

# Regression:

A machine learning perspective

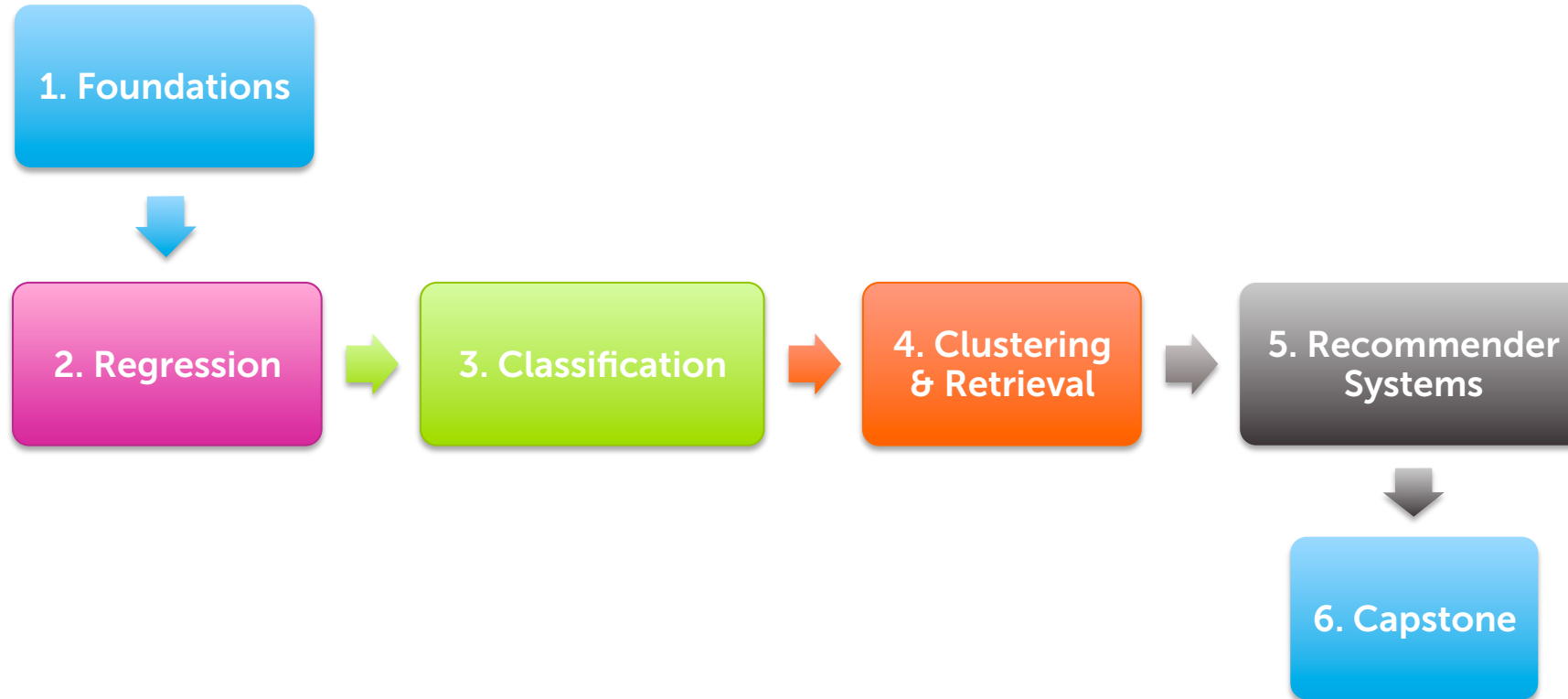
Emily Fox & Carlos Guestrin

Machine Learning Specialization

University of Washington

# Part of a specialization

# This course is a part of the Machine Learning Specialization

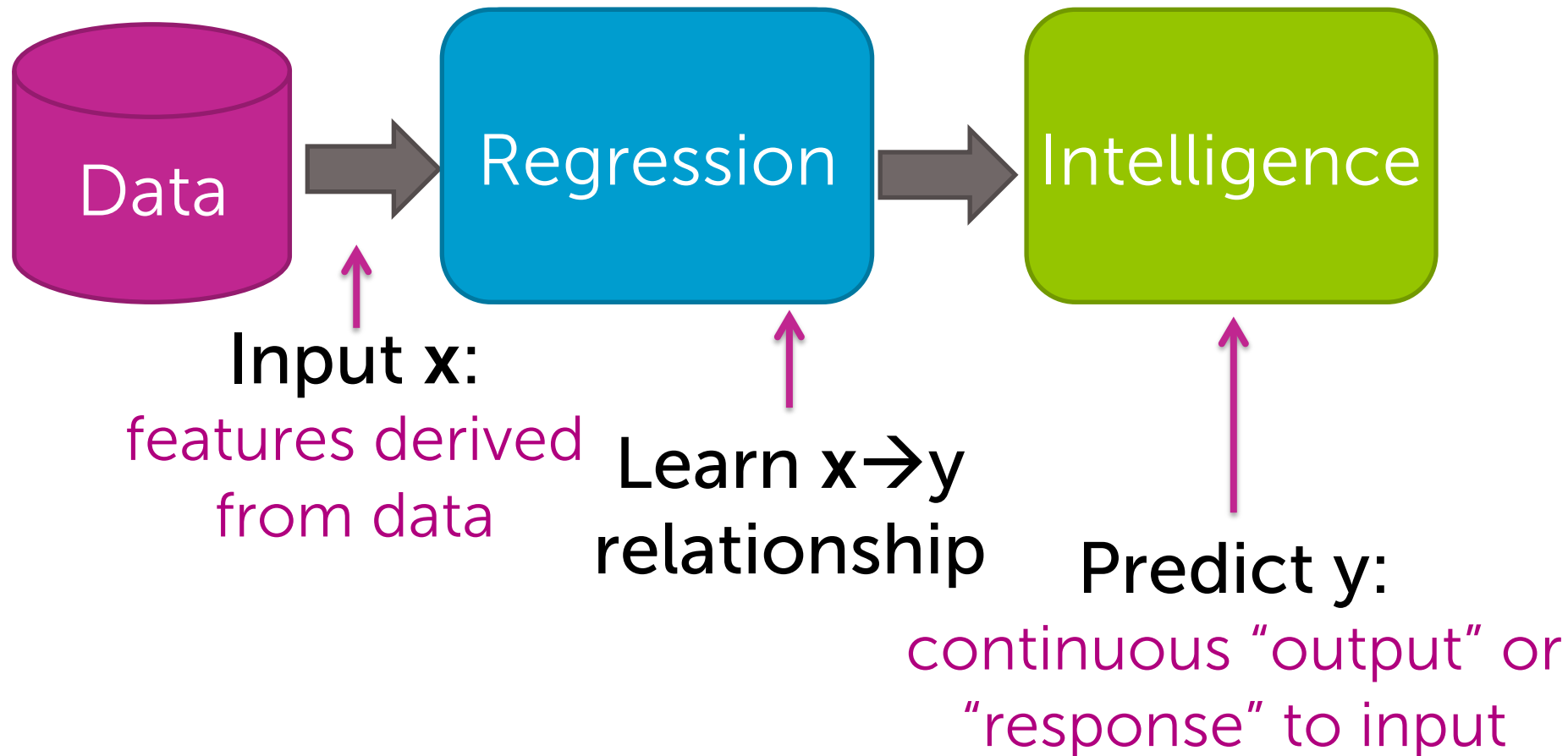


# What is the course about?



# What is regression?

From features to predictions



