

6.036 Introduction to Machine Learning

(meets with 6.862)

6.036 Information

- Lectures: Profs. Barzilay, **Jaakkola**, Matusik, Parrilo
- TAs (too many to list on the slide, sorry)
- Homeworks (0-5): 10% of grade in total
- Projects (1-3): 30% of grade
- Exams (midterm,final): 60% of grade
- courses.csail.mit.edu/6.036/ (general info)
- 6.036 Stellar page (assignments, material, submissions)
- piazza.com/mit/spring2017/6036 (all questions)
- 6036-staff@lists.csail.mit.edu (exceptions)

Things to note

- We will offer this course again in the fall. Consider taking it then.
- We cannot accept listeners, cross-registered students this time around because of the numbers involved
- HW #0 (background) is due this Friday 9am

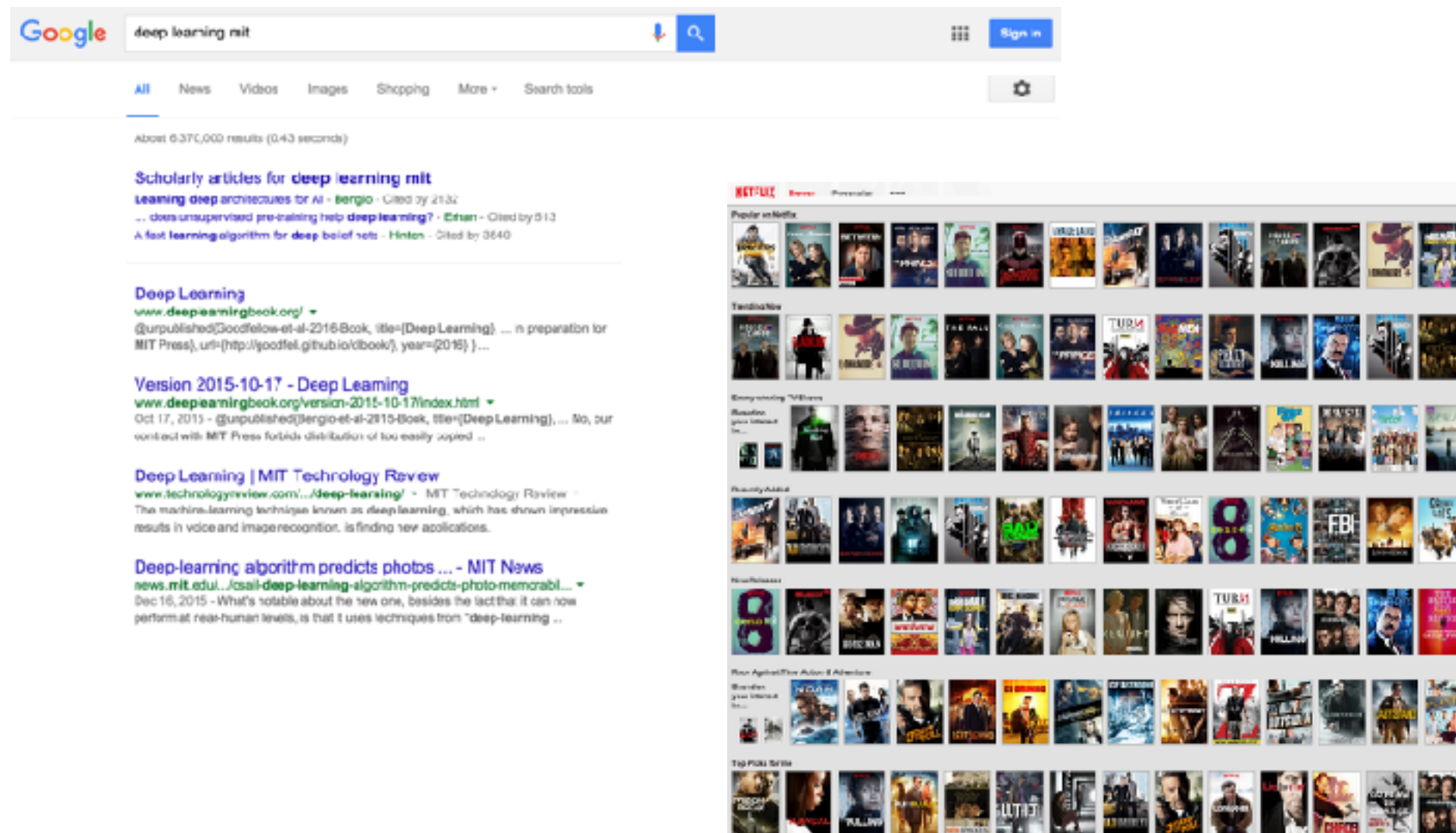
Machine learning

- 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

ML is everywhere...

- ▶ E.g., access to information



ML is everywhere...

- E.g., interactive access to information



Siri

amazon echo



ML is everywhere...

- E.g., any kind of automation



(Google)



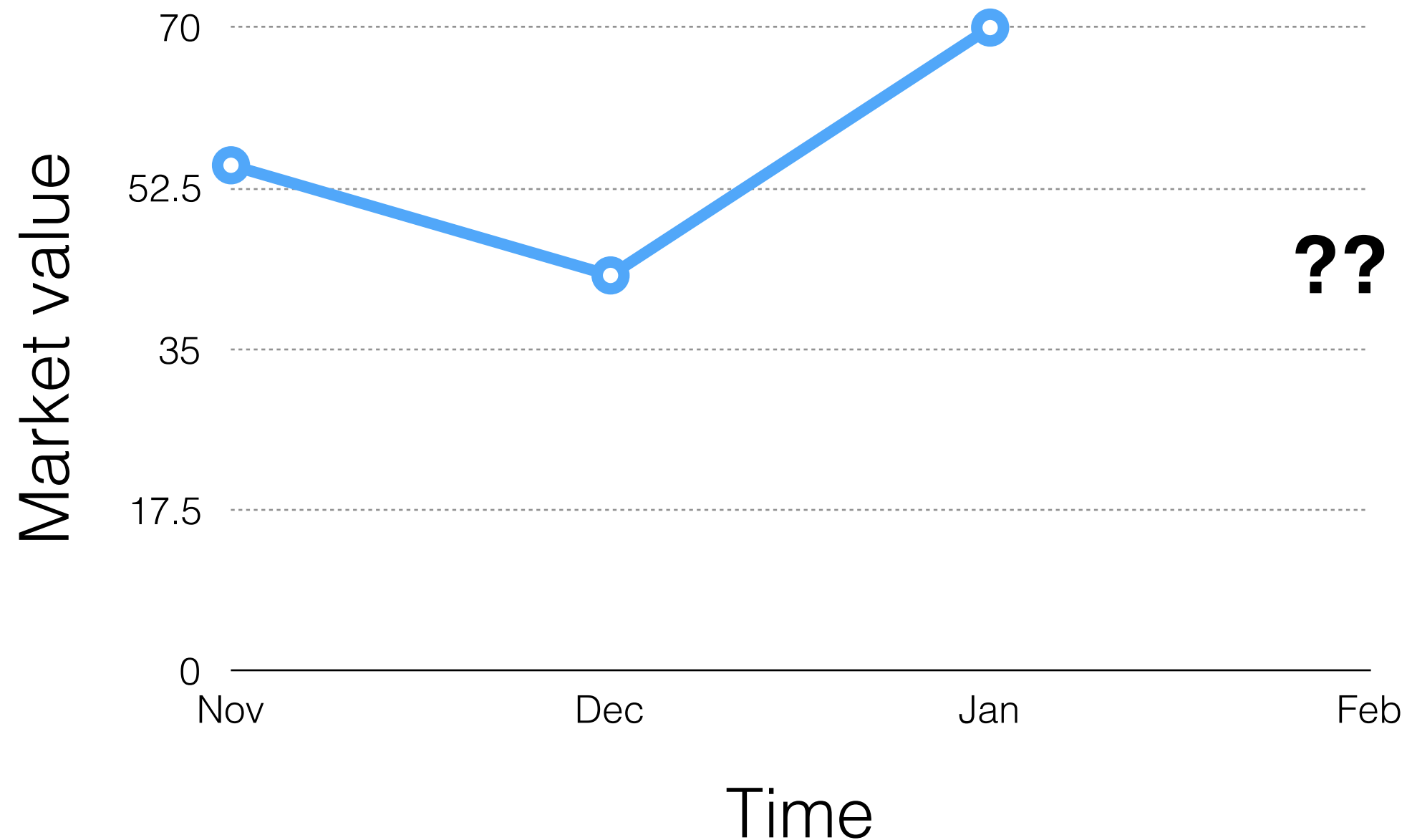
(Mobileye)

