HW

4.3, 4.10, 4.17, 4.19, 4.25, 4.27, 4.31

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4.3

Removing the zeros from the dataset would completely alter the data and therefore change the results (especially when there are so many zeros). Either a small value should be added to all the observations if a log transformation is still desired, or a different method should be used.

4.10

The cutoff of $p = 0.05$ is essentially arbitrary; there's no intrinsic reason that a 5% chance of something happening is significant while a 6% chance is not. In this case, the two p-values are so similar that they tell the same story: there is around a 5% chance that these results would occur due to pure randomness if the null hypothesis were true. As such, it's better to report and discuss the p-value itself rather than a simple "yes/no" of significance.

4.17

The number of O-ring incidents based on temperature is given as follows:

Launch temperature	Number of incidents
Below 65F	1 1 1 2
Above 65F	1 1 3 0 (x17)

A t-test of these values (assuming equal variance) yields a t-statistic of 2.643. According to the following table:

# of arrangements	t-statistic
2380	-1.188
3400	-0.463
2040	0.231
1530	0.939
855	1.716
316	2.643
95	3.888
10	5.952

there are $316 + 95 + 10 = 421$ arrangements with t-statistics of 2.643 or greater, out of a total $10,626$ arrangements. This gives a one-sided p-value of $\frac{421}{10,626} = 0.04$.

4.19

I will answer parts **(b)** and **(c)** first. The `wilcox.test` function in R allows for computing either an exact *p*-value or one based on the normal approximation. If using the approximate value, continuity correction is optional. In my case, I will compute the approximate *p*-value with continuity correction.
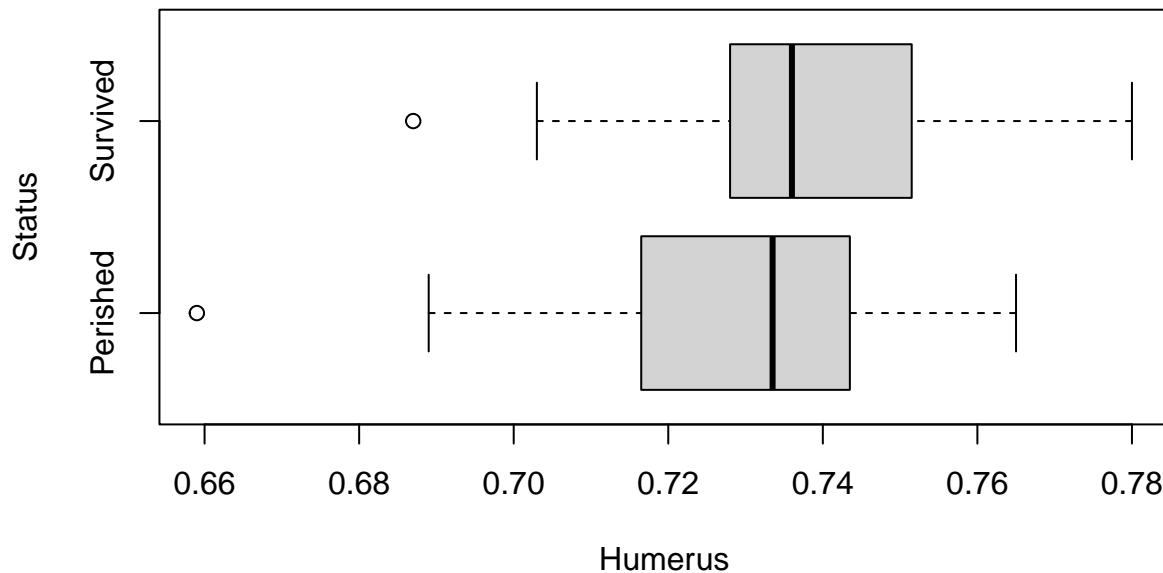

Figure 1: Humerus length of sparrows.

