Module 3, Day 2

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MLDS
MACHINE LEARNING
FOR DATA SCIENCE

Goal

- Perform **linear regression** in its most basic form through simplest example
  - Predict house price with just single feature, i.e., house size

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Machine Learning Purpose

- **Predict** something given a set of **features** that influences prediction:
  - Predict house price given its size, location, configuration (features)

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Machine Learning Training

Before predicting, we have to:

- Choose/Create a **model**
- **Train** the model to learn prediction with **data**

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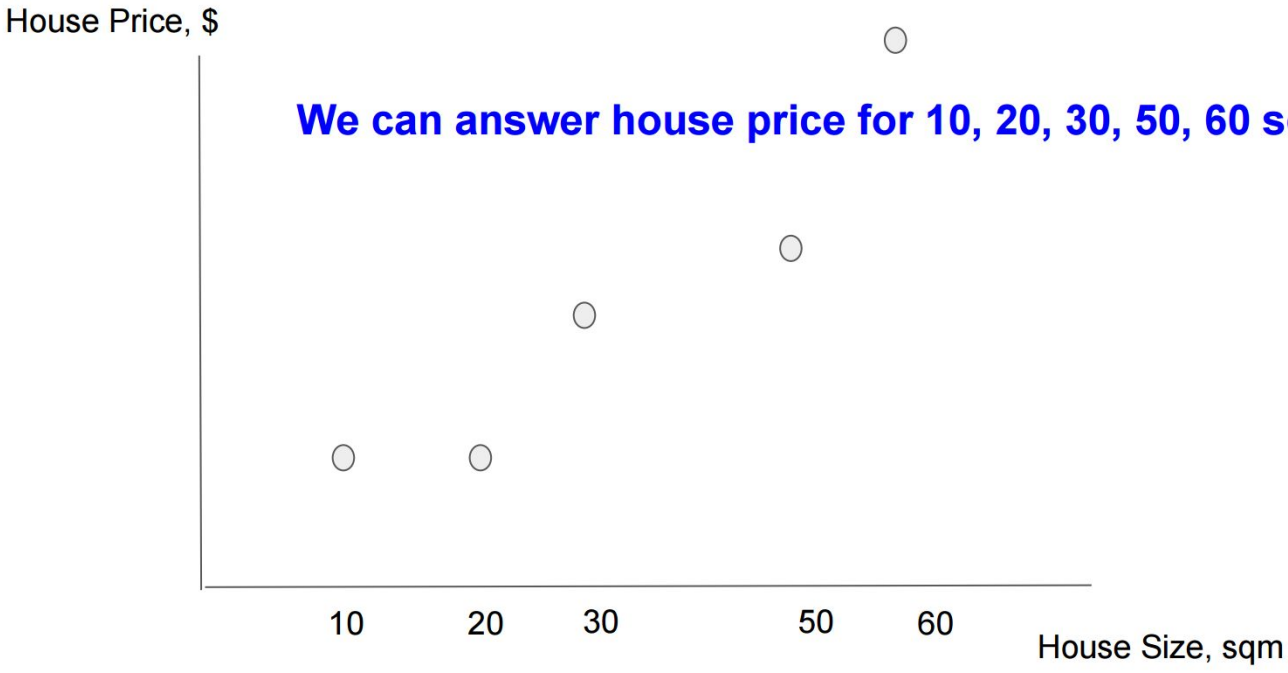
What is the House Price?



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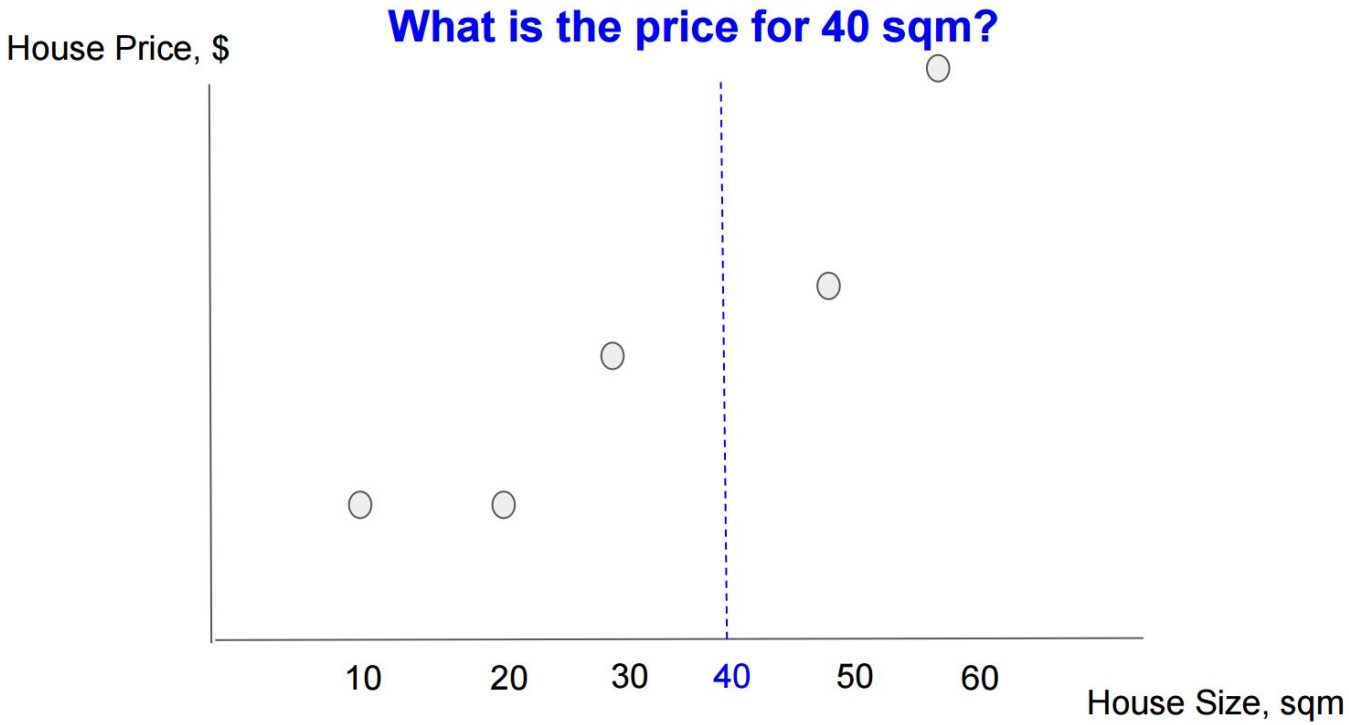

