Theory, Practice & Products

The three perspectives of machine learning

Approaches

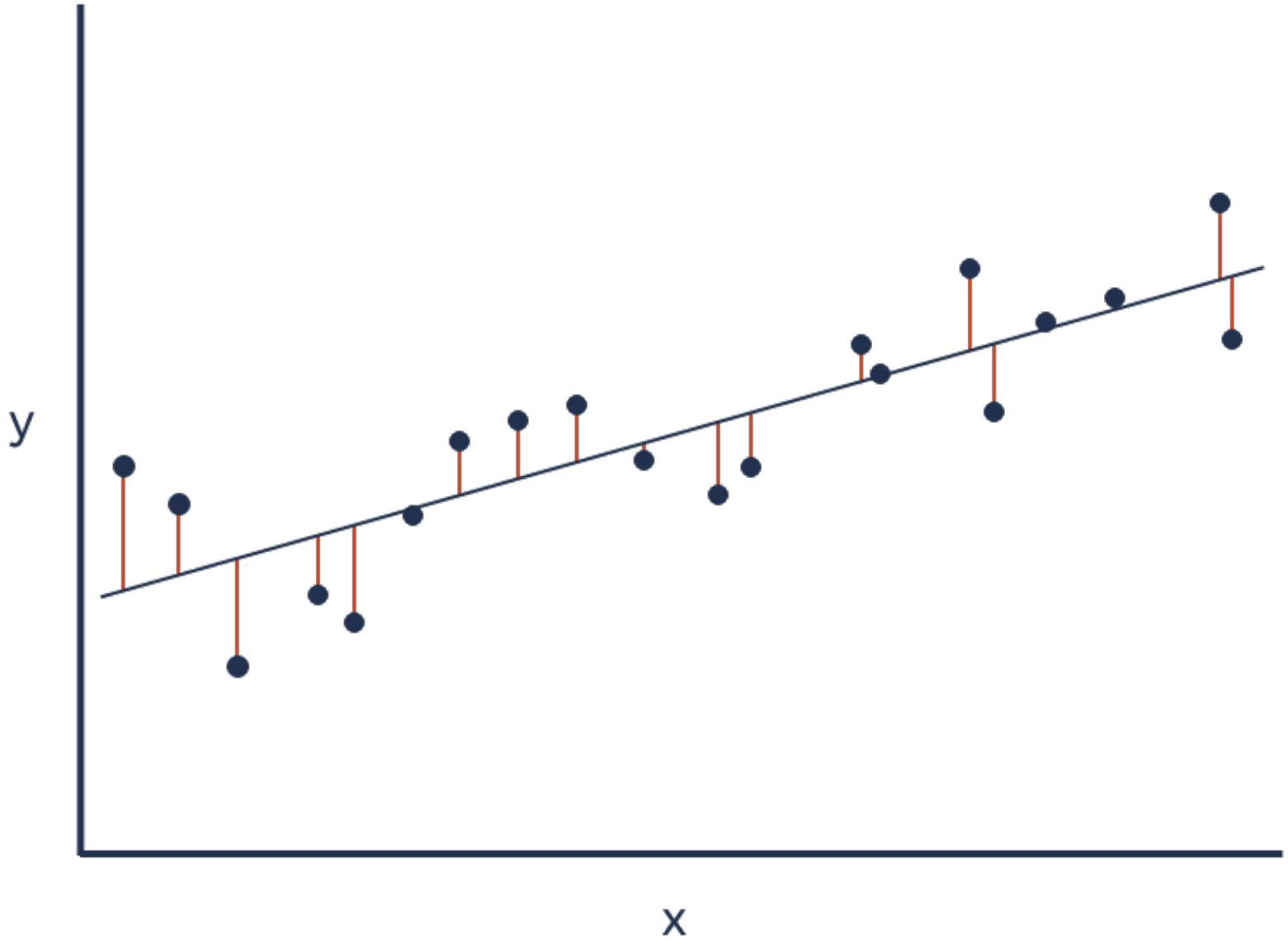
Roles

- Software Engineers
- Data Analysts
- Data Engineers
- Machine Learning Engineers
- Data Scientists
- Research Engineers

