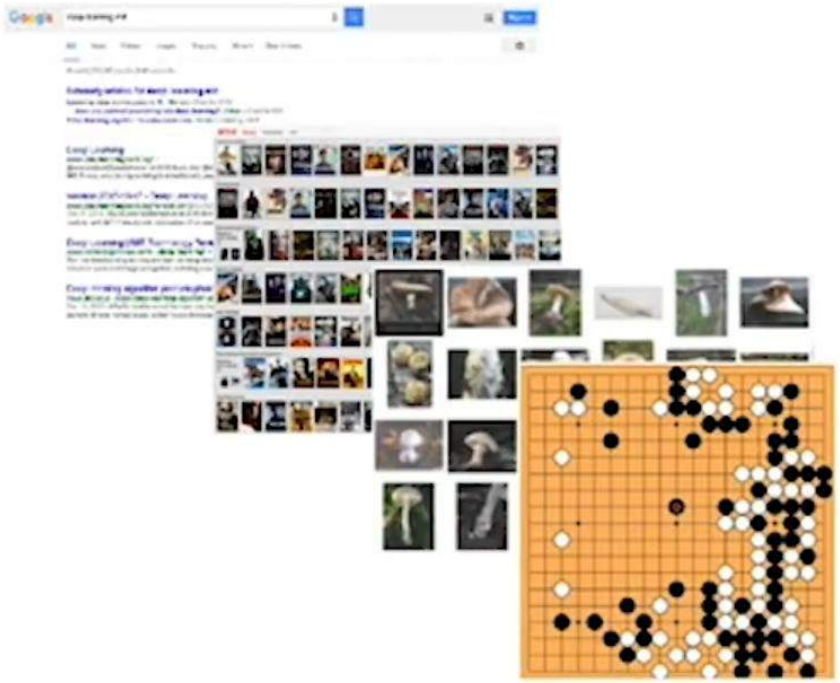
Machine Learning
Lecture 1

Machine learning is everywhere

- Search, content recommendation, image/scene analysis, machine translation, dialogue systems, automated assistants, game playing, sciences (biology, chemistry, etc), …



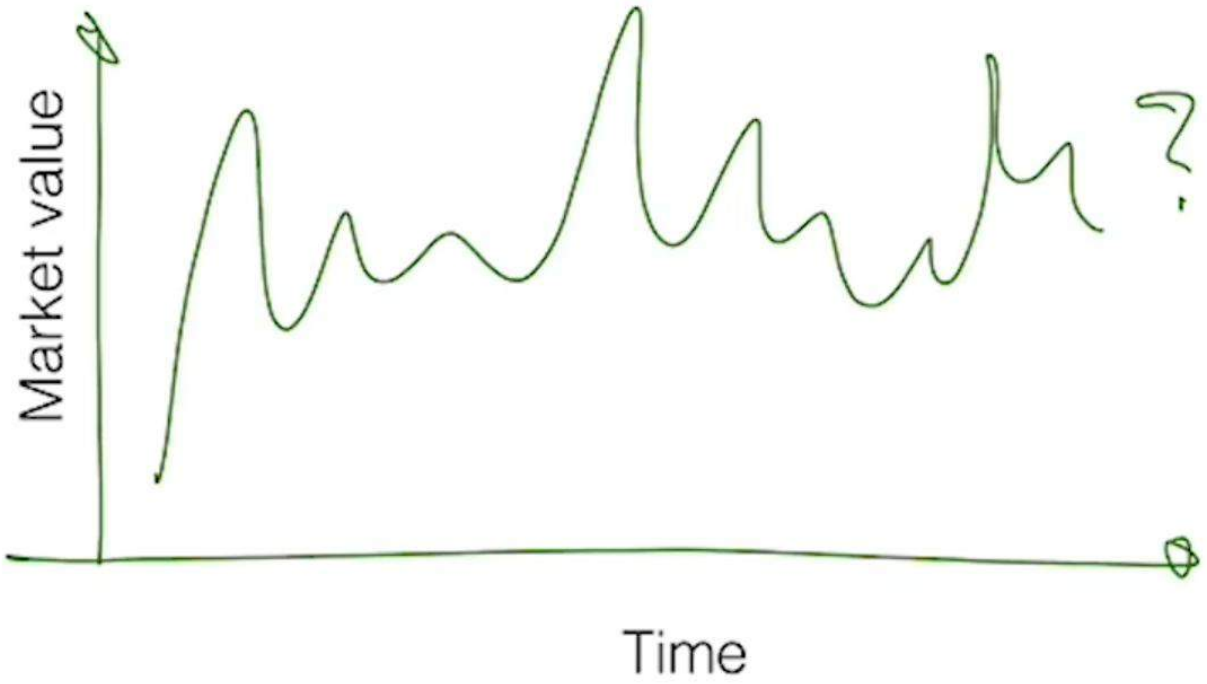
Machine learning: what is it?

- A brief definition

Machine learning as a discipline aims to design, understand and apply computer programs that learn from experience (i.e., data) for the purpose of modeling, prediction, or control

Prediction problems

- About future events

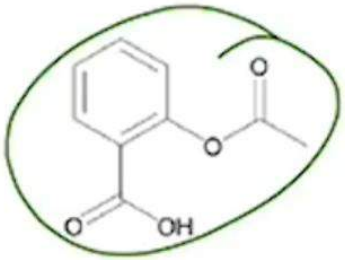


- Also collision avoidance, monitoring, medical risk, etc.

Prediction problems

- About properties we don't yet know

would I like this movie?



soluble in water?

