Quick Review of Regression Analysis in Excel and Matlab

CEE 3804
Introduction to Transportation Engineering

Objectives of the Presentation

- Review how to do basic data curve fitting using Excel and Matlab

- For this exercise I use the free rolling friction data provided in class

Excel Basic Curve Fitting

Excel Representation of Free Rolling Friction Coefficient versus Speed Data

Speed (km/hr)	Speed (m/s)	froll (dim)
0	0.00	0.0120
20	5.56	0.0122
40	11.11	0.0125
60	16.67	0.0130
80	22.22	0.0139
100	27.78	0.0149
120	33.33	0.0160
140	38.89	0.0175
160	44.44	0.0190
180	50.00	0.0210
200	55.56	0.0235
220	61.11	0.0270

Basic Curve Fit Analysis in Excel (2)

- Create a scattered plot of the data (speed in m/s versus f_{roll})
- Make sure the data and the plot are labeled

Speed (km/hr)	Speed (m/s)	froll (dim)
0	0.00	0.0120
20	5.56	0.0122
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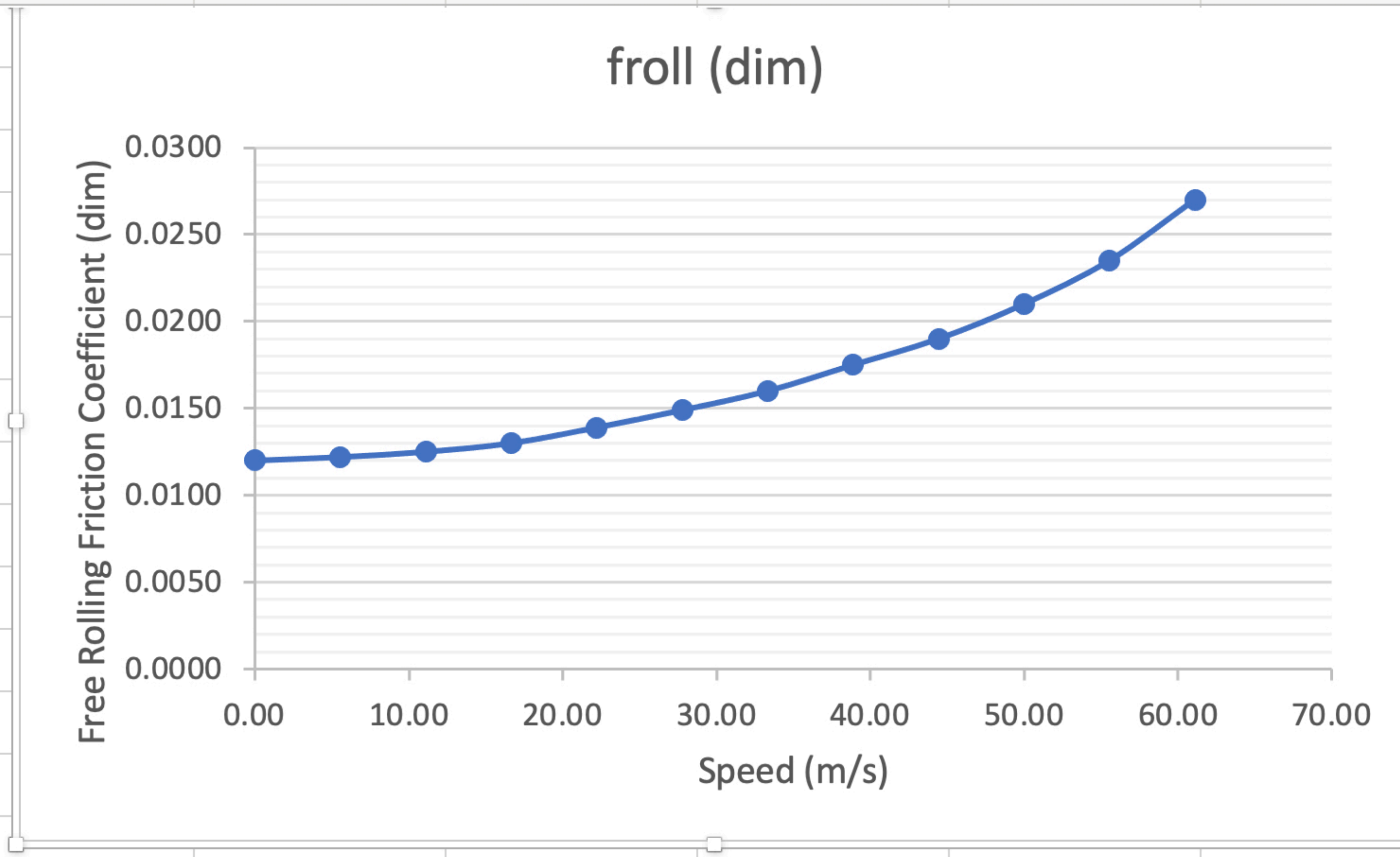
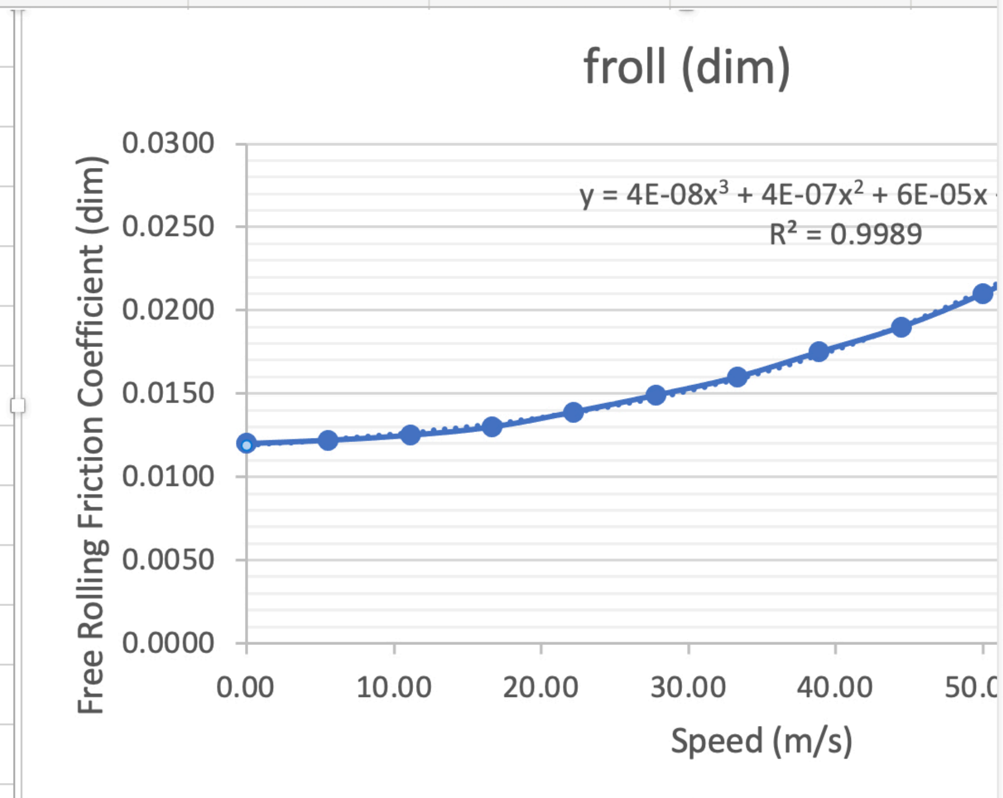
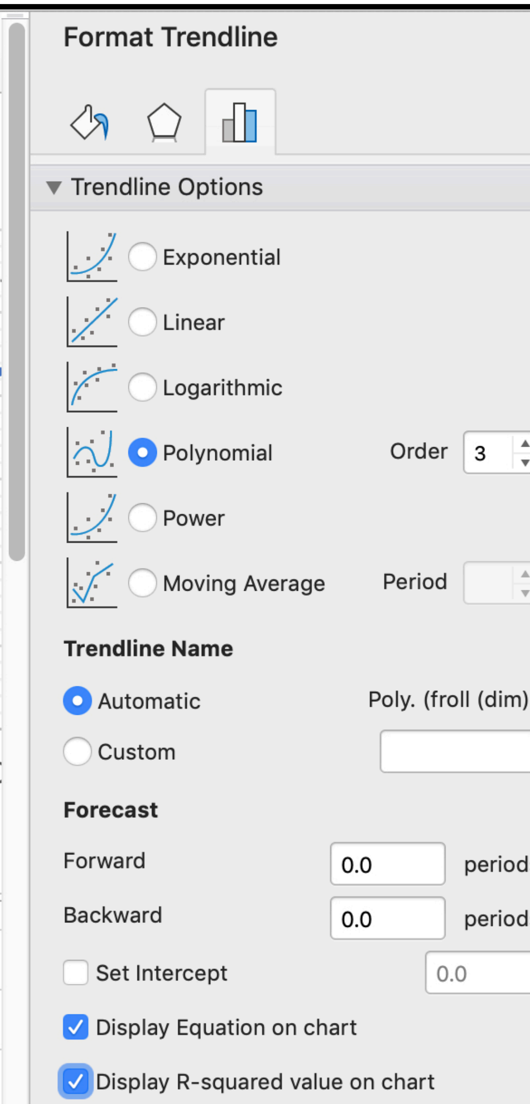