Theory

$$f(x) = w_1 x + w_0$$

$$f(x) = w_1 x + w_0 + \epsilon$$


y
x

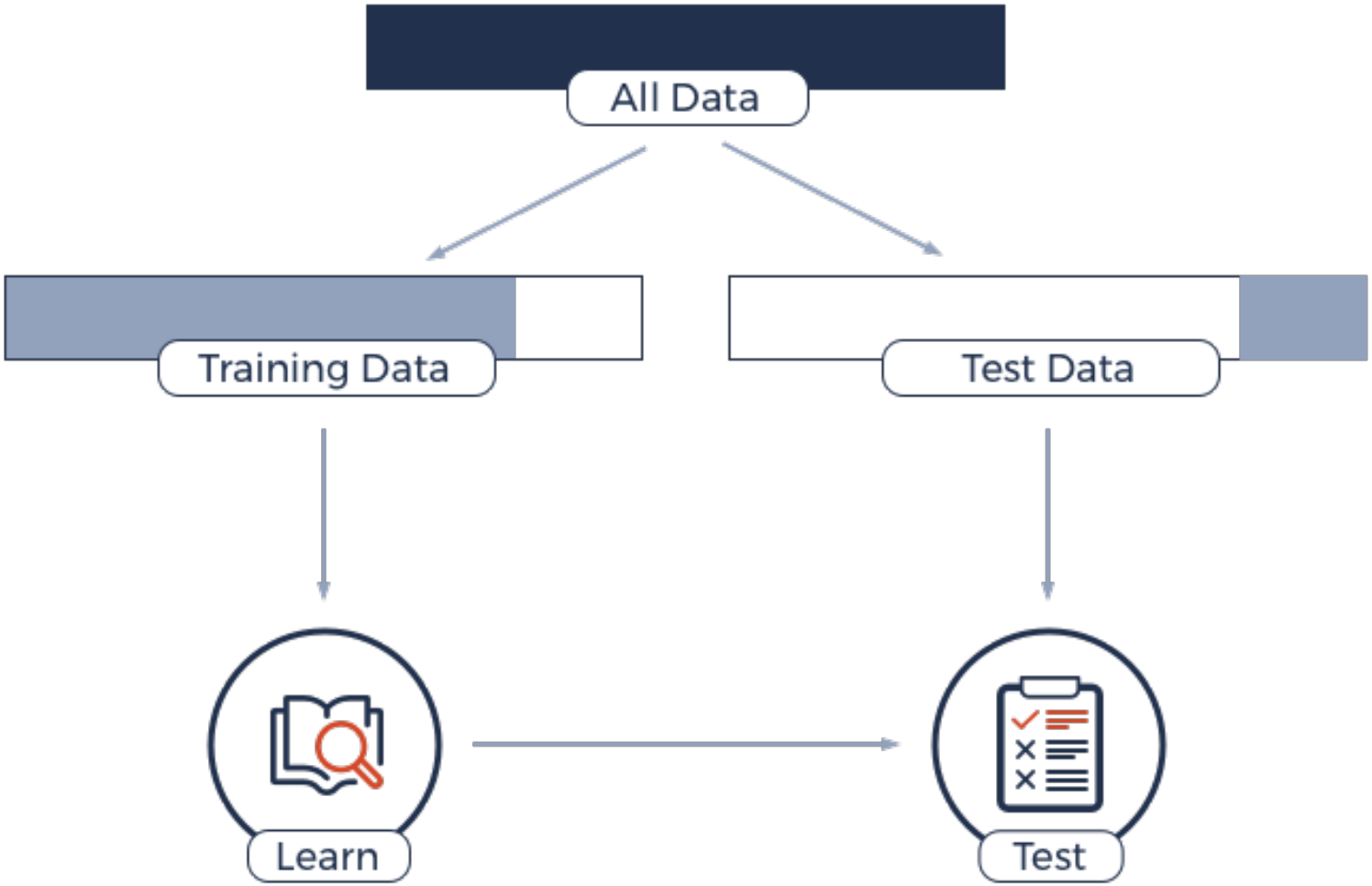
$$\min_{w_1, w_0} \sqrt{\sum_i^n (y_i - (w_1 x_i + w_0))^2}^2$$

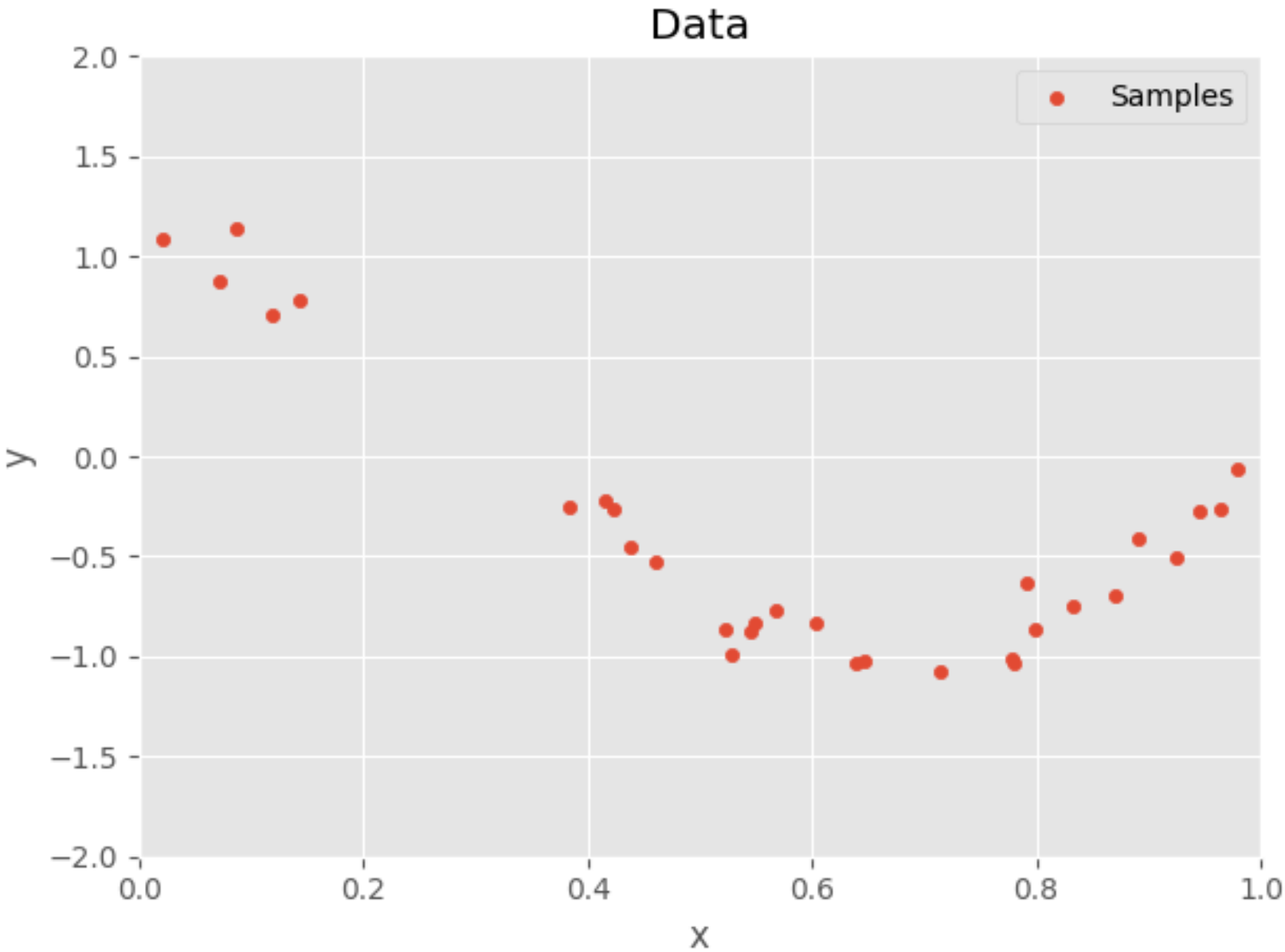
$$\min_{\mathbf{w}} \; ||\mathbf{y} - \mathbf{w}^T\mathbf{X}||_2^2$$

