Introduction to Automatic Machine Learning

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H2O.ai

Agenda

- Intro to H2O-3 software
- What is Automatic Machine Learning (AutoML)
- AutoML in H2O-3

What is H2O?

A Machine Learning Platform

H2O.ai
The Company

Founded in 2012

Advised by Stanford Professors:
Hastie, Tibshirani & Boyd

Headquarters: Mountain View, California, USA

H2O-3
The Platform

Open Source Software

R, Python, Scala and Web Interfaces

Distributed Machine Learning Algorithms

H2O-3: The Machine Learning Platform

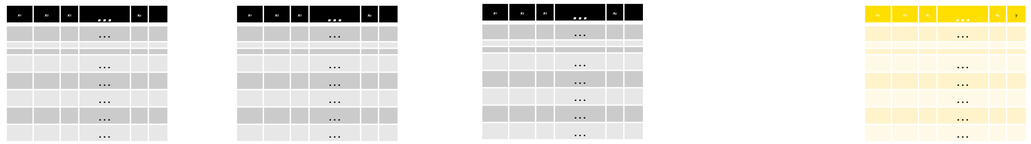
Core Algorithms are written in high-performance Java

14+ ALGORITHMS

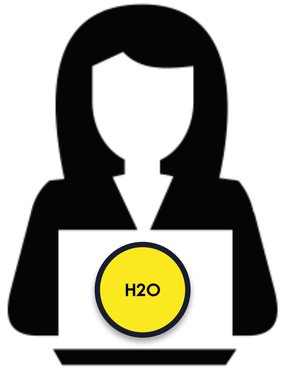
- Statistical Analysis
- Ensembles
- Deep Neural Networks
- Clustering
- Dimensionality Reduction
- Word Embedding
- Time Series
- ML Tuning

Benefits of H2O-3

No Data Size Limit

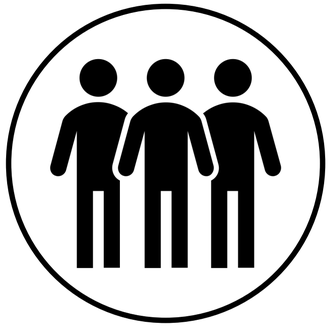


Easy Deployment



Live Results!