Machine learning

- For the pragmatist
 - science/engineering
 - molecular biology, computer vision, robotics, natural language processing, computer systems, computational neuroscience, medical informatics, materials science, physics, education, social sciences, etc.
 - corporations, startups
 - Google, Microsoft, Netflix, Amazon, Facebook, IBM, etc.
 - financial, advertising industry, etc.
 - military, security, etc.
 - etc.
- For the idealist
 - goal to realize thinking, learning machines
 - how do they (or we) learn, how fast?
 - what is easy, hard or learnable?
 - etc.

Prediction problems

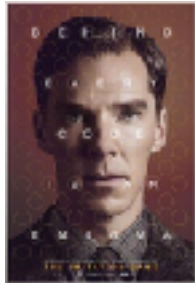
- About future events



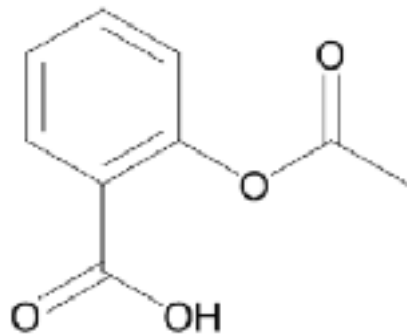
- Markets, collision avoidance, monitoring, medical risk, etc.

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)

Image



...

Category

mushroom

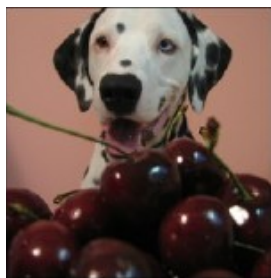
cherry

...

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)

Image



...

Category

mushroom

cherry

...

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

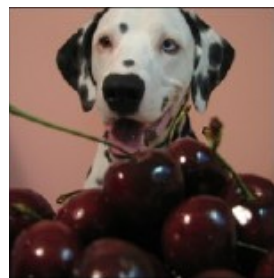
Example: supervised learning

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

Image

Category

$$h\left(\begin{array}{c} \text{Image of mushrooms} \end{array}; \theta\right) = \text{mushroom}$$



cherry

...

...

- 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...

English

$h(\text{Is it real? ; } \theta)$

Will it continue?

For how long?

...

Spanish

¿Es real?

¿Continuará?

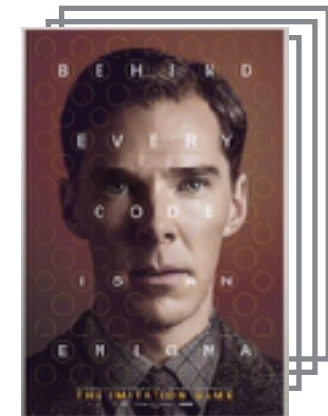
¿Por cuanto tiempo?

...

- 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...



-1



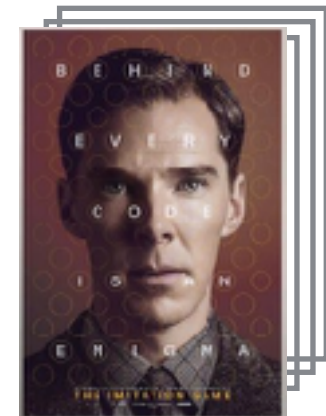
0



+1



+1



?, ?,

A concrete example

- Learning to predict preferences from just a little data...



-1



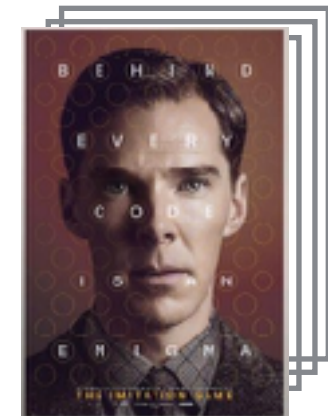
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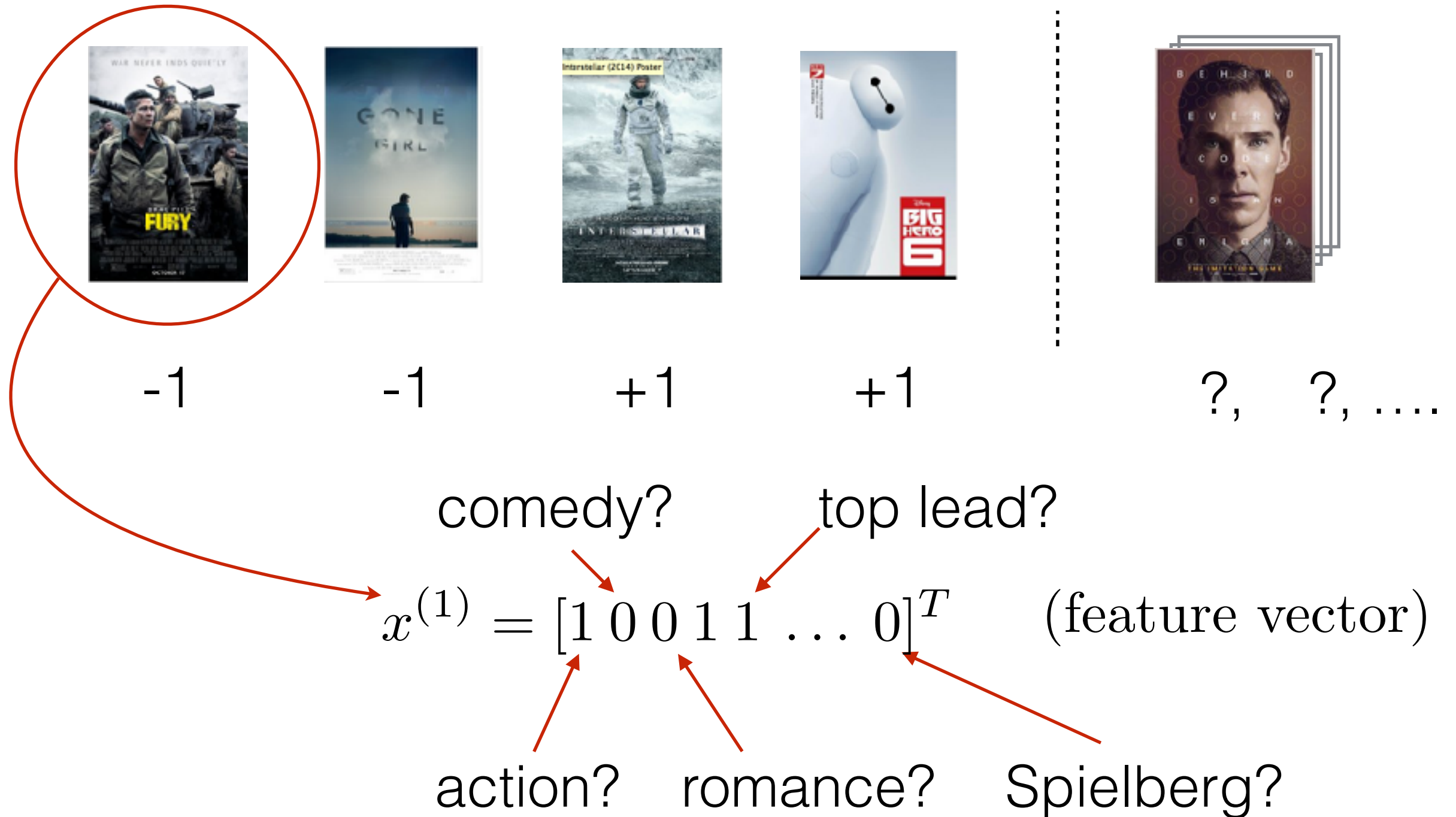
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A concrete example

