
Applied Machine Learning with Big Data “EE 6973”



Topic:
Linear Regression

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Logistics

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Course Web: <https://github.com/ml6973/Course>

Mailing list: TBD

Course Social Network: TBD



Outline

Prerequisites:

Calculus

Python

Linear Algebra

Probability

3 Types of Learning

A gray circle representing supervised learning.

Supervised

- Learning from labeled data
- E.g., Spam classification

- Classification
- Regression
- Ranking

A green circle representing unsupervised learning.

Unsupervised

- Discover structure in unlabeled data
- E.g., Document clustering

- Clustering
- Hidden Markov Models

A yellow circle representing reinforcement learning.

Reinforcement

- Learning by “doing” with delayed reward
- E.g., Chess computer

Supervised Learning

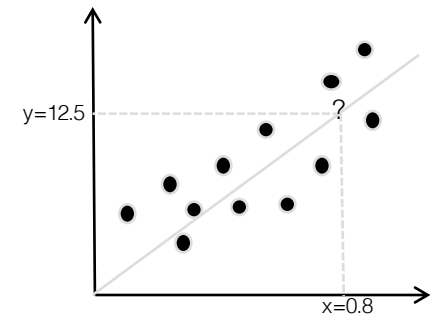
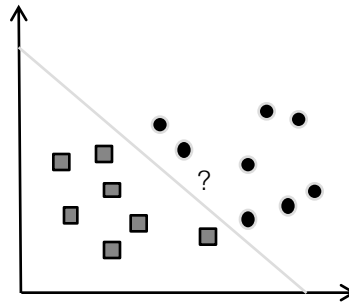
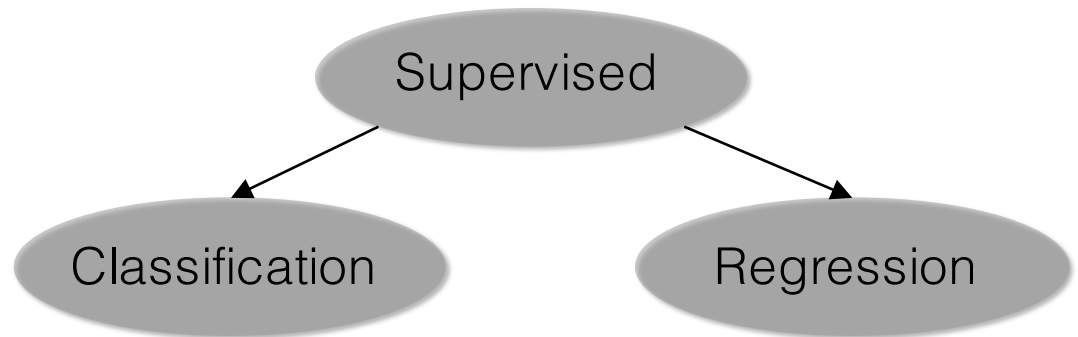
Given examples of a function $(X, F(X))$