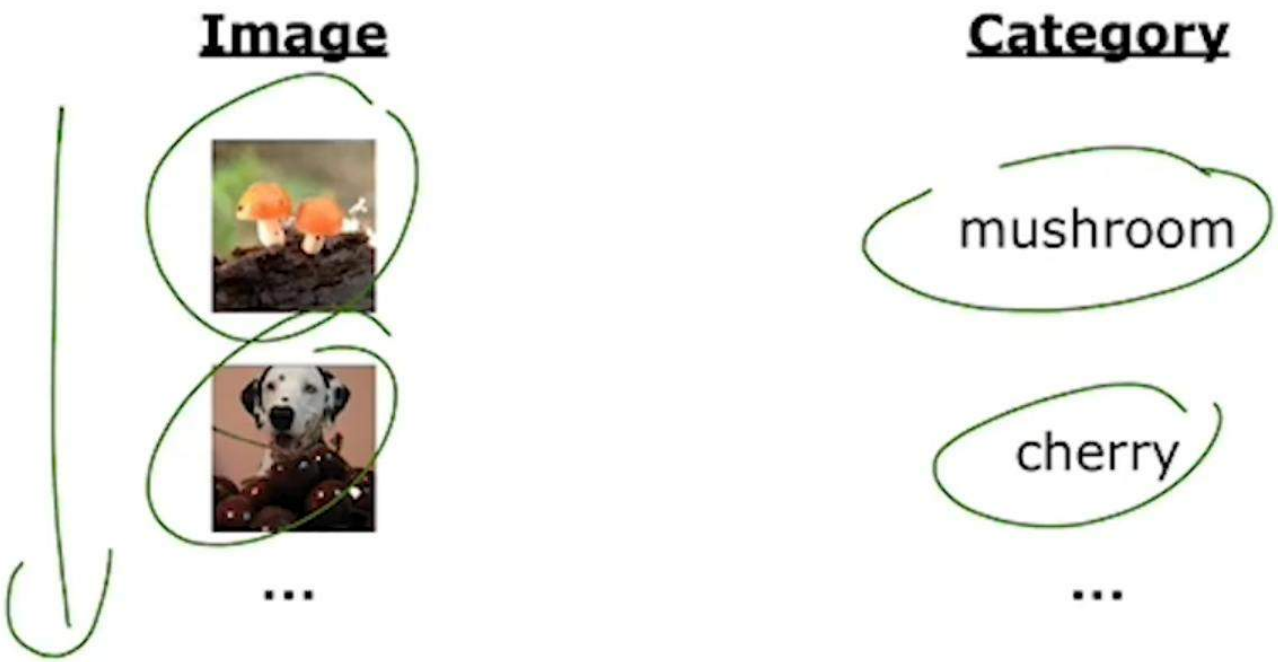
what is the image about?

"ML is very cool"

what is it in Spanish?

Example: supervised learning

- It is easier to express tasks in terms of examples of what you want (rather than how to solve them)
- E.g., image classification (1K categories)



Example: supervised learning

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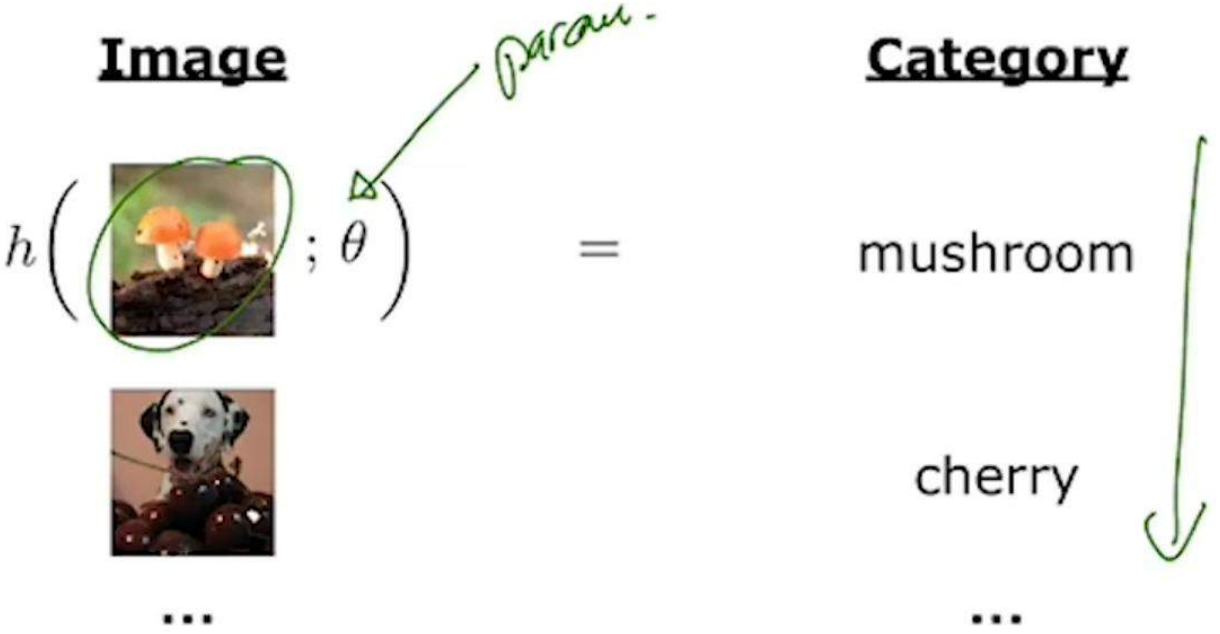
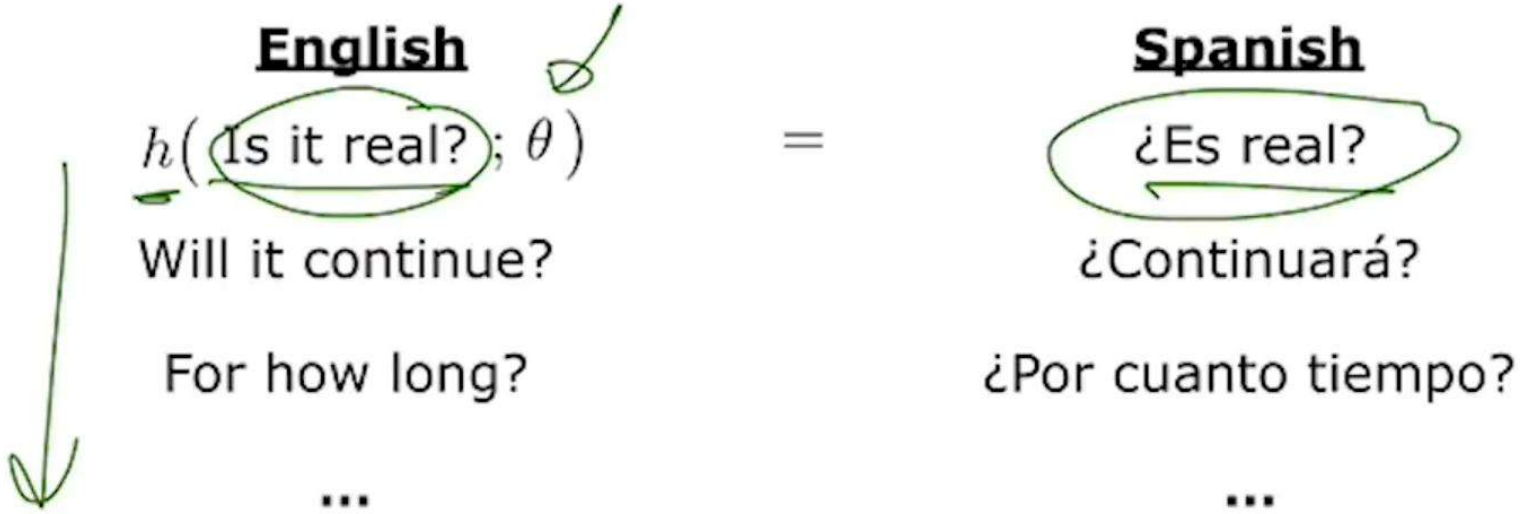
- E.g., image classification (1K categories)



