Chapter 1: The Machine Learning Landscape

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What is Machine Learning?

Machine Learning is the science (and art) of programming computers so they can learn from data.

Here is a slightly more general definition:

[Machine Learning is the] field of study that gives computers the ability to learn without being explicitly programmed. —Arthur Samuel, 1959

And a more engineering-oriented one:

A computer program is said to learn from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P, improves with experience E. —Tom Mitchell, 1997

Training Set: The examples that the system uses to learn are called the training set. Each training example is called a training instance (or sample).

Why Use Machine Learning?

To understand why to use Machine Learning, compare the traditional approach with the machine learning approach.

In the traditional approach, **we** write the rules to solve the problem, whereas in the machine learning approach, the ML algorithm **automatically** learns from data and creates rules to solve the problem.

Moreover a machine learning system can adapt to change. Whenever the data changes, the ML model can adapt to learn and adjust the rules to better solve the problem.

Machine Learning is great for:

- Problems for which existing solutions require a lot of hand-tuning or long lists of rules: one Machine Learning algorithm can often simplify code and perform better.

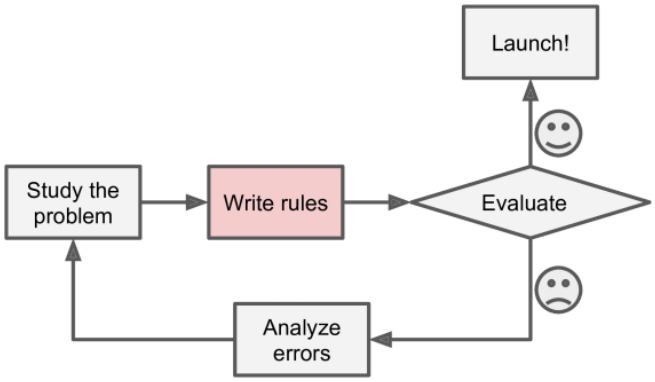

Figure 1: Traditional Approach

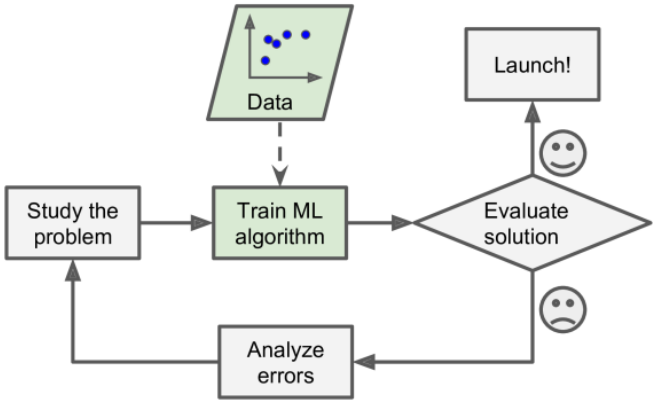

Figure 2: Machine Learning Approach

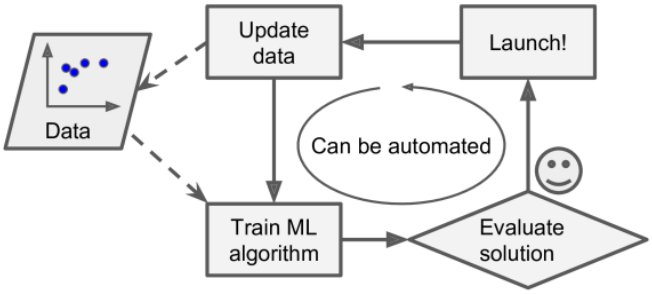

Figure 3: Automatically Adopting to Change

- Complex problems for which there is no good solution at all using a traditional approach: the best Machine Learning techniques can find a solution.
- Fluctuating environments: a Machine Learning system can adapt to new data.
- Getting insights about complex problems and large amounts of data.

Types of ML Systems

There are so many different types of Machine Learning systems that it is useful to classify them in broad categories based on:

- Whether or not they are trained with human supervision (supervised, unsupervised, semisupervised, and Reinforcement Learning)
- Whether or not they can learn incrementally on the fly (online versus batch learning)
- Whether they work by simply comparing new data points to known data points, or instead detect patterns in the training data and build a predictive model, much like scientists do (instance-based versus model-based learning)

Supervised/Unsupervised Learning

Machine Learning systems can be classified according to the amount and type of supervision they get during training. There are four major categories: supervised learning, unsupervised learning, semisupervised learning, and Reinforcement Learning.

Supervised Learning

In supervised learning, the training data you feed to the algorithm includes the desired solutions, called labels.

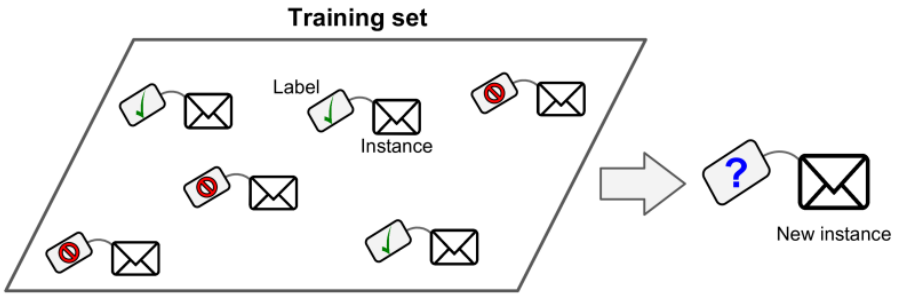

Figure 4: A labeled training set for supervised learning

Classification: Predicting a class value. In the case of spam filter, classify the email as spam or ham.

Regression: Predicting a numerical value, such as the price of a car, given a set of features.

Unsupervised Learning

In unsupervised learning, as you might guess, the training data is unlabeled. The system tries to learn without a teacher.

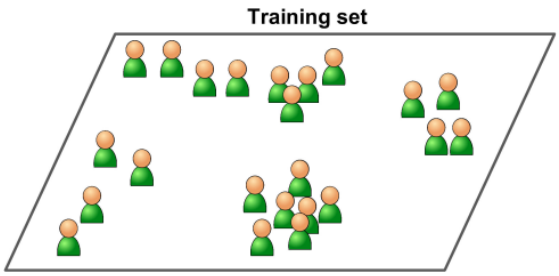

Figure 5: An unlabeled training set for unsupervised learning