

# Introduction to Machine Learning

## Regularization

Instructor: Pat Virtue

# Announcements

## Assignments:

- HW2 (written & programming)
  - Due Tomorrow, Tue 2/4, 11:59 pm
  - FAQ on Piazza
  - Come see us for help!

## A few logistics:

- E-mail Daniel for any logistic related questions, including extensions
  - [dpbird@andrew.cmu.edu](mailto:dpbird@andrew.cmu.edu)
- Public/private Piazza posts
- Continuing to improve based on your feedback

# Plan

## Last time

- Wrap up MLE for linear regression
- Classification models
- (MLE for logistic regression)

## Today

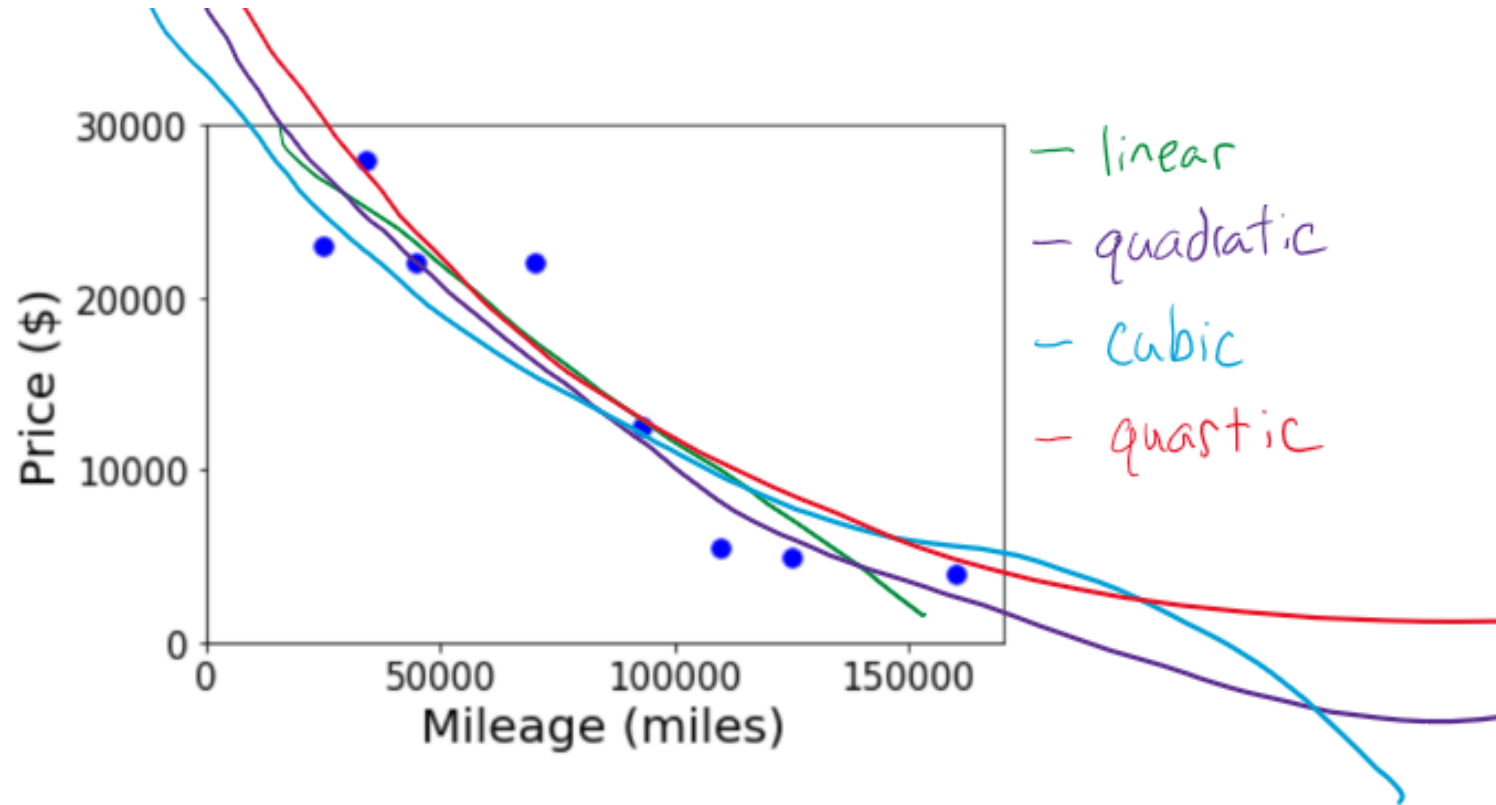
- Logistic regression
  - Updated lecture 5 notes on website
  - Jupyter notebook on website
- Begin regularization