Basic Curve Fit Analysis in Excel (3)

- Right click on the data line and “Add a Trendline”
- Using the “Format Trendline” panel (see figure) select a “Polynomial” of order 3 (cubic) equation
- Select “Display Equation on Chart” to see the 3rd order polynomial

	A	B	C
1	Speed (km/hr)	Speed (m/s)	froll (dim)
2	0	0.00	0.0120
3	20	5.56	0.0122
4	40	11.11	0.0125
5	60	16.67	0.0130
6	80	22.22	0.0139
7	100	27.78	0.0149
8	120	33.33	0.0160
9	140	38.89	0.0175
10	160	44.44	0.0190
11	180	50.00	0.0210
12	200	55.56	0.0235
13	220	61.11	0.0270





Matlab Basic Curve Fitting

Matlab Script to Plot the Free Rolling Friction Coefficient versus Speed

Create a new Matlab script and type the information provided in this example

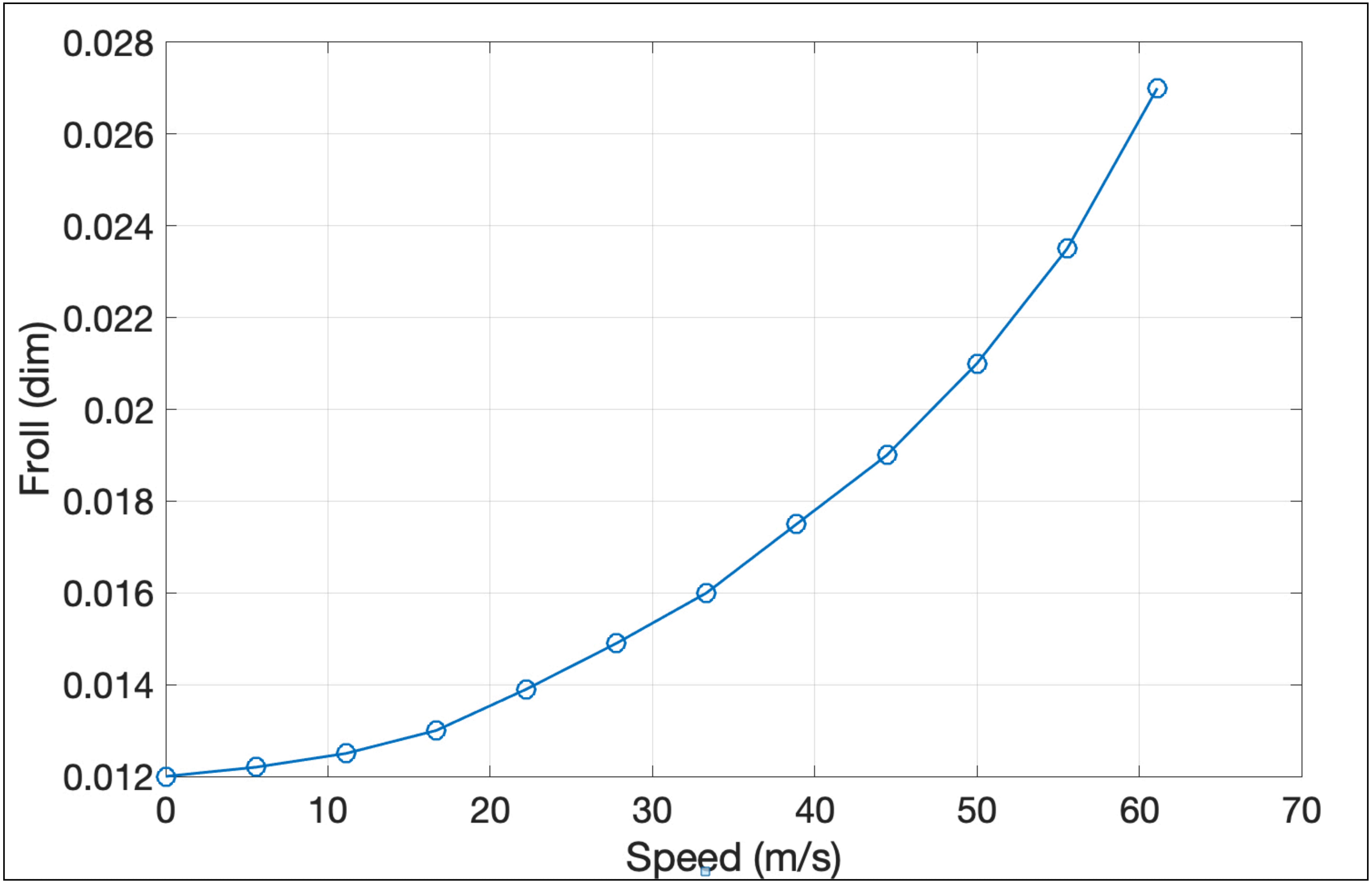
```
% Define a vector of speeds from 0 to 220 at steps of 20 km/hr
% This is a vector operation in Matlab
speed = 0:20:220;  % speed in km/hr

% Define the free rolling friction experimental values defined by Hucho
froll = [.012 0.0122 0.0125 0.013 0.0139 0.0149 0.0160 ...
   0.0175 0.019 0.021 0.0235 0.027];   % rolling friction coefficient (dim)

% Convert the speed vector to speed in meters/second
speed_ms = speed / 3.6;        %  speed in meters/second

% Plot the values of free rolling friction (froll)
plot(speed_ms,froll,'o-')
xlabel('Speed (m/s)')
ylabel('Froll (dim)')
grid
```

