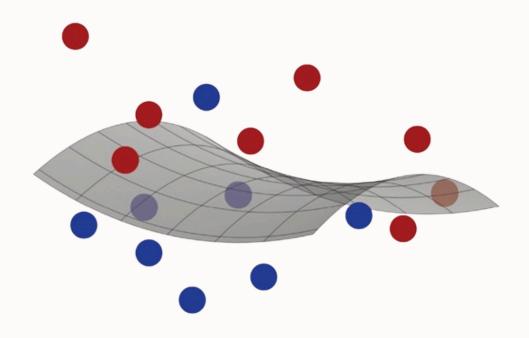
Foundations of Machine Learning

DAY - 4 Learning Stages



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In spam detection, machine learning teaches a model to classify emails as spam or not through several learning stages. There are as follows:

• • Examples

- These are the actual data items we feed into the model. In this case, each example is an email.
- We use examples for both training the model and testing how well it works.

• ***** Features

- Features are like characteristics or signals extracted from each example.
- For emails, features could include:
- Length of the message
- Sender's name
- Whether the email has certain keywords like "Free", "Win", "Money", etc.
- Structure of the header
- Each email is turned into a list or vector of such features that describe it.

• **Labels**

- Each example has a label a category that tells us what the email actually is.
- For our spam problem:
 - Label is either spam or not spam (binary classification)
- In regression tasks, the label is a real number instead of a category.

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• **!** Hyperparameters

- These are settings we give to the learning algorithm before training.
- They are not learned from the data, we have to choose them ourselves.
- Examples: learning rate, number of layers in a neural network, etc.

Training Sample

- This is the dataset we use to teach the model.
- It includes both the features and their correct labels.
- For spam detection: a set of emails + their correct spam/not-spam tags.

• 🔍 Validation Sample

- Used for tuning we adjust hyperparameters using this data.
- It helps us figure out which version of the model works best before testing it.
- We don't touch the test data yet.

• 📊 Test Sample

- We use this after the model is trained and tuned.
- We feed in new emails (not seen before), and the model tries to label them.
- Then we compare the model's predictions with the real labels to see how accurate it is.

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N Loss Function

- This function measures how wrong the model's prediction is compared to the actual label.
- Let's say:
 - The real label of an email is "spam"
 - The model predicted "not spam"
- Then the loss function will give a high value, saying "That was a bad mistake."
- If it predicted correctly, the loss is low (like 0).
- Some types of loss functions:
 - Zero-One Loss: 0 if prediction is correct and 1 if wrong
 (This is basic but not smooth, so not used in training much.)
 - Squared Loss (for regression): penalizes the square of the difference between predicted and real value
 - Cross-Entropy Loss (used in classification): punishes confident wrong predictions more harshly than uncertain ones
- Basically, the goal of training is to minimize this loss to make the model's predictions as close to reality as possible.
- Hypothesis Set
 - This is the collection of all possible functions (models) the algorithm can choose from during training.
 - For example, in spam detection, the hypothesis set might include:
 - Linear classifiers
 - Decision trees
 - Neural nets
 - Each one represents a different way to separate spam from not-spam based on features.
 - The learning algorithm's job is to pick the best hypothesis (model) from this set — the one that performs best on the training data and generalizes well.

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- Process Summary
 - During training, the learning algorithm takes:
 - A hypothesis set
 - A loss function
 - The training data
 - and uses them to find the model (function) that performs best.
 - We tune it using the validation set and evaluate it on the test set to measure real-world performance.