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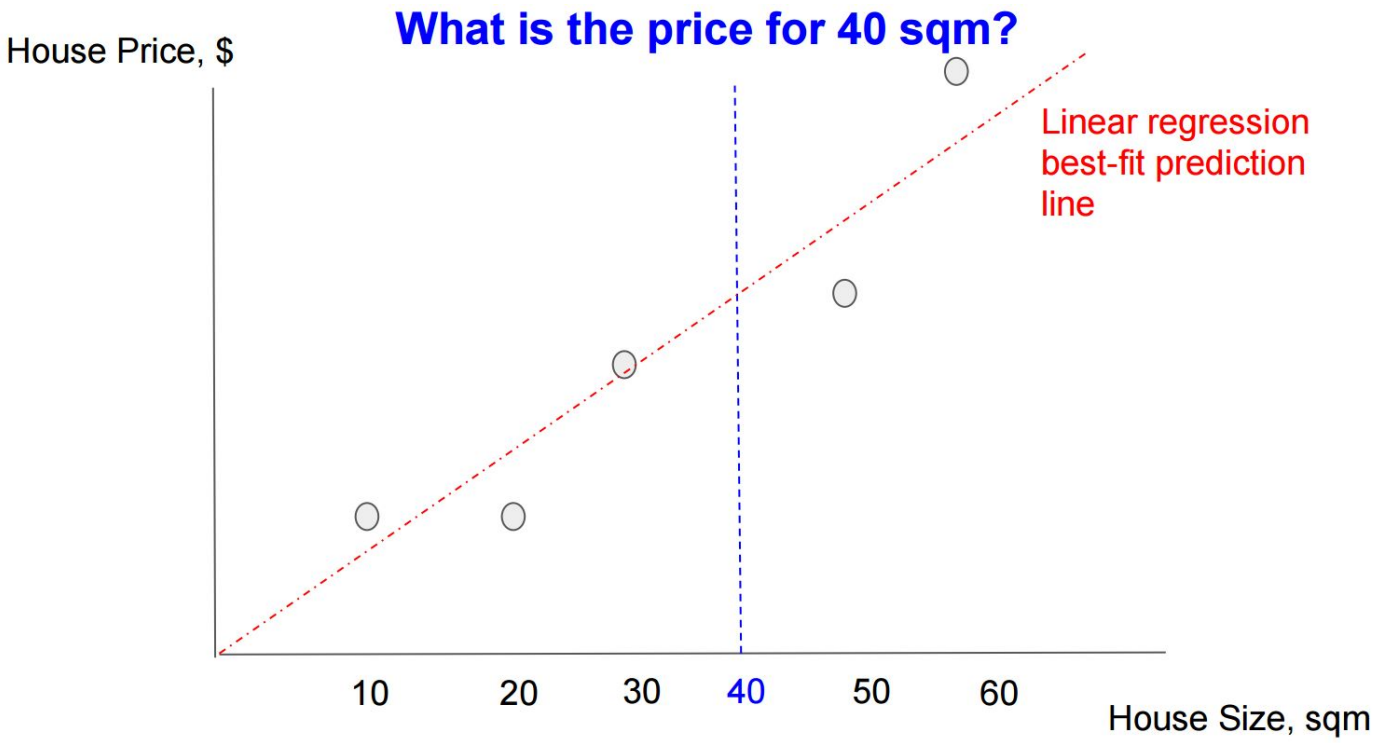

