INTRODUCTION TO DATA SCIENCE

This lecture is
based on course by E. Fox and C. Guestrin, Univ of Washington

20/10/2020

WFAiS UJ, Informatyka Stosowana
I stopień studiów

Regression for predictions

- **Primer**
- **Advanced**
  - **Linear regression**
  - **Multiple regression**
  - **Accesing performance**
  - **Ridge regression**
  - **Feature selection and lasso regression**
  - **Nearest neighbor and kernel regression**

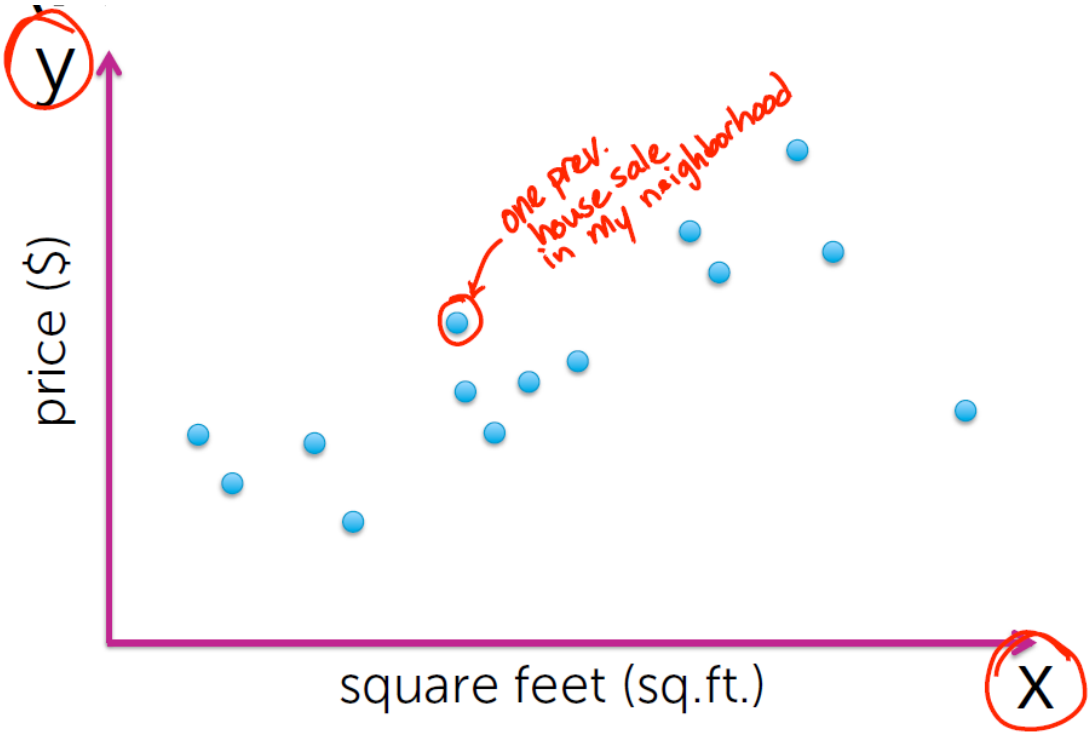
How much is my house worth

- **Predicting value of the house**

Lets look at the recent
sales in the neighborhood.
How much did they sell for?
What do that houses look like?

Naive: plot recent house sales

- **We take observations that we have and make a plot of them.**

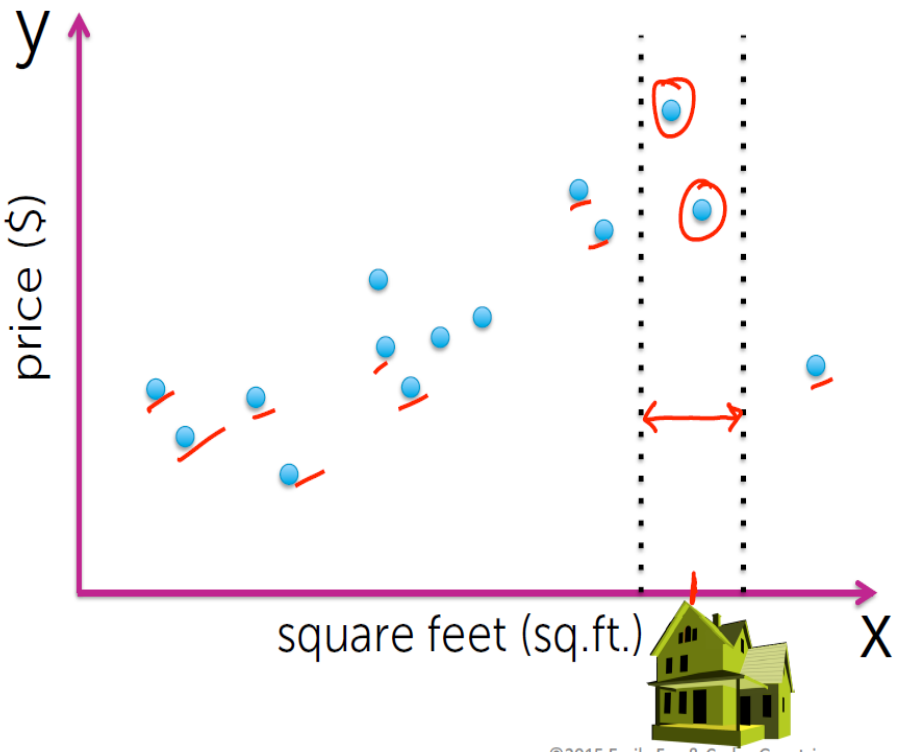


Terminology:

x – feature, covariate, or predictor

y – observation or response

Predict by prizes of similar houses

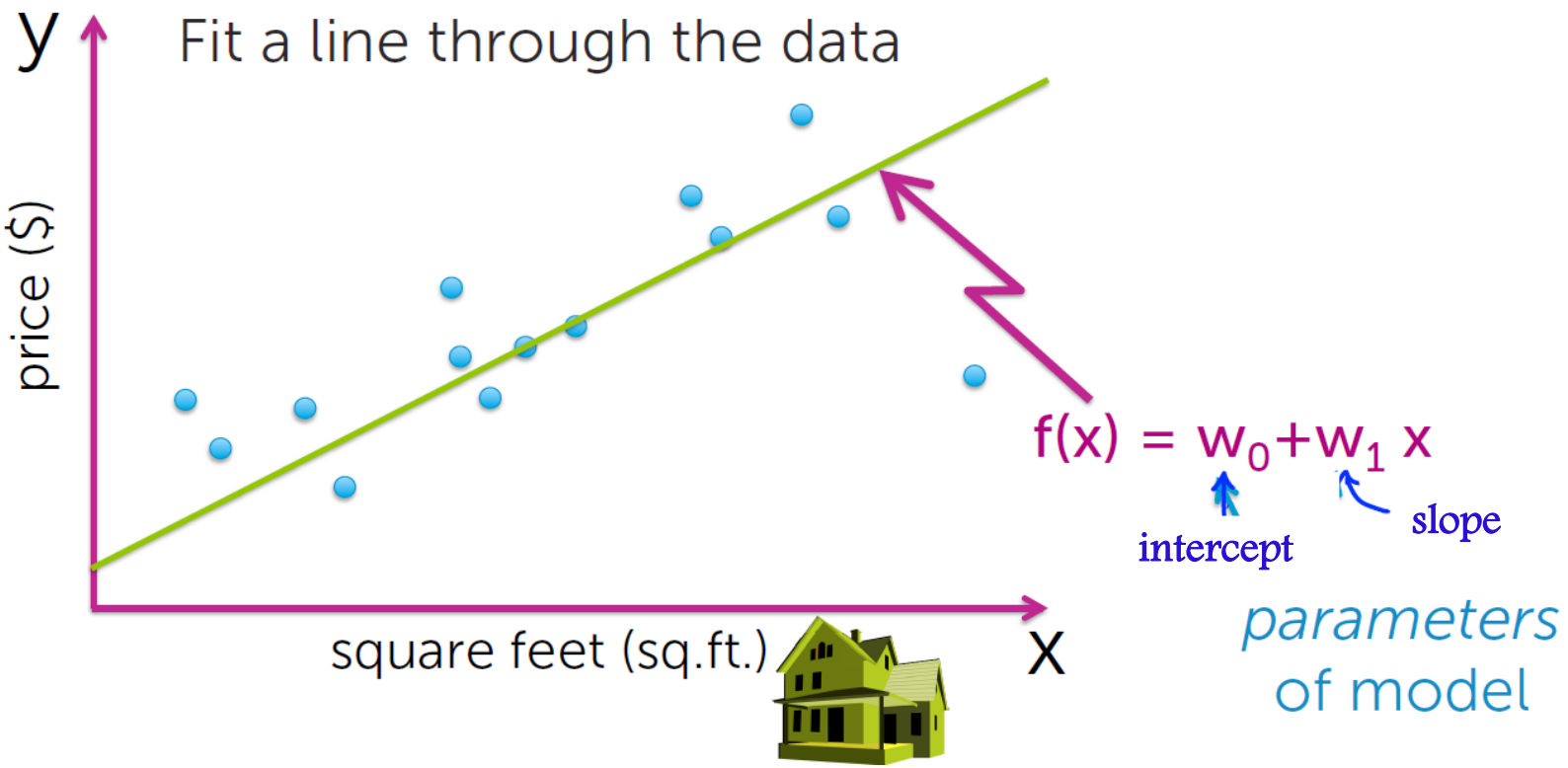


- Look at average price in range
- **Still only 2 houses!**
- Throwing out info from all other sales

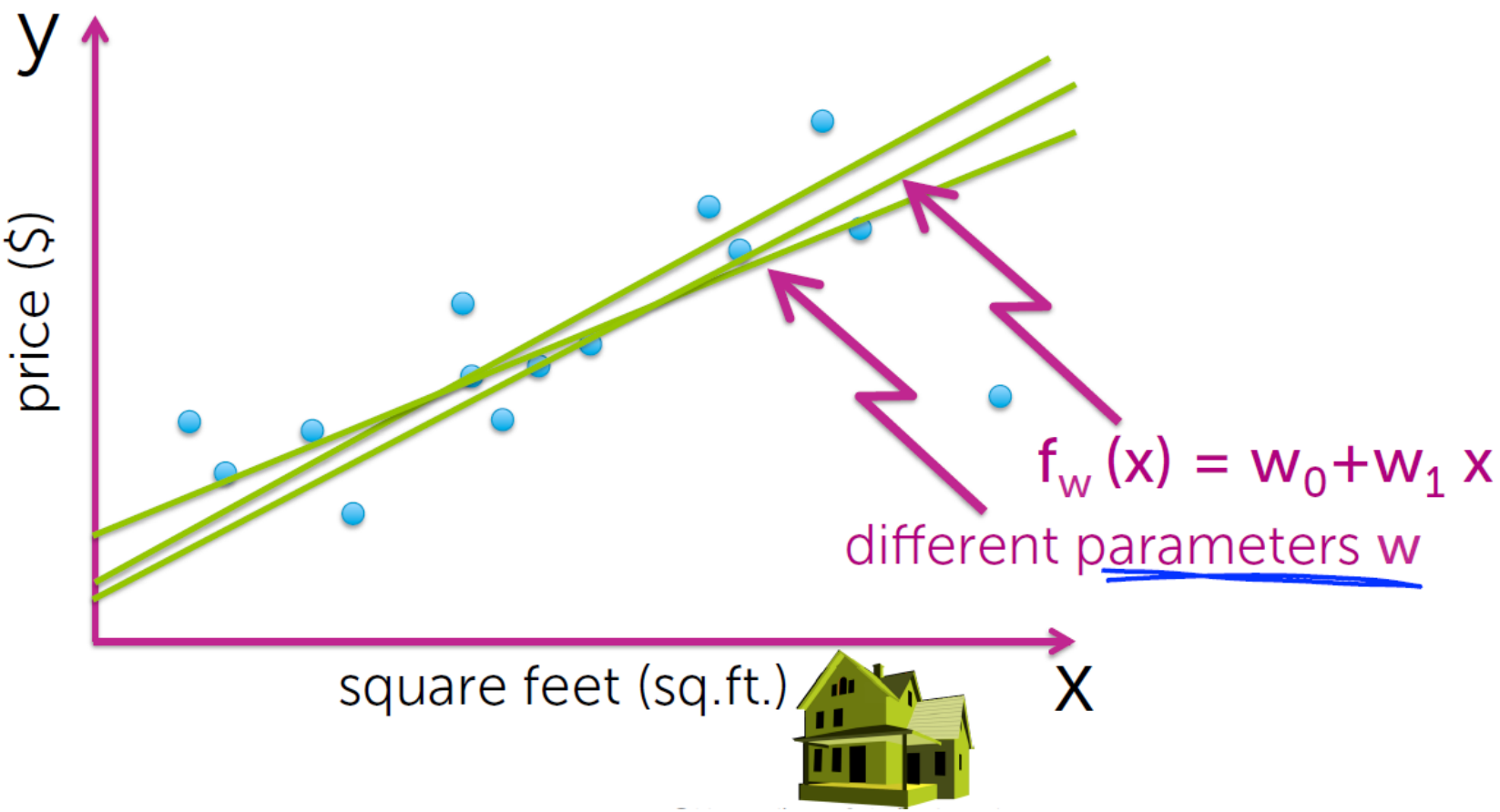
Is it really reasonably to believe that there is no information there? We would like to leverage all avaible information.

