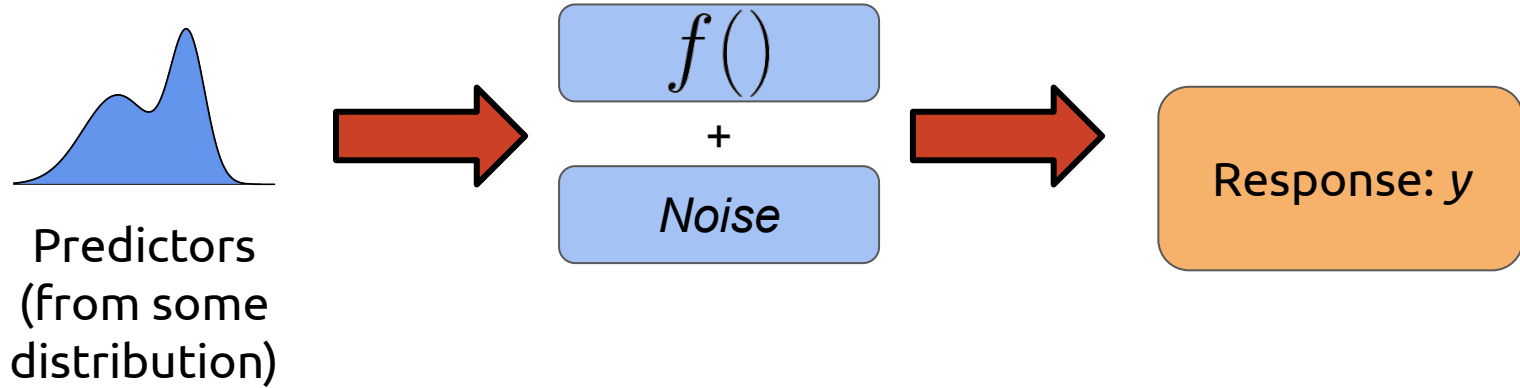
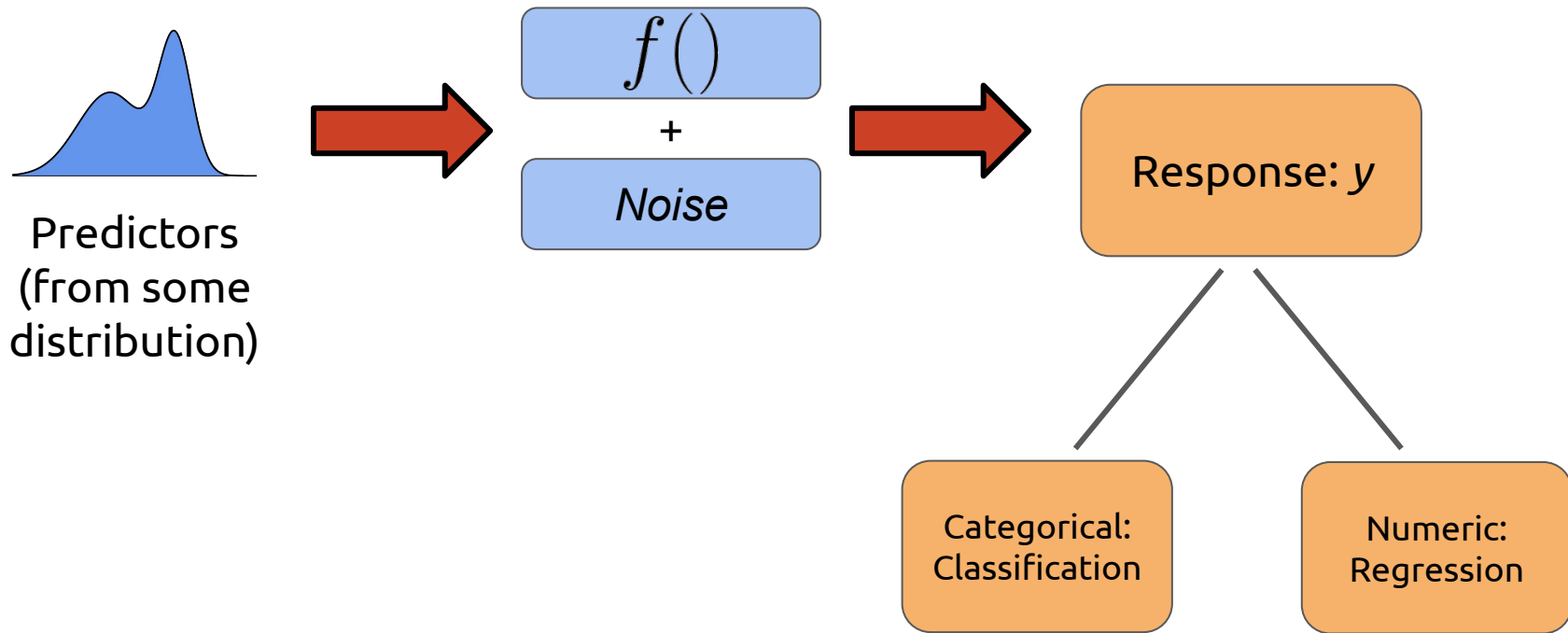


