Common Theme, Toolbox and Research workflow in Data Science

Apply different algorithms to solve different problems based on the same <Theme> and <Research Workflow>

Algorithms

- SVM
- KNN
- Naïve Bayes
- Neural Network
- Logistics Regression
- NLP

Problems

- Regression
- Classification
- Recommendation System
- Clustering
- Association

Common Theme in Machine Learning

Common Data Scientists Toolbox

Every professional requires mastery of their tools box

Every profession has a standard protocol

Common Toolbox

You need to know why, when and how to different tools properly

This requires understanding of the each of concepts behind the tools

Common Terminology

Underfit vs Overfit

Bias vs Variance

Train/Test Split

Removing Bias

Cross Validation

Normalized Data

Encoding Categorical Variables

Precision vs Accuracy

Precision vs Recall

In-sample vs Out-of-sample data

Data Normalization

Normalization or scaling refers to bringing all the columns into similar range.

Two common ways: Min-Max normalization and Z-score normalization

$$z = \frac{x - \min(x)}{\max(x) - \min(x)}$$

$$z = \frac{x - \mu}{\sigma}$$

μ = Mean

σ = Standard Deviation

One-Hot encoding or Using dummies variables

Method in bringing in categorical variables as additional features

A categorical variable that can have N possible values will turn into a (N-1) additional dummy variables (or N-1 features) where each one of the dummy variable can take only either 0 or 1 and for one of the possible values in the categorical variable. Reason for only N – 1 is because when all other dummy variables are 0, it implicitly mean it is for the last N value

Example: Sex has only two possible values: Male and Female. We can create 1 dummy variable, say, Male And if it is male, Male will be 1, otherwise it is 0. We do NOT need two dummy variable

Example: Education has “Primary”, “High-School”, “College”, “Master” and “PhD”. Then one can create 4 dummy variable, called edu1, edu2, edu3, edu4.

For Primary, the 4 dummy variables values will be (1, 0, 0, 0)
For College, the 4 dummy variables values will be (0, 0, 1, 0)
For PhD, the 4 dummy variables values will be (0, 0, 0, 1)

K-Fold Cross Validation

To make sure your model is not too sensitive to the training samples

Say K = 10

Split your dataset into 10 parts, label them as Part1, Part2, Part3, … , Part10

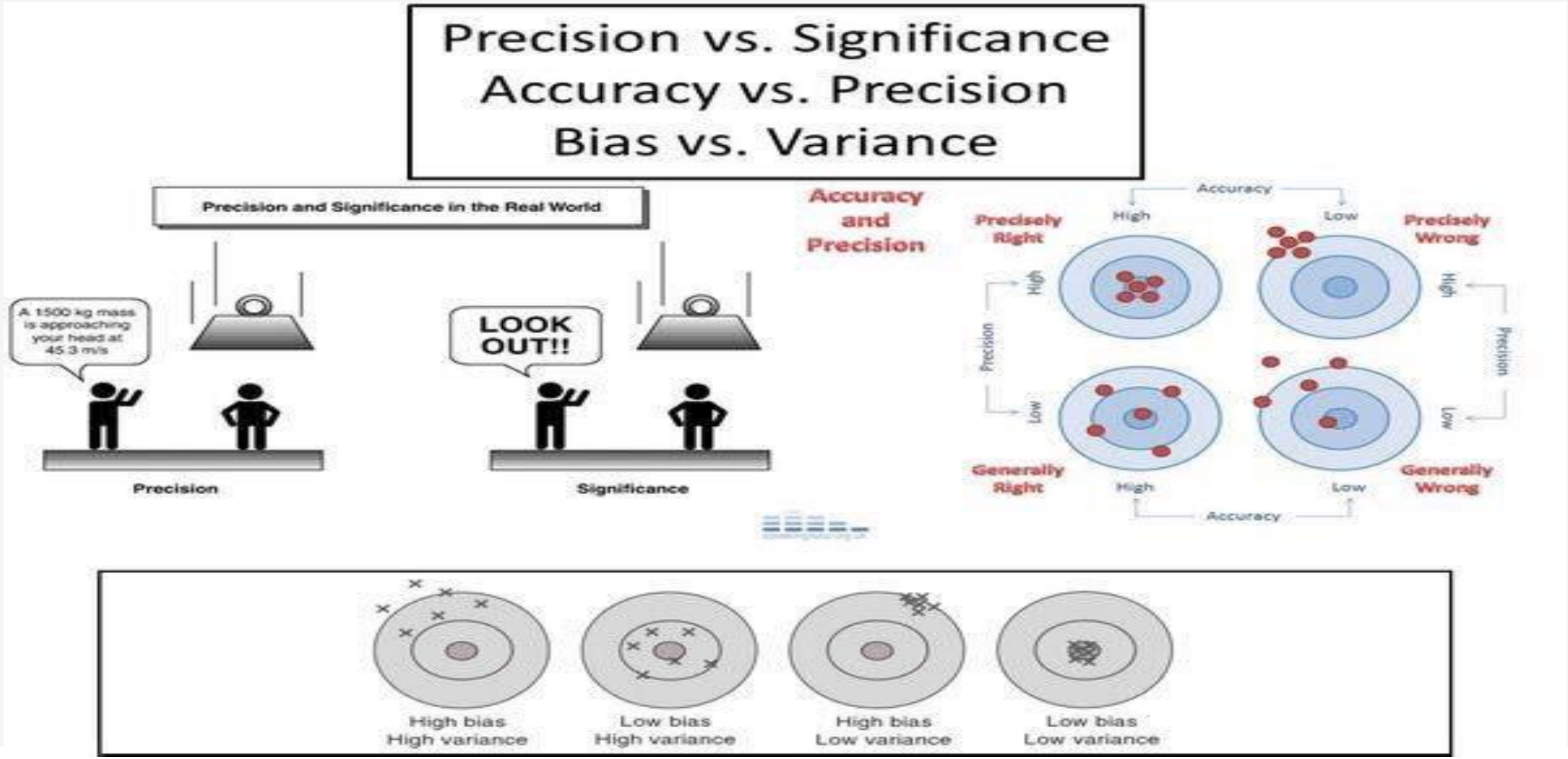
Run through the following algorithms:

For i from 1 to 10:
Use Part_i as your testing dataset, all the others Part1, … Part_(i-1), Part_(i+1), … Part_10
as the training set.

Build a different model, called, Model_i

Compare all the 10 models, Model_1, Model_2, …, Model_10 to make sure their performance are similar

Bias vs Variance trade-off



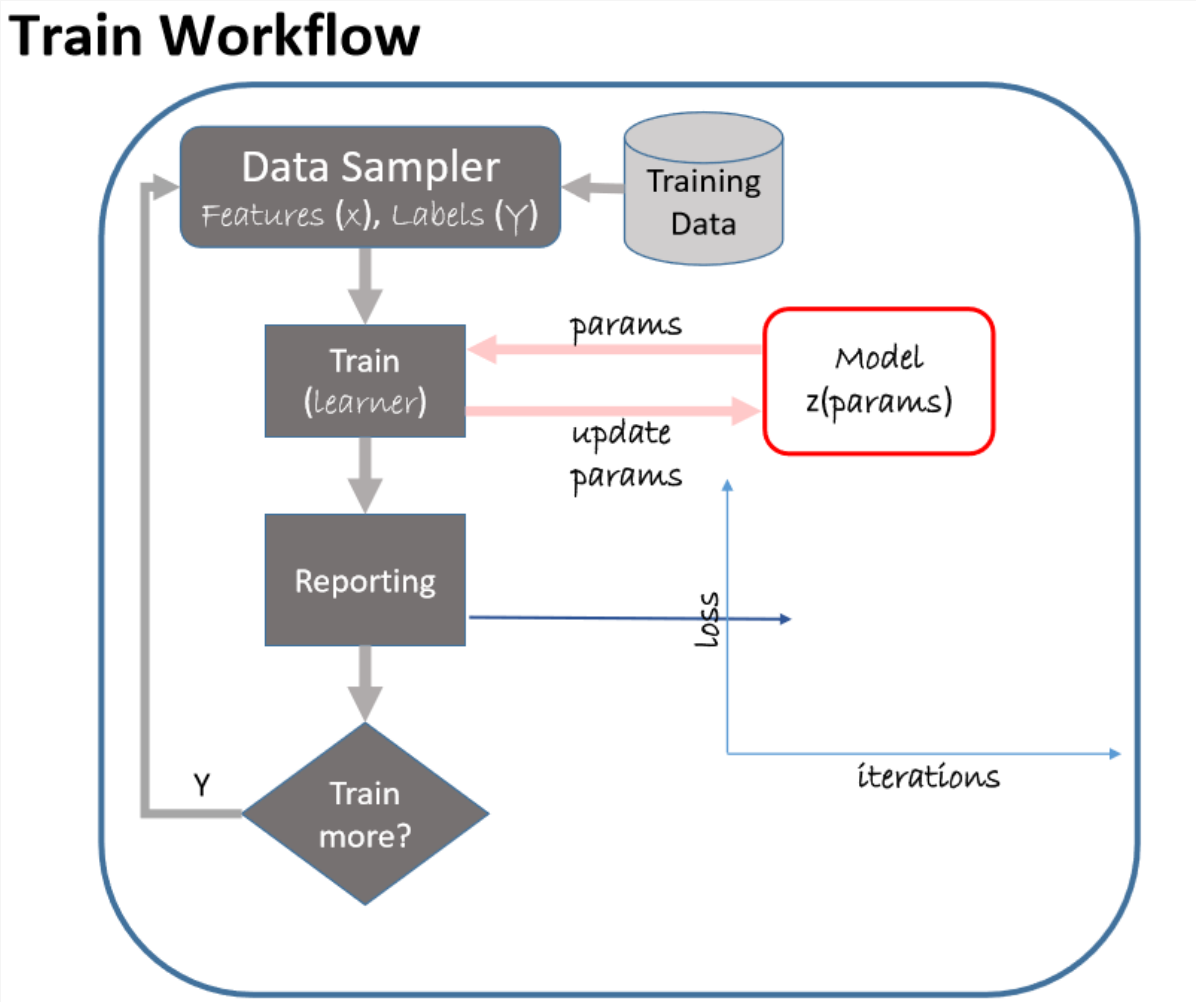
Regularization

- Dilemma: Too simple model will underfit (high bias, low variance) while more complicated model will overfit (low bias, high variance)