- Learning to predict preferences from just a little data...



Supervised learning

- Learning to predict preferences from just a little data...



$x^{(1)}$

-1



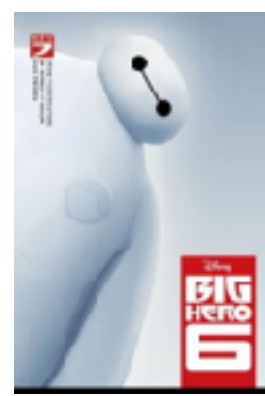
$x^{(2)}$

-1



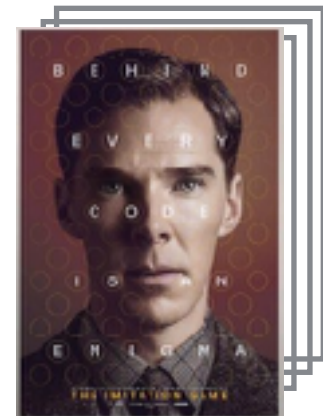
$x^{(3)}$

+1



$x^{(4)}$

+1



$x^{(5)}, x^{(6)}, \dots$

?, ?,

Supervised learning

- Learning to predict preferences from just a little data...

 $x^{(1)}$

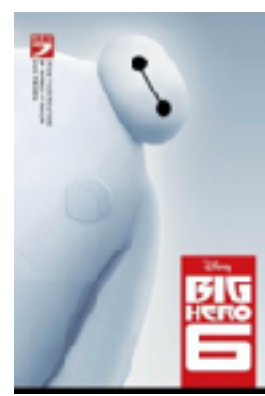
-1

 $x^{(2)}$

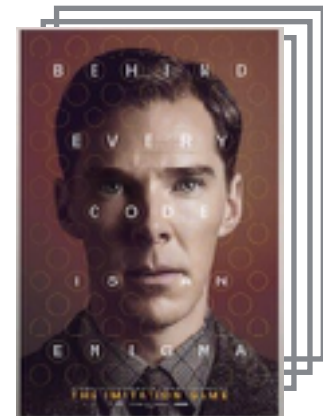
-1

 $x^{(3)}$

+1

 $x^{(4)}$

+1

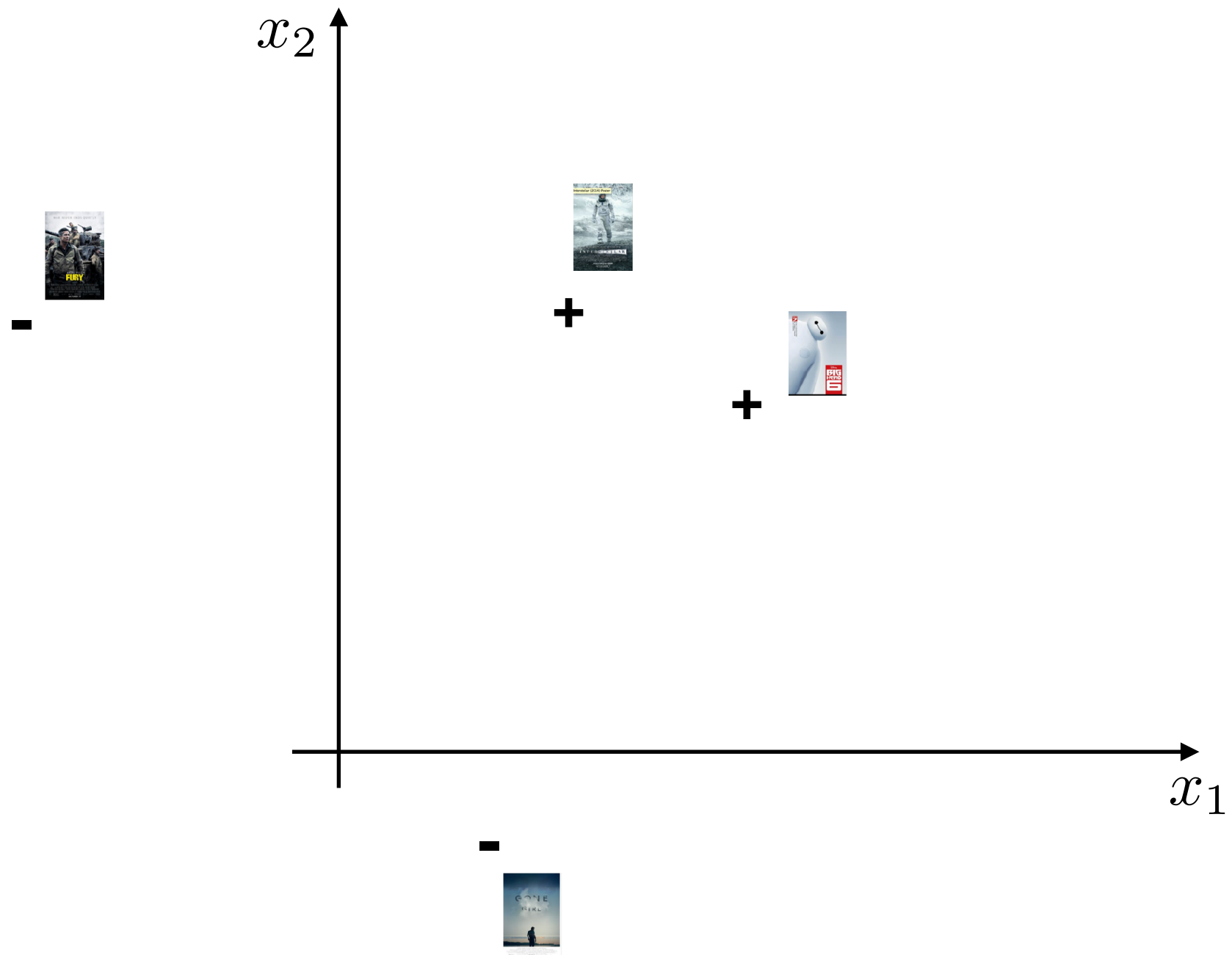
 $x^{(5)}, x^{(6)}, \dots$

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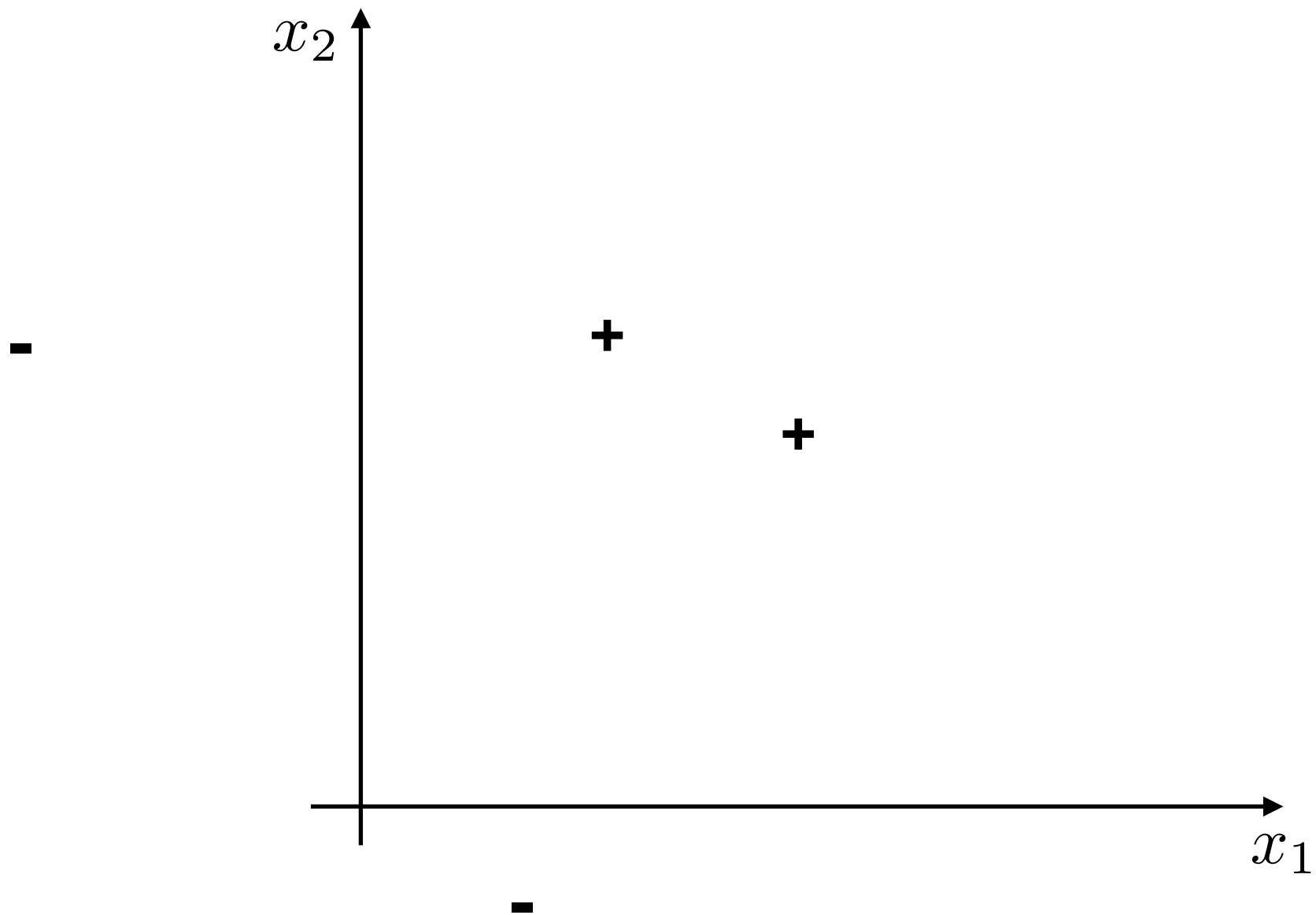
Training set