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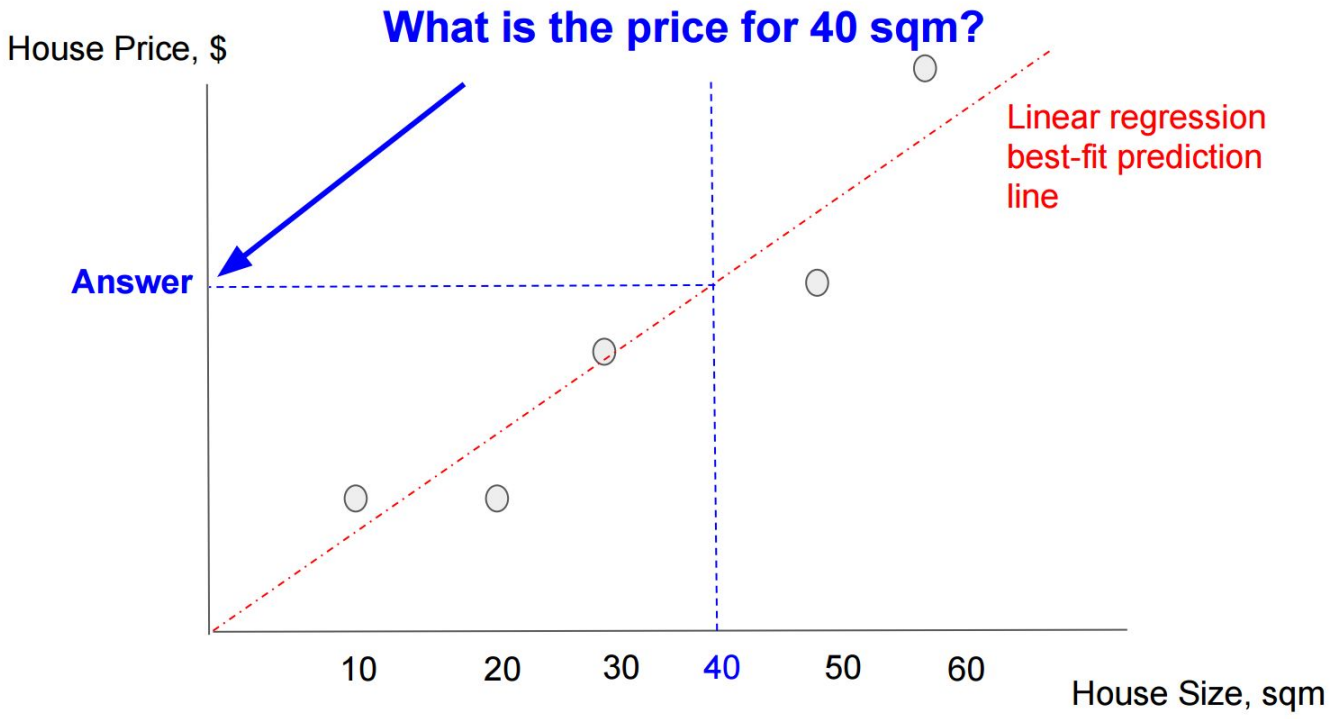

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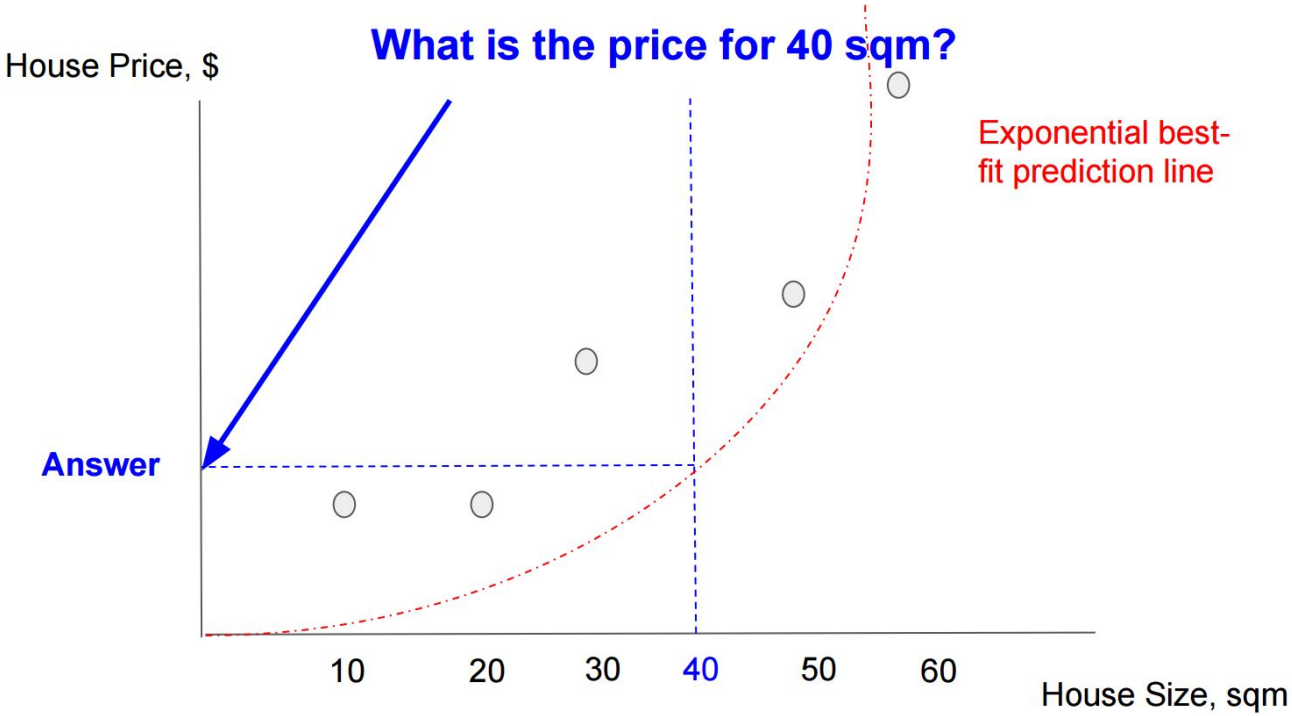

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Cost Function: Best-fit Prediction

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Minimize difference between predicted & actual values

