Artificial Intelligence Foundation – JC3001

Lecture 38: Machine Learning – Regression I

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November 2025

Material adapted from:
Russell and Norvig (AIMA Book): Chapter 19 (19.4–19.6)
Sebastian Thrun (Stanford University / Udacity)
Andrew Ng (Stanford University / Coursera)

Course Progression

- Part 1: Introduction
  1. Introduction to AI ✓
  2. Agents ✓
- Part 2: Problem-solving
  1. Search 1: Uninformed Search ✓
  2. Search 2: Heuristic Search ✓
  3. Search 3: Local Search ✓
  4. Search 4: Adversarial Search ✓
- Part 3: Reasoning and Uncertainty
  1. Reasoning 1: Constraint Satisfaction ✓
  2. Reasoning 2: Logic and Inference ✓
  3. Probabilistic Reasoning 1: BNs ✓
  4. Probabilistic Reasoning 2: HMMs ✓
- Part 4: Planning
  1. Planning 1: Intro and Formalism ✓
  2. Planning 2: Algorithms & Heuristics ✓
  3. Planning 3: Hierarchical Planning ✓
  4. Planning 4: Stochastic Planning ✓
- Part 5: Learning
  1. Learning 1: Intro to ML ✓
  2. **Learning 2: Regression**
  3. Learning 3: Neural Networks
  4. Learning 4: Reinforcement Learning
- Part 6: Conclusion
  1. Ethical Issues in AI
  2. Conclusions and Discussion

Objectives

- Regression Problems
- Gradient Algorithms
- Linear Regression
- Linear Classifiers

- Recap
- Linear Regression
- Hypothesis Representation

We learned the basic terminology for machine learning:

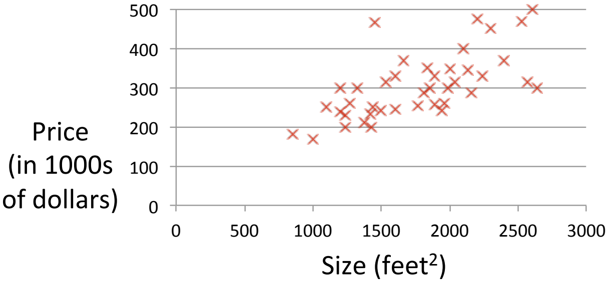
- Types of machine learning models:
  - Supervised Learning
  - Unsupervised Learning
  - Reinforcement Learning
- Supervised learning tasks
  - Classification
  - Regression
- Issues with Machine Learning

And studied one simple, but powerful, machine learning model: Decision Trees

- Recap
- Linear Regression
- Hypothesis Representation

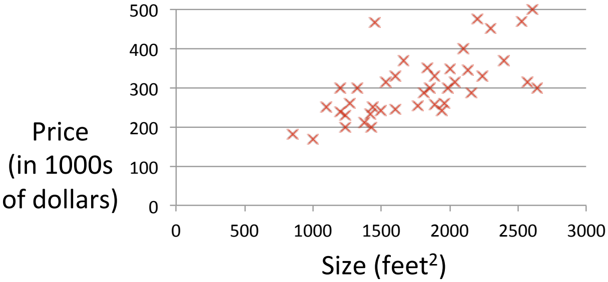
Supervised Learning Example

House Prices (Portland, OR)



Supervised Learning Example

House Prices (Portland, OR)



<u>Supervised Learning</u>

Given the “right answer” for each example in the data.

