Chapter15 mini quiz Q1 (Lec10) [ALL CORRECT]

Spoiler: All of them are extremely similar!

Data

```
x = [5  10  15  20  25  30  35  40  45  50];
y = [17  24  31  33  37  37  40  40  42  41];
plot(x, y, 's');
```


Linear fit

```
poly_order_1 = polyfit(x, y, 1); % n = degree = 1

% xx = 5:2:50; % 5 to 50, steps of 2
% yy = polyval(poly_order_1, xx)
% plot(x, y, 'o', xx, yy, '-')

Sr = sum((y - polyval(poly_order_1, x)) .^ 2);
St = sum((y - mean(y)) .^ 2);

linear_r2 = 1 - (Sr/St)
```

```
linear_r2 =
0.8385
```

Quadratic fit

```
poly_order_2 = polyfit(x, y, 2); % n = degree = 2

% xx = 5:2:50; % 5 to 50, steps of 2
% yy = polyval(poly_order_2, xx)
% plot(x, y, 'o', xx, yy, '-')

Sr = sum((y - polyval(poly_order_2, x)) .^ 2);
St = sum((y - mean(y)) .^ 2);

quadratic_r2 = 1 - (Sr/St)
```

```
quadratic_r2 =
0.9800
```

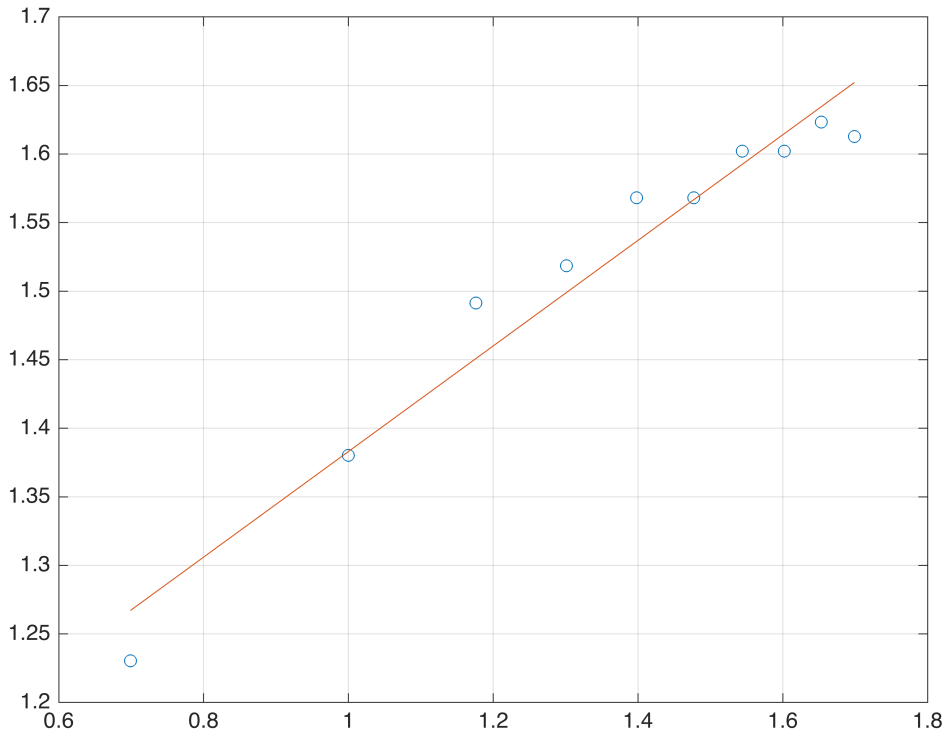
Cubic fit

```
poly_order_3 = polyfit(x, y, 3); % n = degree = 3

% xx = 5:2:50; % 5 to 50, steps of 2
% yy = polyval(poly_order_3, xx)
% plot(x, y, 'o', xx, yy, '-')

Sr = sum((y - polyval(poly_order_3, x)) .^ 2);
St = sum((y - mean(y)) .^ 2);

cubic_r2 = 1 - (Sr/St)
```

```
cubic_r2 =
0.9897
```

A power equation fit

```
new_power_x = log10(x);
new_power_y = log10(y);

[a, ~] = linregr(new_power_x, new_power_y);
```

