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DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

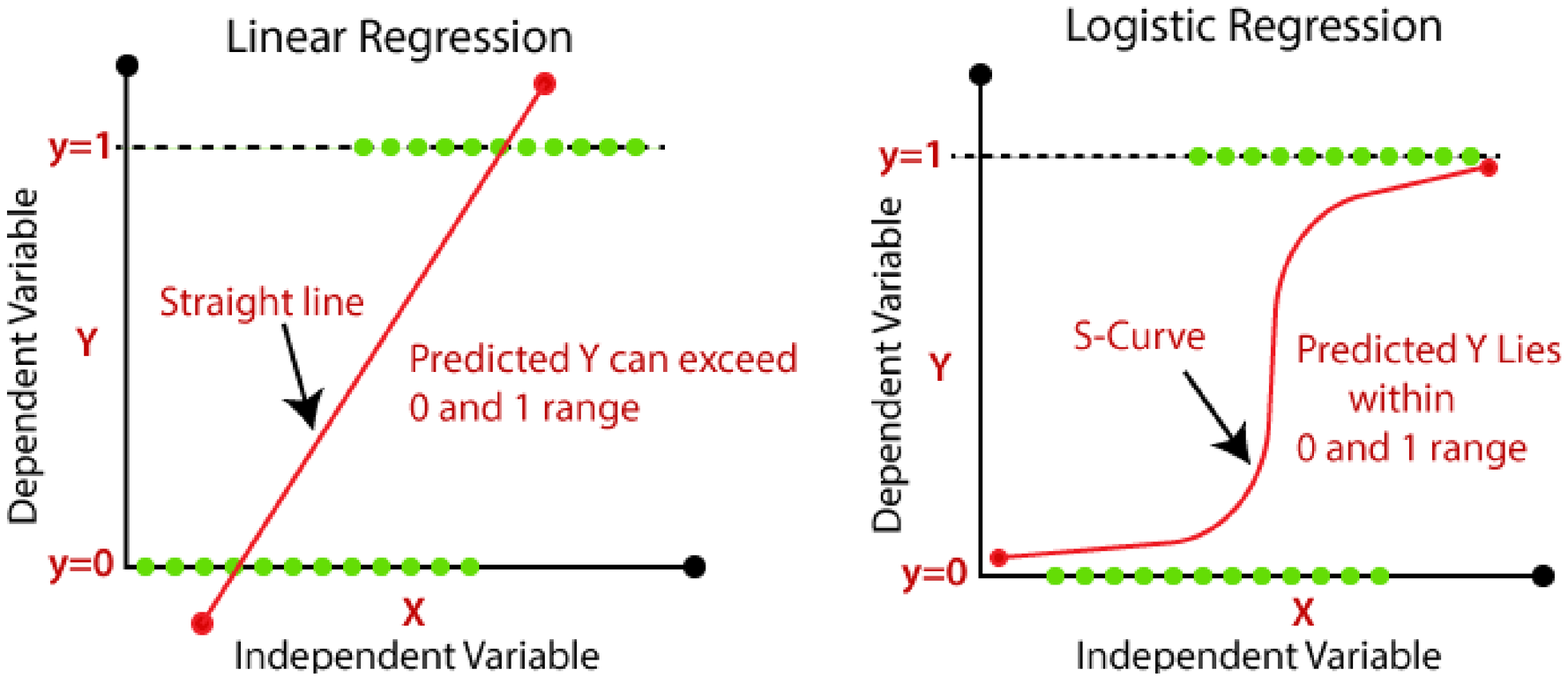
23AMB201 - MACHINE LEARNING

II YEAR IV SEM

UNIT II – SUPERVISED LEARNING ALGORITHMS

TOPIC 6 – Polynomial Regression

Recall


Linear Regression
y=1
y=0
Dependent Variable
Y
X
Independent Variable
Straight line
Predicted Y can exceed
0 and 1 range
Logistic Regression
y=1
y=0
Dependent Variable
Y
X
Independent Variable
S-Curve
Predicted Y Lies
within
0 and 1 range

What is Linear and Non Linear?

