Hadoop Intro

Jay Urbain, PhD

References follow

References (abbreviated)

Hadoop: The Definitive Guide, 4th Edition, Storage and Analysis at Internet Scale, Tom White, Publisher: O'Reilly Media, March 2015
http://shop.oreilly.com/product/0636920033448.do

http://hadoop.apache.org/

Cloudera
https://www.cloudera.com/documentation.html
https://www.cloudera.com/documentation/enterprise/latest/topics/quickstart.html

Hortonworks
https://docs.hortonworks.com/

MSOE CS4230 Distributed and Cloud Computing
http://jayurbain.com/msoe/cs4230/outline.html

Prerequisites

- Install Virtual Box:

https://www.virtualbox.org/wiki/VirtualBox

- Download Cloudera Quickstart VM:

https://www.cloudera.com/downloads.html?src=GoogleAdWords&gclid=CjwKEAjwsqjKBRDtwOSjs6GTgmASJACRbI3fv5t4JrzIWrgx3PIsoOpPlWXOiKDHNAPWgRsfS45qlxoCK2rw_wcB

Goals

- Provide a basic overview of Hadoop Tools
- Go into a little more depth with MapReduce and Hive

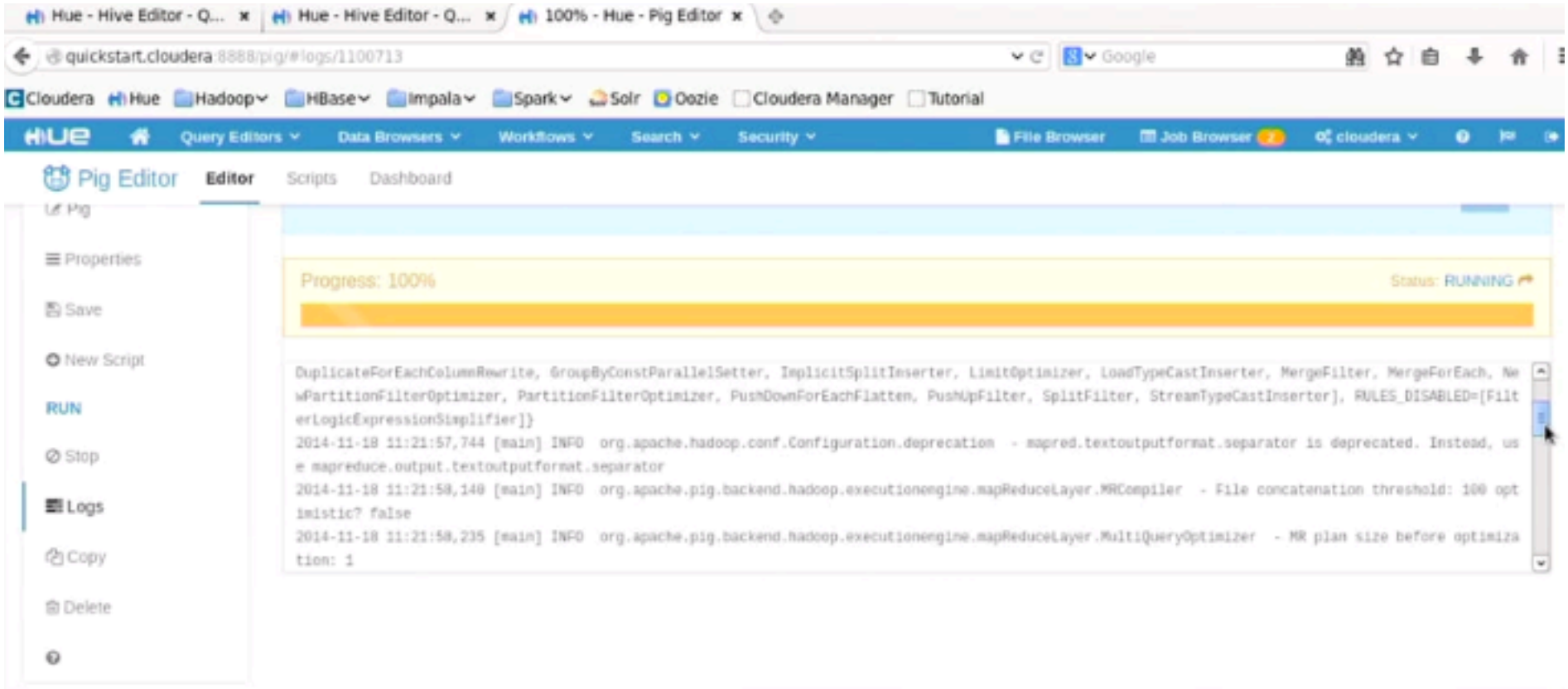
- Expected background:
  - Programming language – Java, Python
  - Relational database – admin, query
  - Basic Linux commands

Hadoop

Two fundamental components plus *projects*

- Open-source data storage:
  - HDFS
- Processing API:
  - MapReduce
- Other projects/libraries:
  - Hbase, Hive, Pig, Spark, Storm, etc.

Hadoop – technology used to store and process large amounts of data



Understanding RDBMS Limits

Limits using RDBMS

- Scalability – moving towards terabyte repositories
- Performance – e.g., need *realtime*
- Stream processing
- Query-ability
- Application of machine learning, iterative processing for optimizing coefficients
- Hadoop ecosystem

Database Choices

- File systems
  - Host file system
  - HDFS (Hadoop Distributed File System)
  - AWS S3
- Databases
  - NoSQL
    - Key/value – Redis
    - Column store – Vertica
    - Document – MongoDB
  - RDBMS – MySQL, Postgres, Oracle, et.

Hadoop and HBase

- Hadoop uses an alternative file system (HDFS)
- Modeled after *The Google File System* paper:
  http://xpgc.vicp.net/course/svt/TechDoc/storagepaper/gfs-sosp2003.pdf

- Hbase (also Hive, BigTable, Dynamo, etc.)
  - NoSQL (non-relational) database
  - Wide column store – key, 1..n values
  - Wide column schema can vary
    - E.g., customer id, customer attribute values

CAP Theorem

- Consistency
  - Support atomic transactions, ACID properties
  - Strong consistency
- Availability
  - Uptime
- Partitioning
  - Can split data across multiple machines
  - Scalability – partition data and processing across multiple machines

- DB systems can meet 2 of 3 properties
  - RDBMS – ?
  - Hadoop - ?

CAP Theorem

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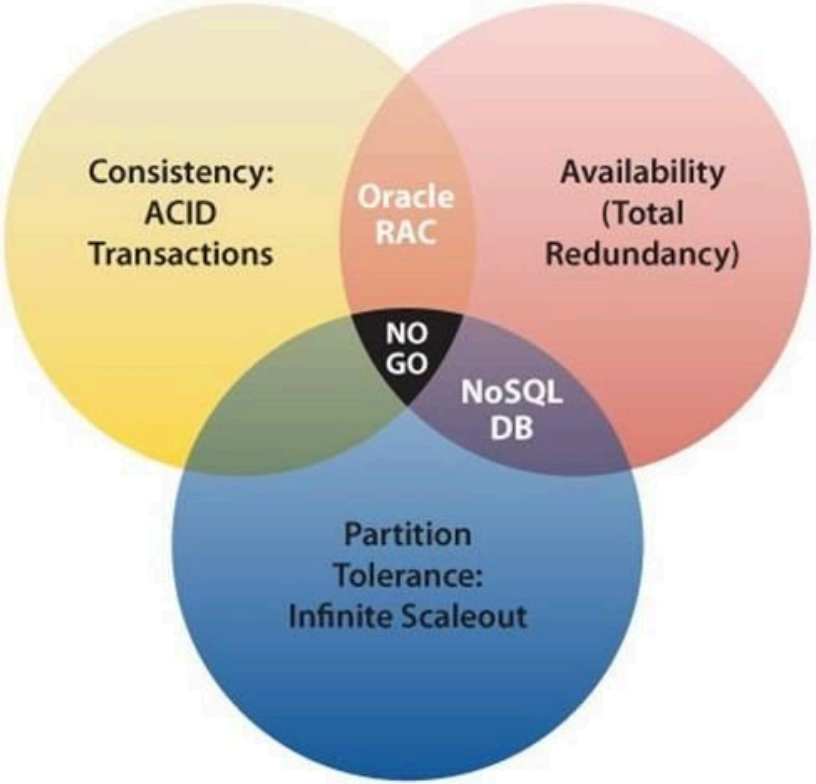
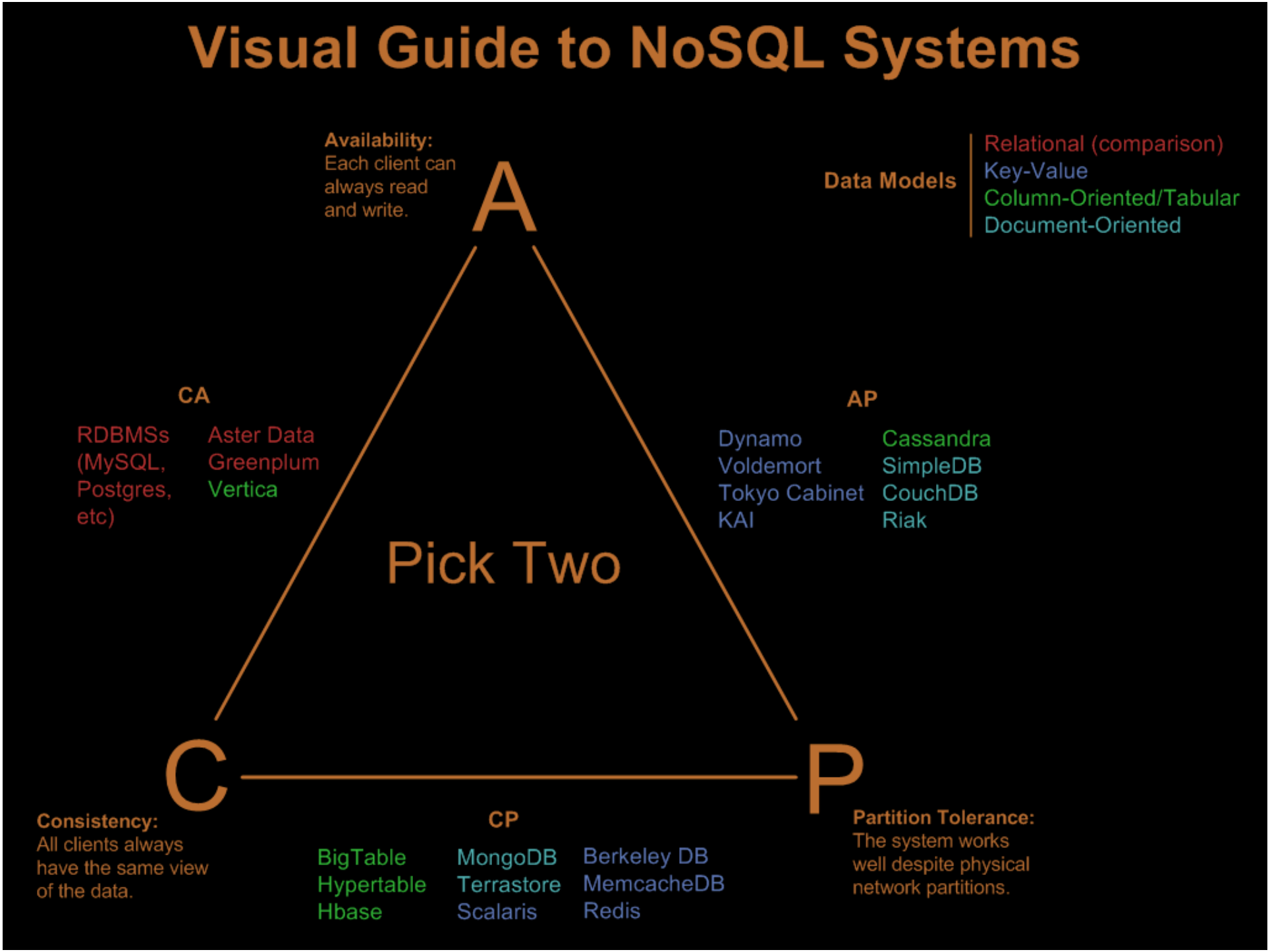
- DB systems can meet 2 of 3 properties
  - RDBMS – consistency, availability
  - Hadoop – availability, partitioning

CAP Theorem

- Interpretation and implementations of CAP theorem vary, but most of the NoSQL database systems favor *partition tolerance and availability over strong consistency.*



Visual Guide to NoSQL Systems



Hadoop CAP Properties

- Scalability (partition tolerance)
  - Commodity hardware for data storage
- Availability
  - 3 copies of data by default
  - partition tolerance
  - Commodity hardware for distributed processing
- Originally designed by Google to index the Internet!
- Top users: Facebook, Yahoo, many others

Data for Hadoop

- Transactional data
  - Not a good fit for Hadoop
  - Need to maintain consistency
  - E.g., Healthcare: prescription, charge capture, financial transactions
  - Keep in RDBMS
- Behavioral data – world of big data
  - Batch data, stream processing, iterative processing
  - E.g., Analyze transaction history, health records, sensor data, etc.

