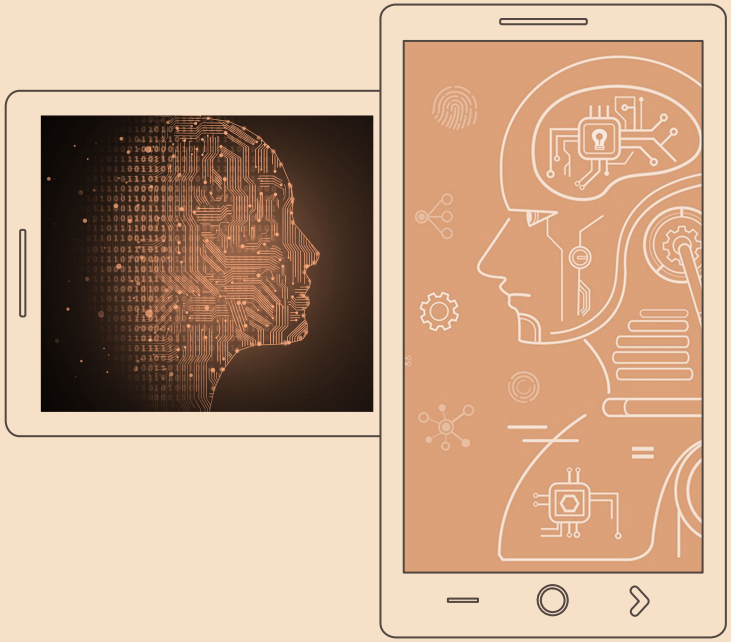


Machine Learning

Use Overfitting To Evaluate Different Models

Project Explanation:

Determining which model is the better model.

Suppose we collect a set of sample data and distribute the sample data by
Training phase: 50%, Validation phase: 25%, Test phase: 25%

Training Phase				Validation Phase				Test Phase	
Real Data Set 1 50% of the collcted data		Model 1: Linear Regression	Model 2: Non-Linear Regression	Real Data Set 2 25% of the collcted data		Model 1: Linear Regression	Model 2: Non-Linear Regression	Real Data Set 3 25% of the collcted data	The better model
x	y	$\hat{y} = a1 + b1 * x$	$\hat{y} = a2 + b2 * x^2$	x	y	$\hat{y} = a1 + b1 * x$	$\hat{y} = a2 + b2 * x^2$	x	
1	1.8			1.5	1.7			1.4	
2	2.4	Find Y values		2.9	2.7			2.5	
3.3	2.3			3.7	2.5			3.6	
4.3	3.8			4.7	2.8			4.5	
5.3	5.3			5.1	5.5			5.4	
1.4	1.5			X	X	X	X	X	X
2.5	2.2			X	X	X	X	X	X
2.8	3.8			X	X	X	X	X	X
4.1	4			X	X	X	X	X	X
5.1	5.4			X	X	X	X	X	X

Model 1: Linear Regression

Find Y values

01

N = 10

Count the number of values.

02

Find
X * Y and X * X.

Real Data X * Y and X * X.

03

Find
ΣX, ΣY, ΣXY, ΣP.

ΣP = ΣX*X = 121.34,
ΣX = 31.8, ΣY = 32.5,
ΣXY = 120.8.

04

Slope(b) = 0.863177681

(NΣXY - (ΣX)(ΣY)) / (NΣX^2 - (ΣX)^2)

05

Intercept(a) = 0.505094974

(ΣY - b(ΣX)) / N

06

Regression Equation(y) = a + bx

Use real data X to calculate.

Model 2: Non-Linear Regression

Step Values

01

N = 10

Count the number of values.

02

Find
X * Y and X * X.

Real Data X * Y and X * X.

03

Find
ΣX, ΣY, ΣXY, ΣP, ΣPY, ΣP^2

ΣP = ΣX*X = 121.34, ΣX = 31.8,
ΣY = 32.5, ΣXY = 120.8,
ΣPY = 509.762,
ΣPP = 2329.9862

04

Slope(b) = 0.134562411

(NΣPY - (ΣP)(ΣY)) / (NΣP^2 - (ΣP)^2)

05

Intercept(a) = 1.6172197

(ΣY - b(ΣP)) / N

06

Regression Equation(y) = a + bx^2

Use real data X to calculate.

Data Table:

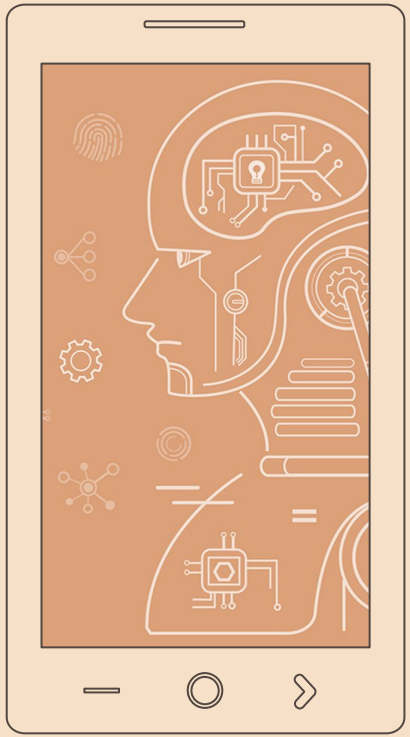
After used both linear and non-linear regression to calculate the Y value. Next step is to determining which model is the better model.