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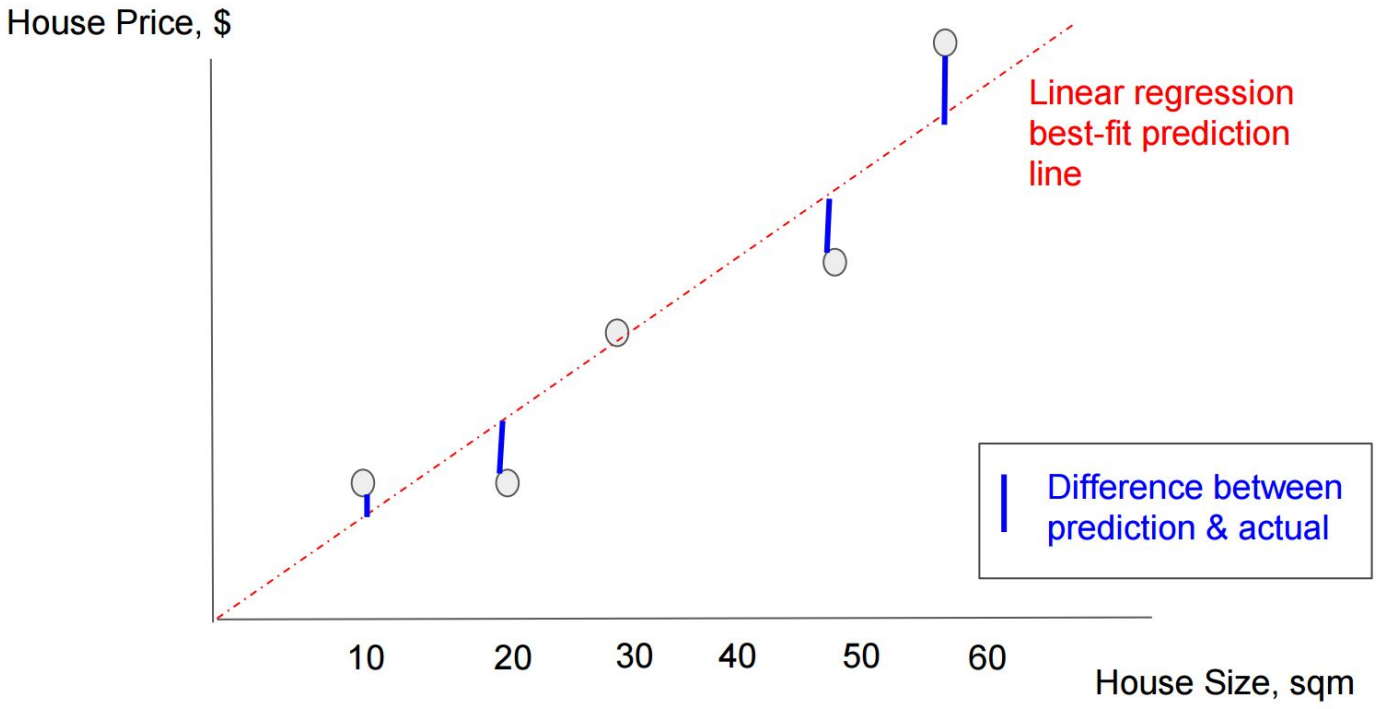
What is the House Price?



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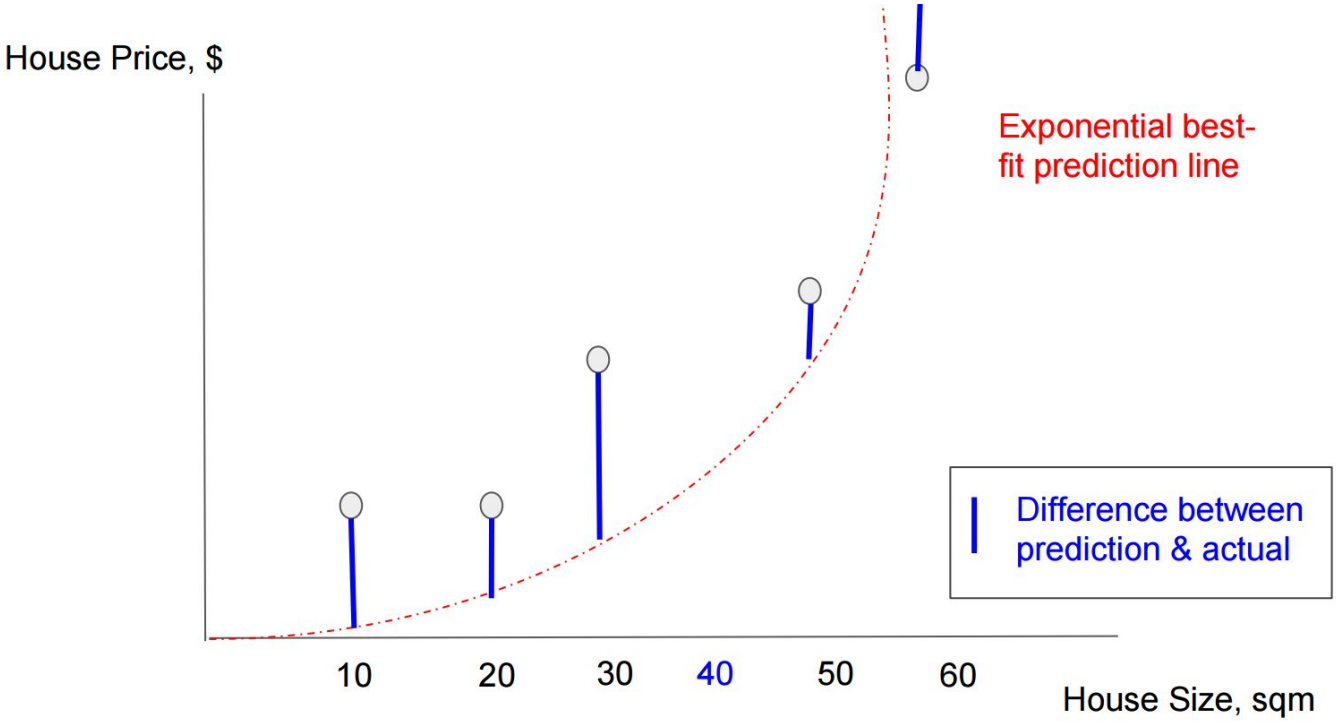
What is the House Price?