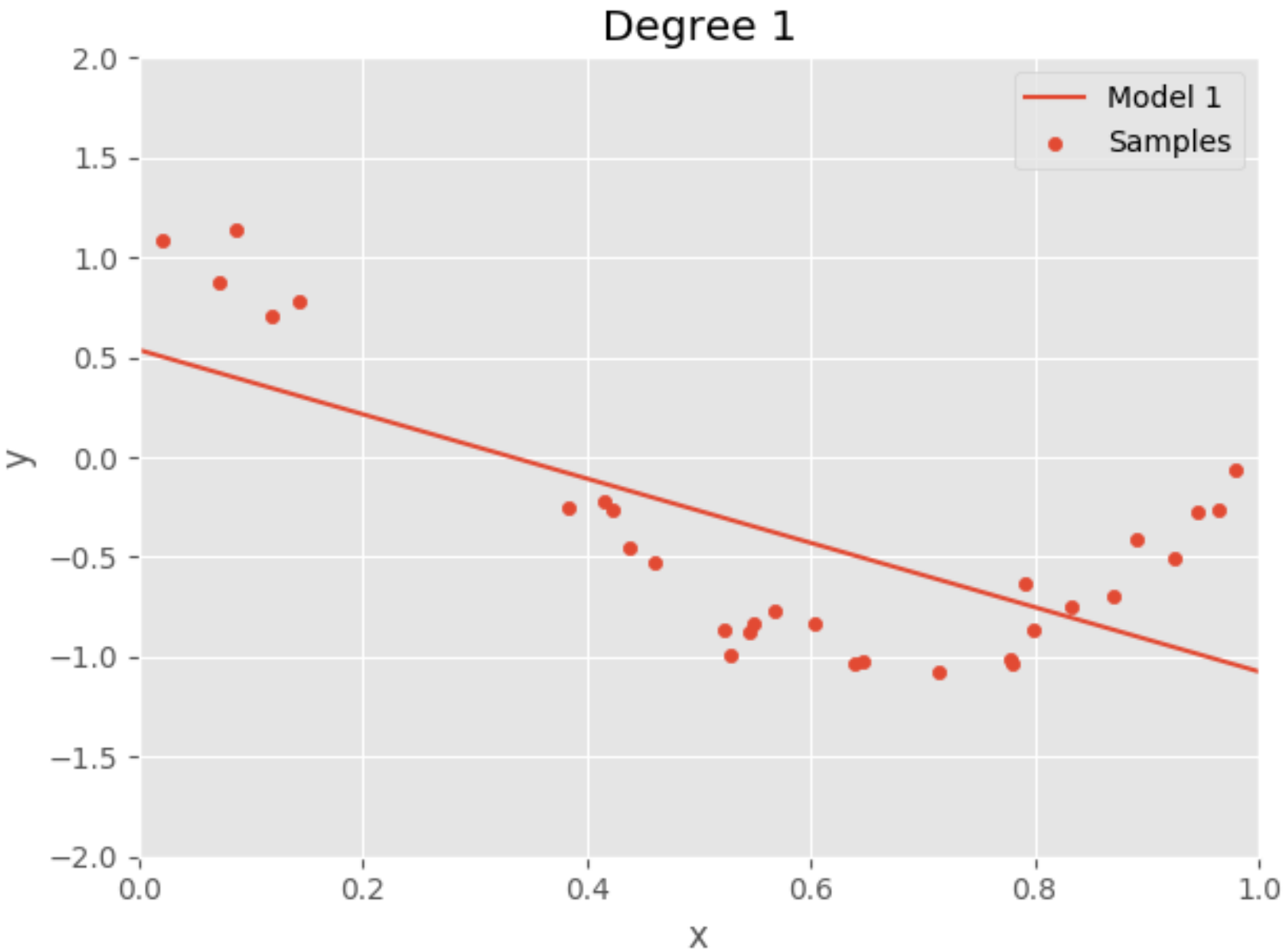
$$\min_{\mathbf{w}} \; ||\mathbf{y} - \mathbf{w}^T\mathbf{X}||_2^2$$