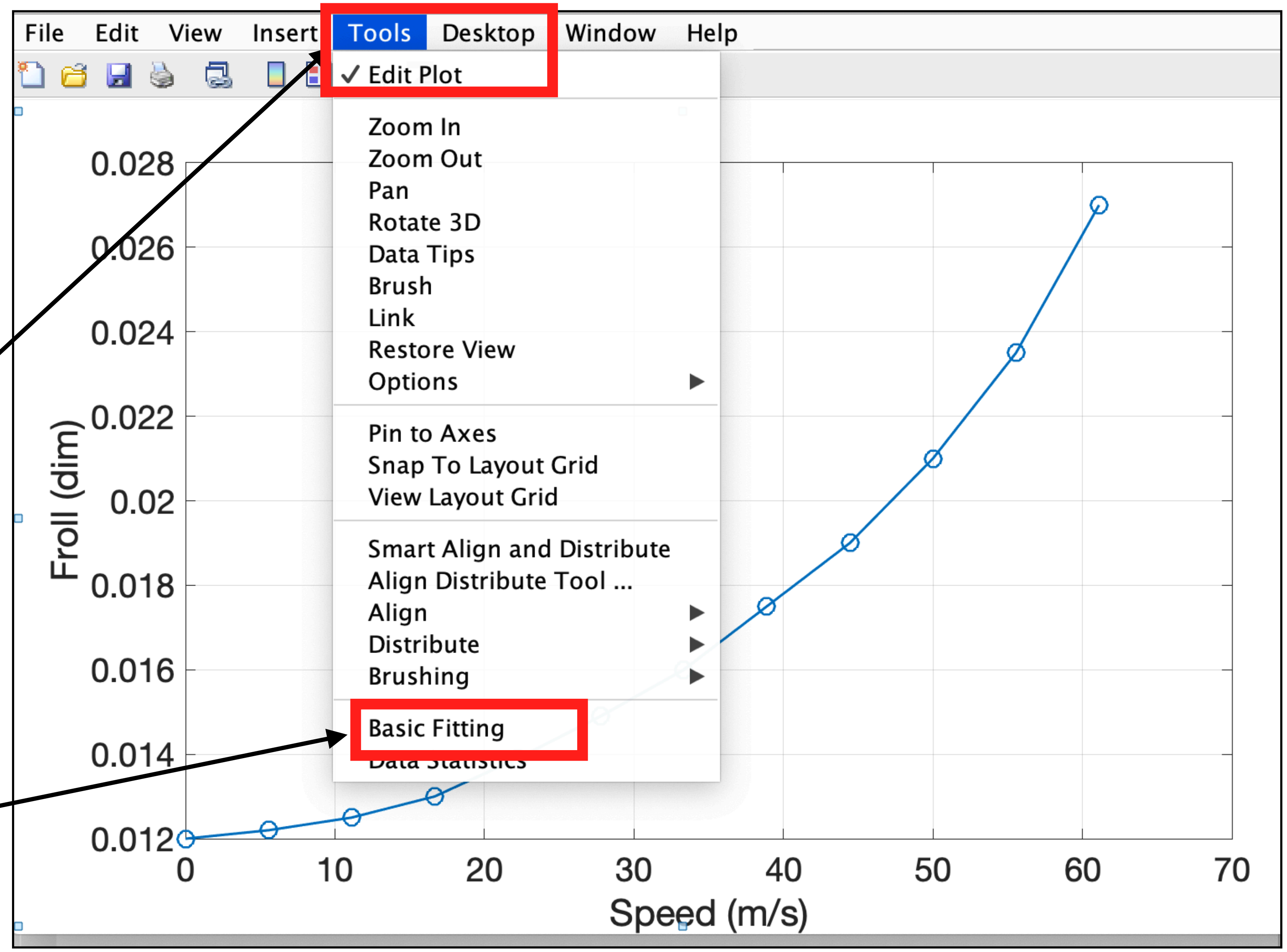
Plot Produced by the Matlab Script