Introduction to Supervised Learning

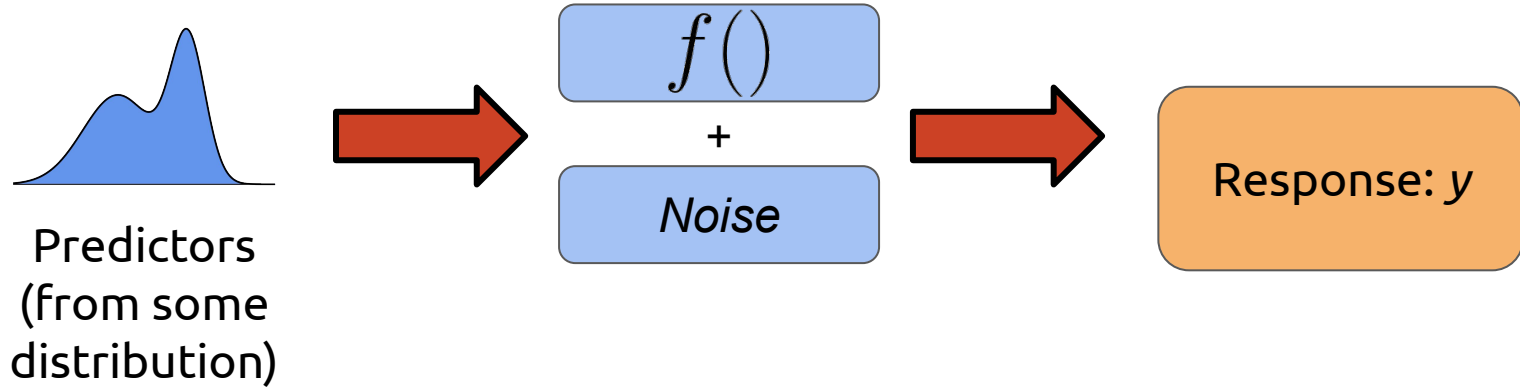
Supervised Learning - Setup



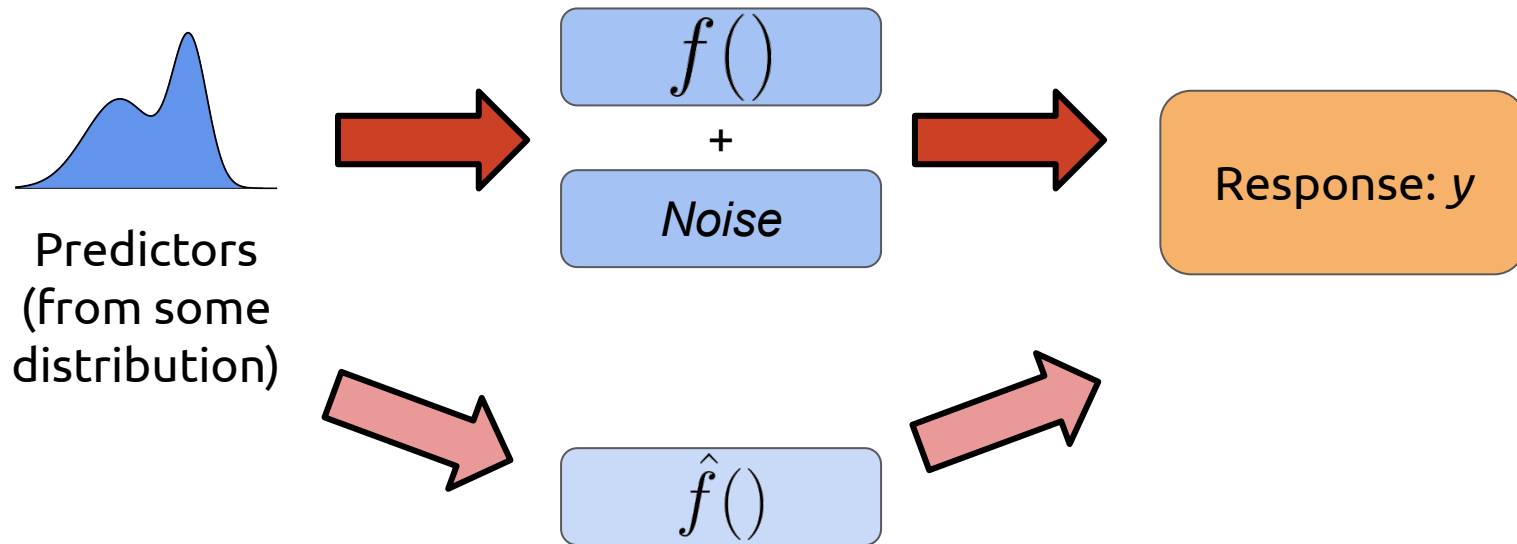
Supervised Learning - Setup



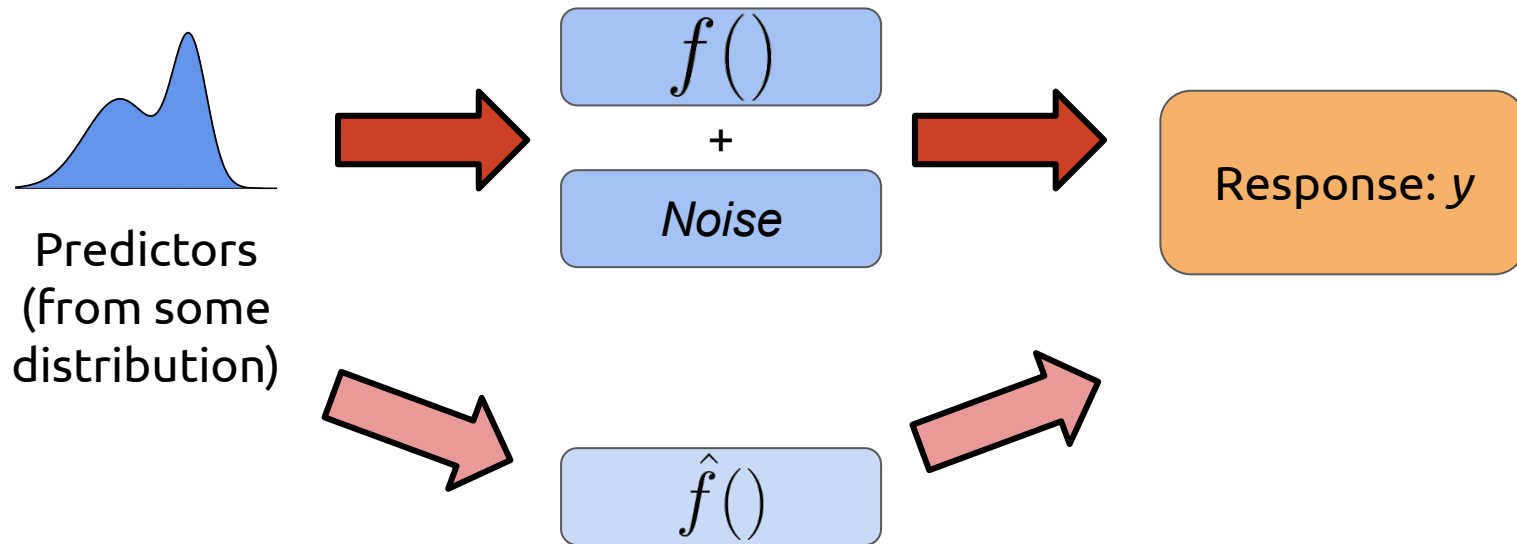
Supervised Learning - Setup



Supervised Learning - Goals

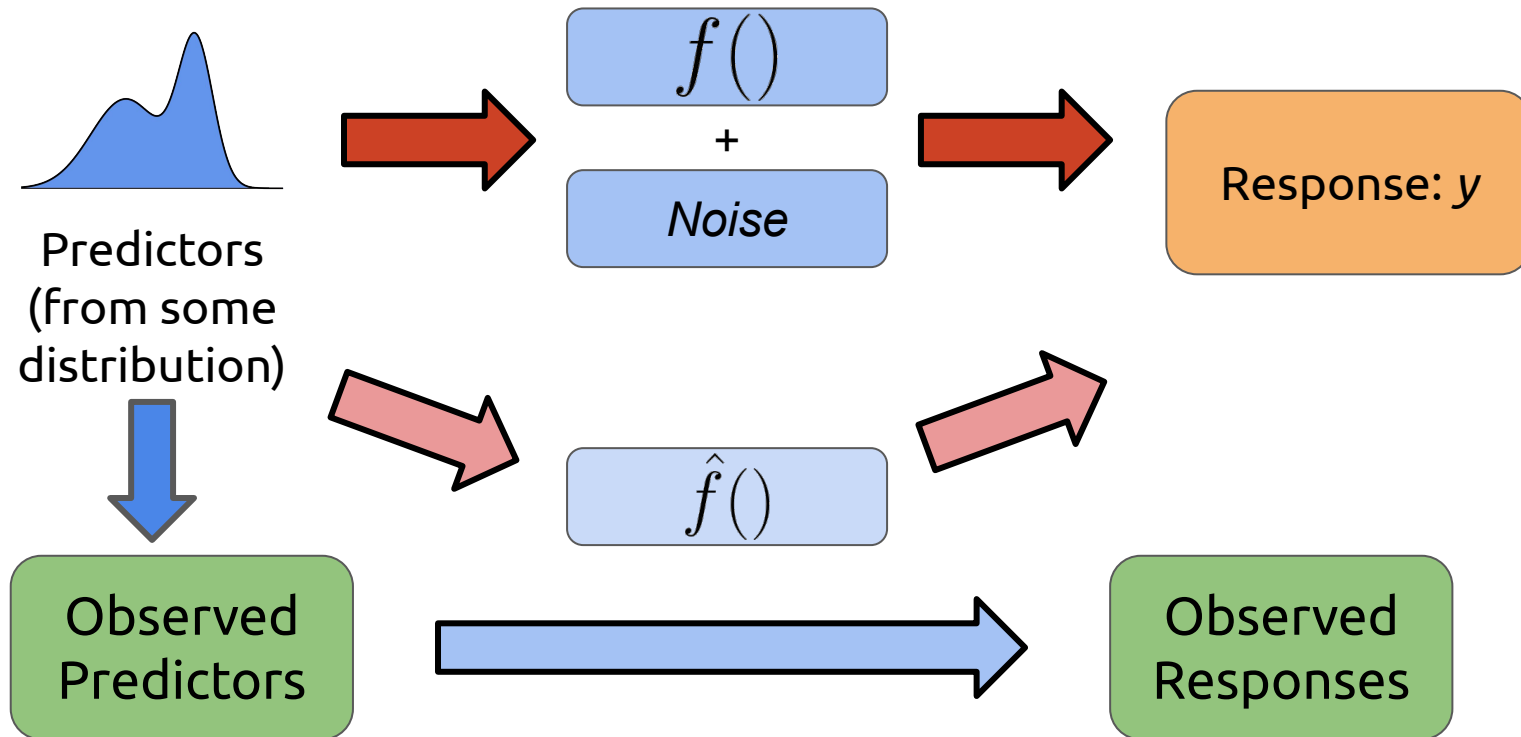


Supervised Learning - Goals



Goal: Choose a function so that the our predictions are close (on average) to the true values.

Supervised Learning - How



Supervised Learning - Goals

To measure how “good” our model is, we need some way to measure “error” (eg. mean squared error).

