

- (d) At the 0.05 significance level, should I reject the null hypothesis? Justify your answer, referring to specific SAS output.
- (e) Explain what your answer to the previous question means for antigen concentrations in the two populations of children.
- (f) Circle all of the statements below that are true.
- i. The Wilcoxon rank sum test is a parametric test.
 - ii. The two-independent-sample t-test requires the standard deviations in the two populations to be equal.
 - iii. An assumption of the Wilcoxon rank sum test is that the medians in the two populations are equal.
2. The dataset for this problem is described as follows (in the textbook *Applied Regression* by Fox):

Data on Vocabulary and Education from the 1989 General Social Survey

[1] Observation Index

[2] Education, in years

[3] Vocabulary Test Score, 10-Item Test with possible scores 0 - 10.

Source: 1989 General Social Survey, National Opinion Research Center.
Distributed by the Inter-University Consortium for Political and Social Research.

Here are the first 10 rows of the dataset:

Obs	obsno	yrsed	score
1	1	0	5
2	2	1	1
3	3	3	1
4	4	3	3
5	5	4	1
6	6	4	0
7	7	4	1
8	8	4	2
9	9	4	4
10	10	4	5

I wish to use these data to infer about the relationship between education and vocabulary.

- (a) The scatterplot possibly indicates a weak linear relationship, but it looks wierd. Why are all the data points laid out in rows and columns?

- (b) From the regression output, give the point estimate and 95% confidence interval for the slope (numeric answer):

- (c) In one sentence, interpret the point estimate of the slope in terms of the years of education and vocabulary.

- (d) What quantity are you 95% confident lies in the confidence interval that you cited?

- (e) At the 0.05 significance level, is the slope different from 0? Cite two different parts of the regression output to support your answer.

- (f) Based on this regression model, what vocabulary score would you predict for a person with 8 years of education? (Numeric answer; show your work.)
3. Researchers wished to compare the effectiveness of four different treatment regimens for chronic renal failure in dogs. Twenty-eight dogs in stage 3 renal failure were randomly assigned to four different treatment groups (7 dogs in each group). The outcome variable was change in serum creatinine from pretreatment to 8 weeks on treatment. A negative change represented a decrease in serum creatinine, which is the hoped-for outcome.

Refer to the SAS output below in answering the following questions.

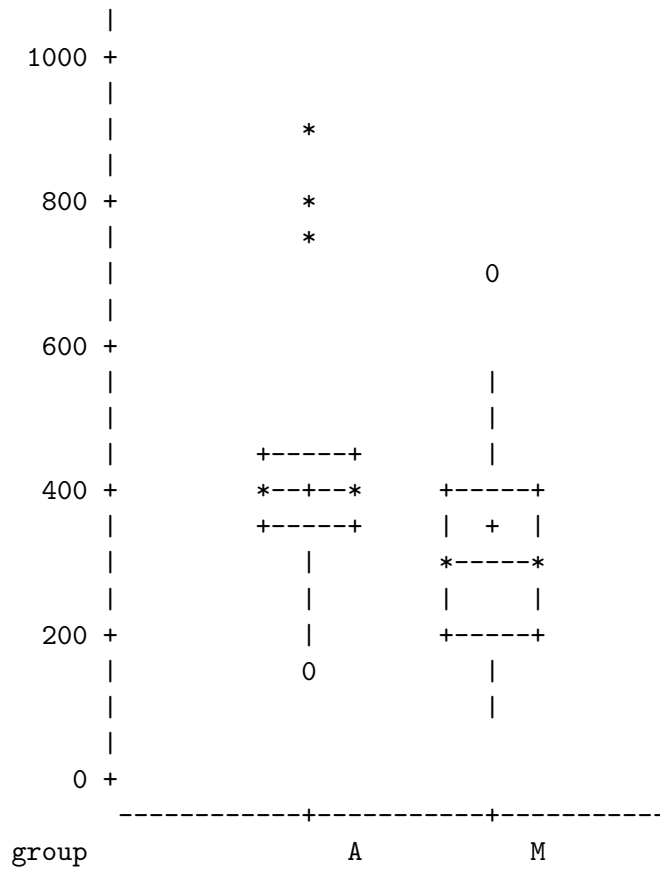
- (a) ANOVA was used for the analysis. Explain briefly why ANOVA was the correct method instead of the Chi square test.
- (b) Do the data appear to satisfy the assumptions of ANOVA? Explain briefly, referring to specific SAS output.
- (c) Write the null and alternative hypotheses being tested by the global F test. Use standard statistical symbols. Briefly define the symbols that you use.
- (d) At the 0.05 significance level, is the null hypothesis rejected? Justify your answer with specific SAS output.
- (e) Which population means, if any, are significantly different from each other? Justify your answer with specific SAS output.