Test set

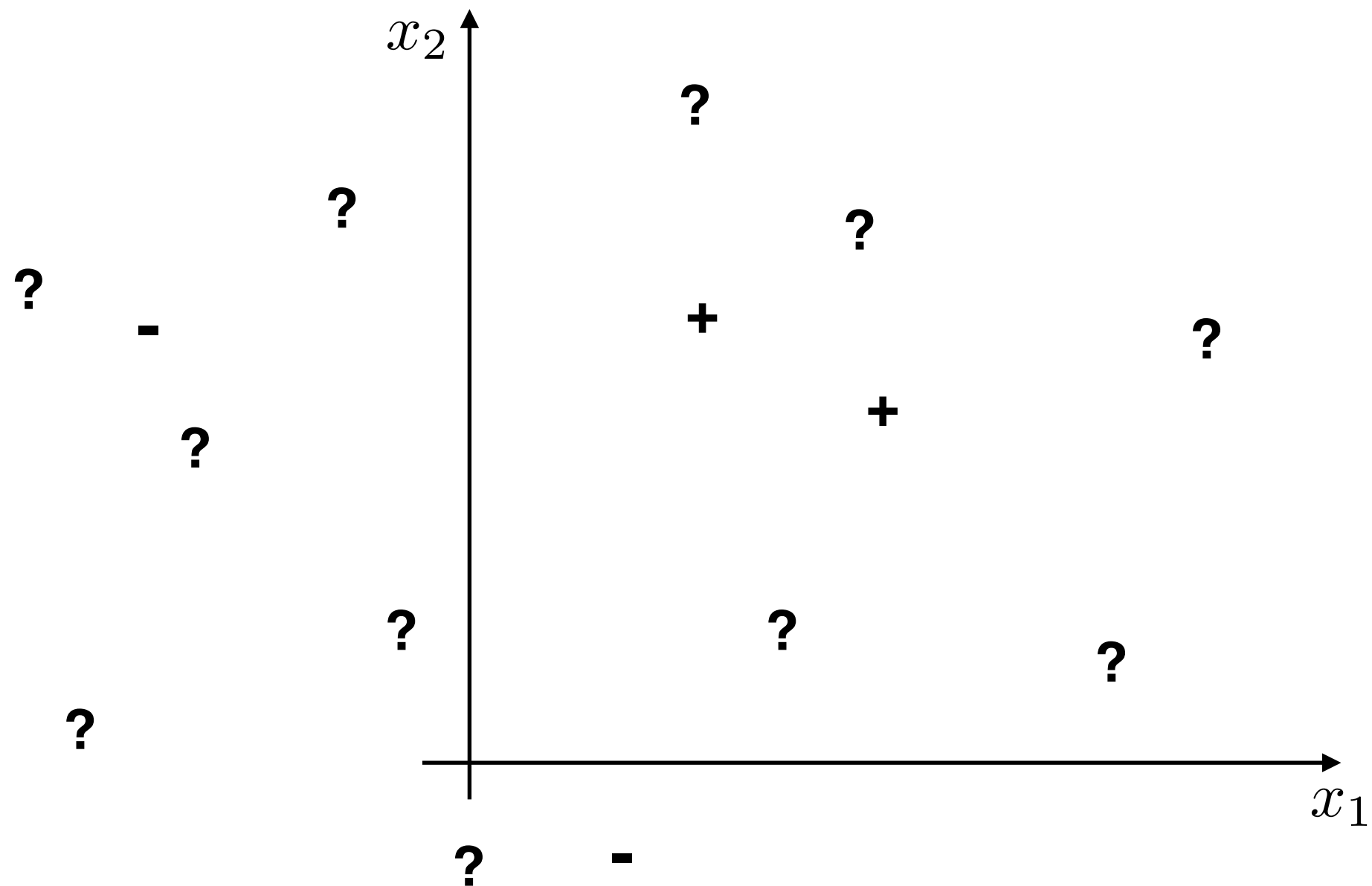
Supervised learning



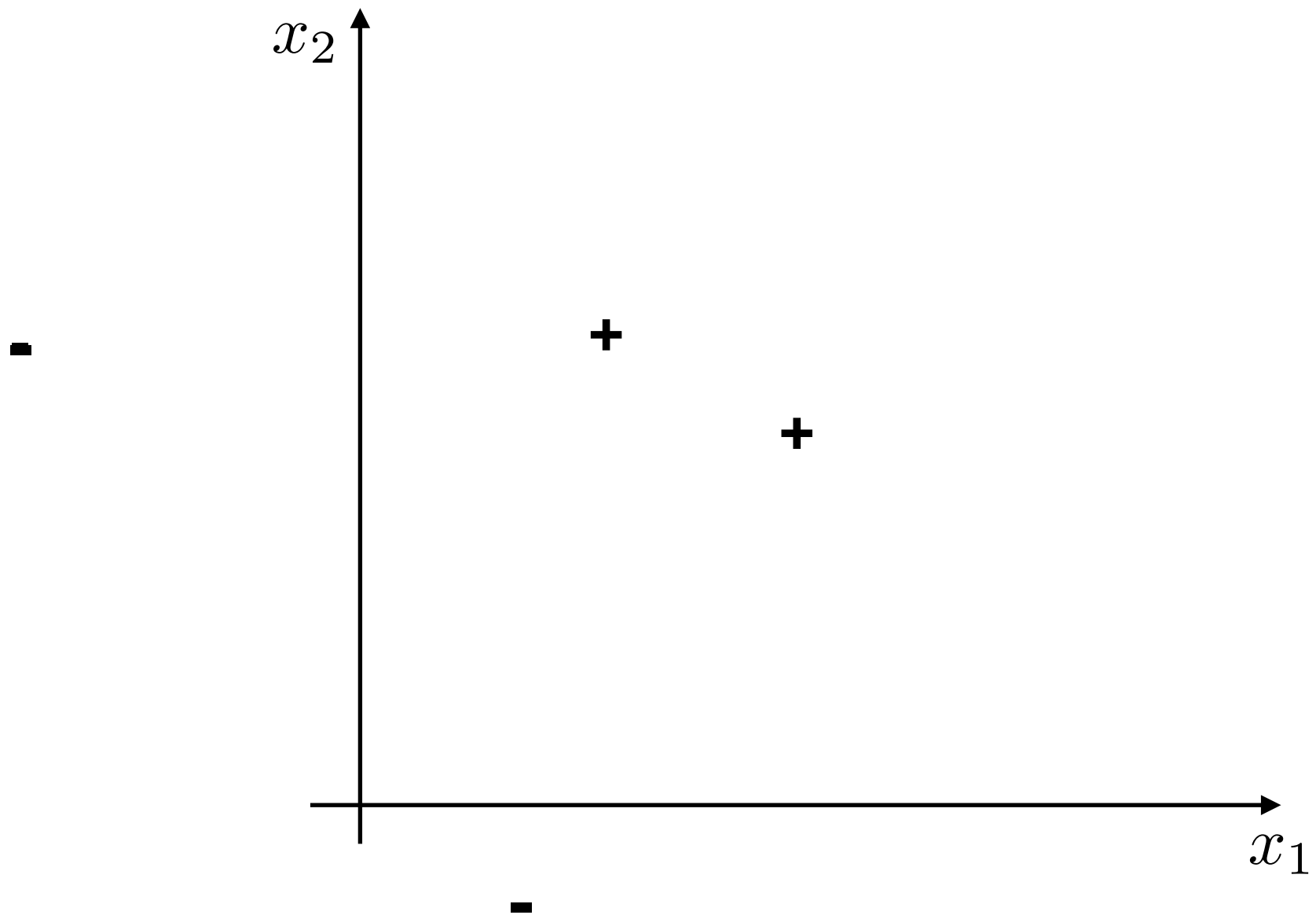
Supervised learning: training set



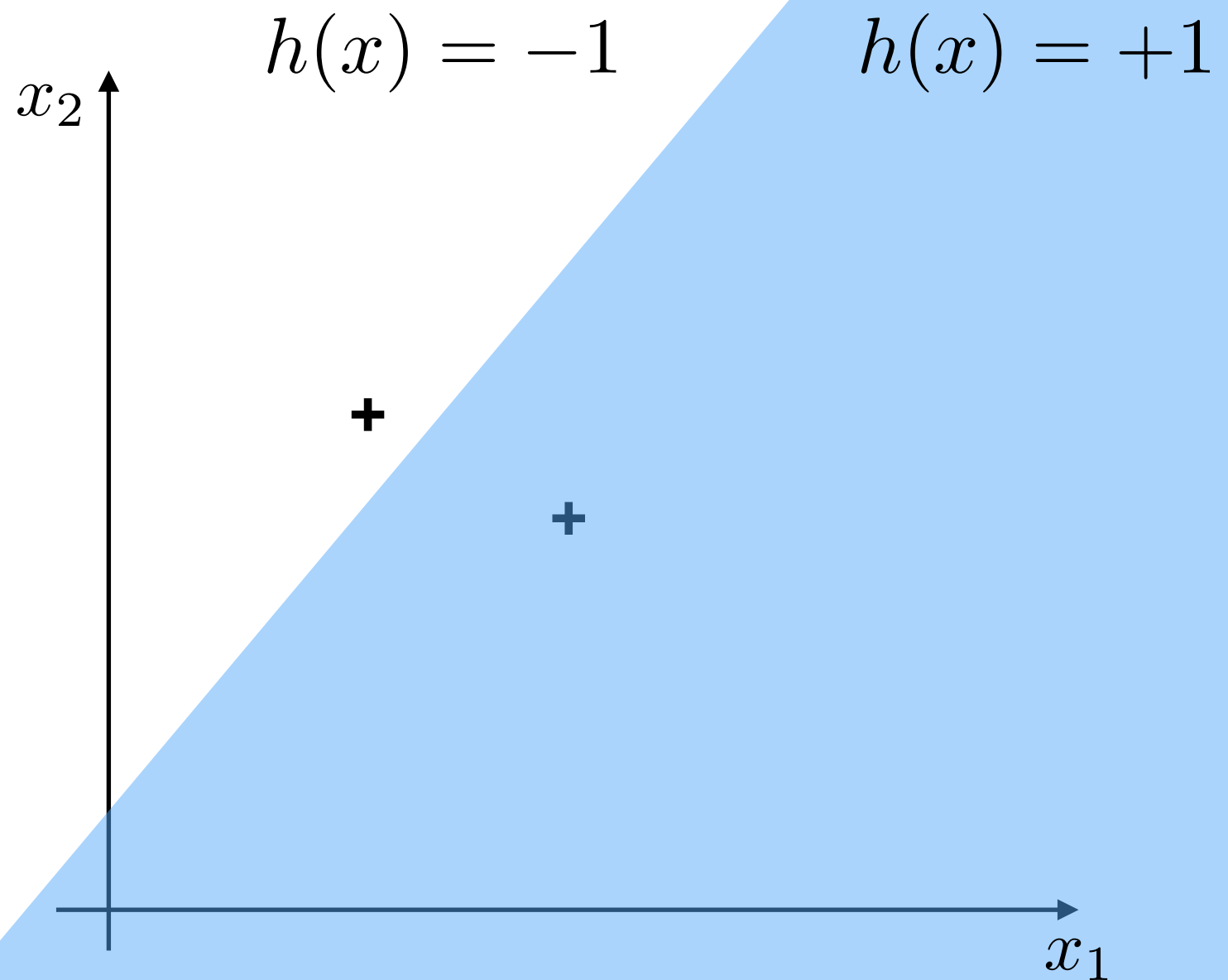
Supervised learning: test set



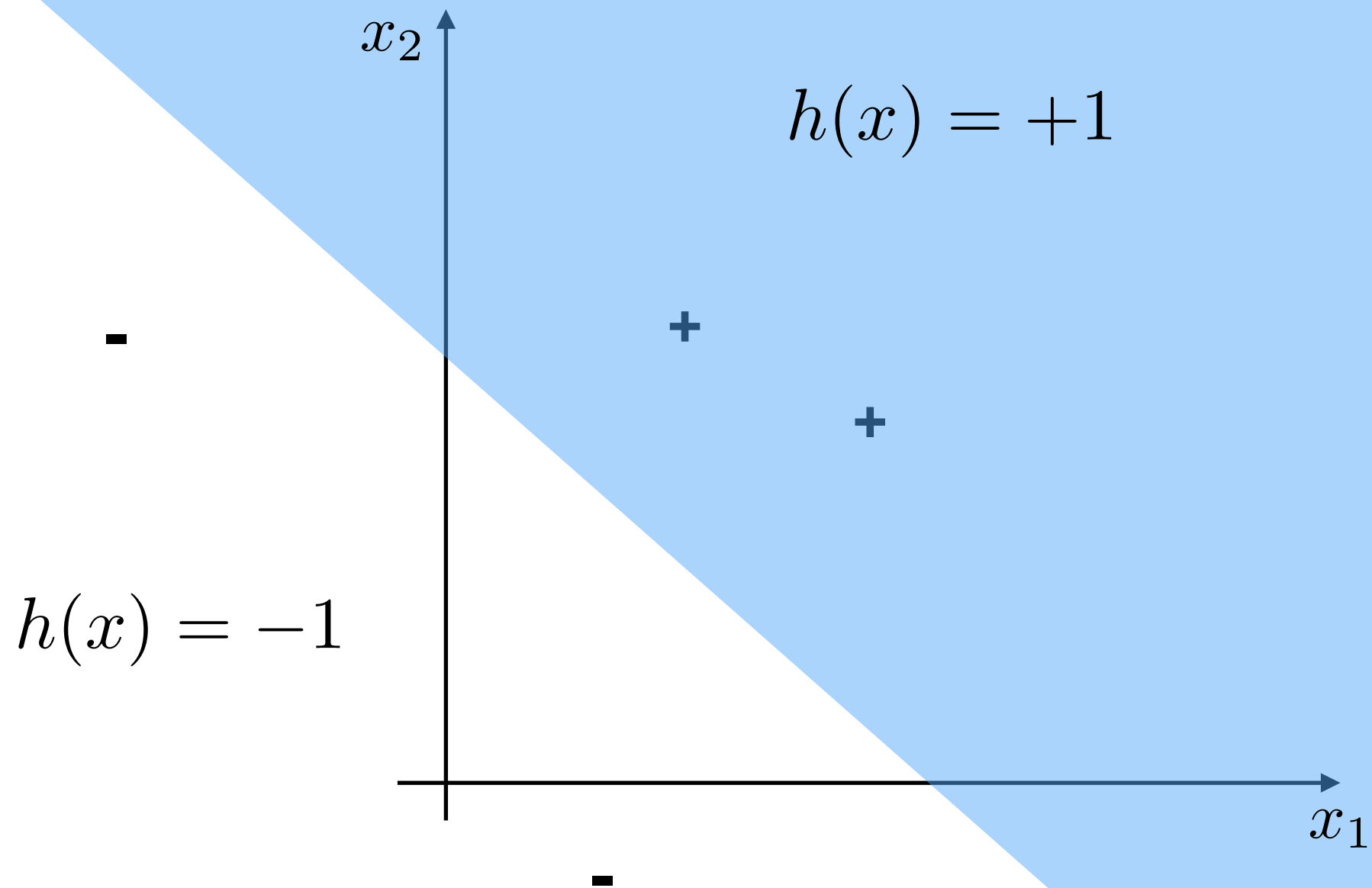