- Rather than specify the solution directly (hard), we automate the process of finding one based on examples

Example: supervised learning

- It is easier to express tasks in terms of examples of what you want (rather than how to solve them)
- No limit to what you can learn to predict…



- Already in production for some language pairs (Google)

A concrete example

- Learning to predict preferences from just a little data…



A concrete example

- Learning to predict preferences from just a little data…

A concrete example

- Learning to predict preferences from just a little data…

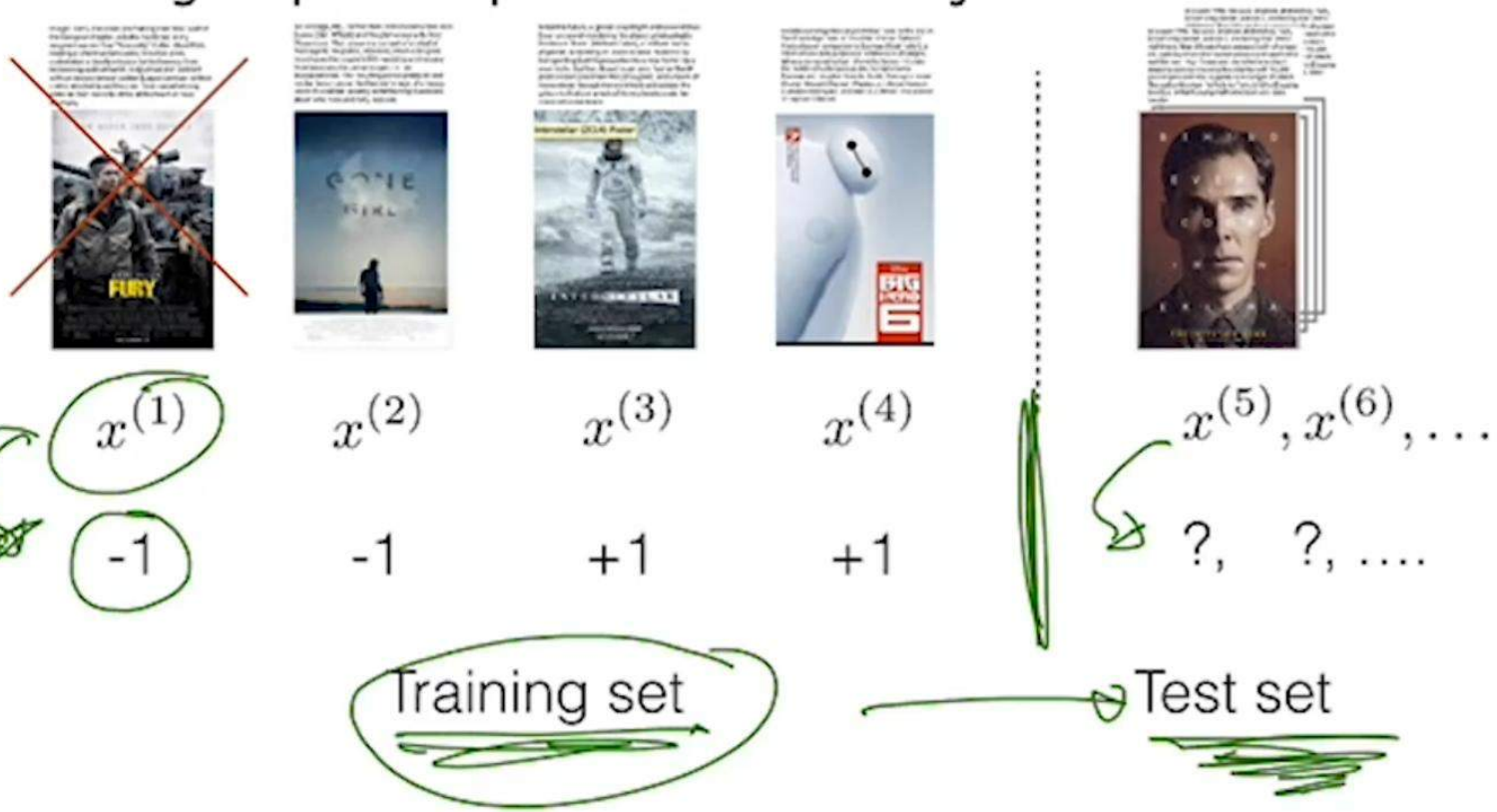
comedy? top lead?

$$x^{(1)} = [1\ 0\ 0\ 1\ 1\ \ldots\ 0]^T \quad \text{(feature vector)}$$

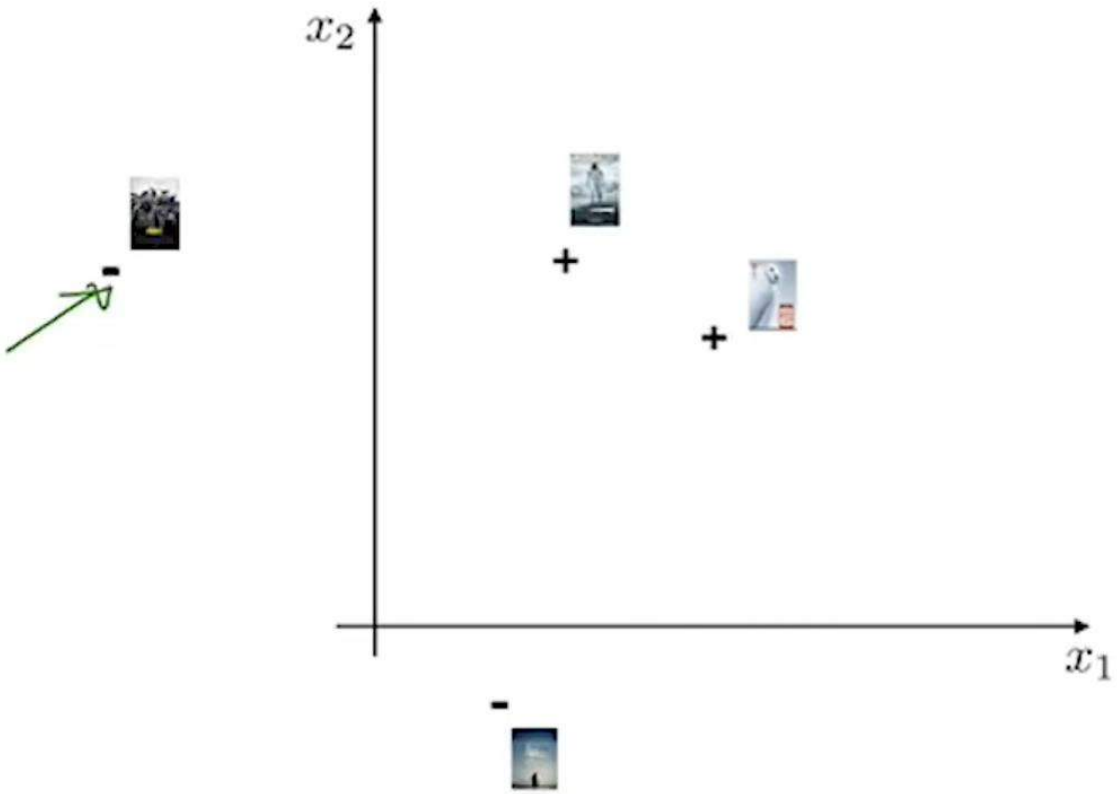
action? romance? Spielberg?