Changing Data Landscape

- Think about different activities

Review

- Hadoop is not a database. It is an alternative file system (HDFS) with a processing library.
  - True
  - False

- Under which CAP Theory property(s) does a transaction fall?
  - Availability
  - Consistency
  - Partitioning
  - Scalability

- What data is a good candidate for Hadoop?
  - Transactional
  - LOB
  - Relational
  - Behavioral

Hadoop Distributions

- 100% Open Source
  - Apache Hadoop, many versions, aggressive release cycle
- Commercial – provide additional administrative tools, and applications
  - Hortonworks
  - Cloudera
  - MapR
- Cloud
  - AWS
    - Can use Apache Hadoop on AWS with a particular version
    - Can use commercial version implemented on AWS cloud, e.g., MapR on AWS.
  - Windows Azure HDInsight

Why Use Hadoop

- If you have *behavioral* data versus *transactional* data, Hadoop can be a better fit: cheaper, faster, better
- Cheaper
  - Scales to petabytes or more
- Faster
  - Parallel data processing
- Better
  - Suited for particular types of 'Big Data'

Hadoop Business Problems

Use behavioral data to make better decisions:

- Sensor data modeling
  - Identify predictive patterns in large heterogeneous sensor data
  - Location, activity, equipment, environmental
- Risk modeling
  - Need to make best decisions from as much credit data as possible
  - Optimize healthcare best practices
- Credit card activity
  - Use machine learning to identify patterns in transaction data
- Customer churn
  - Expensive to acquire new customer.
- Recommendation engine
  - Netflix, Amazon from preferences
- Search
  - Indexing, construct distributed inverted index
- Machine learning
  - Fit complex, high-dimensional, non-linear models to massive data sets
- Add targeting
  - Classic behavior modeling from click-through data
- Data transformation
  - Patient de-identification, NLP

Organizations often combine transactional data with behavioral data to make better decisions

- Facebook
- Yahoo!
  - Hortonworks was started from ex-Yahoo'ers
- Amazon
- eBay
- American Airlines
- NY Times
- Federal Reserve Board
- IBM
- Orbitz
- Etc.

Hadoop versus HBase

Hadoop

ID	Data
1	Name="Lynn", Location="Irvine"
2	Name="Sam", Car="Honda"
3	Location="LA", Car="Toyota", Color="Red"

HBase

- HDFS file system is designed for very large blocks 64/128M chunks versus 8K blocks in traditional file system.
- Written in Java, programming API
- HBase wide column store, schema on read. Easier for non-programmers.
- HBase stores table in HDFS.

Hadoop Job Categories

- Hadoop Developer – our focus
- Hadoop Administrator
- Hadoop Architect

- Note: *Debugging is multi-disciplinary*
  - Problems due to cluster architecture, available resources can cause programs to fail
  - Often need to change your program to optimize use of existing resources

Review

- In Hadoop the processing API is _____
  - MapReduce
  - HDFS
  - Hbase
  - Hive

- Programmers can natively process large files using _____, but Analysts can use _____ to query data from large files
  - MapReduce; Hbase
  - Hbase; MapReduce
  - Hbase; HDFS
  - HDFS; MapReduce

Java Virtual Machines

- JVM – execute Java bytecode in an executable program.
- Hadoop processes run in *separate* JVM's.
- Traditional data processing programs run multiple processes (threads) in the same JVM, and can share state.
- By running processes on separate JVM's they can *not* share state.
- JVM process for Version 2.0 MapReduce (MRv2) has been changed from Version 1.0: MRv2 add the YARN resource management layer.

Hadoop File System - HDFS

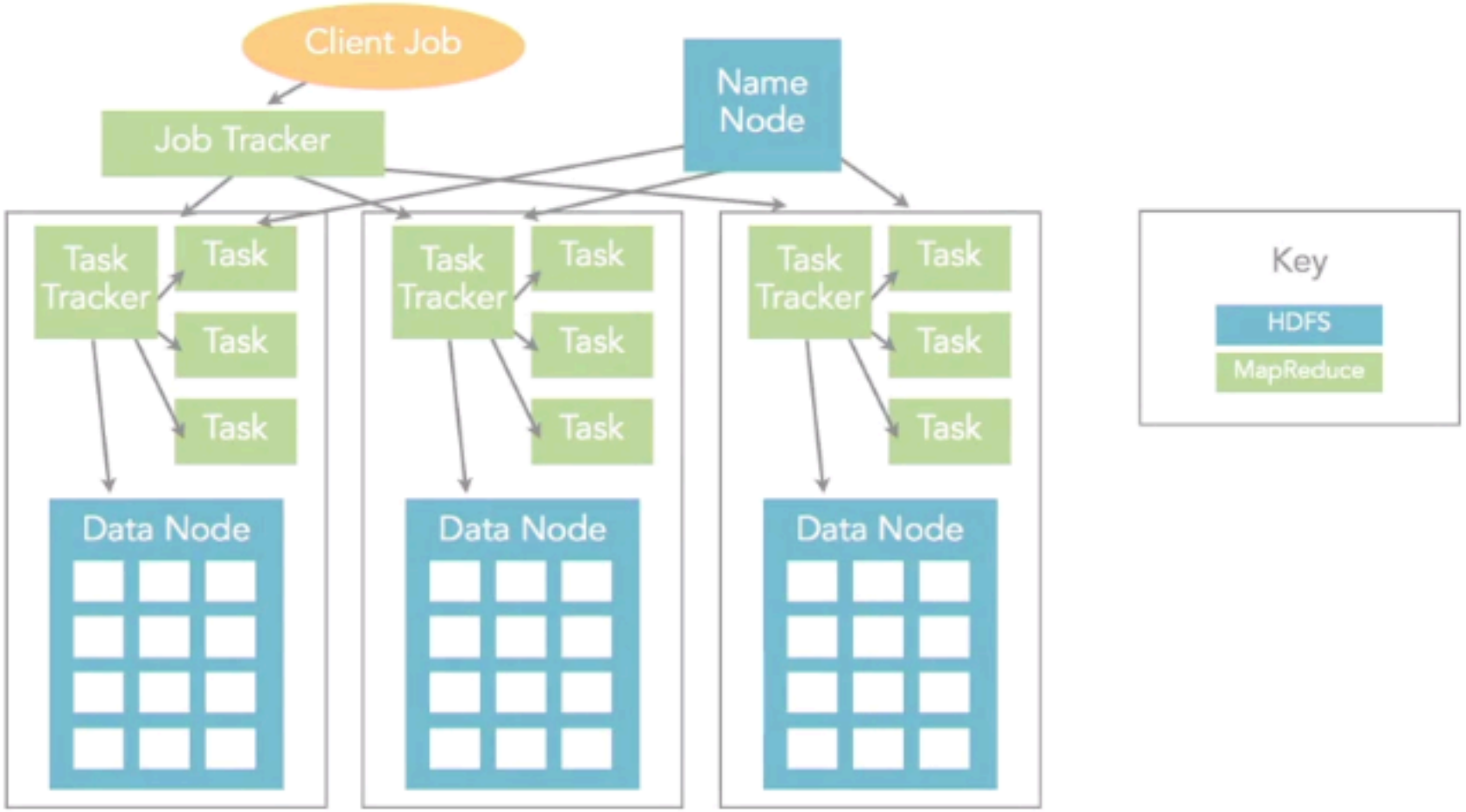
- HDFS
  - Distributed (triple replicated, files partitioned on 3-nodes)
  - pseudo-distributed modes (single node)
- Regular file system
  - Standalone
- Cloud file system
  - AWS S3; Azure Blob

Running Hadoop: Files and JVMs

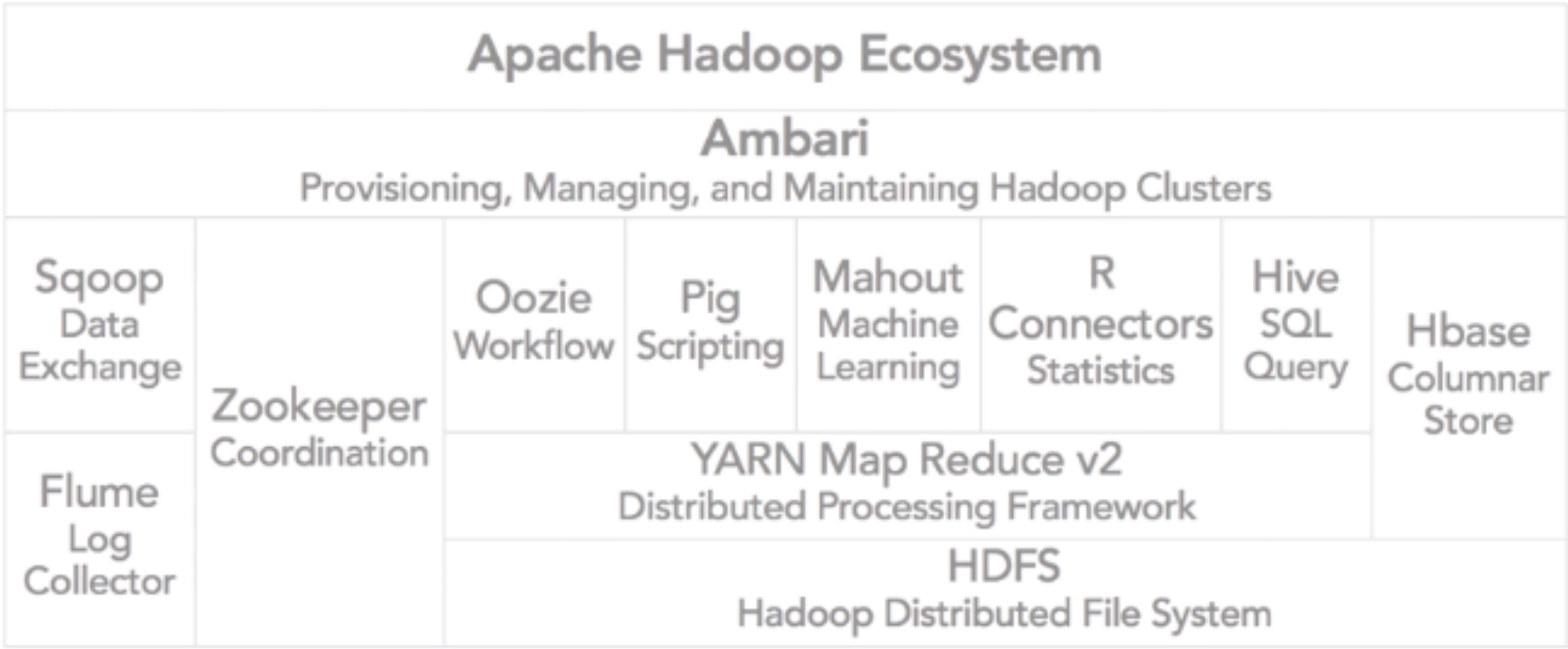
- Single node
  - Local file system
  - Single JVM
- Pseudo-distributed
  - Uses HDFS
  - JVM daemons run processes