nonlinear function

$y = -x^2 + 4x$

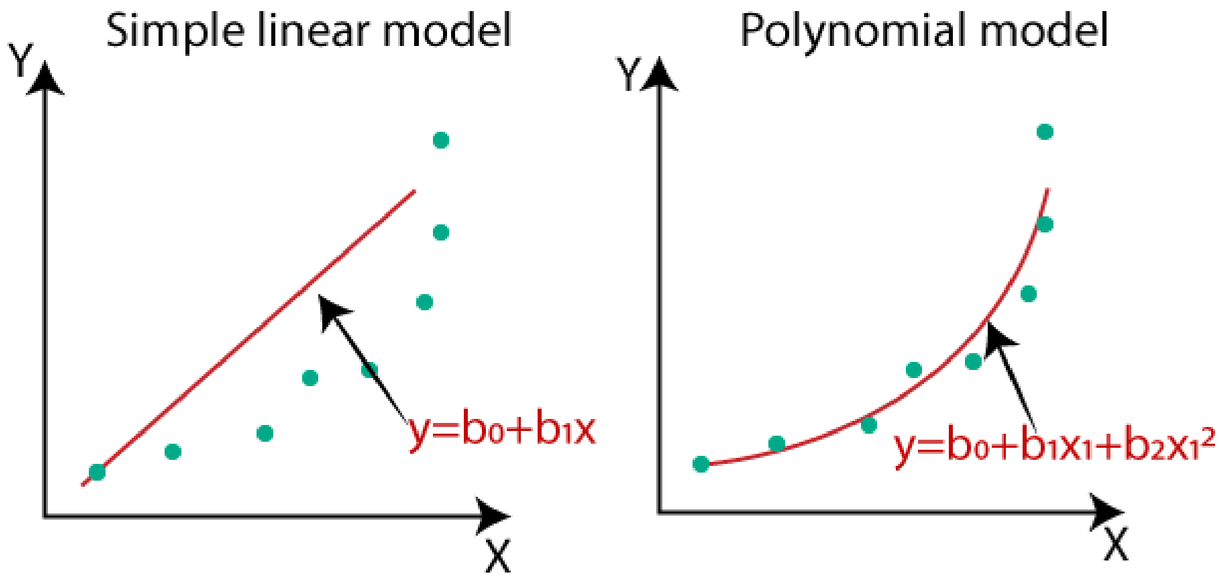
linear function

$y = 4x$

Why Polynomial Regression ?

Polynomial Regression is a regression algorithm that models the relationship between a dependent(y) and independent variable(x) as nth degree polynomial.

$$y= b_0+b_1x_1+ b_2x_1^2+ b_2x_1^3+..... b_nx_1^n$$



Polynomial Linear Regression: What and Why?

Simple Linear Regression

$$y = b_0 + b_1 x_1$$

Multiple Linear Regression

$$y = b_0 + b_1 x_1 + b_2 x_2 + \ldots + b_n x_n$$

Polynomial Linear Regression

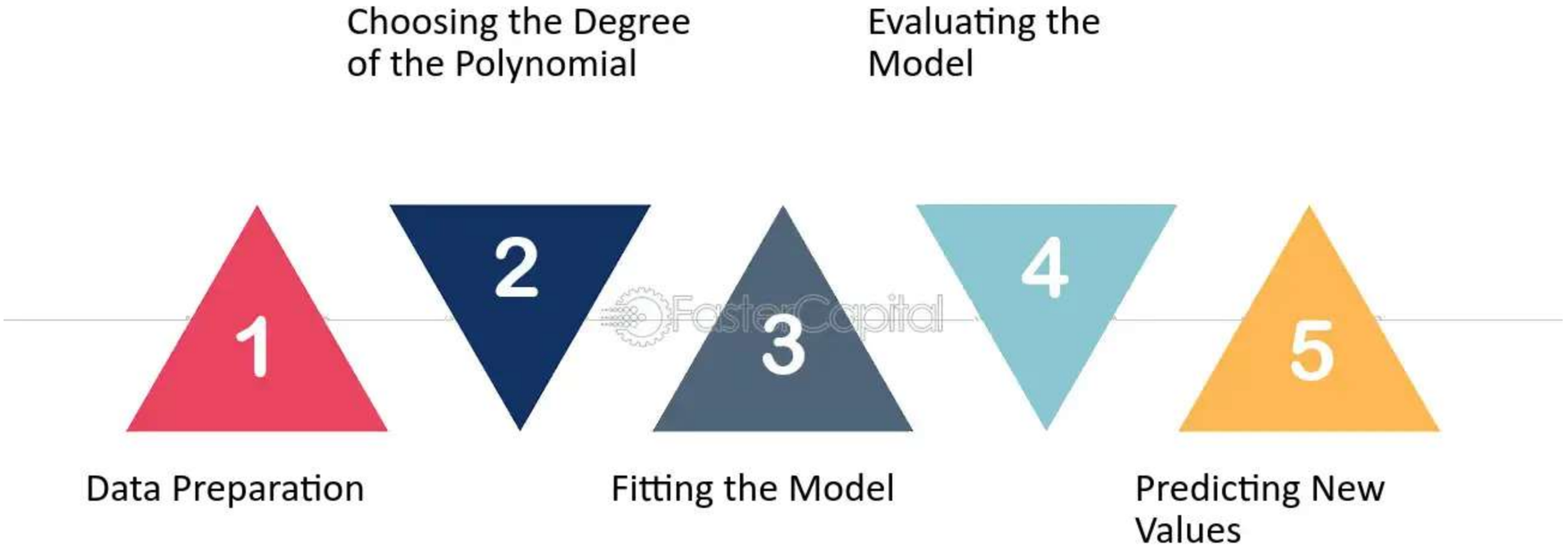
$$y = b_0 + b_1 x_1 + b_2 x_1^2 + \ldots + b_n x_1^n$$

A Polynomial Regression algorithm is also called Polynomial Linear Regression because it does **not depend on the variables, instead, it depends on the coefficients**, which are arranged in a linear fashion.