Predict function $F(X)$ for new examples X

Discrete $F(X)$: Classification

Continuous $F(X)$: Regression

$F(X) = \text{Probability}(X)$: Probability estimation



Regression and Classification Examples

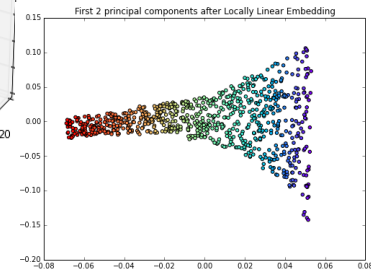
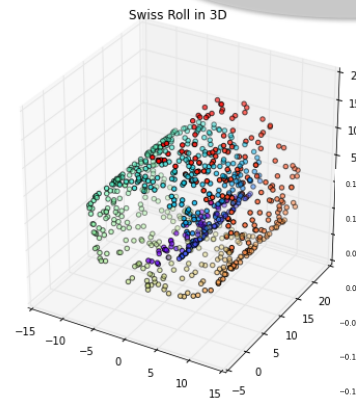
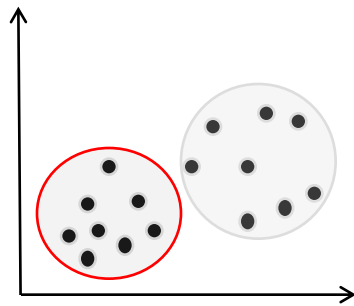
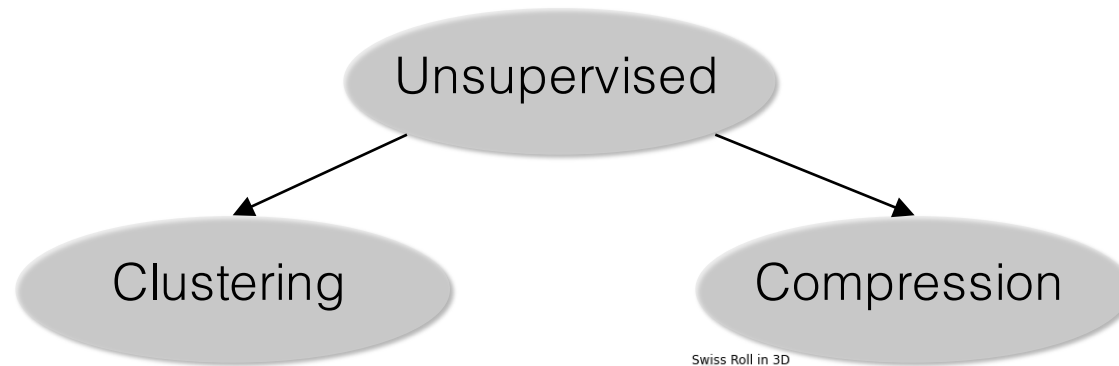
Stock prediction

- * Predict the price of a stock (y)
- * Depends on x =
 - Recent history of stock price
 - News events
 - Related commodities