Fully Distributed Mode

- 3 physical servers
  - daemons run and tracking tasks, manage chunk storage
- Job Tracker and Name Node (chunk/data mgmt.) runs on a separate server(s) server
- All separate JVM's



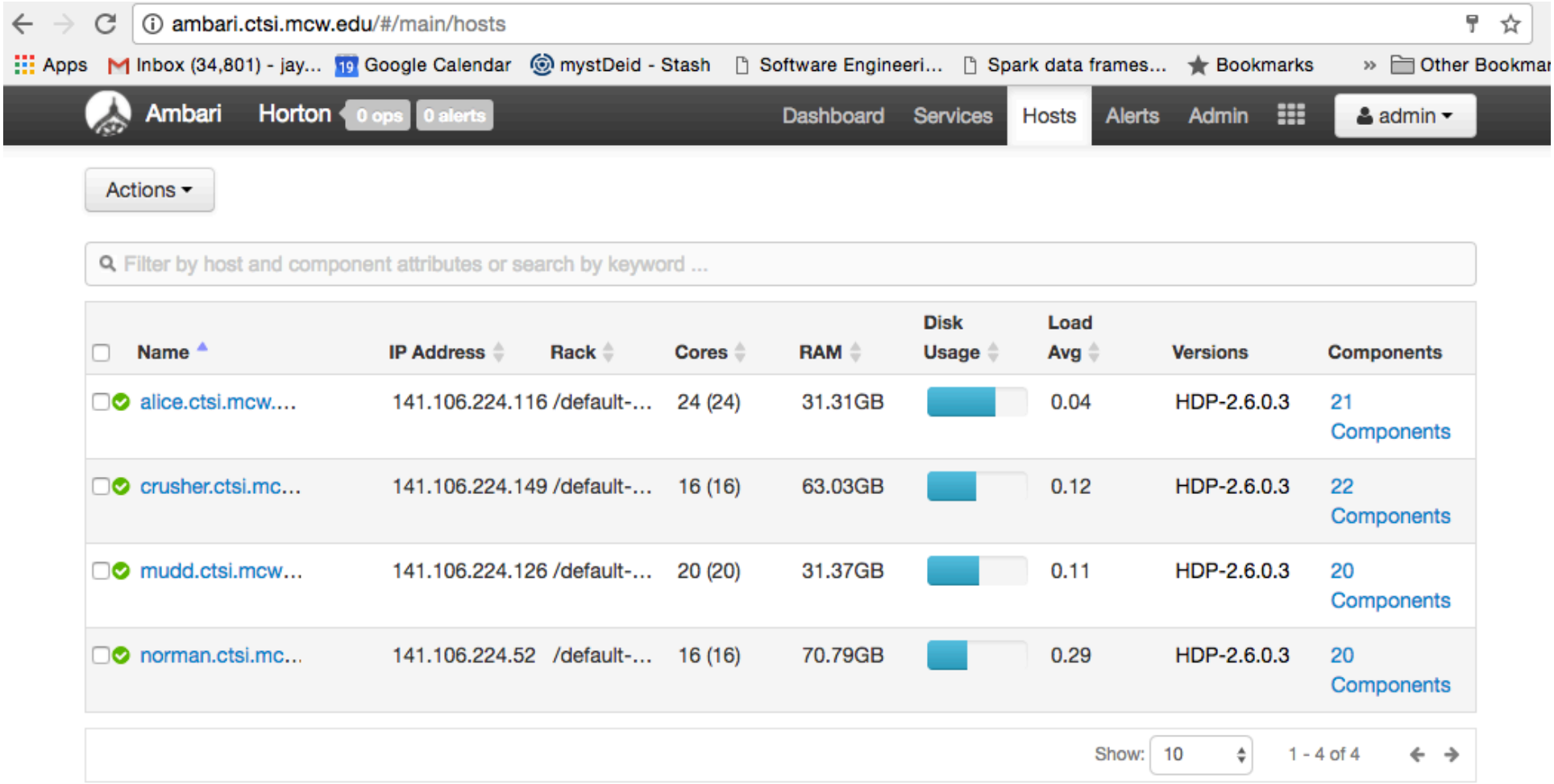
Hadoop Cluster Components “Ecosystem”

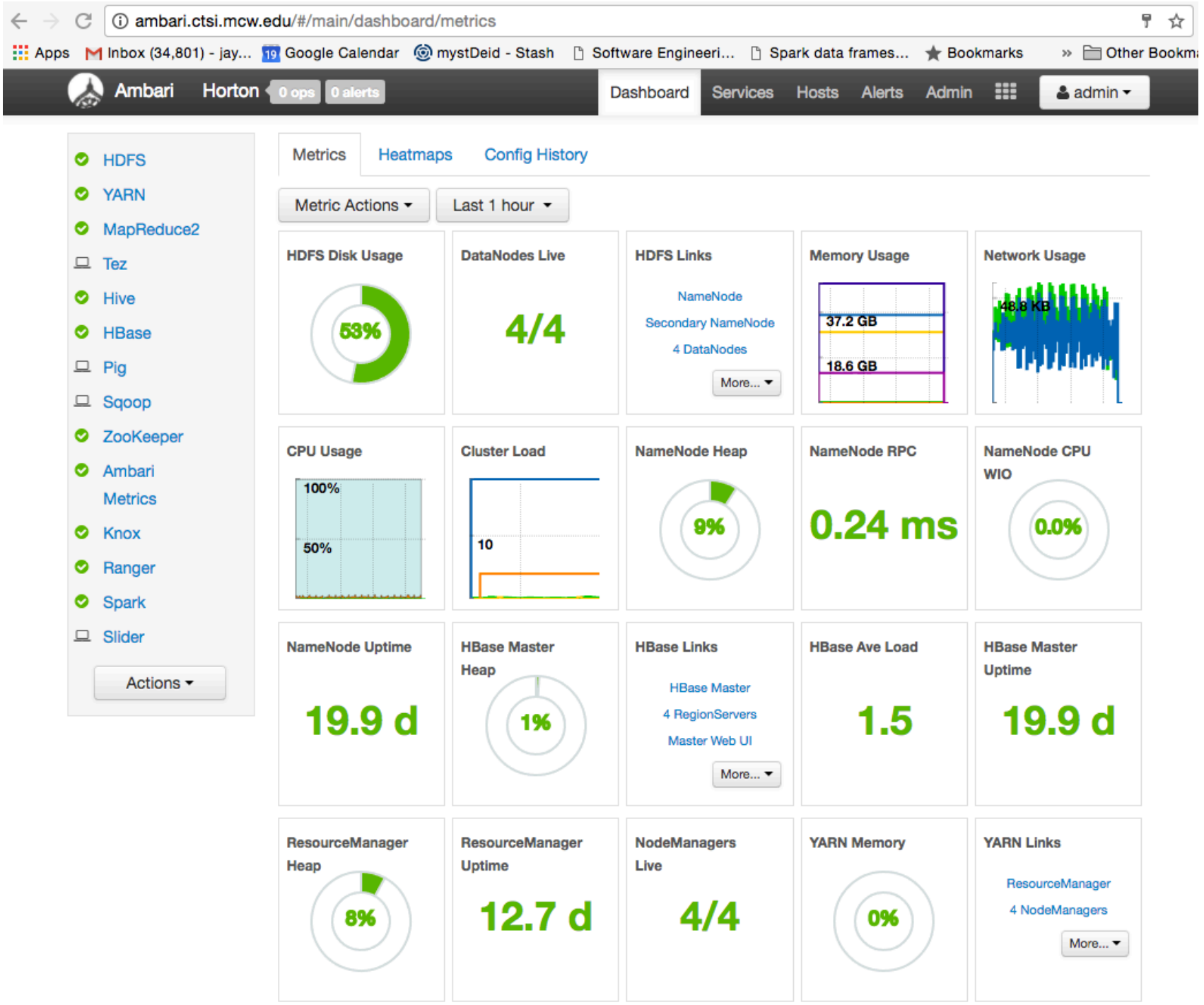


YARN – Yet Another Resource Negotiator
Hive – HQL - SQL like query language
Pig – scripting language for ETL
Mahout – machine learning library
Oozie - workflow, coordination of jobs
Zookeeper – coordinates groups of jobs
Sqoop - data exchange between RDBMS and Hadoop
Flume – log collector
Ambari – provisioning, managing and monitoring Hadoop Clusters