Supervised learning: classifier



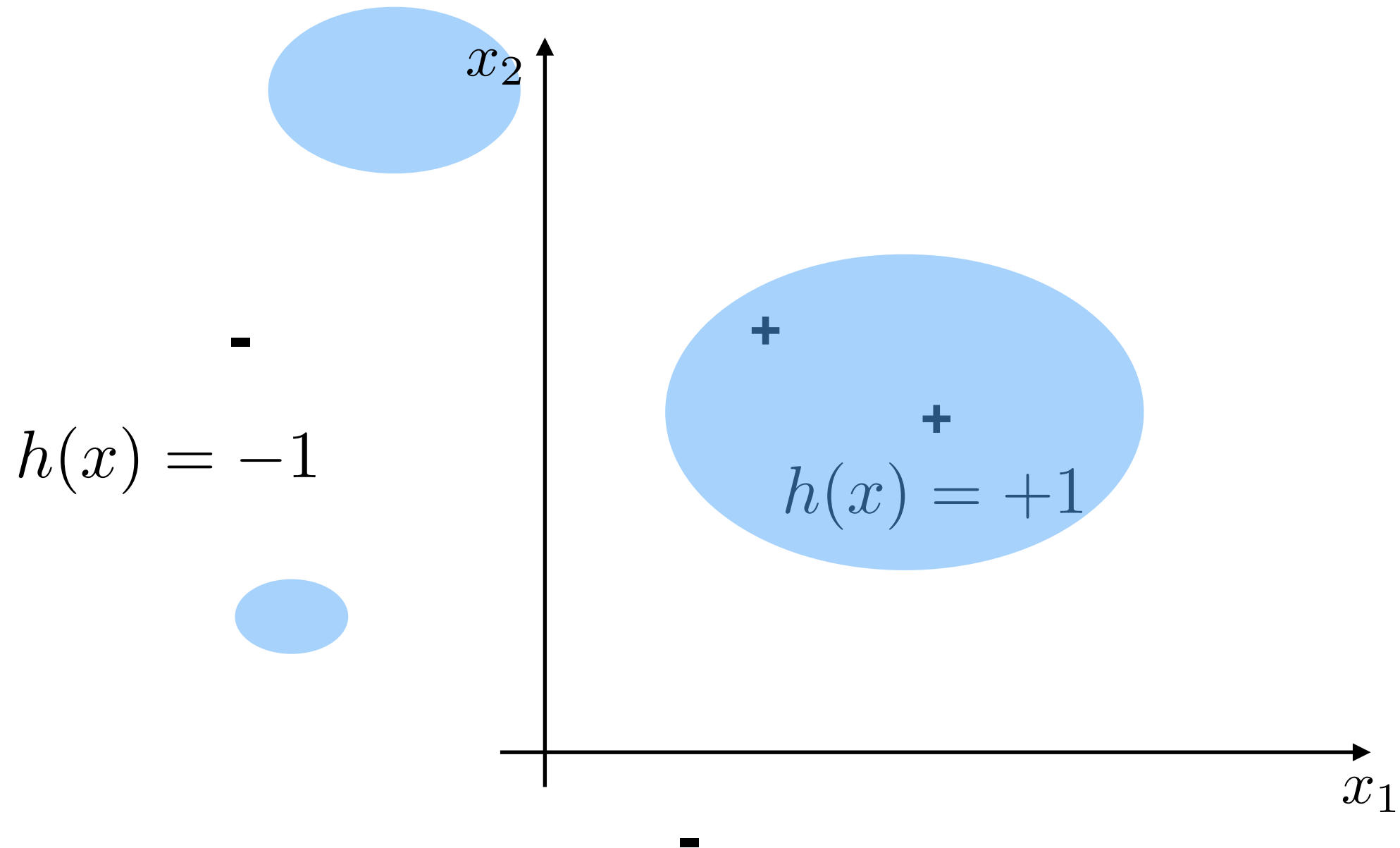
Supervised learning: classifier



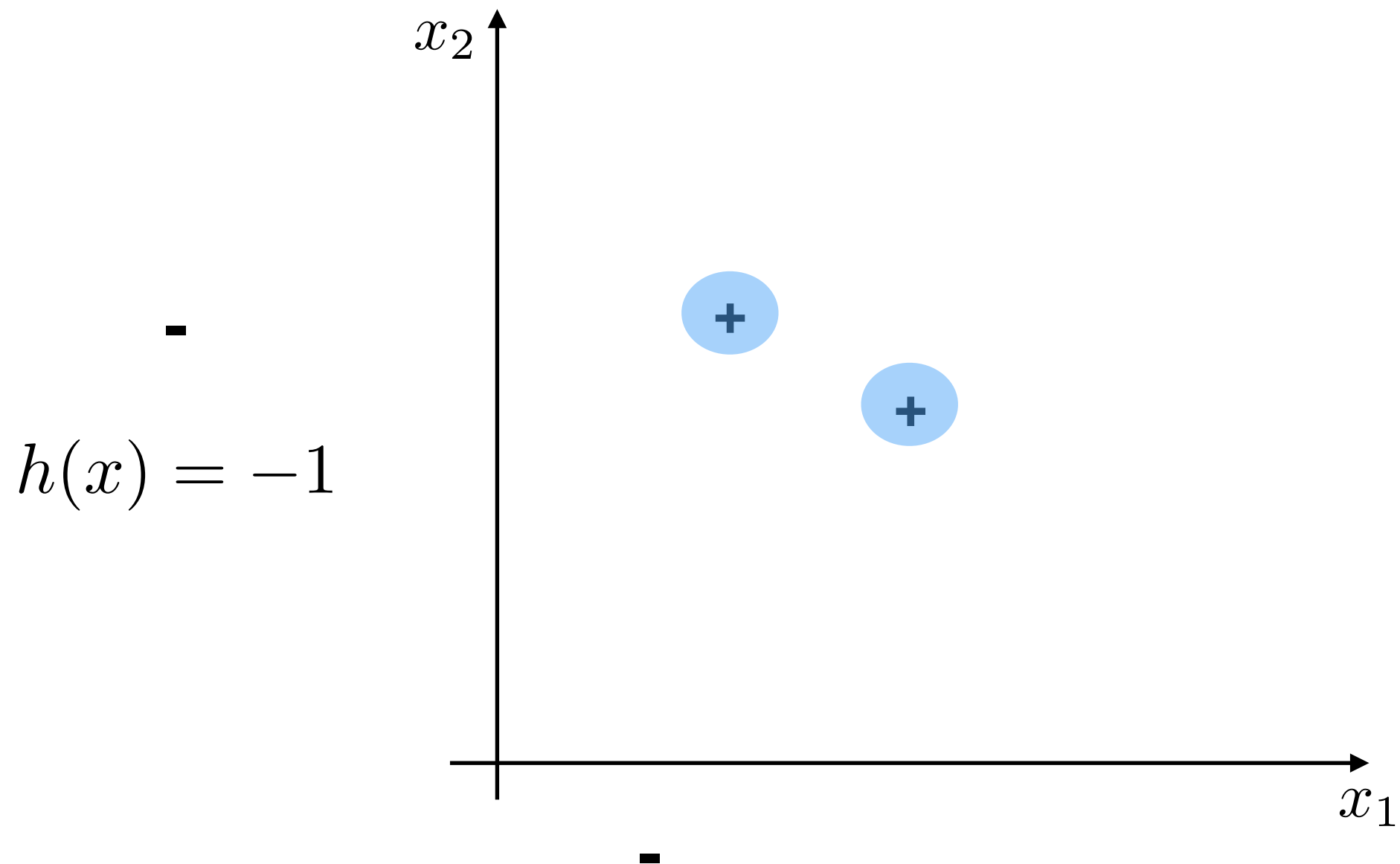
Supervised learning: classifier



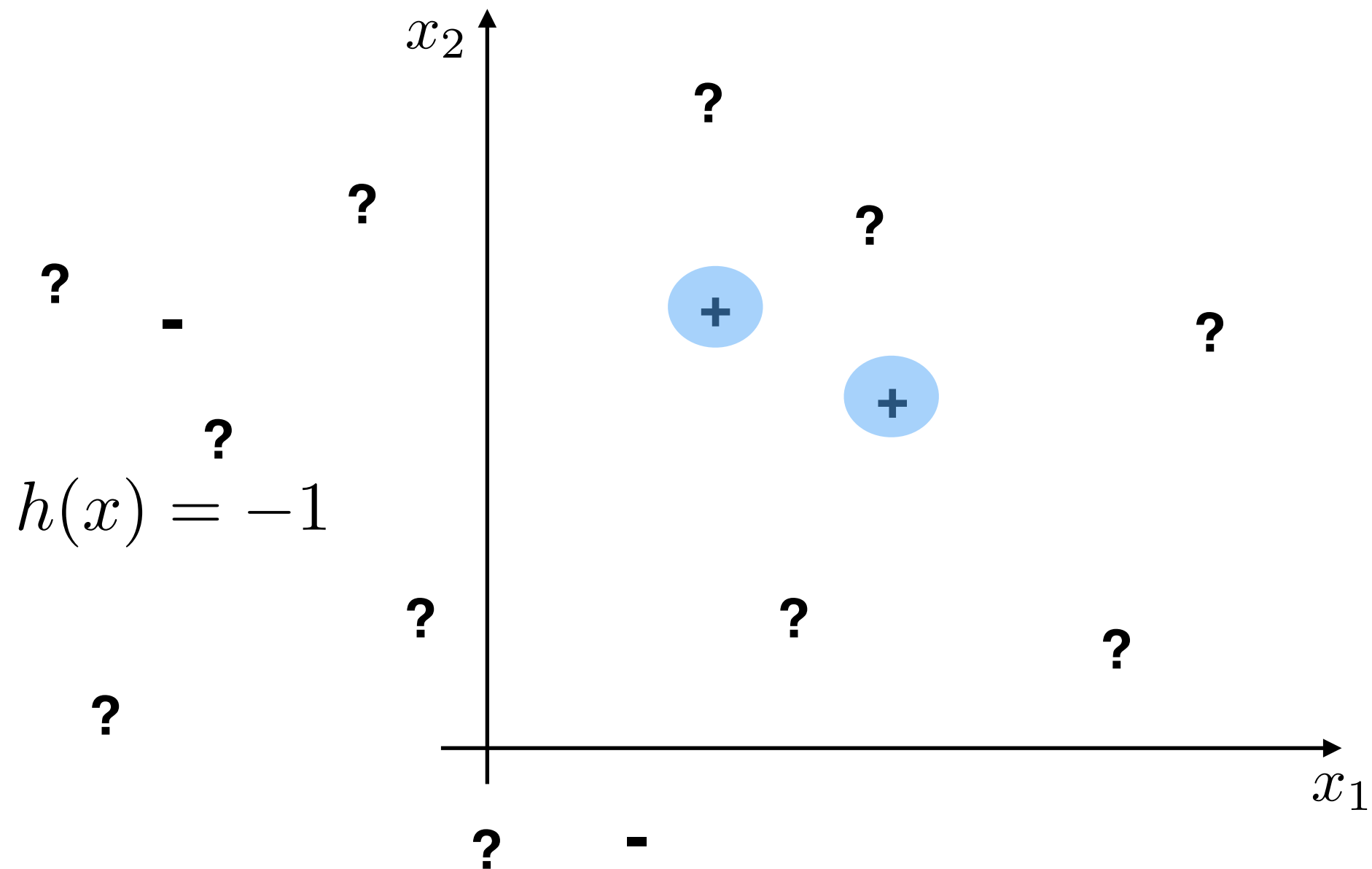