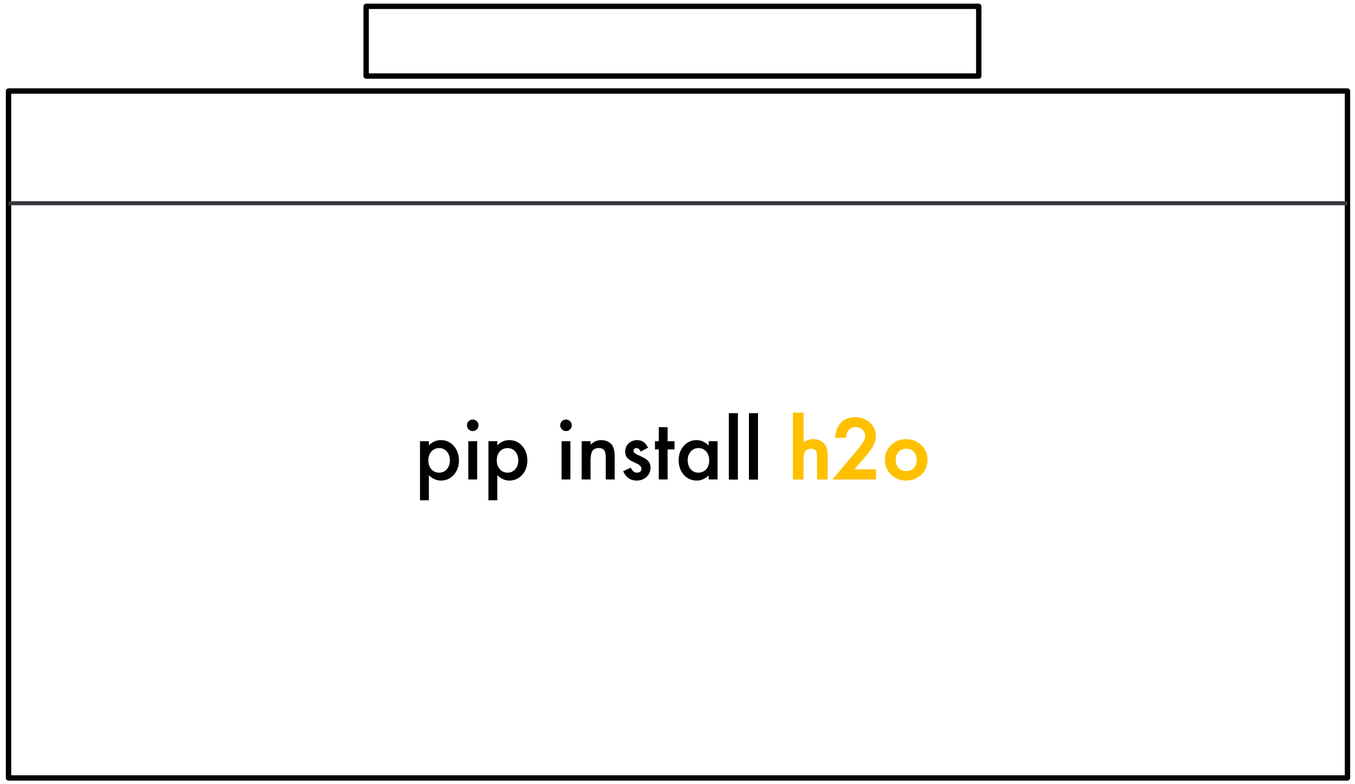
Easy Learning Curve



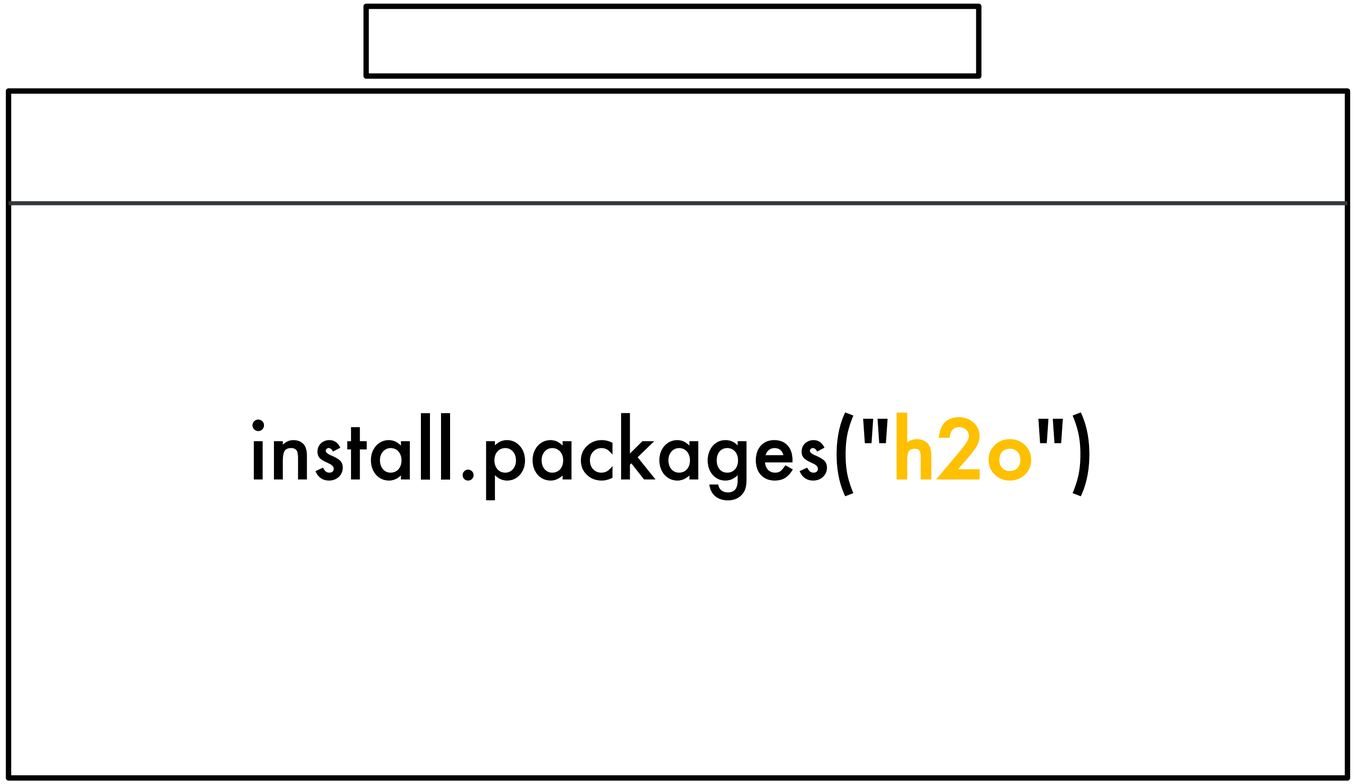
💛 R + 💛 Py. + 💛UI

What is H2O-3?

What is H2O-3?

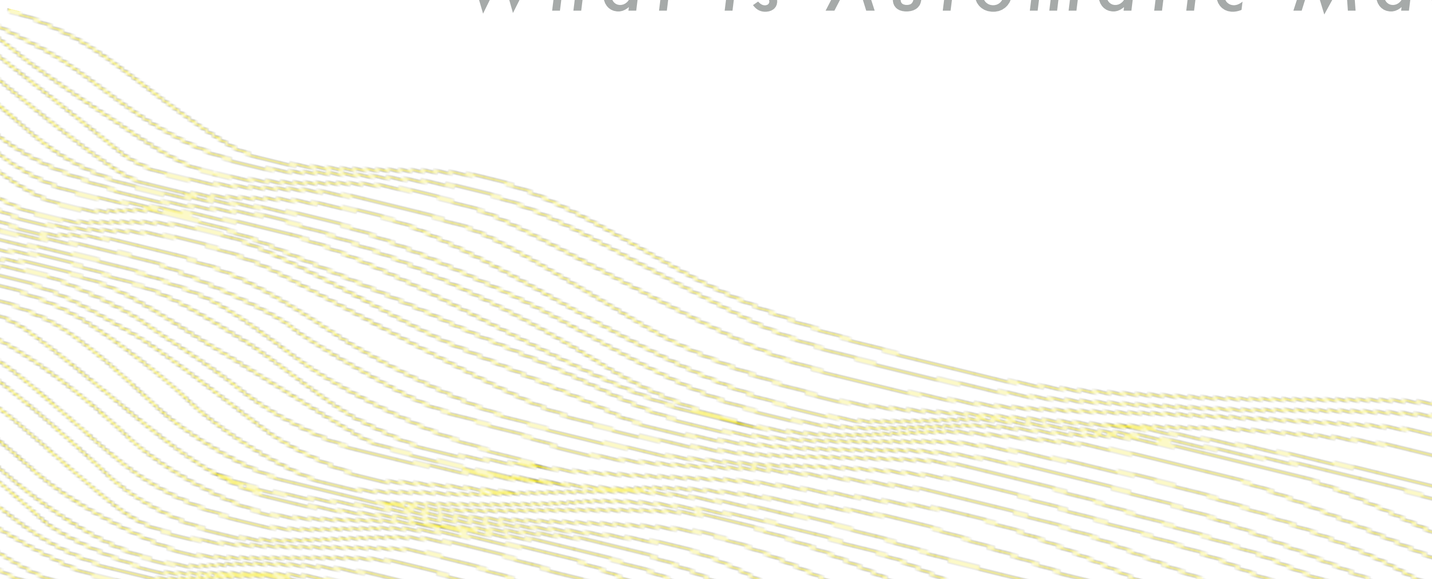


What is H2O-3?



Auto-What?

What is Automatic Machine Learning?



