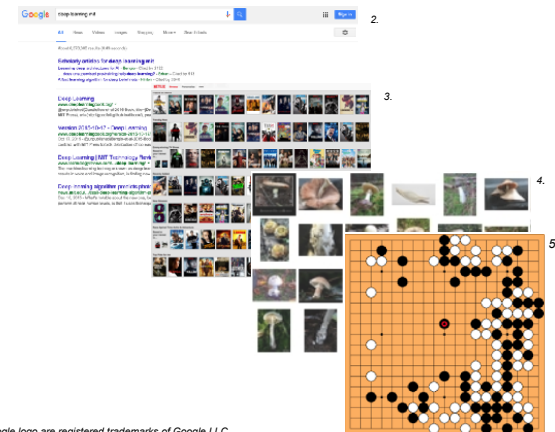# Machine Learning
Lecture 1 [1.]

Machine learning is everywhere

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

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3. Screenshot of Netflix (n.d.), (c) Netflix, Inc.

5. © Senseis Library

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

Market value

Time

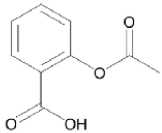‣ Also collision avoidance, monitoring, medical risk, etc.

Prediction problems
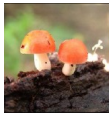
‣ About properties we don't yet know

6. © Black Bear Pictures

would I like this movie?

soluble in water?

7. , © Neural Information Processing Systems Foundation, Inc.

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**
. © Neural Information Processing Systems Foundation, Inc.	mushroom
8. © Geoffrey Hinton, University of Toronto.	cherry
...	...

Example: supervised learning

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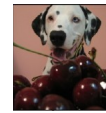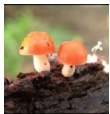‣ E.g., image classification (1K categories)

Image	**Category**
© Neural Information Processing Systems Foundation, Inc	mushroom
© Geoffrey Hinton, University of Toronto.	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)
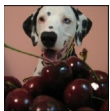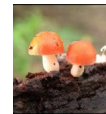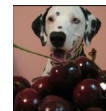‣ E.g., image classification (1K categories)

Image	**Category**
$h\left(\ \ \ ; \theta\right)\ =$ *© Neural Information Processing Systems Foundation, Inc*	mushroom
© Geoffrey Hinton, University of Toronto.	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…

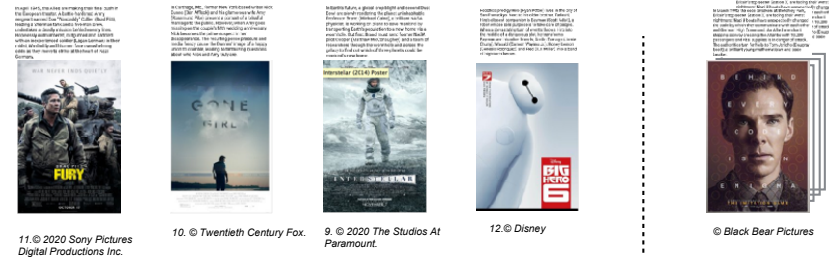| **English**		**Spanish**
$h\big(\text{ Is it real? } ; \theta\big)$	$=$	¿Es real?
Will it continue?		¿Continuará?
For how long?		¿Por cuanto tiempo?
…		…

‣ Already in production for some language pairs (Google)