# Salary after ML specialization



hard work



- How much will your salary be? ( $y = \$\$$ )
- Depends on  $\mathbf{x}$  = performance in courses, quality of capstone project, # of forum responses, ...

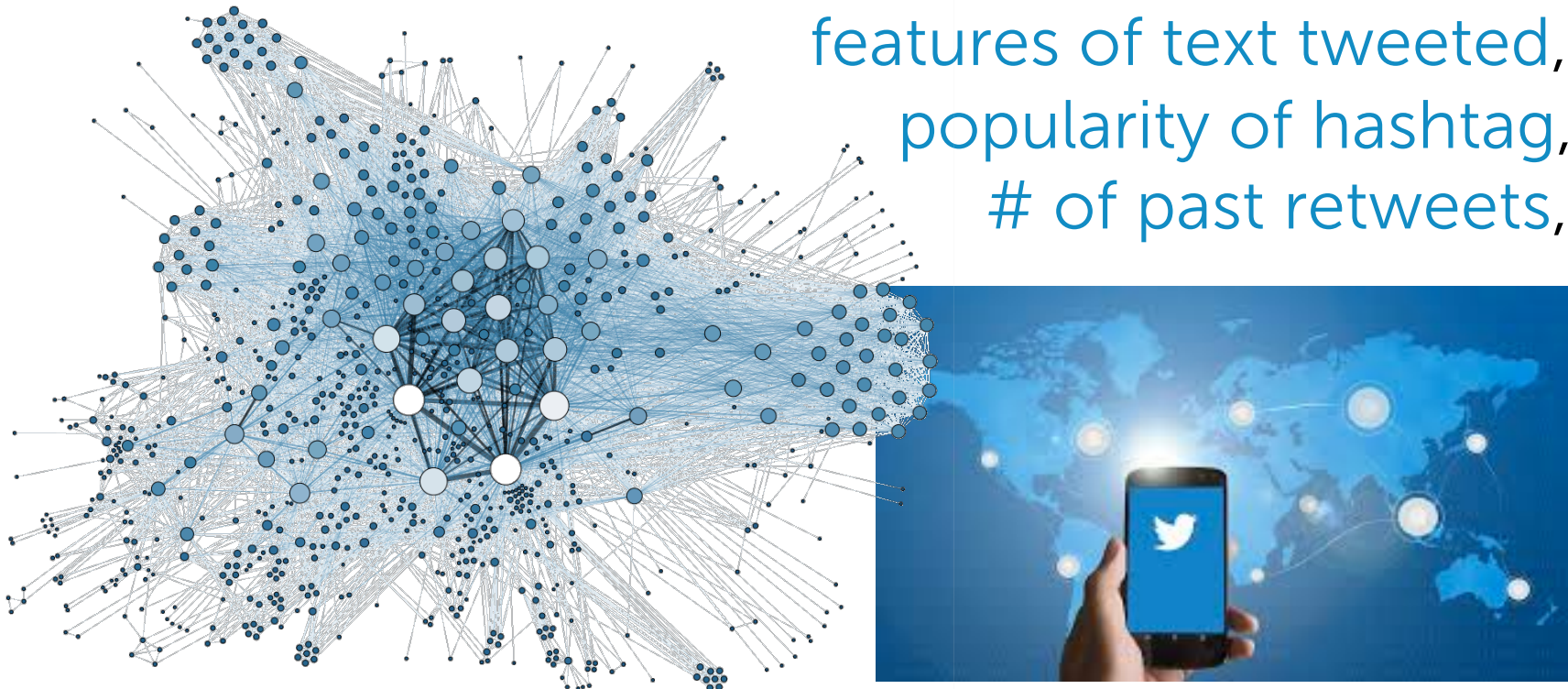
# Stock prediction

- Predict the price of a stock ( $y$ )
- Depends on  $\mathbf{x}$  =
  - Recent history of stock price
  - News events
  - Related commodities