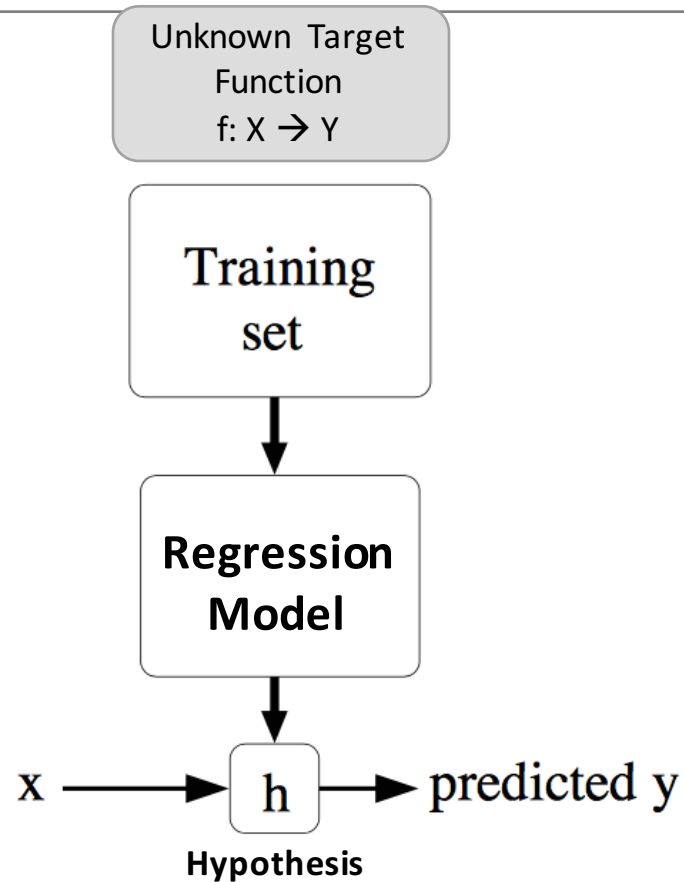
Spam or Not spam emails

Music or Tweeter
Sentiment Analysis

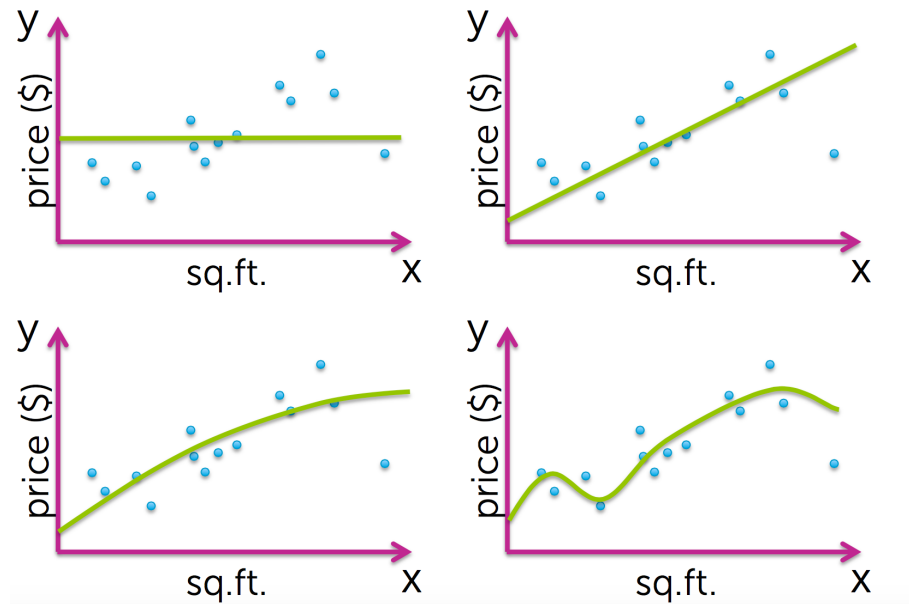
Unsupervised Learning



Linear Regression Learning Model



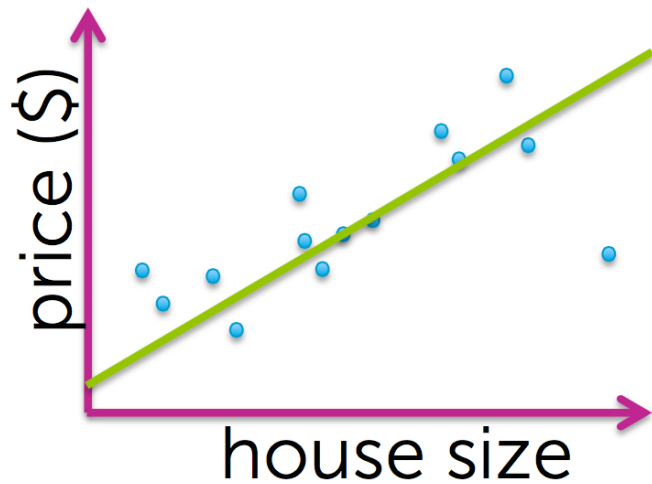
What is Linear Regression?



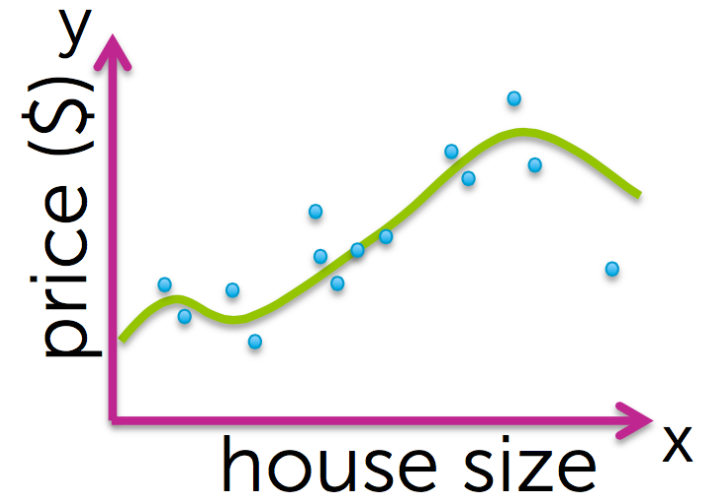
Simple Regression vs. Multiple Regression

What makes it simple?