A boxplot of the data is given in Figure 1. A table comparing the *p*-values of the rank-sum test, the two-sample *t*-test, and the *t*-test with the smallest observation removed is shown below:

	Rank-sum	t-test	t-test (w/o smallest observation)
p-value	0.172	0.081	0.18

The *p*-value of the rank-sum test is nearly identical to that of the *t*-test with the smallest outlier removed. When there are outliers such as this, the rank-sum test deals with them handily, and the *t*-test requires a decision regarding any outliers. Both can give helpful results, but the *t*-test requires more verification of the data.
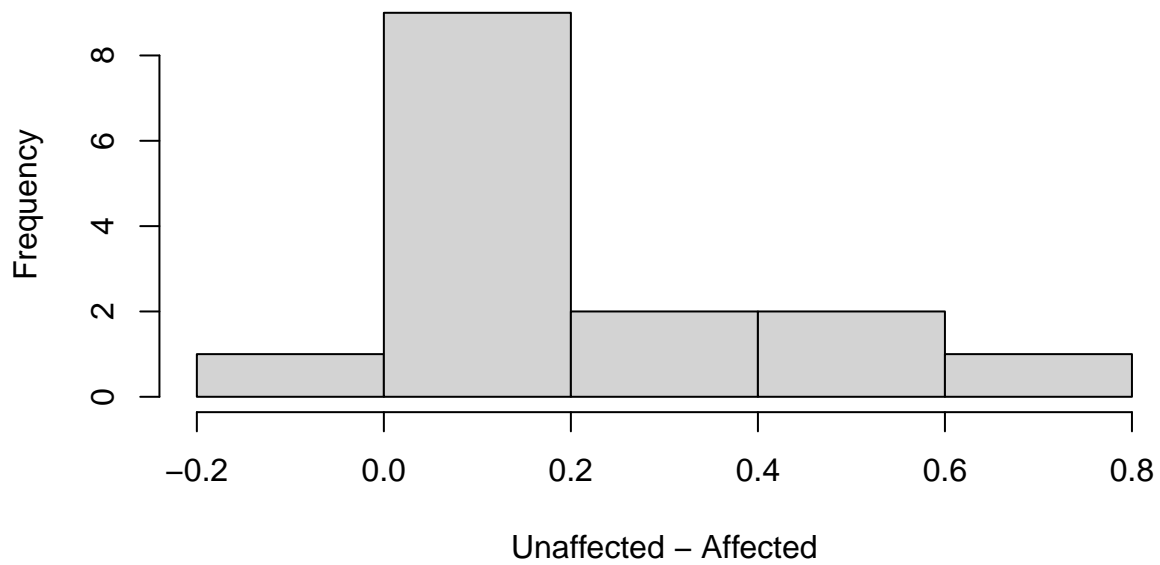
4.25

A boxplot of the data:
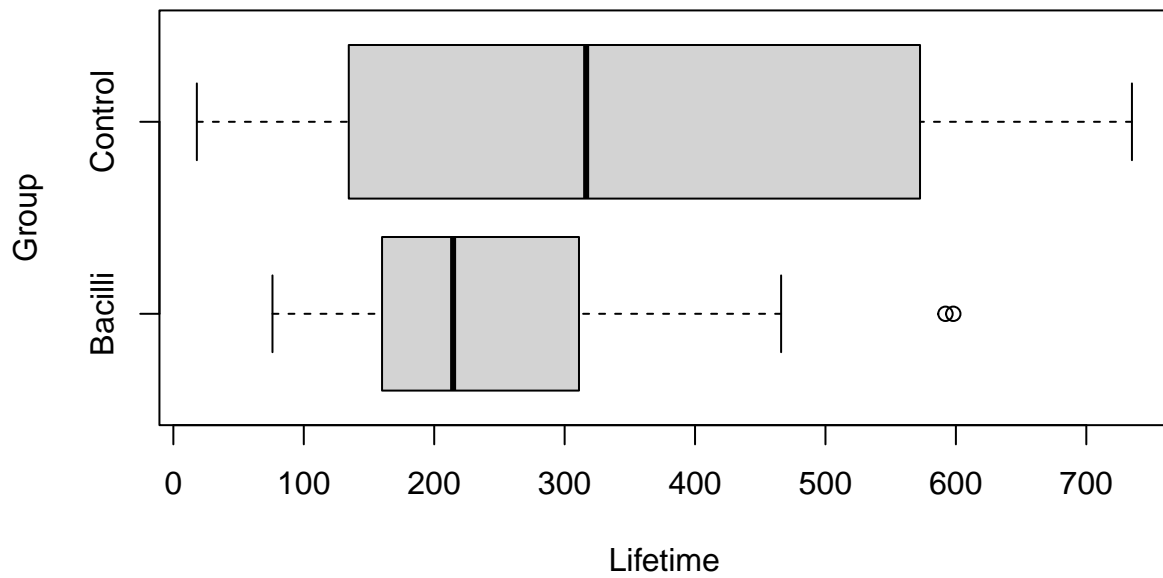
The Welch t-test gives a two-sided p-value of 0.002, and a confidence interval of $-165.807 < \mu_{\text{bacilli}} - \mu_{\text{control}} < -39.593$. The additive model is not ideal, as there is only one treatment, and the groups are delineated based on whether or not they received the treatment.

