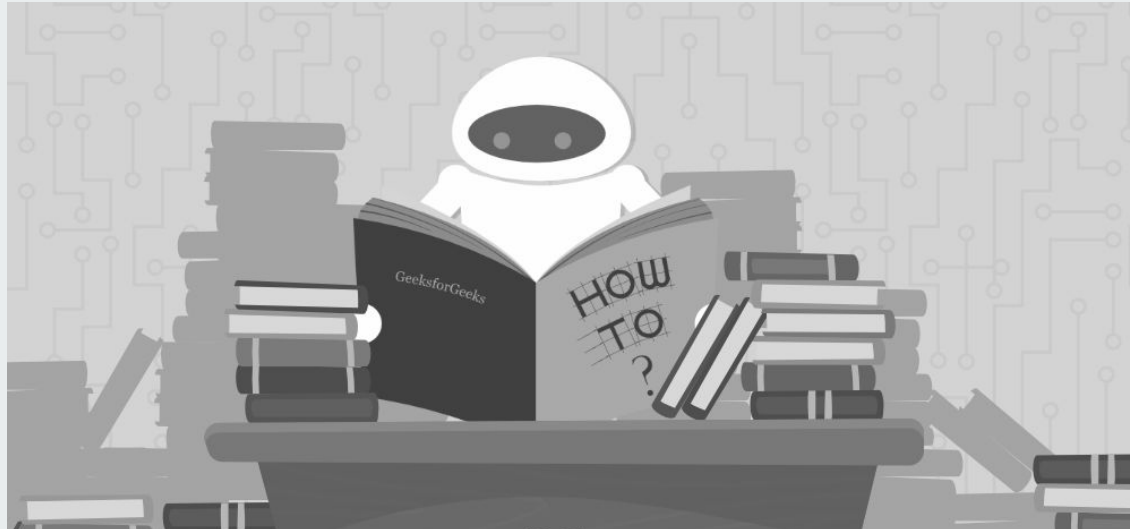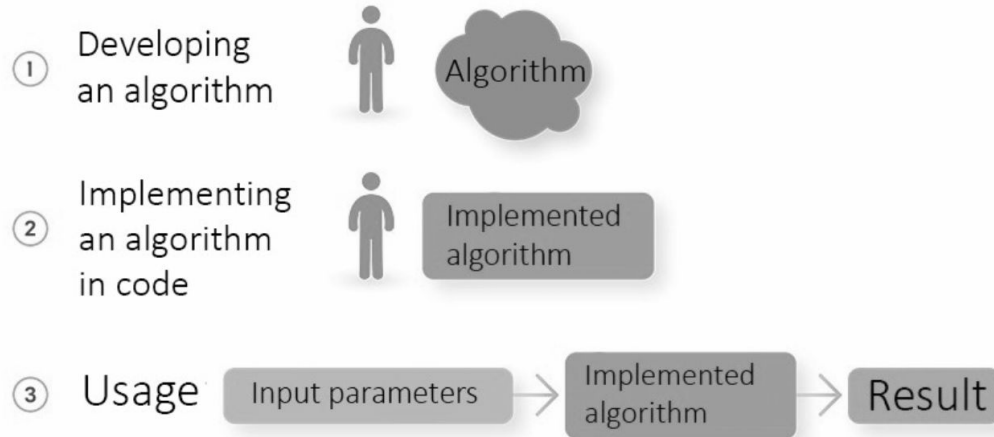# Machine Learning Foundation

What is Machine Learning?