<u>Regression Problem</u>

Predict real-valued output

Training Example and Notation

Training Set of
House Prices
(Portland, OR)

Size in feet^2 (x)	Price ($) in 1000's (y)
2104	460
1416	232
1534	315
852	178

Training Example and Notation

Training Set of House Prices (Portland, OR)

Size in feet^2 (x)	Price ($) in 1000's (y)
2104	460
1416	232
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Notation:

m = Number of training examples

x's = "input" variable / features

y's = "output" variable / "target" variable

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(x, y) – one training example

$(x^{(i)}, y^{(i)})$ – i^{th} training example

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$x^{(1)} = 2104$

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$x^{(1)} = 2104$

$x^{(2)} = 1416$

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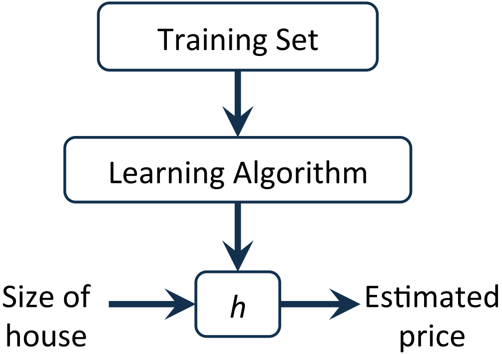
$x^{(1)} = 2104$

$x^{(2)} = 1416$

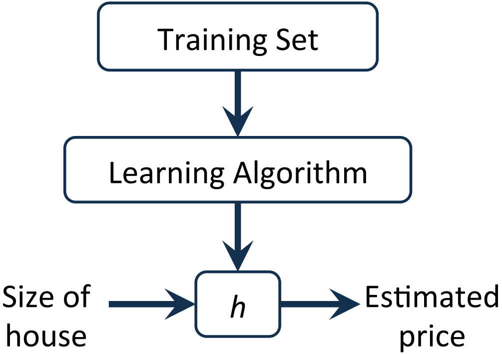
$y^{(1)} = 460$

Outline

- Recap
- Linear Regression
- Hypothesis Representation

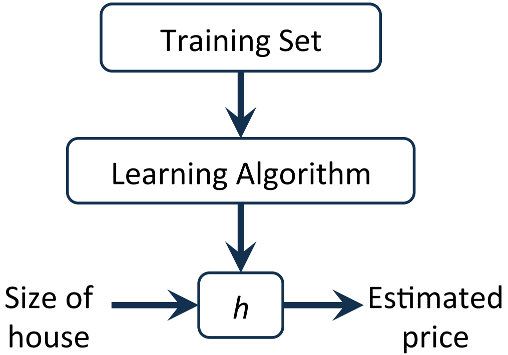

Training Set
Learning Algorithm
Size of house
h
Estimated price

Hypothesis Representation



h maps from x's to y's

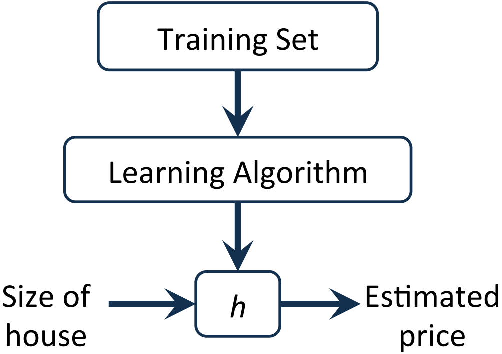
Hypothesis Representation



h maps from x's to y's

How do we represent h?

Hypothesis Representation

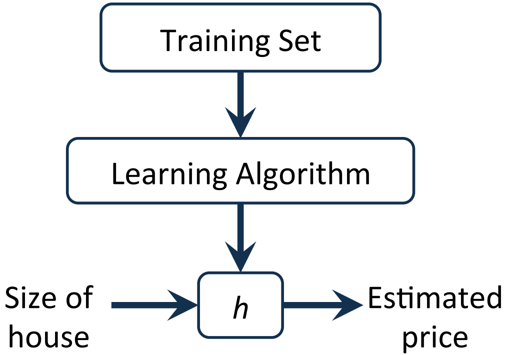


h maps from x's to y's

How do we represent h?

$h_{\boldsymbol{w}}(x) = \boldsymbol{w}_0 + \boldsymbol{w}_1 x$
Shorthand: $h(x)$

Hypothesis Representation



h maps from x's to y's

How do we represent h?