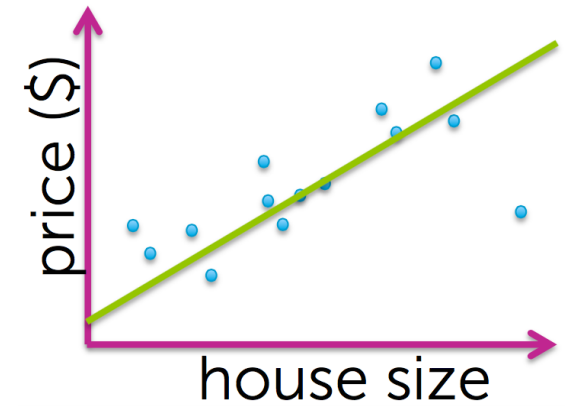
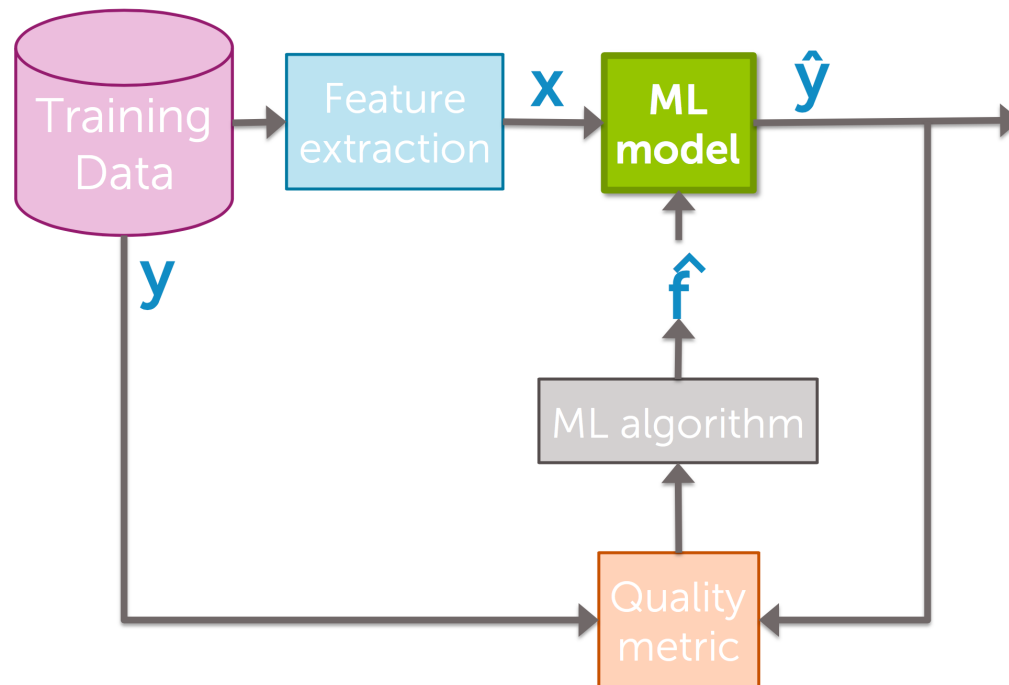
1 input and just fit a line to data