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Cost function: How different is your model from reality

sum((y_ - y)**2)

Where:

y_: Actual value

y: Predicted value

**2: Power of 2

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Linear Regression

y = W.x + b

y: Predicted house price

x: House size from dataset

Find a good W, b

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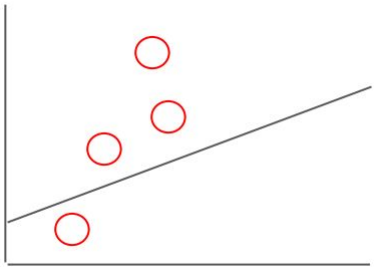
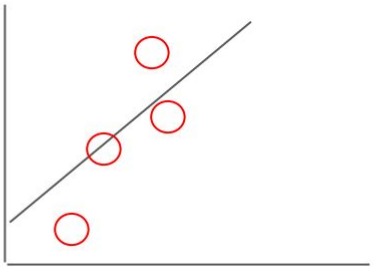
W: Gradient (Steepness)

W1 < W2 < W3

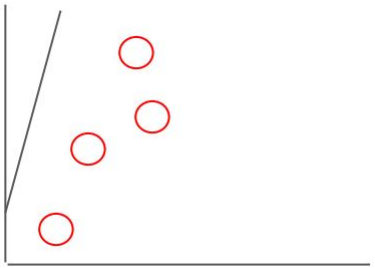
y = W1.x + b



y = W2.x + b



y = W3.x + b



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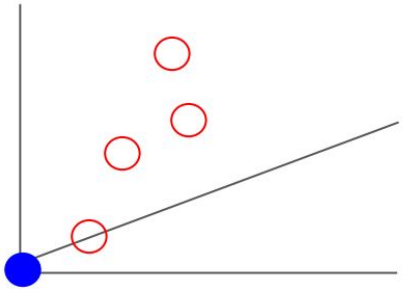
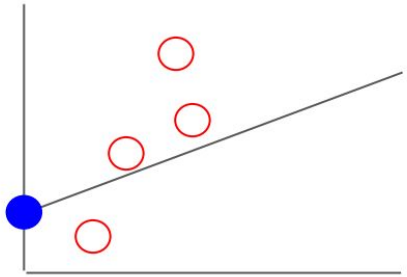
b: Intersect

b1 < b2 < b3

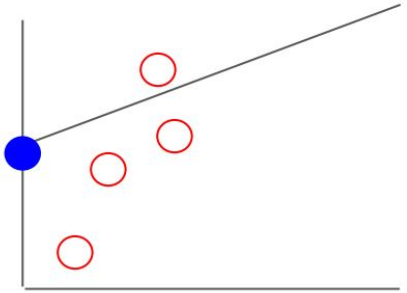
y = W.x + b1



y = W.x + b2



y = W.x + b3



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Train: Find W, b

W_best, b_best = 0, 0

Loop J times:

    Choose current_W, current_b

    If cost(current_W, current_b) < cost(W_best, b_best):

    W_best, b_best = current_W, current_b

What is the best way to choose current_W, current_b?

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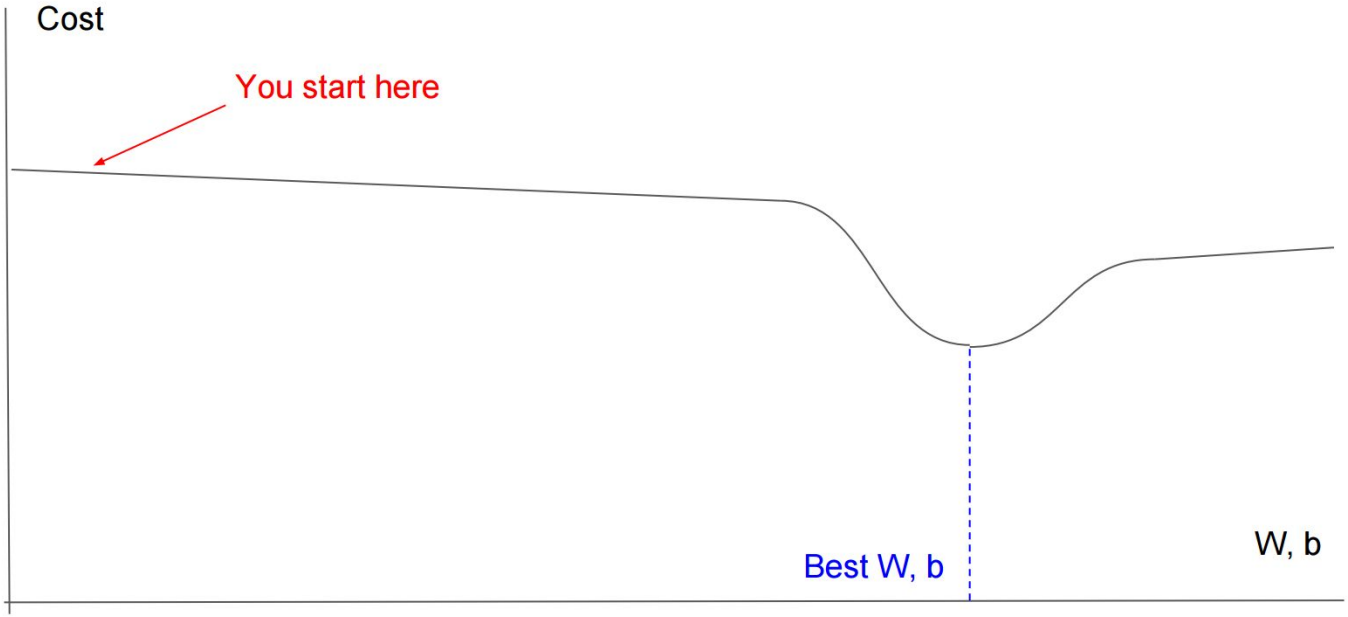
Finding Minimum Cost Function



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Choosing Training Method

- Random
  - Could take forever

- Gradient descent
  - From current viewpoint, move towards direction where steepness is greatest

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Ready?