A concrete example

‣ Learning to predict preferences from just a little data…

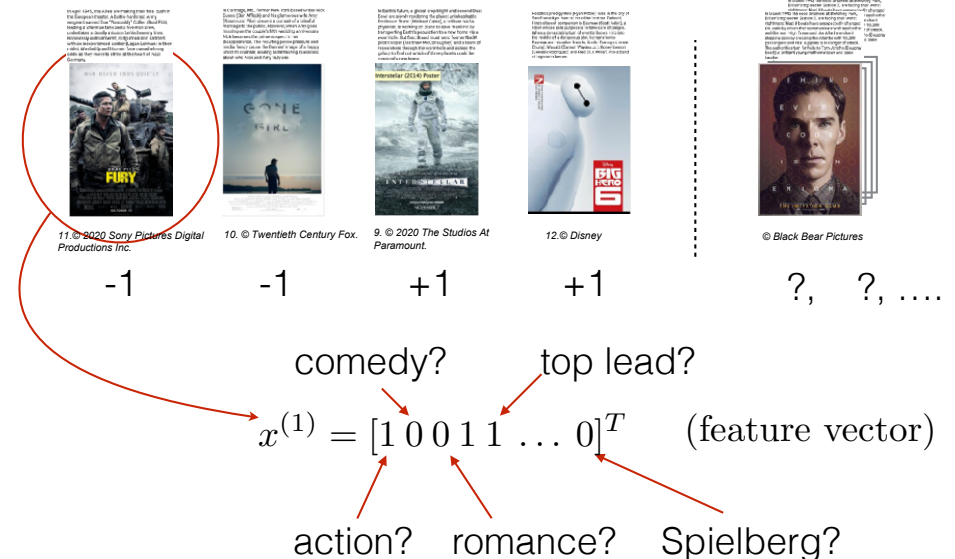*11.© 2020 Sony Pictures Digital Productions Inc.*   *10. © Twentieth Century Fox.*   *9. © 2020 The Studios At Paramount.*   *12.© Disney*   *© Black Bear Pictures*

A concrete example

‣ Learning to predict preferences from just a little data…

11.© 2020 Sony Pictures Digital Productions Inc.   *10. © Twentieth Century Fox.*   *9. © 2020 The Studios At Paramount.*   *12.© Disney*   *© Black Bear Pictures*

-1   -1   +1   +1   ?,   ?, ….

A concrete example

‣ Learning to predict preferences from just a little data…

11.© 2020 Sony Pictures Digital Productions Inc.   *10. © Twentieth Century Fox.*   *9. © 2020 The Studios At Paramount.*   *12.© Disney*   *© Black Bear Pictures*

-1   -1   +1   +1   ?,   ?, ….

comedy?   top lead?

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

action?   romance?   Spielberg?

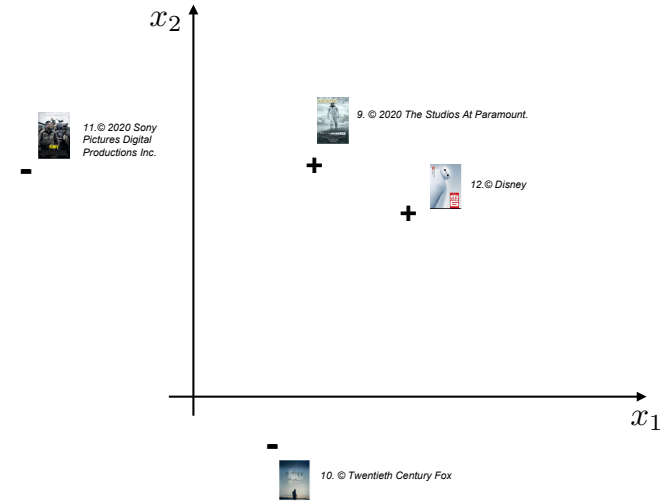# Supervised learning

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

11.© 2020 Sony Pictures Digital Productions Inc.
$x^{(1)}$

10. © Twentieth Century Fox.
$x^{(2)}$

9. © 2020 The Studios At Paramount.
$x^{(3)}$

12.© Disney
$x^{(4)}$

© Black Bear Pictures
$x^{(5)}, x^{(6)}, \ldots$

-1   -1   +1   +1   ?,   ?, ...