# Logistic Regression

See Lecture 5 slides

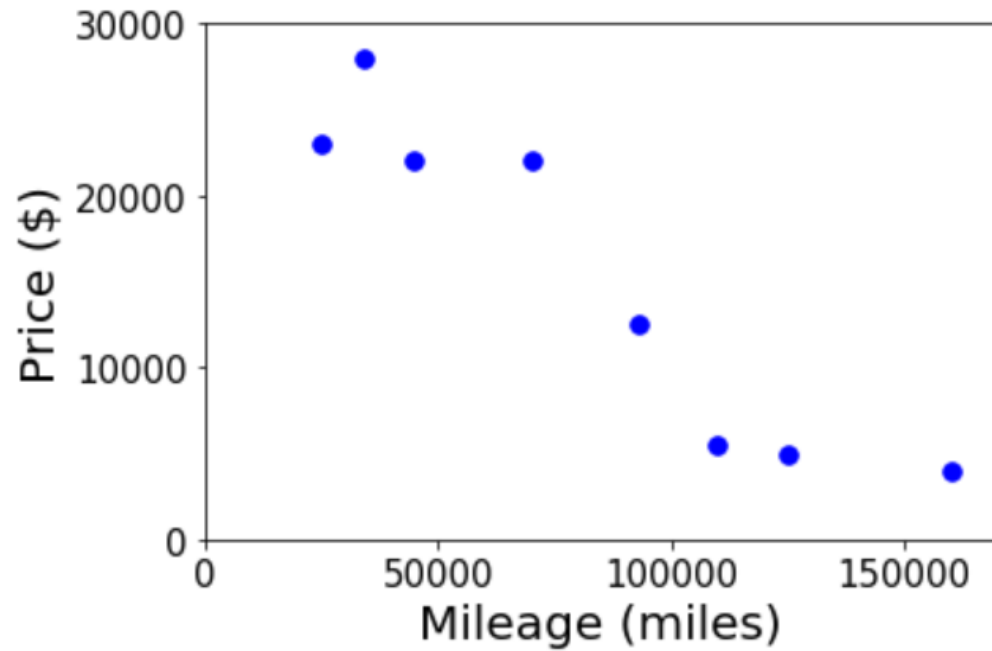
# Overfitting with Polynomial Linear Regression