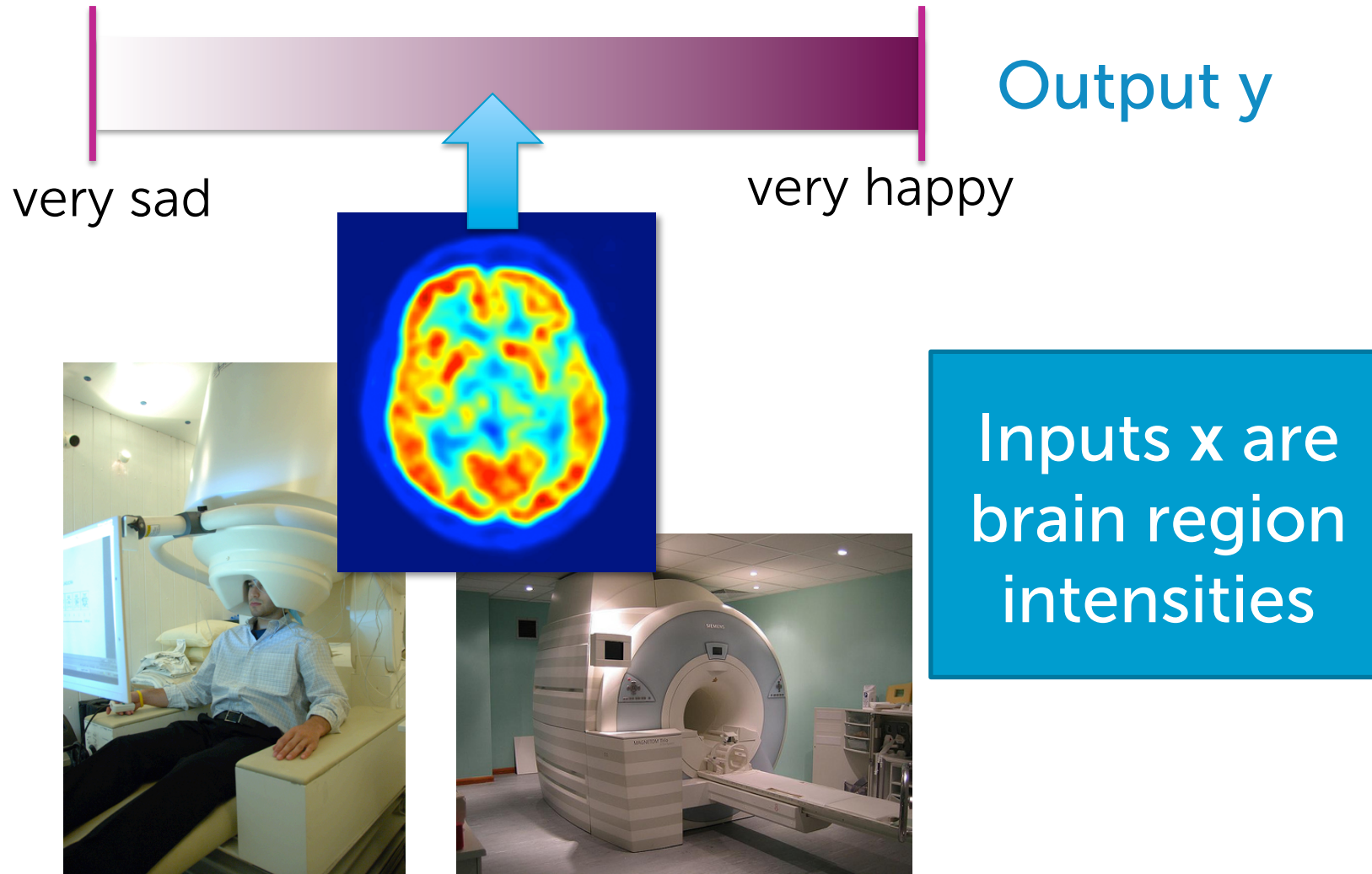
# Tweet popularity

- How many people will retweet your tweet? ( $y$ )
- Depends on  $\mathbf{x}$  = # followers,  
# of followers of followers,  
features of text tweeted,  
popularity of hashtag,  
# of past retweets,...