$h_{\boldsymbol{w}}(x) = \boldsymbol{w}_0 + \boldsymbol{w}_1 x$
Shorthand: $h(x)$

Linear regression with one variable (x)
Univariate linear regression

Choosing ws

Training Set

Size in feet^2 (x)	Price ($) in 1000's (y)
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852	178
...	...

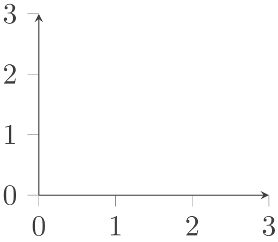
Hypothesis: $h_{\boldsymbol{w}}(x) = \boldsymbol{w}_0 + \boldsymbol{w}_1 x$

$\boldsymbol{w}_i$'s: Parameters

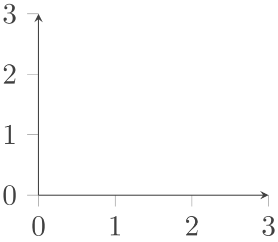
How to choose $\boldsymbol{w}_i$'s?

Hypothesis Example

$$h_{\boldsymbol{w}}(x) = \boldsymbol{w}_0 + \boldsymbol{w}_1 x$$



$$\boldsymbol{w}_0 = 1.5$$
$$\boldsymbol{w}_1 = 0$$



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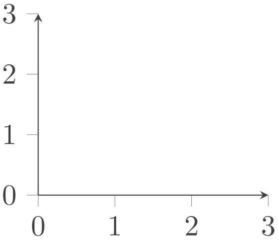

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Hypothesis Example

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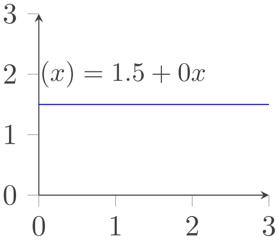

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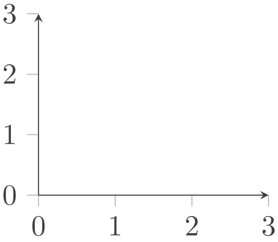

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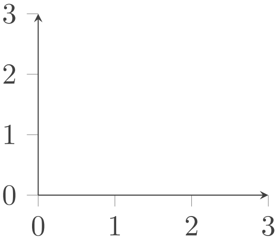

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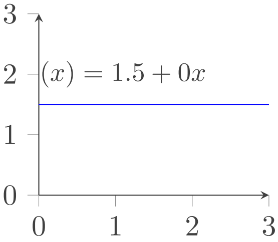

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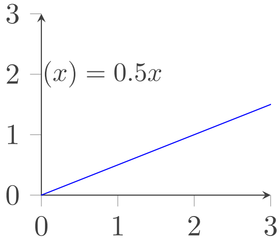

$$\boldsymbol{w}_0 = 0$$
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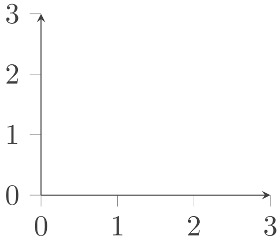

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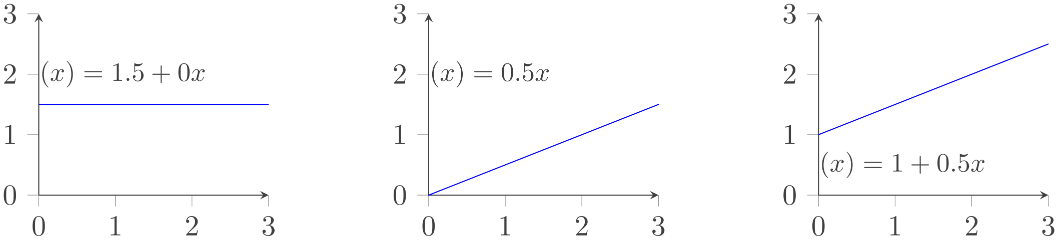

$$\boldsymbol{w}_0 = 1.5 \quad \boldsymbol{w}_1 = 0$$

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To continue in the next session.