- Machine Learning is a field of study that gives computers the ability to learn without being explicitly programmed.
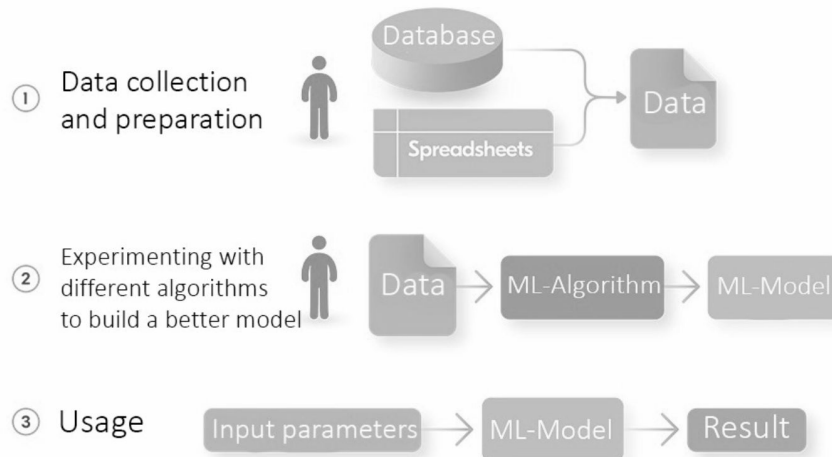
How is it different from traditional programming?

How a software developer creates a

How is it different from traditional programming?

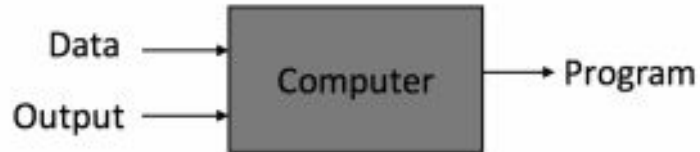**How a ML Engineer develops a model**

① Data collection and preparation

Database

Spreadsheets

Data

② Experimenting with different algorithms to build a better model

Data → ML-Algorithm → ML-Model

③ Usage

Input parameters → ML-Model → Result

How is it different from traditional programming?

Traditional Programming

Data ⟶ Computer ⟶ Output
Program ⟶

Machine Learning

Data ⟶ Computer ⟶ Program
Output ⟶

What are different types of ML Algorithms?

Machine learning

Supervised

Unsupervised

Reinforcement

Task Driven
Regression / Classification

Data Driven
Clustering / Association

Learn to react to an
environment
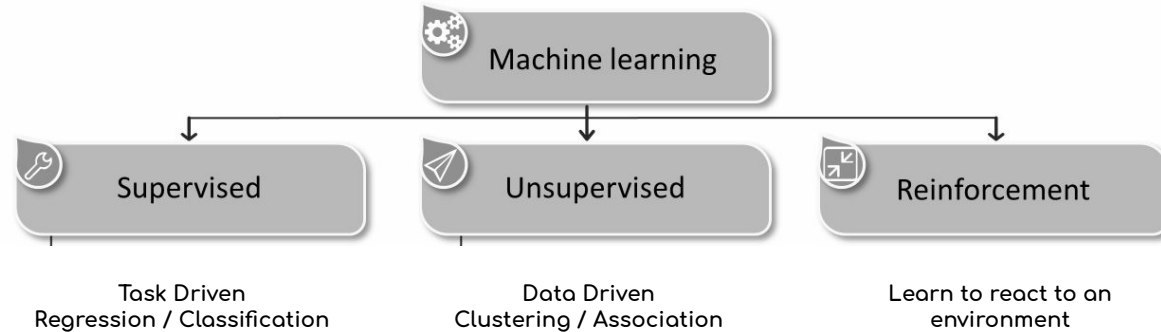
What are different types of ML?