Fit **more complex relationships** than just a line

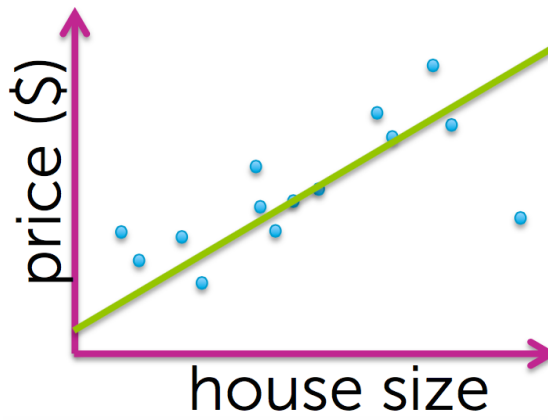


Regression Model



Predicting house prices

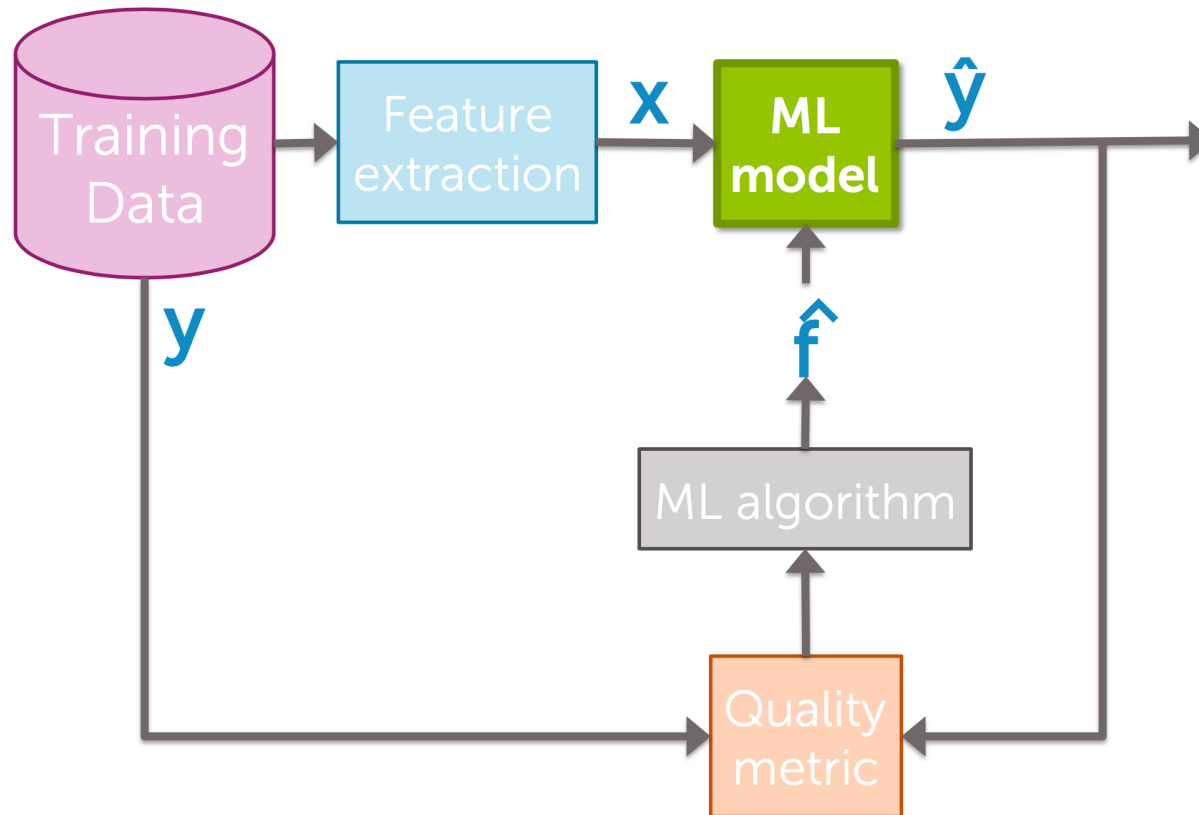
How much is my house worth?



Look at recent sales in my neighborhood

- How much did they sell for?