Training set   Test set
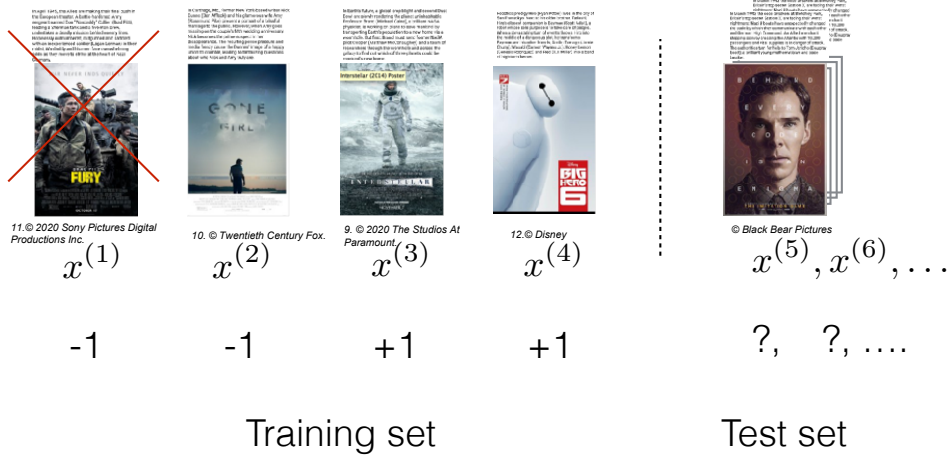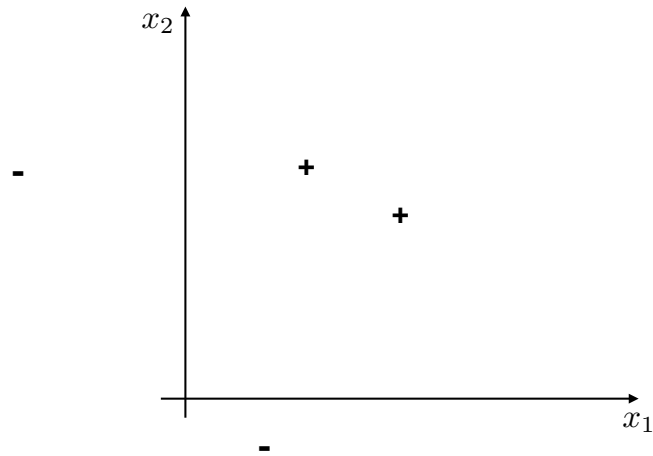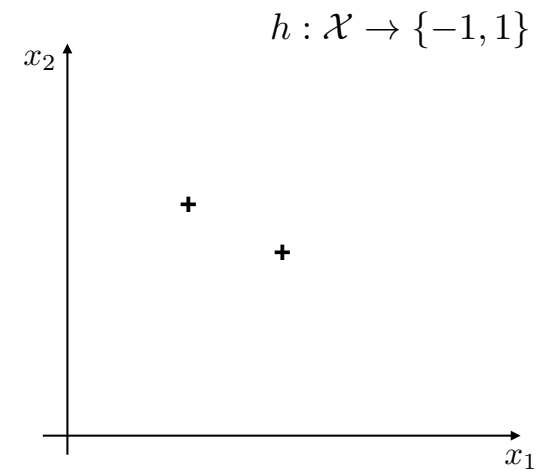
Supervised learning

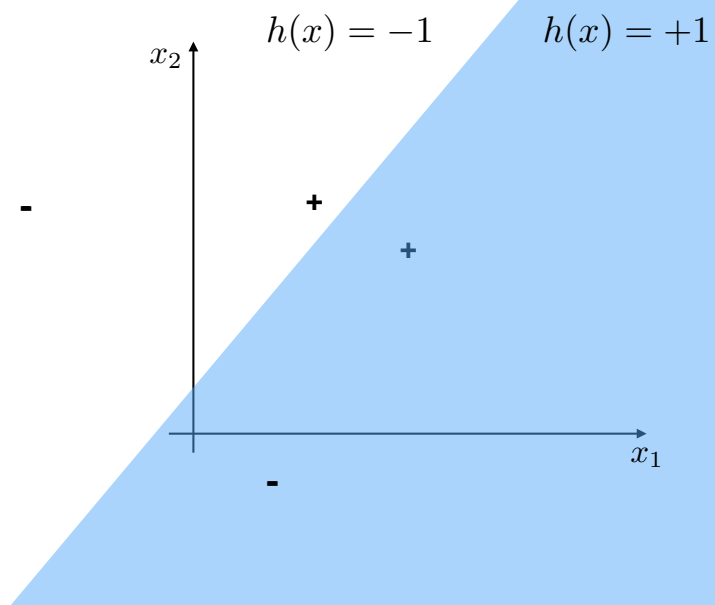# Supervised learning: training set
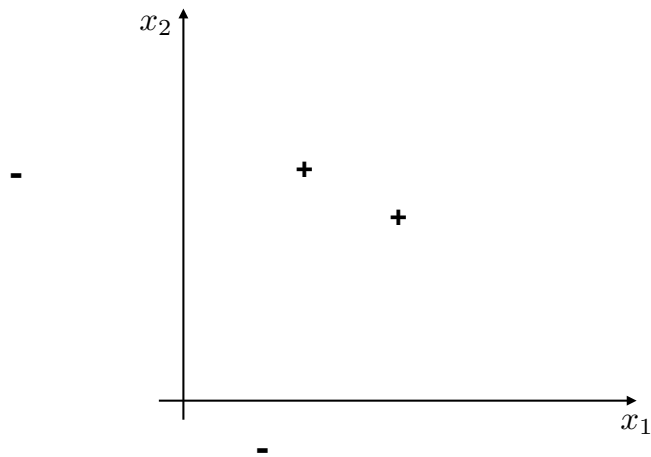
Supervised learning: test set