Supervised Learning

Labeled Data → ML Algorithm → Model → Labels

Unlabeled Data → Model

Categorical Data
Classification Task
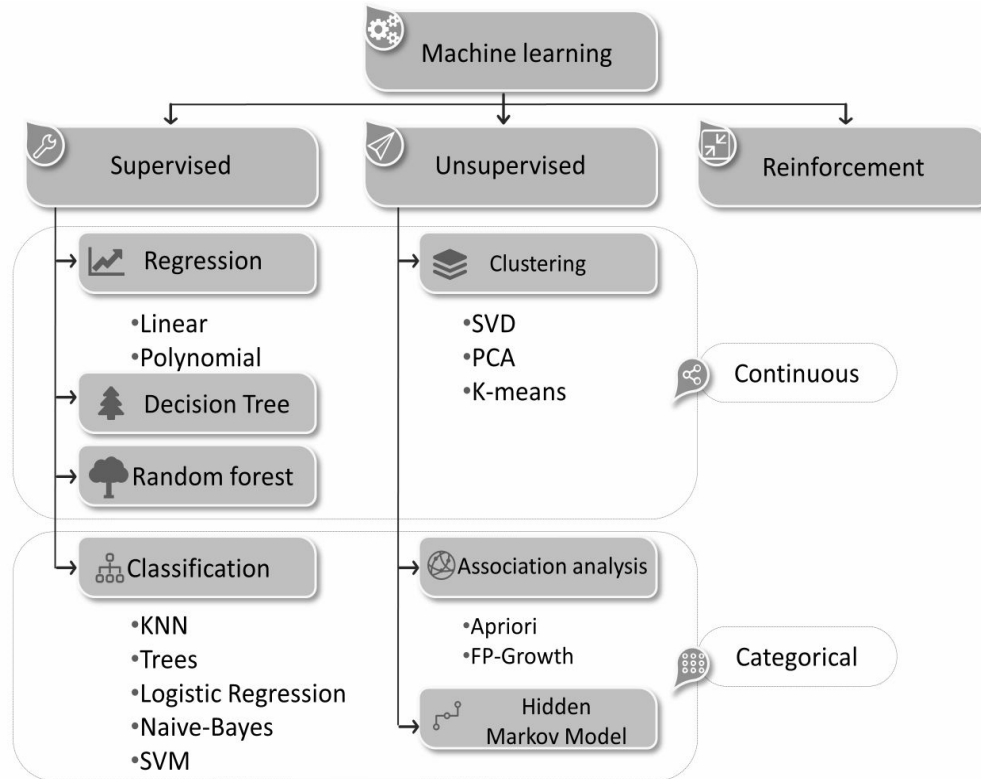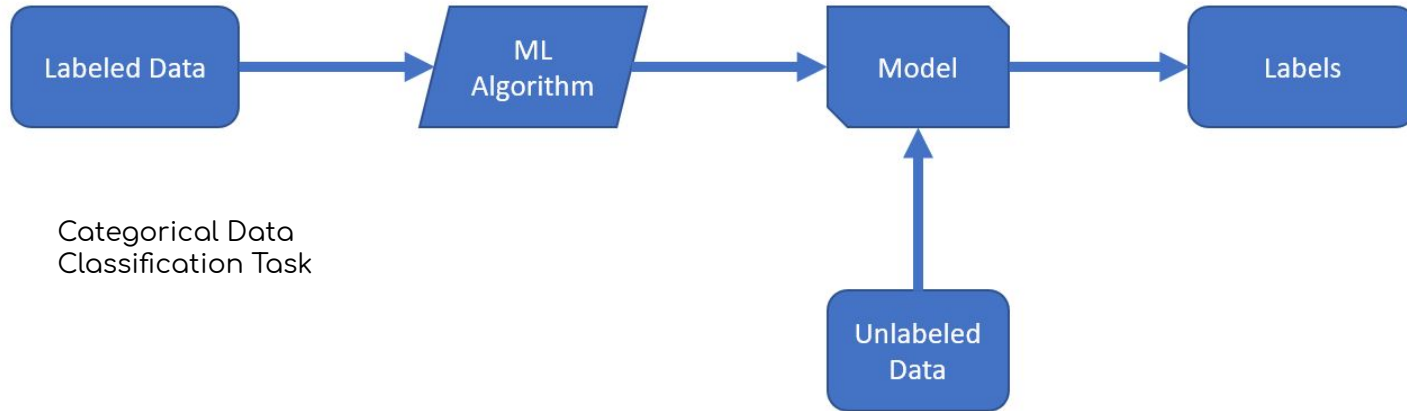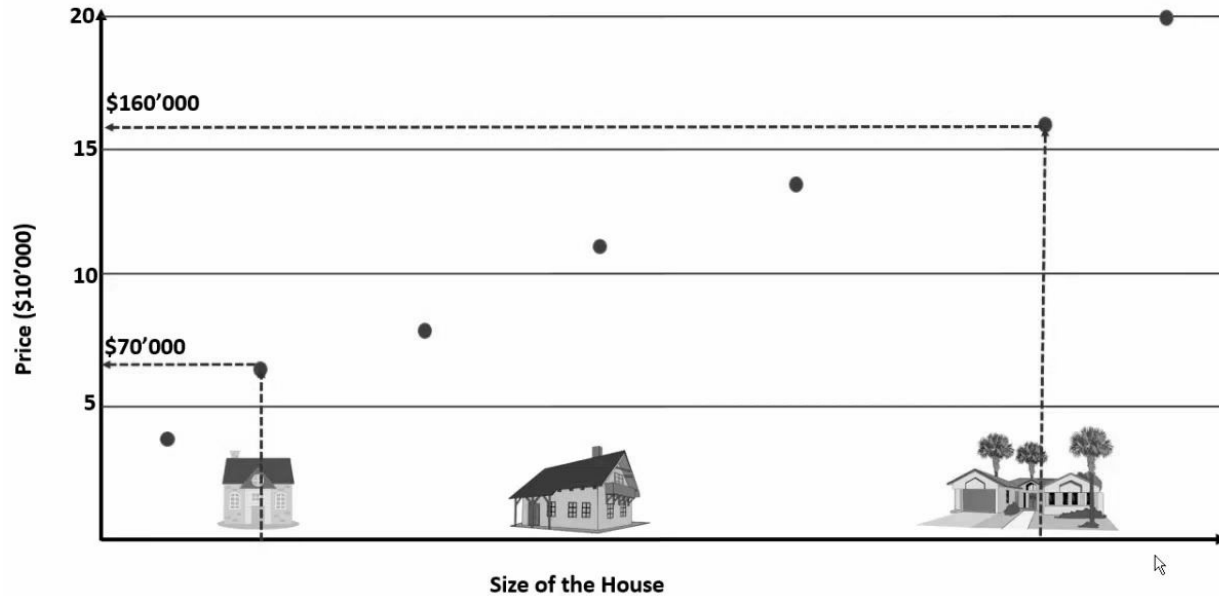