youtube.com/user/0xdata

Checkout GitHub

https://github.com/h2oai/sparkling-water



H2O World Training

h2o

Full day of immersive training with H2O.

You can also download this book as: ePUB (for iPad, iPhone, Mac), MOBI (for Kindle) or PDF (for Windows and others).

Sparkling Water Tutorials

Running Sparkling Water Locally

Thank you!

Learn more about H_2O at
h2o.ai
or

```
> for r in sparkling-water; do
git clone “git@github.com:h2oai/$r.git”
done
```

Follow us at @h2oai

And the winner is …