

BIBD Coding Example

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6/6/2023

4.42. Seven different hardwood concentrations are being studied to determine their effect on the strength of the paper produced. However, the pilot plant can only produce three runs each day. As days may differ, the analyst uses the balanced incomplete block design that follows. Analyze the data from this experiment (use $\alpha = 0.05$) and draw conclusions.

Hardwood Concentration (%)	Days			
	1	2	3	4
2	114			
4	126	120		
6		137	117	
8	141		129	149
10		145		150
12			120	
14				136

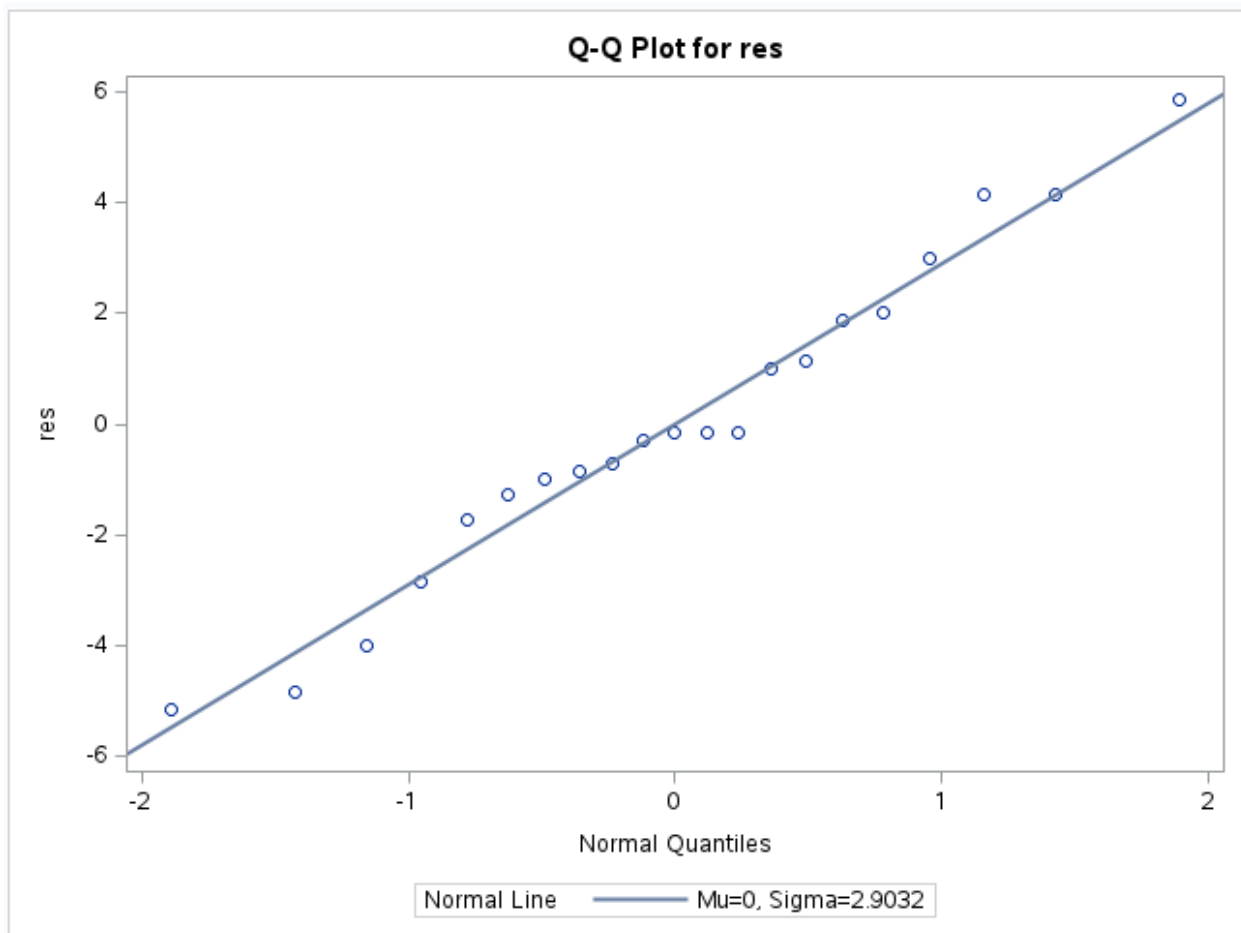
Hardwood Concentration (%)	Days		
	5	6	7
2	120		117
4		119	
6			134
8			
10	143		
12	118	123	
14		130	127

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Concentration	6	2037.619048	339.603175	16.12	0.0005
Days	6	394.095238	65.682540	3.12	0.0701

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Concentration	6	1317.428571	219.571429	10.42	0.0021
Days	6	394.095238	65.682540	3.12	0.0701