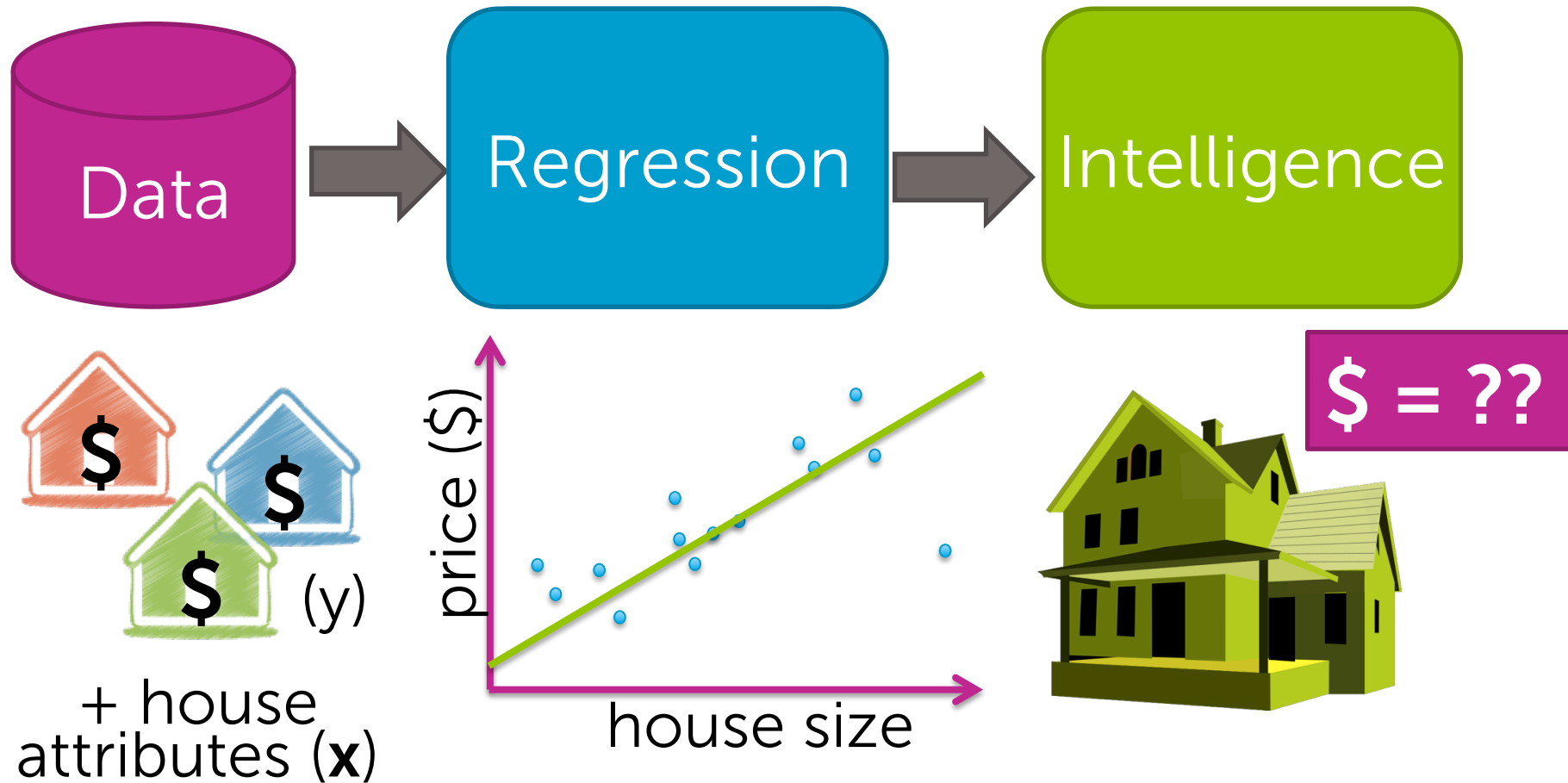




# Reading your mind



# Case Study: Predicting house prices



# Impact of regression

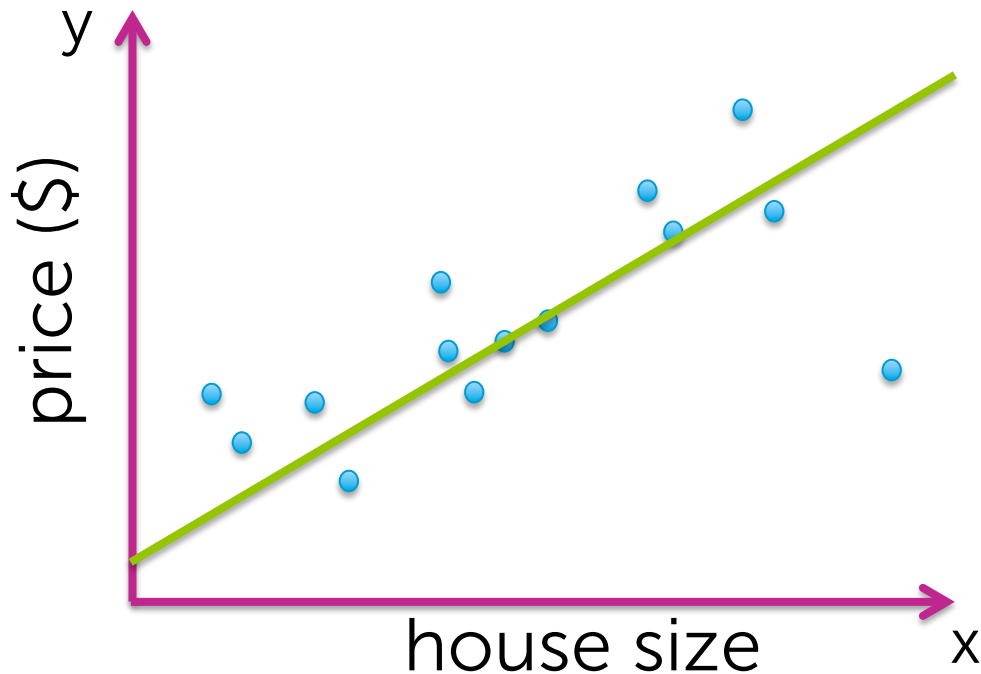
# Course outline



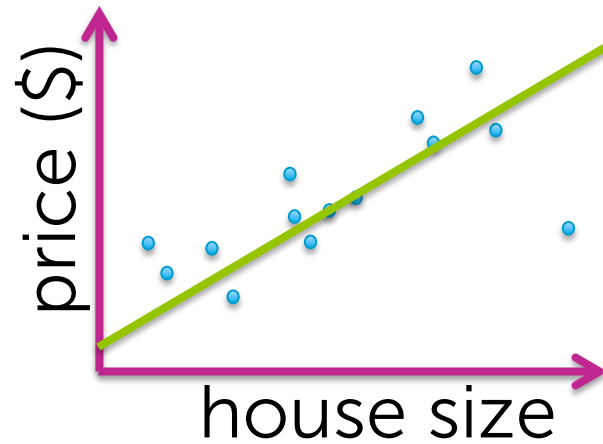
# Module 1: Simple Regression

What makes it simple?

