Regression example

underfit

- Does not fit the training set well

high bias

just right

- Fits training set pretty well

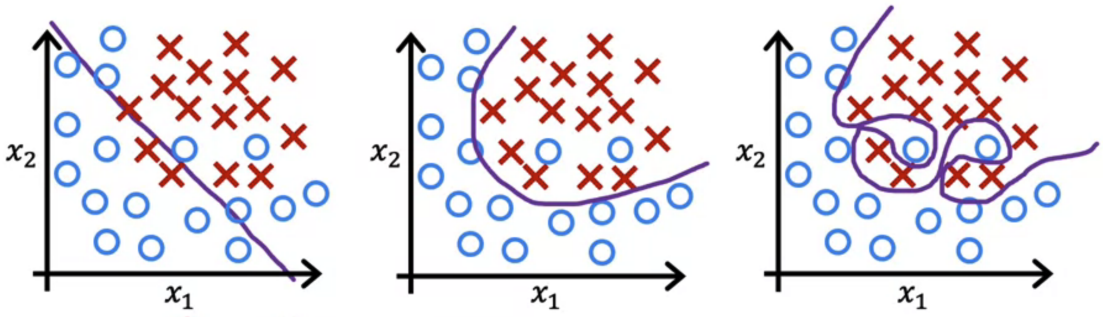
generalization

overfit

- Fits the training set extremely well

high variance

Classification



$z = w_1x_1 + w_2x_2 + b$

$f_{\vec{w},b}(\vec{x}) = g(z)$

g is the sigmoid function

underfit high bias

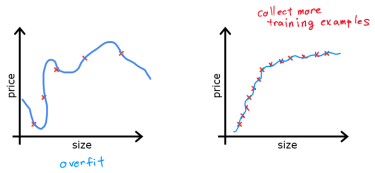
$z = w_1x_1 + w_2x_2 + w_3x_1^2 + w_4x_2^2 + w_5x_1x_2 + b$

just right

$z = w_1x_1 + w_2x_2 + w_3x_1^2x_2 + w_4x_1^2x_2^2 + w_5x_1^2x_2^3 + w_6x_1^5x_2 + \cdots + b$

overfit

Collect more Training Data



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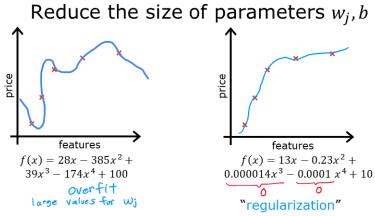
Reduce the size of parameters w_j, b



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Select Features to Include/Exclude

size	bedrooms	floors	age	avg income	school rating	...	distance to coffee shop	price
x_1	x_2	x_3	x_4	x_5	x_6		x_{100}	y

all features

overfit

selected features

size
bedrooms
school ratings
just right

model selection
course 2

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It doesn't make a huge difference whether you regularize the parameter b as well, you could do so if you want or not if you don't. I usually don't and it's just fine to regularize w1, w2, all the way to wn, but not really encourage b to become smaller. In practice, it should make very little difference whether you also regularize b or not.

Goals

In this lab, you will explore:

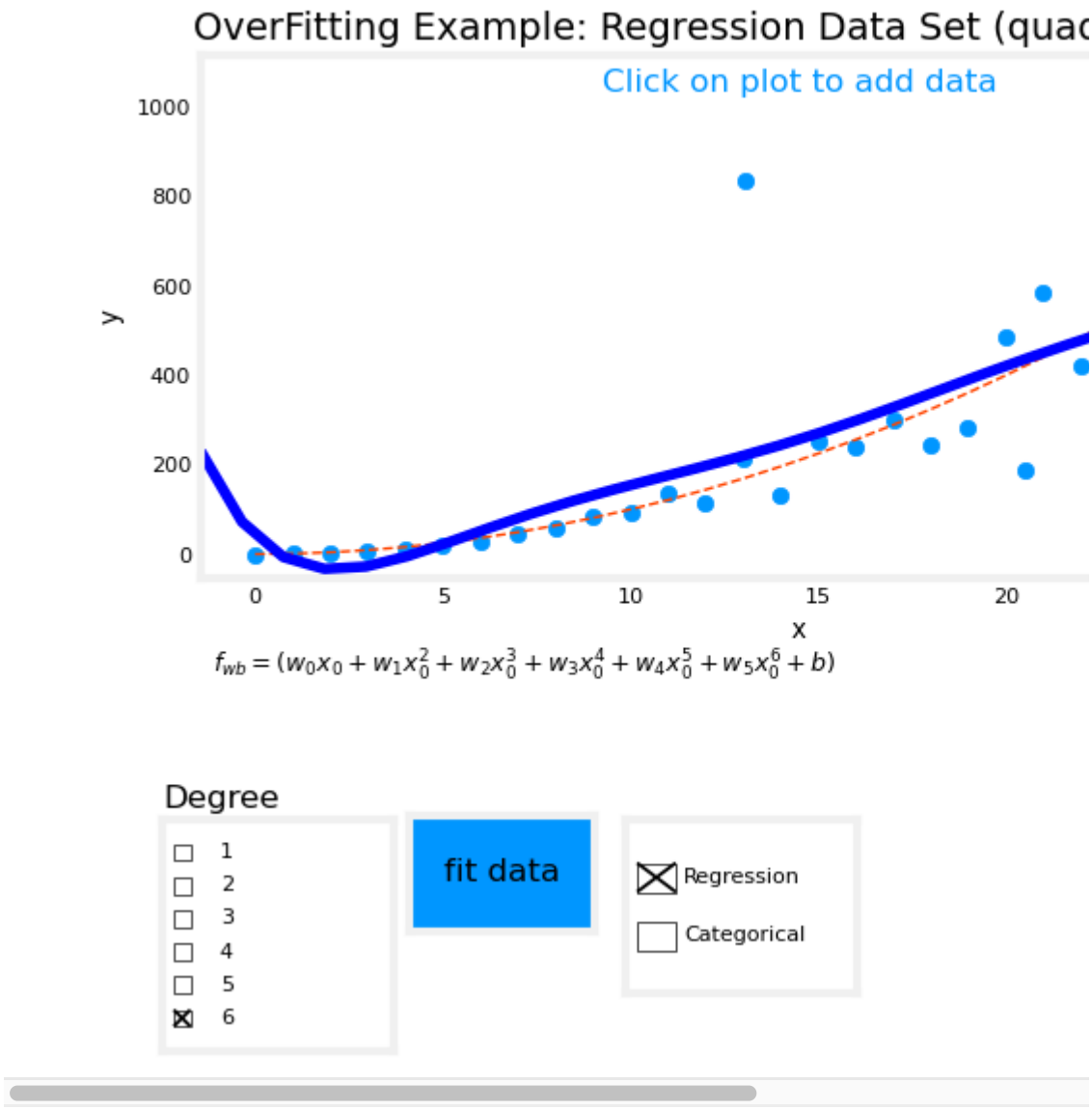
- the situations where overfitting can occur
- some of the solutions

In [1]:
```
%matplotlib widget
import matplotlib.pyplot as plt
from ipywidgets import Output
from plt_overfit import overfit_example, output
plt.style.use('./deeplearning.mplstyle')
```

Overfitting

The week's lecture described situations where overfitting can arise. Run the cell below to generate a plot that will allow you to explore overfitting. There are further instructions below the cell.

In [2]:
```
plt.close("all")
display(output)
ofit = overfit_example(False)
```



In the plot above you can:

- switch between Regression and Categorization examples
- add data
- select the degree of the model
- fit the model to the data

Here are some things you should try:

- Fit the data with degree = 1; Note 'underfitting'.
- Fit the data with degree = 6; Note 'overfitting'
- tune degree to get the 'best fit'
- add data:
  - extreme examples can increase overfitting (assuming they are outliers).
  - nominal examples can reduce overfitting
- switch between `Regression` and `Categorical` to try both examples.

To reset the plot, re-run the cell. Click slowly to allow the plot to update before receiving the next click.

Notes on implementations:

- the 'ideal' curves represent the generator model to which noise was added to achieve the data set
- 'fit' does not use pure gradient descent to improve speed. These methods can be used on smaller data sets.

Congratulations!

You have developed some intuition about the causes and solutions to overfitting. In the next lab, you will explore a commonly used solution, Regularization.

In [ ]: