Machine Learning with H2O for R Users

Professor Matthew Lanham
Academic Director, MS BAIM Program

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Tech Talk Disclaimer

- I am not affiliated with H2O, nor receive any compensation or benefits for giving this talk.
- I'm a professor that teaches Data Mining, Predictive Analytics, and R courses at Purdue University.
- I wanted to share one lecture on the topic that I teach to my M.S. in Business Analytics & Information Management (BAIM) students that introduces the platform.
- If H2O would like to provide me competition or benefits for this talk or future talks, I'm happy to have that discussion ☺

Materials

You can get the slides and codes for this presentation here:

https://github.com/MatthewALanham/InformsBA2019

Agenda

- About H2O Platform
- **h2o** R Library/API demo
- AutoML - Automated Machine Learning demo
- H2O Flow demo

H2O.ai is Democratizing Artificial Intelligence

- https://www.h2o.ai/
- H2O was founded in 2012
- Provide scalable architecture + distributed machine learning algorithms to tackle small and big data problems
- They claim to be focusing on automated AI and making AI more accessible to everyone
- Have 5000+ customers and there are several interesting customer stories on their website (https://www.h2o.ai/customer-stories/)

H2O Pros

- Open source (Apache 2.0 licensed)
- Well-documented and commercially supported
  - Bookmark: http://docs.h2o.ai/h2o/latest-stable/h2o-docs/welcome.html
- Easy to use (technical to sort-of-technical person)
- Scalable to big data
- Has mature architecture
- OS: Windows, Mac, Ubuntu, RHEL/CentOS
- APIs - R, Python, Scala, or a Web GUI (no programming)
- Automated Model Building functionality via AutoML
- Can train and tune a deep learning model in one line of code

H2O Platform

High performance learning

- Distributed (multi-core + multi-node) implementations of ML algorithms
- Core algorithms written in high performance Java

Use favorite language, environment, and easily deploy into action

- APIs available that make it easy to work with big data from you laptop using your favorite analytics language
- Meant to work anywhere – Your laptop, Hadoop, Spark, EC2, etc.
- Easily deploy models to production as pure Java code OR if you can just save your models to disk as R/Python

H2O Distributed Computing

H2O Cluster

- Multi-node cluster with shared memory model
- All computations are in memory
- Each node only sees some rows of the data
- No limit on cluster size

Distributed Key Value Store

- Objects in the H2O cluster such as data frames, models, and results are all referenced by key
- Any node in the cluster can access any object in the cluster by key

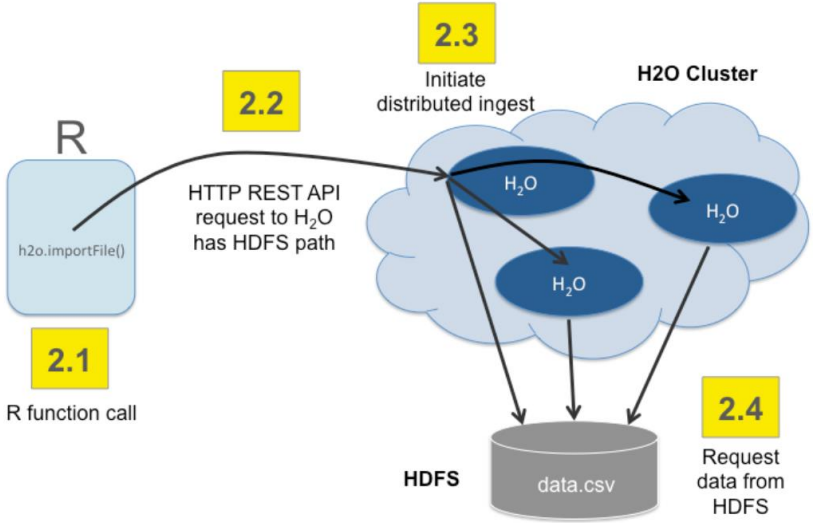
H2O Frame

- Distributed data frames (collection of vectors)
- Columns are distributed (across nodes) arrays
- Works just like R's data.frame or Python Pandas DataFrame

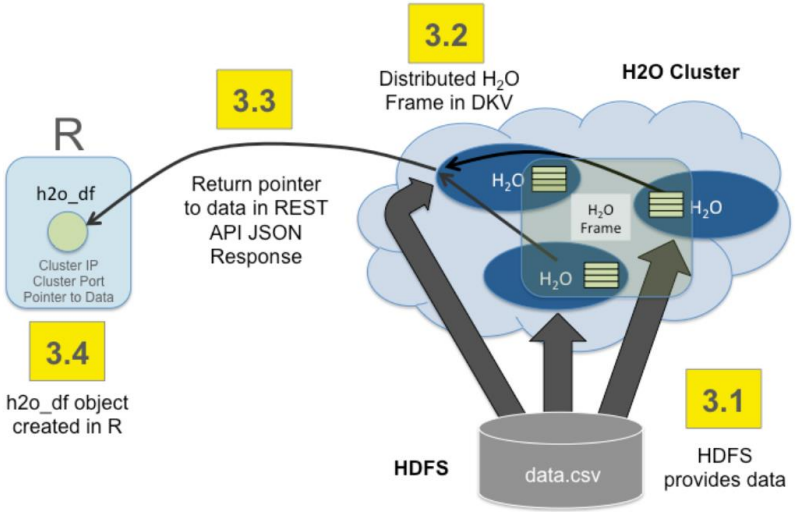
H2O Distributed Computing

Source: http://docs.h2o.ai/h2o/latest-stable/h2o-docs/architecture.html

The R client tells the cluster to read the data



The data is returned from HDFS into a distributed H2O Frame



H2O Algorithms + Common Workflow Tasks

Supervised

- Cox Proportional Hazards (CoxPH)
- Deep Learning (Neural Networks)
- Distributed Random Forest (DRF)
- Generalized Linear Model (GLM)
- Gradient Boosting Machine (GBM)
- Naïve Bayes Classifier
- Stacked Ensembles
- XGBoost