H2O-3: What is Machine Learning

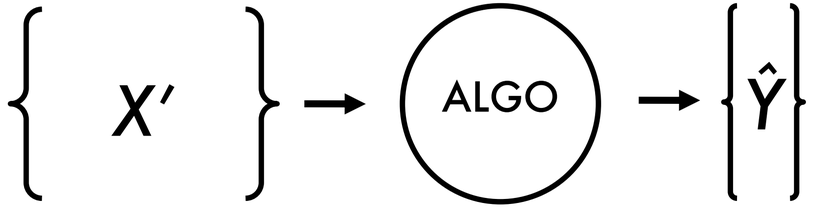
Historical Data

ID	Symptoms	Duration	Flu
1	8	1	YES
2	8	2	NO
3	0	2	NO
4	1	10	YES

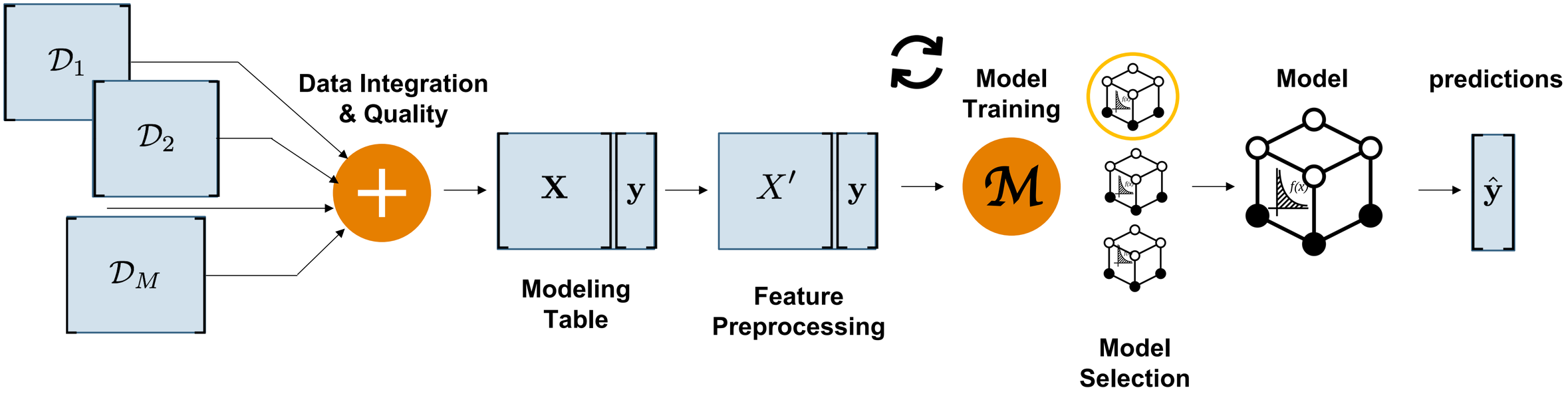
Build a Model

$$g : x \rightarrow y$$

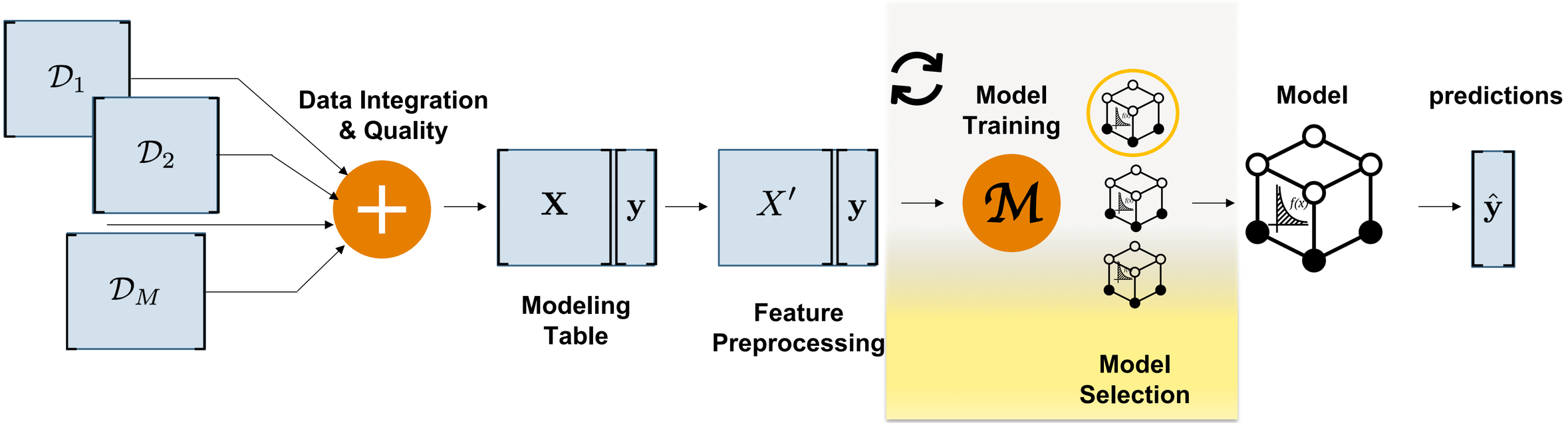
Make Predictions



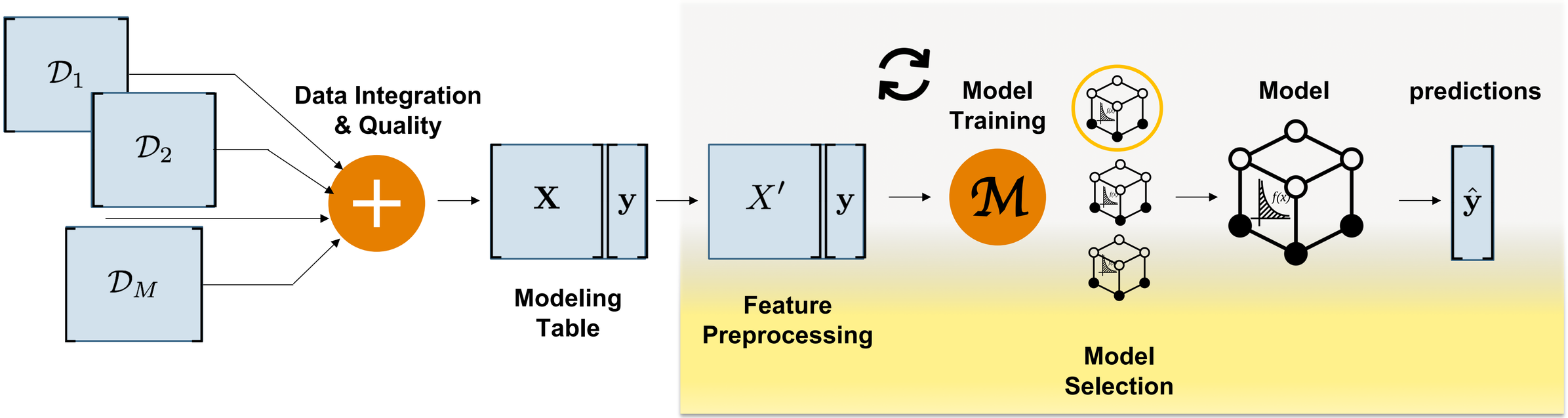
The Machine Learning Pipeline



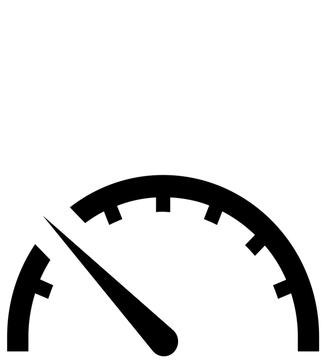
What is Automatic Machine Learning?

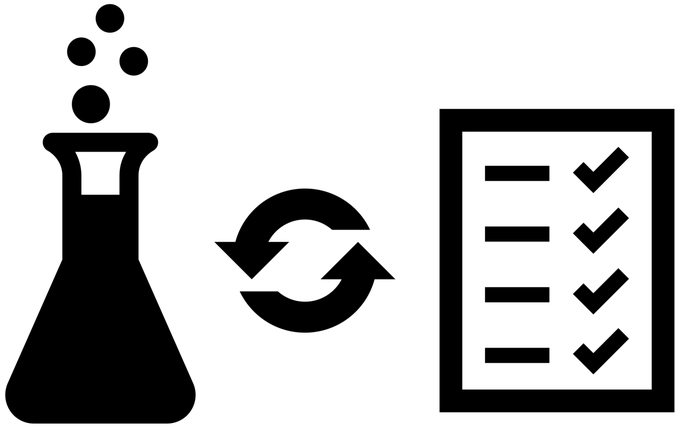


What is Automatic Machine Learning?



The Goal

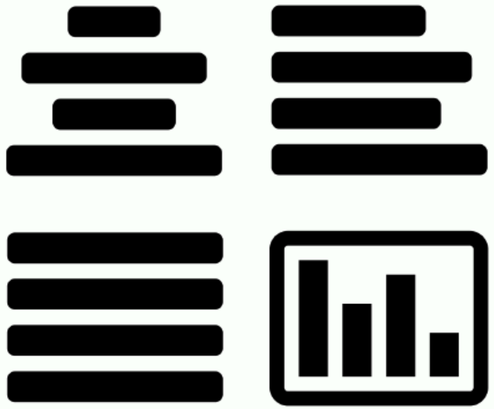


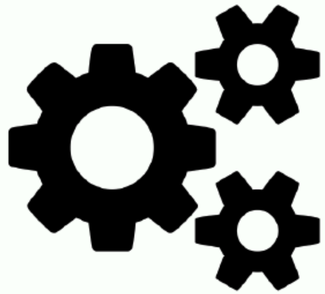


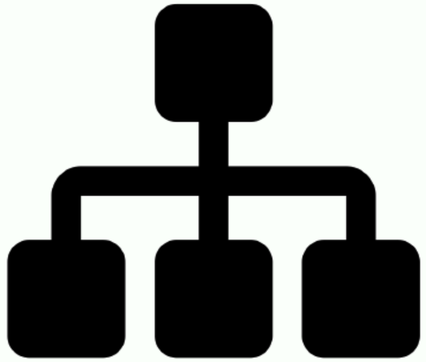
Automatic Machine Learning

The Aspects of AutoML

Model Generation







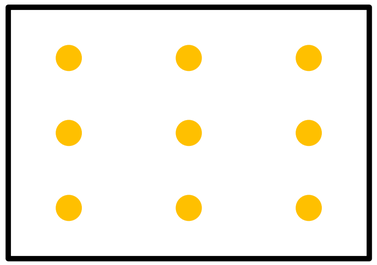
Data Prep

Ensembles

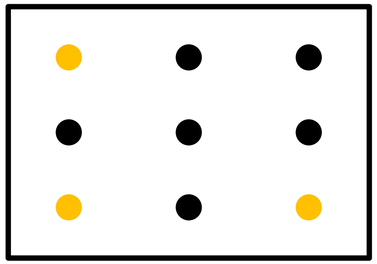
Data Prep

- **Format Data:**
  - Imputation, one-hot encoding, standardization
- **Chose Features:**
  - Feature selection, feature extraction (e.g. PCA)
- **Advanced Encoding:**
  - Count, Label, Target encoding of categorical features