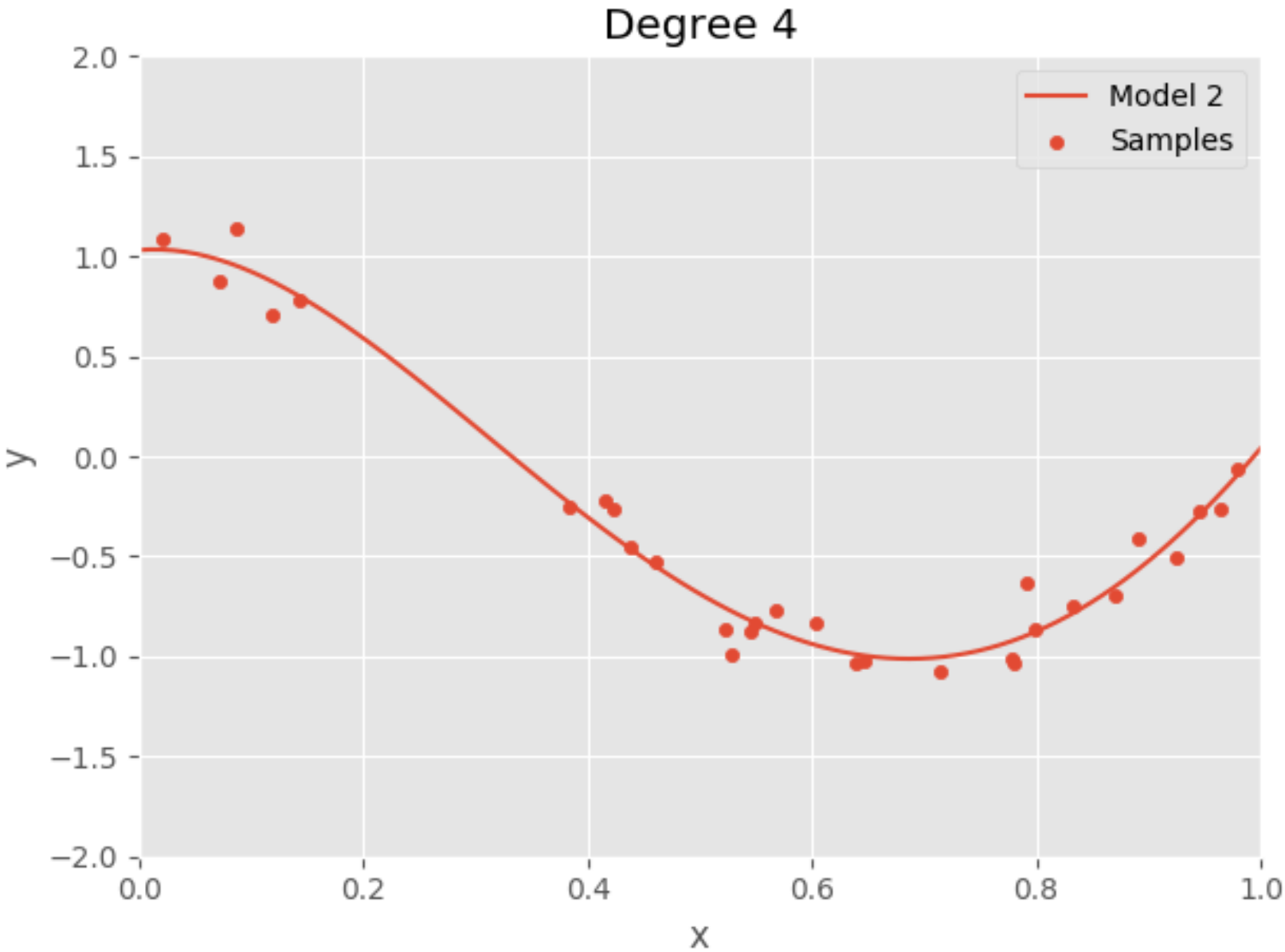
$$\min_{\mathbf{w}} \left\| \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ \vdots \\ y_n \end{bmatrix} - \begin{bmatrix} w_0 \\ w_1 \\ w_2 \\ \vdots \\ w_m \end{bmatrix} \begin{bmatrix} x_1^0 & x_1^1 & x_1^2 & \dots & x_1^m \\ x_2^0 & x_2^1 & x_2^2 & \dots & x_2^m \\ x_3^0 & \ddots & & & \\ \vdots & & \ddots & & \\ x_n^0 & \dots & \dots & \dots & x_n^m \end{bmatrix} \right\|_{2,1}^2$$