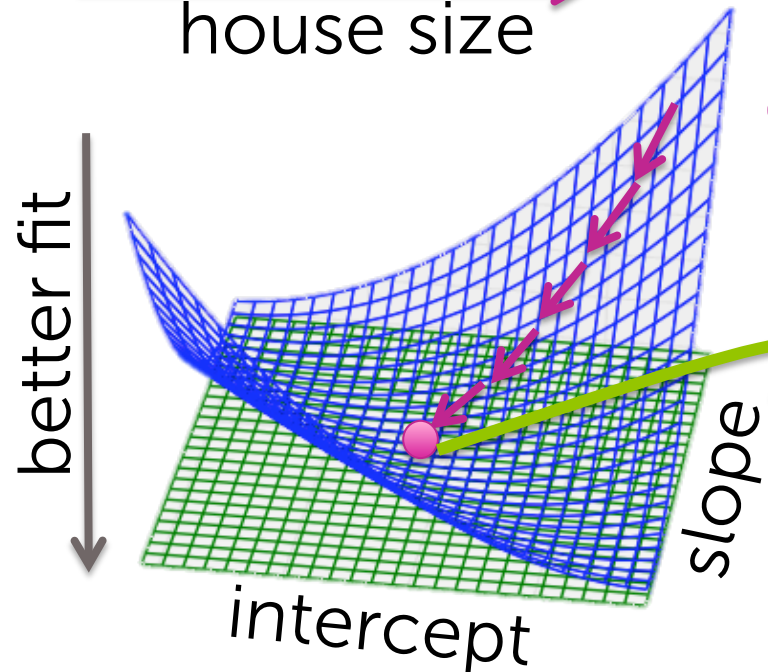
1 input and just fit a line to data



# Module 1: Simple Regression



Define **goodness-of-fit** metric for each possible line

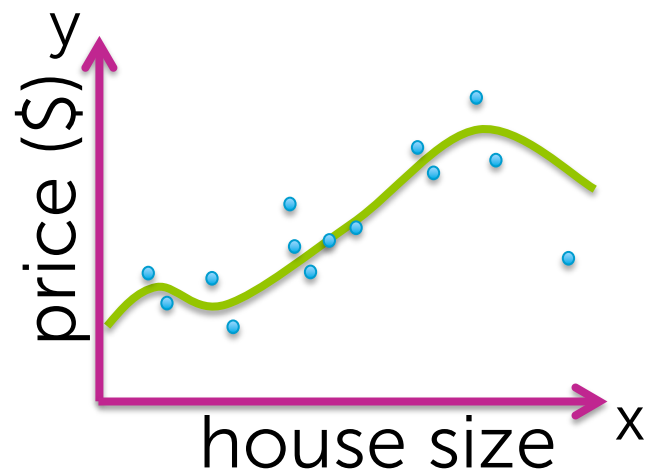


**Gradient descent algorithm**

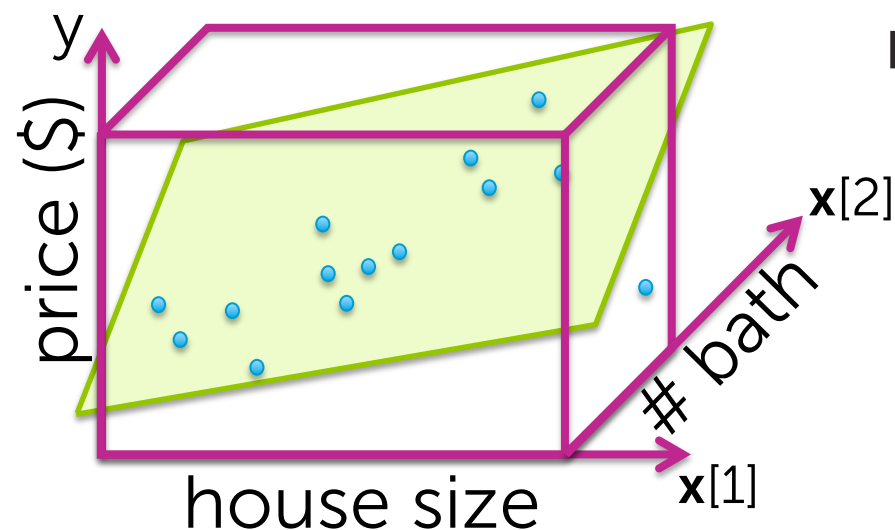
Get estimated parameters

- interpret
- use to form predictions

# Module 2: Multiple Regression



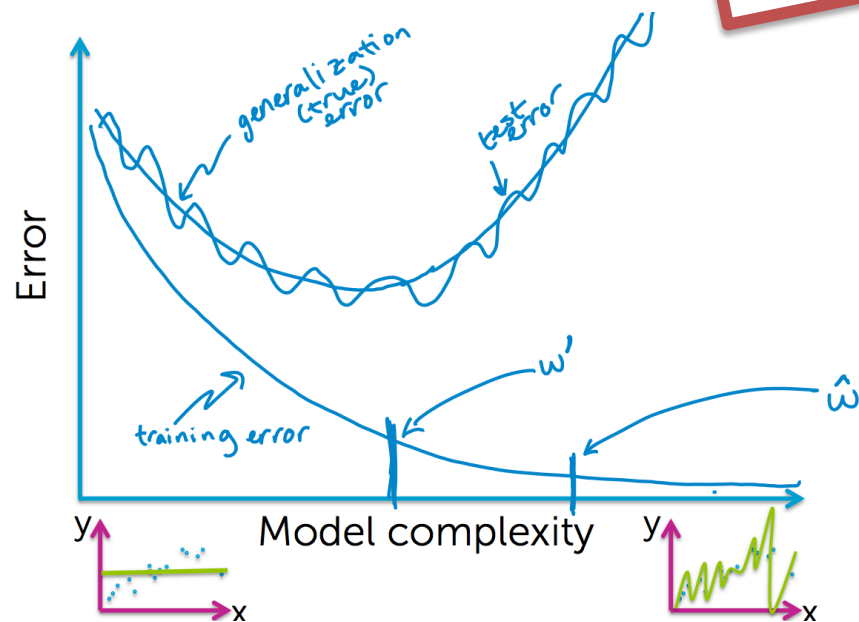
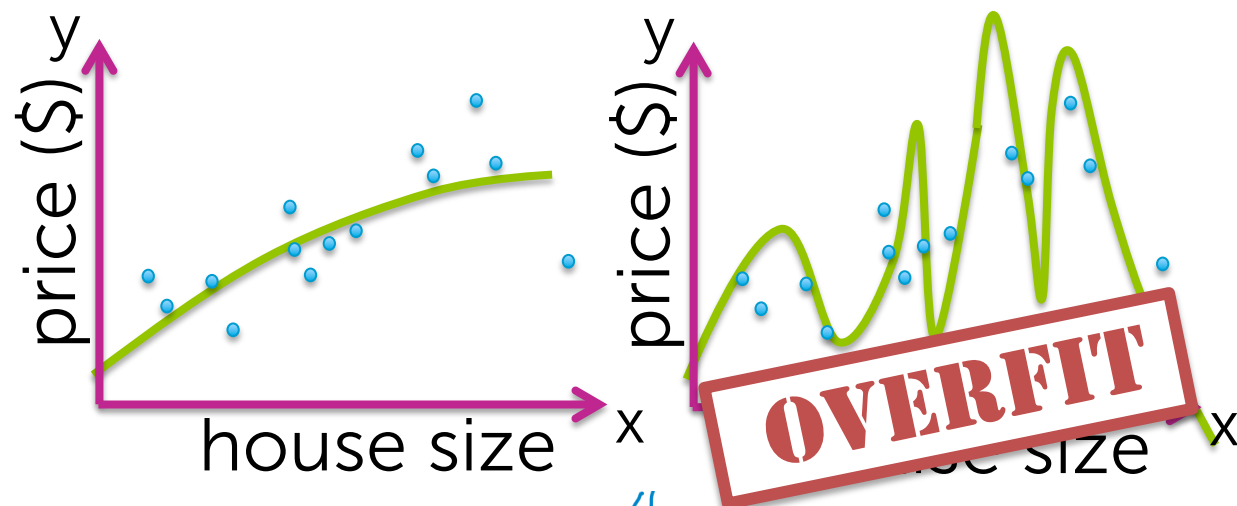
Fit **more complex relationships** than just a line



Incorporate more inputs

- Square feet
- # bathrooms
- # bedrooms
- Lot size
- Year built
- ...

