Intro to AutoML
with Python

Lauren DiPerna // Data Scientist @ **H2O.ai**

H2O.ai

Agenda

- Intro to H2O-3 software
- How the Python API works
- What is AutoML
- Demo

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

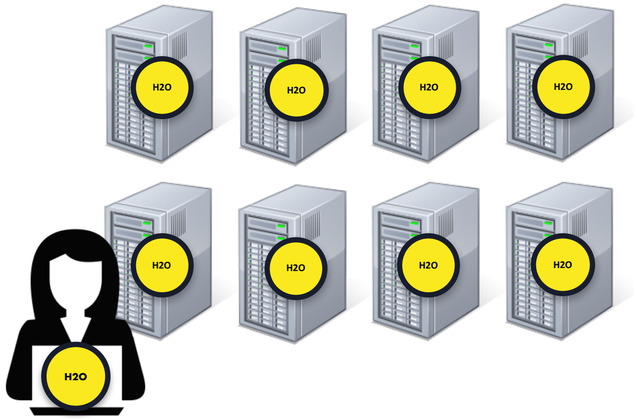
Open Source Software

R, Python, Scala and Web Interfaces

Distributed Machine Learning Algorithms

H2O-3: The Machine Learning Platform

Java-Based Software for **In-Memory** for **Data Modeling**



Parallel: uses many CPUs

Distributed: uses many machines

H2O-3: The Machine Learning Platform

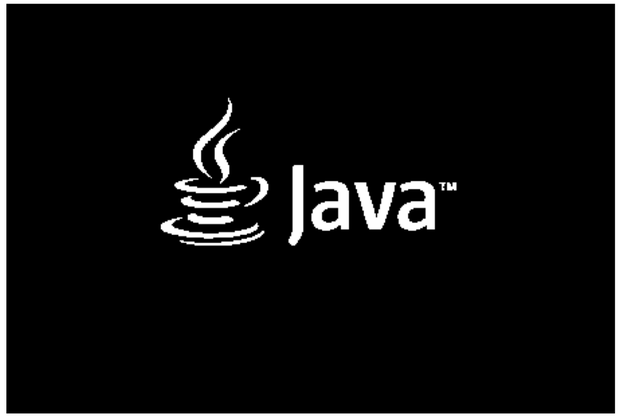
Core Algorithms are written in high-performance Java

14+ ALGORITHMS

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

H2O-3: The Machine Learning Platform

Core Algorithms are written in high-performance Java



Supervised & Unsupervised

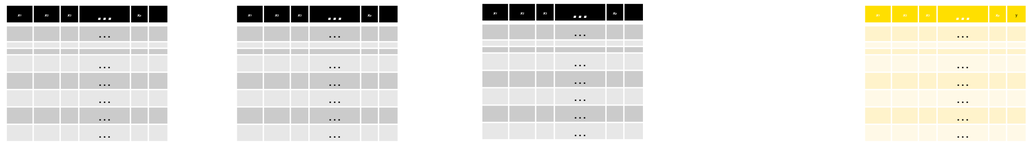
H2O-3: The Machine Learning Platform

Multiple APIs

H_2O Flow

Benefits of H2O-3

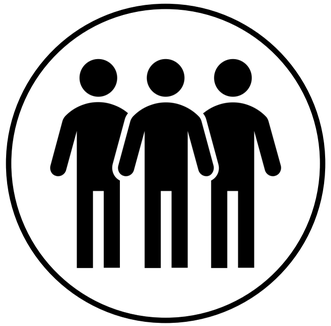
No Data Size Limit



Easy Deployment

Live Results!

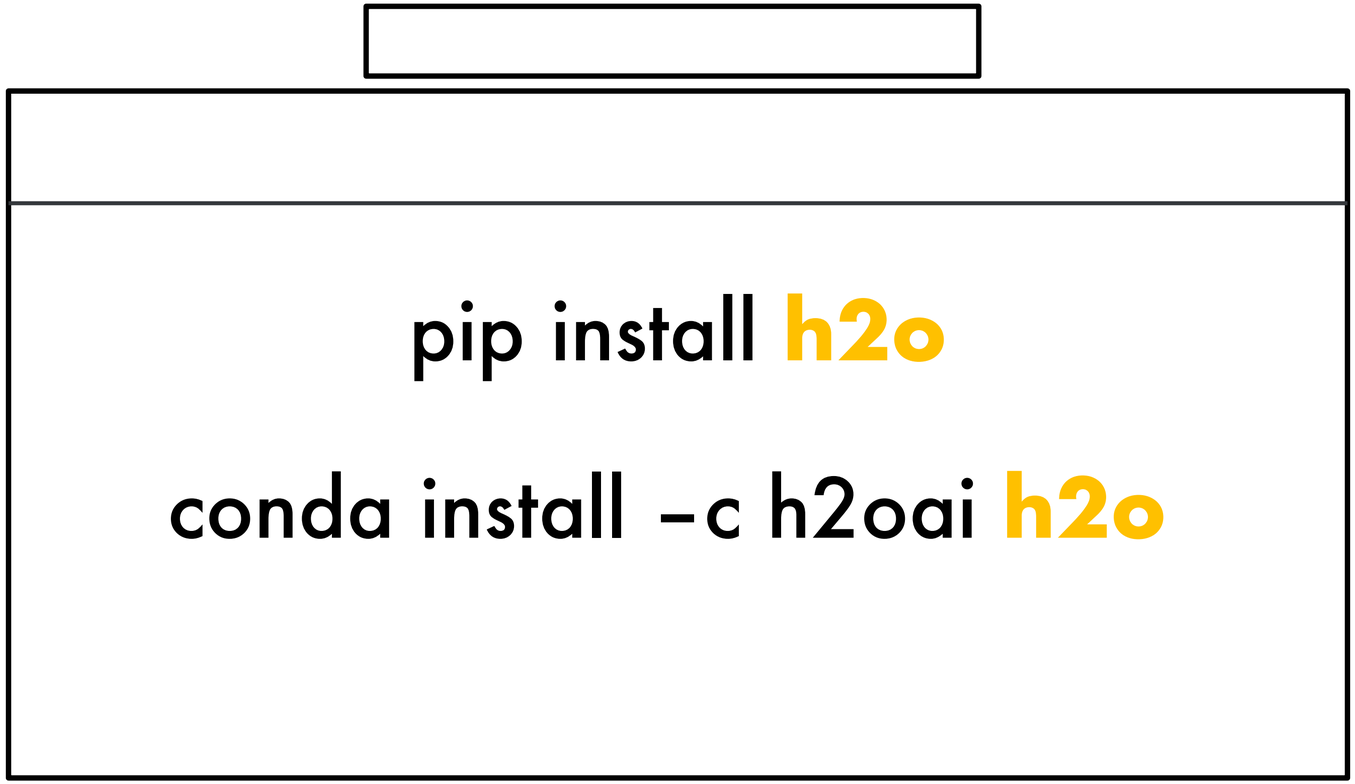
Easy Learning Curve



💛 R + 💛 Py. + 💛UI

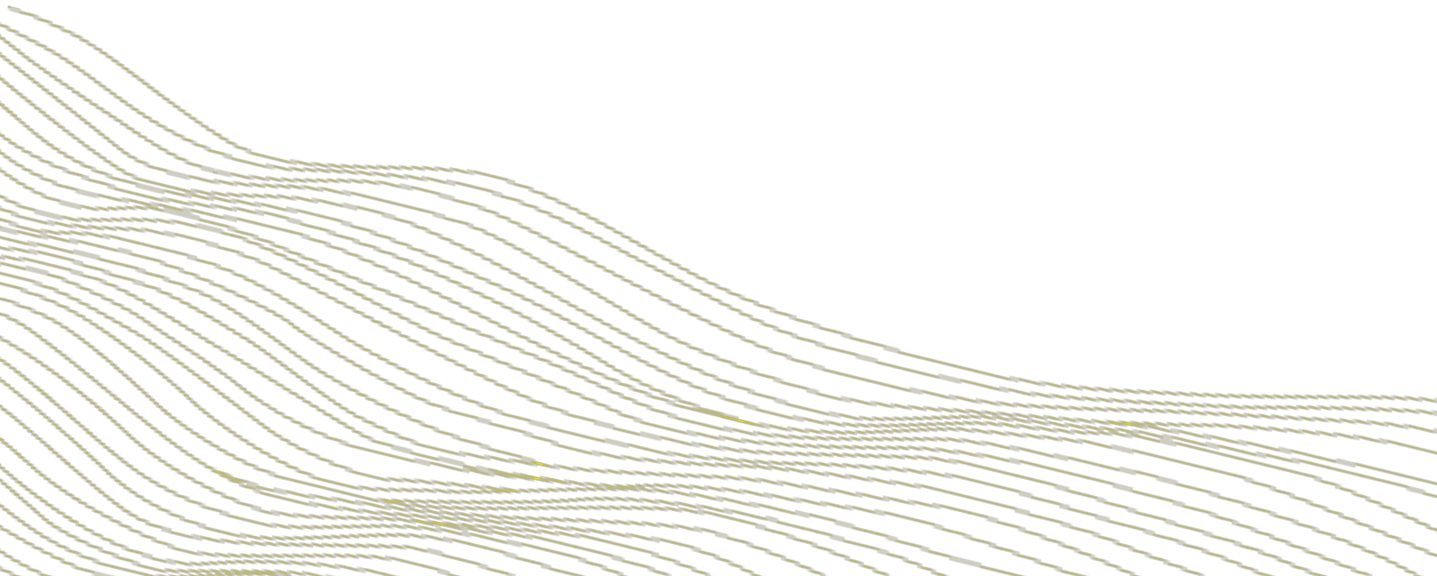
What is H2O-3?

What is H2O-3?



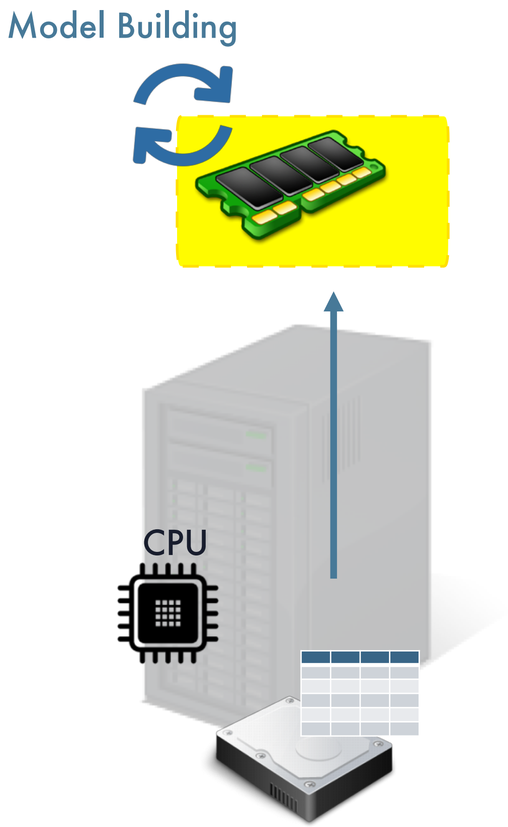
H2O Cluster & H2O Frame

2 key concepts

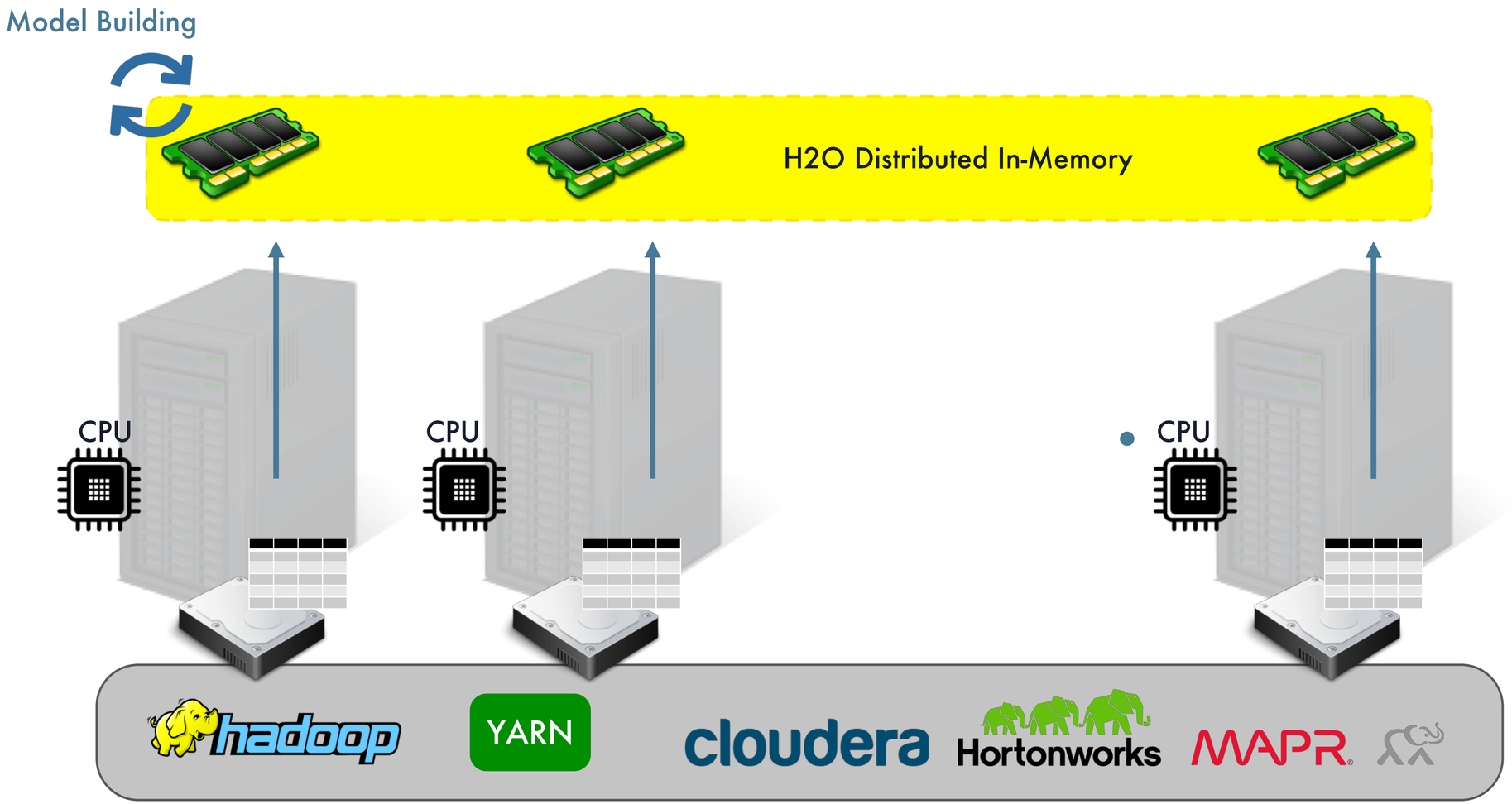


The H2O Cluster

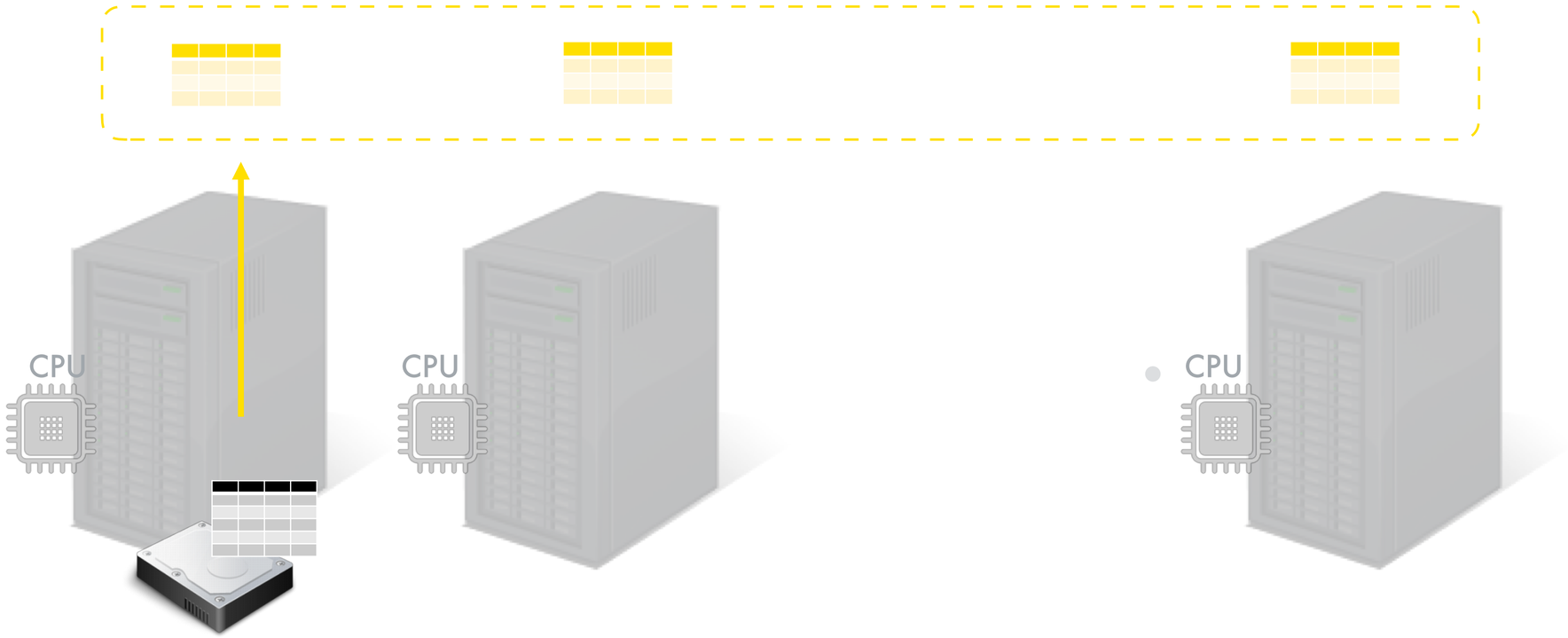
The H2O Cluster



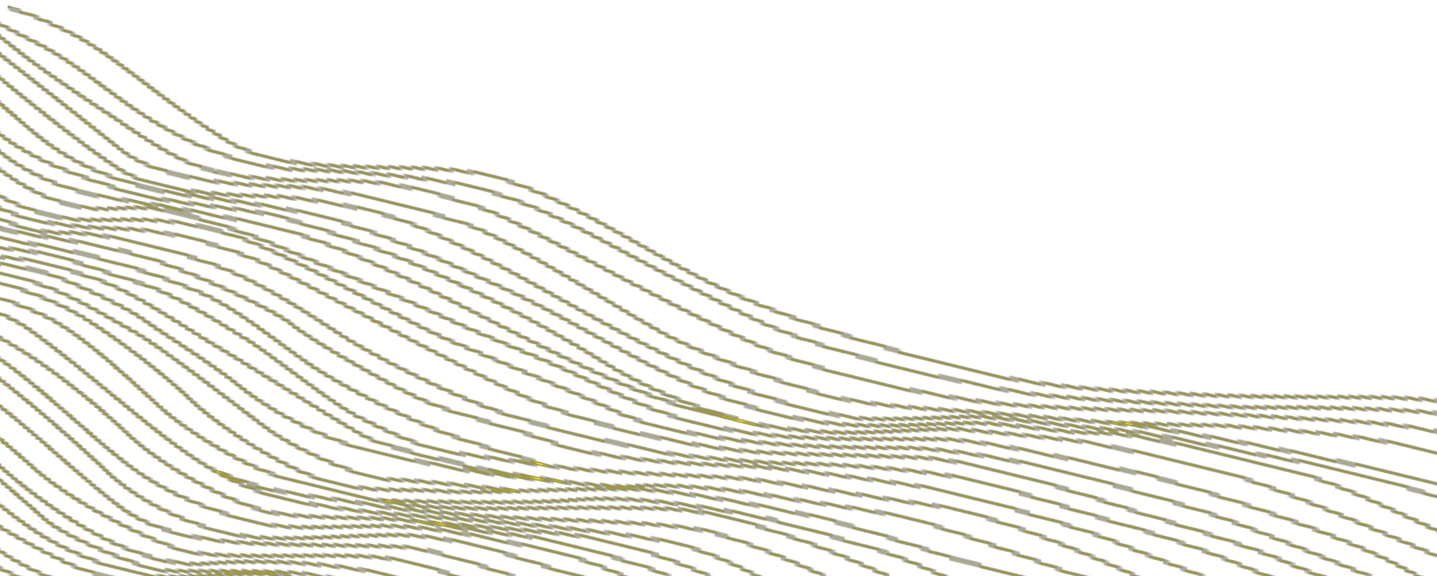
The H2O Cluster



The Distributed H2O Frame



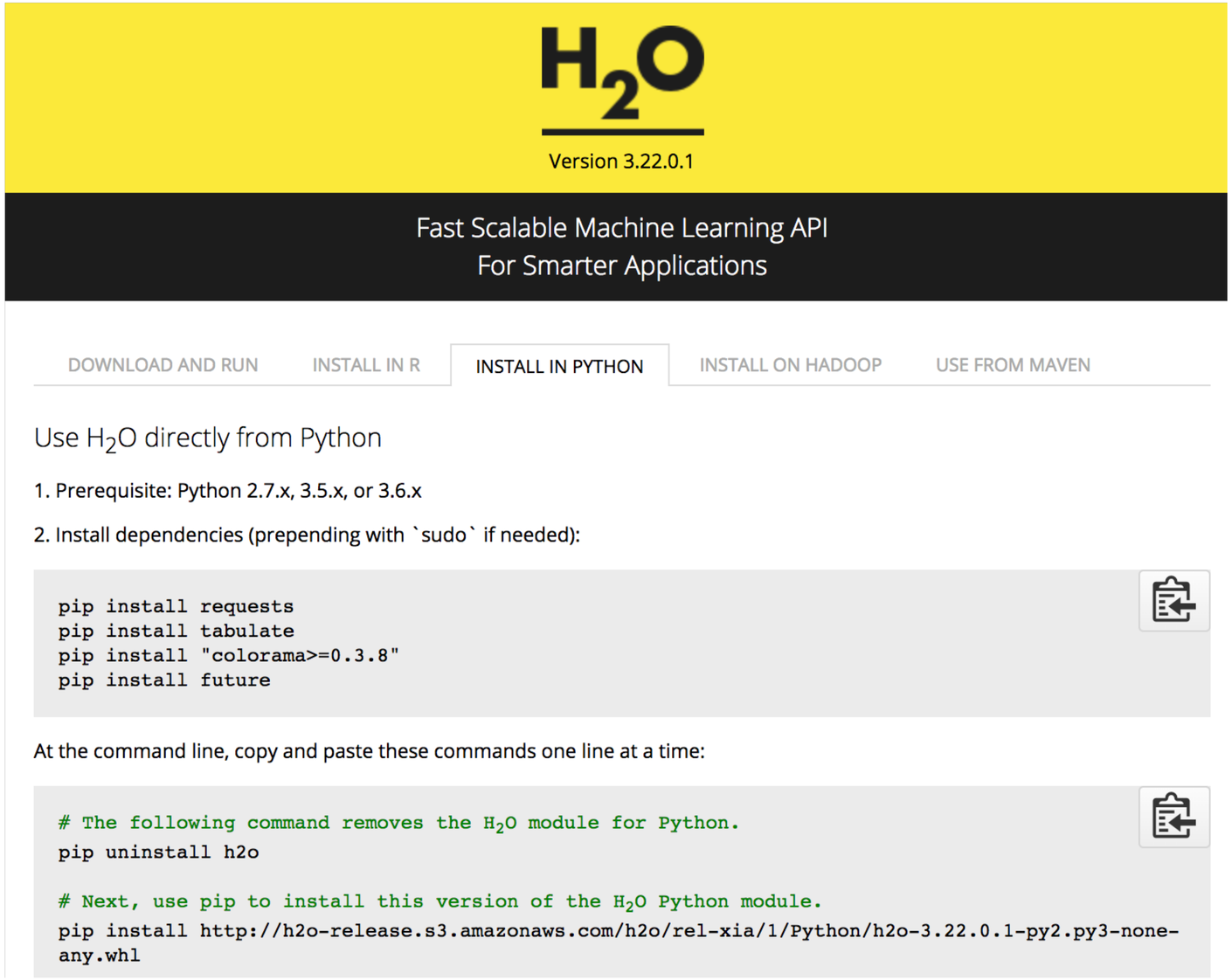
The H2O Python API



Importing the Python Package

If you want to use the H2O Python API ...

You have to import the **H2O Python Module**



Communication

h2o.import_file(…)
requests file import

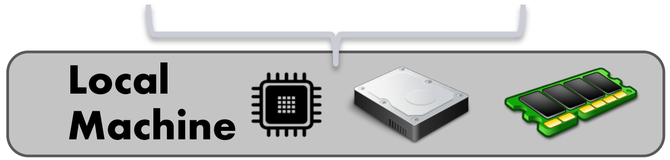
File Edit View Insert Cell Kernel Help Python 3

Code CellToolbar

```
In [ ]: import h2o
        from h2o.estimators.glm import H2OGeneralizedLinearEstimator
        h2o.init()

        # import the boston dataset:
        # this dataset looks at features of the boston suburbs and predicts median housing prices
        # the original dataset can be found at https://archive.ics.uci.edu/ml/datasets/Housing
        boston = h2o.import_file("https://s3.amazonaws.com/h2o-public-test-data/smalldata/gbm_test/Bosto

        # set the predictor names and the response column name
        predictors = boston.columns[:-1]
        # set the response column to "medv", the median value of owner-occupied homes in $1000's
        response = "medv"

        # convert the chas column to a factor (chas = Charles River dummy variable (= 1 if tract bounds
        boston['chas'] = boston['chas'].asfactor()

        # split into train and validation sets
        train, valid = boston.split_frame(ratios = [.8])


        # try using the `alpha` parameter:
        # initialize the estimator then train the model
        boston_glm = H2OGeneralizedLinearEstimator(alpha = .25)
        boston_glm.train(x = predictors, y = response, training_frame = train, validation_frame = valid)

        # print the mse for the validation data
        print(boston_glm.mse(valid=True))
```