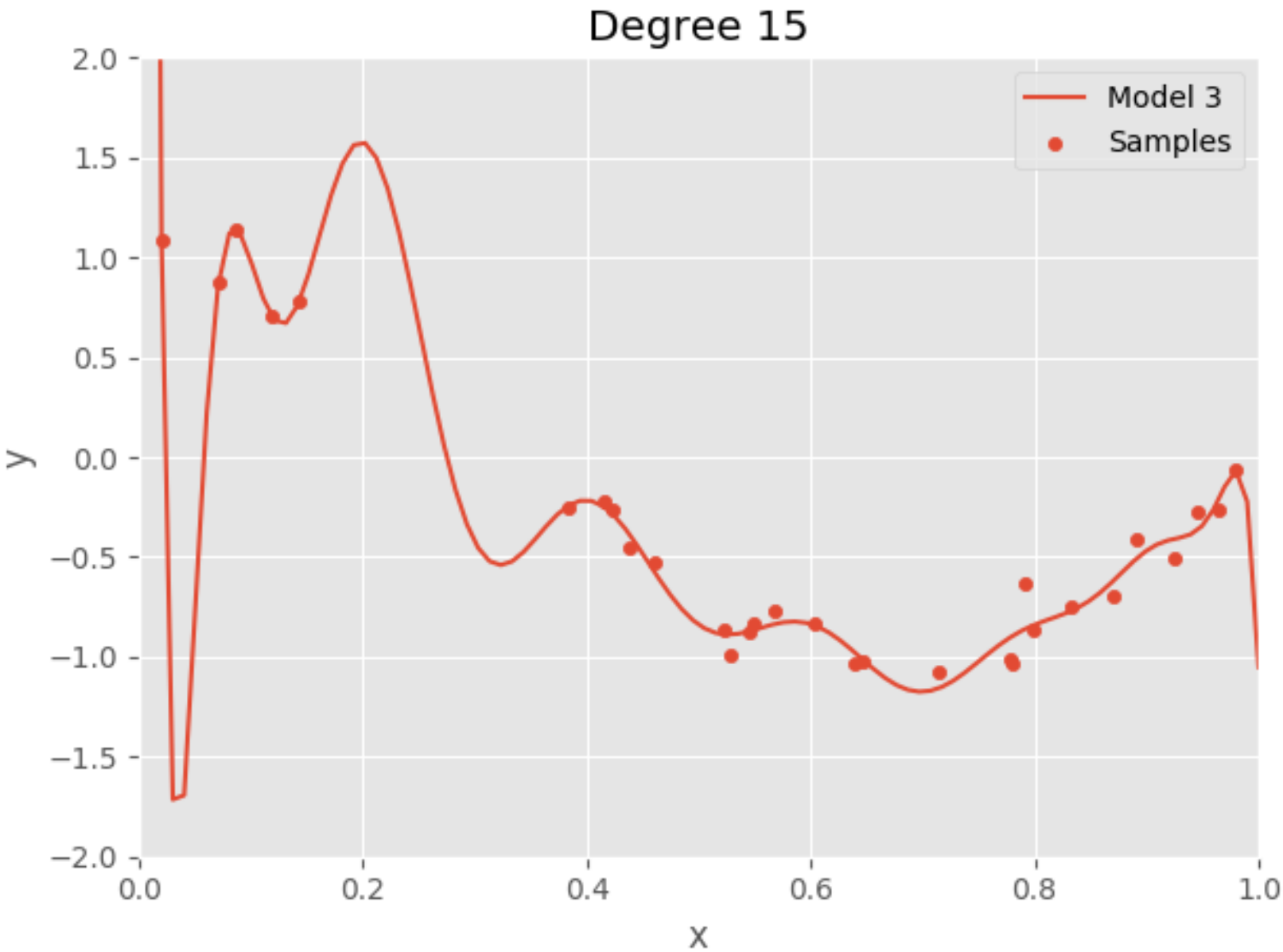
Practice

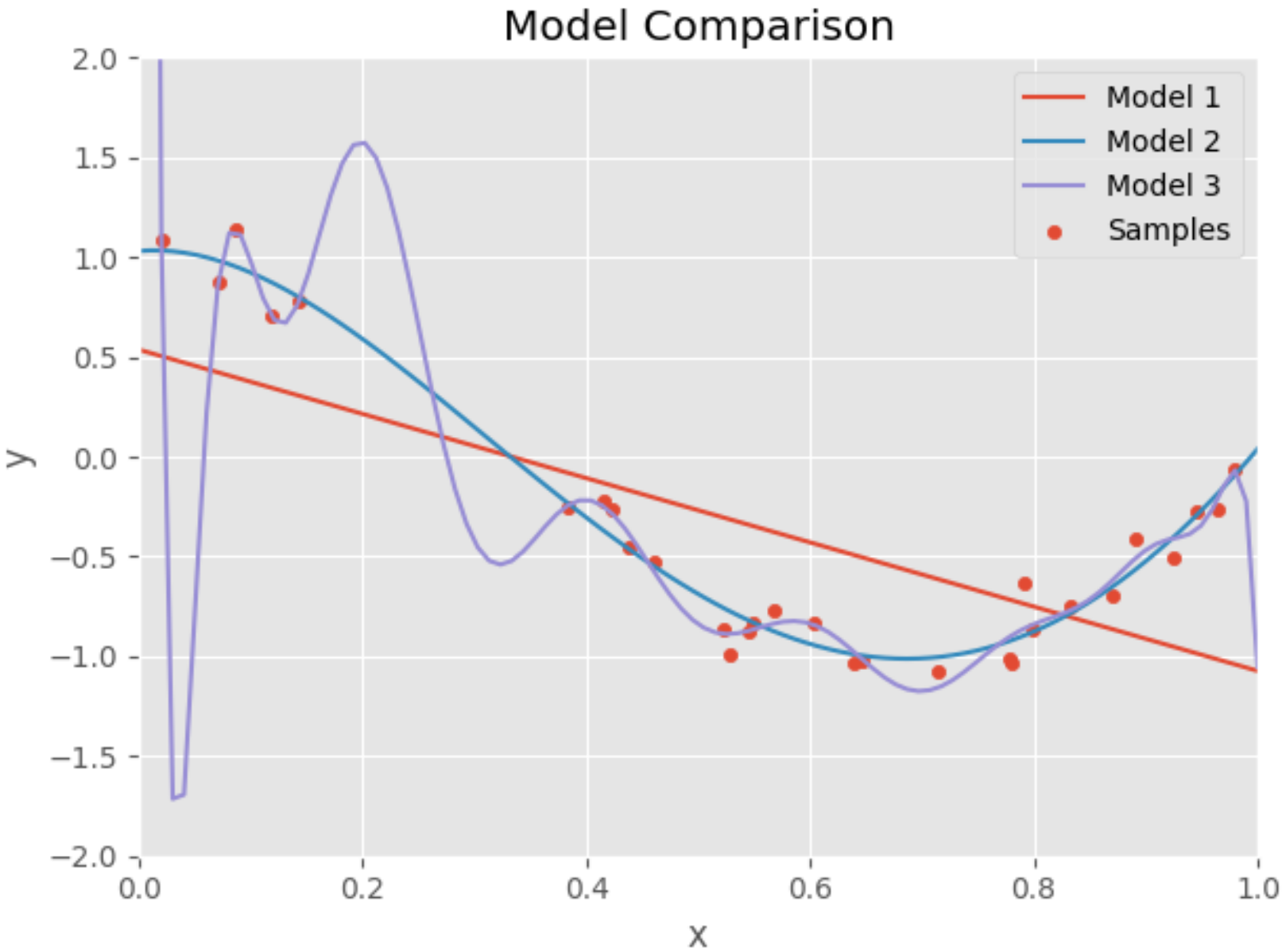

All Data
Training Data
Test Data
Learn
Test


Data
Samples
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
y
0.0
0.2
0.4
0.6
0.8
1.0
x