Linear regression: a model based relation

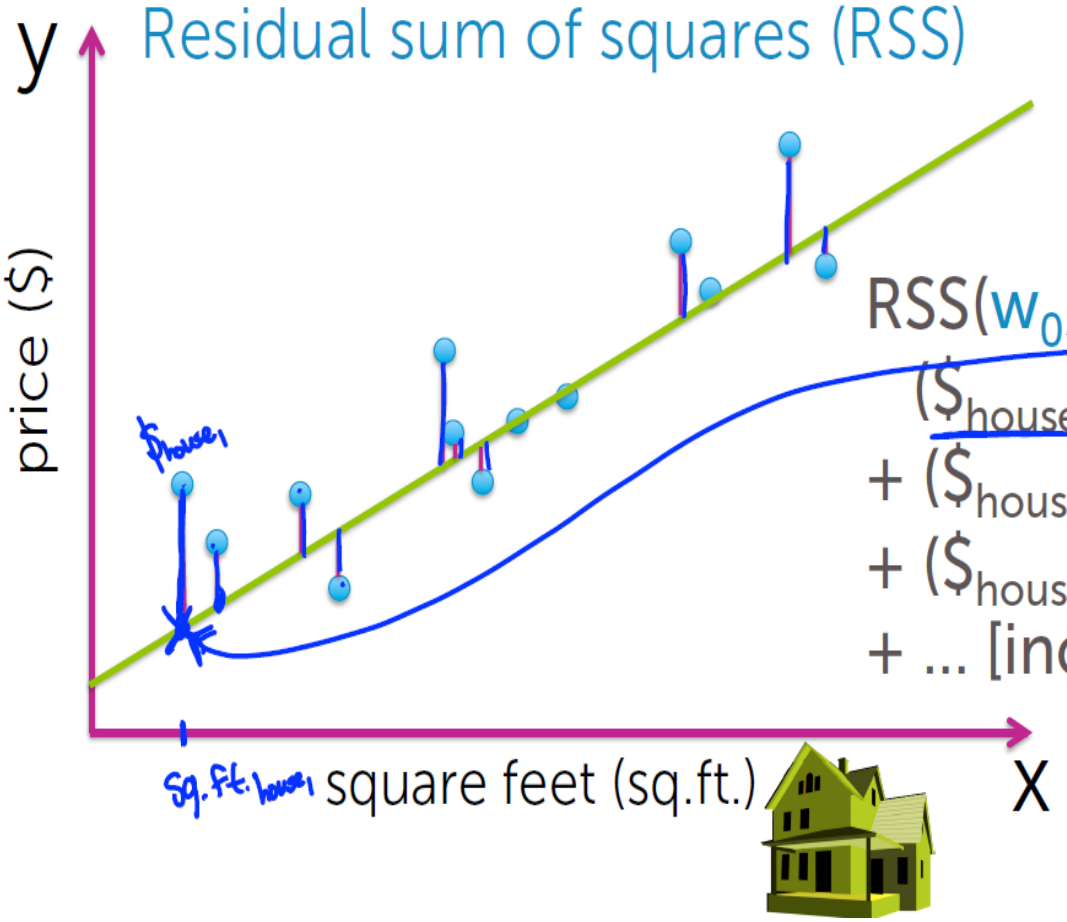
Use a linear regression model



Which line?

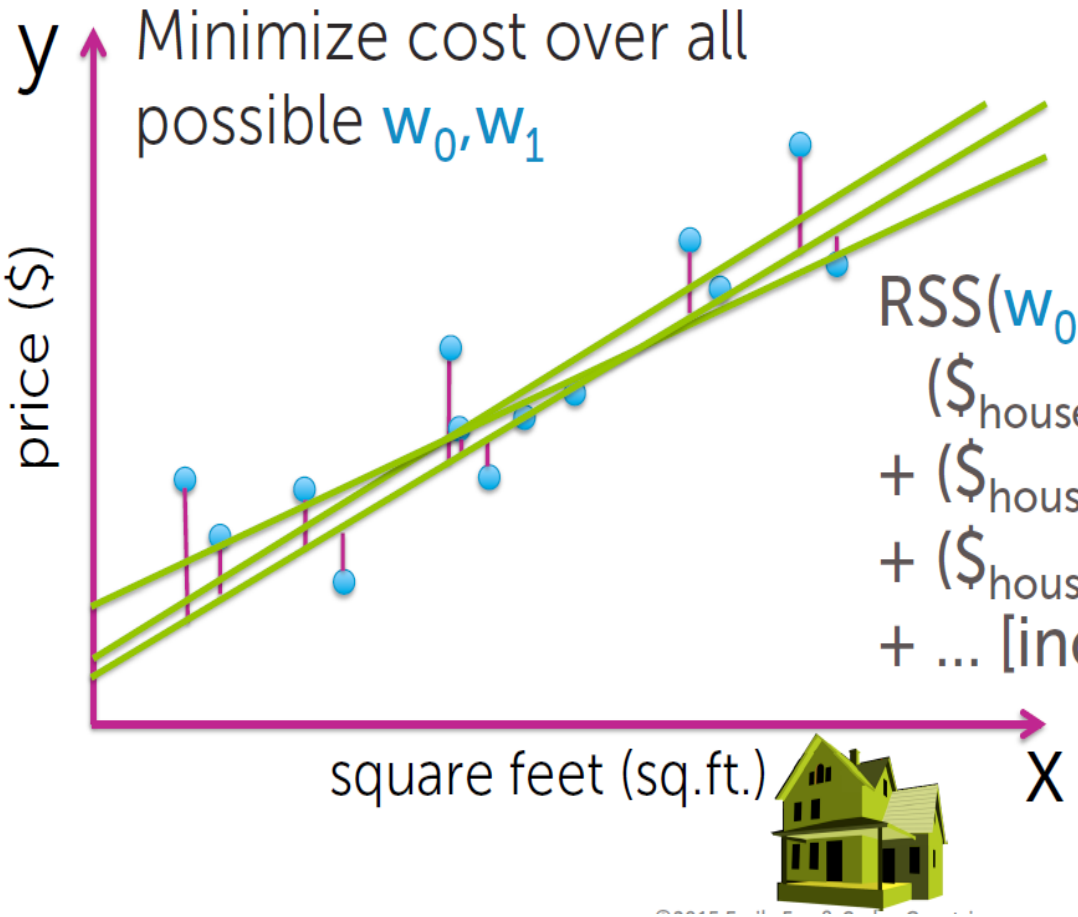


Defining a cost of a given line



$$RSS(w_0,w_1) = ($_{house\ 1} - [w_0 + w_1 sq.ft._{house\ 1}])^2 + ($_{house\ 2} - [w_0 + w_1 sq.ft._{house\ 2}])^2 + ($_{house\ 3} - [w_0 + w_1 sq.ft._{house\ 3}])^2 + \ldots \text{[include all houses]}$$