Recap:

- Model: Linear regression, y = W.x + b
- Cost: Least squared, cost = sum((y_ - y)**2)
- Train: Gradient descent

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Step 1: Model $\mathbf{y = W.x + b}$

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Tensorflow Model

Recap:

- Model: Linear regression, y = W.x + b
- Cost: Least squared, cost = sum((y_ - y)**2)
- Train: Gradient descent

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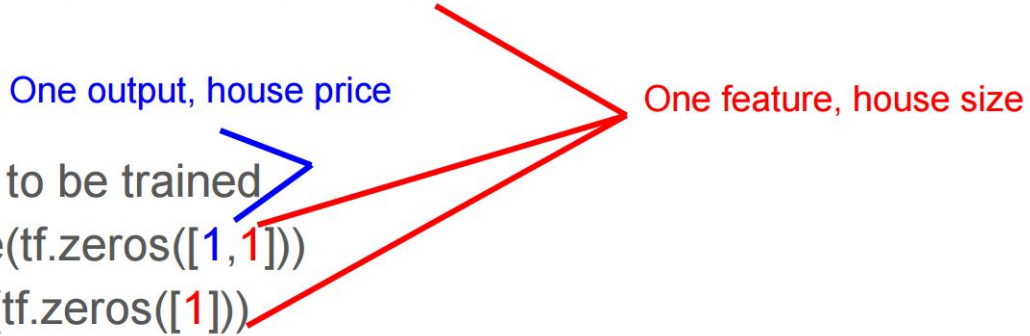
Tensorflow Model

tf.placeholder

- Hold data to be feed into the model
- x = tf.placeholder(tf.float32, [None, 1])

tf.Variable

- Hold variables to be trained
- W = tf.Variable(tf.zeros([1,1]))
- b = tf.Variable(tf.zeros([1]))



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Tensorflow Model

tf.matmul(x,W)

- Multiply 2 matrices
- product = tf.matmul(x,W)

‘+’

- y = product + b
- Expands to:
  - y = tf.matmul(x,W) + b = W.x + b

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Step 2: Cost Function

sum((y_ - y) 2)**

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Best-fit: Minimize Difference Prediction and Actual

Actual values:

One output, house price

- y_ = tf.placeholder(tf.float32, [None, 1])

Minimize difference between actual and prediction:

- cost = tf.reduce_sum(tf.pow((y_-y), 2))

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Step 3: Data

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Faking Data

```
for i in range(100):
  // Create fake data for actual data
  xs = np.array([[i]])
  ys = np.array([[2*i]])
```

- xs = 0, 1, 2, …., 99
- ys = 0, 2, 4, …., 198
- ys is always twice of xs
- **y = W.x + b where W = 2, b = 0 => Best fit: y = 2x**

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Step 4: Train

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Train using Gradient Descent

Train using Gradient Descent with steps in 0.000001

- train_step = tf.train.GradientDescentOptimizer(0.00001).minimize(cost)

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Train Model

- sess = tf.Session()
- init = tf.initialize_all_variables()
- sess.run(init)
- steps = 100

Tensorflow Non-interactive Mode

Nothing is actually executed until sess.run(...)

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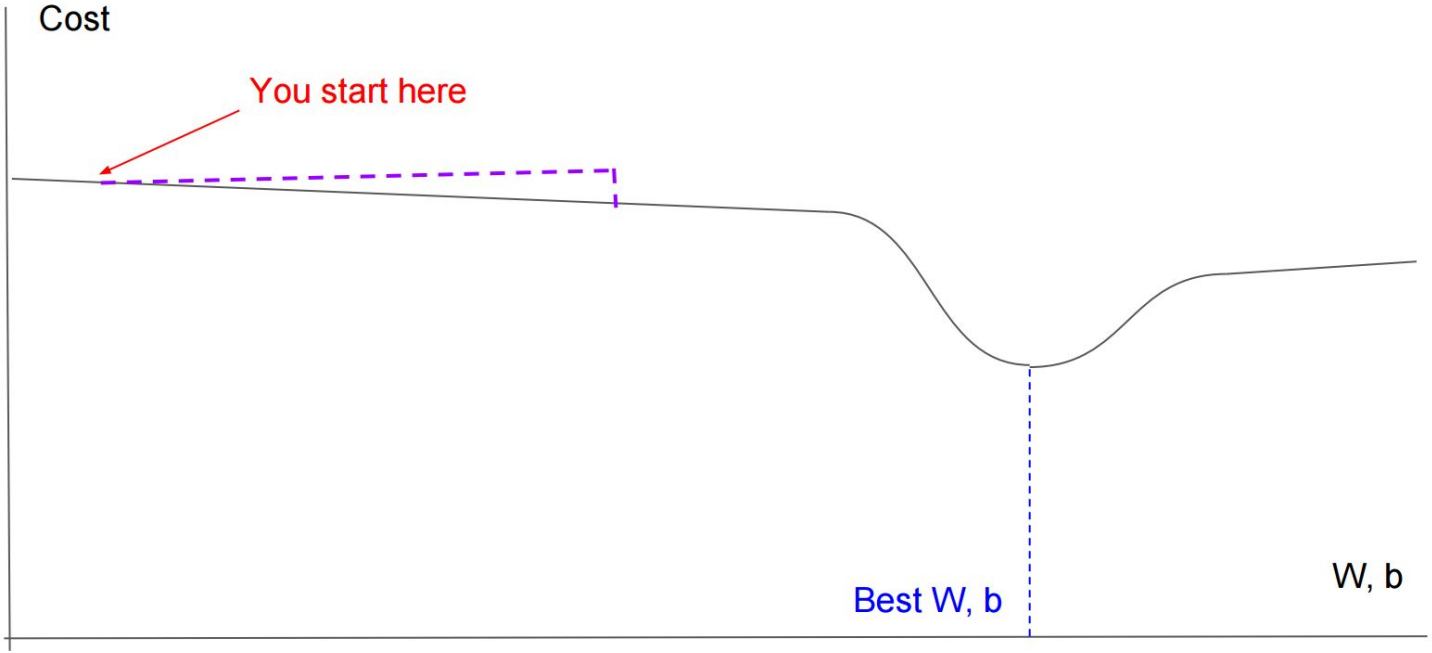
Finding Minimum Cost Function