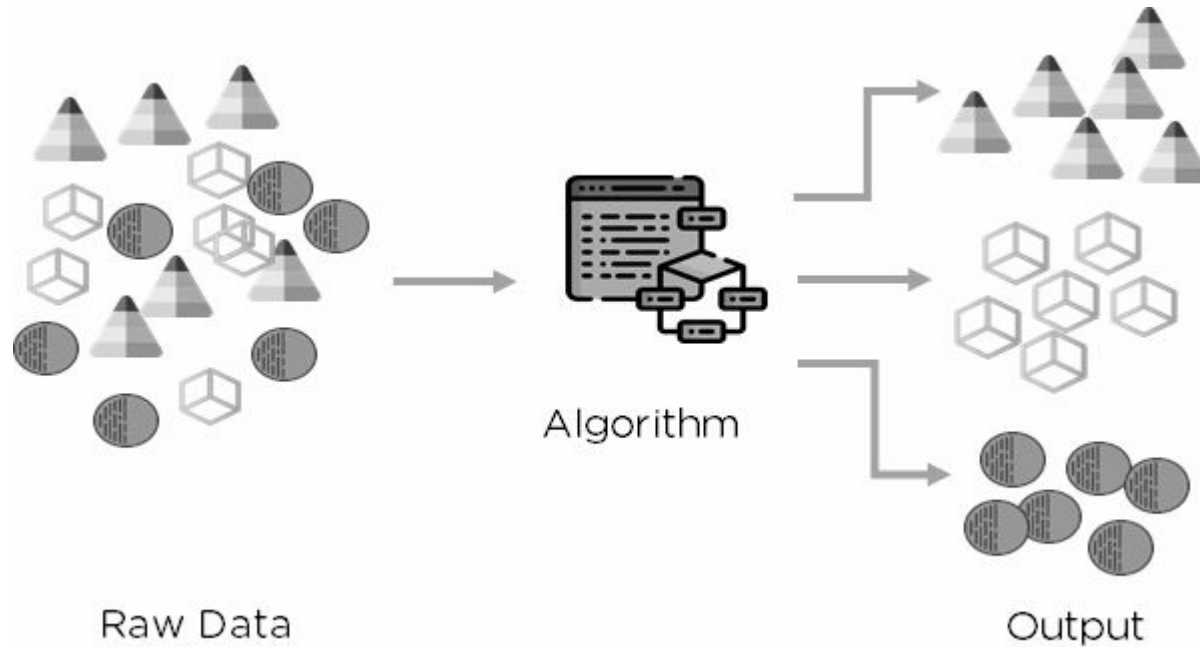
Supervised Learning - Classification
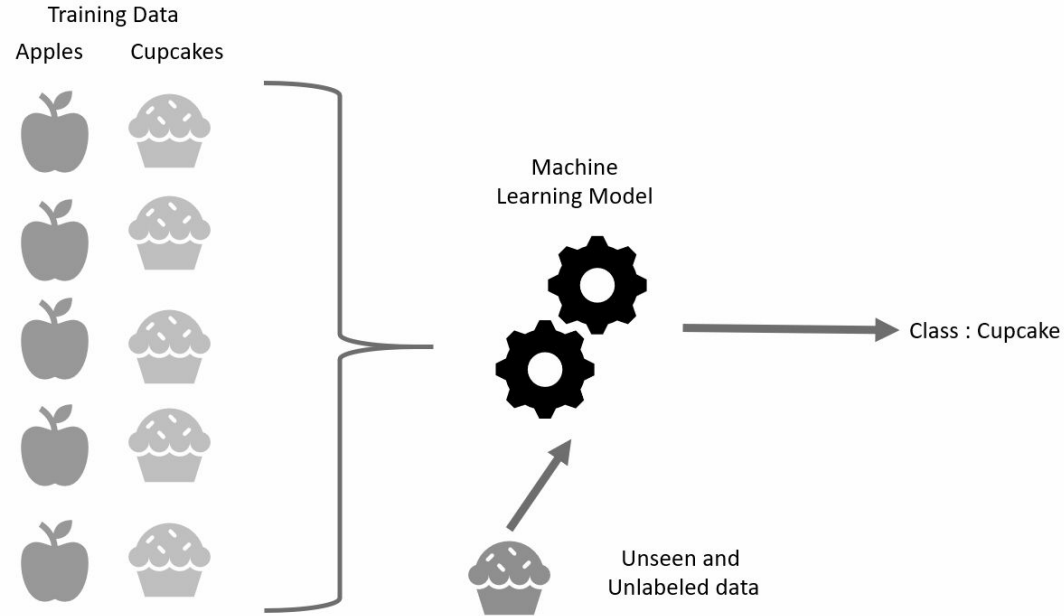
Supervised Learning - Regression