Degree 1
Model 1
Samples
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
y
0.0
0.2
0.4
0.6
0.8
1.0
x

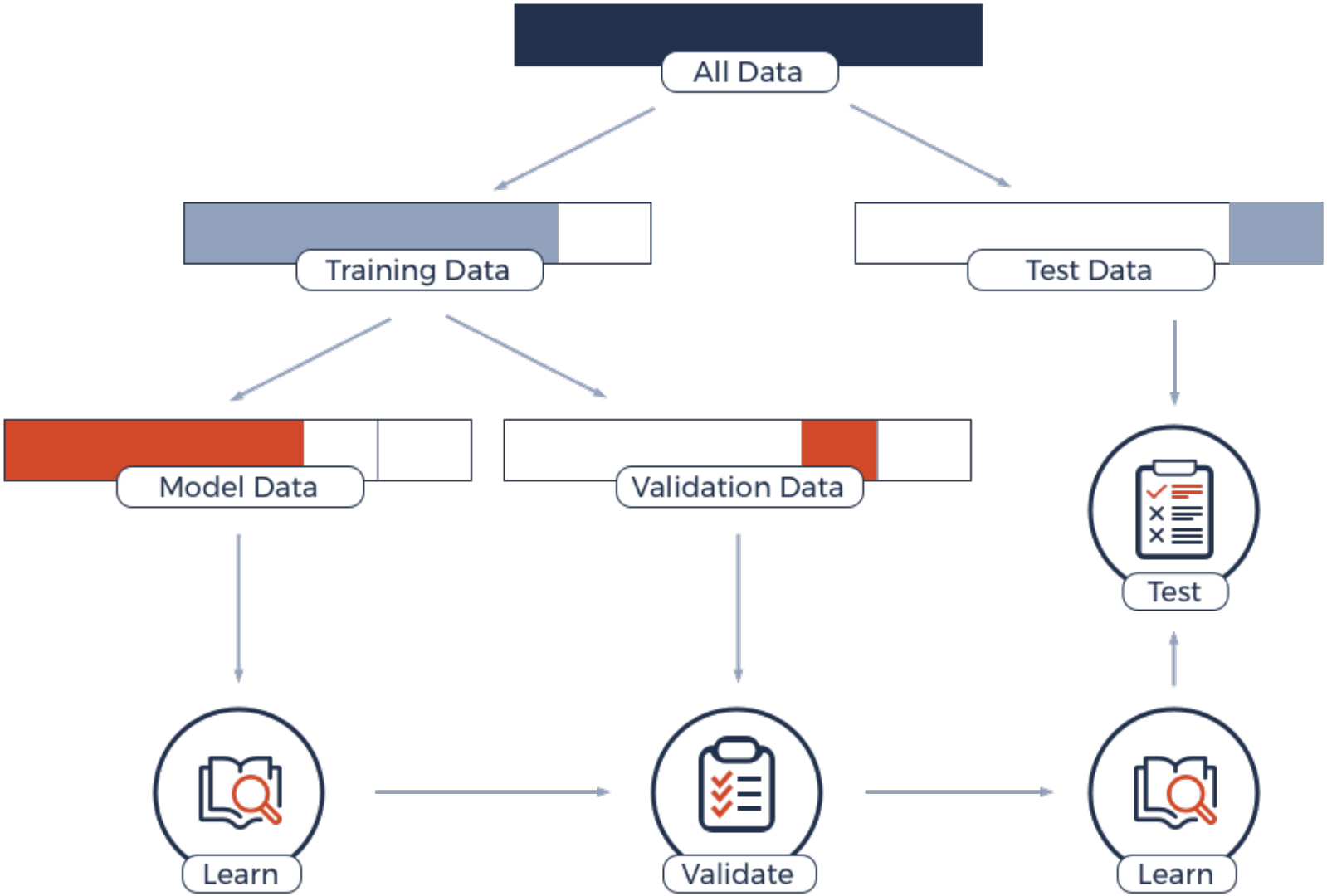

Degree 4
Model 2
Samples
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
y
0.0
0.2
0.4
0.6
0.8
1.0
x