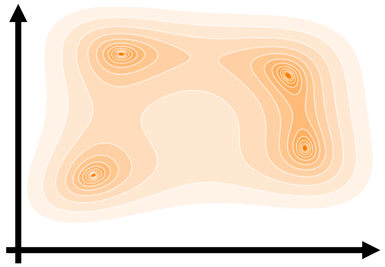
Model Generation



Cartesian grid search

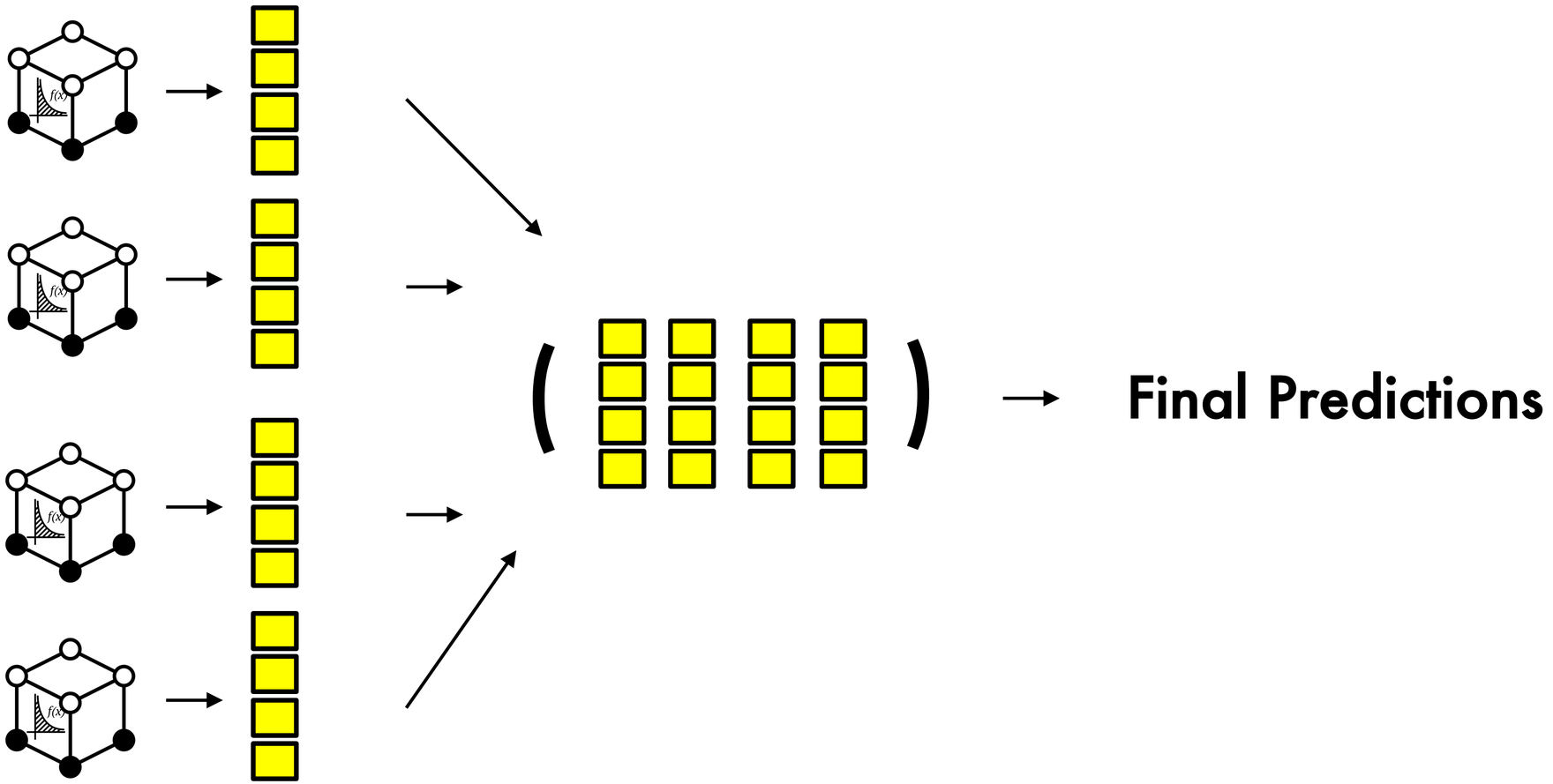


Random grid search



Bayesian Hyperparameter Optimization

Ensembles



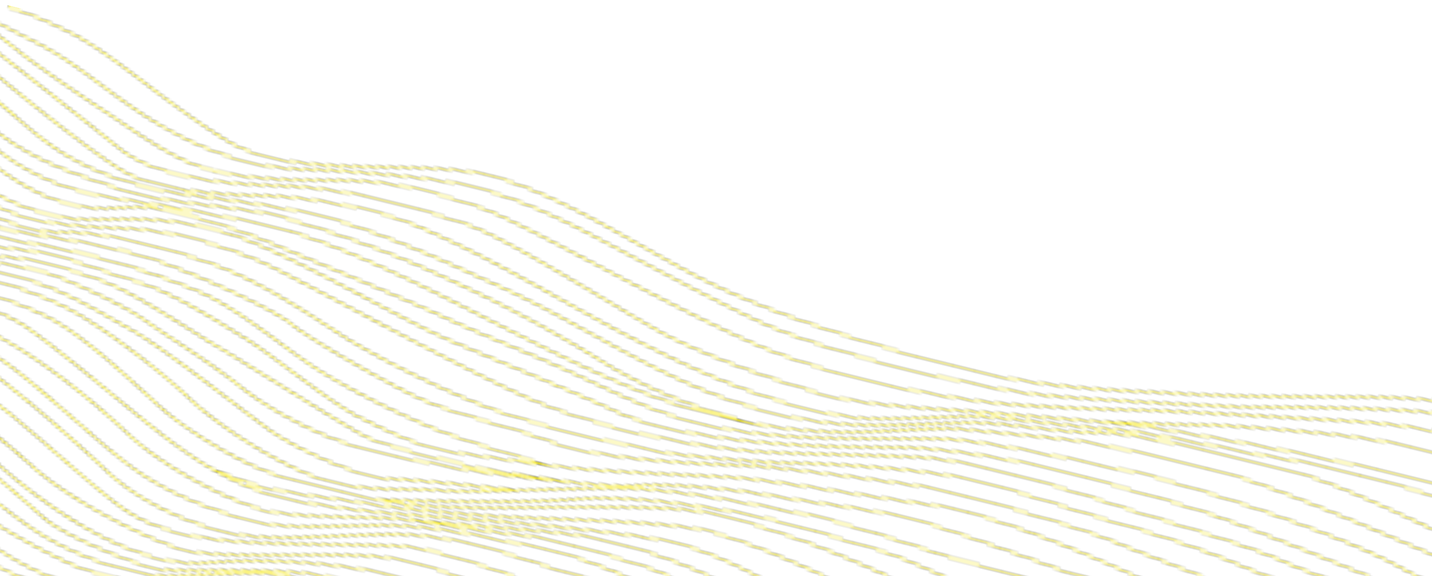
Ensembles

Ensembles often **out-perform** individual models

- Bagging
- Boosting
- **Stacking / Super Learning (Wolpert, Breiman)**
- Ensemble Selection (Caruana)