- (f) Does this study indicate that any one of the 4 treatments is clearly the best? Explain briefly.
4. Biologists are planning to study body temperature in a particular species of finches (a kind of bird). They want to construct a confidence interval for the mean body temperature in adults of this species.
- (a) The biologists are convinced that body temperatures in this species follow a normal distribution with standard deviation 1.5 degrees Fahrenheit. How many finches will they need to capture and measure in order to construct a 90% confidence interval width no greater than 2 degrees? (Numeric answer; show your work.)
- (b) Without doing any calculations, state whether the biologists would need a larger sample or a smaller sample if they wanted a 95% c.i. instead of a 90% c.i.
5. Write the data type for each of the following variables. Choose from binary, nominal, ordinal, quantitative discrete, or quantitative continuous.
- (a) winning scores in college football games
- (b) whether or not the home team wins each college football game
- (c) patients' conditions as described by the American Hospital Association: good, fair, serious, critical

SAS for problem 1

The UNIVARIATE Procedure
Variable: conc

Schematic Plots



The TTEST Procedure

Variable: conc

group	N	Mean	Std Dev	Std Err	Minimum	Maximum
A	23	419.9	178.0	37.1210	170.0	900.0
M	15	329.3	171.0	44.1396	105.0	715.0
Diff (1-2)		90.5797	175.3	58.1817		

group	Method	Mean	95% CL Mean	Std Dev
A		419.9	342.9 496.9	178.0
M		329.3	234.7 424.0	171.0
Diff (1-2)	Pooled	90.5797	-27.4183 208.6	175.3
Diff (1-2)	Satterthwaite	90.5797	-27.0541 208.2	

group	Method	95% CL	Std Dev
A		137.7	252.0
M		125.2	269.6
Diff (1-2)	Pooled	142.6	227.7
Diff (1-2)	Satterthwaite		

Method	Variances	DF	t Value	Pr > t
Pooled	Equal	36	1.56	0.1283
Satterthwaite	Unequal	30.953	1.57	0.1265

Equality of Variances

Method	Num DF	Den DF	F Value	Pr > F
Folded F	22	14	1.08	0.8975

NPARIWAY Procedure

Wilcoxon Scores (Rank Sums) for Variable conc
Classified by Variable group

group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
A	23	509.0	448.50	33.470412	22.130435
M	15	232.0	292.50	33.470412	15.466667