Unsupervised Learning - Clustering

Raw Data → Algorithm → Output
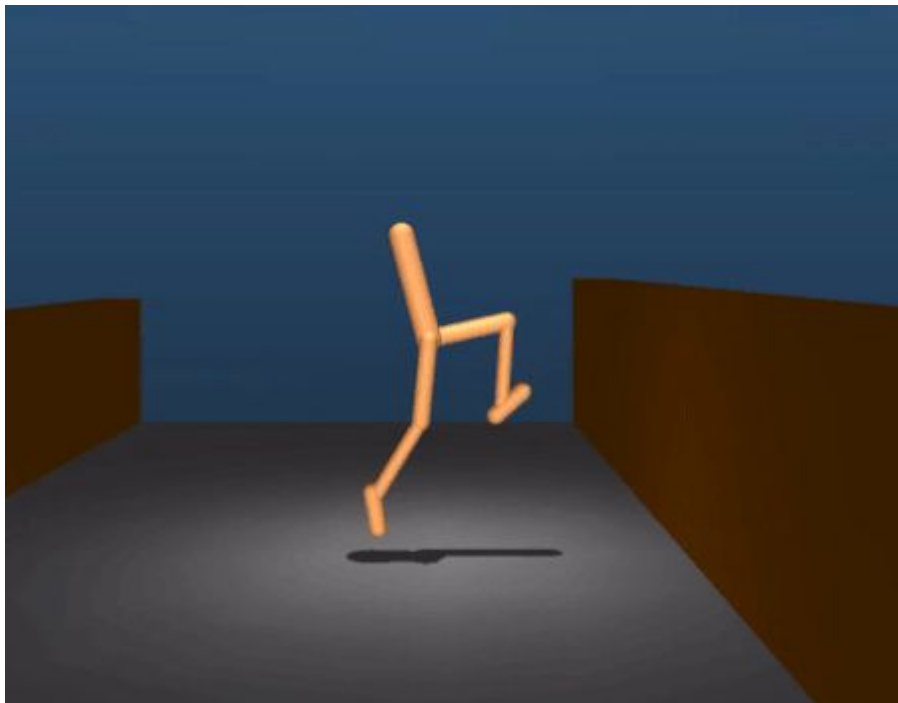
Reinforcement Learning
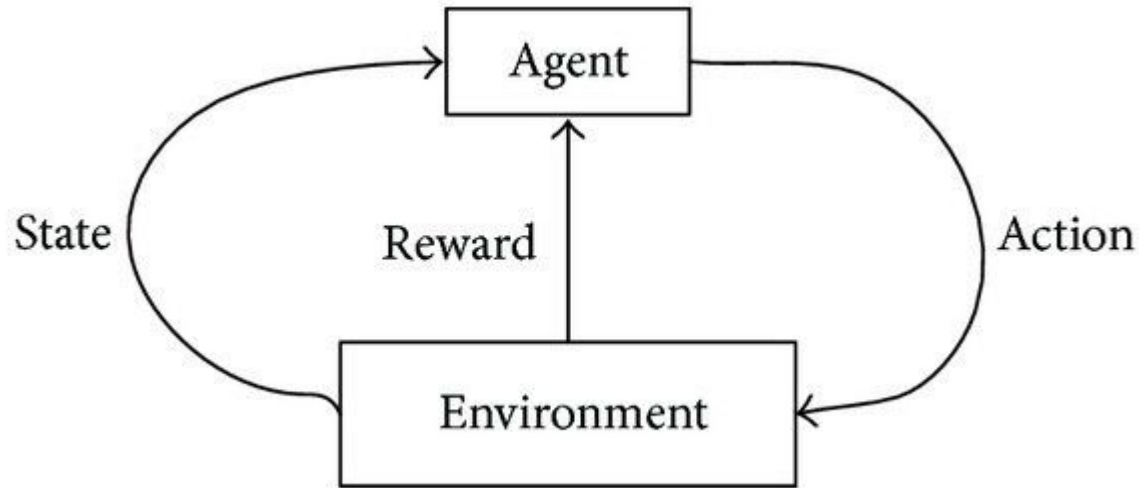
Reinforcement Learning

Use cases of Supervised Learning

- Spam Classification
- Face Detection
- University Admission Prediction
- House Price Prediction

Use cases of Unsupervised Learning

- Customer Segmentation
- Market Basket Analysis
- Recommender Systems
- Anomaly Detection

