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Q7. An object is suspended in a wind tunnel and the force measured for various wind velocity is given:-

v	10	20	30	40	50	60	70	80
F	25	70	380	550	610	1220	830	1450

We know that for $v = 0 \Rightarrow F = 0$

∴ Second-order polynomial regression must PASS through ORIGIN.

$$\Rightarrow y = a_1 x + a_2 x^2$$

This can be written as

$$\begin{bmatrix} x_1 & x_1^2 \\ x_2 & x_2^2 \\ | & | \\ | & | \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} = \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ | \\ | \end{bmatrix}$$

$$X \quad A \quad = \quad Y$$

Calculate $A = (X^T X)^{-1} X^T Y$

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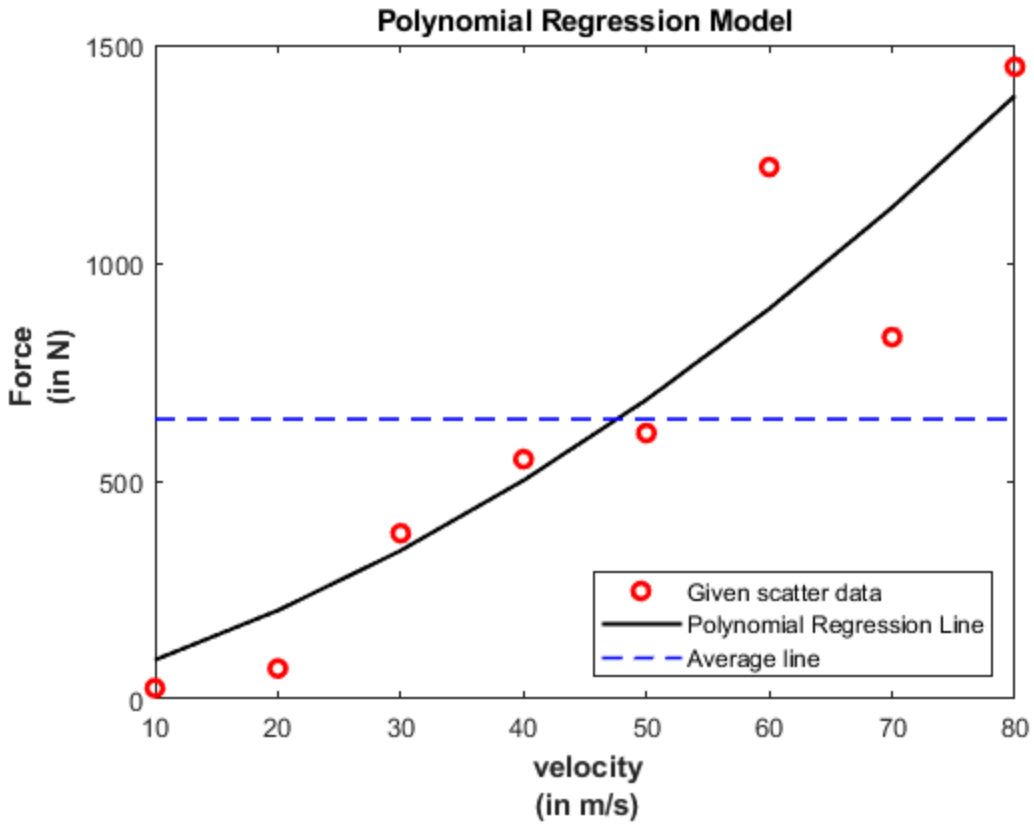
where $X = \begin{bmatrix} 10 & 100 \\ 20 & 400 \\ 30 & 900 \\ 40 & 1600 \\ 50 & 2500 \\ 60 & 3600 \\ 70 & 4900 \\ 80 & 6400 \end{bmatrix}$ $Y = \begin{bmatrix} 25 \\ 70 \\ 380 \\ 550 \\ 610 \\ 1220 \\ 830 \\ 1450 \end{bmatrix}$

$$(X^T X)^{-1} = 10^{-3} \begin{bmatrix} 0.7984 & -0.0118 \\ -0.0118 & 0.0002 \end{bmatrix}$$

this gives us $\Rightarrow a_1 = 7.7710 \quad a_2 = 0.1191$

```
clc;
clear all;
clear;

x=10:10:80;
y= [25 70 380 550 610 1220 830 1450];

[b1, b2]= polynomial_no_intercept(x,y);

y_poly= b1*x + b2*x.^2;

y_avg= (sum(y)/length(y))*ones([1,length(y)]);

St= sum((y-y_avg).^2);
Sr_poly= sum((y-y_poly).^2);

fprintf('Coefficient of Determination (Polynomial): %f\n',(St-
Sr_poly)/St);

figure(1);
plot(x,y,'or','Linewidth',2);
hold on;
plot(x, y_poly, 'k','Linewidth',1.5);
hold on;
plot(x, y_avg, '--b','Linewidth',1.2);
hold on;
title('Polynomial Regression Model');
legend('Given scatter data','Polynomial Regression Line','Average
 line','Location','southeast');
xlabel({'\bf velocity','\bf (in m/s)'});
ylabel({'\bf Force','\bf (in N)'});
```

Coefficient of Determination (Polynomial): 0.872720



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```
function [b1,b2]= polynomial_no_intercept(x,y)
    % XA = Y
    n = length(x);
    X = zeros(n,2);

    X(:,1)= x;
    X(:,2)= x.^2;

    Y= y';

    % X'XA = X'Y
    X_trans= X';

    % A = inv(X'X)X'Y
    A = inv(X_trans*X)*X_trans*Y;
    b1 = A(1);
    b2 = A(2);
end
```

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