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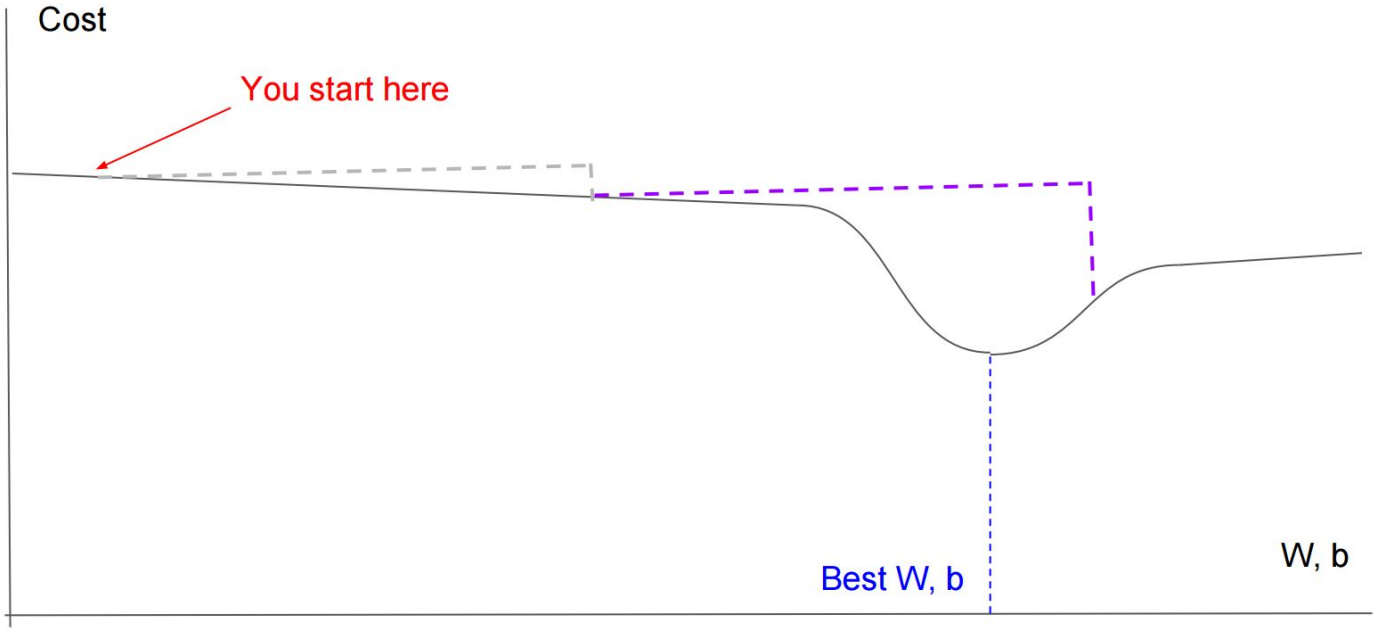
Finding Minimum Cost Function



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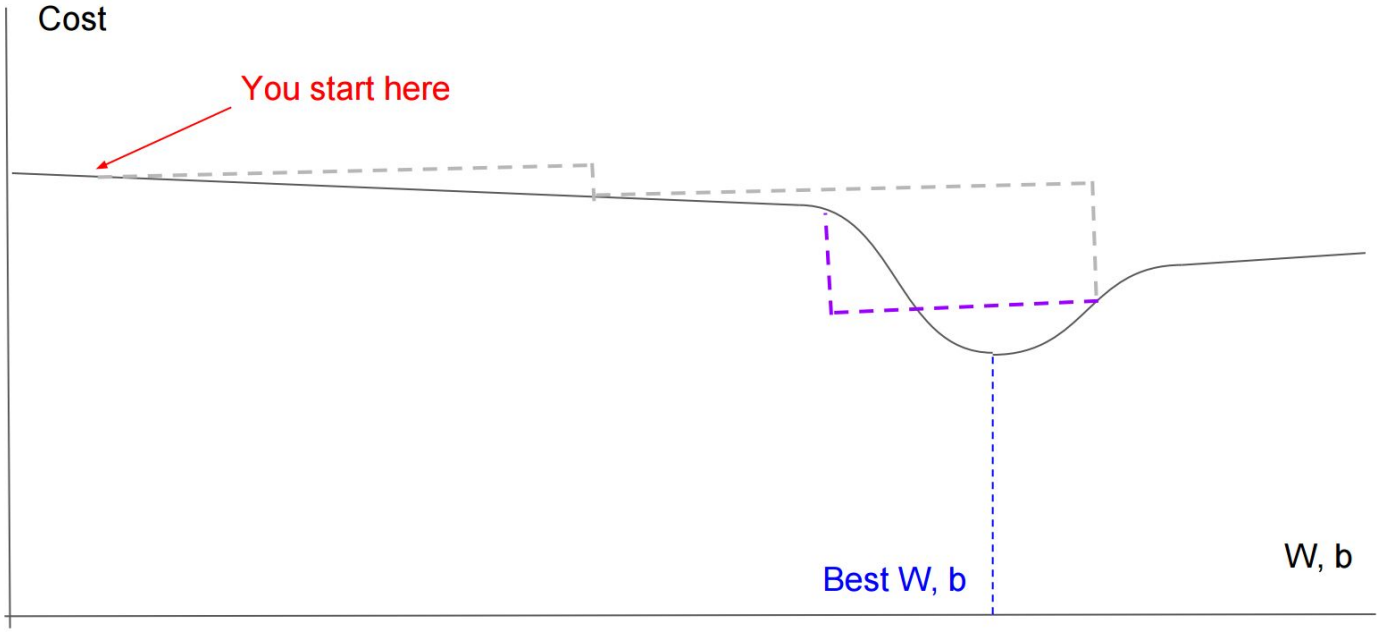
Finding Minimum Cost Function