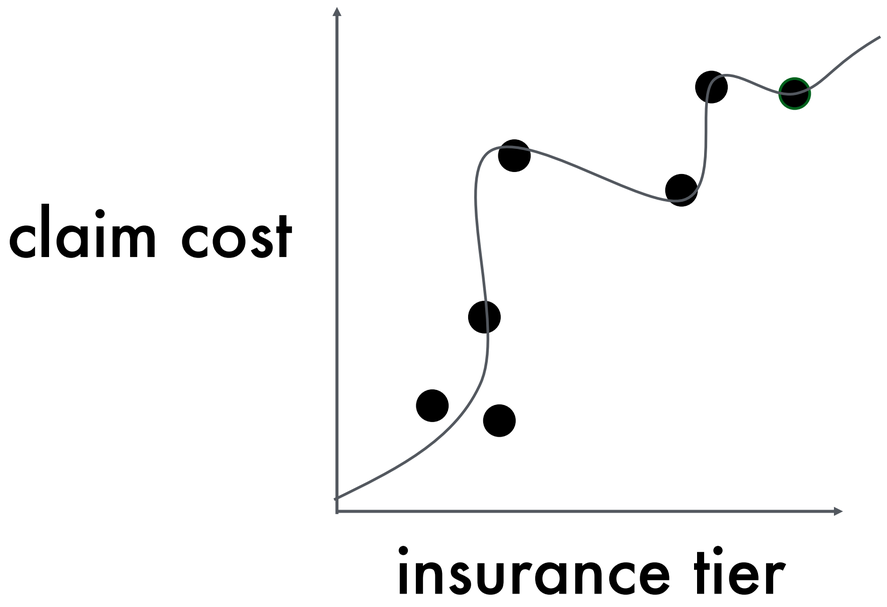
H2O's AutoML

Scalable Automatic Machine Learning

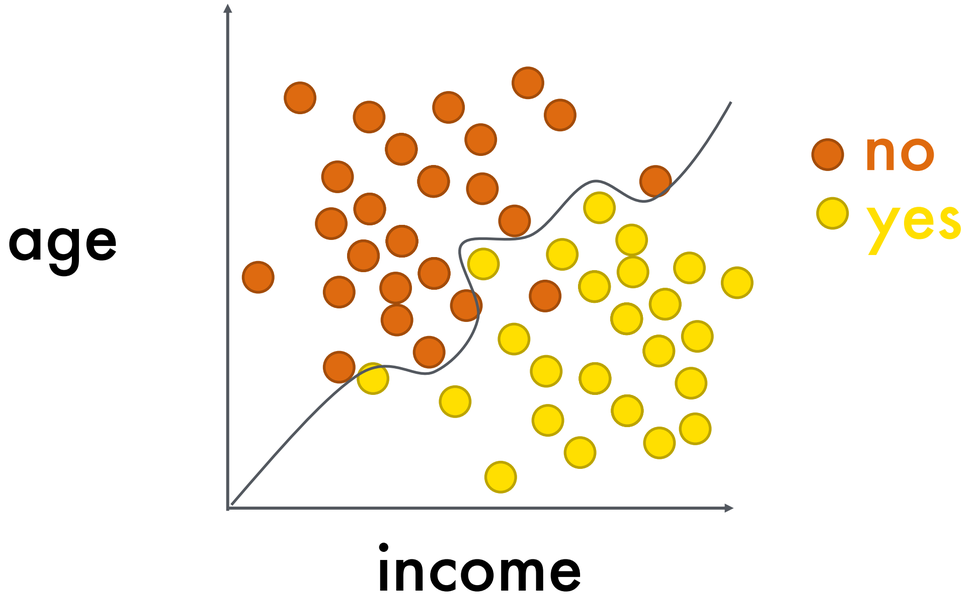


AutoML: Supervised Learning

Regression:
How much will a claim cost?

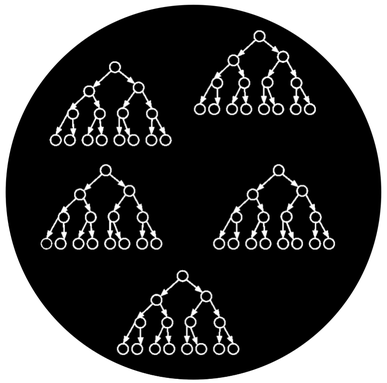


Classification:
Will a borrower pay off their loan?