Polynomials	Form	Degree	Examples
Linear Polynomial	$p(x): ax+b, a \neq 0$	Polynomial with Degree 1	$x + 8$
Quadratic Polynomial	$p(x): ax^2+b+c, a \neq 0$	Polynomial with Degree 2	$3x^2-4x+7$
Cubic Polynomial	$p(x): ax^3+bx^2+cx, a \neq 0$	Polynomial with Degree 3	$2x^3+3x^2+4x+6$

Position	Level(X-variable)	Salary(Y-Variable)
Business Analyst	1	45000
Junior Consultant	2	50000
Senior Consultant	3	60000
Manager	4	80000
Country Manager	5	110000
Region Manager	6	150000
Partner	7	200000
Senior Partner	8	300000
C-level	9	500000
CEO	10	1000000

Implementing Polynomial Regression



Example

```
[ ]  import numpy as np
     import matplotlib.pyplot as plt
     from sklearn.preprocessing import PolynomialFeatures
     from sklearn.linear_model import LinearRegression

     # Generate Sample Data (Non-Linear Relationship)
     X = np.array([1, 2, 3, 4, 5, 6, 7, 8, 9, 10]).reshape(-1, 1)
     y = np.array([1.5, 2.5, 3.8, 5.0, 7.1, 9.3, 12.2, 15.0, 19.0, 23.5])
```

Example

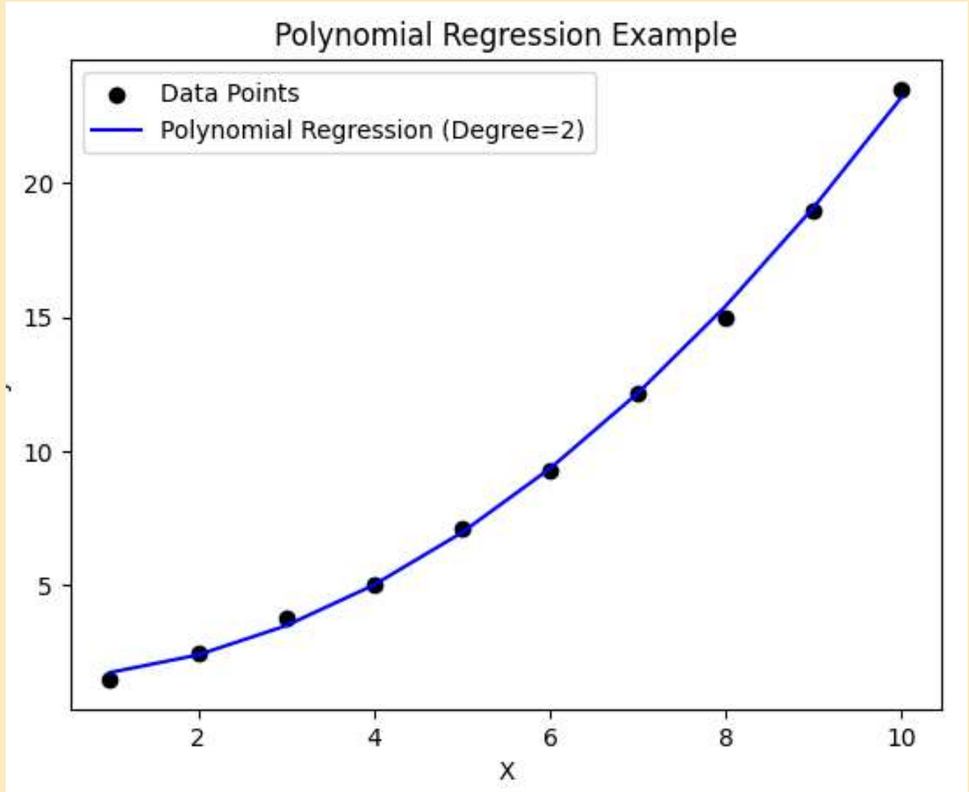
```
poly = PolynomialFeatures(degree=2)
X_poly = poly.fit_transform(X)  # Transforms X into [1, X, X^2]

# Fit Polynomial Regression Model
model = LinearRegression()
model.fit(X_poly, y)
y_pred = model.predict(X_poly)
```

Example

```
# Visualization
plt.scatter(X, y, color="black", label="Data Points")
plt.plot(X, y_pred, color="blue", label="Polynomial Regression (Degree=2)")
plt.xlabel("X")
plt.ylabel("y")
plt.legend()
plt.title("Polynomial Regression Example")
plt.show()
```

Example


Polynomial Regression Example
Data Points
Polynomial Regression (Degree=2)
20
15
10
5
2
4
6
8
10
X

References

Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, ―Learning from Data, AML Book Publishers, 2012.

P. Flach, ―Machine Learning: The art and science of algorithms that make sense of data‖, Cambridge University Press, 2012.

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