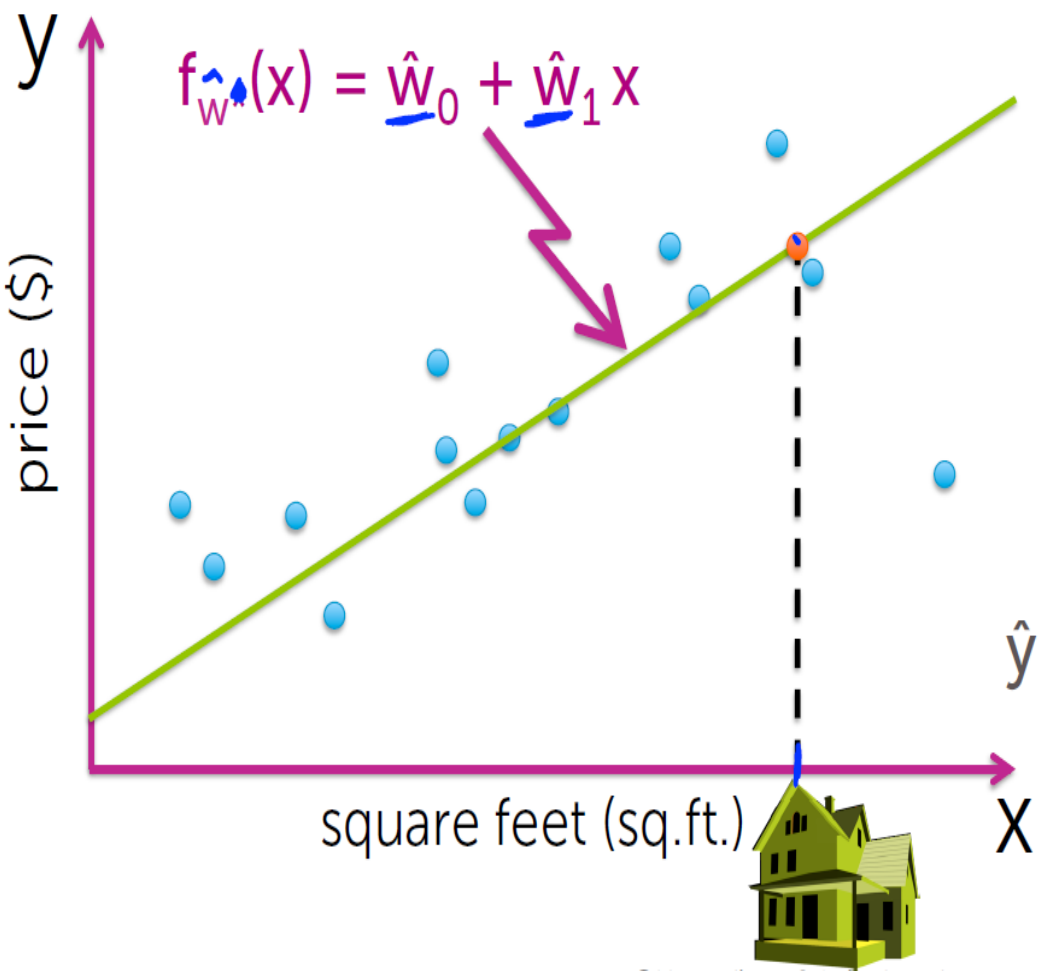
Find „best” line



$$RSS(w_0,w_1) = (\$_{house\ 1} - [w_0 + w_1 sq.ft._{house\ 1}])^2 + (\$_{house\ 2} - [w_0 + w_1 sq.ft._{house\ 2}])^2 + (\$_{house\ 3} - [w_0 + w_1 sq.ft._{house\ 3}])^2 + \ldots \text{[include all houses]}$$

$$\hat{W} = (\hat{w}_0, \hat{w}_1)$$

Predicting your house price



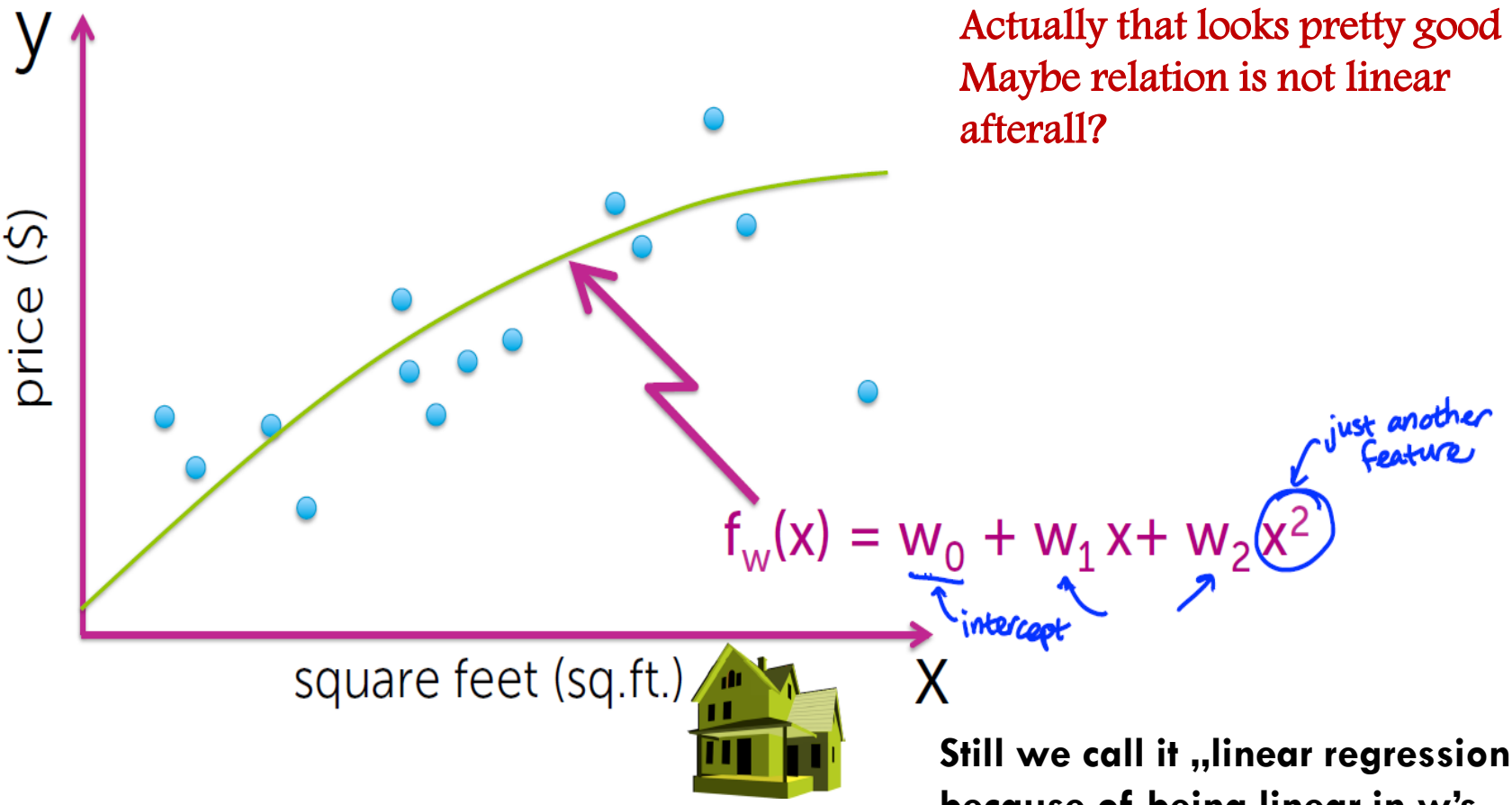
Q. What do you think?
Is it good analysis?