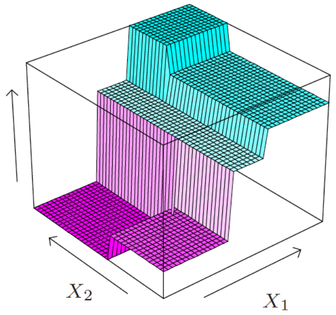


AutoML: Supervised Learning

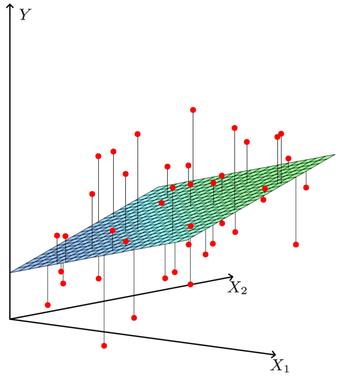
DRF
XRT



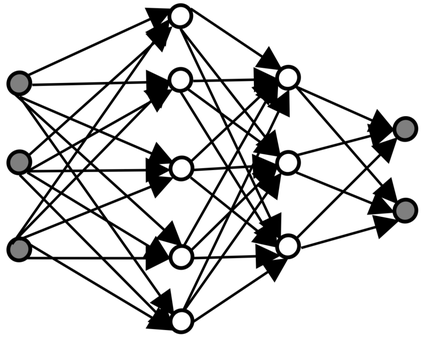
GBM
XGBoost



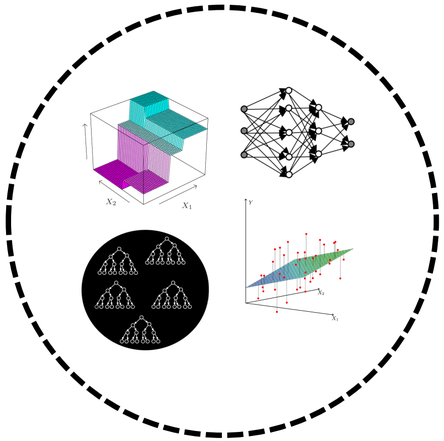
GLM



DNN



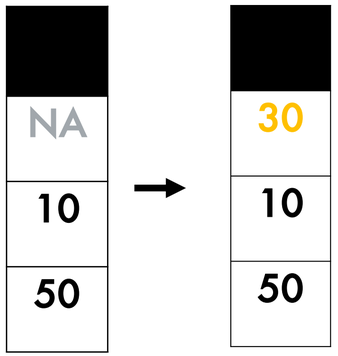
Stacked
Ensemble



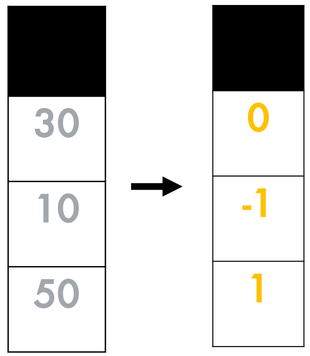
1. Data Preprocessing

AutoML Inherits from **H2O Algorithm**

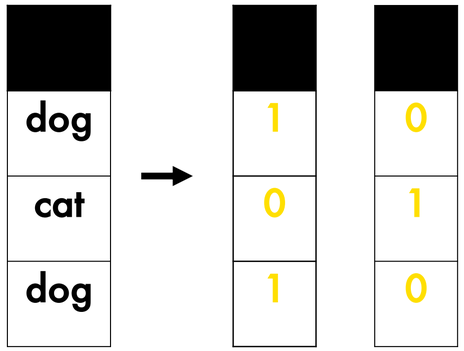
Imputation



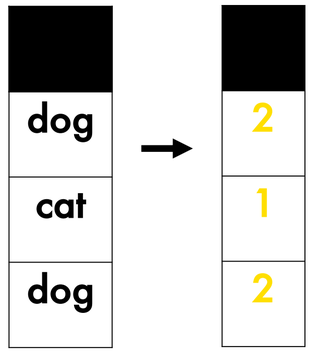
Standardization



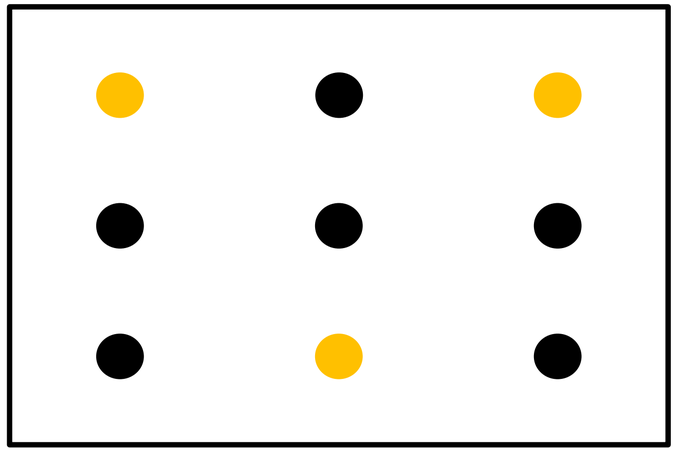
One-hot Encoding

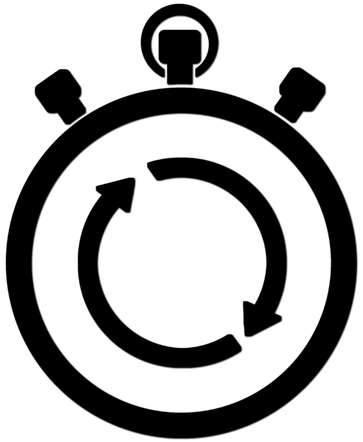


Label Encoder



2. Model Generation





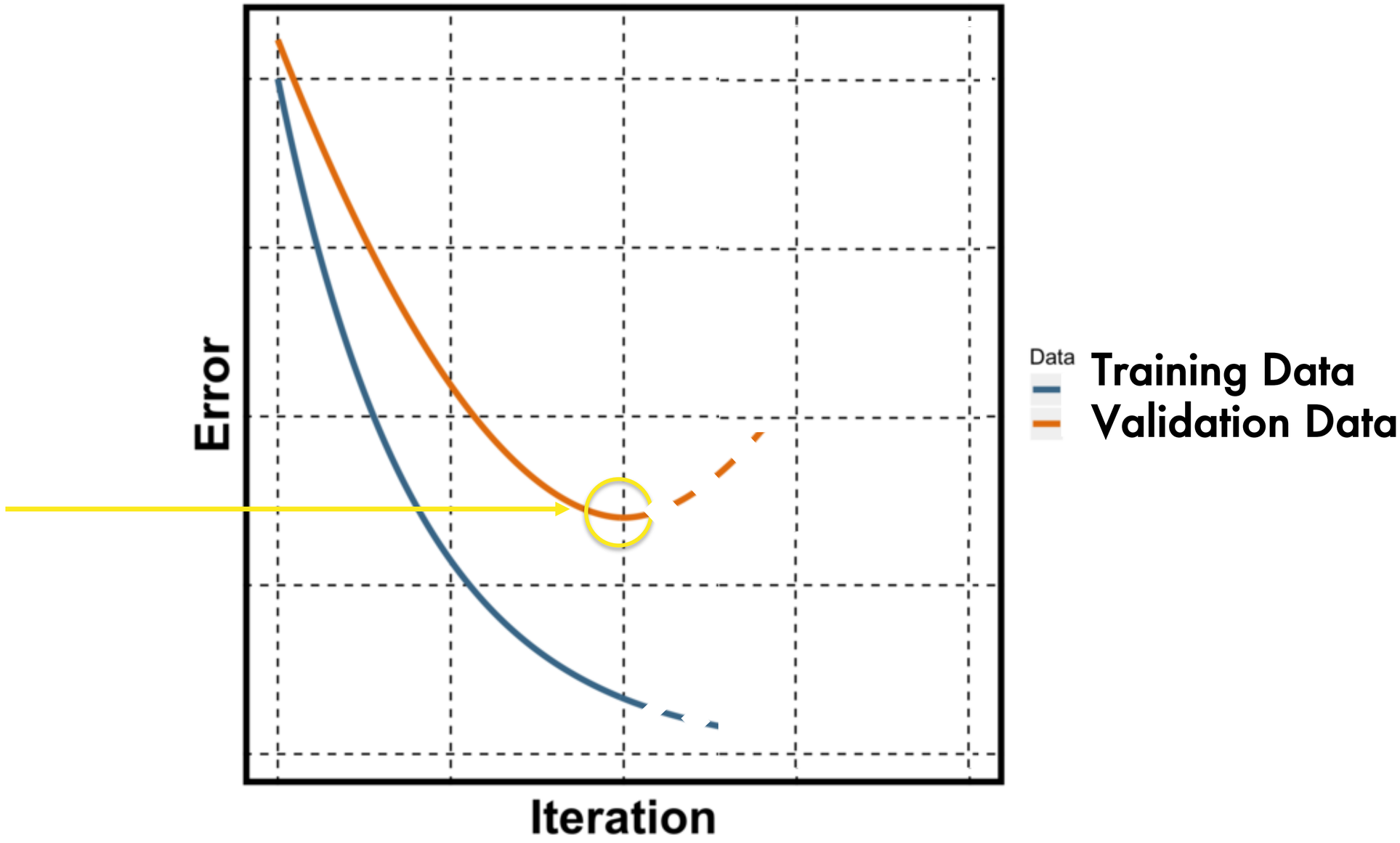
```
1037    void defaultSearchGBM(Key<Grid> gridKey) {
1038      Algo algo = Algo.GBM;
1039      WorkAllocations.Work work = workAllocations.getAllocation(algo, JobType.HyperparamSearch);
1040      if (work == null) return;
1041
1042      GBMParameters gbmParameters = new GBMParameters();
1043      setCommonModelBuilderParams(gbmParameters);
1044      gbmParameters._score_tree_interval = 5;
1045      gbmParameters._histogram_type = SharedTreeParameters.HistogramType.AUTO;
1046
1047      Map<String, Object[]> searchParams = new HashMap<>();
1048      searchParams.put("_ntrees", new Integer[]{10000});
1049      searchParams.put("_max_depth", new Integer[]{3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17});
1050      searchParams.put("_min_rows", new Integer[]{1, 5, 10, 15, 30, 100});
1051      searchParams.put("_learn_rate", new Double[]{0.001, 0.005, 0.008, 0.01, 0.05, 0.08, 0.1, 0.5, 0.8});
1052      searchParams.put("_sample_rate", new Double[]{0.50, 0.60, 0.70, 0.80, 0.90, 1.00});
1053      searchParams.put("_col_sample_rate", new Double[]{ 0.4, 0.7, 1.0});
1054      searchParams.put("_col_sample_rate_per_tree", new Double[]{ 0.4, 0.7, 1.0});
1055      searchParams.put("_min_split_improvement", new Double[]{1e-4, 1e-5});
1056
1057      Job<Grid> gbmJob = hyperparameterSearch(gridKey, work, gbmParameters, searchParams);
1058      pollAndUpdateProgress(Stage.ModelTraining, "GBM hyperparameter search", work, this.job(), gbmJob);
1059    }
```