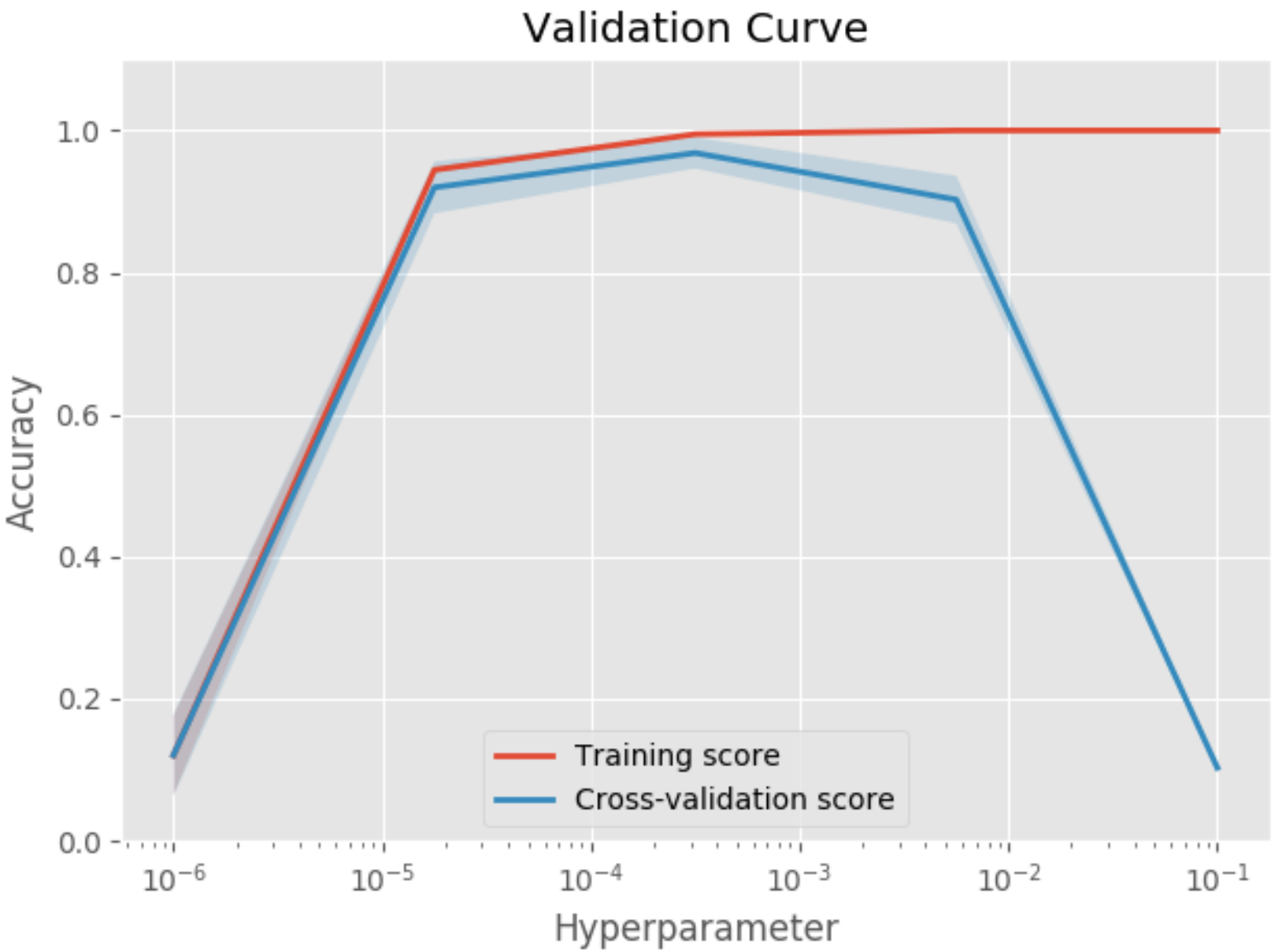

Degree 15
Model 3
Samples
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
y
0.0
0.2
0.4
0.6
0.8
1.0
x