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic 232.0000

Normal Approximation

Z -1.7926

One-Sided Pr < Z 0.0365

Two-Sided Pr > |Z| 0.0730

Kruskal-Wallis Test

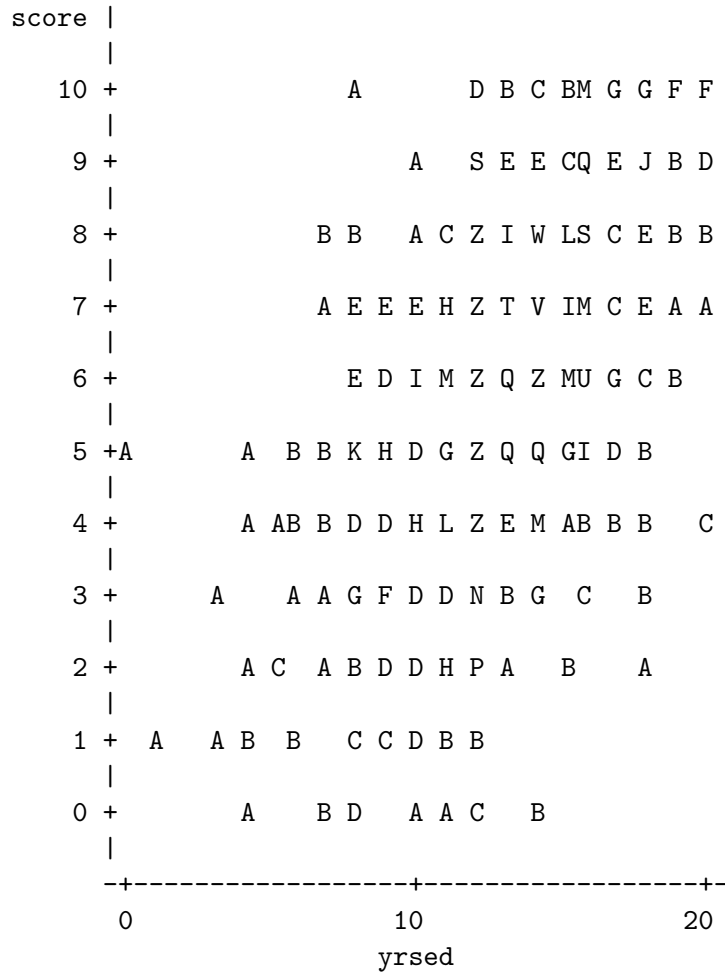
Chi-Square 3.2673

DF 1

Pr > Chi-Square 0.0707

SAS for problem 2

Plot of score*yrsted. Legend: A = 1 obs, B = 2 obs, etc.



The REG Procedure
 Model: MODEL1
 Dependent Variable: score

Number of Observations Read 968
 Number of Observations Used 968

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1175.11129	1175.11129	318.92	<.0001
Error	966	3559.41351	3.68469		
Corrected Total	967	4734.52479			

Root MSE 1.91956 R-Square 0.2482
 Dependent Mean 5.94008 Adj R-Sq 0.2474
 Coeff Var 32.31530

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	1.13481	0.27606	4.11	<.0001
yrsed	1	0.37413	0.02095	17.86	<.0001