A. I am not sure that it has linear trend. Did you tried quadratic function?

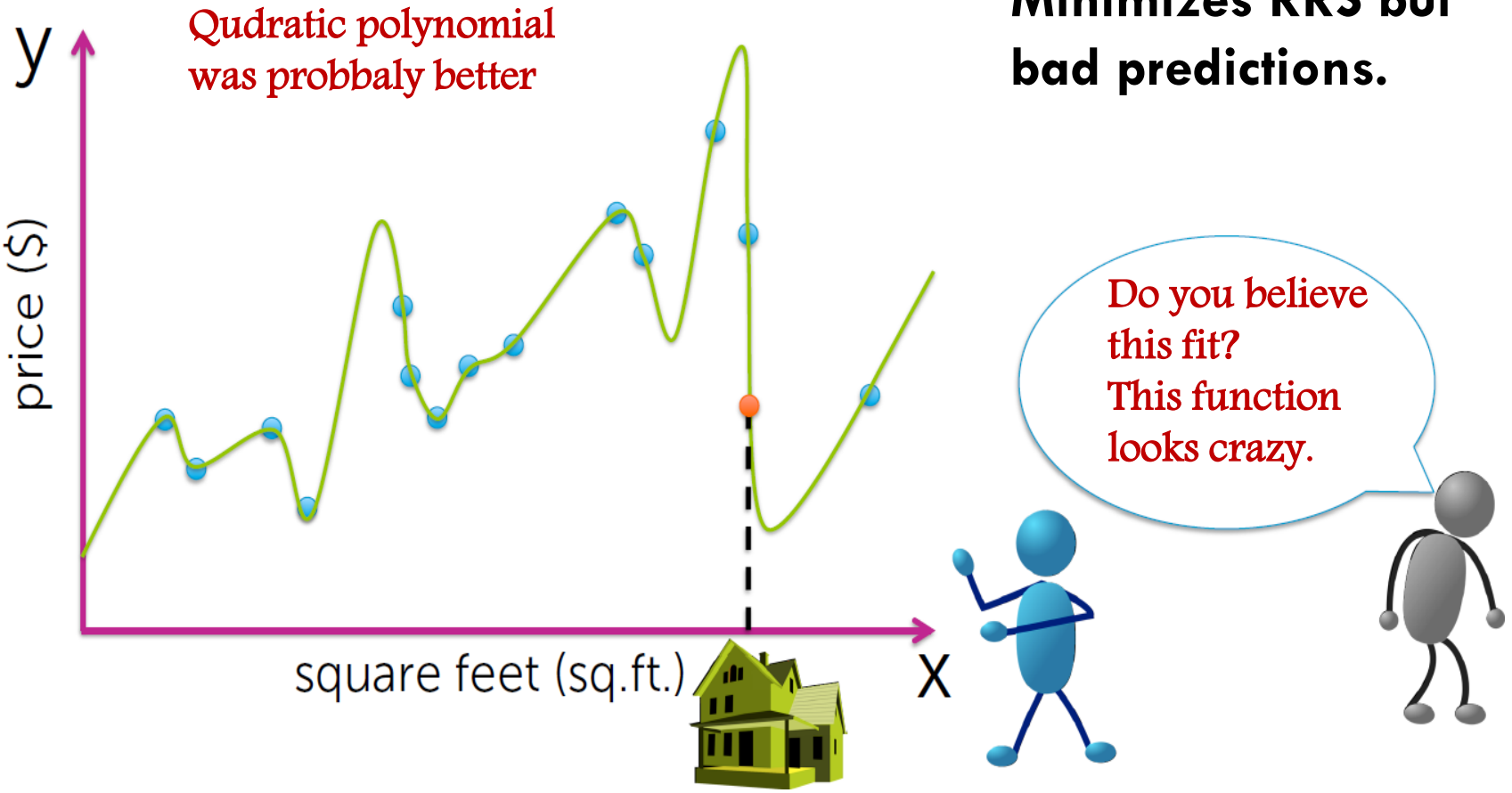
Best guess of your house price:

$\hat{y} = \hat{w}_0 + \hat{w}_1 \text{ sq.ft.}_{\text{your house}}$

What about quadratic function?



Or even higher order polynomial?