REST / JSON

H2O Cluster



H2O.ai

Cluster Does Heavy Lifting

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Code CellToolbar

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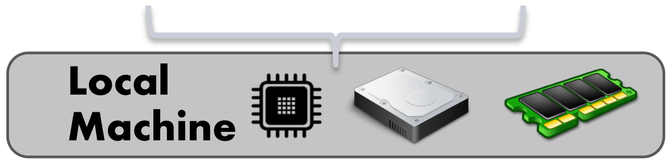
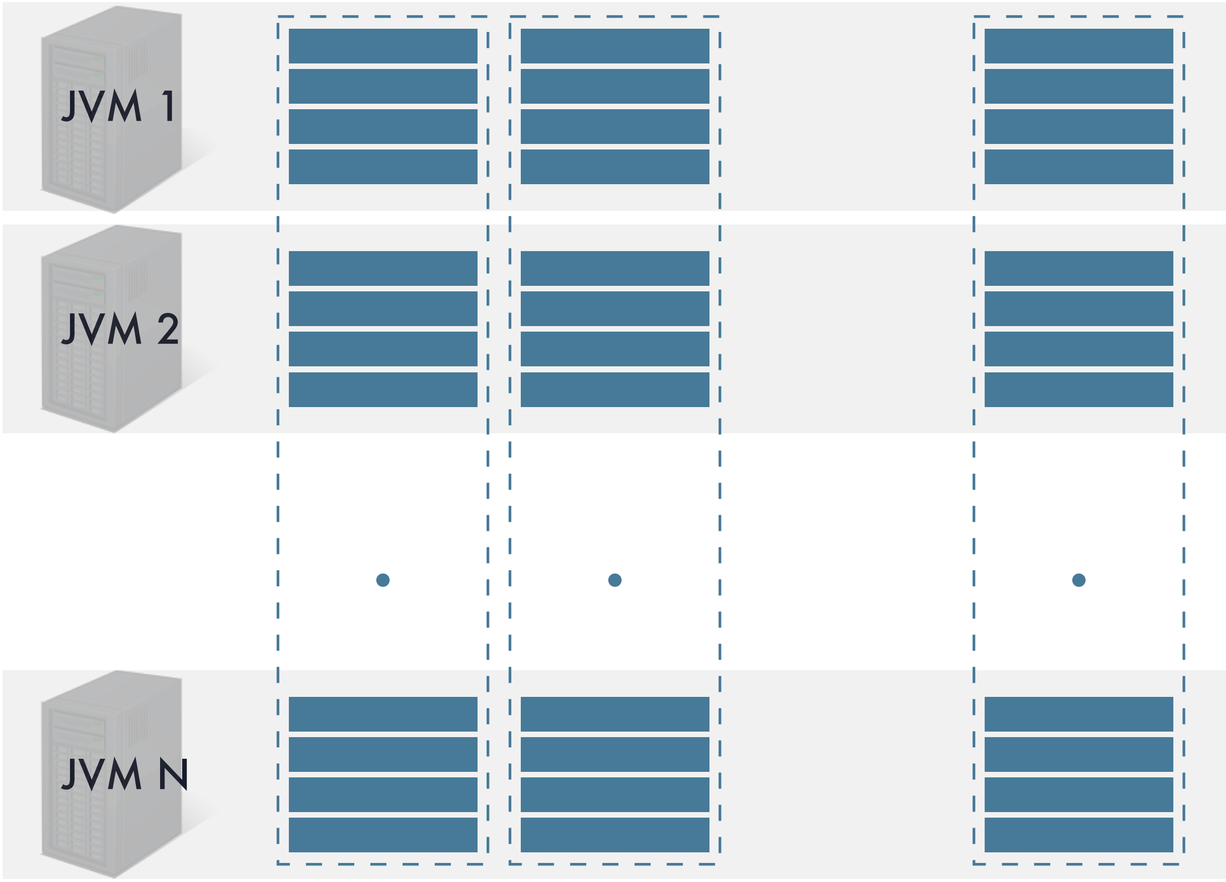


REST/
JSON

H2O Cluster



H2O.ai

H2O Client

cluster returns frame key

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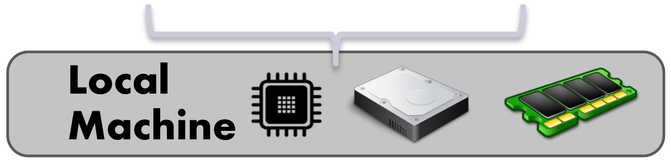


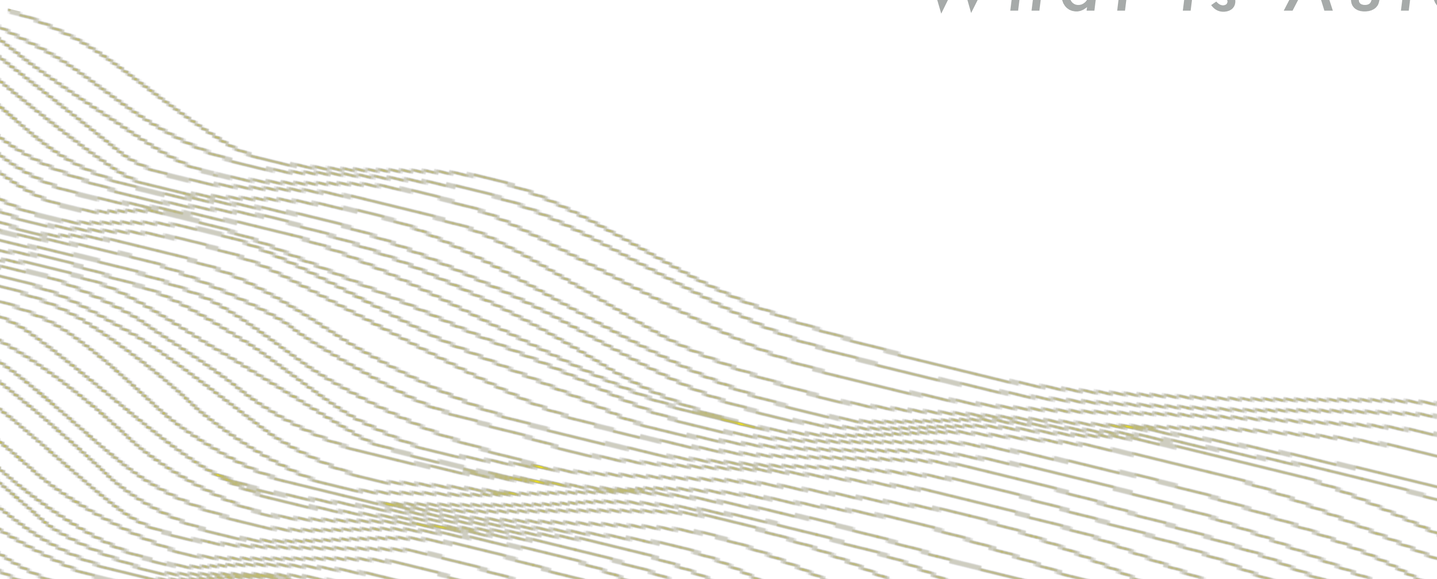
REST/ JSON

x1	x2	x3	...	xp	y

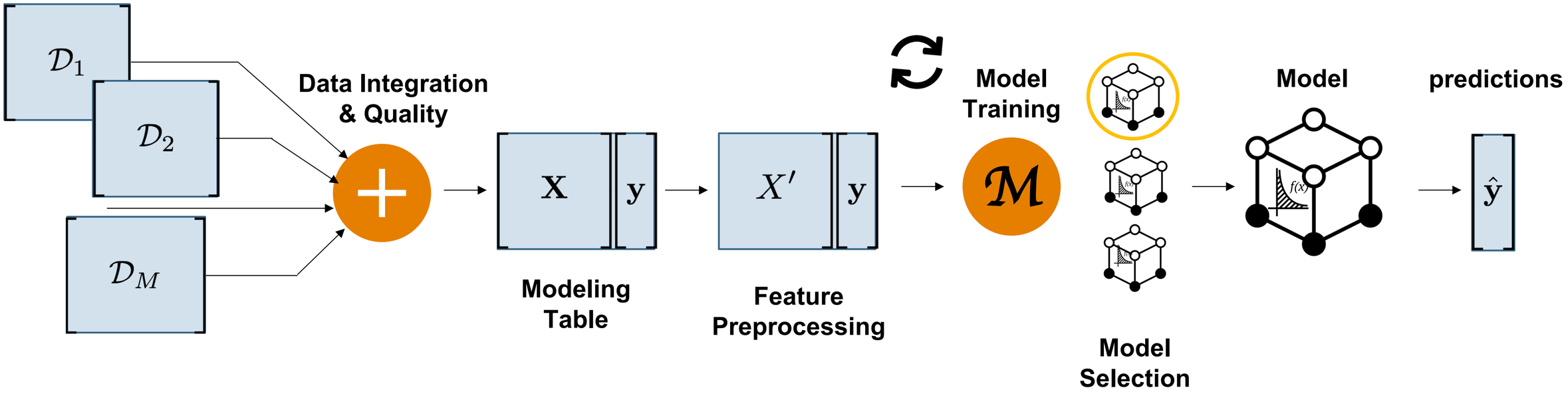
H2O.ai

Auto-What?

What is AutoML?