Supervised learning

- Learning to predict preferences from just a little data…



Supervised learning

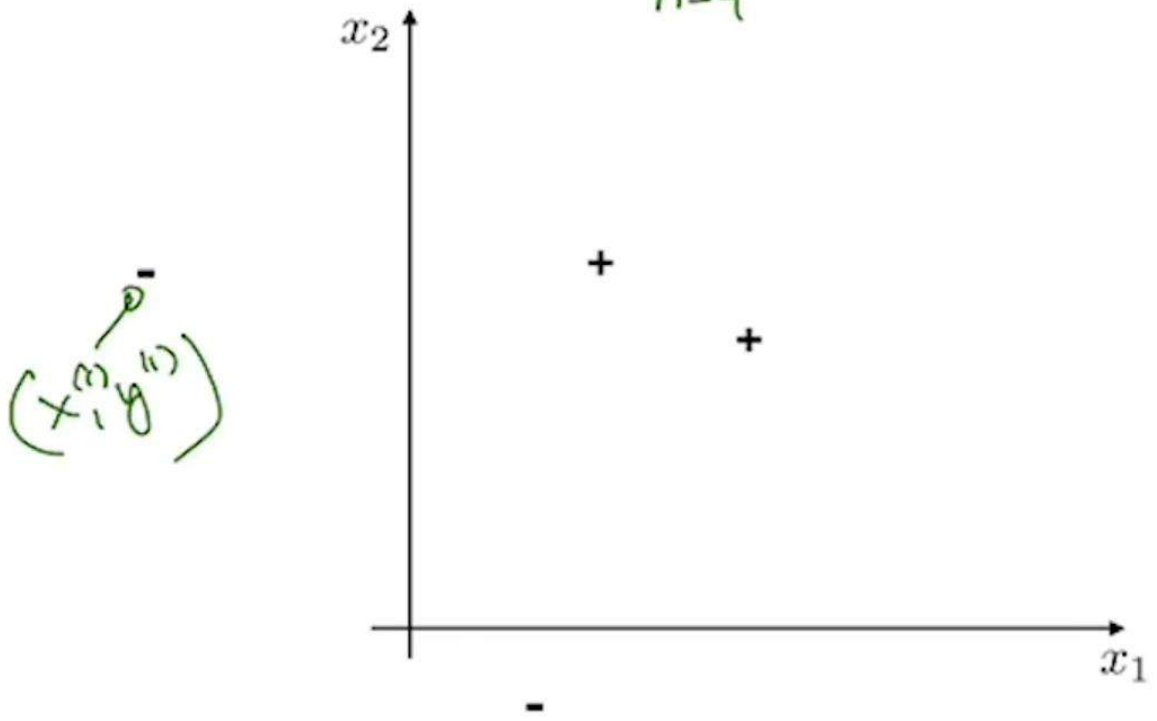


Supervised learning: training set

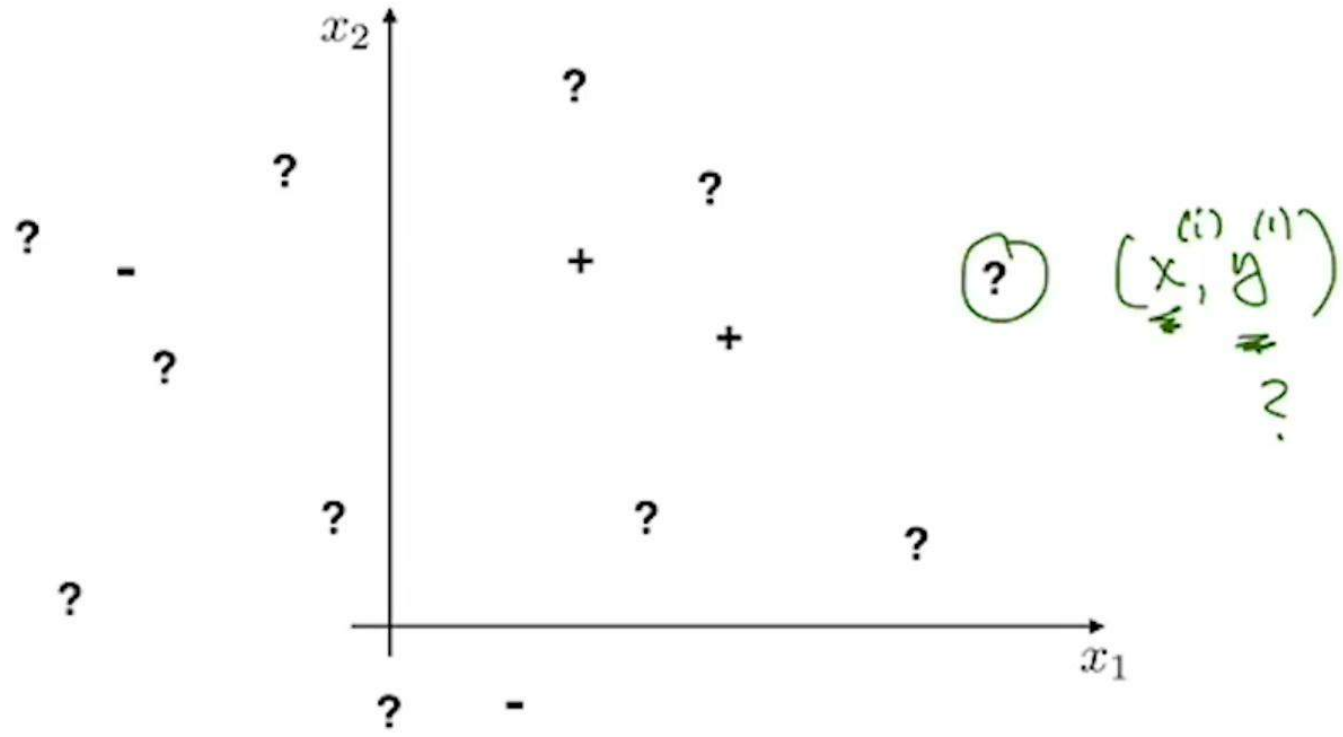
$S_n = \{ (x^{(i)}, y^{(i)}), i = 1, \ldots, n \}$