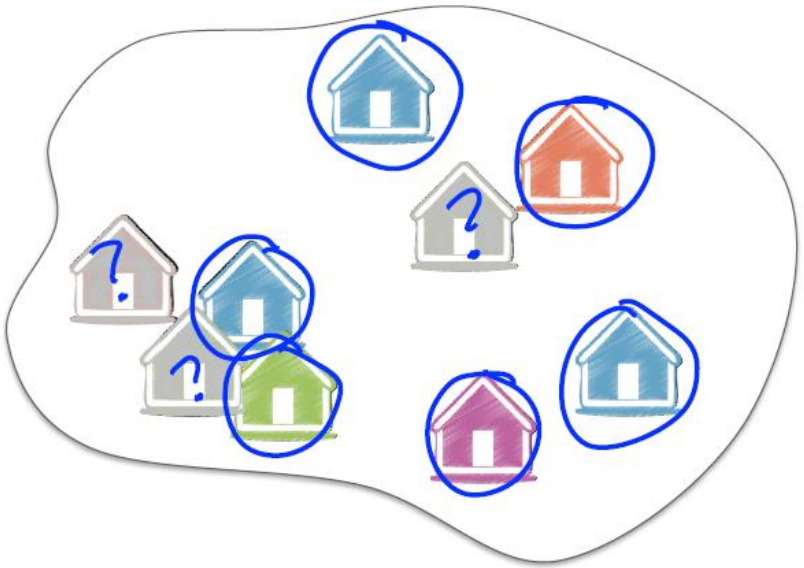


How to choose model order/complexity

- Want good predictions, but can't observe future
- **Simulate predictions**

1. Remove some houses
2. Fit model on remaining
3. Predict heldout houses

We have to work with the data that we have

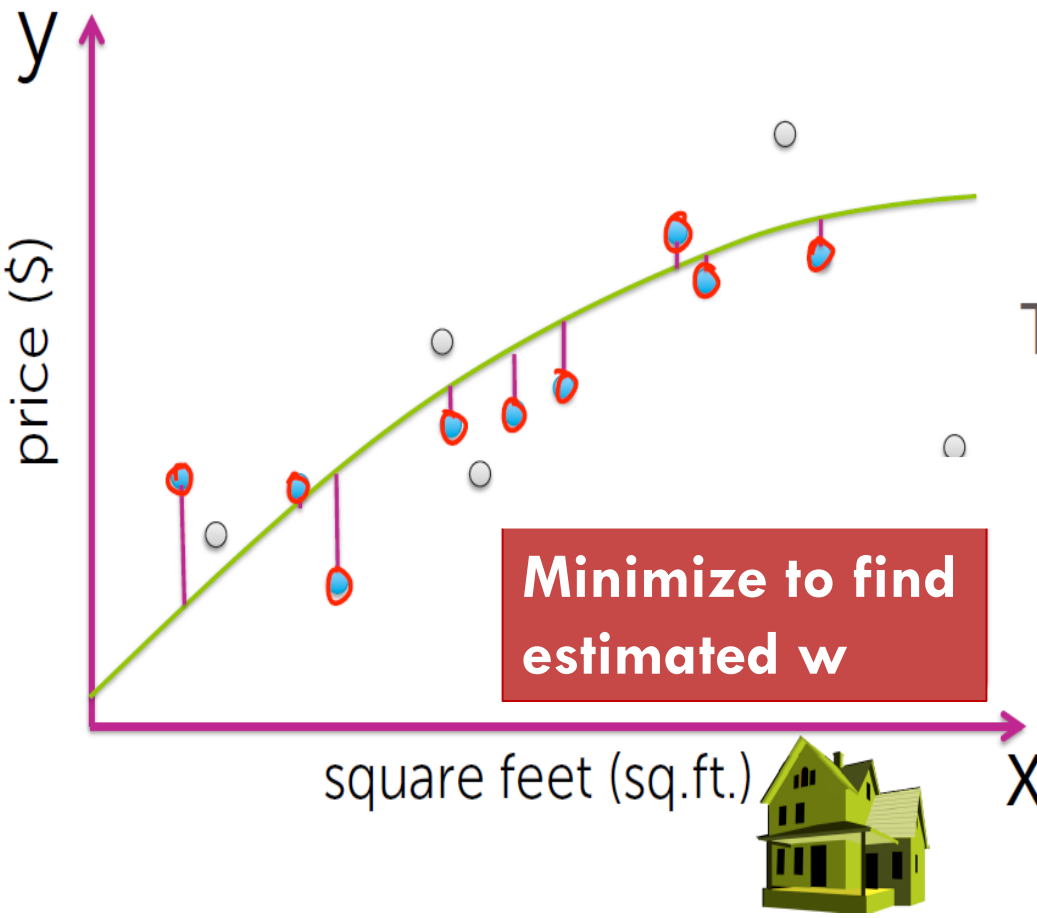


Training/test split

– training set

– test set

Training error



Training error (w) =

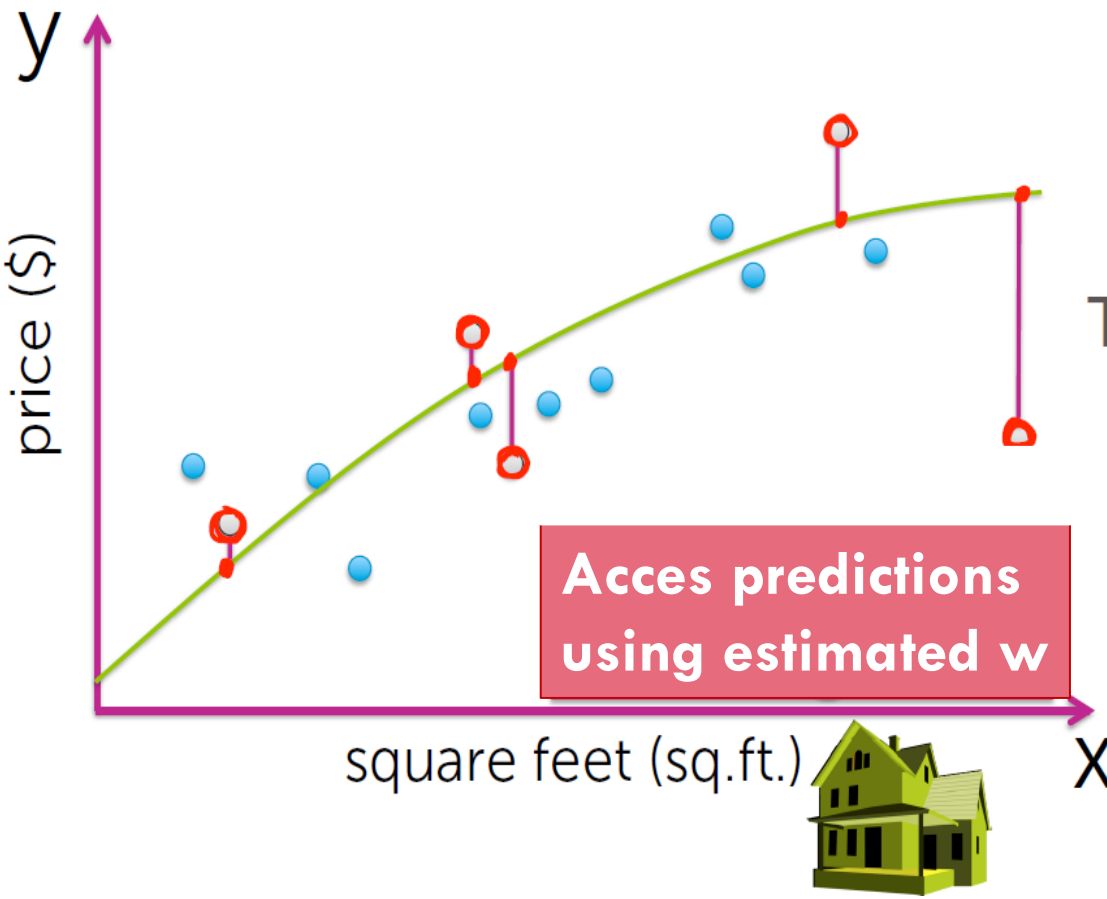
$(\$_{train\ 1} - f_w(sq.ft._{train\ 1}))^2$

$+ (\$_{train\ 2} - f_w(sq.ft._{train\ 2}))^2$

$+ (\$_{train\ 3} - f_w(sq.ft._{train\ 3}))^2$

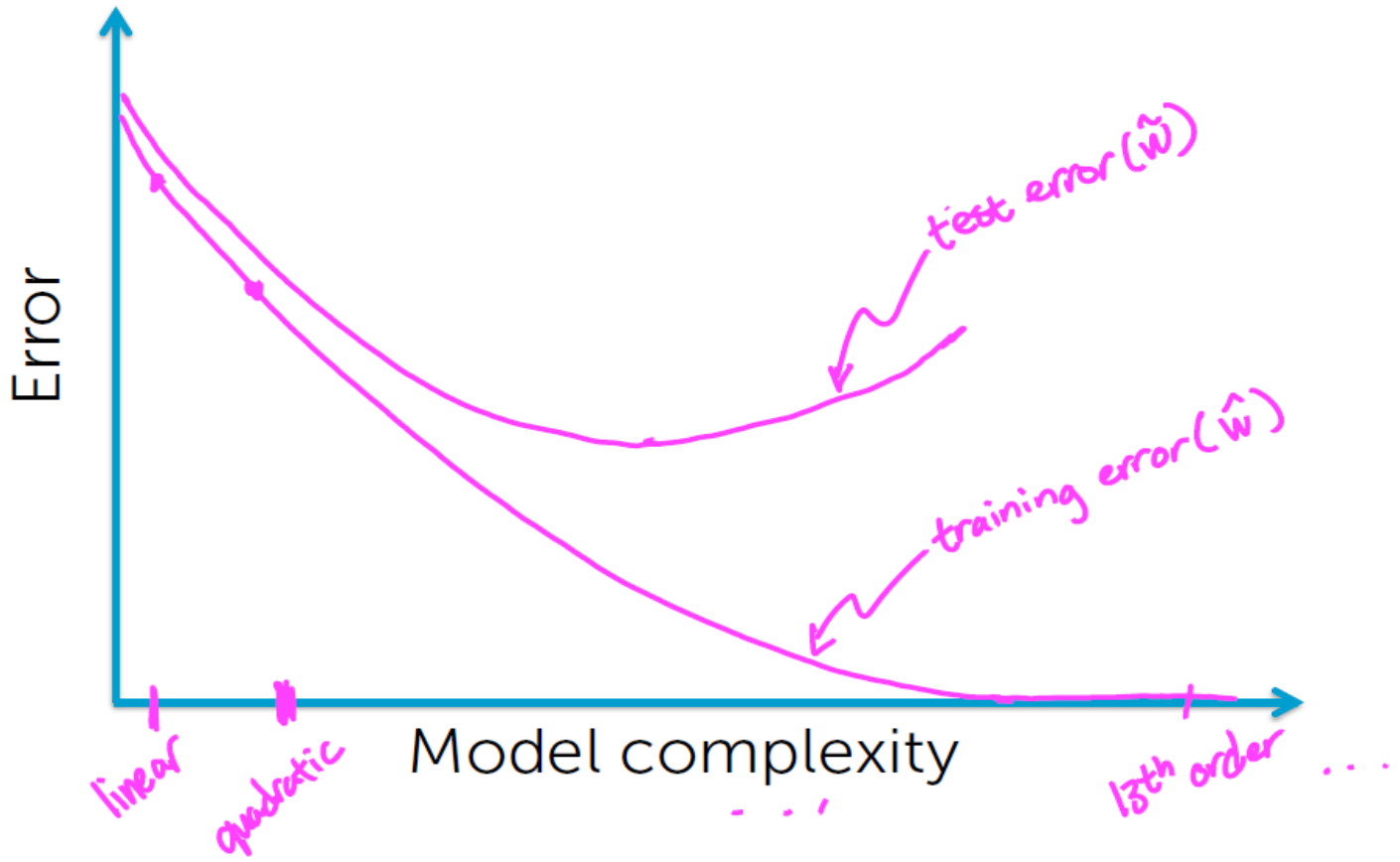
+ ... [include all training houses]