Supervised learning: classifier



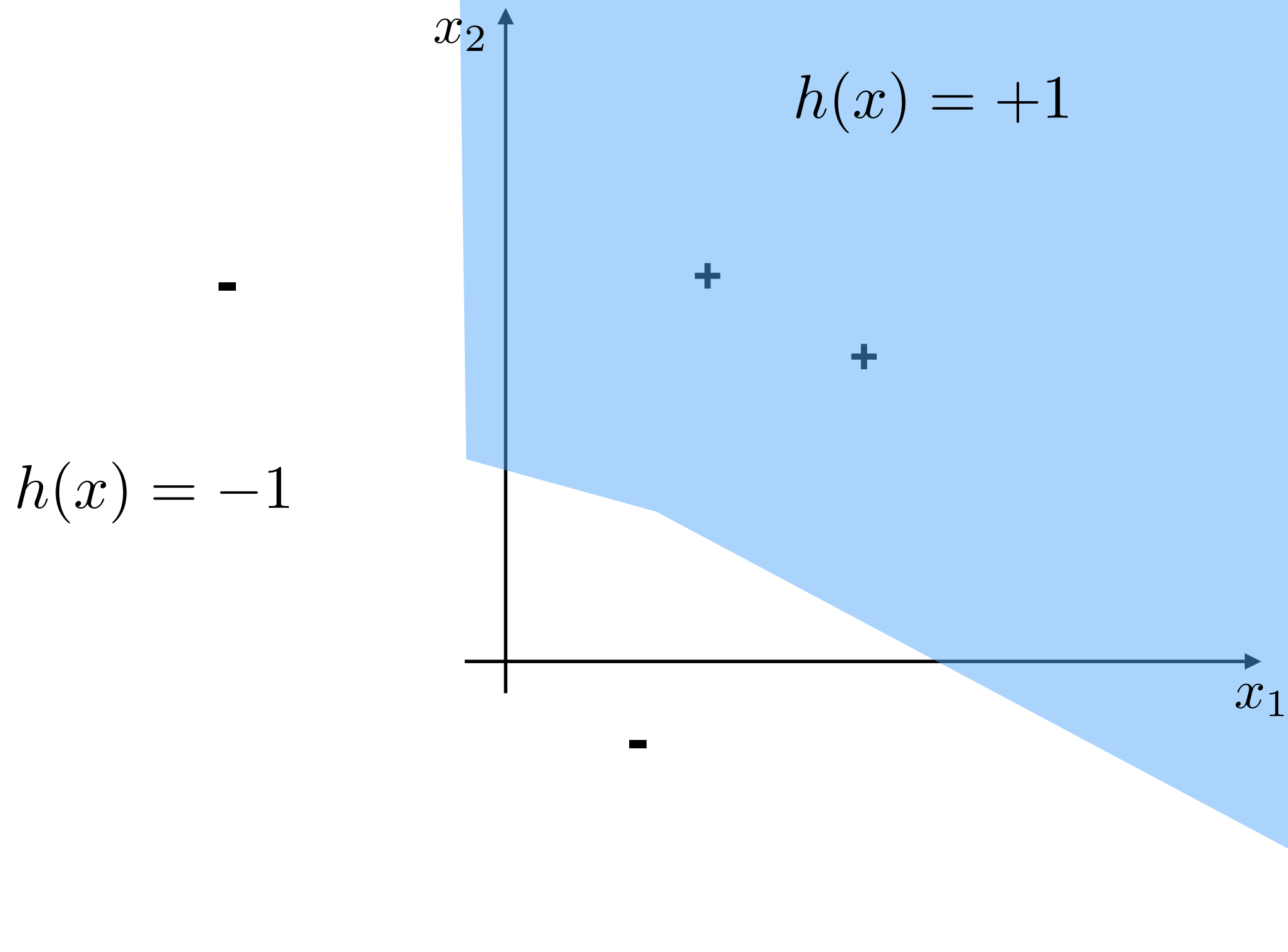
Supervised learning: classifier



Supervised learning: generalization



Supervised learning: NN classifier



Supervised learning +

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

$$h\left(\text{image of a news website}$$

- Regression

$$h\left(\text{image of a living room}$$

- Structured prediction

$$h\left(\text{image of a group of people at an outdoor market}$$

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