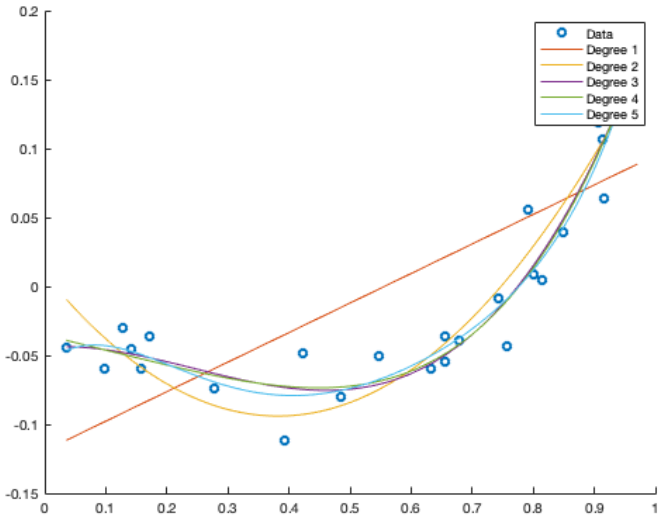
Homework 2 - Question 1

```
data = readtable('polydata.csv');
Y = data.Var2;
Y_size = size(Y);

disp("1a)");
X_d1 = create_Matrix_X(data, 1);
B_ols_d1 = fitlm(X_d1, Y);
fprintf("B_ols for polynomial degree 1 = \n");
disp(B_ols_d1.Coefficients.Estimate)

X_d2 = create_Matrix_X(data, 2);
B_ols_d2 = fitlm(X_d2, Y);
fprintf("B_ols for polynomial degree 2 = \n");
disp(B_ols_d2.Coefficients.Estimate)

X_d3 = create_Matrix_X(data, 3);
B_ols_d3 = fitlm(X_d3, Y);
fprintf("B_ols for polynomial degree 3 = \n");
disp(B_ols_d3.Coefficients.Estimate)

X_d4 = create_Matrix_X(data, 4);
B_ols_d4 = fitlm(X_d4, Y);
fprintf("B_ols for polynomial degree 4 = \n");
disp(B_ols_d4.Coefficients.Estimate)

X_d5 = create_Matrix_X(data, 5);
B_ols_d5 = fitlm(X_d5, Y);
fprintf("B_ols for polynomial degree 5 = \n");
disp(B_ols_d5.Coefficients.Estimate)

%b)Scatter plot
disp("1b)");
scatter(X_d1, Y)
hold on

myplot(X_d1, B_ols_d1.Coefficients.Estimate)
myplot(X_d1, B_ols_d2.Coefficients.Estimate)
myplot(X_d1, B_ols_d3.Coefficients.Estimate)
myplot(X_d1, B_ols_d4.Coefficients.Estimate)
myplot(X_d1, B_ols_d5.Coefficients.Estimate)
legend('Data', 'Degree 1','Degree 2', 'Degree 3', 'Degree 4', 'Degree 5')

snapnow

%c) Cross-validation
disp("1c)");
idxs = randperm(30);
fprintf("When using 5-fold cross validation, best degree polynomial = %d \n",perform_cross_validation(data, 5, 5, idxs));
disp("From the plots, it looks like the third order polynomial fits the data with some noise. However on repeating this");
disp("experiment multiple times, when the data is permuted, the best fit with varies d=3,4,5. Observed that d=3 is mostly the best fit.");
function min_idx = perform_cross_validation(data, k, d, idxs)
    average_MSE = zeros(d,1);
    Y = data.Var2;
    Y = Y(idxs);
    for j = 1:d
        X = create_Matrix_X(data, j);
        X = X(idxs, :);
        chunk_size = size(Y,1)/k;
        for i=1:k
            index = (i * chunk_size) - chunk_size;
            X_test = X(index+1:index+chunk_size, :);
            Y_test = Y(index+1:index+chunk_size, :);
            X_train = [X(1:index, :);X(index+chunk_size+1:end, :)];
            Y_train = [Y(1:index);Y(index+chunk_size+1:end)];
            B = fitlm(X_train,Y_train);
            yfit = predict(B, X_test);
            average_MSE(j) = average_MSE(j) + mean((Y_test-yfit).^2);
        end
    end
    average_MSE = average_MSE/k;
    fprintf("Average MSE for degree polynomial from d=1:%d is \n", d);
    fprintf("%f \n", average_MSE);
    [M, min_idx] = min(average_MSE);
end

function X = create_Matrix_X(data, d)
    Y = data.Var2;
    X = zeros(size(Y,1),d);
    for k = 1:d
        X(:, k) = data.Var1.^k;
    end
end

function myplot(X, B)
t = linspace(min(X),max(X));
plot(t, polyval(flipud(B), t))
end
```

```
1a)
B_ols for polynomial degree 1 =
   -0.1191
    0.2142

B_ols for polynomial degree 2 =
    0.0088
   -0.5382
    0.7046

B_ols for polynomial degree 3 =
   -0.0442
    0.0331
   -0.5857
    0.7963

B_ols for polynomial degree 4 =
   -0.0353
   -0.1075
   -0.0113
   -0.0447
    0.4024

B_ols for polynomial degree 5 =
   -0.0567
    0.3964
   -3.3845
    8.7537
   -9.3436
    3.8535

1b)
```




```
1c)
Average MSE for degree polynomial from d=1:5 is
0.003221
0.000625
0.000419
0.000474
0.000630
When using 5-fold cross validation, best degree polynomial = 3
From the plots, it looks like the third order polynomial fits the data with some noise. However on repeating this
experiment multiple times, when the data is permuted, the best fit with varies d=3,4,5. Observed that d=3 is mostly the best fit.
```

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