Test error

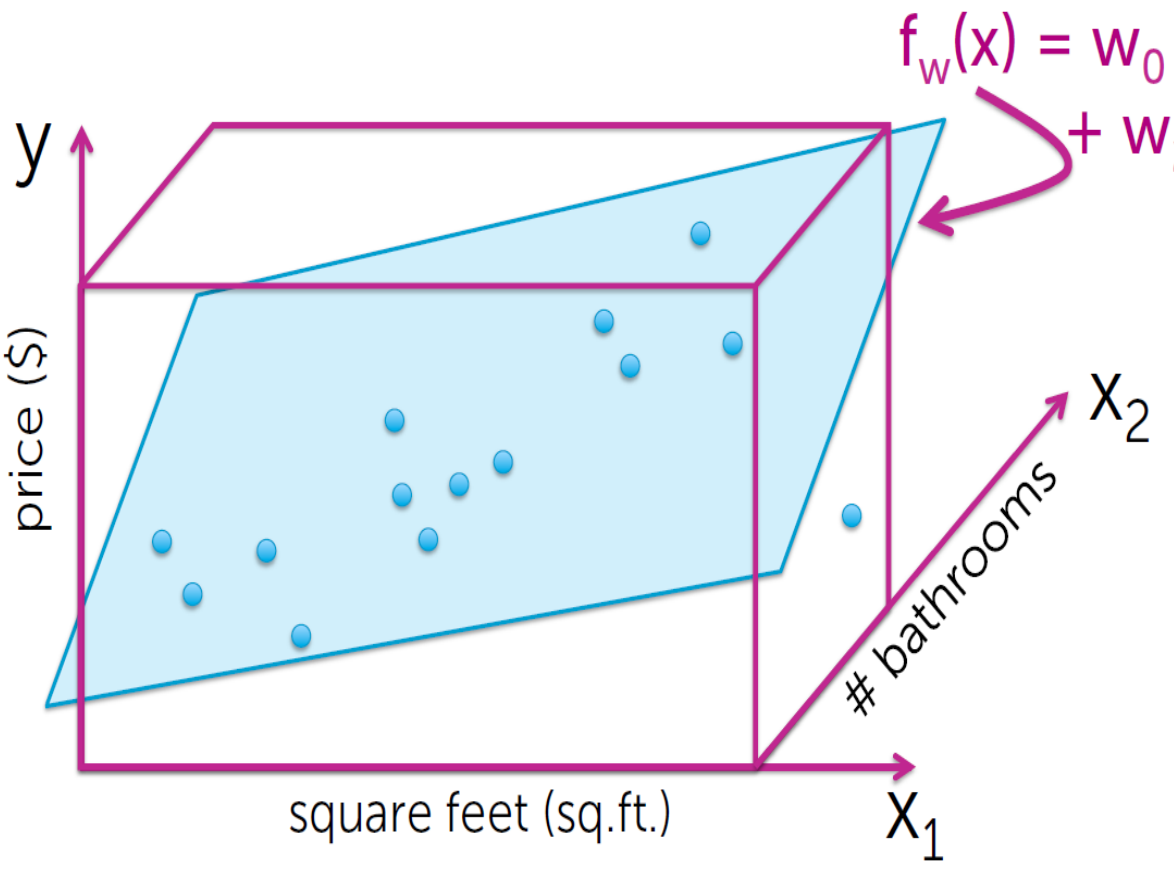


Test error ($\hat{w}$) =
$(\$_{test\ 1} - f_{\hat{w}}(sq.ft._{test\ 1}))^2$
$+ (\$_{test\ 2} - f_{\hat{w}}(sq.ft._{test\ 2}))^2$
$+ (\$_{test\ 3} - f_{\hat{w}}(sq.ft._{test\ 3}))^2$
+ ... [include all test houses]