Typical Machine Learning Flow

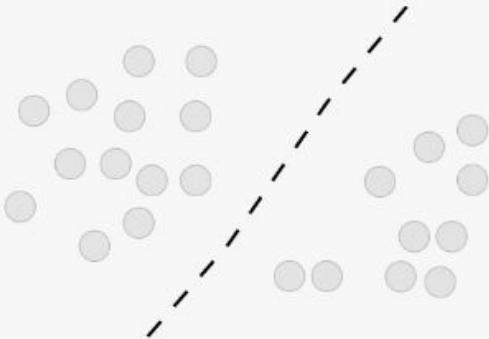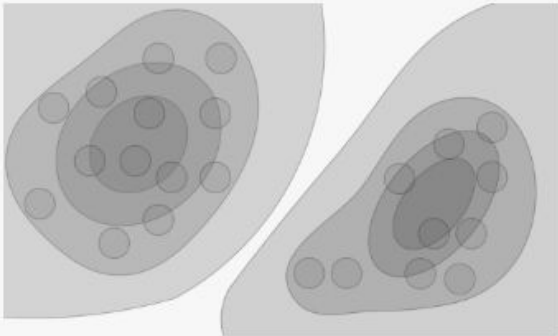# Supervised Learning - Classification Terminology

- **Classifier:** An algorithm that maps the input data to a specific category.
- **Classification model:** A classification model tries to draw some conclusion from the input values given for training. It will predict the class labels/categories for the new data.
- **Feature:** A feature is an individual measurable property of a phenomenon being observed.
- **Binary Classification:** Classification task with two possible outcomes. Eg: Gender classification (Male / Female)
- **Multi class classification:** Classification with more than two classes. In multi class classification each sample is assigned to one and only one target label. Eg: An animal can be cat or dog but not both at the same time.

Supervised Learning - Classification Terminology

- **Multi label classification**: Classification task where each sample is mapped to a set of target labels (more than one class). Eg: A news article can be about sports, a person, and location at the same time.
- The following are the steps involved in building a classification model:
  - Initialize the classifier to be used.
  - Train the classifier: All classifiers in scikit-learn uses a fit(X, y) method to fit the model(training) for the given train data X and train label y.
- **Predict the target:** Given an unlabeled observation X, the predict(X) returns the predicted label y.
- **Evaluate** the classifier model

Generative vs Discriminative Models

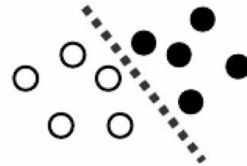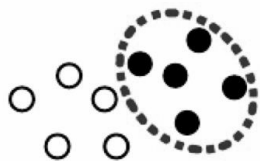|	Discriminative model	Generative model
Goal	Directly estimate $P(y|x)$	Estimate $P(x|y)$ to then deduce $P(y|x)$
What's learned	Decision boundary	Probability distributions of the data
Illustration		
Examples	Regressions, SVMs	GDA, Naive Bayes

Generative vs Discriminative Models

- Generative classifiers
    - Assume some functional form for P(Y), P(X|Y)
    - Estimate parameters of P(X|Y), P(Y) directly from training data
    - Use Bayes rule to calculate P(Y |X)
- Discriminative Classifiers
    - Assume some functional form for P(Y|X)
    - Estimate parameters of P(Y|X) directly from training data.

Generative vs Discriminative Models

- Generative:
  - probabilistic "model" of each class
  - decision boundary:
    - where one model becomes more likely
  - natural use of unlabeled data
- Discriminative:
  - focus on the decision boundary
  - more powerful with lots of examples
  - not designed to use unlabeled data
  - only supervised tasks

Generative and Discriminative Classifiers - Examples

- Generative classifiers
    - Naïve Bayes
    - Bayesian networks
    - Markov random fields
    - Hidden Markov Models (HMM)
- Discriminative Classifiers
    - Logistic regression
    - Support Vector Machine
    - Traditional neural networks
    - Nearest neighbour
    - Conditional Random Fields (CRF)s