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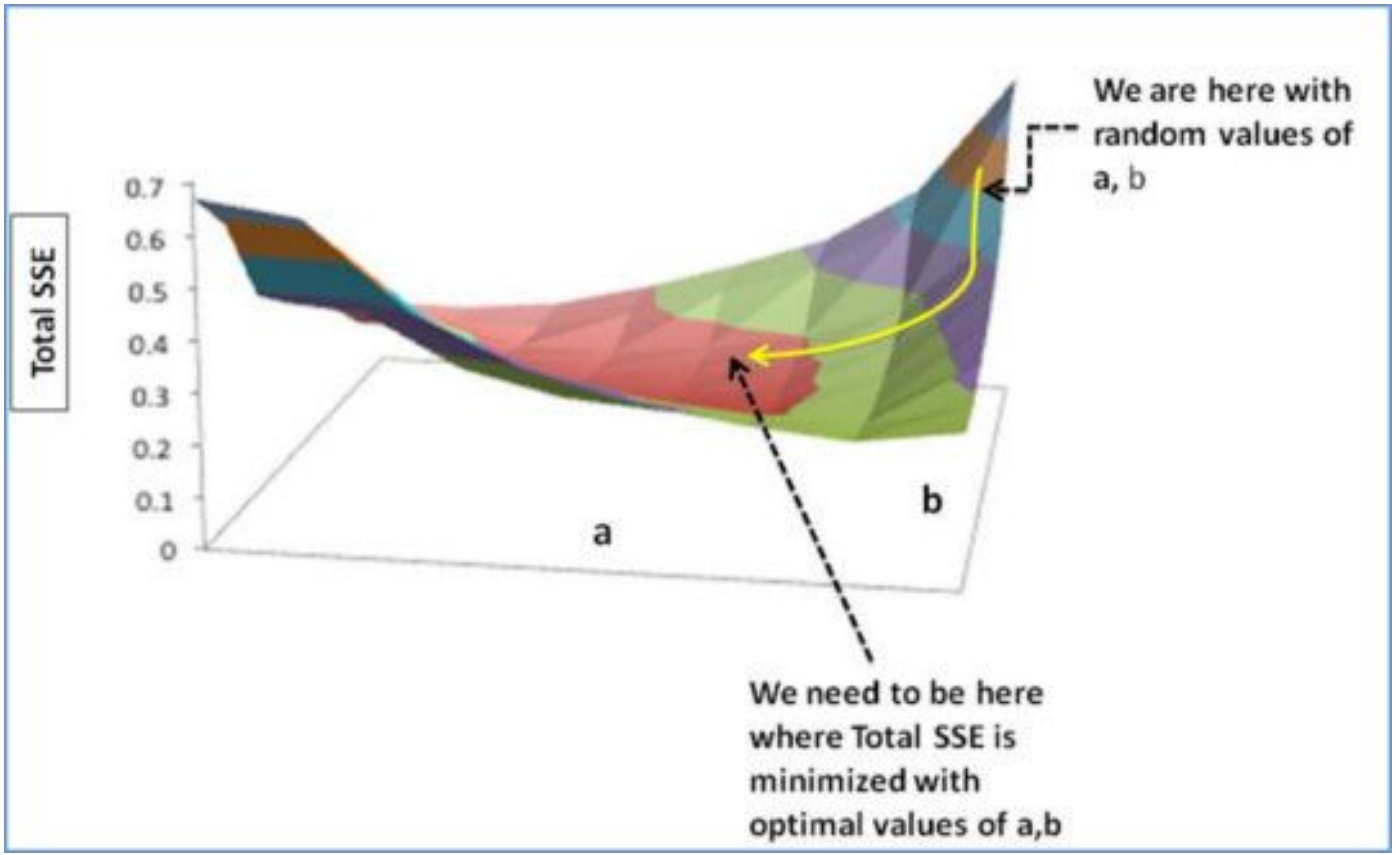
Finding Minimum Cost Function



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Go!!!!!

```
for i in range(steps):
  # Create fake data for y = W.x + b where W = 2, b = 0
  xs = np.array([[i]])
  ys = np.array([[2*i]])

  # Train
  feed = { x: xs, y_: ys }
  sess.run(train_step, feed_dict=feed)

  print("After %d iteration:" % i)
  print("W: %f" % sess.run(W))
  print("b: %f" % sess.run(b))
```

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Thanks!

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