$x^{(i)} \in \mathbb{R}^2$ $y^{(i)} \in \{-1, 1\}$

$n = 4$



Supervised learning: test set



Supervised learning: training set

$$\mathcal{S}_n = \{ (x^{(i)}, y^{(i)}), i = 1, \dots, n \}$$

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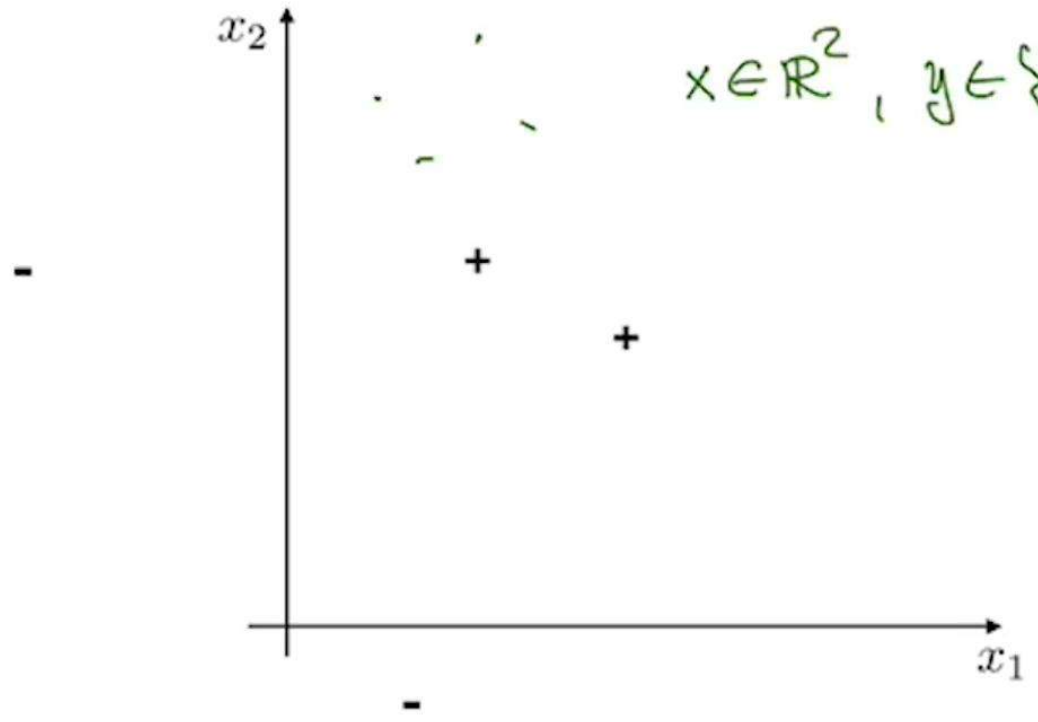
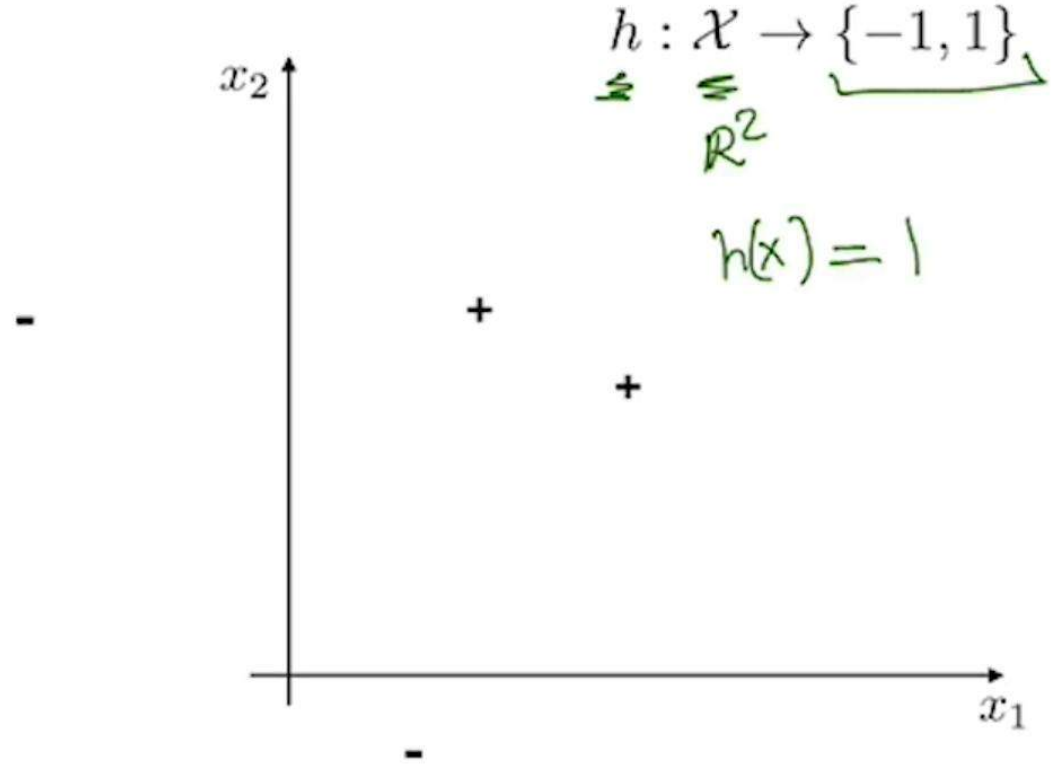
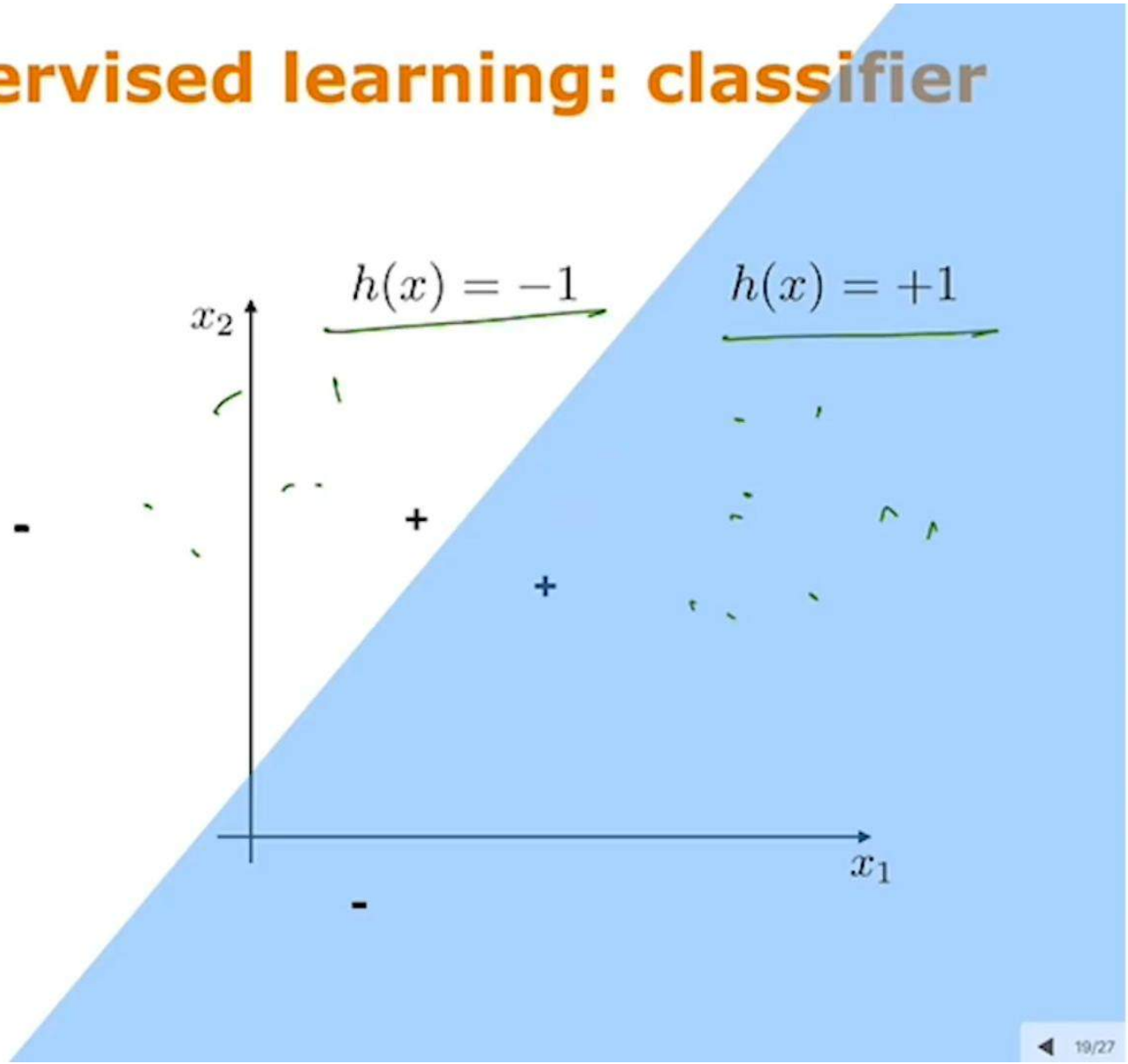