Unsupervised

- Aggregator
- Generalized Low Rank Models (GLRM)
- Isolation Forest
- K-Means Clustering
- Principal Component Analysis (PCA)

Common

- Quantiles
- Early Stopping

Generic Models

- Generic Models

Miscellaneous

- Word2vec

Common workflow tasks:

- Imputation, normalization, auto one-hot encoding
- Cross-validation, grid or random search
- Variable importance, model evaluation metrics, plots

Source: http://docs.h2o.ai/h2o/latest-stable/h2o-docs/data-science.html#

H2O Installation

- You obtain **h2o** for R just like any other R package:

install.packages("h2o")

- The library is really **just an API**

- All the data is stored on the cluster (the server), not on our client. Even when the client and cluster are the same machine.

  Thus, when we want to train a model or make predictions, we first have to get the data into the H2O cluster.

- You will need java, but most likely you already have that on your machine. If not, go to: http://www.oracle.com/technetwork/java/javase/downloads/index.html

H2O Demo in RStudio

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Demo

See *h2o.R* script

AutoML

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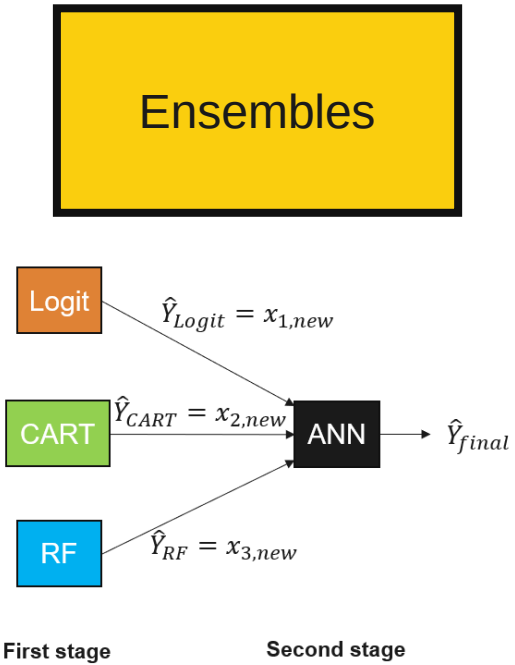
AutoML

AutoML is the path of least resistance for finding a competitive predictive model.

Data Preparation	Model Generation	Ensembles
• Imputation • One-hot encoding • Standardization • Label/Target encoding • Feature selection	• Logistic regression? • Tree? • Neural network? • Hyperparameter tuning • Generalizability/early stopping	• Focus on predictive performance? • Stacking/meta-modeling? • Ensemble selection

AutoML

- The goal of AutoML is to achieve competitive prediction.
- Ensembling
  - Combining multiple learners together.
  - Many different ways to do this.
  - Can perform well if you have decent base learners and the models have uncorrelated errors
- Stacking tries to find the optimal combination of base learners via a meta-model.
- AutoML uses Random Grid Search (GBMs, GLMs, etc.) with Stacked Ensembles
- Provides a **Leaderboard** output of the top models. Demo…



H2O Flow

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H2O Flow

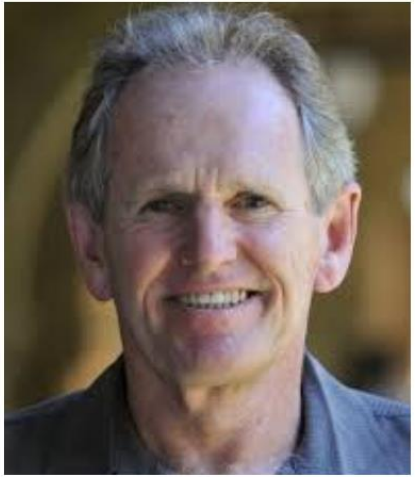
- Flow is the name of the web GUI that is part of H2O. It is just another client, making the same web service calls to the H2O backend that the R client is making.
- You can do the following:
  - *View data you have uploaded through your client*
  - *Upload data directly*
  - *View models you have created through your R client (and those currently being created)*
  - *Create models directly*
  - *View and run predictions you have generated through your client*
- If using your RStudio Desktop, open a browser and go here to see your flow
  - http://127.0.0.1:54321/flow/index.html
- If using RStudio Server, the link will be slightly modified (example):
  - http://rstudio.scholar.rcac.purdue.edu:54321/flow/index.html

Future investigations

- Testing performance on large scale datasets
- Importing non-native h2o models into the workflow
- Integrating models into applications outside of H2O

> “H2O.ai provides impressively scalable implementations of many of the important machine learning tools in a user-friendly environment. Allowing for free academic use sets a generous example for commercial software developers — it is also the way forward in the era of open-source software.”

Trevor J. Hastie
John A. Overdeck Professor of Mathematical Sciences
Professor of Statistics
Professor of Biomedical Data Science
Department of Statistics
Stanford University
USA



Additional Resources/Examples

- https://github.com/DarrenCook/h2o
- https://github.com/h2oai/h2o-meetups/tree/master/2018_09_05_SF_Meetup_AutoML