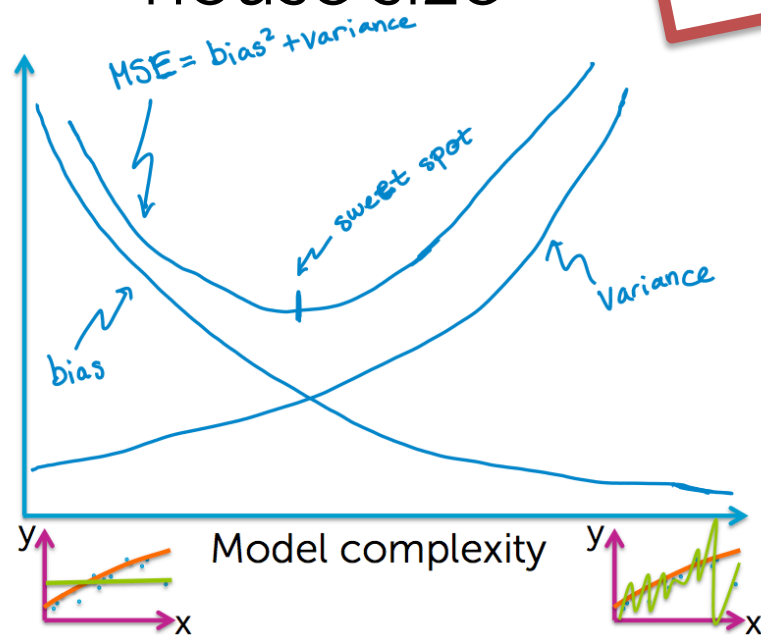
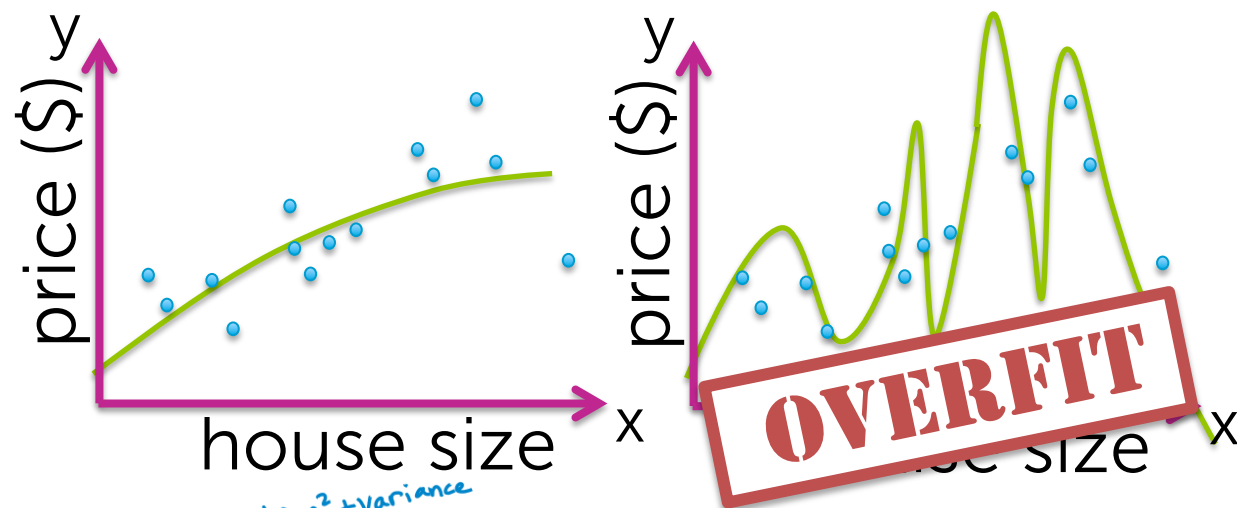
# Module 3: Assessing Performance



Measures of error:

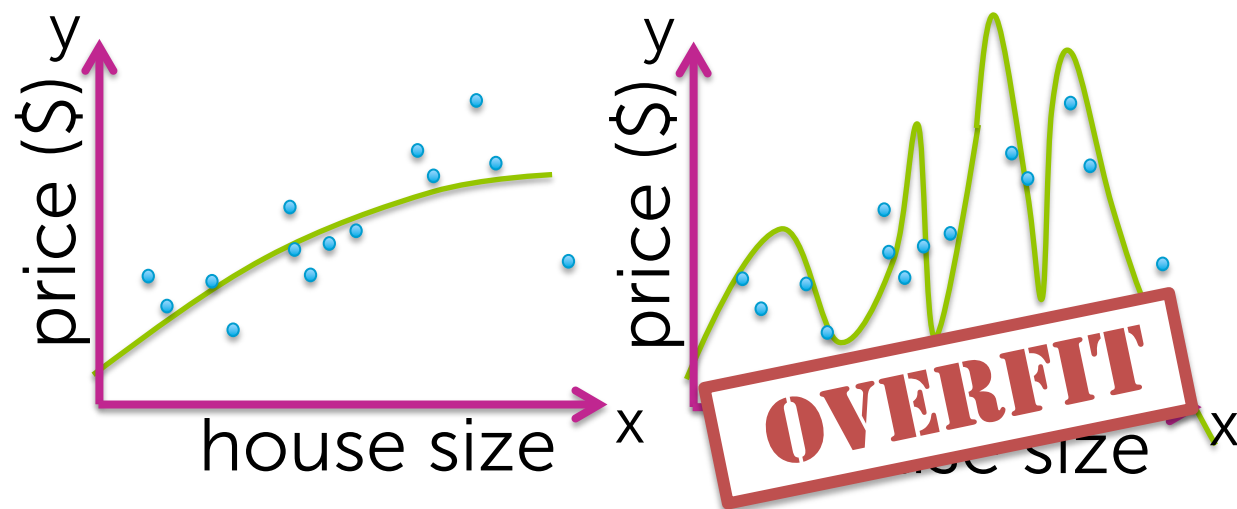
- Training
- Test
- True (generalization)