Supervised learning: training set

x_2

$-$

$+$

$+$

$-$

x_1

Supervised learning: classifier

$h : \mathcal{X} \to \{-1, 1\}$

x_2

$-$

$+$

$+$

$-$

x_1

Supervised learning: classifier

$h(x) = -1$ $h(x) = +1$

x_2

$-$

$+$

$+$

$-$

x_1

Supervised learning: classifier

x_2

$h(x) = +1$

$-$

$+$

$+$

$h(x) = -1$

$-$

x_1

Supervised learning: classifier

x_2

? $h(x) = +1$

?

?

?   -

+

?   ?

?

+

?

$h(x) = -1$?   ?   ?

?

x_1

?   -

Supervised learning: classifier

x_2

-

+

$h(x) = -1$ +

$h(x) = +1$

x_1

-

Supervised learning: classifier

x_2

-

+

+

$h(x) = -1$

x_1

-
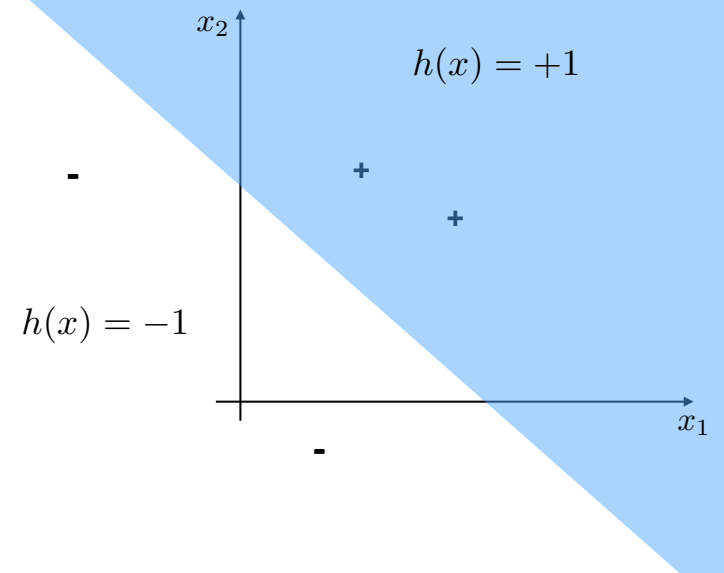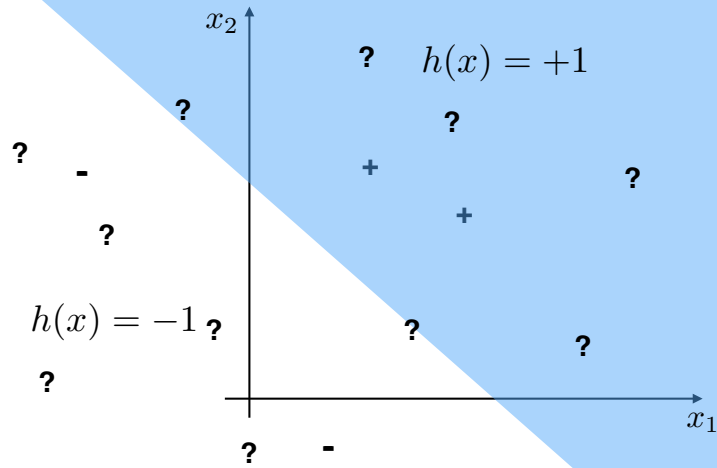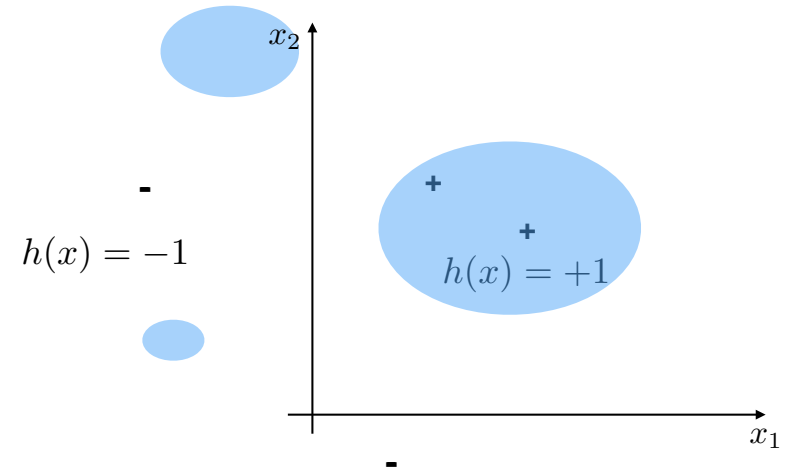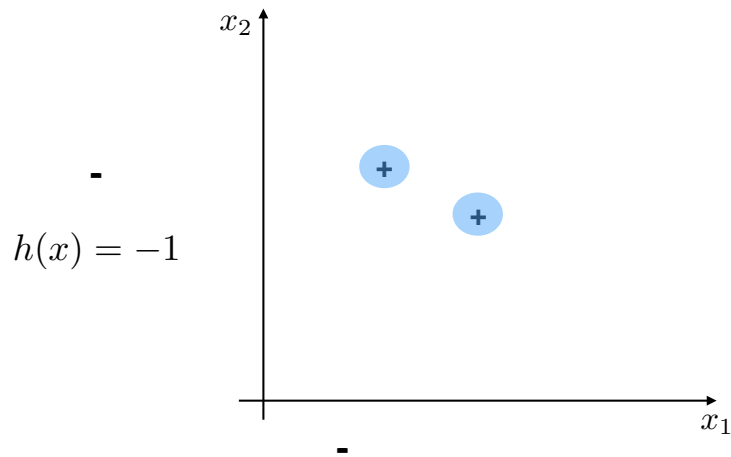
Supervised learning: generalization