Our goal is to minimize the expected loss over *new* data.

Important: We are not trying to minimize loss over the observed data (which is often very easy to do), but to minimize the *generalization error* - the performance on unseen data.

Linear Regression

Given k predictors $x^{(1)}, x^{(2)}, \dots, x^{(k)}$, linear regression uses the following equation to predict the target variable:

$$\hat{f}(\vec{x}) = \beta_0 + \beta_1 x^{(1)} + \beta_2 x^{(2)} + \dots + \beta_k x^{(k)}$$

Here, $\beta_0, \beta_1, \dots, \beta_k$ are constants that are determined by using the available training data.

Linear Regression

Example: We might want to try and predict home price (our target) based on square footage (sqft), number of bedrooms (br), and number of floors (floors).

The model we will use to make predictions will look like:

$$\hat{f}(\vec{x}) = \beta_0 + \beta_1 \cdot (\text{sqft}) + \beta_2 \cdot (\text{br}) + \beta_3 \cdot (\text{floors})$$

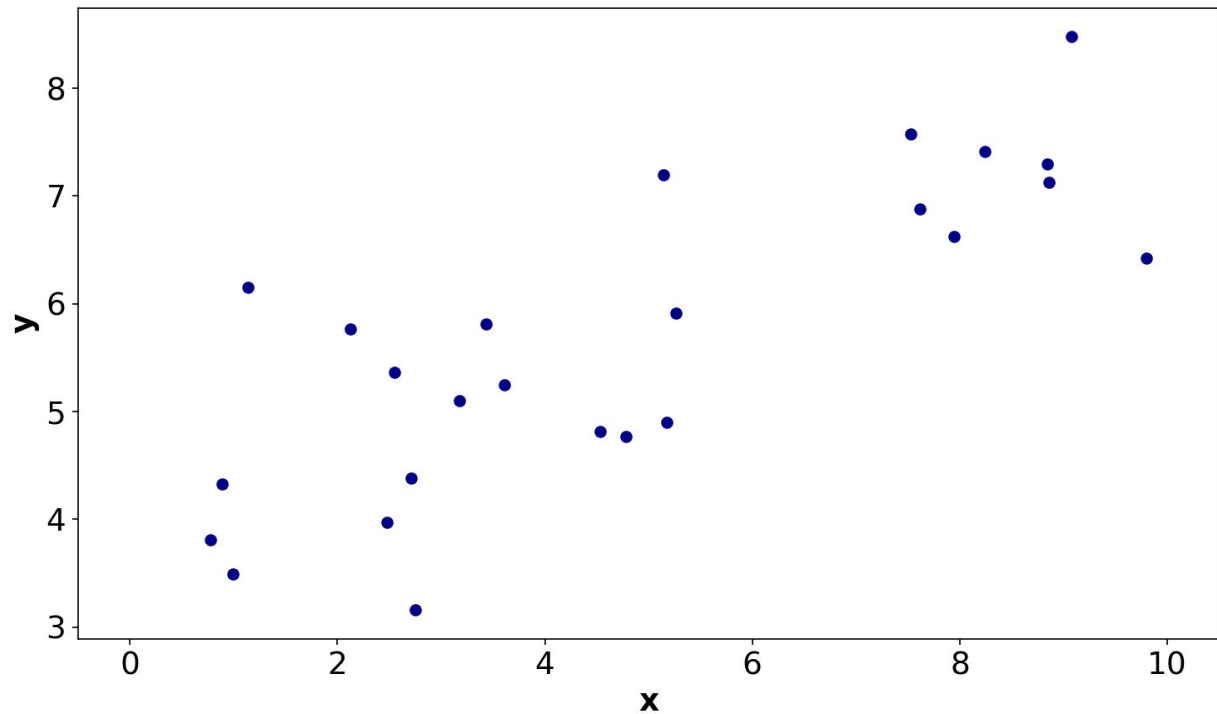
Linear Regression

How do we find the values for the coefficients?

The usual way to do it is to minimize the total squared residuals between the predicted and actual values for the data used to fit/train the model.