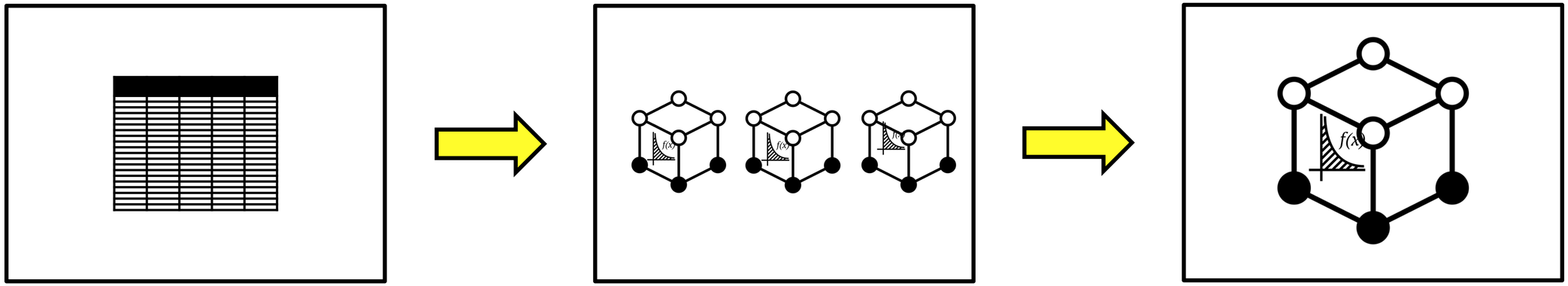


The Machine Learning Pipeline



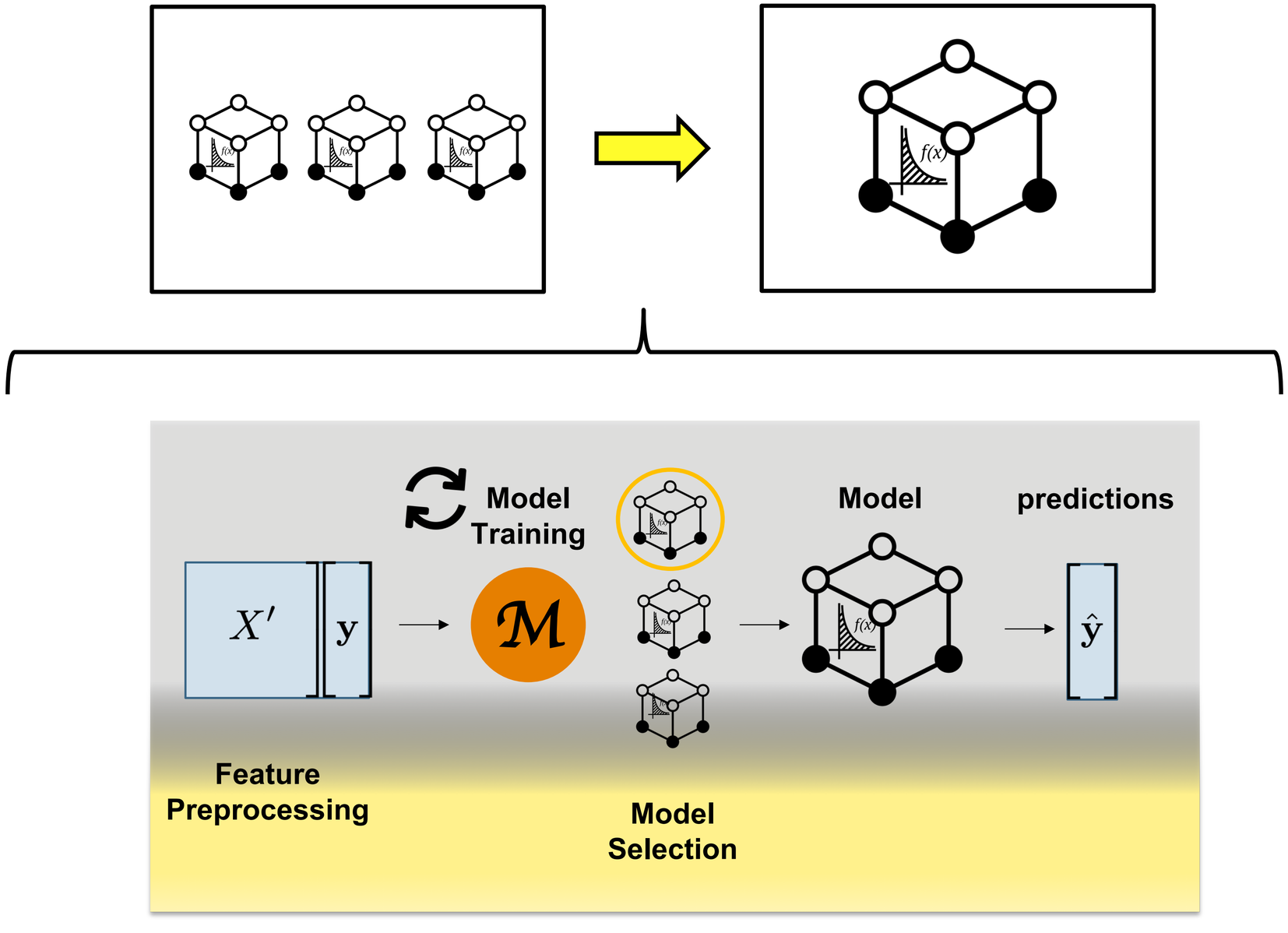
H2O.ai

What is Automatic Machine Learning?



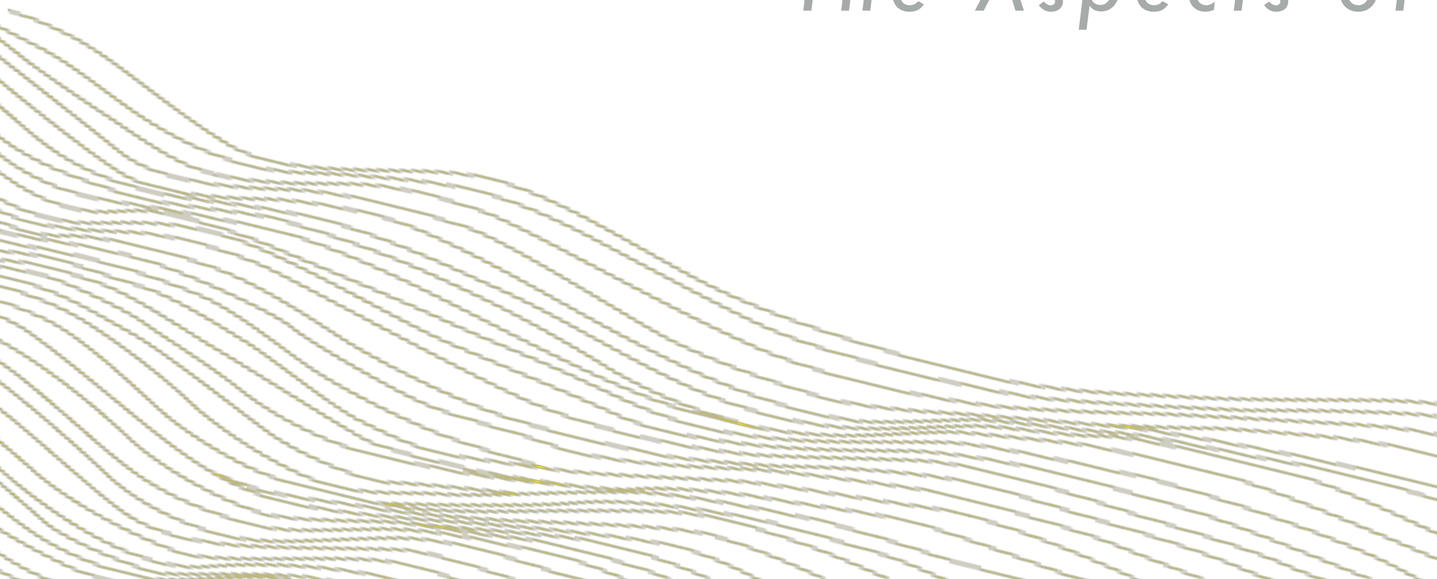
Work **No Work** **No Work**

What is Automatic Machine Learning?