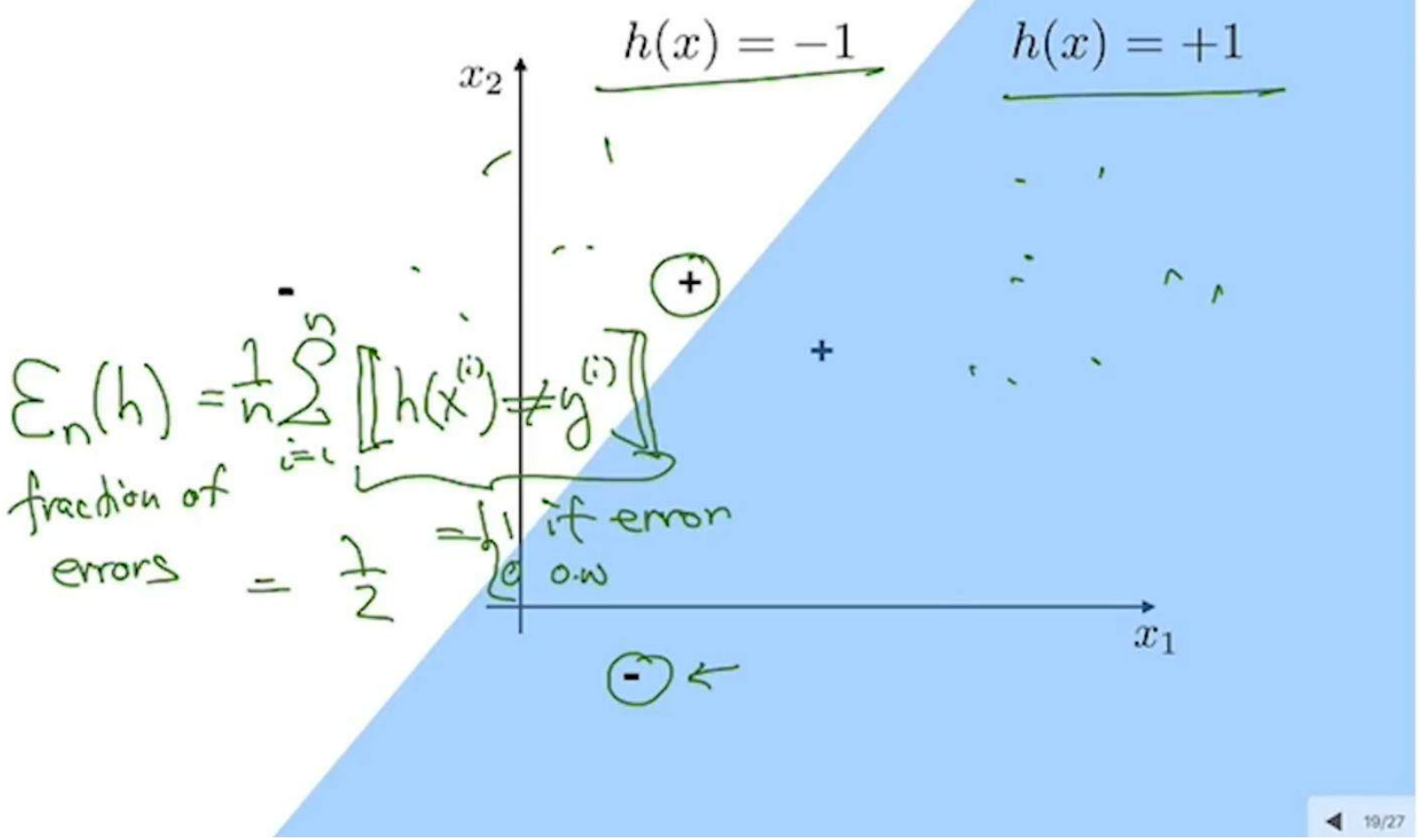
Supervised learning: classifier



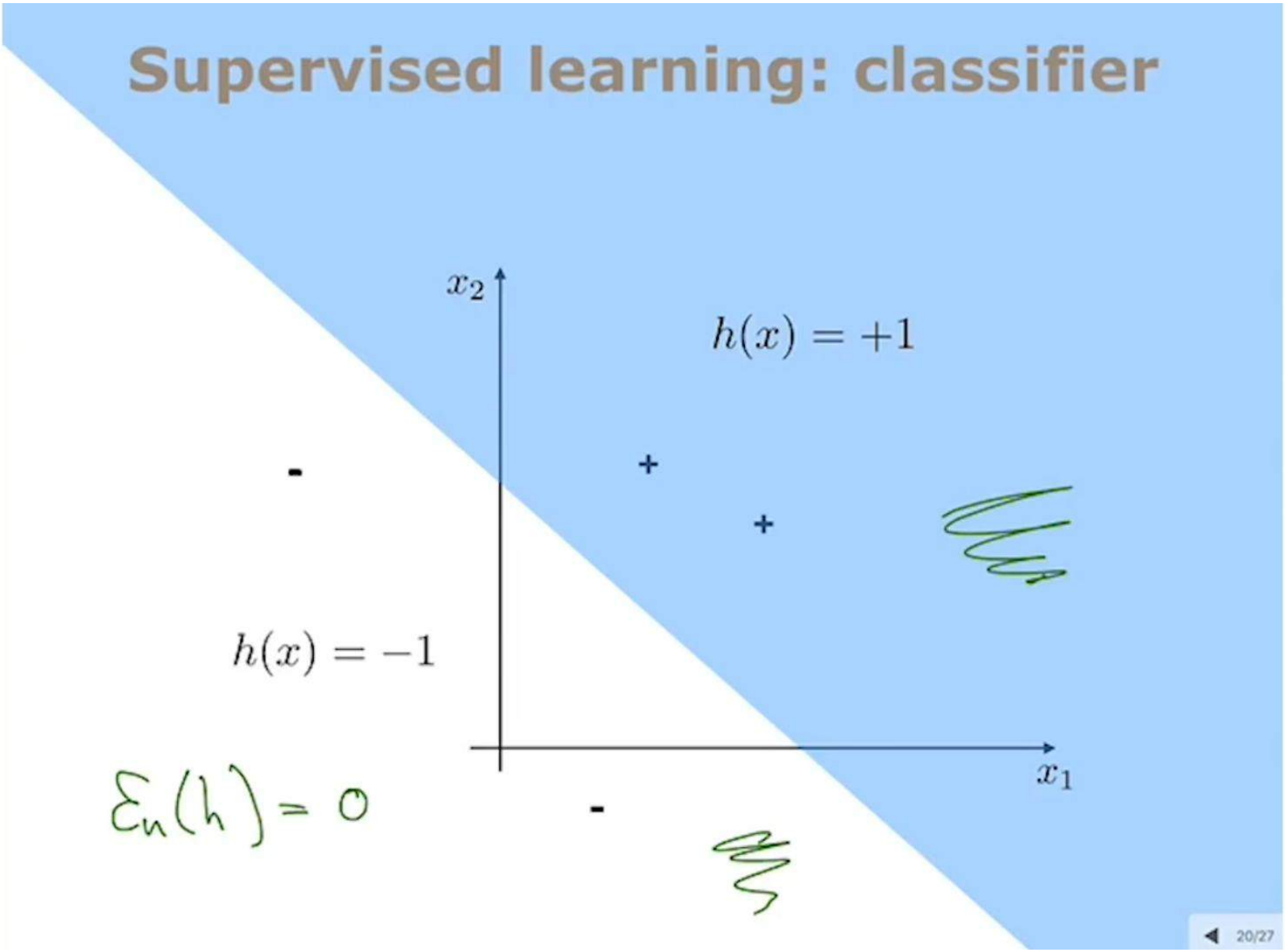
Supervised learning: classifier



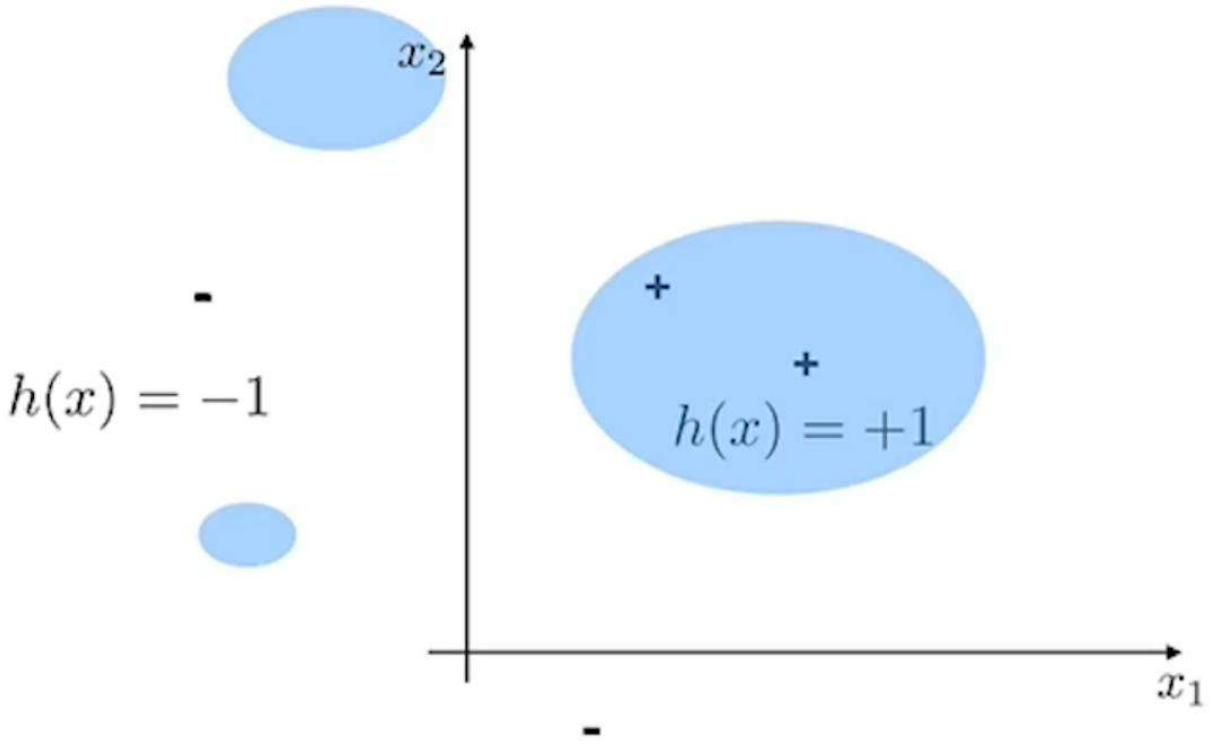
Supervised learning: classifier



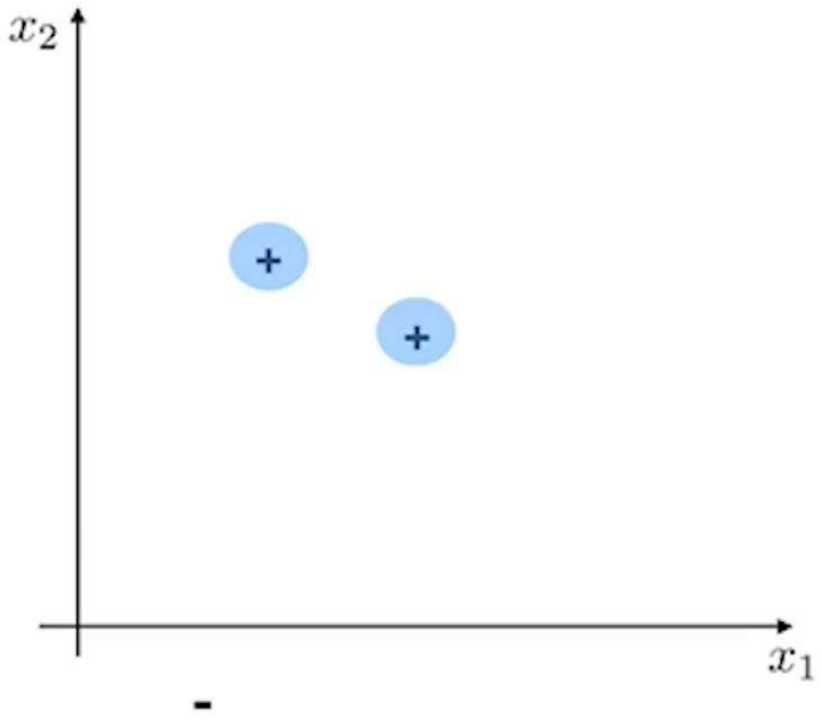
Supervised learning: classifier



Supervised learning: classifier



Supervised learning: classifier



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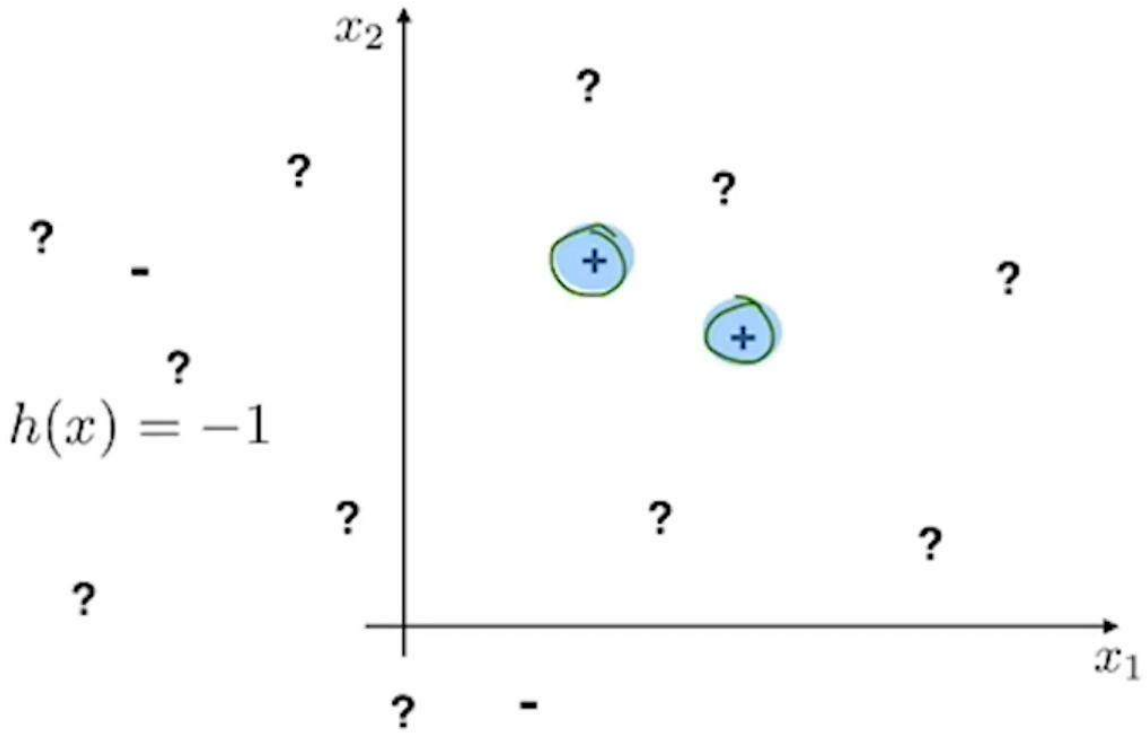
$h(x) = -1$

$\mathcal{E}_n(h) = 0$

-

Supervised learning: generalization



Supervised learning +

- Multi-way classification (e.g., three-way classification)

$$h\left(\text{  }\right) = \text{politics} \qquad h : \mathcal{X} \to \{\text{politics}, \text{sports}, \text{other}\}$$

- Regression

$$h\left(\text{  }\right) = \$1{,}349{,}000 \qquad h : \mathcal{X} \to \mathbb{R}$$

- Structured prediction

$$h\left(\text{  }\right) = \begin{array}{l}\text{A group of people}\\ \text{shopping at an}\\ \text{outdoor market}\end{array} \qquad h : \mathcal{X} \to \{\text{English sentences}\}$$

Types of machine learning

- Supervised learning
  - prediction based on examples of correct behavior
- Unsupervised learning
  - no explicit target, only data, goal to model/discover
- Semi-supervised learning
  - supplement limited annotations with unsupervised learning
- Active learning
  - learn to query the examples actually needed for learning
- Transfer learning
  - how to apply what you have learned from A to B
- Reinforcement learning
  - learning to act, not just predict; goal to optimize the consequences of actions
- Etc.

Key things to understand

- Posing supervised machine learning problems
- Supervised classification
- The role of training/test sets
- A classifier
- A set of classifiers
- Errors, generalization