4.27

A histogram of the differences in hippocampus volumes:

And of the differences of the log-transformed data:
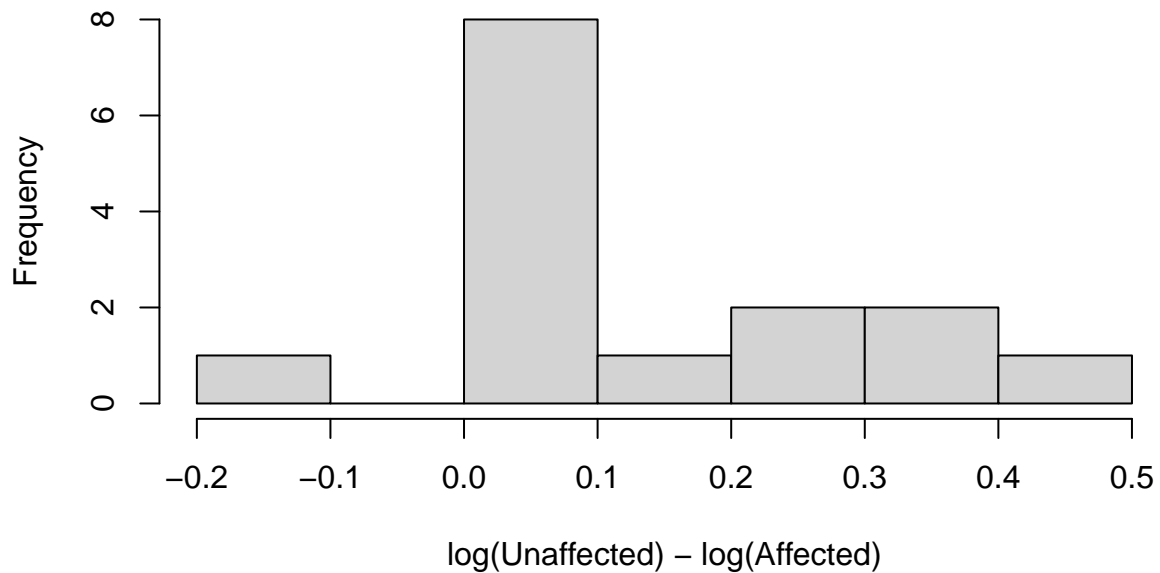
The signed-rank test of the difference in log values gives a *p*-value of 0.002, and the untransformed data gives 0.002.

Based on the histograms, neither distribution is particularly normal, though the log-transformed data has a

less normal distribution than the untransformed data. The rank test would therefore be more useful on the log-transformed data.

4.31

A boxplot of the data is given in Figure 2. It is important to note that 3 patients were still alive at the time this data was collected, so their survival time was recorded at 122 months, but the actual value is an unknown amount larger than this. A kernel density plot is provided in Figure 3.
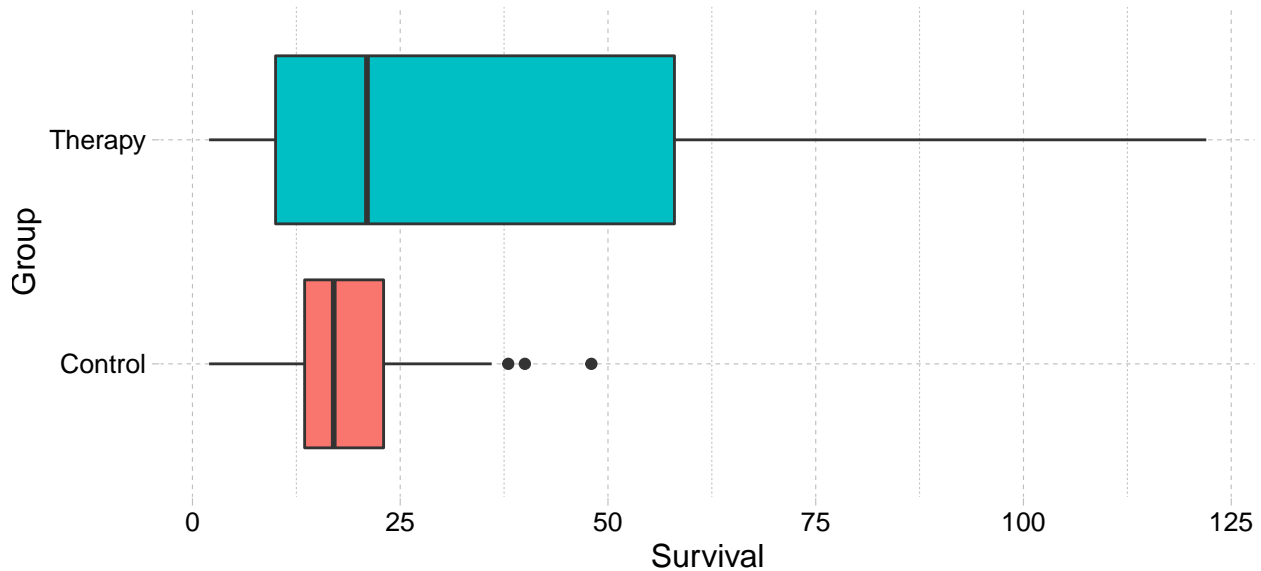