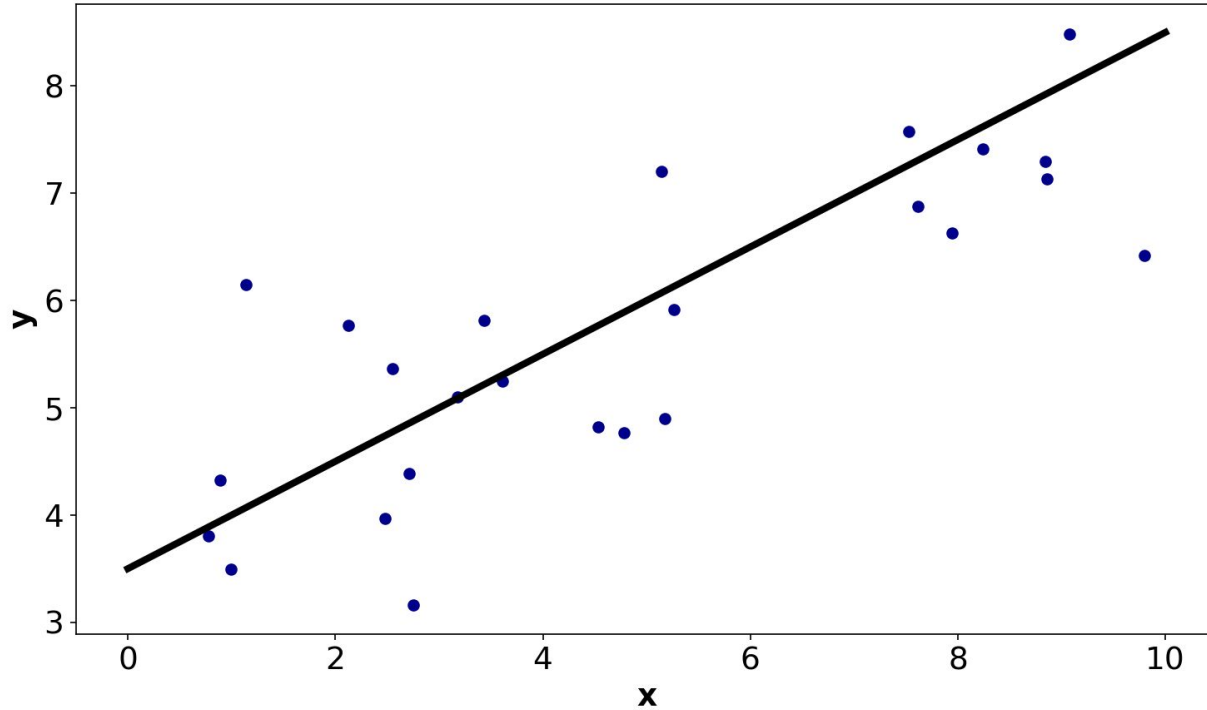
$$RSS = \sum_{i=1}^n (y_i - \hat{f}(\vec{x}_i))^2$$

Linear Regression



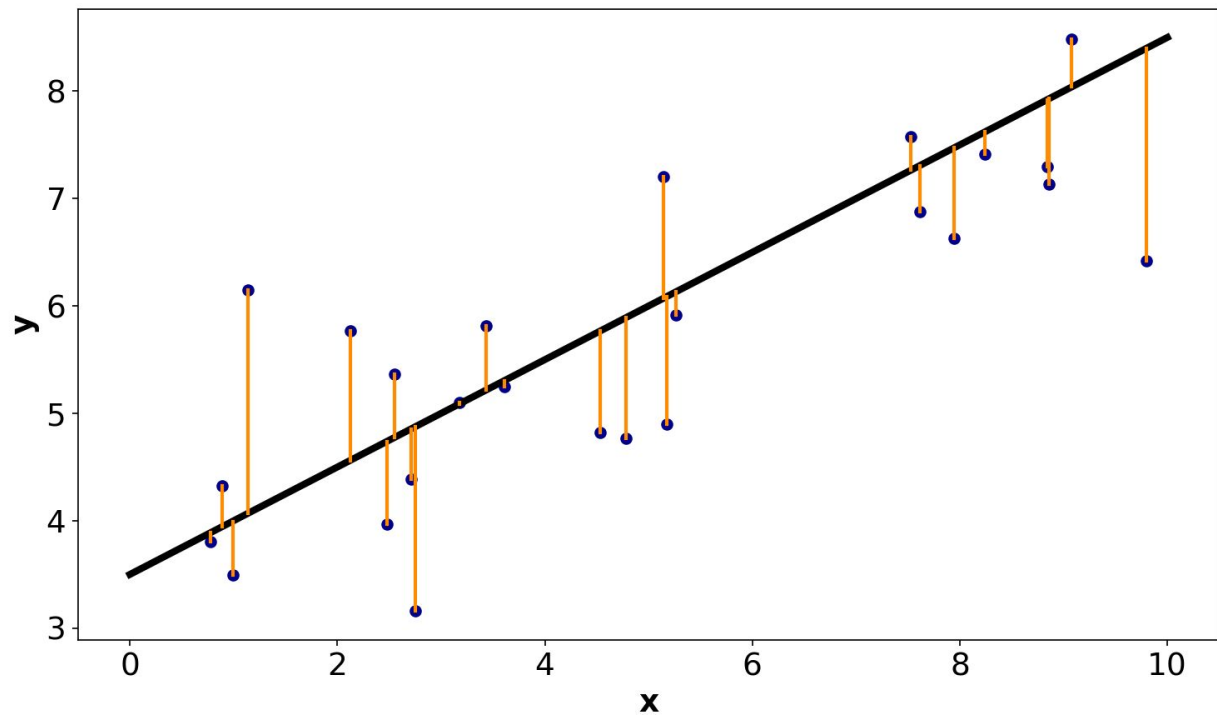
Example: Let's say we have this data available. We want to predict y based on our one predictor, x .