Random Grid Search

H2O.ai

AutoML: Early Stopping

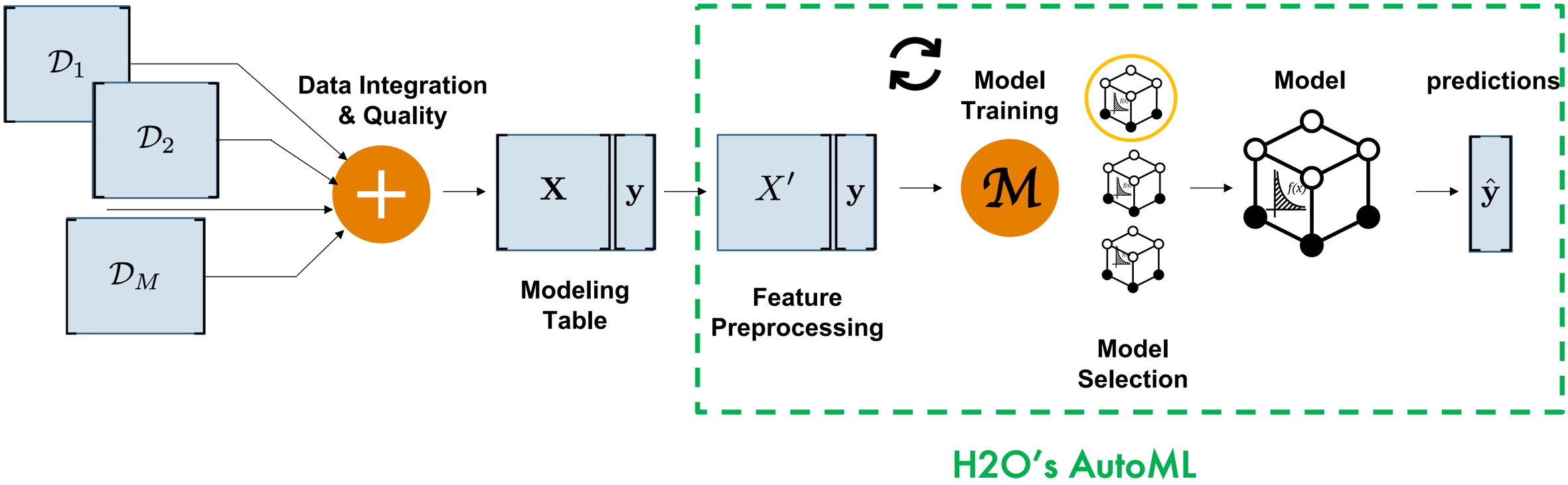
The Sweet Spot



AutoML: Summary

1. 7 Different ML Algorithms
2. Imputation, Categorical Encoding & Standardization
3. Random Grid Search
4. Early Stopping for Individual Models
5. 2 Stacked Ensembles
6. Auto-selects Winning Model

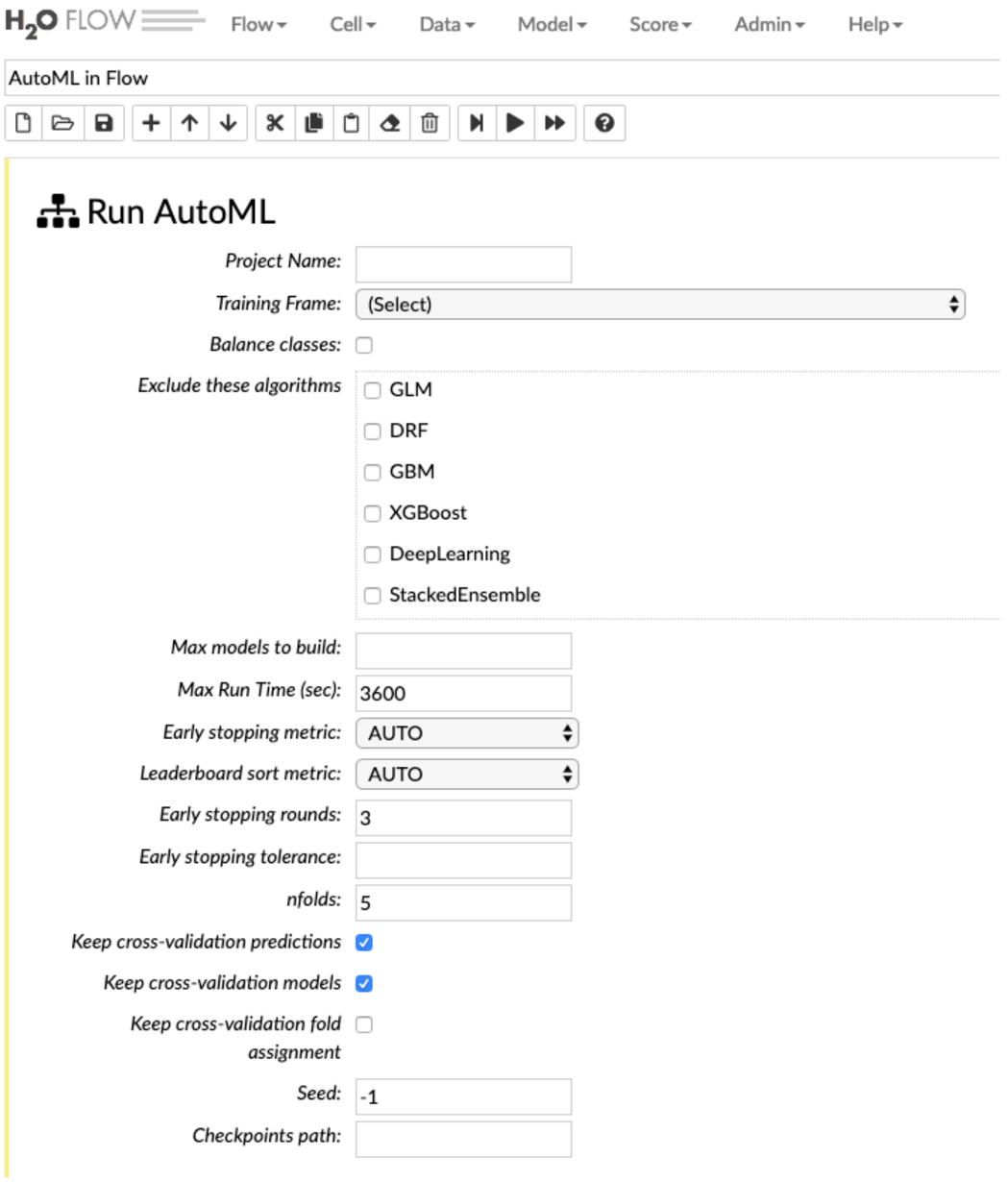
The Machine Learning Pipeline



The Interface: Web UI

2 Required parameters

training frame & response



H2O.ai

The Interface: Python

```
from h2o.automl import H2OAutoML

automl = H2OAutoML(max_runtime_secs = 60, seed = 12345)

automl.train(x = predictor_columns, y = target, training_frame = loan_stats)
```

```
automl.leaderboard
```