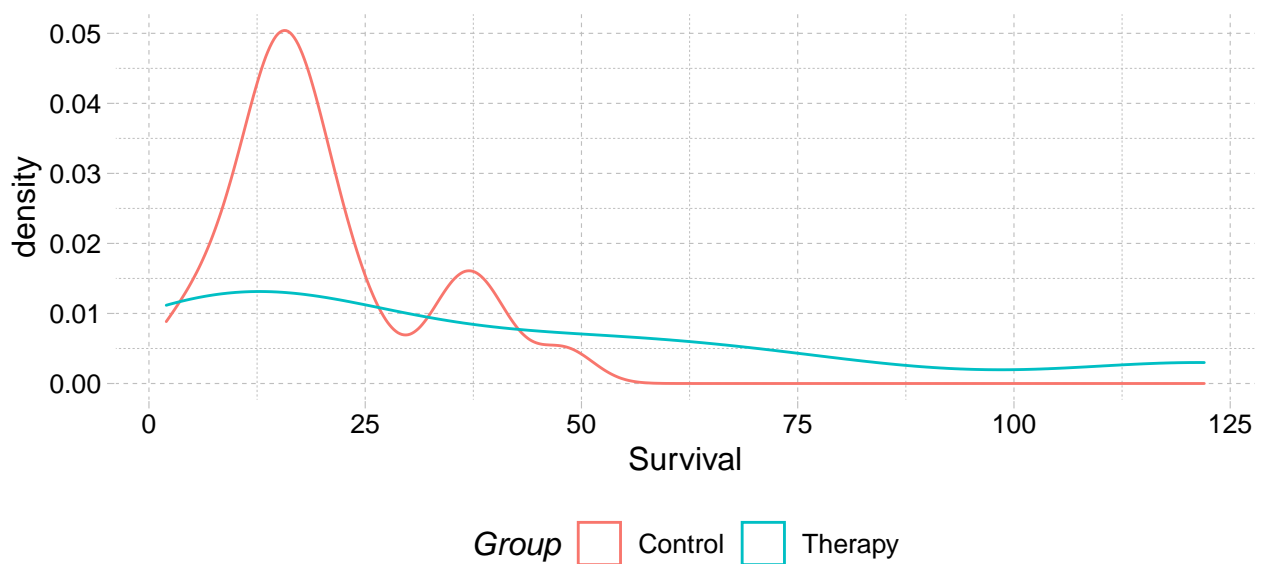Figure 2: Boxplot of breast cancer patients' lifespan (months after start of study).

Figure 3: Density plot of breast cancer patients' lifespan (months after start of study).

The density plot shows that these data are not at all normally distributed, and so a t-test will likely perform quite

poorly. Due to this as well as the fact that there are censored observations, instead a rank-sum test is used. This test gives a p-value of 0.265, which offers no real evidence that there is a difference between the groups. This is a bit surprising based on the boxplots, but the "therapy" group had a huge spread (in fact, the distribution was nearly flat), so it's entirely possible that the high-value observations were just due to random chance.

Since no conclusions are being drawn, no inferences need to be made.