Basic Curve Fit Analysis

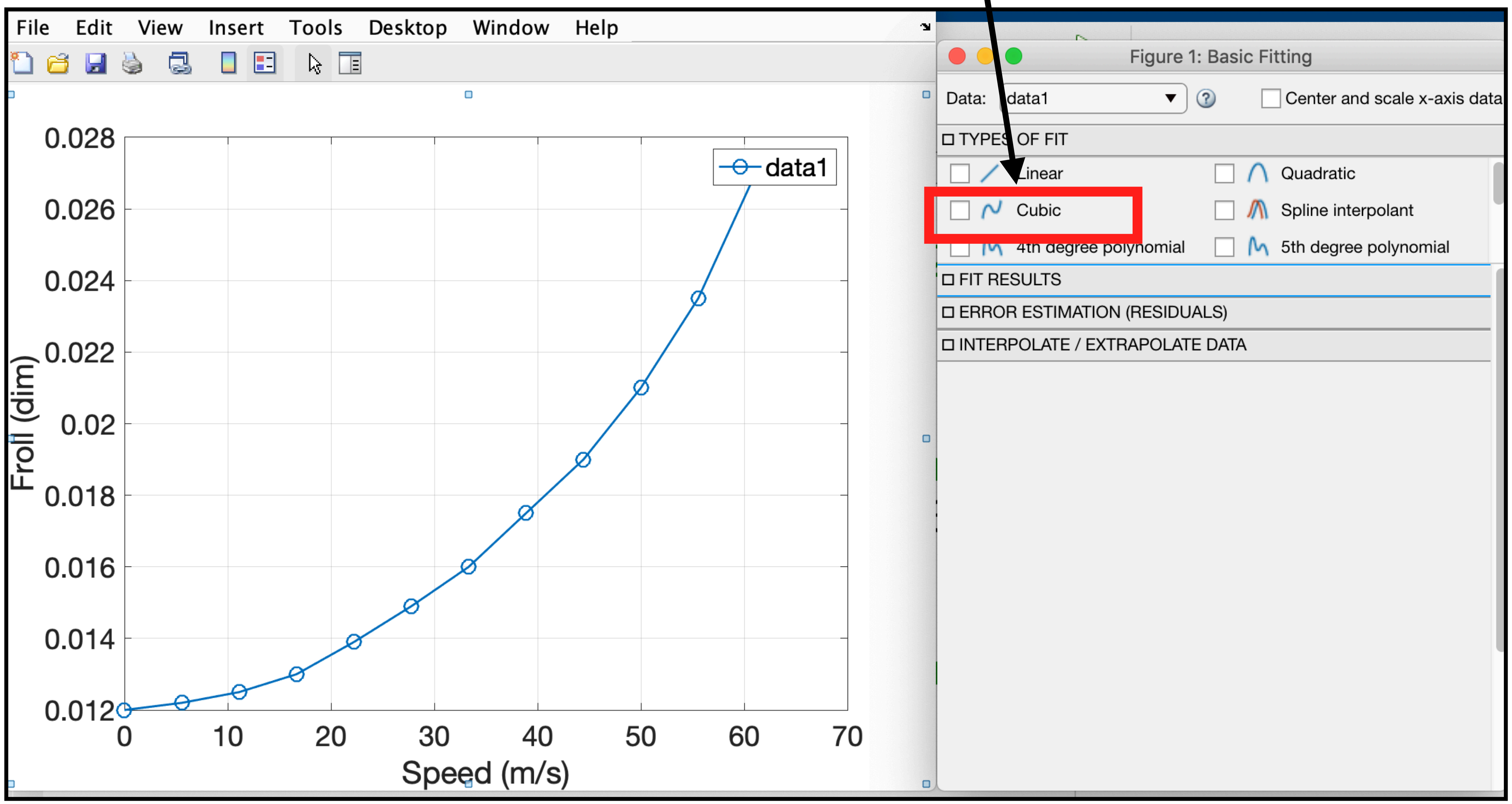
With the plot window open:

- Go to the Pull-Down Menu “Tools”
- Select the Basic Fitting option (see figure)



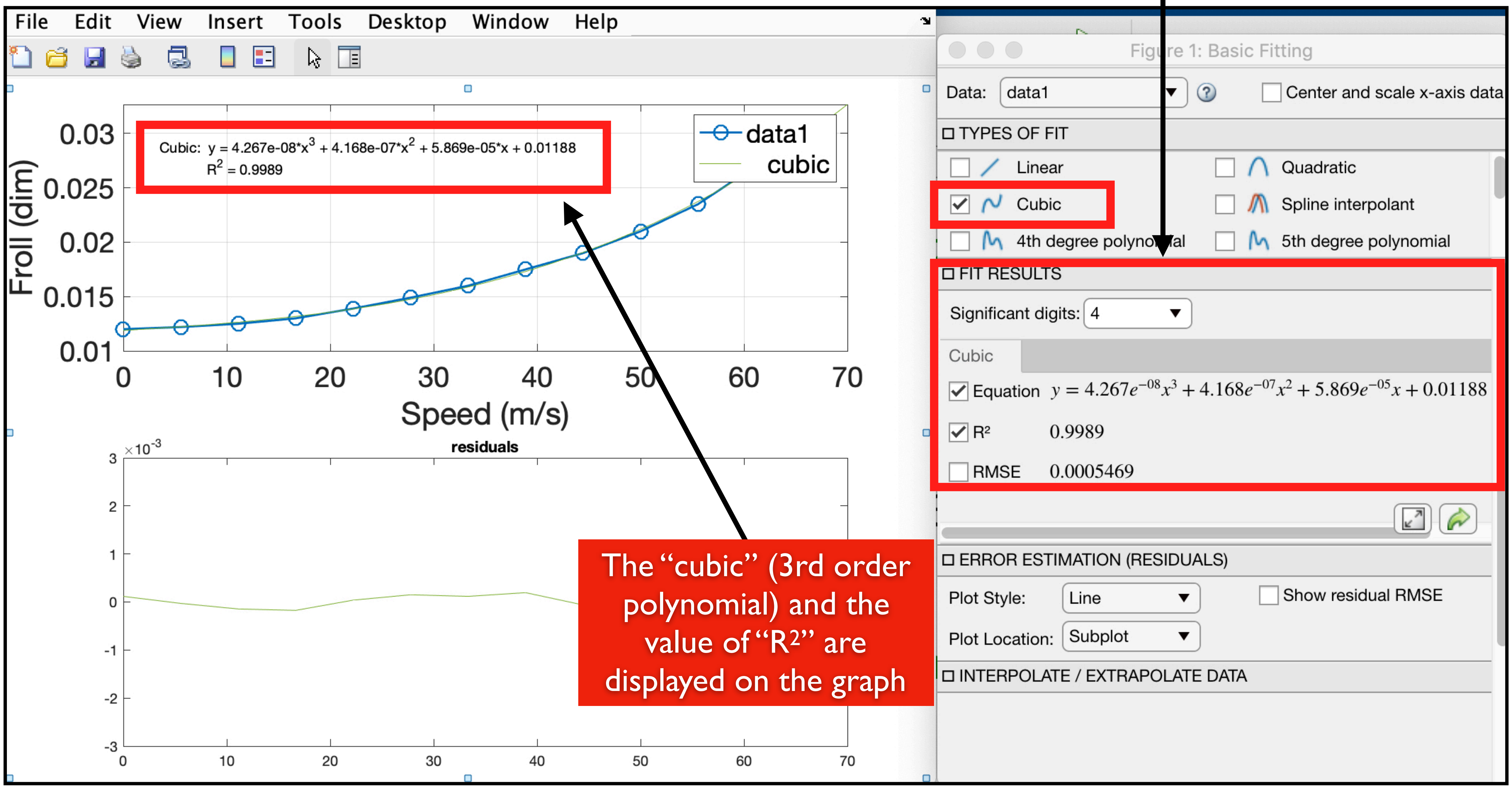
Basic Curve Fit Analysis (2)