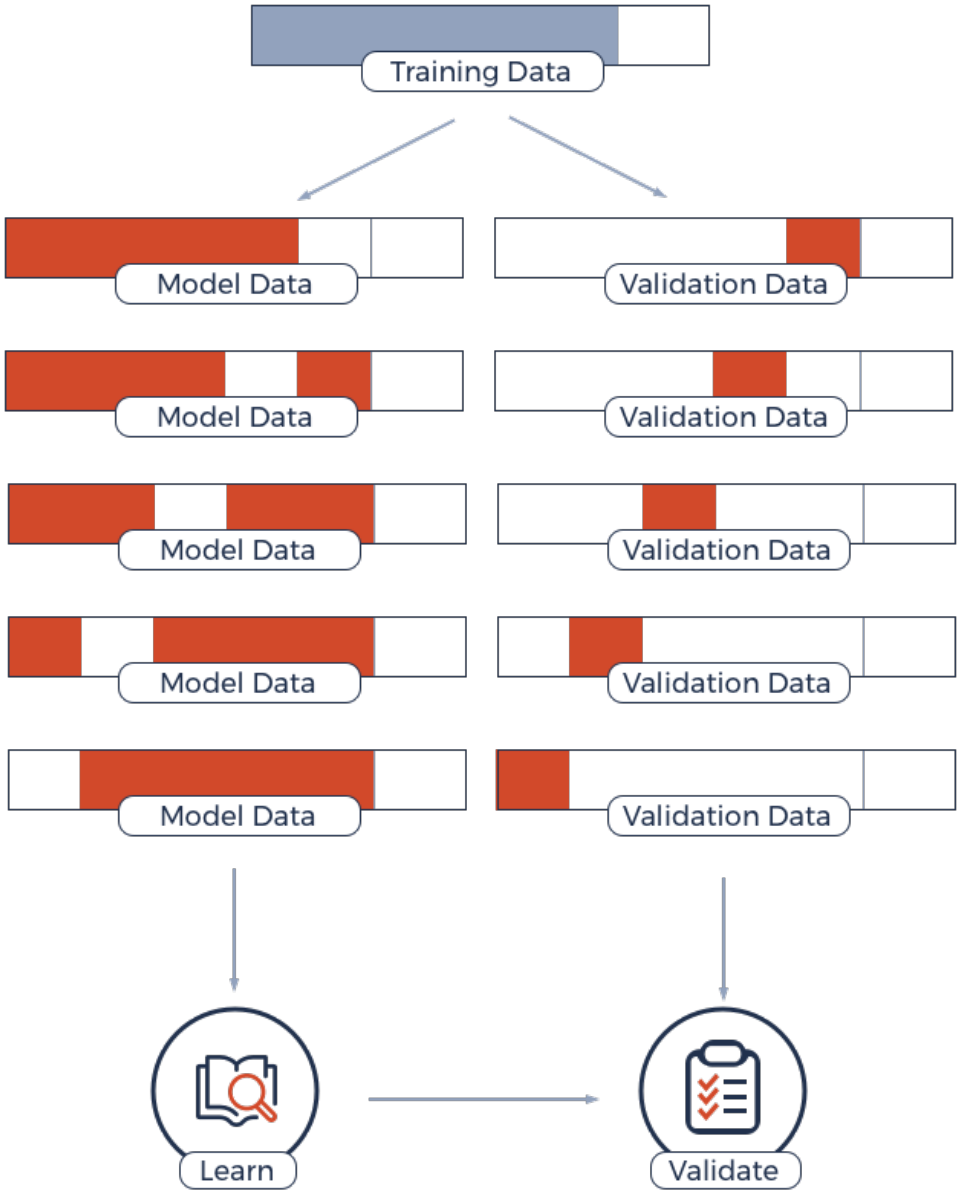

Model Comparison
Model 1
Model 2
Model 3
Samples
y
x
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
0.0
0.2
0.4
0.6
0.8
1.0

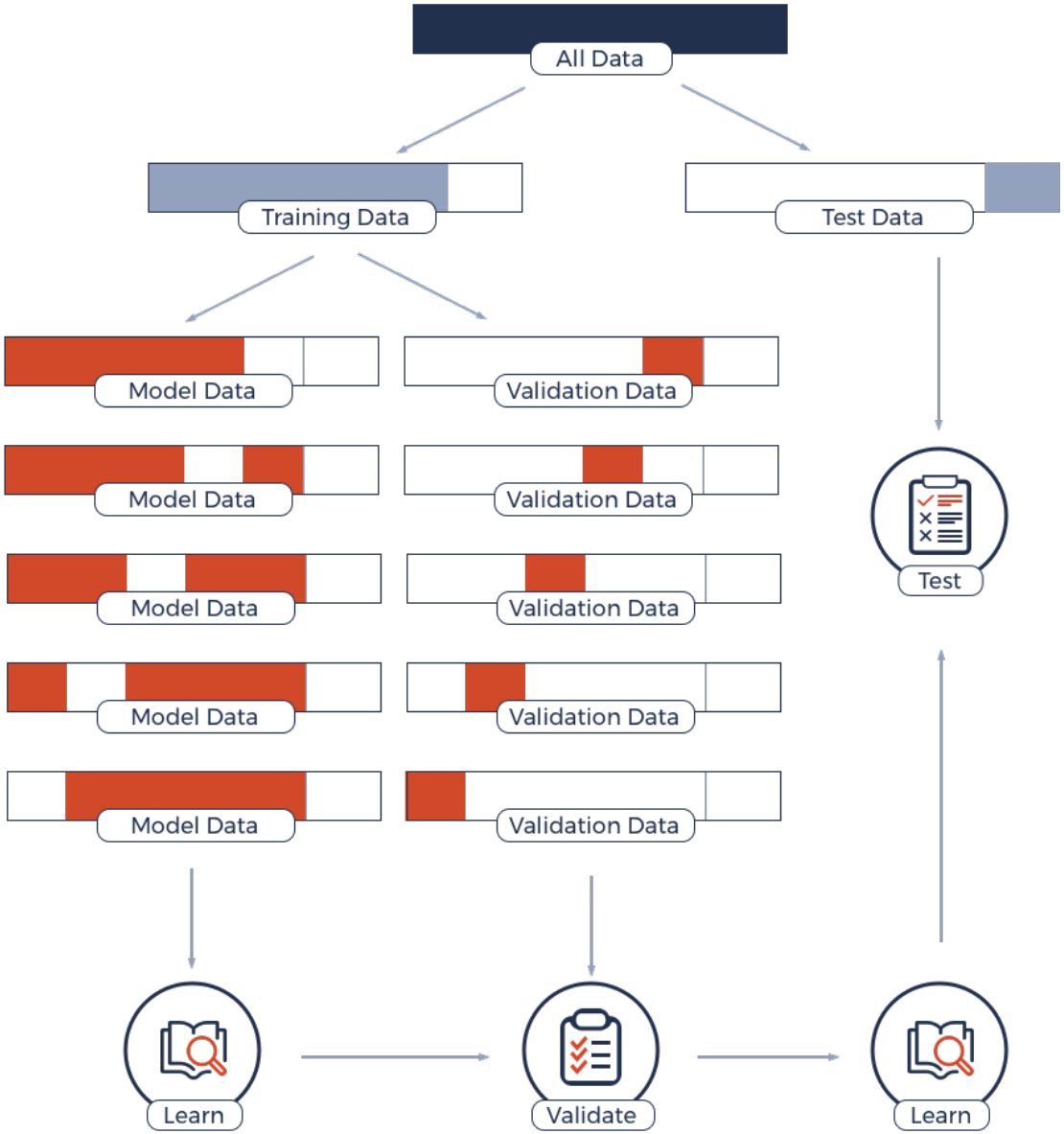
Model Fitting

- Underfitting
- Generalizing
- Overfitting


All Data
Training Data
Test Data
Model Data
Validation Data
Test
Learn
Validate
Learn


Validation Curve
Accuracy
1.0
0.8
0.6
0.4
0.2
0.0
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
Hyperparameter
Training score
Cross-validation score


Training Data
Model Data
Validation Data
Model Data
Validation Data
Model Data
Validation Data
Model Data
Validation Data
Model Data
Validation Data
Learn
Validate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Model Data
Validation Data
Model Data
Validation Data
Model Data
Validation Data
Model Data
Validation Data
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Learn
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Learn

Products

- Business
- Engineering

Questions

These slides are designed for educational purposes, specifically the CSCI-470 Introduction to Machine Learning course at the Colorado School of Mines as part of the Department of Computer Science.