Biostats Project 2 - ANOVA

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## Warning: package 'kableExtra' was built under R version 3.5.2
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Introduction

Poisons of various kinds have been known to mankind for thousands of years. Animal studies are a necessary evil in the ongoing search of better treatments. One way of measuring the efficacy of a given treatment is survival time after a lab animal has been administered poison as well as the treatment. In this experiment, three different poisons are administered, along with four different treatments. Each treatment-poison combination is tested on four different animals, for a total of 4x4x3 = 48 observations of survival time in units of 10 hours. Source: G.E.P. Box and D.R. Cox, *Journal of the Royal Statistical Society*, 1964. **Objective:** This experiment has been conducted in order to address the question of whether there is a more/most effective treatment for one or more of the poisons, including detecting any poison-treatment interactions.

Methods

Descriptive analysis (interaction plot) and a two-way complete ANOVA model was fit to investigate interactions, as well as the association between the two factors and survival time of the animals. ANOVA diagnostics and remedial measures (transformation of the response variable) were performed in order to both check and remediate model assumptions. Hypothesis testing was conducted with a .05 level of significance. A main effects model was used after no interaction was found.

Results

The interaction plot, showing visually potential interactions, is shown in Figure 1. There

appears to be an interaction between poison and treatment when comparing treatment 3 and 4, for example, and possible between treatments 2 and 4 as well, not to mention other comparisons. The ANOVA table of the two-way complete model is shown in Table 1. The interaction is not significant, so a main effects model is included in Table 2.

The residual plot and qq-plot are shown in Figures 2 and 3, respectively. The residual and qq-plots suggest a transformation might be needed, since the variance of the residuals does not appear constant, and the response variable doesn't appear very normally distributed. After using a reciprocal transformation (1/y), the residual and qq-plots look much better, as seen in Figures 4 and 5, respectively.

In conclusion, the interaction between poison type and treatment type does not appear to be significant. Treatment type did by itself have a significant effect on survival time, as did poison. No preplanned or comprehensive pairwise comparisons were made, but confidence intervals for the least squared means of each treatment, and each poison, are included below (Tables 3 and 4, and Figures 6 and 7). Treatment 2 appears to have performed the best, and poison 3 appears to have been the deadliest.

Figure 1: Survival times by treatment and poison

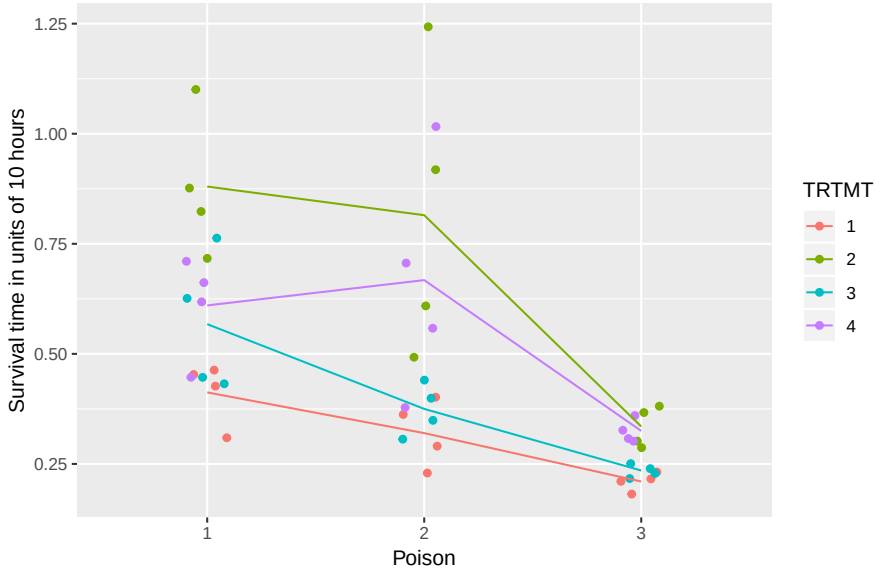

Table 1: ANOVA two-way complete model

	Sum Sq	Df	F value	Pr(>F)
factor(POISON)	1.0330125	2	23.221737	0.0000003
factor(TRTMT)	0.9212062	3	13.805582	0.0000038
factor(POISON):factor(TRTMT)	0.2501375	6	1.874333	0.1122506
Residuals	0.8007250	36	NA	NA

Table 2: ANOVA main affects model with transformed data

	Sum Sq	Df	F value	Pr(>F)
factor(POISON)	34.87712	2	71.70843	0
factor(TRTMT)	20.41429	3	27.98160	0
Residuals	10.21386	42	NA	NA