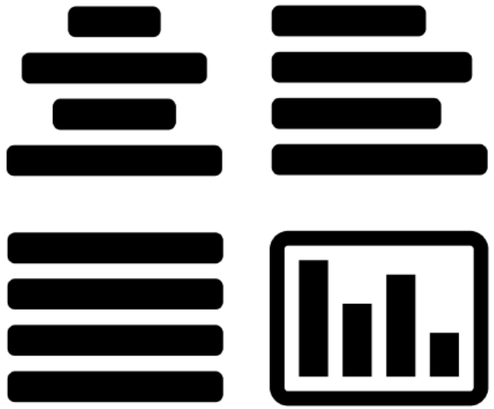


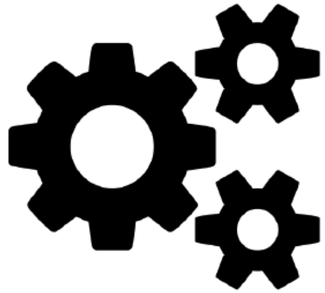
Automatic Machine Learning

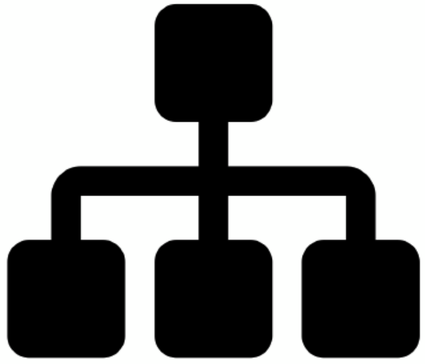
The Aspects of AutoML



Model Generation







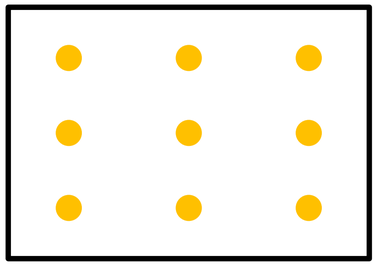
Data Prep

Ensembles

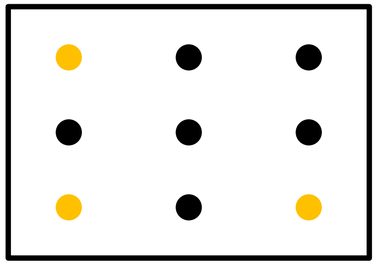
Data Prep

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

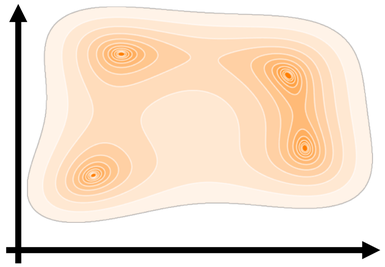
Model Generation



Cartesian grid search

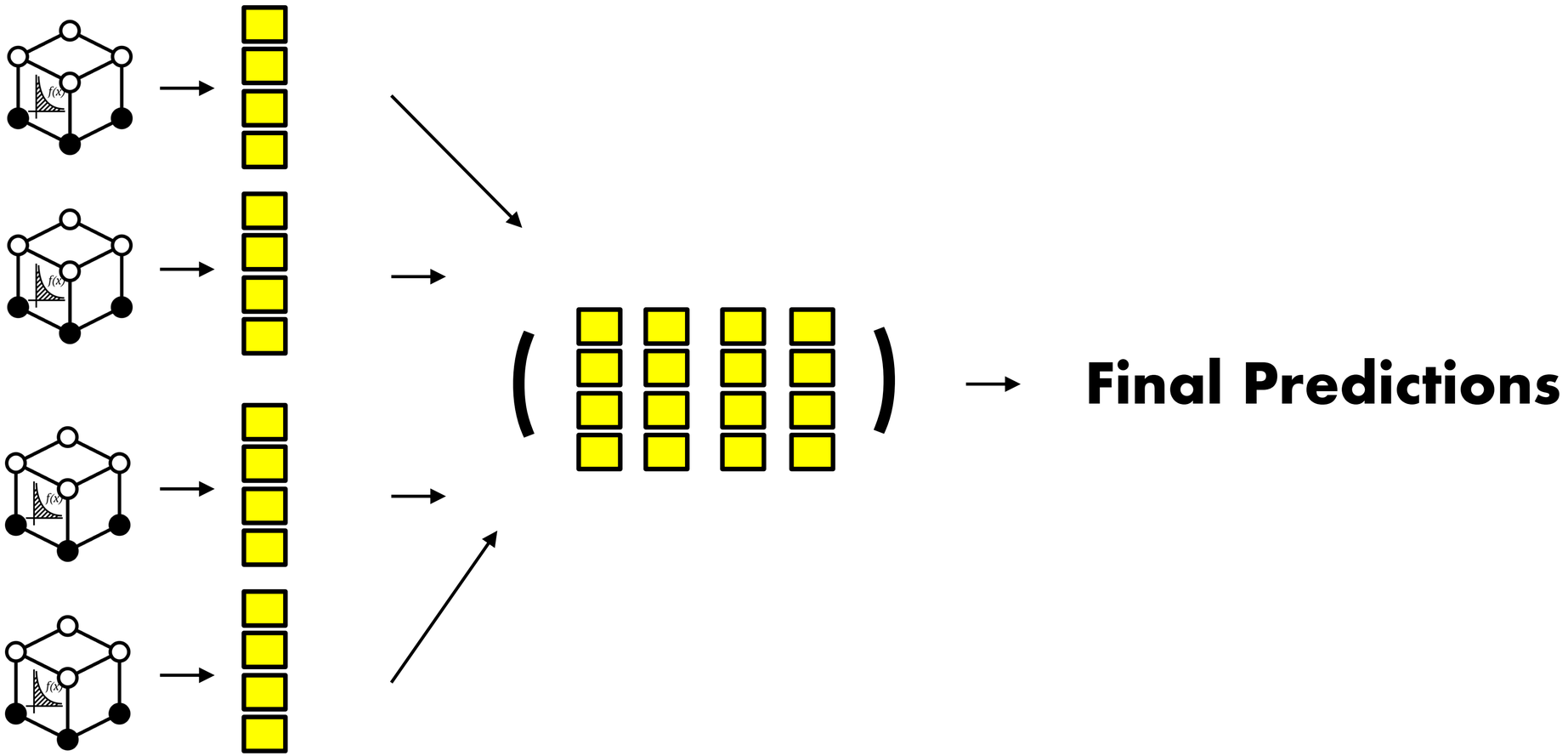


Random grid search



Bayesian Hyperparameter Optimization

Ensembles



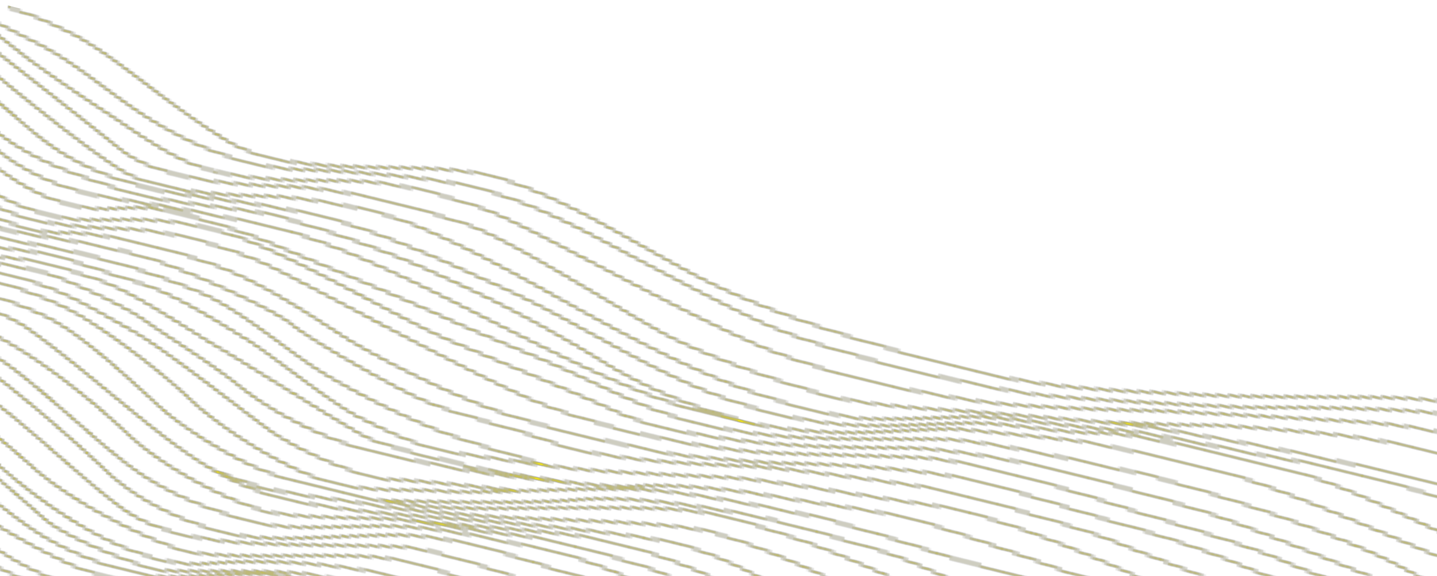
Ensembles

Ensembles often **out-perform** individual models

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

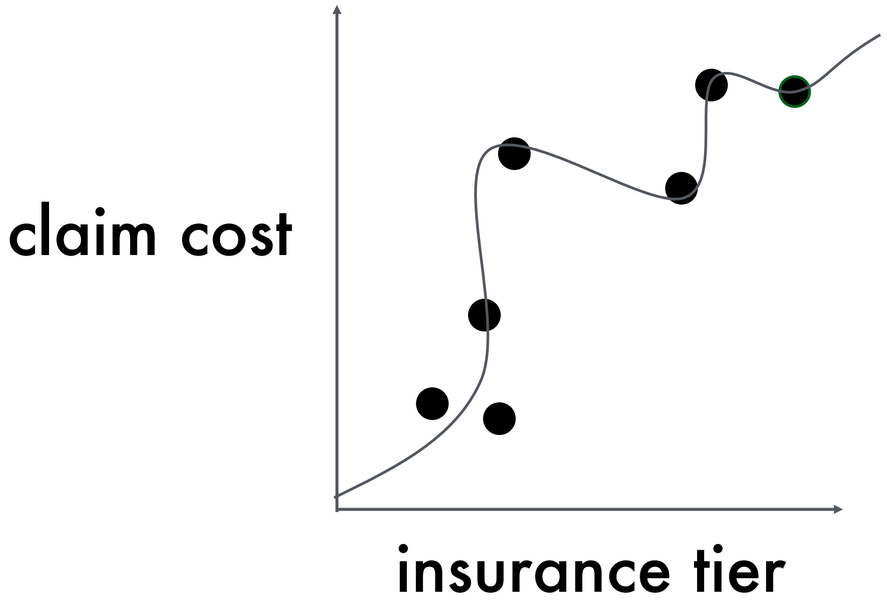
H2O's AutoML

Scalable Automatic Machine Learning

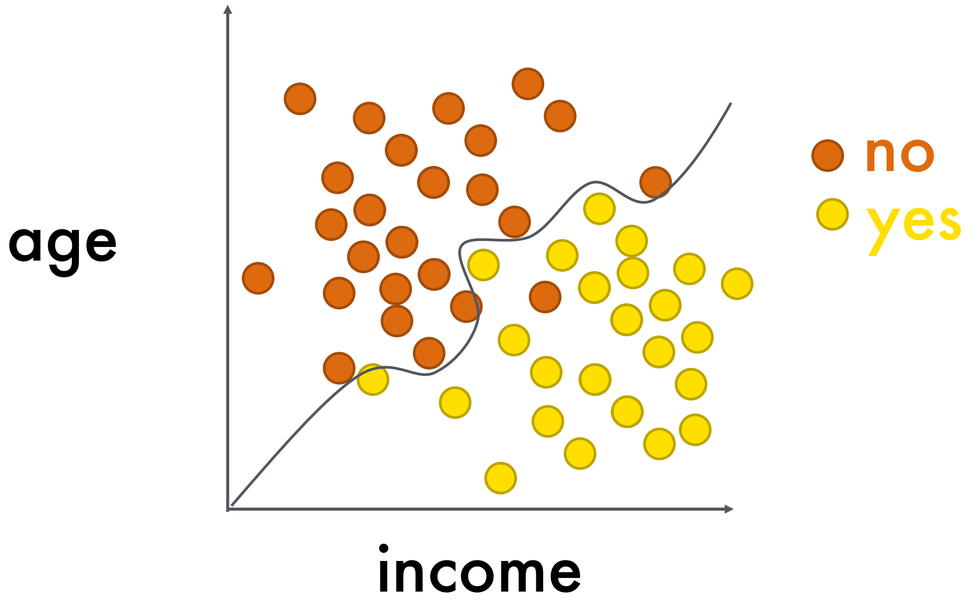


AutoML: Supervised Learning

Regression:
How much will a claim cost?

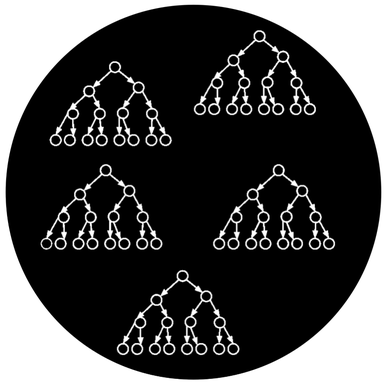


Classification:
Will a borrower pay off their loan?