Better fit training data with higher model complexity



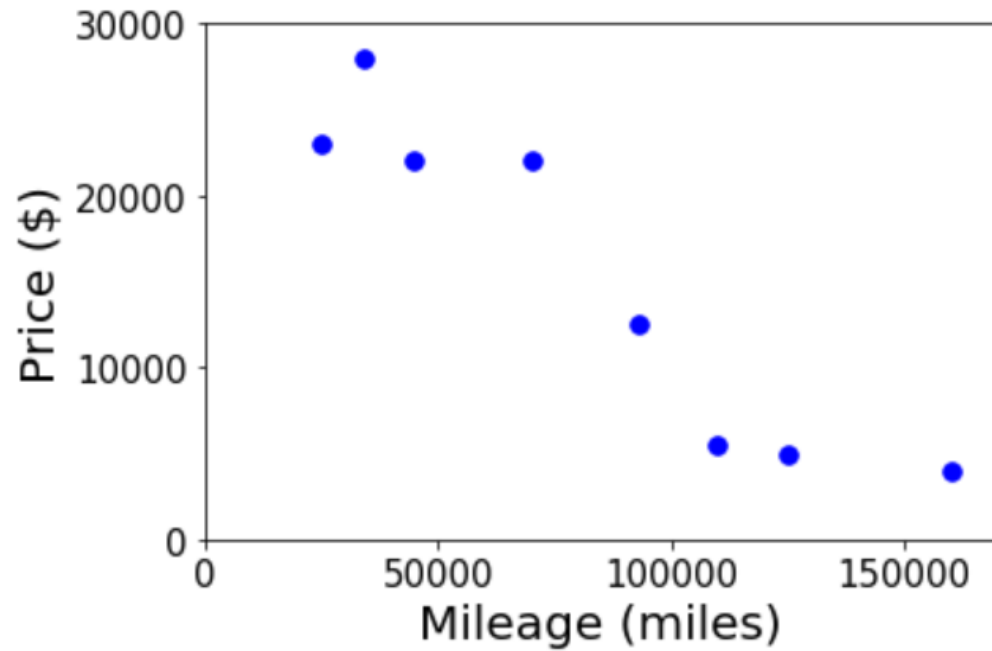
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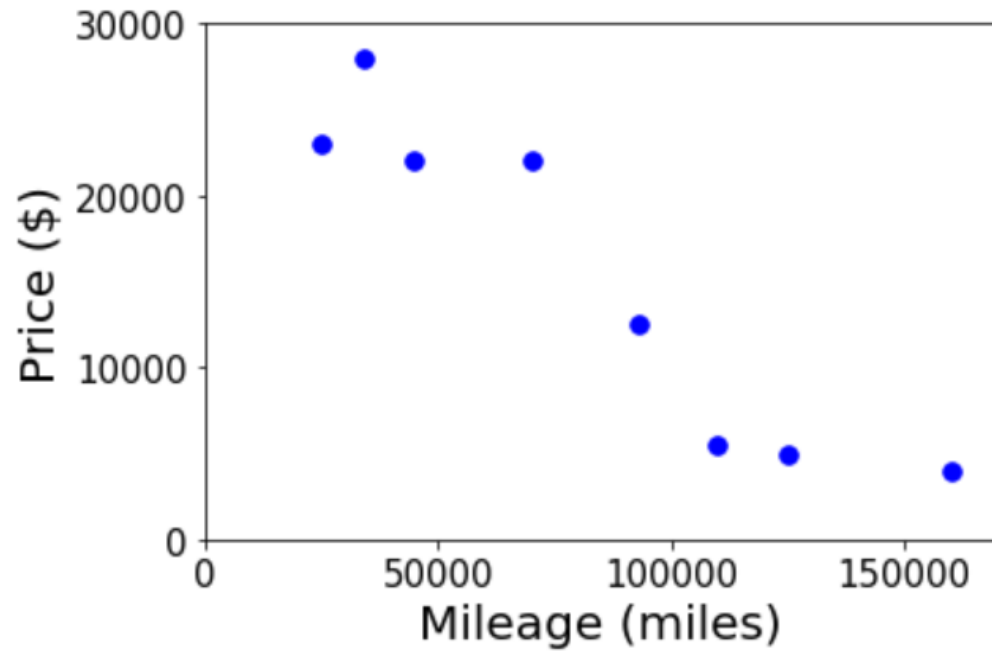
# Overfitting with Polynomial Linear Regression

How can we deal with overfitting?



# Overfitting with Polynomial Linear Regression

What are additional symptoms of overfitting?





# Regularization

Combine original objective with penalty on parameters

# Regularization

Ridge Regression: Linear regression with  $\ell_2$  penalty on weights

# Regularization

But how do we choose  $\lambda$ ?