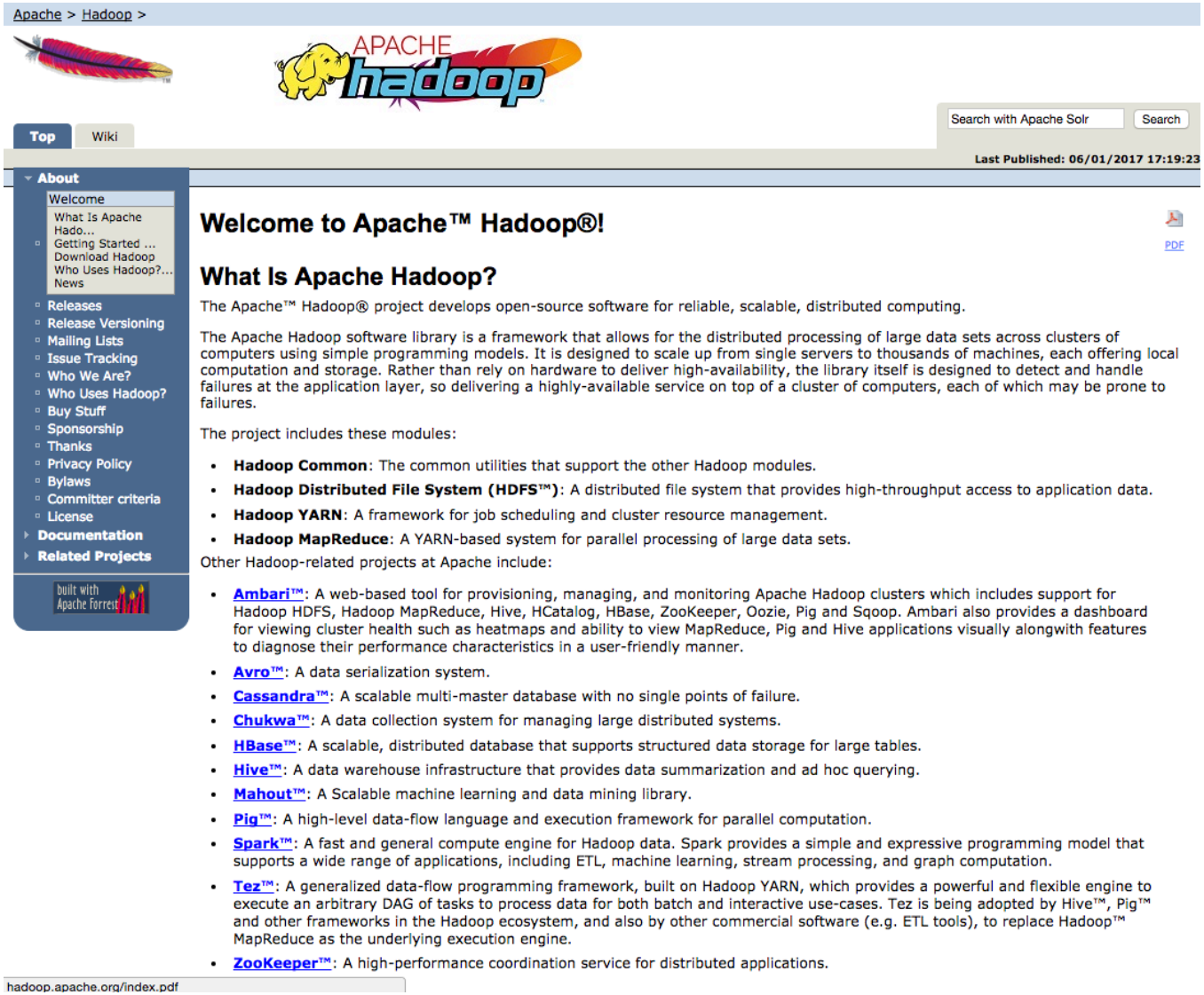
Ambari

- http://ambari.ctsi.mcw.edu/#/login




ambari.ctsi.mcw.edu/#/main/dashboard/metrics
Apps
Inbox (34,801) - jay...
Google Calendar
mystDeid - Stash
Software Engineeri...
Spark data frames...
Bookmarks
Other Bookm
Ambari
Horton
0 ops
0 alerts
Dashboard
Services
Hosts
Alerts
Admin
admin
HDFS
YARN
MapReduce2
Tez
Hive
HBase
Pig
Sqoop
ZooKeeper
Ambari Metrics
Knox
Ranger
Spark
Slider
Actions
Metrics
Heatmaps
Config History
Metric Actions
Last 1 hour
HDFS Disk Usage
53%
DataNodes Live
4/4
HDFS Links
NameNode
Secondary NameNode
4 DataNodes
More...
Memory Usage
37.2 GB
18.6 GB
Network Usage
48.8 KB
CPU Usage
100%
50%
Cluster Load
10
NameNode Heap
9%
NameNode RPC
0.24 ms
NameNode CPU WIO
0.0%
NameNode Uptime
19.9 d
HBase Master Heap
1%
HBase Links
HBase Master
4 RegionServers
Master Web UI
More...
HBase Ave Load
1.5
HBase Master Uptime
19.9 d
ResourceManager Heap
8%
ResourceManager Uptime
12.7 d
NodeManagers Live
4/4
YARN Memory
0%
YARN Links
ResourceManager
4 NodeManagers
More...

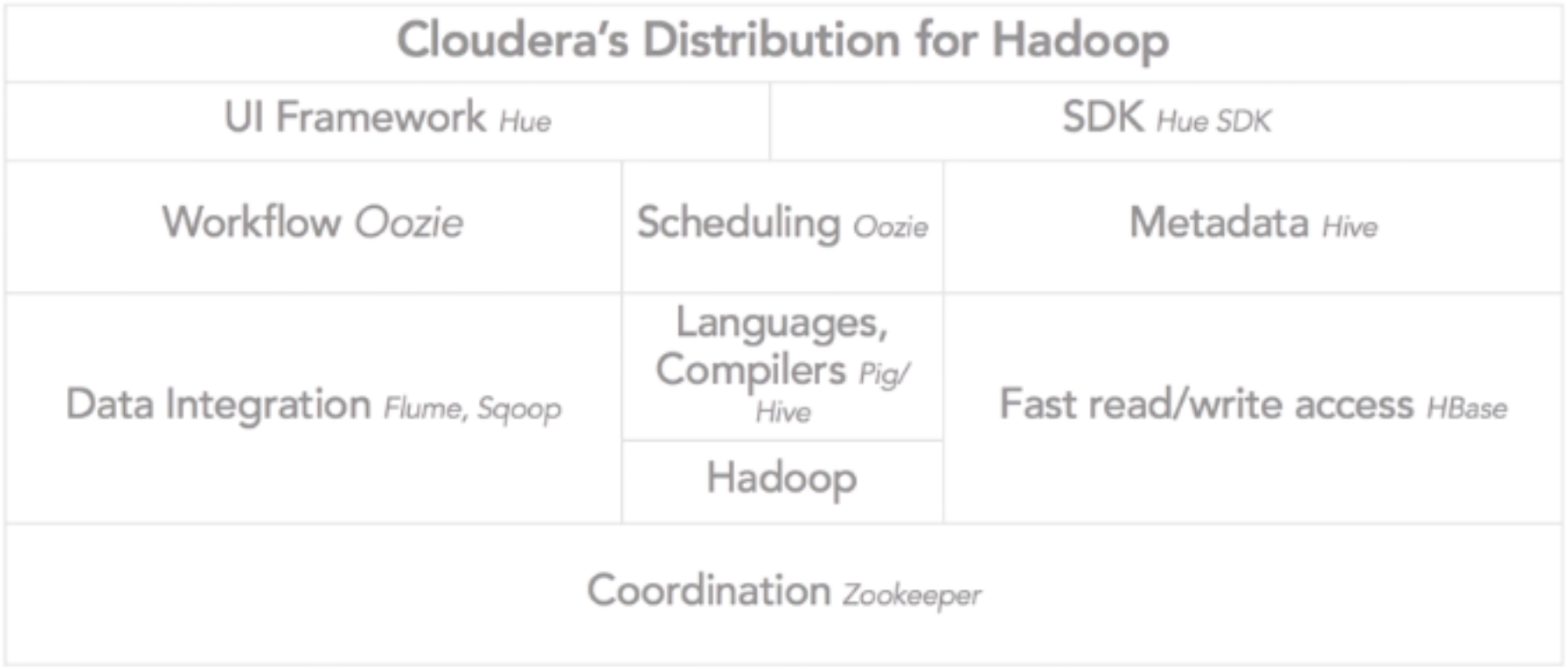
http://hadop.apache.org



Setting up binaries and setting up plain vanilla Hadoop is difficult.

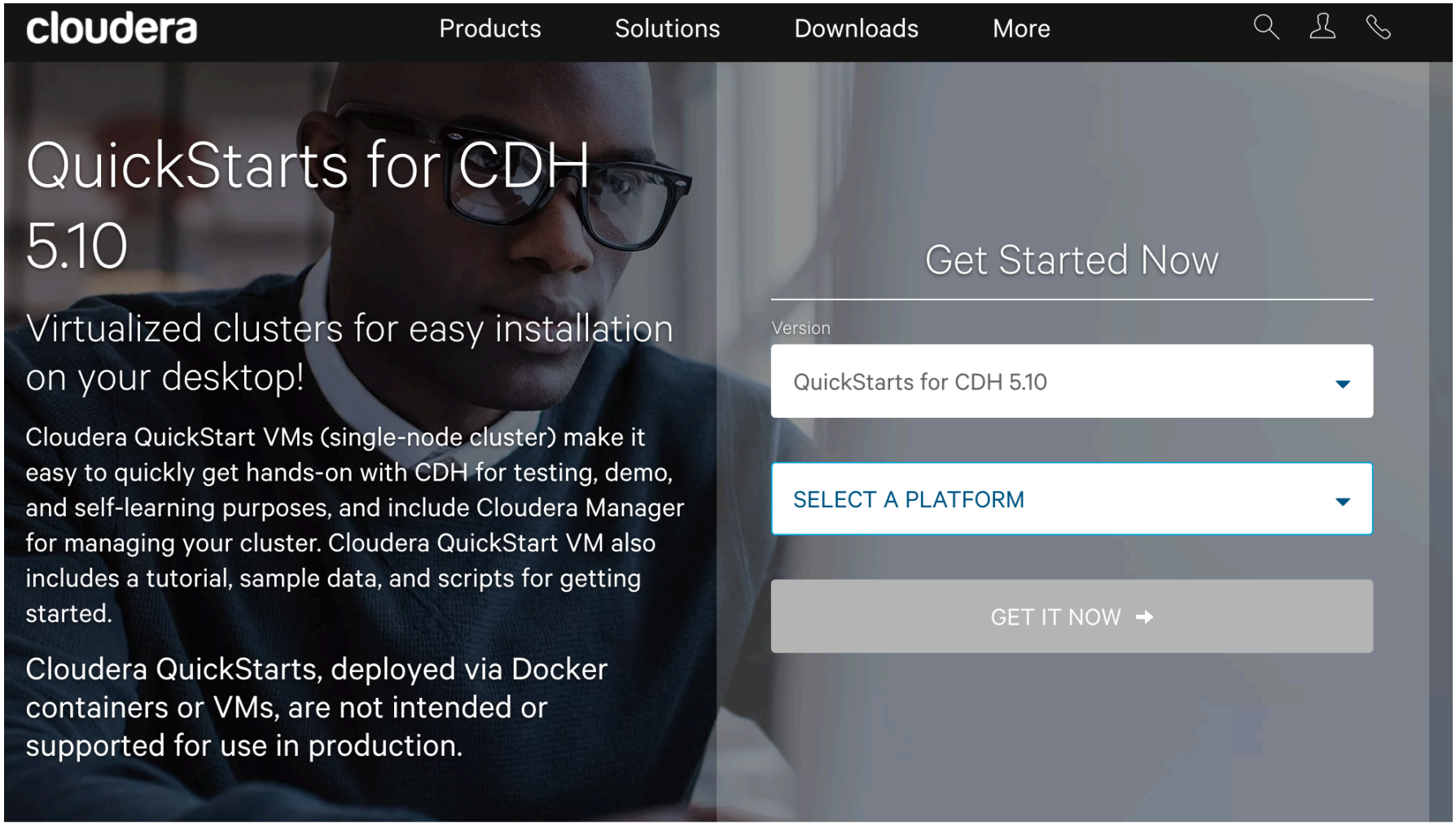
- Go with a distribution from Cloudera or Hortonworks, or cloud.