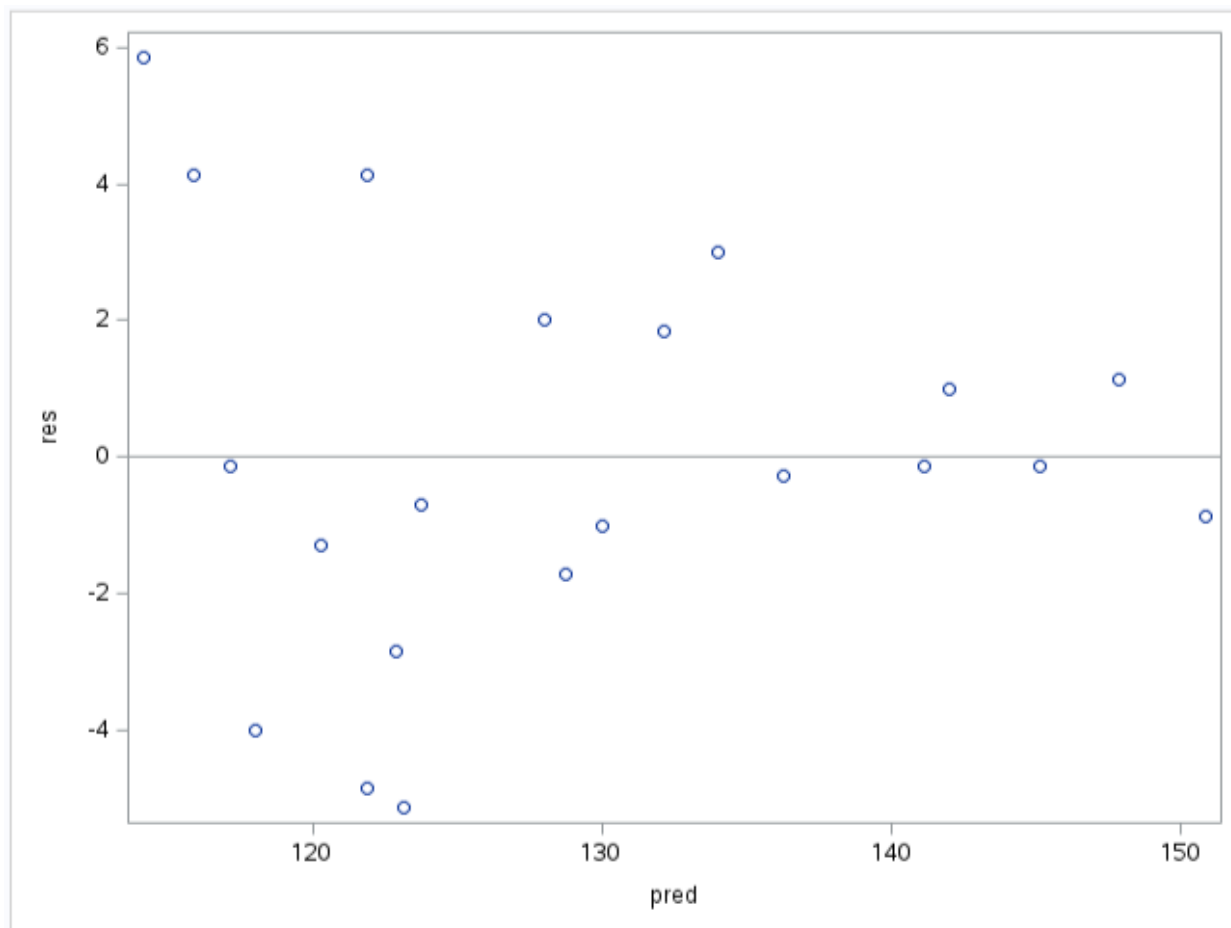
Using the type III SS, we see that concentrations is significant at the 0.05 level. We reject the null hypothesis and conclude that at least one concentration of hardwood has a different effect on strength compared to the others.

We fail to reject the null hypothesis for the days at the 0.05. We conclude there there is no significant effect on strength between days.



Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.974003	Pr < W	0.8190
Kolmogorov-Smirnov	D	0.13867	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.040987	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.242785	Pr > A-Sq	>0.2500

Judging from the QQ plot and the Shapiro-Wilk test, we do not see any concerning results and conclude the assumption of normality is met.



There is an obvious megaphone shape present in the residual plot. We conclude the assumption of constant variance is not met.

```

1  /* BIBD */
2  /* Read in data */
3  proc import datafile="/home/u60711948/My SAS Files/Stat 571B Experimental Design/Temporary/hardwood.csv"
4      dbms=csv
5      out=hardwood
6      replace;
7      getnames=yes;
8  run;
9
10 /* Run ANOVA and check means */
11 proc glm data=hardwood;
12 class Concentration Days;
13 model Strength = Concentration Days;
14 lsmeans Concentration / alpha=0.05 adjust=tukey;
15 output out=myout r=res p=pred;
16 run;
17
18 /*check residuals & model assumptions*/
19 proc sgplot data=myout;
20 scatter y=res x=pred;
21 refline 0;
22 run;
23
24 proc univariate data=myout normal;
25 var res;
26 qqplot res/normal(mu=est sigma=est);
27 run;

```