- Select the type of curve fit desired in the right-hand side panel
- For this example, select a "Cubic" or third order polynomial



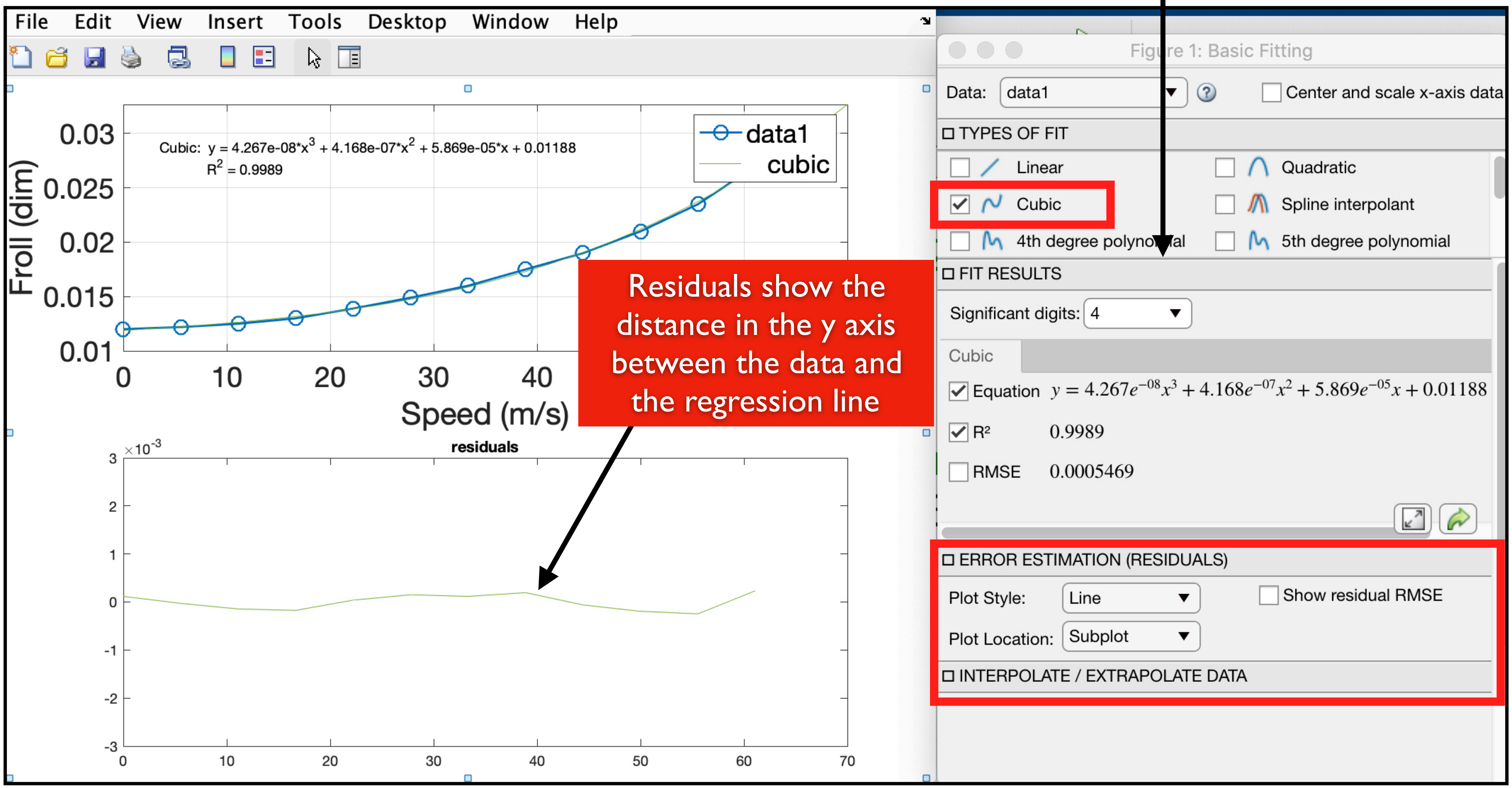
Basic Curve Fit Analysis (3)