Figure 2: Residuals by the fitted values

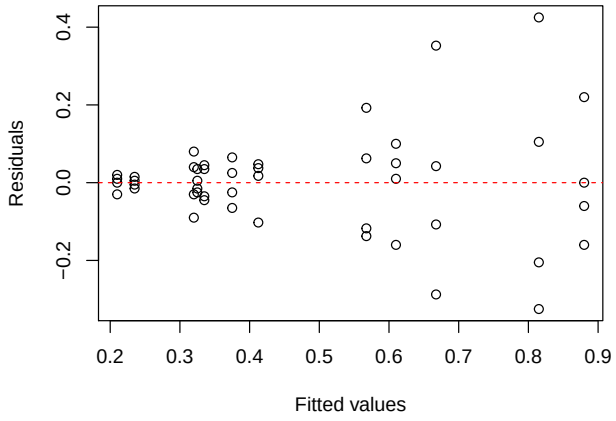

Figure 3: QQ−plot of the response variable

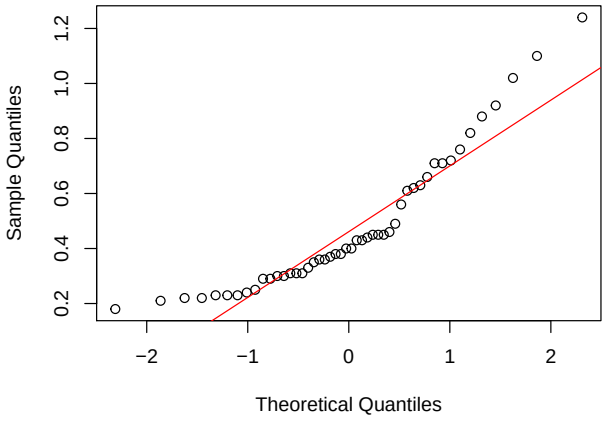

Figure 4: Residuals of transformed data

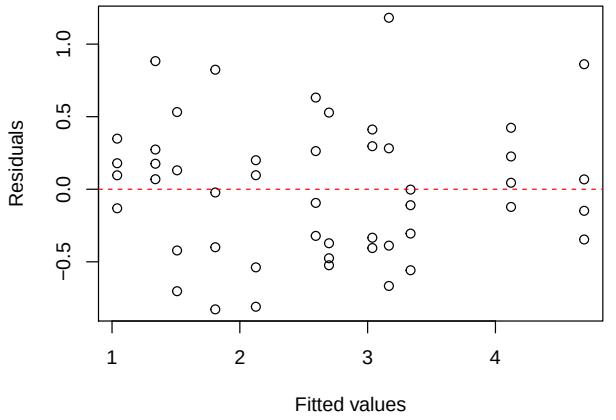

Figure 5: QQ−plot of the transformed data

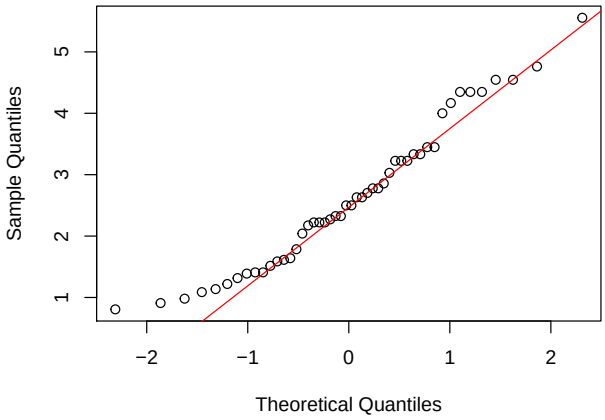

Table 3: Mean survival time by treatment

TRTMT	lsmean	SE	df	lower.CL	upper.CL
1	0.3141667	0.0456623	42	0.2220164	0.4063169
2	0.6766667	0.0456623	42	0.5845164	0.7688169
3	0.3925000	0.0456623	42	0.3003498	0.4846502
4	0.5341667	0.0456623	42	0.4420164	0.6263169

Table 4: Mean survival time by poison

POISON	lsmean	SE	df	lower.CL	upper.CL
1	0.617500	0.0395447	42	0.5376956	0.6973044
2	0.544375	0.0395447	42	0.4645706	0.6241794
3	0.276250	0.0395447	42	0.1964456	0.3560544

Figure 6: Survival time means by treatment

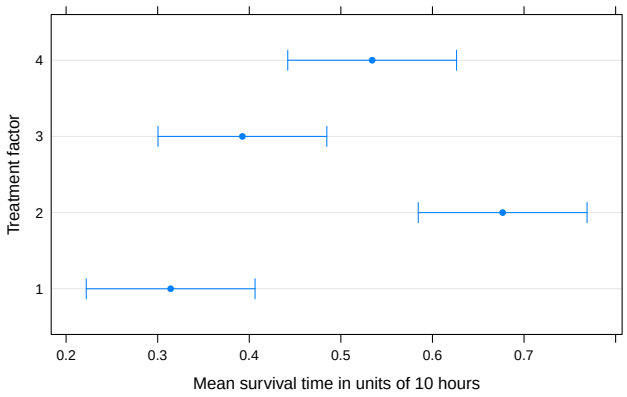

Figure 7: Survival time means by poison