- Is there any tools to help finding the right balance?
  - Idea is penalize complicated model automatically (adjusted R-square instead of R-square)

Important Concepts

Every professions have a “Best Practice” workflow

Research Workflow (Train-Validate-Test Cycle)



Reference: Microsoft Professional Program in Artificial Intelligence

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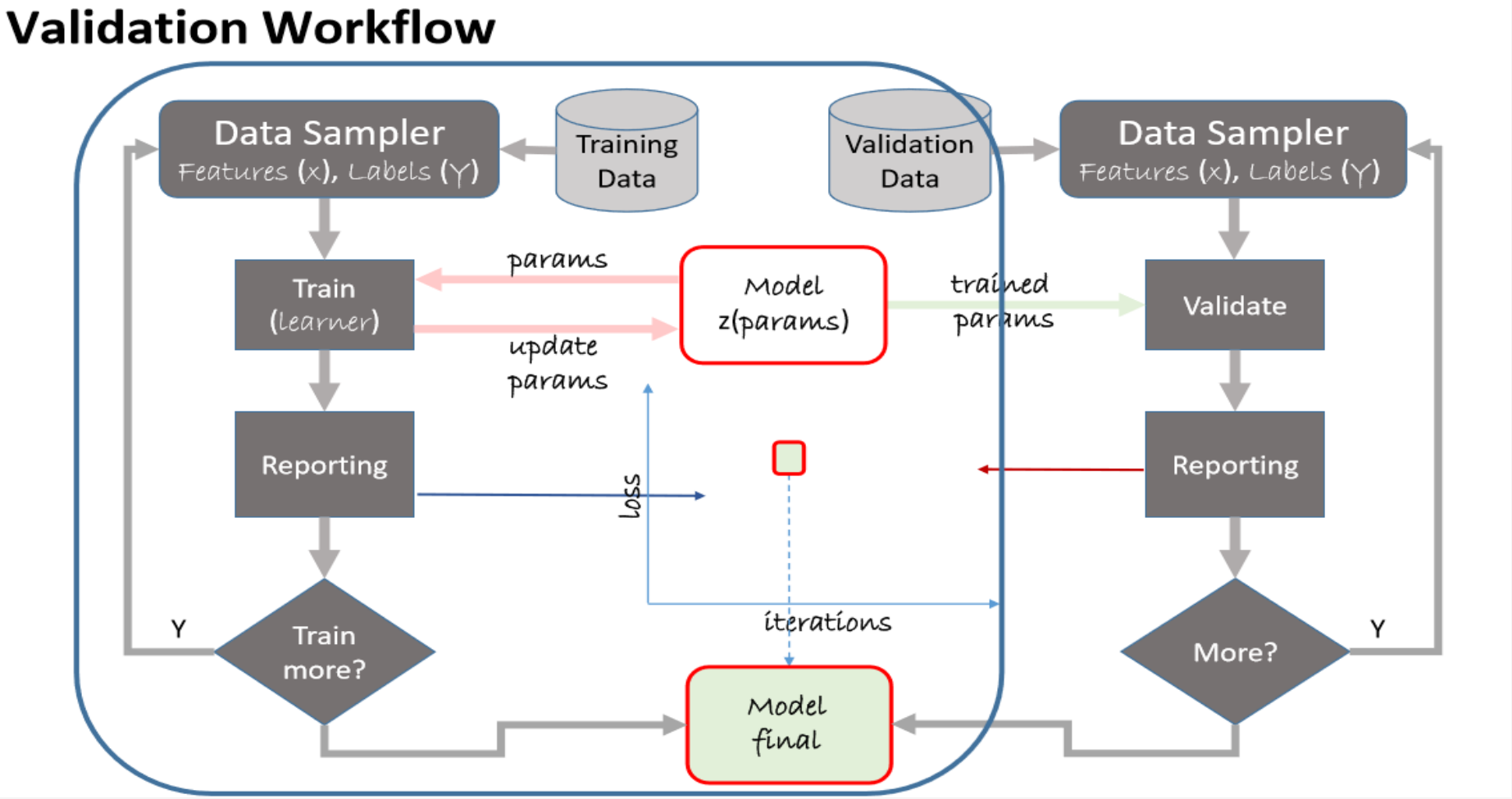