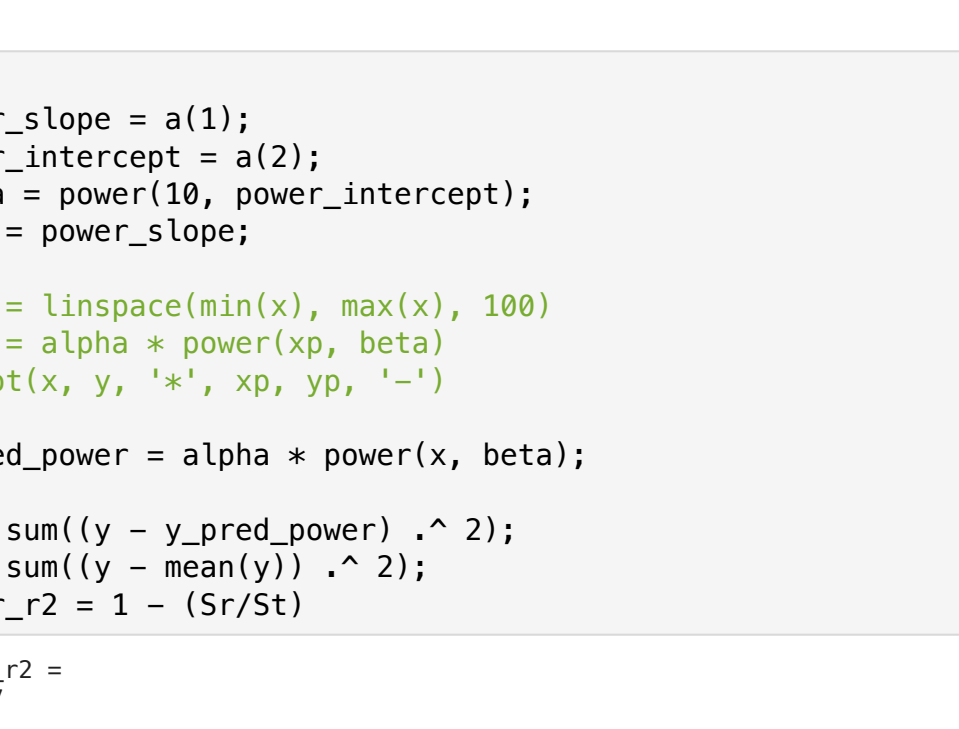



```
power_slope = a(1);
power_intercept = a(2);
alpha = power(10, power_intercept);
beta = power_slope;

% xp = linspace(min(x), max(x), 100)
% yp = alpha * power(xp, beta)
% plot(x, y, '*', xp, yp, '-')

y_pred_power = alpha * power(x, beta);

Sr = sum((y - y_pred_power) .^ 2);
St = sum((y - mean(y)) .^ 2);
power_r2 = 1 - (Sr/St)
```

```
power_r2 =
0.9377
```

A saturation-growth-rate equation fit

```
new_sat_x = 1 ./ x;
new_sat_y = 1 ./ y;

[a, r2] = linregr(new_sat_x, new_sat_y);
```




```
sat_slope = a(1);
sat_intercept = a(2);
```

```
alpha = 1 / sat_intercept;
beta = sat_slope * alpha;

% xp = linspace(min(x), max(x), 100)
% yp = alpha .* (xp ./ (beta + xp))
% plot(x, y, '*', xp, yp, '-')

y_pred_sat = alpha .* (x ./ (beta + x));

Sr = sum((y - y_pred_sat) .^ 2);
St = sum((y - mean(y)) .^ 2);
sat_r2 = 1 - (Sr/St)
```

```
sat_r2 =
0.9892
```

Chapter15 mini quiz Q2 (Lec10) [ALL CORRECT]

Multiple Linear Regression

The following data are provided

```
x = [1 2 3 4 5]
```

```
y = [2.2 2.8 3.6 4.5 5.5]
```

Fit the following model to this data and the general linear least-squares model

$$y = a + b \cdot x + \frac{c}{x}$$

$$\underset{\uparrow}{\boldsymbol{y}} = \underset{\uparrow}{\boldsymbol{a}}_{a_0} + \underset{\uparrow}{\boldsymbol{b}}_{a_1} \cdot \underset{\uparrow}{\boldsymbol{x}}_{x_1} + \underset{\uparrow}{\boldsymbol{c}}_{a_2} \cdot \underset{\uparrow}{\frac{1}{\boldsymbol{x}}}_{x_2} \qquad \text{(from the general multiple linear form)}$$

(view the x as x_1 and $\frac{1}{x}$ as x_2 in multiple linear regression; look at them as separate terms, not like variables)

Data

```
x = [1 2 3 4 5]';
y = [2.2 2.8 3.6 4.5 5.5]';
```

Plot data

```
% skipped
```

Create Z matrix

```
Z = [ones(size(y)) x 1./x]
```

```
Z = 5×3
    1.0000    1.0000    1.0000
    1.0000    2.0000    0.5000
    1.0000    3.0000    0.3333
    1.0000    4.0000    0.2500
    1.0000    5.0000    0.2000
```

Solve for unknown parameters a

```
a = (Z'*Z) \ (Z'*y)
```

```
a = 3×1
    0.3745
    0.9864
    0.8456
```

Plot data and the best fitted curve

```
% skipped
```

Compute Sr (the sum of the squares of the residuals between the best-fit curve and the data)

```
sr = sum((y - (Z*a)).^2)
```

```
sr =
0.0028
```

Compute St (the sum of the squares of the residuals between the data points and the mean)

```
st = sum((y - mean(y)).^2)
```

```
st =
6.9480
```

Compute r2 (the coefficient of determination)

```
r2 = 1 - (sr/st)
```

```
r2 =
0.9996
```

Compute syx (the standard error of the estimate)

```
syx = sqrt( sr / (length(y) - 3) )
```

```
syx =
0.0372
```

Predict the value of y for the given x

Also use the least-squares fit to predict the value of y when x = 2.5.

y(2.5) = ?

```
xtest = 2.5
```

```
xtest =
2.5000
```

```
ypred = a(1) + (a(2)*xtest) + (a(3).*(1/xtest))
```

```
ypred =
3.1789
```