# Module 3: Assessing Performance



Bias-variance  
tradeoff

# Module 4: Ridge Regression



Ridge total cost =  
measure of fit + measure of  
model complexity

↖ ↗

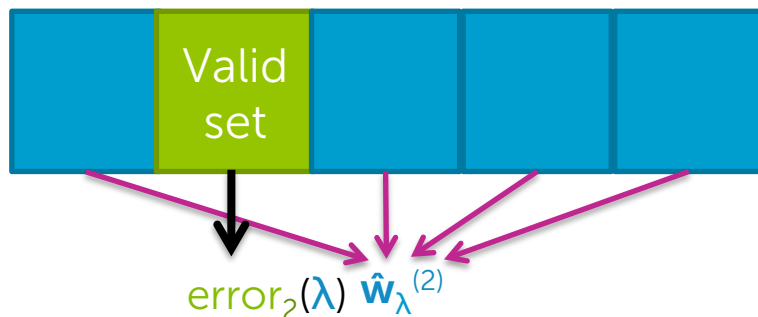
bias-variance tradeoff

# Module 4: Ridge Regression

How to choose balance?  
(i.e., model complexity)

measure of fit + measure of  
model complexity

Cross validation



# Module 5: Feature Selection & Lasso Regression



Useful for **efficiency**  
of predictions and  
**interpretability**

Lot size  
Single Family  
Year built  
Last sold price  
Last sale price/sqft  
Finished sqft  
Unfinished sqft  
Finished basement sqft  
# floors  
Flooring types  
Parking type  
Parking amount  
Cooling  
Heating  
Exterior materials  
Roof type  
Structure style

Dishwasher  
Garbage disposal  
Microwave  
Range / Oven  
Refrigerator  
Washer  
Dryer  
Laundry location  
Heating type  
Jetted Tub  
Deck  
Fenced Yard  
Lawn  
Garden  
Sprinkler System  
⋮



# Module 5: Feature Selection & Lasso Regression

Lasso total cost =

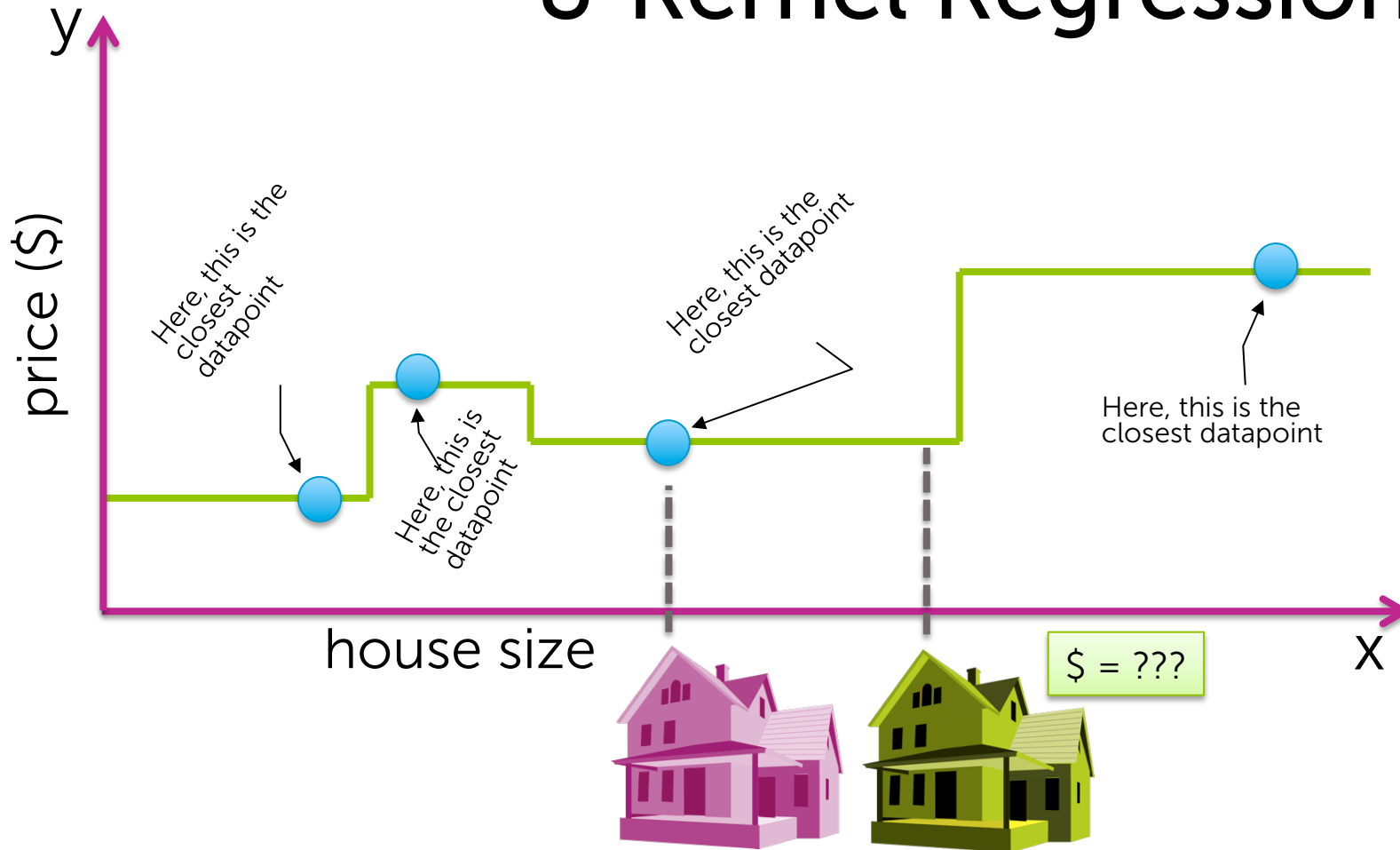
measure of fit + (different) measure of  
model complexity

knocks out certain features...  
"sparsity"