Linear Regression



One possible line:
 $y = 3.5 + 0.5x$

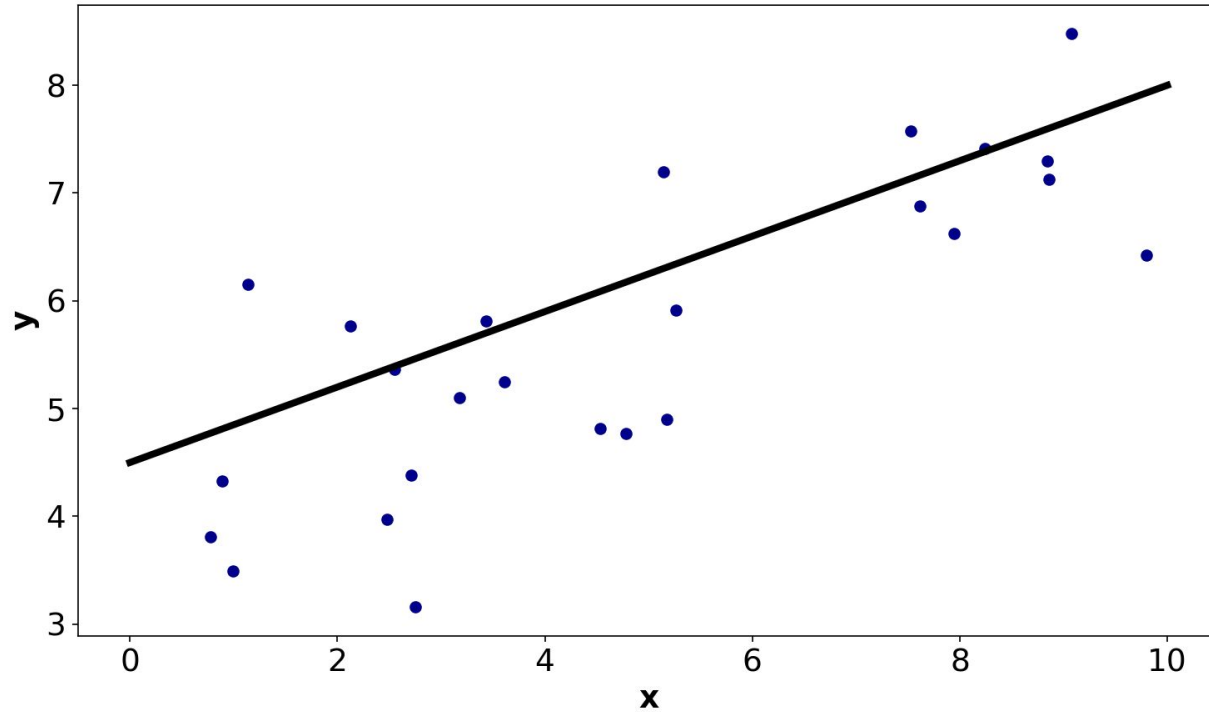
Linear Regression



One possible line:
 $y = 3.5 + 0.5x$

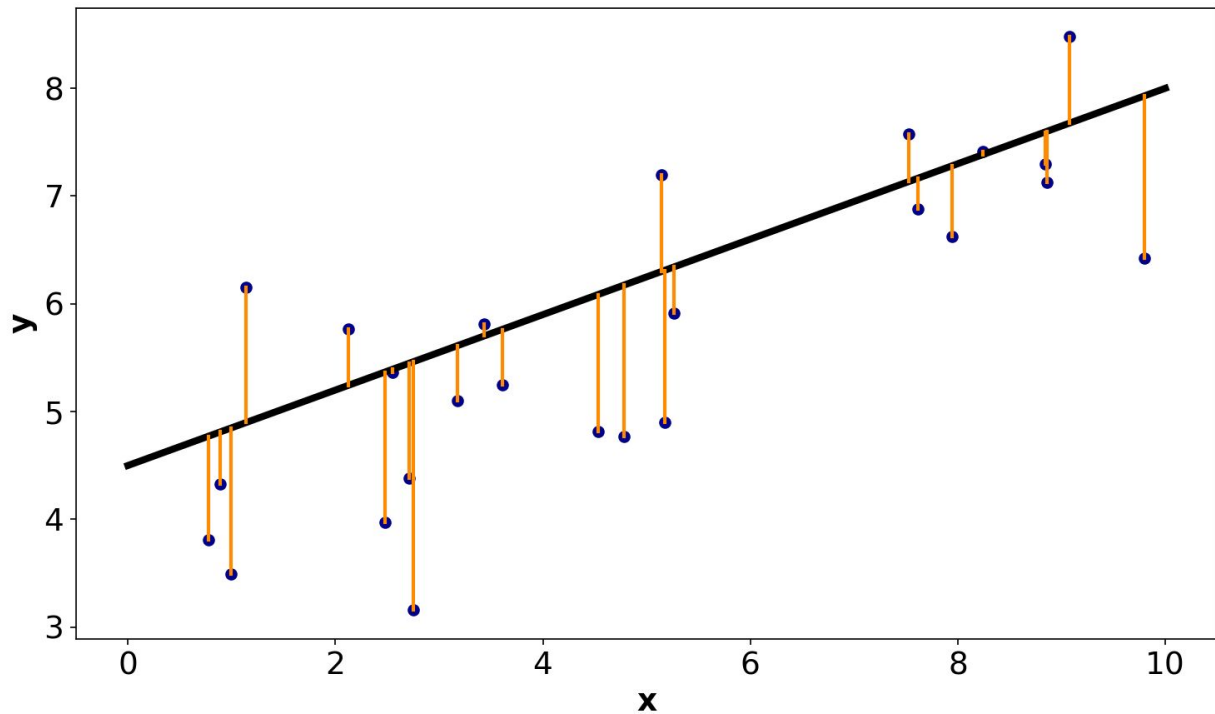
For this line,
RSS = 20.36

Linear Regression



Another possibility:
 $y = 4.5 + 0.35x$

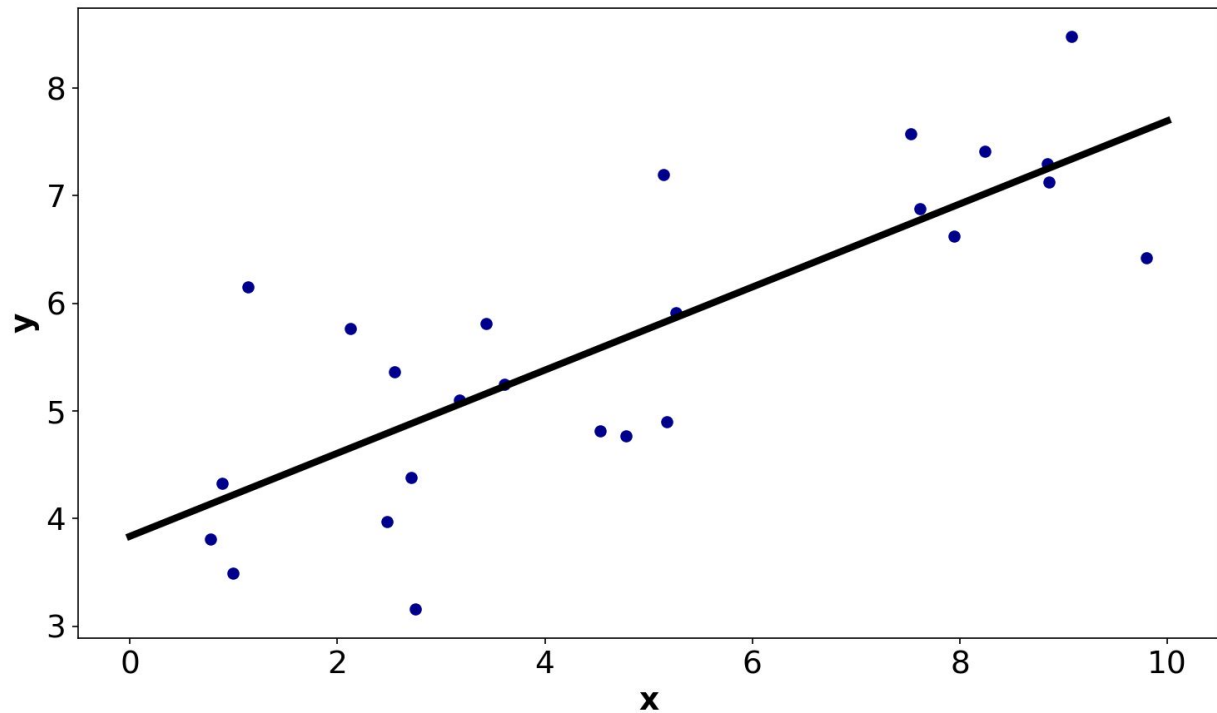
Linear Regression



Another possibility:
 $y = 4.5 + 0.35x$

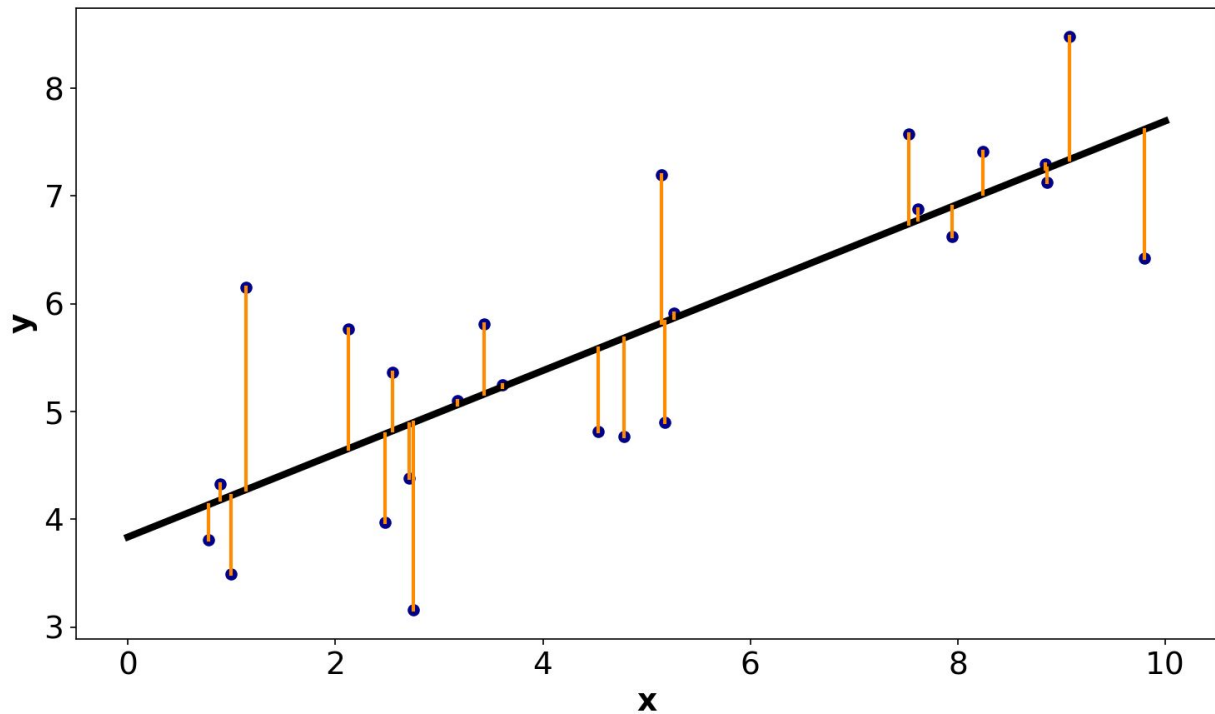
Here,
RSS = 24.28

Linear Regression



The best possible:
 $y = 3.84 + 0.386x$

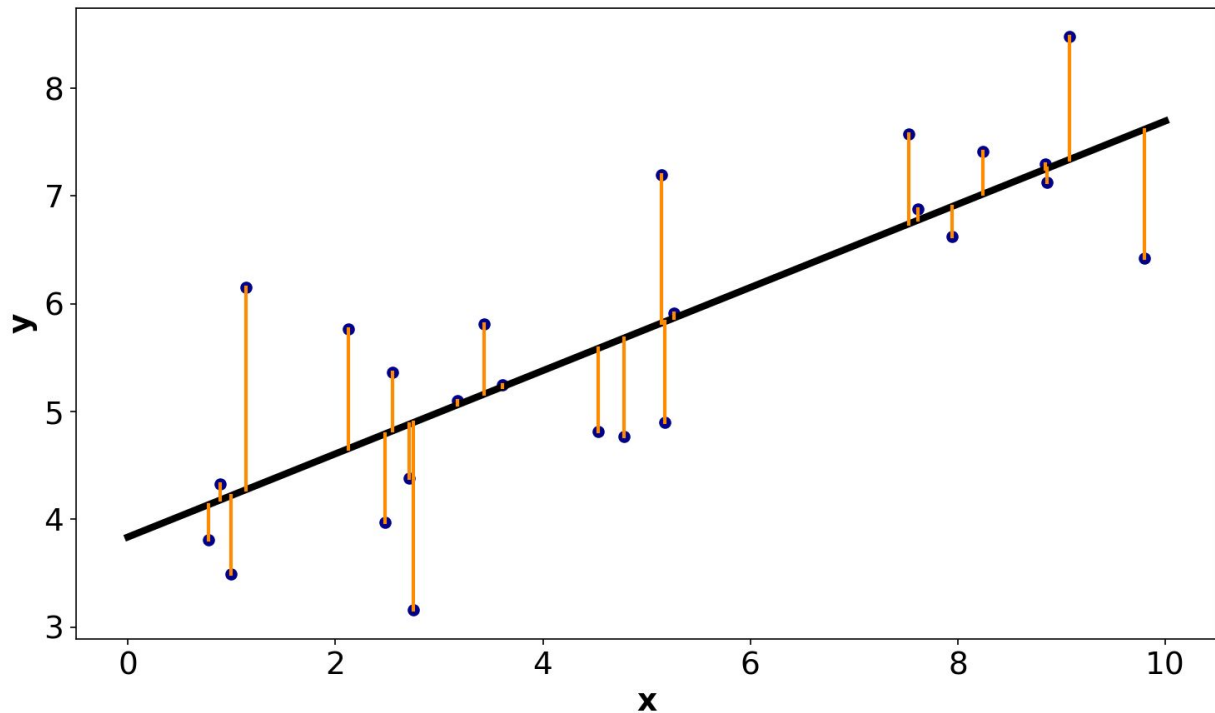
Linear Regression



The best possible:
 $y = 3.84 + 0.386x$

Here,
RSS = 17.97

Linear Regression



For the best-fitting line, the average (absolute) residual is equal to 0.67.

Can we expect that on new data generated by the same process, we will be off on average by 0.67 still?