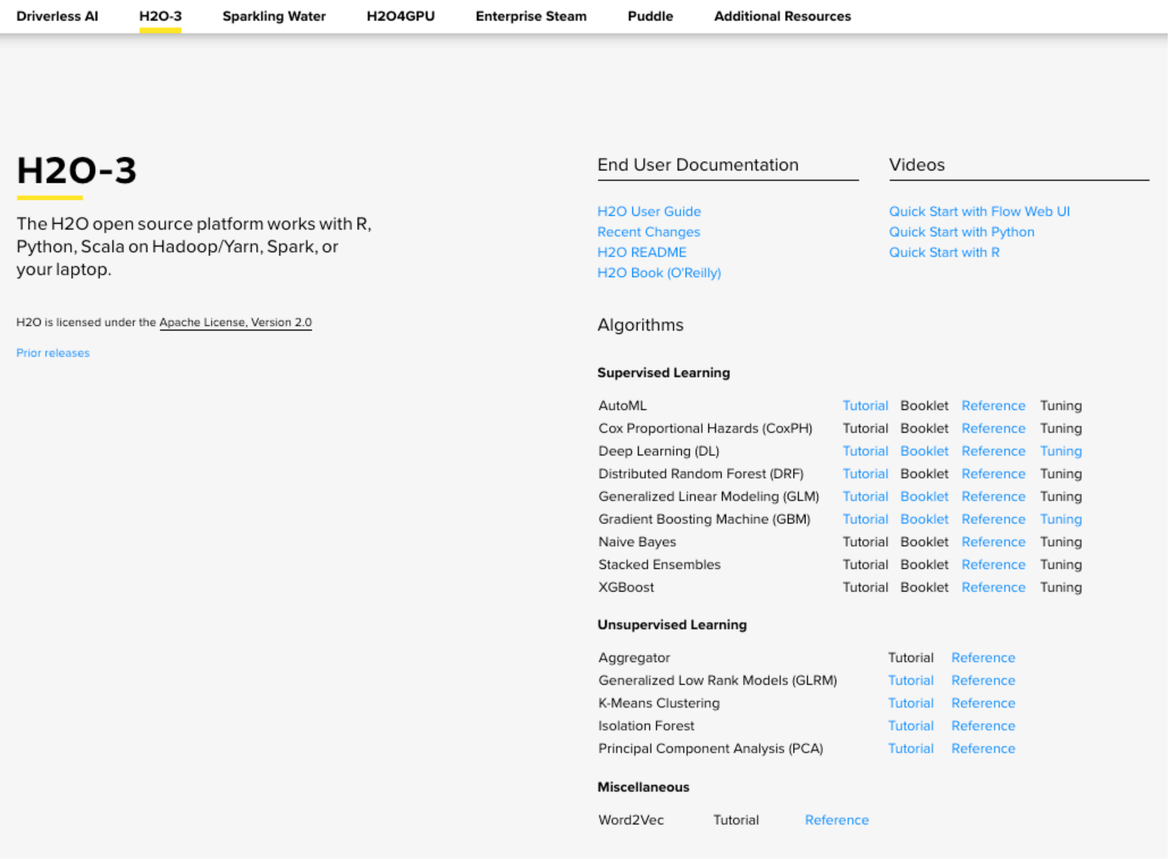
model_id	auc	logloss
StackedEnsemble_AllModels_0_AutoML_20180113_105834	0.720685	0.385048
StackedEnsemble_BestOfFamily_0_AutoML_20180113_105834	0.720319	0.385191
GLM_grid_0_AutoML_20180113_105834_model_0	0.71506	0.384576
GBM_grid_0_AutoML_20180113_105834_model_0	0.709894	0.387613
GBM_grid_0_AutoML_20180113_105834_model_1	0.703851	0.388938
GBM_grid_0_AutoML_20180113_105834_model_2	0.699872	0.391217
DRF_0_AutoML_20180113_105834	0.690366	0.406982
XRT_0_AutoML_20180113_105834	0.685729	0.39767

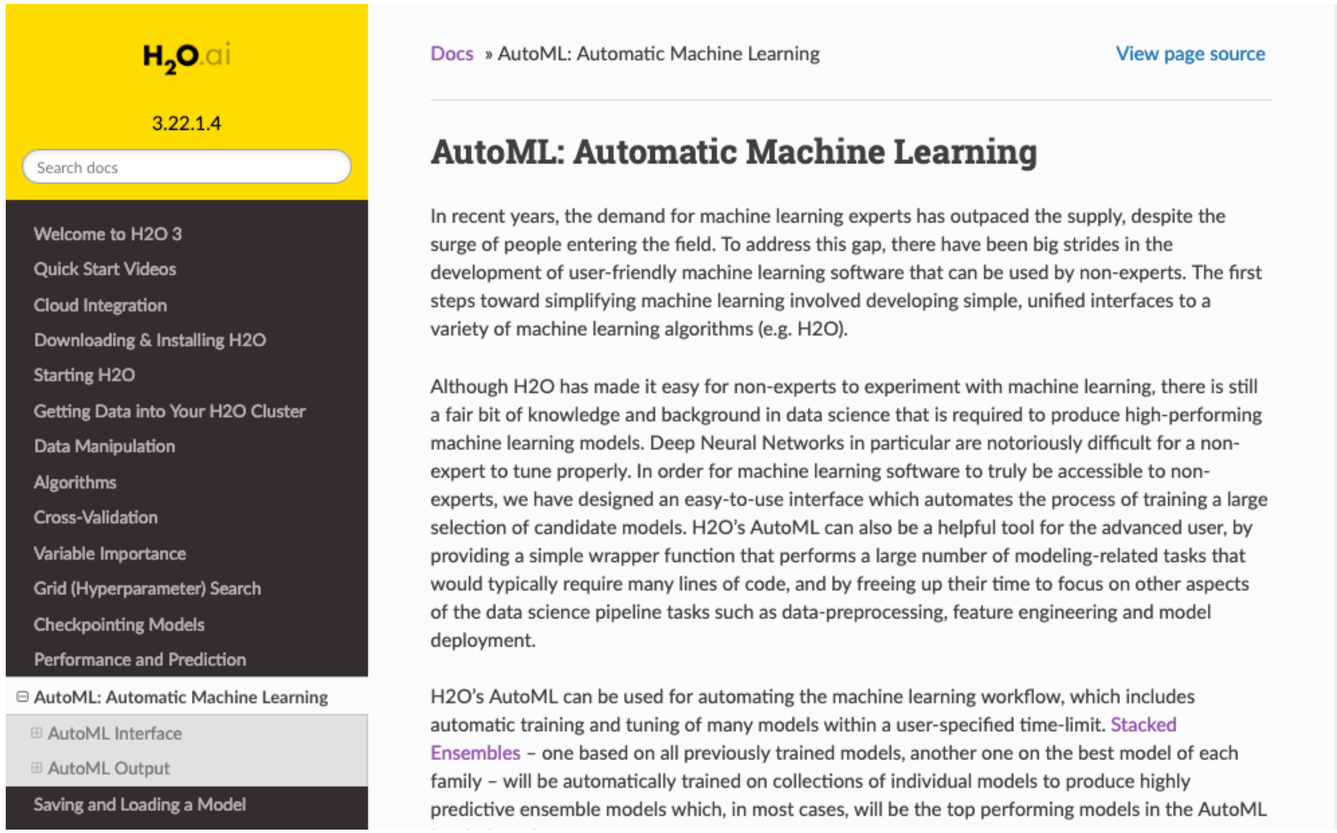
The Interface: R

```
automl <- h2o.automl(max_runtime_secs = 60, seed = 12345,
                     x = predictors, y = target, training_frame = loan_stats)

automl@leaderboard
```

Additional Resources





http://docs.h2o.ai

AutoML Tutorials

https://bit.ly/2TRNqTw