Cloudera Distribution

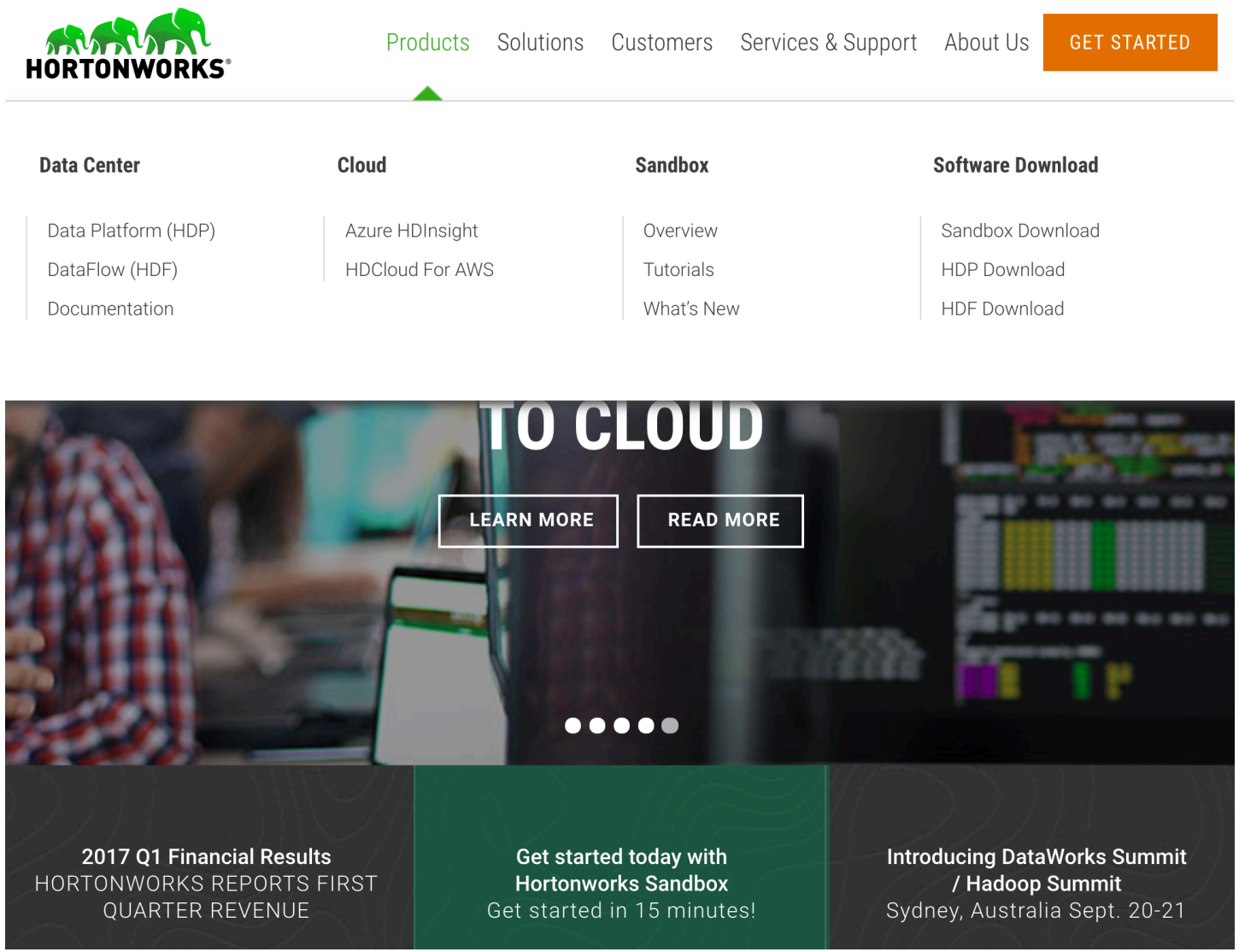


https://www.cloudera.com

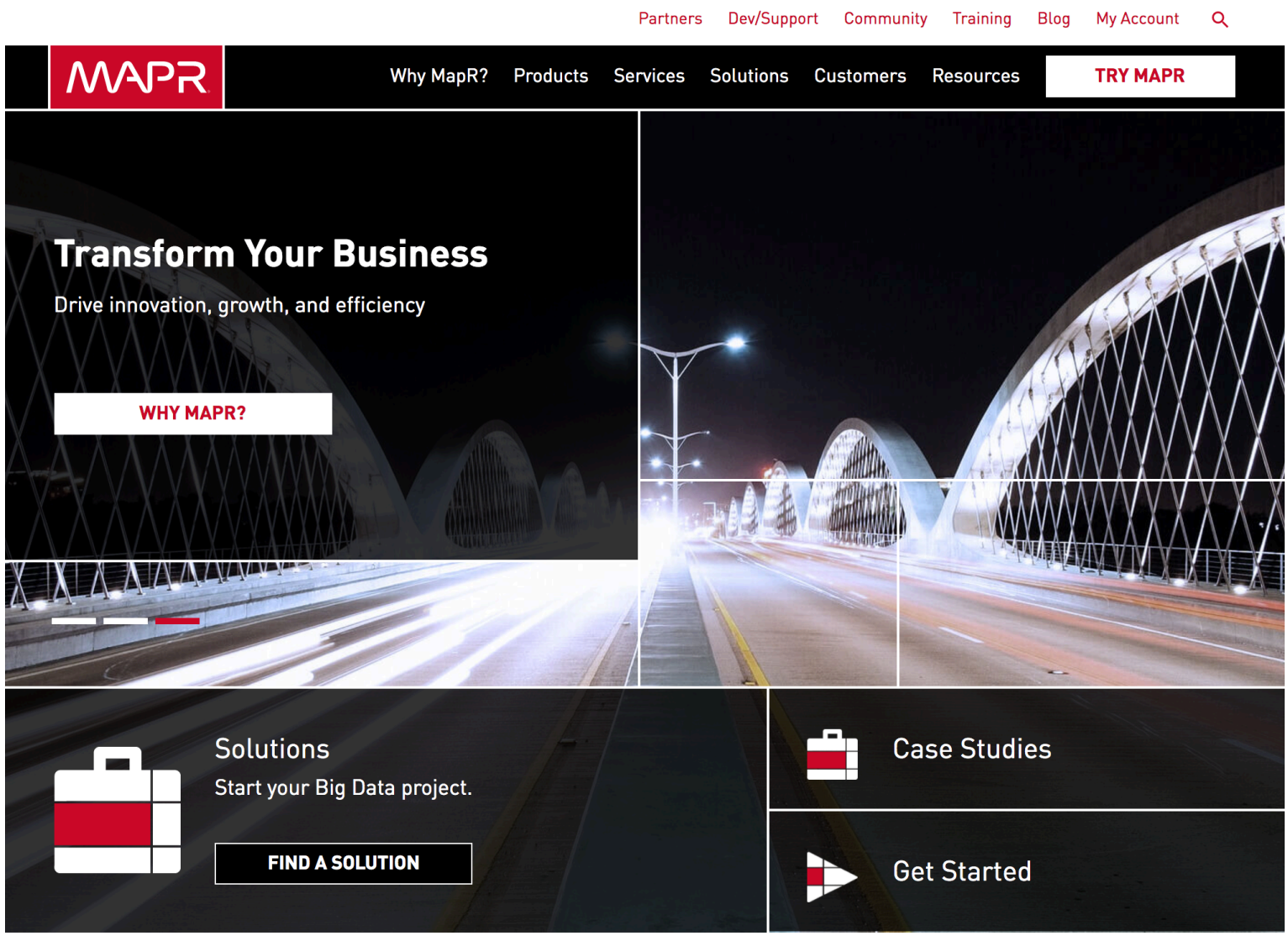
Downloads: Cloudera Quick Start



https://hortonworks.com/



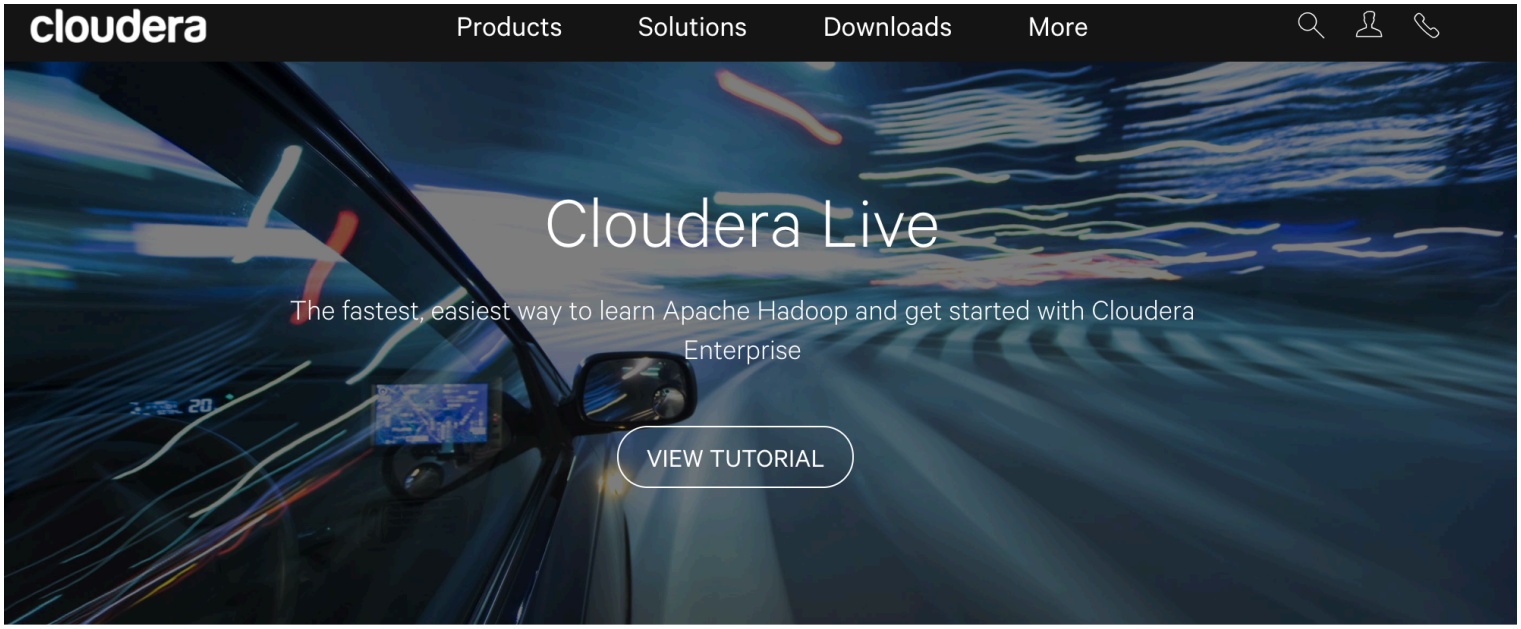
https://mapr.com/



Selecting Vendors

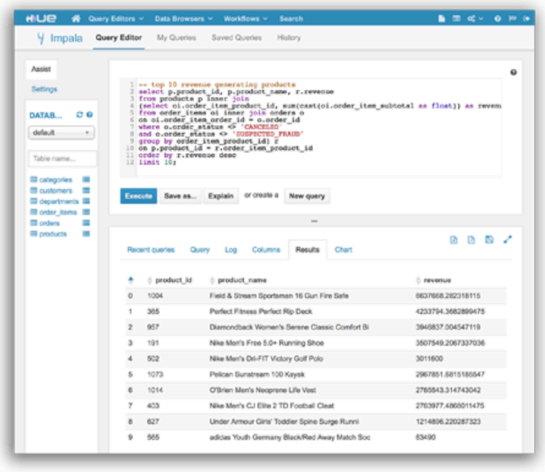
- Review vendor resources
- Important to see which projects vendors are supporting, e.g., Tez for interactive queries on Hadoop in addition to batch-based queries.
- Applications targeted and provided by vendors
- Very competitive, no right/wrong answer

https://www.cloudera.com/get-started/cloudera-live.html
Note: scroll down and select Online HUE Tutorial

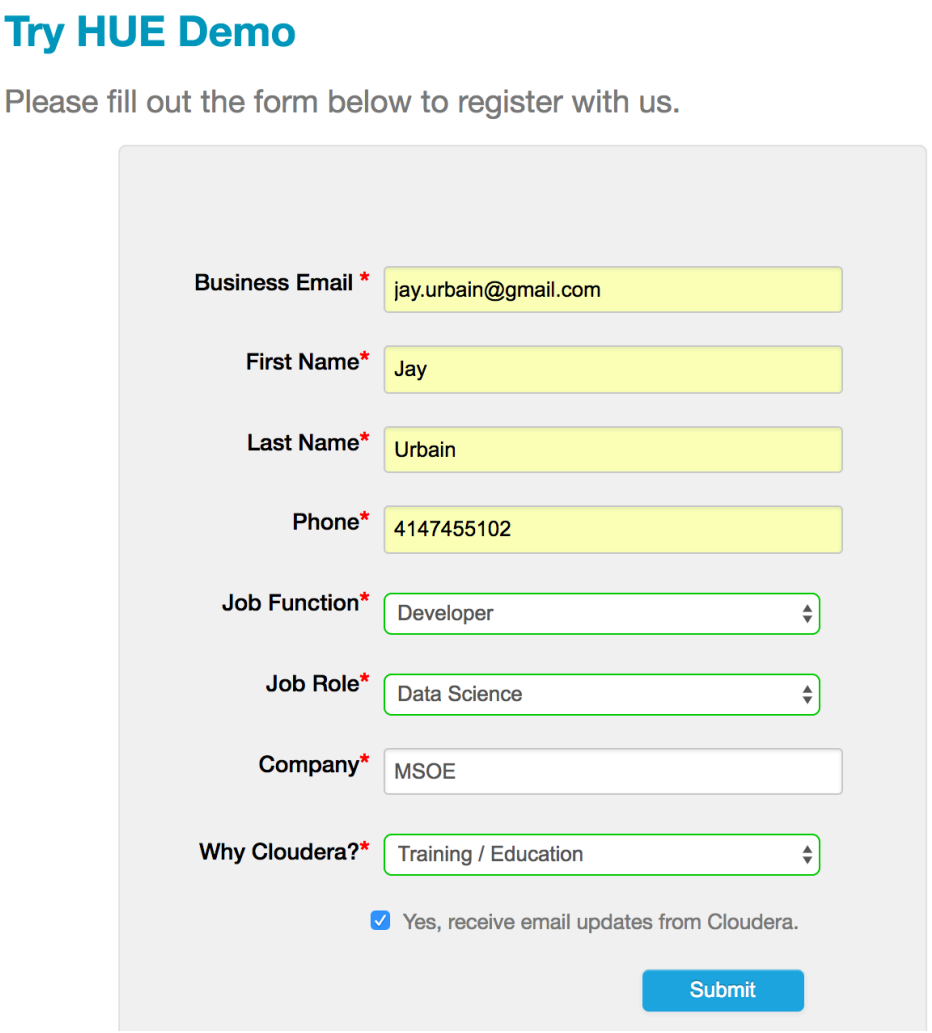


Interactive Hadoop tutorials

Quickly get started with enterprise Hadoop with all-inclusive interactive tutorials. Using these tutorials, you can experiment and explore the full capabilities of Cloudera Enterprise to see how you can get more value from your data, fast. Tutorials are available as part of the Quickstart VM or the Hue interface.