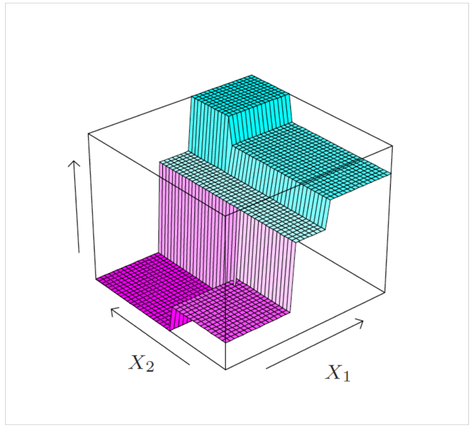


H2O AutoML: Available Algos

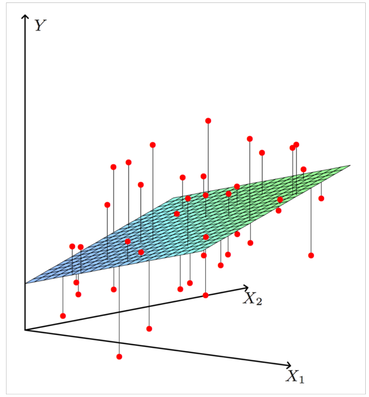
DRF
XRT



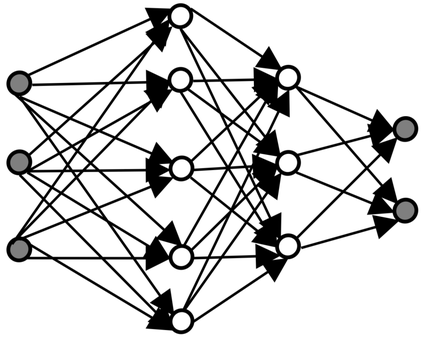
GBM
XGBoost



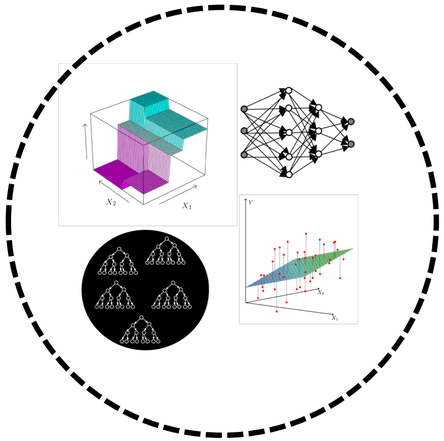
GLM



DNN



Stacked Ensemble

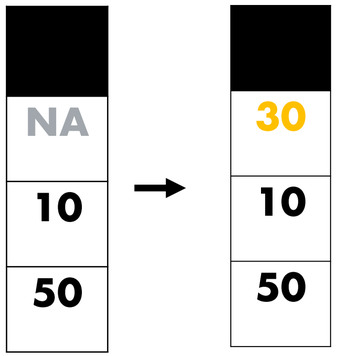


H2O.ai

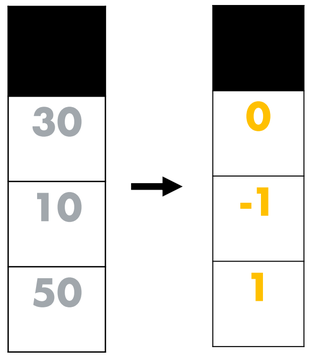
AutoML: Data Preprocessing

Inherits from **H2O Algorithm**

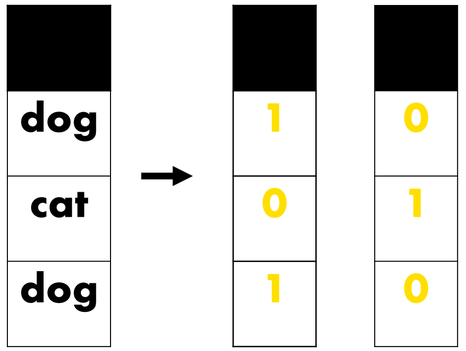
Imputation



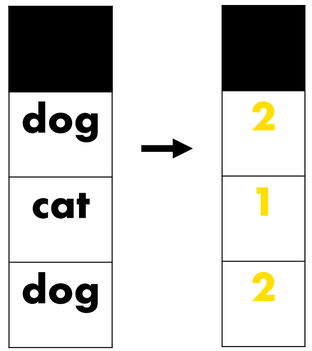
Standardization



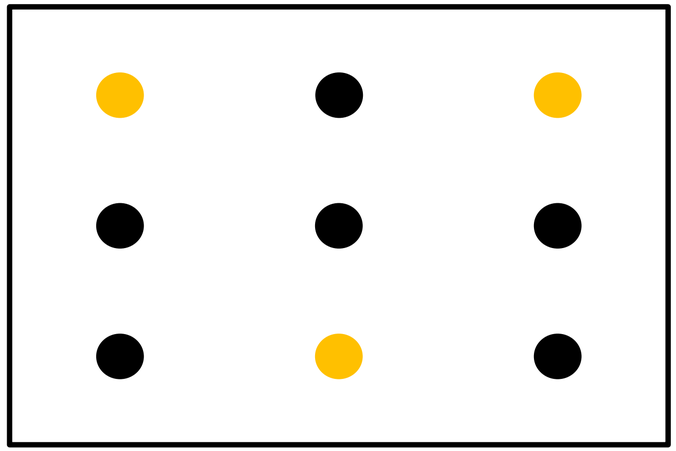
One-hot Encoding

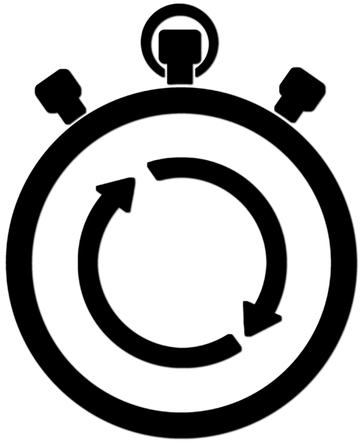


Label Encoder



AutoML: Model Generation





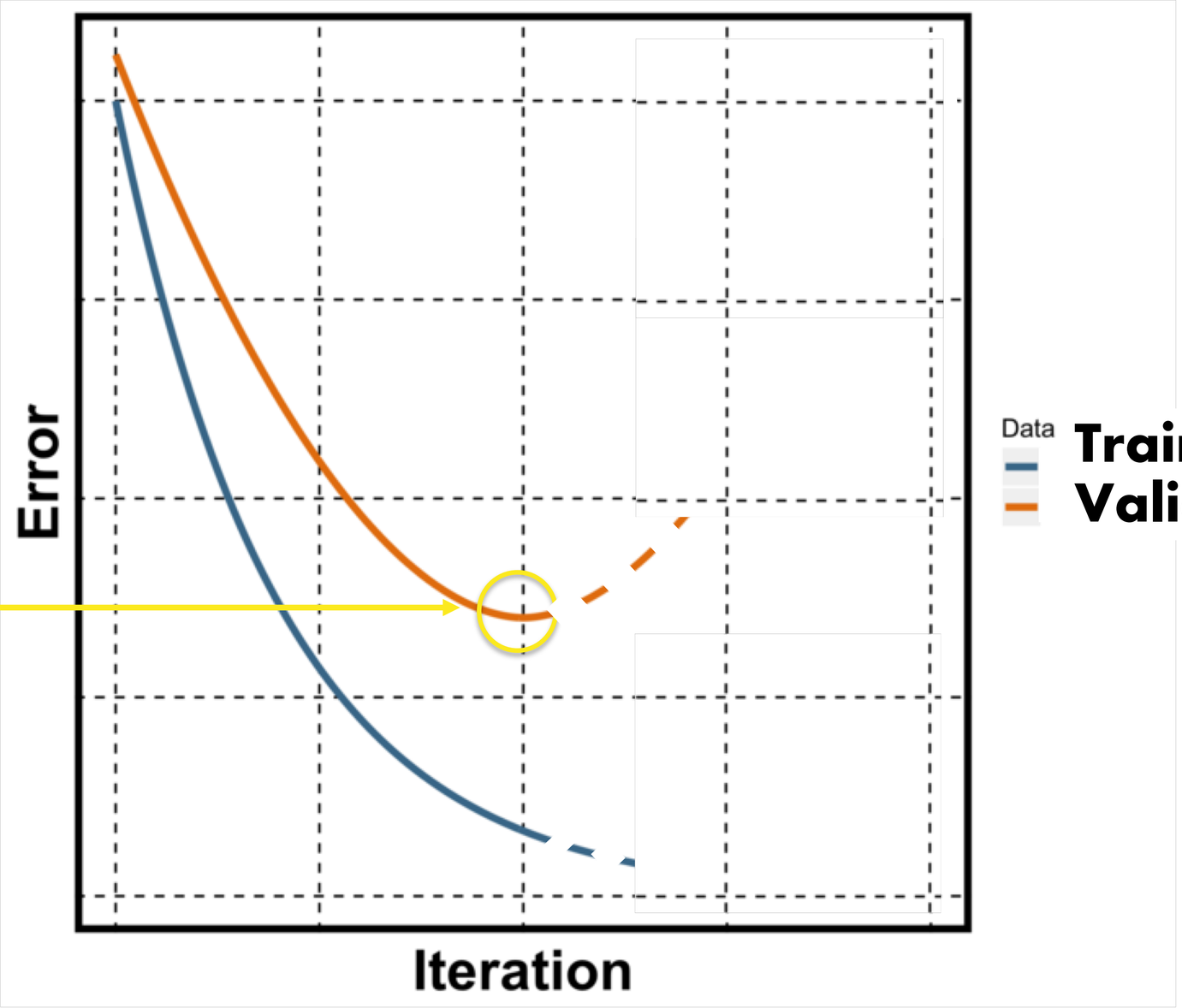