x_2

?

?

?

?   -

+

?

+

?

$h(x) = -1$

?

?   ?   ?

?

?   -

x_1
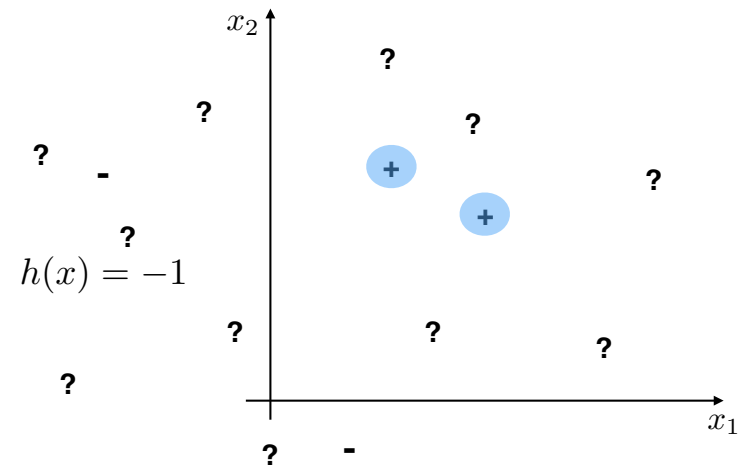
Supervised learning +

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

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

13. BBC news and the BBC logo are registered trademarks of Google LLC.

‣ Regression

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

14. © Robert Paul Properties, Cambridge.

‣ Structured prediction

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

15. © Computer Vision & Pattern Recognition Lab, 2017.

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

Attribution List - Lecture 1 - 6.86x Maxchine Learning

8.
Unit 1 Lecture 1: Introduction to Machine Learning
Thumbnail of one Dalmatian dog
Slides: # 5, #10, #11, #12, #13, #14
Object Source / URL: https://www.slideserve.com/rufin/an-overview-of-deep-learning
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Movie poster thumbnail for "Big Hero 6"
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Thumbnail of a living room
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Unit 1 Lecture 1: Introduction to Machine Learning
Thumbnail of a group of people shopping at an outdoor market
Slides: #25
Object Source / URL: http://166.104.231.121/ysmoon/mip2017/lecture_note/제9장.pdf -- page 2
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