

Regression Parameter Estimates

Residuals:

Min	1Q	Median	3Q	Max
-0.339	-0.1071	-0.01023	0.1361	0.3588

Coefficients:

	Value	Std. Error	t value	Pr(> t)
(Intercept)	6.8115	0.1113	61.2054	0.0000
log(time)	-0.5350	0.0609	-8.7850	0.0000

Residual standard error: 0.2135 on 10 df
Multiple R-Squared: 0.8853
F-stat: 77.18 on 1 and 10 df, p-val is 5.14e-06

Meat Processing Example, #8.16

- How much time in hours is needed to ensure that the pH reaches 6.0?
- Regression of ph on log(time)
- Evaluate lack of fit of the regression model

	1	2	3	4	5	6	7	...	12
time	1.00	1.00	2.00	2.00	4.00	4.00	6.00	...	24.00
pH	7.02	6.93	6.42	6.51	6.07	5.99	5.59	...	5.47

$$S_{Total} = \sum_{i=1}^N (y_i - \bar{y})^2$$
$$\sum_{i=1}^I \sum_{j=1}^{n_i} (y_{ij} - \bar{y})^2$$

$$= \sum_{i=1}^N (\hat{y}_i - \bar{y})^2$$
$$= \sum_{i=1}^I \sum_{j=1}^{n_i} (\hat{y}_{ij} - \bar{y})^2$$

$$+ RSS$$
$$+ \sum_{i=1}^N (y_i - \hat{y})^2$$
$$+ \sum_{i=1}^I \sum_{j=1}^{n_i} (y_{ij} - \hat{y}_{ij})^2$$

Total Variability
in Response

=

Variab. Explained
By Model

+

Variability
Unexplained

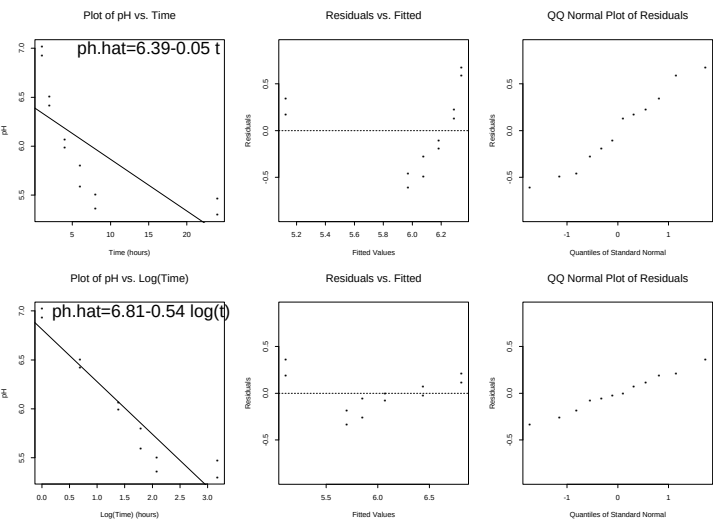
=

Variation Due To
To Reg. Line

+

Variation Around
Reg. Line

$$F = \frac{\text{Variance explained by model}}{\text{Variance due to model error}}$$



Lack of Fit F -test

- We have *repeated observations* of the response at several X values.
- Break down $y_{ij} - \hat{y}_{ij}$ into 2 parts:
 - sampling error: reproducibility of experiment, experimental error variance, $y_{ij} - \bar{y}_i$.
 - lack of fit: how far are group means from regression line, $\bar{y}_i - (\hat{\beta}_0 + \hat{\beta}_1 x_i)$
- Assess *validity* of regression model by determining whether the lack of fit of the linear model is statistically significant.

Source of Variation	Sum of Squares	DF	Mean Square	F -statistic	p -value
Between Groups					
Regression					
Lack of Fit					
Within Groups					
Total					

ANOVA Table for Regression: Ingredients

Analysis of Variance Table

	Df	Sum of Sq	Mean Sq	F Value
Model	K-1	SSREG	SSREG/(K-1)	[SSREG/(K-1)]/[RSS/(N-K)]
Residual	N-K	RSS	RSS/(N-K)	
Total	N-1	SSTOT		

ANOVA Table for Regression

Test $H_o : \mu\{Y_{ij}|X_i\} = \beta_0 = \mu, H_A : \mu\{Y_{ij}|X_i\} = \beta_0 + \beta_1 X_i$

	Df	Sum of Sq	Mean Sq	F Value	Pr(F)
log(time)	1	3.519	3.519	77.176	5.14e-06
Residuals	10	0.456	0.046		

ANOVA Table for Separate Means Model

Test $H_o : \mu\{Y_{ij}|X_i\} = \mu, H_A : \mu\{Y_{ij}|X_i\} = \mu_i, i = 1, \dots, I, j = 1, \dots, n_j$

	Df	Sum Sq	Mean Sq	F Val	Pr(F)
as.factor(log(time))	5	3.916	0.7833	79.588	2.11e-05
Residuals	6	0.059	0.0098		