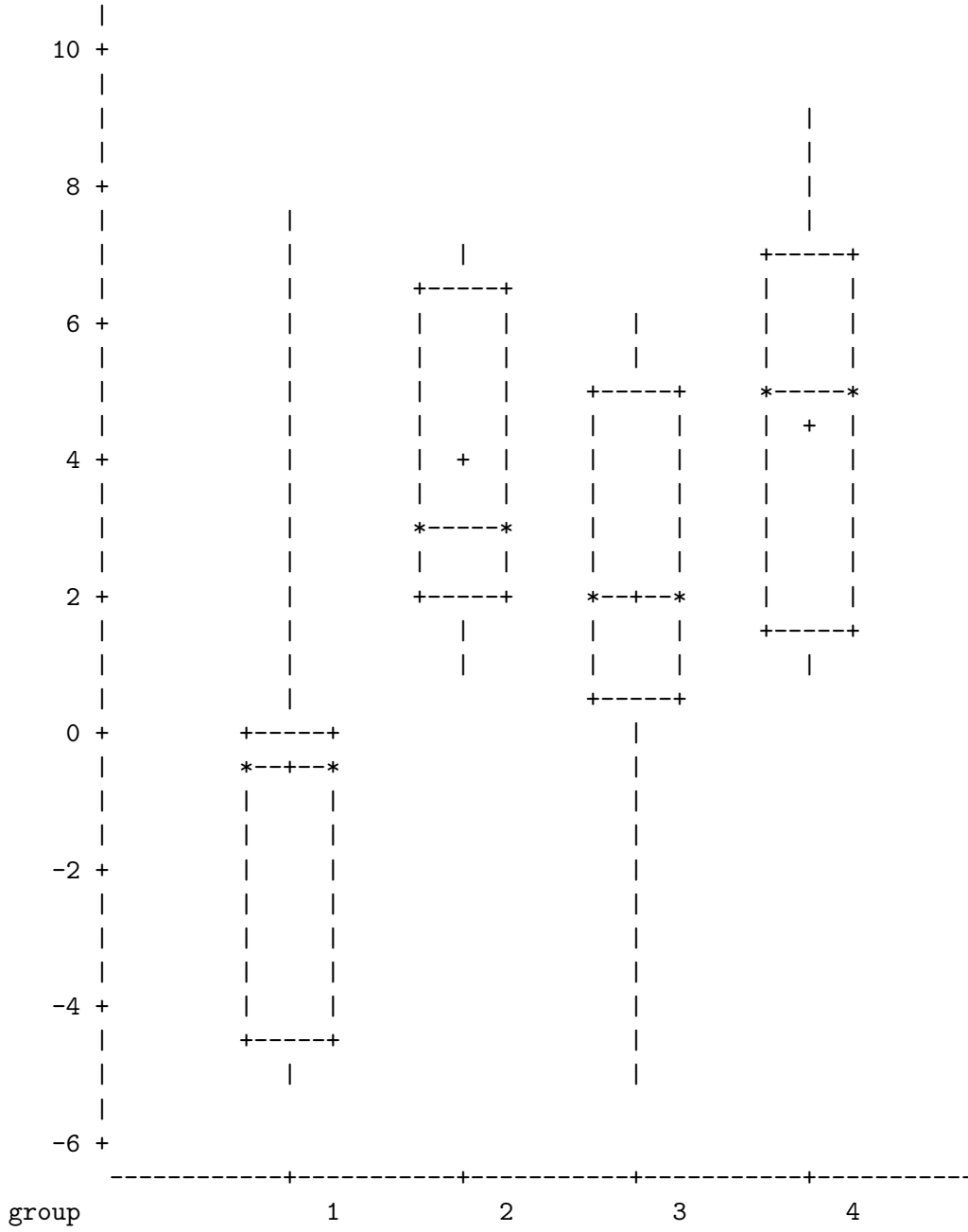
Parameter Estimates

Variable	DF	95% Confidence Limits	
Intercept	1	0.59306	1.67656
yrsed	1	0.33301	0.41524

SAS for problem 3

The UNIVARIATE Procedure
Variable: y

Schematic Plots



The MEANS Procedure

Analysis Variable : y

group	Obs	N	Mean	Std Dev	Minimum	Maximum
1	7	7	-0.6900000	4.1492931	-5.1900000	7.2900000
2	7	7	3.9514286	2.3187743	1.1300000	6.8100000
3	7	7	1.9714286	3.6674125	-4.9700000	6.0700000
4	7	7	4.5342857	2.8108472	1.0400000	8.8500000

The ANOVA Procedure

Class Level Information

Class	Levels	Values
group	4	1 2 3 4

Number of Observations Read 28
 Number of Observations Used 28

The ANOVA Procedure

Dependent Variable: y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	116.8082679	38.9360893	3.54	0.0296
Error	24	263.6647429	10.9860310		
Corrected Total	27	380.4730107			

R-Square 0.307008
 Coeff Var 135.7416
 Root MSE 3.314518
 y Mean 2.441786

Source	DF	Anova SS	Mean Square	F Value	Pr > F
group	3	116.8082679	38.9360893	3.54	0.0296

The ANOVA Procedure

Bonferroni (Dunn) t Tests for y

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	24
Error Mean Square	10.98603
Critical Value of t	2.87509
Minimum Significant Difference	5.0938

Means with the same letter are not significantly different.

Bon Grouping	Mean	N	group
A	4.534	7	4
A			
B A	3.951	7	2
B A			
B A	1.971	7	3
B			
B	-0.690	7	1