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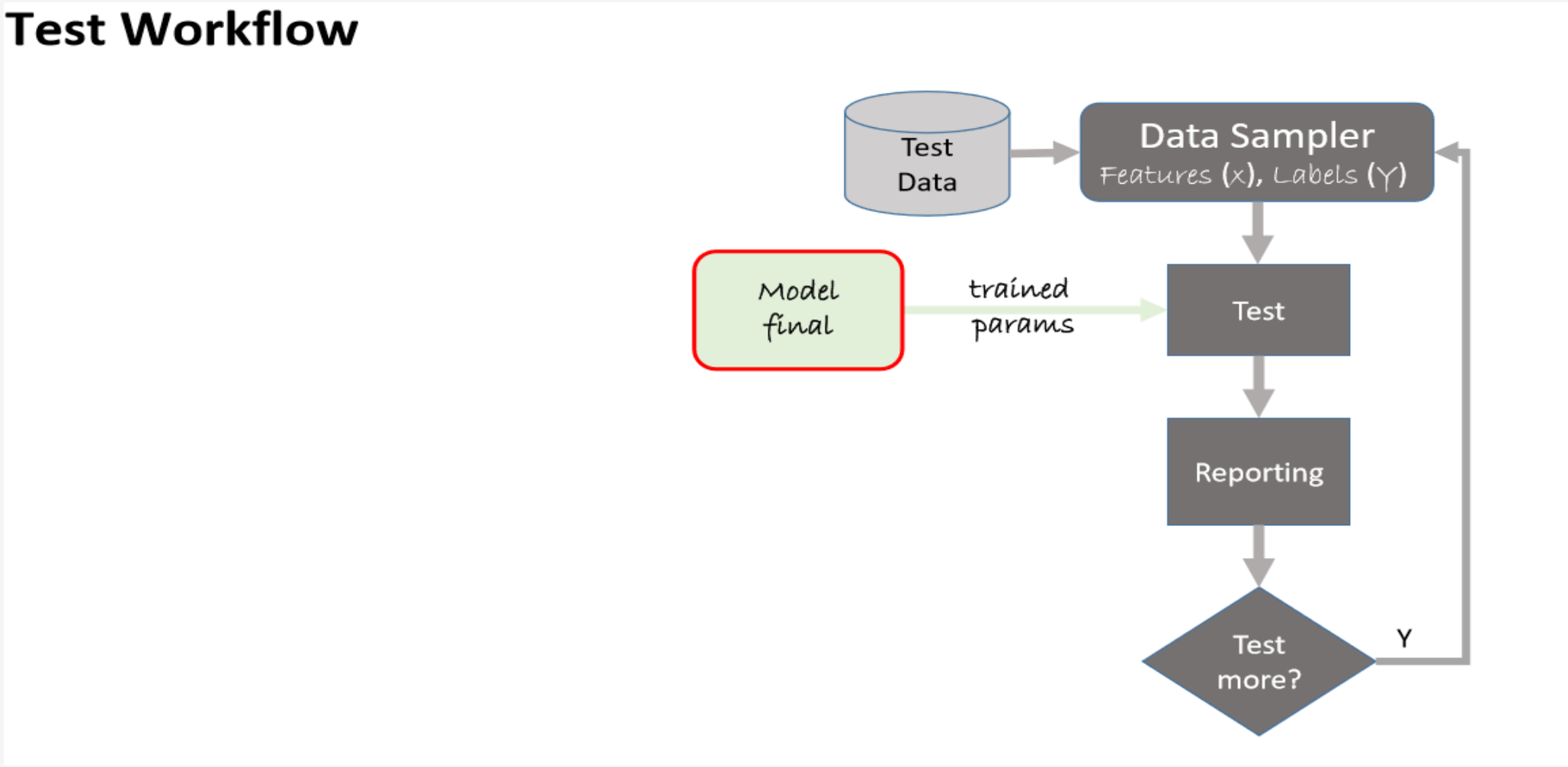

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