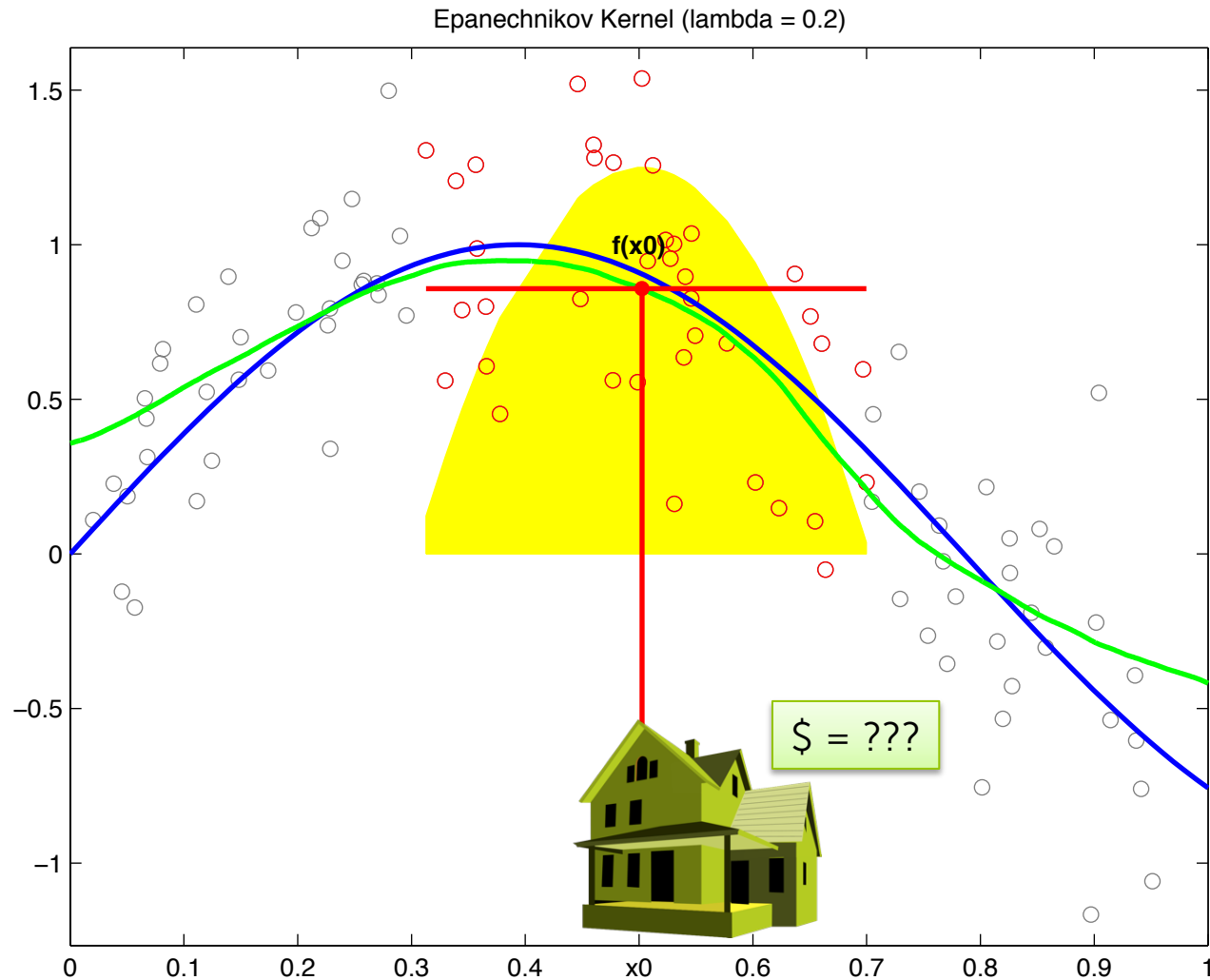
Coordinate descent algorithm



# Module 6: Nearest Neighbor & Kernel Regression



# Module 6: Nearest Neighbor & Kernel Regression



# Summary of what's covered

## Models

- Linear regression
- Regularization: Ridge (L2), Lasso (L1)
- Nearest neighbor and kernel regression

## Algorithms

- Gradient descent
- Coordinate descent

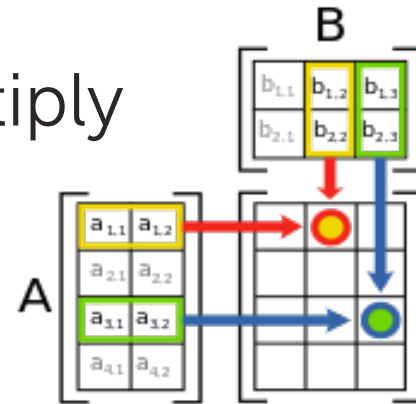
## Concepts

- Loss functions, bias-variance tradeoff, cross-validation, sparsity, overfitting, model selection, feature selection

# Assumed background

# Math background

- Basic calculus
  - Concept of derivatives
- Basic linear algebra
  - Vectors
  - Matrices
  - Matrix multiply



# Programming experience

- Basic Python used
  - Can pick up along the way if knowledge of other language

```
def get_connections(self, user):
    """
    Returns a QuerySet of connections for user.
    """
    set1 = self.filter(from_user=user).select_related(depth=1)
    set2 = self.filter(to_user=user).select_related(depth=1)
    return set1 | set2

def are_connected(self, user1, user2):
    if self.filter(from_user=user1, to_user=user2).count() > 0:
        return True
    if self.filter(from_user=user2, to_user=user1).count() > 0:
        return True
    return False

def remove(self, user1, user2):
    """
    Deletes proper object regardless of the order of users in argument
    """
    connection = self.filter(from_user=user1, to_user=user2)
    if not connection:
        connection = self.filter(from_user=user2, to_user=user1)
    connection.delete()

models.py Top L1 (Python AC yas)-----
```



# Reliance on GraphLab Create

- SFrames will be used, though not required
  - open source project of Dato (creators of GraphLab Create)
  - can use pandas and numpy instead
- Assignments will:
  1. Use GraphLab Create to explore high-level concepts
  2. Ask you to implement *all* algorithms without GraphLab Create
- Net result:
  - learn how to code methods in Python





# Computing needs

- Basic 64-bit desktop or laptop
- Access to internet
- Ability to:
  - Install and run Python (and GraphLab Create)
  - Store a few GB of data





# Let's get started!