Cloudera Live
http://go.cloudera.com/hue-demo



Query. Explore. Repeat.

demo

••••

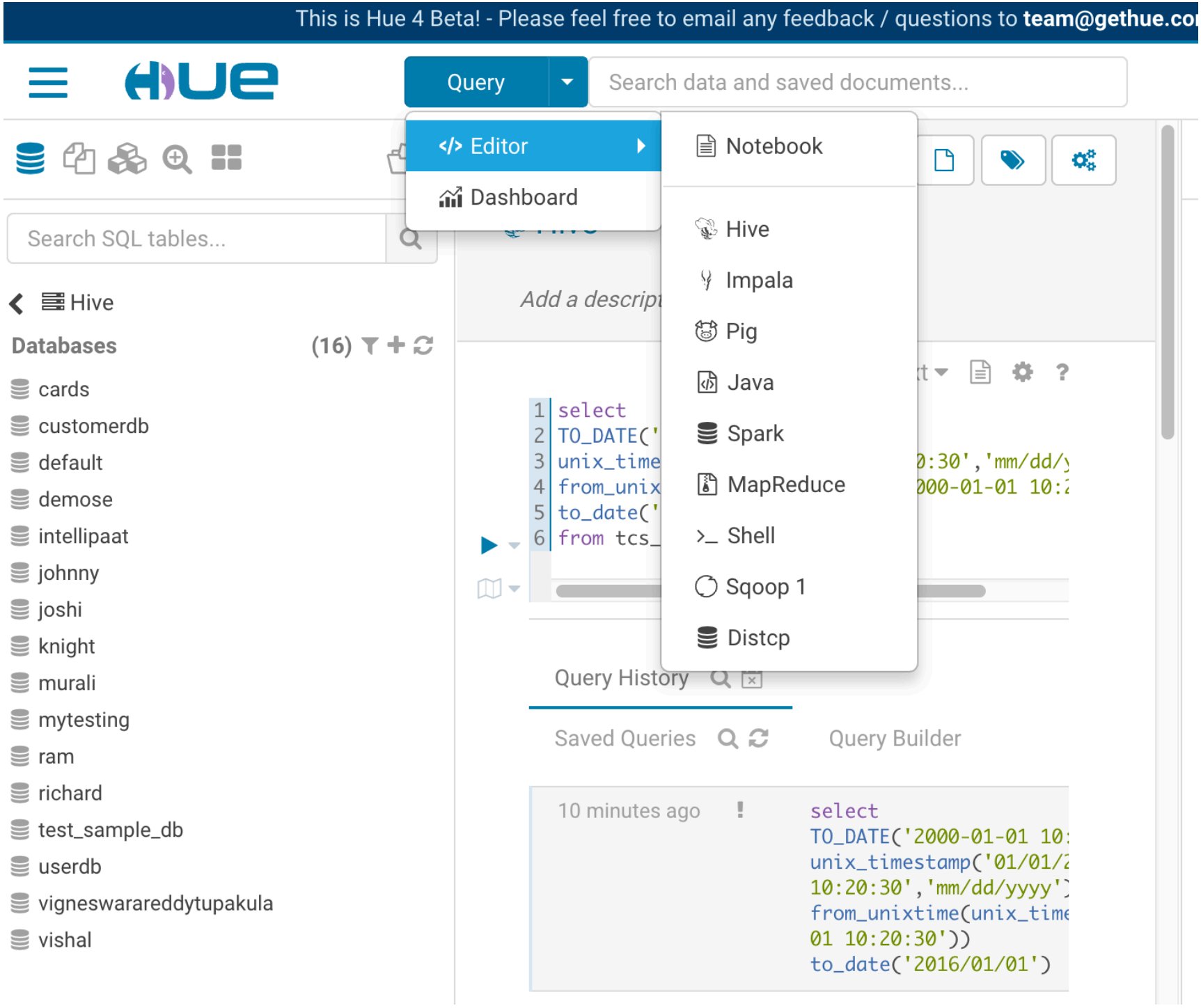
Sign In

Welcome to the Hue 3.12 demo!

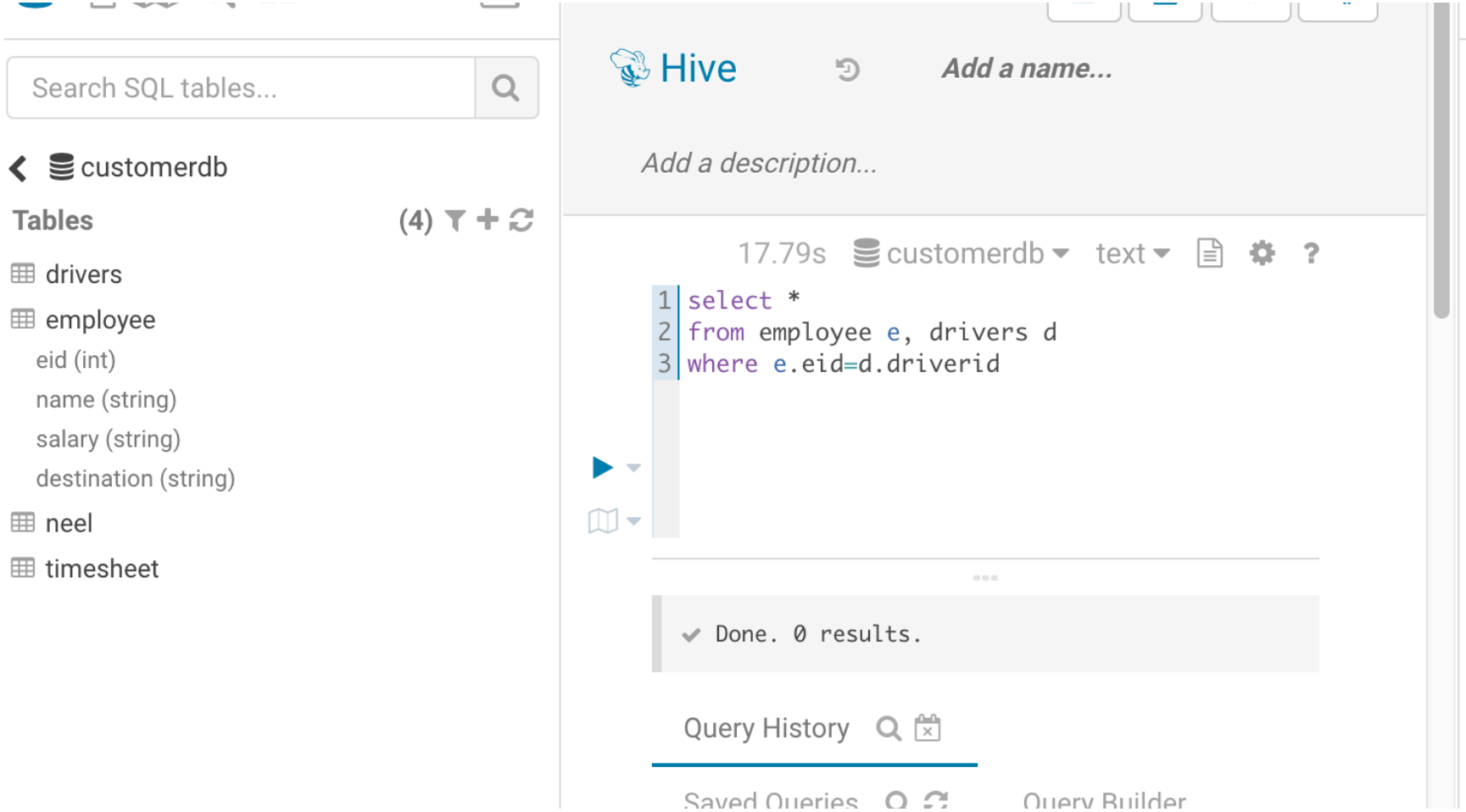
The credentials to sign in:

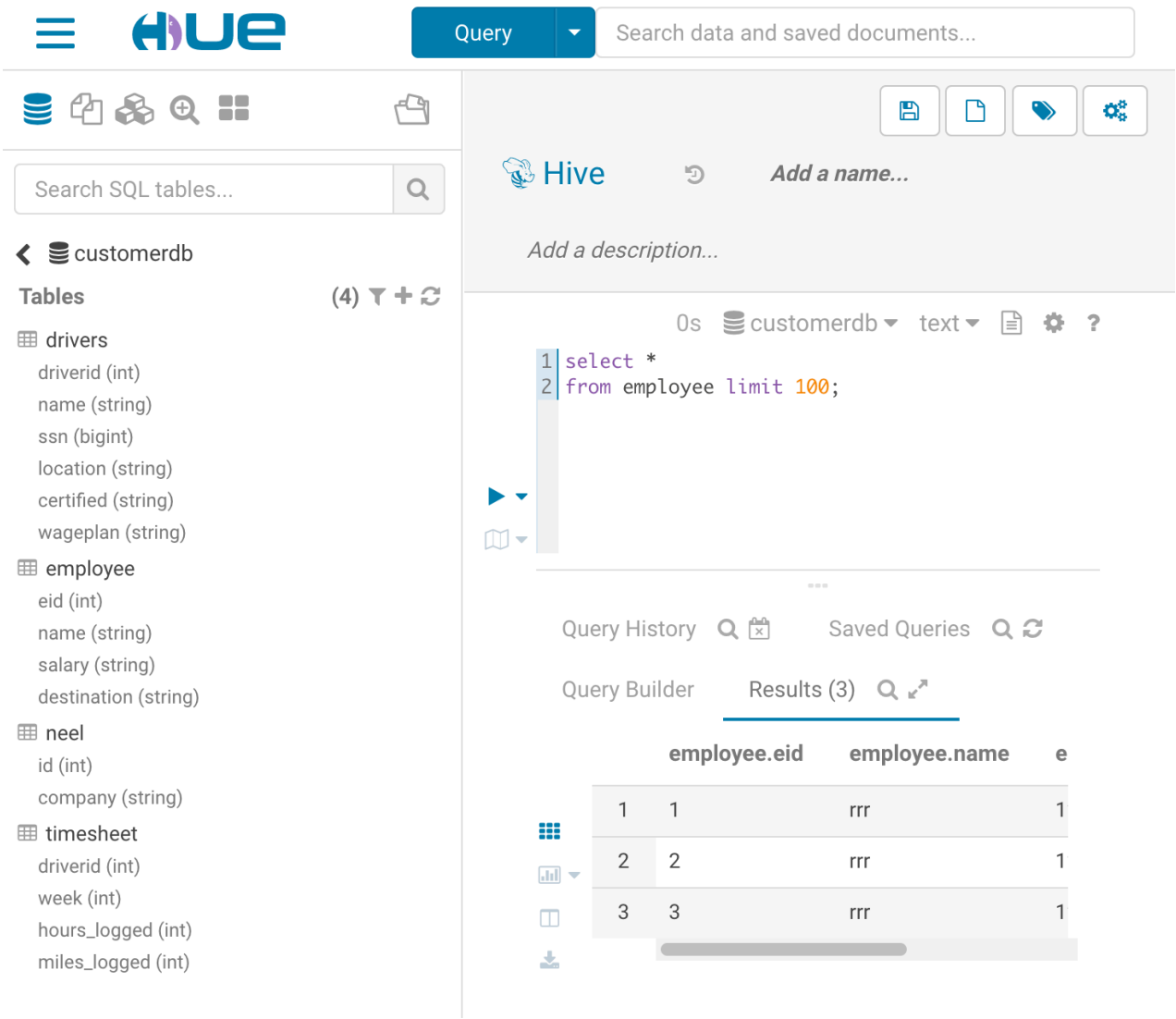
username: **demo**

password: **demo**

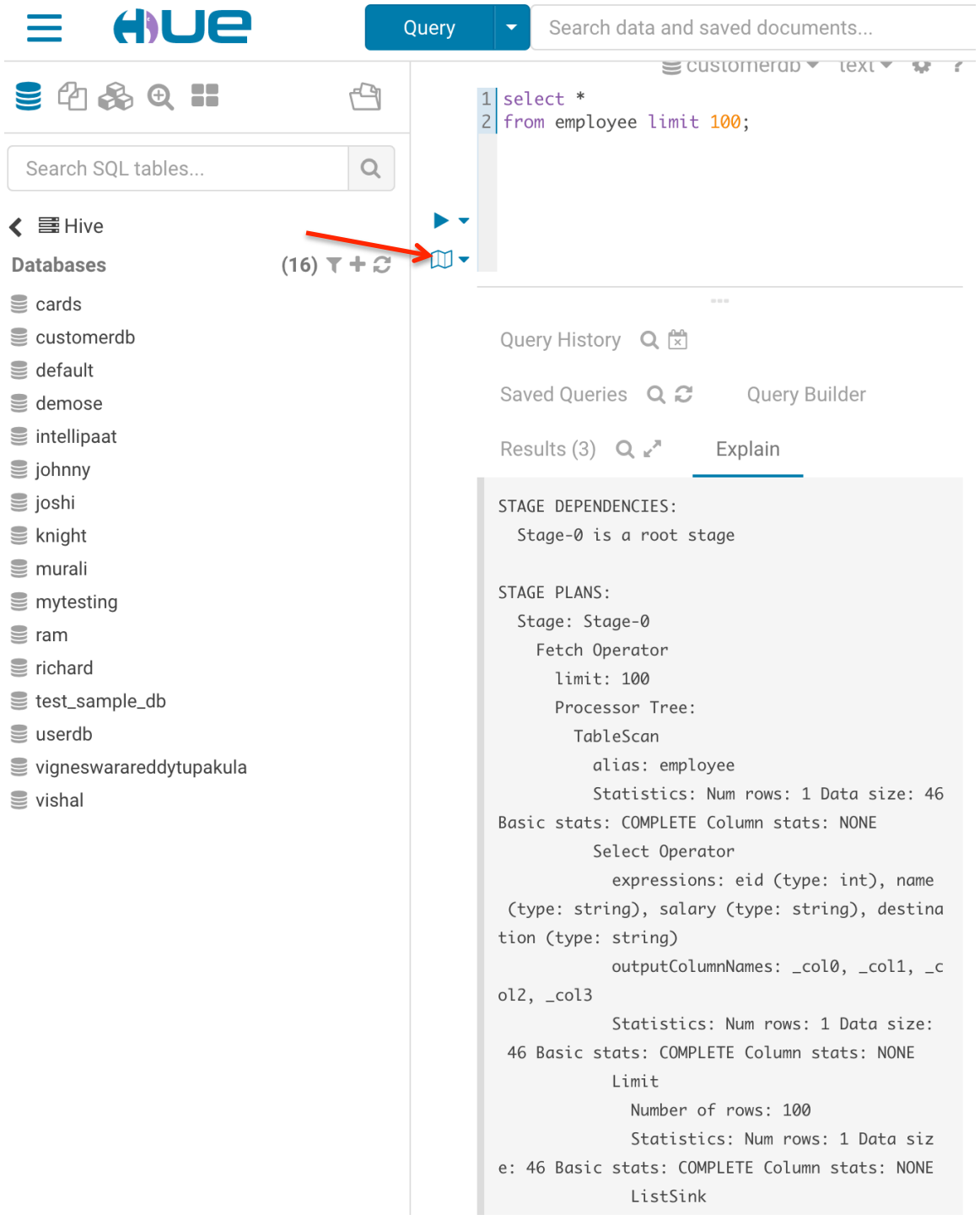

This is Hue 4 Beta! - Please feel free to email any feedback / questions to team@gethue.co
Query
Search data and saved documents...
Editor
Dashboard
Notebook
Hive
Impala
Pig
Java
Spark
MapReduce
Shell
Sqoop 1
Distcp
Search SQL tables...
Hive
Databases (16)
cards
customerdb
default
demose
intellipaat
johnny
joshi
knight
murali
mytesting
ram
richard
test_sample_db
userdb
vigneswarareddytupakula
vishal
Add a descript
1 select
2 TO_DATE('
3 unix_time
4 from_unix
5 to_date('
6 from tcs_
Query History
Saved Queries
Query Builder
10 minutes ago
select
TO_DATE('2000-01-01 10:
unix_timestamp('01/01/2
10:20:30','mm/dd/yyyy')
from_unixtime(unix_time
01 10:20:30'))
to_date('2016/01/01')

Hive Query

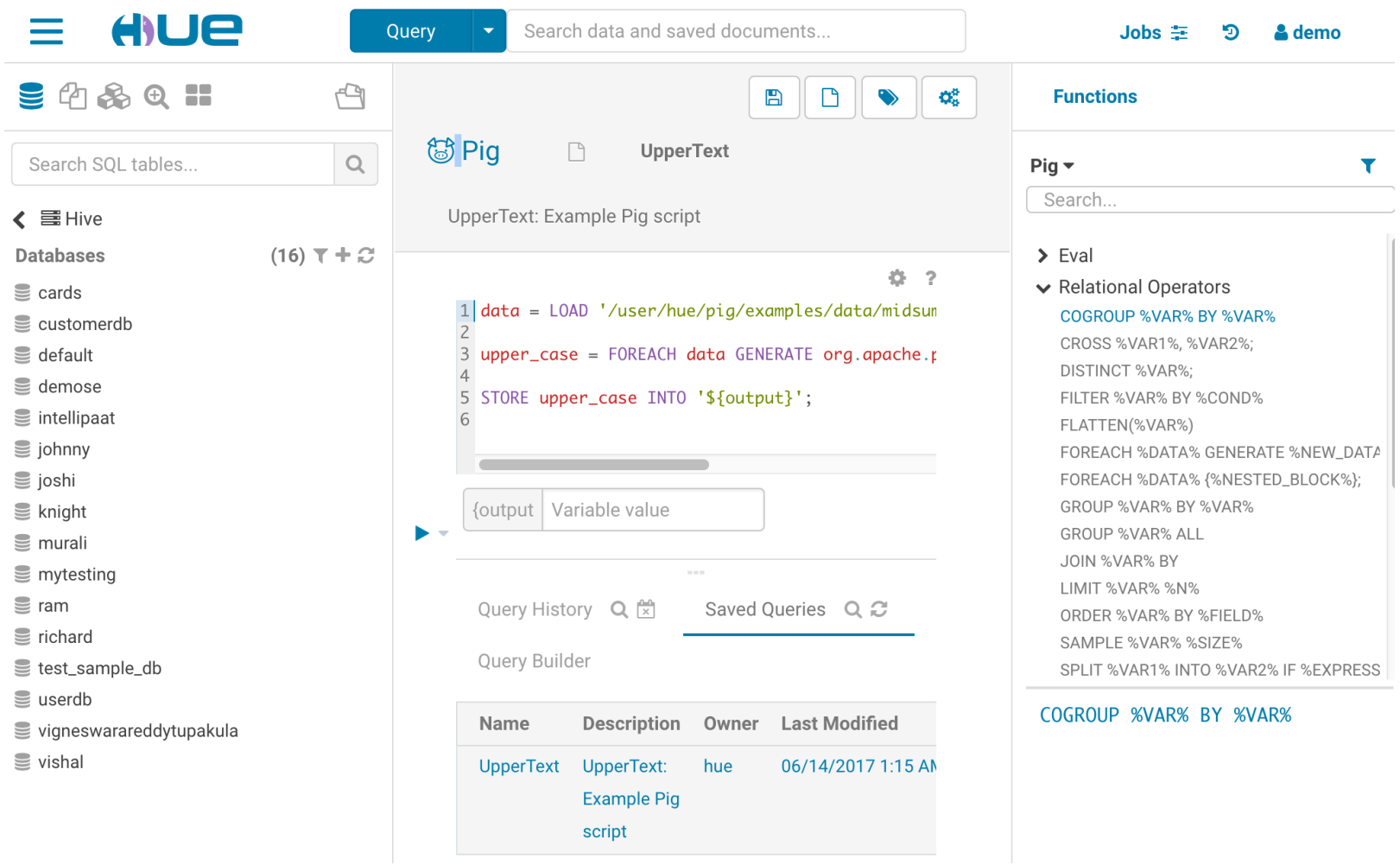

Search SQL tables...
customerdb
Tables (4)
drivers
employee
eid (int)
name (string)
salary (string)
destination (string)
neel
timesheet
Hive
Add a name...
Add a description...
17.79s
customerdb
text
1 select *
2 from employee e, drivers d
3 where e.eid=d.driverid
Done. 0 results.
Query History
Saved Queries
Query Builder



- Hive - bstraction over map reduce,
- You do not get back an immediate result.
- Broken down into a series of Map Jobs and Reduce jobs.
- Runs in parallel across nodes in Hadoop cluster


Query
Search data and saved documents...
customerdb
text
1 select *
2 from employee limit 100;
Search SQL tables...
Hive
Databases (16)
cards
customerdb
default
demose
intellipaat
johnny
joshi
knight
murali
mytesting
ram
richard
test_sample_db
userdb
vigneswarareddytupakula
vishal
Query History
Saved Queries
Query Builder
Results (3)
Explain
STAGE DEPENDENCIES:
Stage-0 is a root stage
STAGE PLANS:
Stage: Stage-0
Fetch Operator
limit: 100
Processor Tree:
TableScan
alias: employee
Statistics: Num rows: 1 Data size: 46 Basic stats: COMPLETE Column stats: NONE
Select Operator
expressions: eid (type: int), name (type: string), salary (type: string), destination (type: string)
outputColumnNames: _col0, _col1, _col2, _col3
Statistics: Num rows: 1 Data size: 46 Basic stats: COMPLETE Column stats: NONE
Limit
Number of rows: 100
Statistics: Num rows: 1 Data size: 46 Basic stats: COMPLETE Column stats: NONE
ListSink