Training/test curve



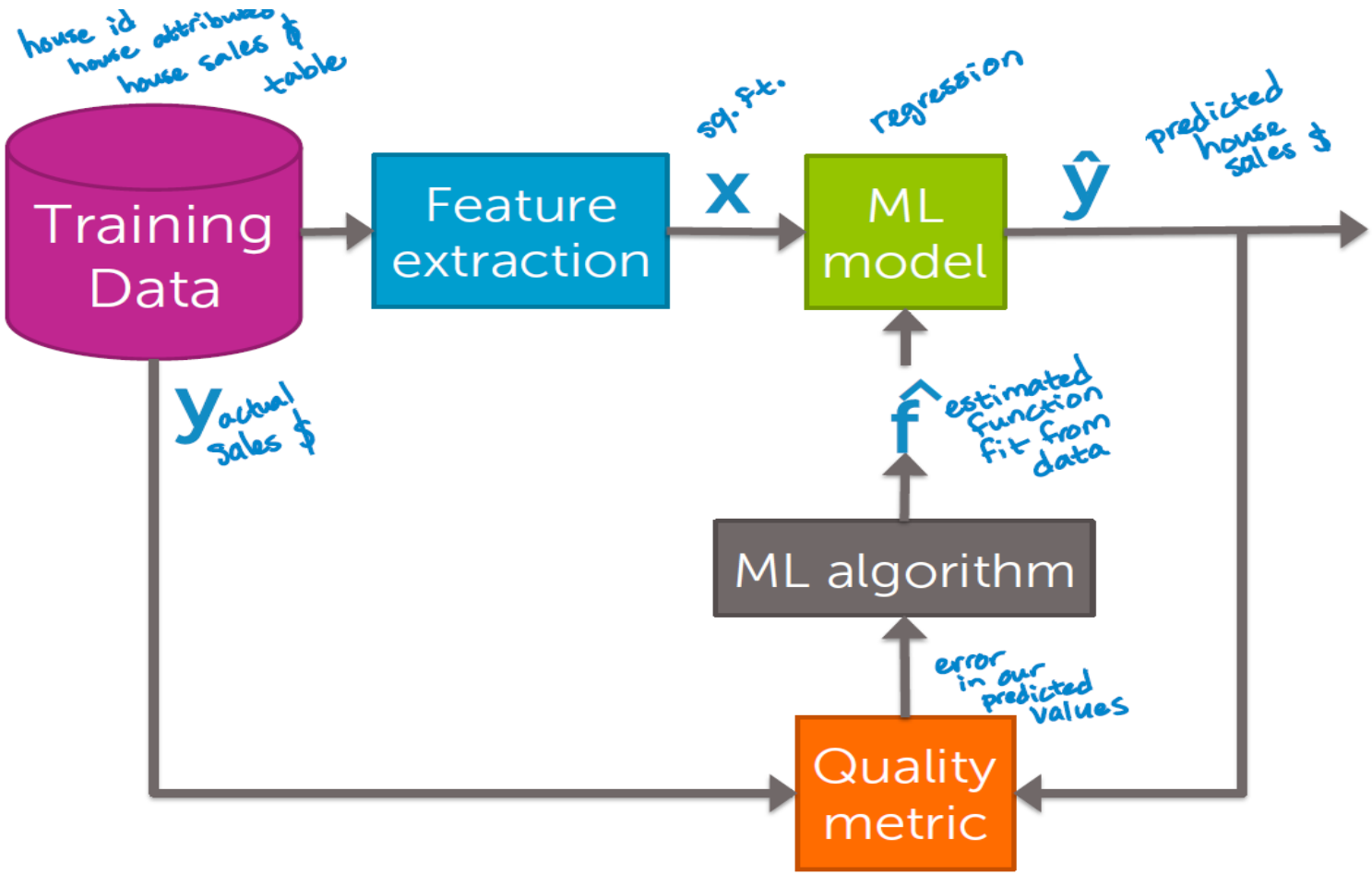
Add more features



- Possible choices:
  - Square feet
  - # bathrooms
  - # bedrooms
  - Lot size
  - Year built
  - …

Where do we stop?

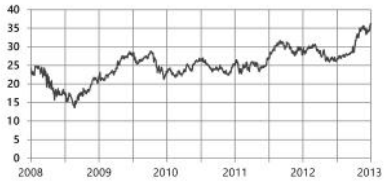
Regression ML block



Other applications

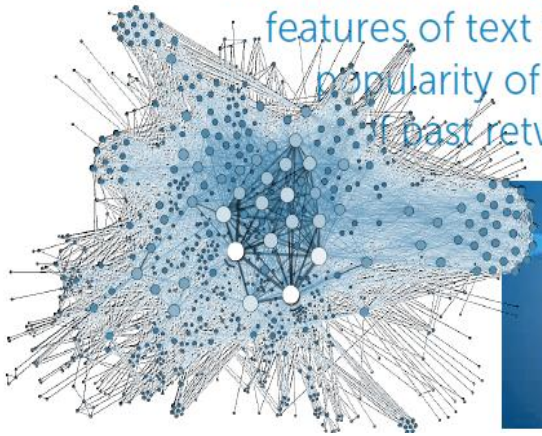
Stock predictions

- Predict the price of a stock
- Depends on
  - Recent history of stock price
  - News events
  - Related commodities



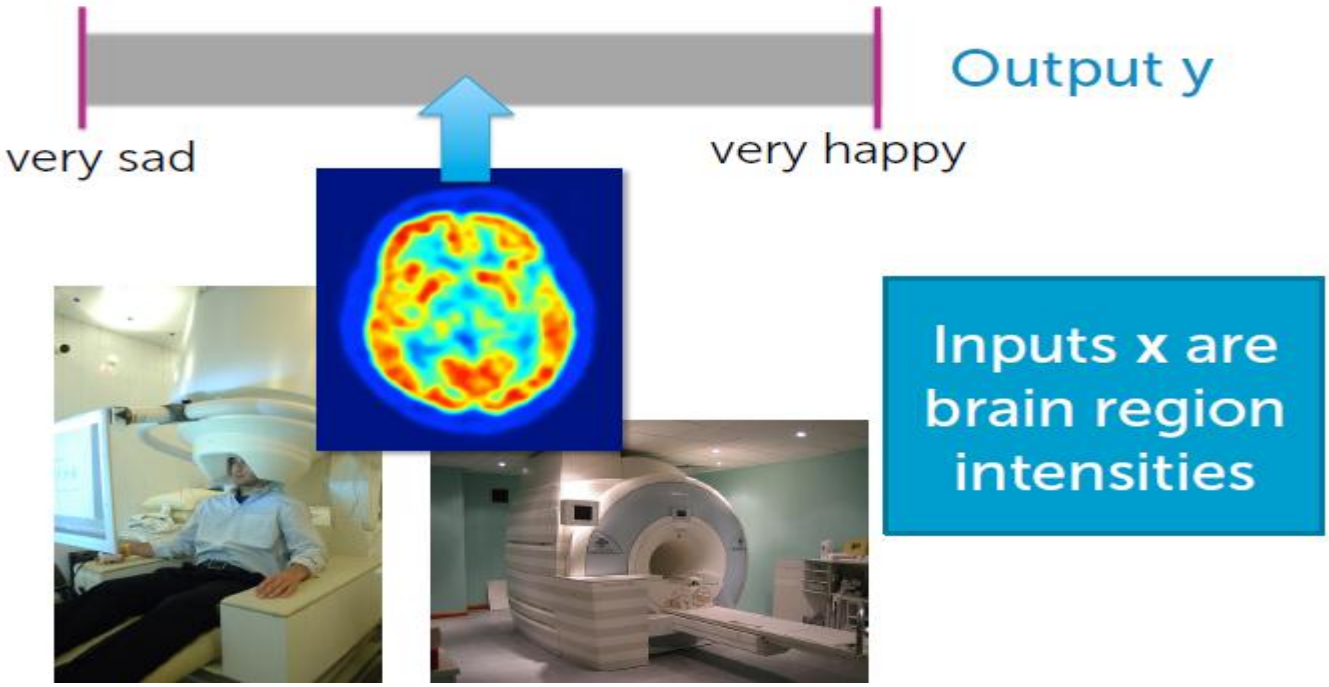
Tweed popularity

- How many people will retweet your tweet?
- Depends on # followers,
  # of followers of followers,
  features of text tweeted,
  popularity of hashtag,
  # past retweets,...



Other applications

Reading your mind



We discussed how to

- Describe the input (features) and output (real-valued predictions) of a regression model
- Calculate a goodness-of-fit metric (e.g., RSS)
- Estimate model parameters by minimizing RSS (algorithms to come…)
- Exploit the estimated model to form predictions
- Perform a training/test split of the data
- Analyze performance of various regression models in terms of test error
- Use test error to avoid overfitting when selecting amongst candidate models
- Describe a regression model using multiple features
- Describe other applications where regression is useful