Regression Model



Regression Algorithm

We will need a starting value for the slope and intercept, a step_size and a tolerance

`initial_intercept = 0, initial_slope = 0, step_size = 0.05, tolerance = 0.01`

The algorithm

In each step of the gradient descent we will do the following:

1. Compute the predicted values given the current slope and intercept
2. Compute the prediction errors (prediction - Y)
3. Update the intercept:

compute the derivative: $\text{sum}(\text{errors})$

compute the adjustment as step size times the derivative

decrease the intercept by the adjustment

4. Update the slope:

compute the derivative: $\text{sum}(\text{errors} * \text{input})$

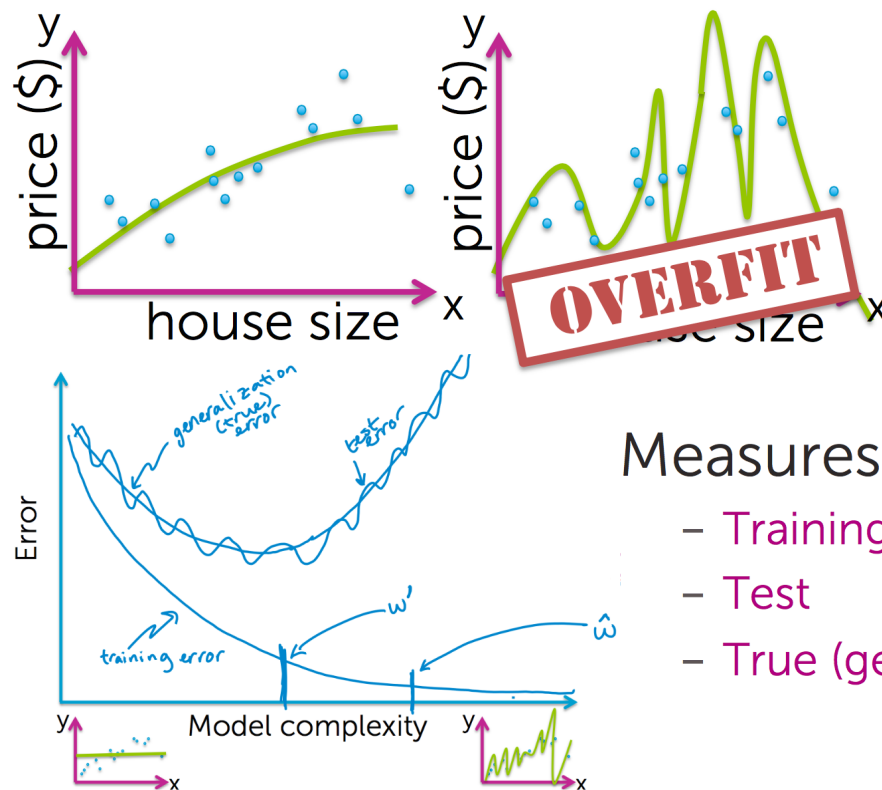
compute the adjustment as step_size times the derivative

decrease the slope by the adjustment

5. Compute the magnitude of the gradient

6. Check for convergence

Assessing Performance



Measures of error:

- Training
- Test
- True (generalization)

Real world examples

$X = \# \text{ hours of exercise in a week} \rightarrow Y = \text{body mass index}$

$Y = \# \text{ hours of studying in a week} \rightarrow Y = \text{grade for the course}$

X

Y

Objective/Error/Cost Function

Thank you

Question #1

What is an appropriate application of linear regression?

- 1) Predicting a person's height, given the amounts of certain substances in their diet
- 2) Predicting whether or not a person likes cake, given the amounts of certain substances in their diet

Question #2

What would lead to a negative r-squared?

- 1) We predict the opposite of the target value
- 2) We predict the negative of the target value
- 3) We predict worse than the mean of the target values

Assignment #1 - closed form example

Computing regression parameters The data

Consider the following 5 point synthetic data set:

X: 0,1,2,3,4

Y: 1,3,7,13,21

We want the line that “best fits” this data set as measured by residual sum of squares

In summary, we have:

slope = 5, intercept = -1

Finally we can add the line to our plot from above