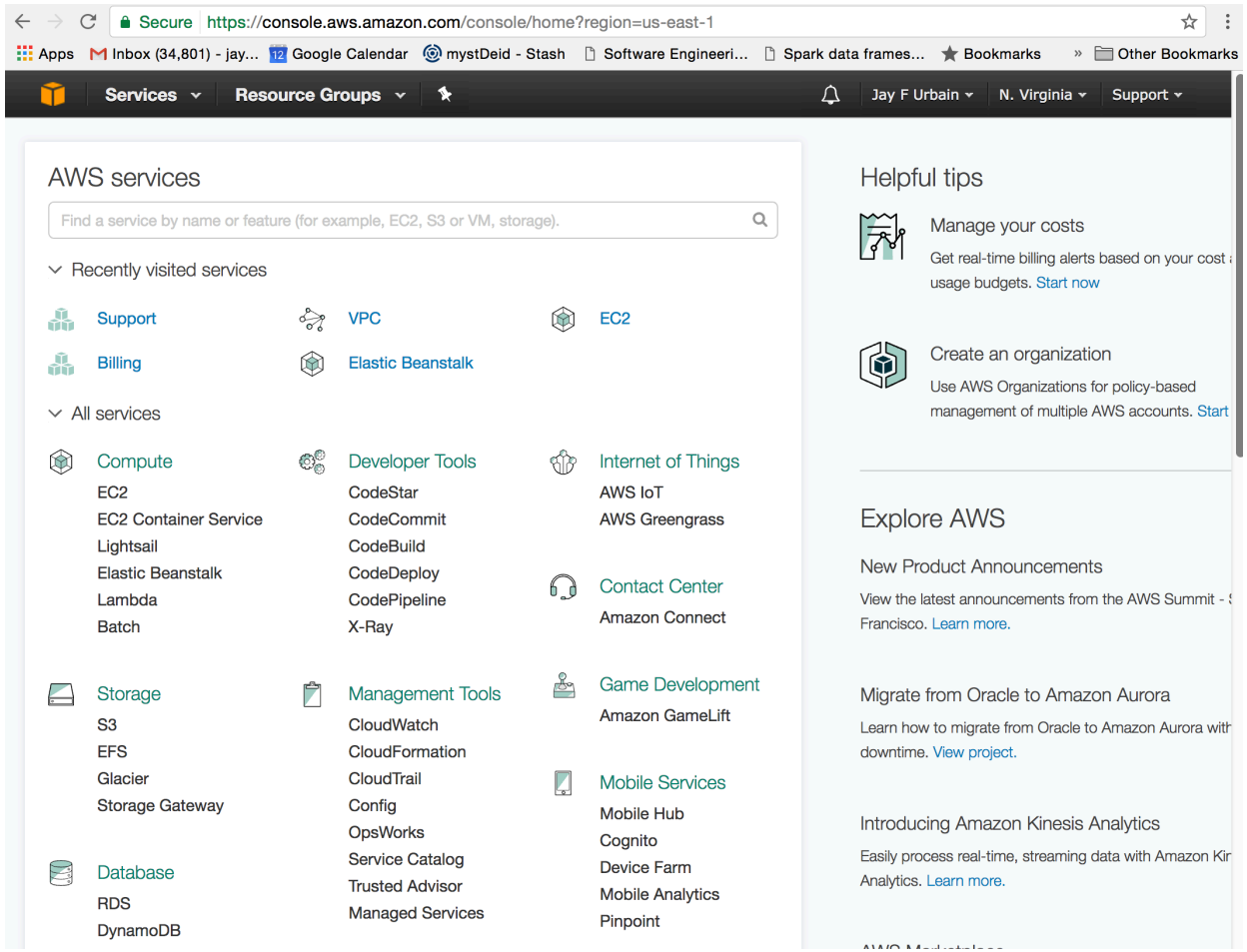
Pig Query for ETL



Hadoop Versions and History

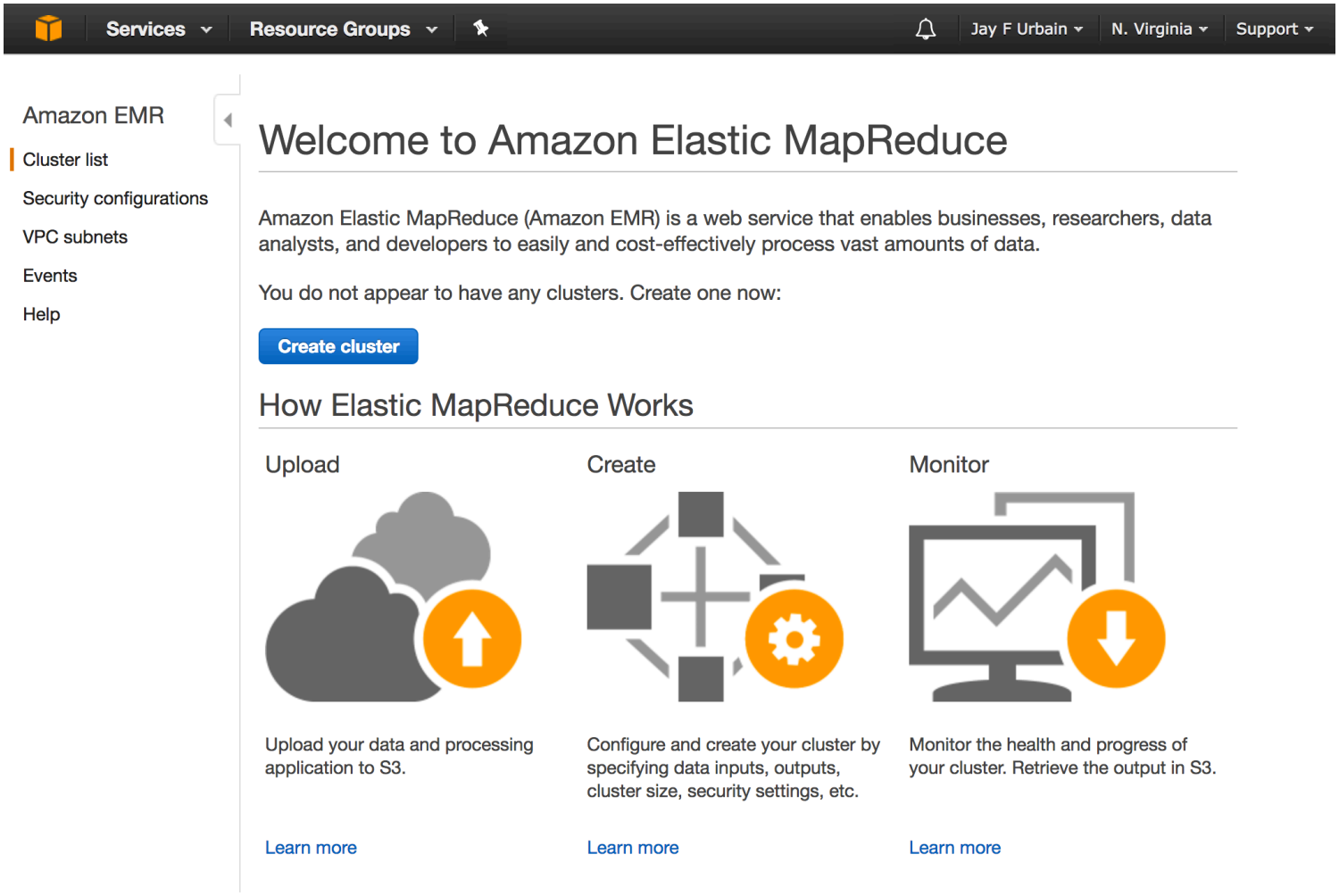
- Relatively new ecosystem - ~2007
- Major stable releases
  - 1.0 2011
  - 2.2 2013 – YARN/MapReduce 2.0
  - 2.4 2014 – Enterprise features, auto-failover
  - 2.7.3 2016 – current
  - 3.0 2017 - alpha
- Decide if you want to work on a Cloud – clusters of VM's.
  - EMR – AWS
  - HDInsight - Azure

EMR – AWS
https://aws.amazon.com



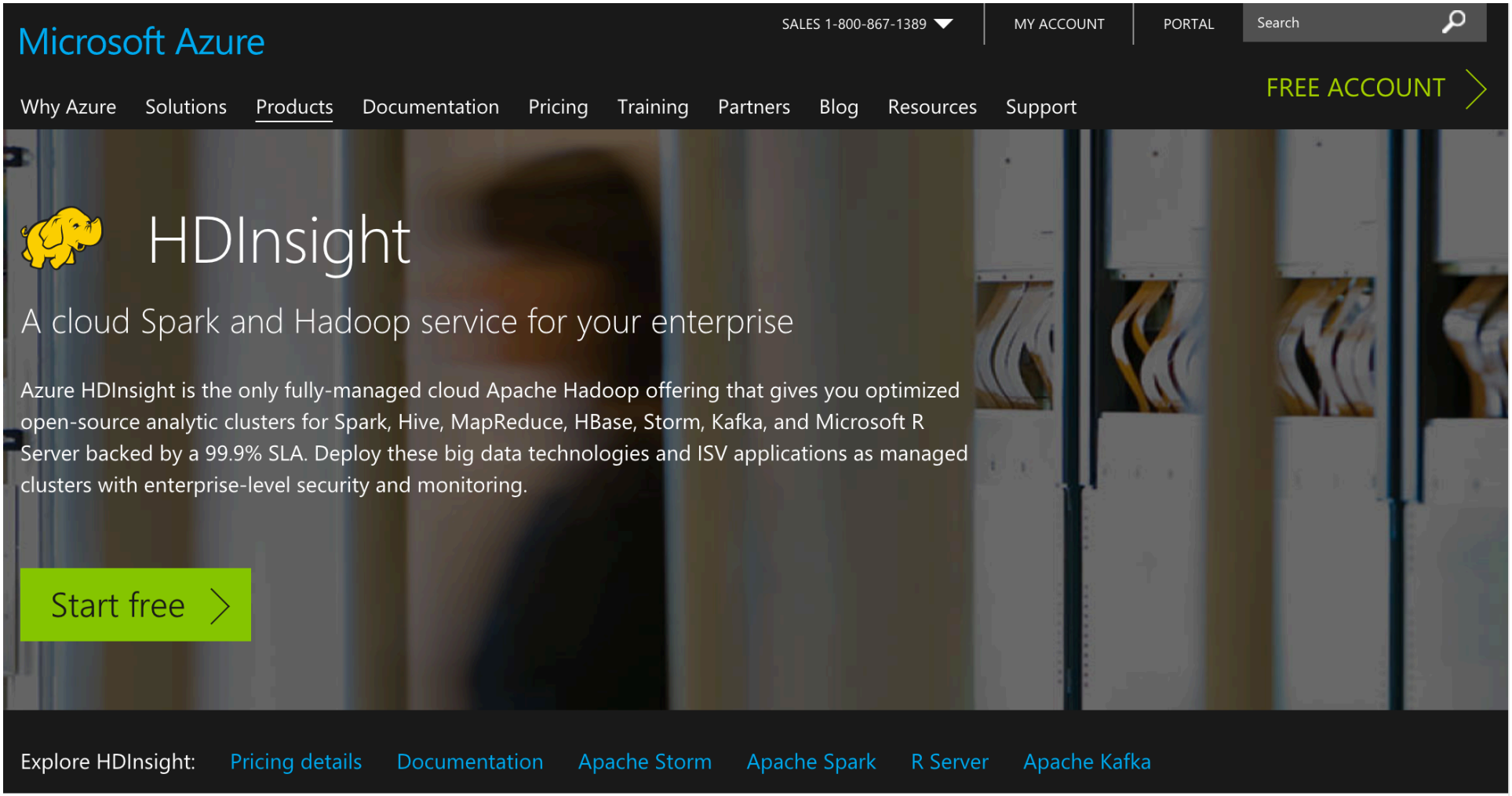
Can run directly out of S3 file system, or copy data from S3 to HDFS.

When you create a cluster, *remember* to shut it off



https://azure.microsoft.com/en-us/services/hdinsight/

Note: Runs on windows not linux, still uses MapReduce, HDFS



Review

- JVMs do not share state and the different Hadoop processes run in separate JVMs
  - True
  - False

- If you deploy in _____ mode you're going to use HDFS and the Java Daemons are going to run all the processes on a single machine.
  - Multi
  - Multi or single
  - Psuedo-distributed

Review

- Which of the following components is for workflow and coordination of jobs?
  - Hbase
  - Pig
  - Hive
  - Oozie

- Which of the following is a way to download Hadoop and start using it?
  - Get the open-source version from the main site, www.hadoop.apahe.org
  - Get a vendor distribution like Cloudera or Hortonworks
  - Run on Cloud like AWS or Azure
  - Cloudera live
  - All of these answers

Review

- Apache Drill (open source version of Google's Dremel stream processing) and Spark add-ons are part of _____
  - Hortonworks
  - MapR
  - Solr
  - Windows 10
  - Cloudera

- When running a Hive query, results will comeback immediately since there is no abstraction layer between it and MapReduce
  - True
  - False

Review

- What is Microsoft's implementation of partially managed Hadoop clusters?
  - Elastic Map Reduce
  - AWS
  - HDInsight
  - MapReduce
  - Foresight

- Understanding the type of activity you want to do and what types of library you want to work with is important when selecting a Hadoop ecosystem.
  - True
  - False