```
1037    void defaultSearchGBM(Key<Grid> gridKey) {
1038      Algo algo = Algo.GBM;
1039      WorkAllocations.Work work = workAllocations.getAllocation(algo, JobType.HyperparamSearch);
1040      if (work == null) return;
1041
1042      GBMParameters gbmParameters = new GBMParameters();
1043      setCommonModelBuilderParams(gbmParameters);
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

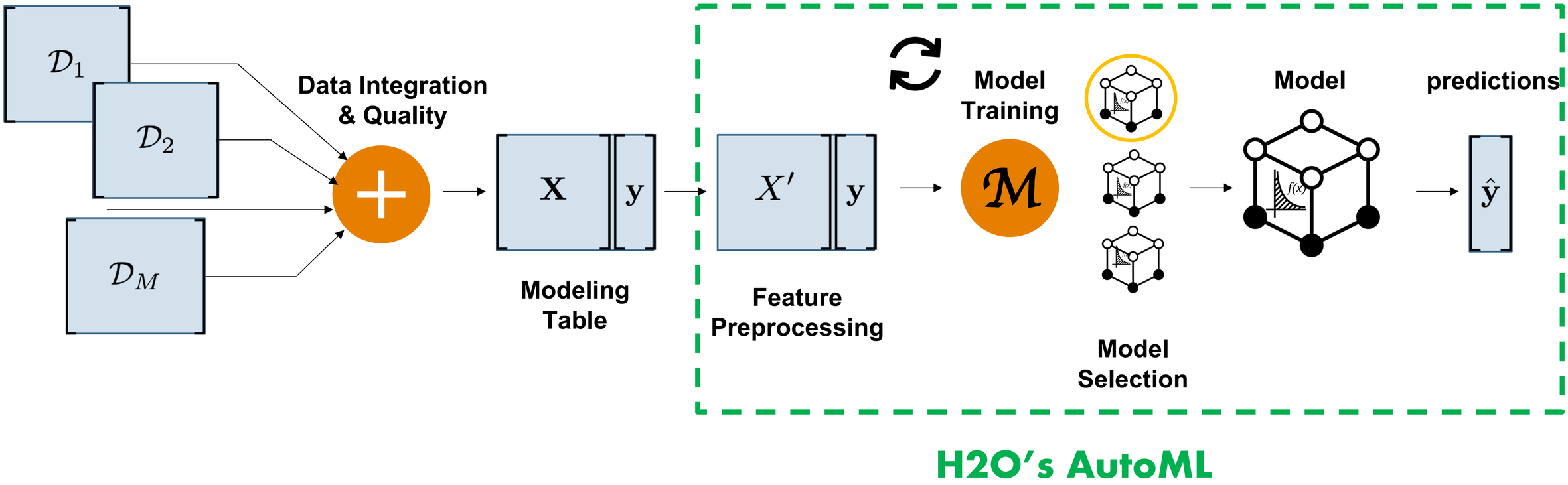
The Sweet Spot



Summary: H2O's AutoML

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

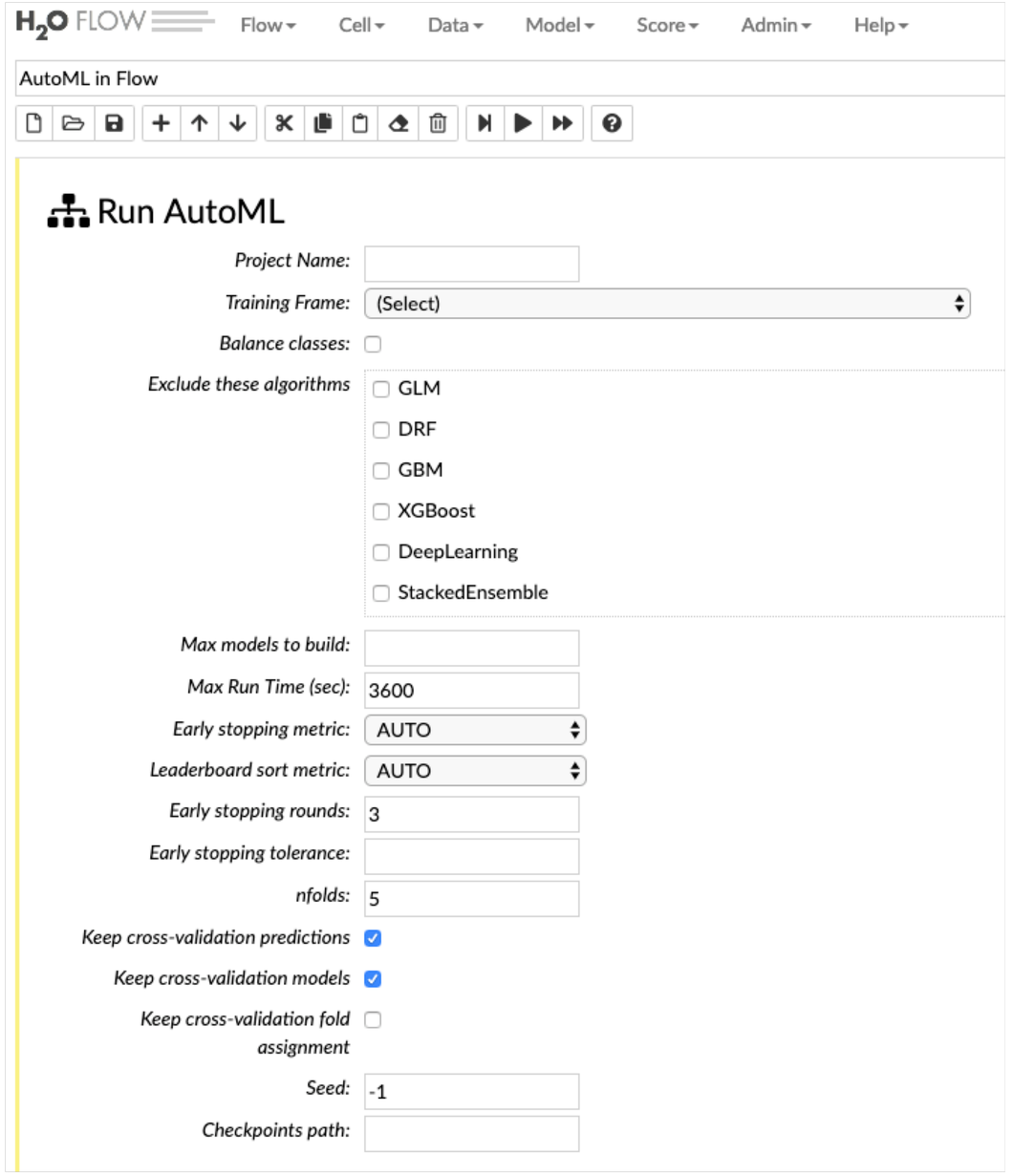
The Machine Learning Pipeline



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

Thanks!