Training Phase				Validation Phase			
Real Data Set 1 50% of the collcted data		Model 1: Linear Regression	Model 2: Non-Linear Regression	Real Data Set 2 25% of the collcted data		Model 1: Linear Regression	Model 2: Non-Linear Regression
x	y	$\hat{y} = a1 + b1 * x$	$\hat{y}=a2 + b2 * x^2$	x	y	$\hat{y}=a1 + b1 * x$	$\hat{y}=a2 + b2 * x^2$
ΣX = 31.8, ΣY = 32.5, ΣXY = 120.8, ΣP = 121.34, ΣPY = 509.762, ΣPP = 2329.9862		a = 0.505094974 b = 0.863177681	a = 1.6172197 b = 0.134562411			a = 0.505094974 b = 0.863177681	a = 1.6172197 b = 0.134562411
1	1.8	1.3683	1.7518	1.5	1.7	1.7999	1.9200
2	2.4	2.2315	2.1555	2.9	2.7	3.0083	2.7489
3.3	2.3	3.3536	3.0826	3.7	2.5	3.6989	3.4594
4.3	3.8	4.2168	4.1053	4.7	2.8	4.5620	4.5897
5.3	5.3	5.0799	5.3971	5.1	5.5	4.9073	5.1172
1.4	1.5	1.7135	1.8810	X	X	X	X
2.5	2.2	2.6630	2.4582	X	X	X	X
2.8	3.8	2.9220	2.6722	X	X	X	X
4.1	4	4.0441	3.8792	X	X	X	X
5.1	5.4	4.9073	5.1172	X	X	X	X

Use Overfitting To Evaluate Different Models

max(Training_Set_MSE, Validation_Set_MSE) / min(Training_Set_MSE, Validation_Set_MSE)

	Training Set	Validation Set	~~Better~~
Model 1	((1.3686-1.8)^2 + (2.2315-2.4)^2 + (3.3536-2.3)^2 + (4.2168-3.8)^2 + (5.0799-5.3)^2 + (1.7135-1.5)^2 + (2.6630-2.2)^2 + (2.9220-3.8)^2 + (4.0441-4)^2 + (4.9073-5.4)^2))/10 = 0.282227077	((1.7999-1.7)^2 + (3.0083-2.7)^2 + (3.6989-2.5)^2 + (4.5620-2.8)^2 + (4.9073-5.5)^2) / 5 = 0.999966548	0.999966548 / 0.282227077 = 3.542060849
Model 2	((1.7518-1.8)^2 + (2.1555-2.4)^2 + (3.0826-2.3)^2 + (4.1053-3.8)^2 + (5.3971-5.3)^2 + (1.8810-1.5)^2 + (2.4582-2.2)^2 + (2.6722-3.8)^2 + (3.8792-4)^2 + (5.1172-5.4)^2)) /10 = 0. 235553231	((1.9200-1.7)^2 + (2.7489-2.7)^2 + (3.4594-2.5)^2 + (4.5897-2.8)^2 + (5.1172-5.5)^2) / 5 = 0.8641603	0.8641603 / 0.235553231 = 3.668641251

Training Phase				Validation Phase				Test Phase	
Real Data Set 1 50% of the collcted data		Model 1: Linear Regression	Model 2: Non-Linear Regression	Real Data Set 2 25% of the collcted data		Model 1: Linear Regression	Model 2: Non-Linear Regression	Real Data Set 3 25% of the collcted data	The better model selected depending on the analysis of overfitting
x	y	$\hat{y} = a1 + b1 * x$	$\hat{y} = a2 + b2 * x^2$	x	y	$\hat{y} = a1 + b1 * x$	$\hat{y} = a2 + b2 * x^2$	x	Use Model 1: $\hat{y} = a1 + b1 * x$
1	1.8	1.3683	1.7518	1.5	1.7	1.7999	1.9200	1.4	1.7135
2	2.4	2.2315	2.1555	2.9	2.7	3.0083	2.7489	2.5	2.6630
3.3	2.3	3.3536	3.0826	3.7	2.5	3.6989	3.4594	3.6	3.6125
4.3	3.8	4.2168	4.1053	4.7	2.8	4.5620	4.5897	4.5	4.3894
5.3	5.3	5.0799	5.3971	5.1	5.5	4.9073	5.1172	5.4	5.1663
1.4	1.5	1.7135	1.8810	X	X	X	X	X	X
2.5	2.2	2.6630	2.4582	X	X	X	X	X	X
2.8	3.8	2.9220	2.6722	X	X	X	X	X	X
4.1	4	4.0441	3.8792	X	X	X	X	X	X
5.1	5.4	4.9073	5.1172	X	X	X	X	X	X

THANKS!