- Enable the "Equation" and "R^2" in the **Fit Results** panel



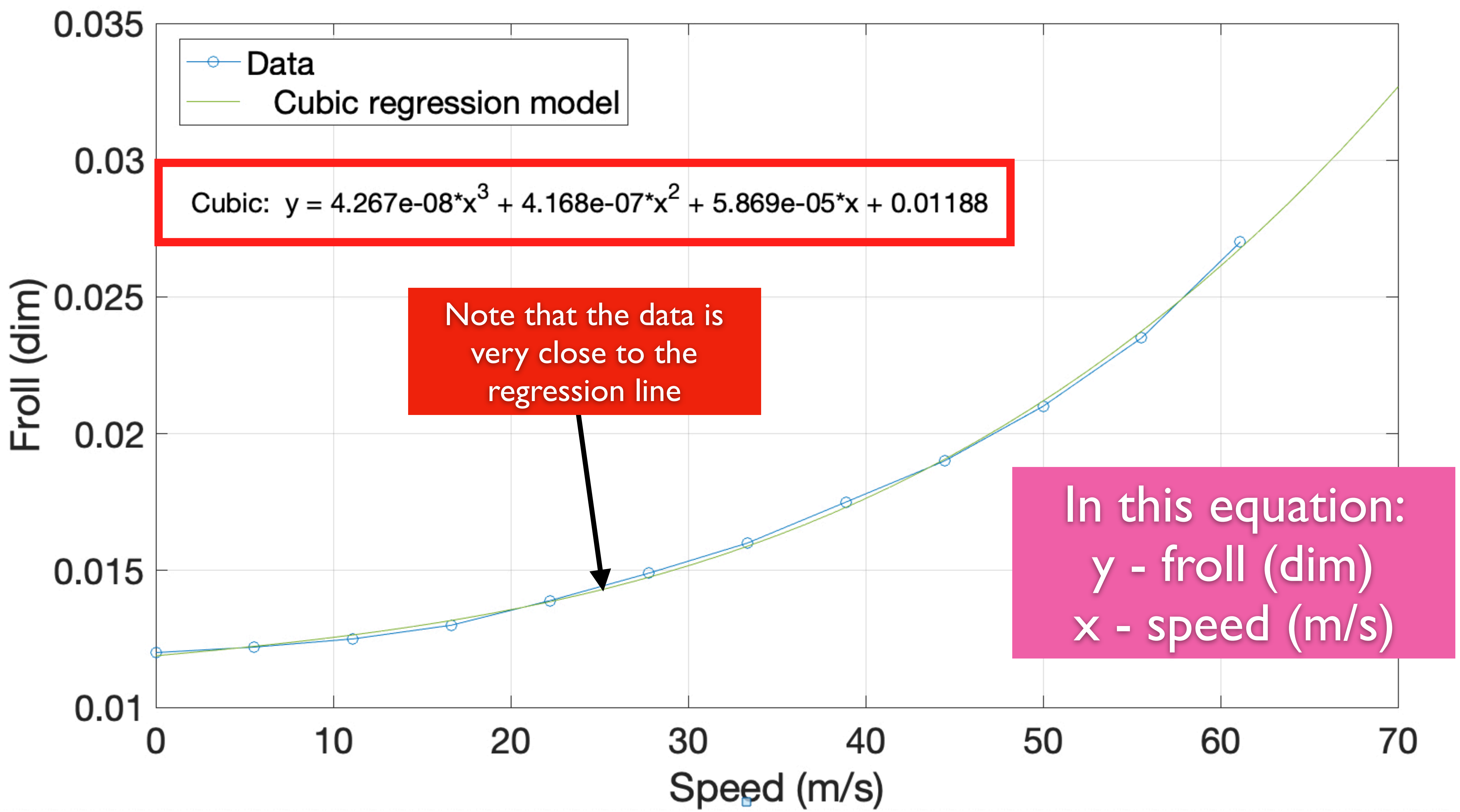
Basic Curve Fit Analysis (4)

- Enable the Error Estimation (called residuals) in the panel of the same name



Basic Curve Fit Analysis (5)

- The curve fit is very accurate because the value of R^2 is near 1.0 (0.9989)
- 99.89 of the variation in the data can be explained by the 3rd



Basic Curve Fit Analysis (6)

- Use the cubic (3rd order polynomial) regression equation to predict the value of rolling friction coefficient for any speed
- Example: Find the value of rolling friction coefficient when a car with radial tires travels at 105 km/hr
- Step 1: convert speed to meters/second
  - *Speed* = 29.17 m/s
- Step 2: substitute the value of *Speed* in the regression equation found:

$$f_{roll} = 4.267e-8(speed^3) + 4.168e-7(speed^2) + 5.869e-5(speed) + 0.01188$$

$$Speed = 29.17 \text{ m/s}$$

$$f_{roll} = 0.015 \text{ (dim)}$$