

Does Water Boil Faster with Salt?

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INTRODUCTION

Research Question: Is water boiling time influenced by the following factors?

1. Adding salt
 2. Varying the amount of water
- **Amounts of water used in the experiment:** 1, 1.5, 2 cup(s)
 - **For each amount of water:** we tested two different types of liquid - pure water, salty water
 - **Repeated every combination of water amount and liquid type:** six times

CONDUCTING THE EXPERIMENT

Boiling Pan:

- 1-quart stainless steel saucepan with no cover

Step-by-step procedure:

1. Place the saucepan on electric stove top (I used smaller size burner).
2. Fill up a clear measuring cup with a desired amount of water - 1, 1.5, or 2 cup(s).
3. Pour the water carefully from the measuring cup into the pan.
4. Add 1/2 teaspoon of salt to the water.
5. Turn on the burner to the highest setting.
6. Once the burner gets turned on, start recording time.
7. Keep an eye out for the water bubbles that started to develop.
8. Once the water comes to a full rolling boil, stop recording time.



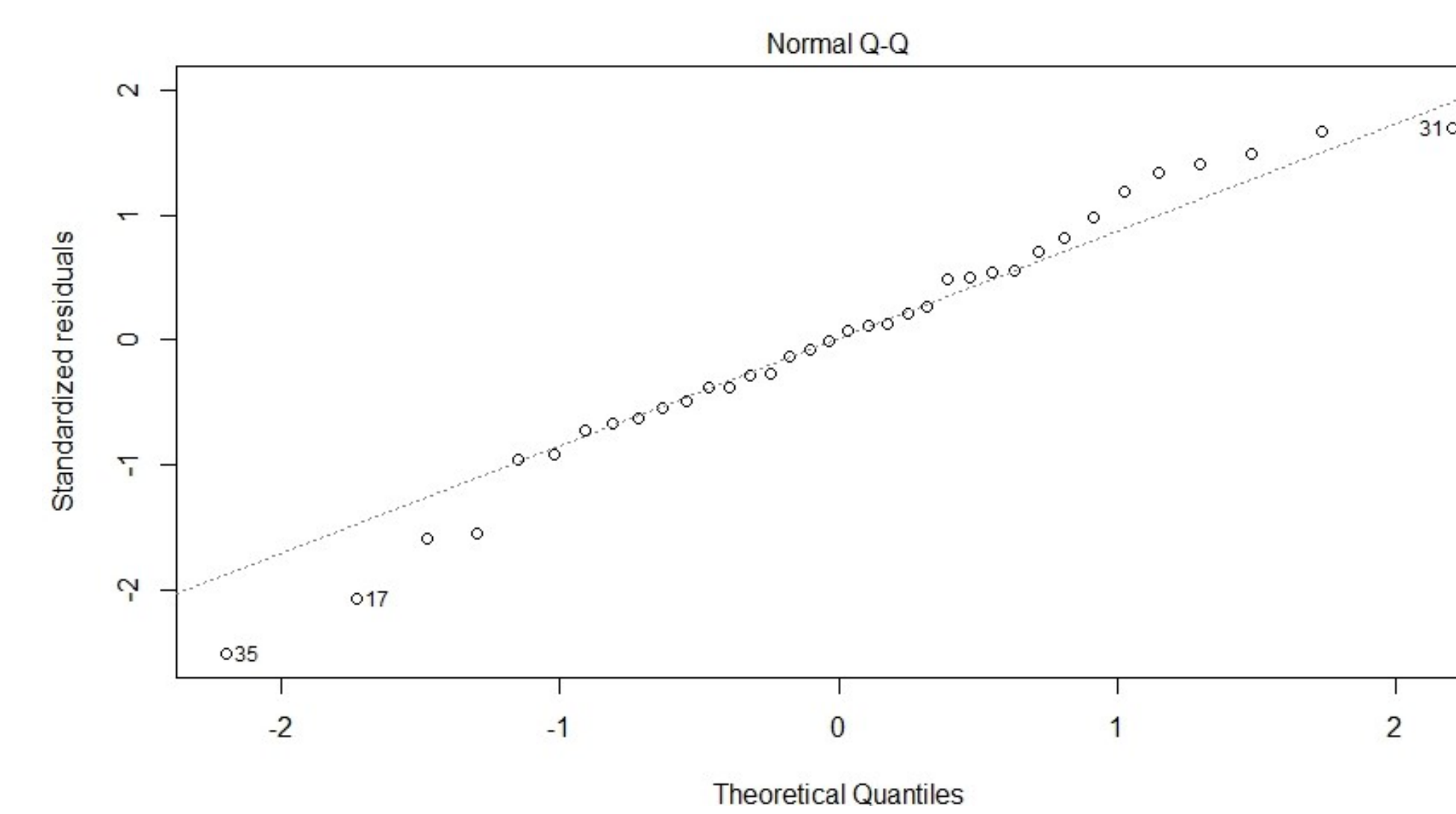
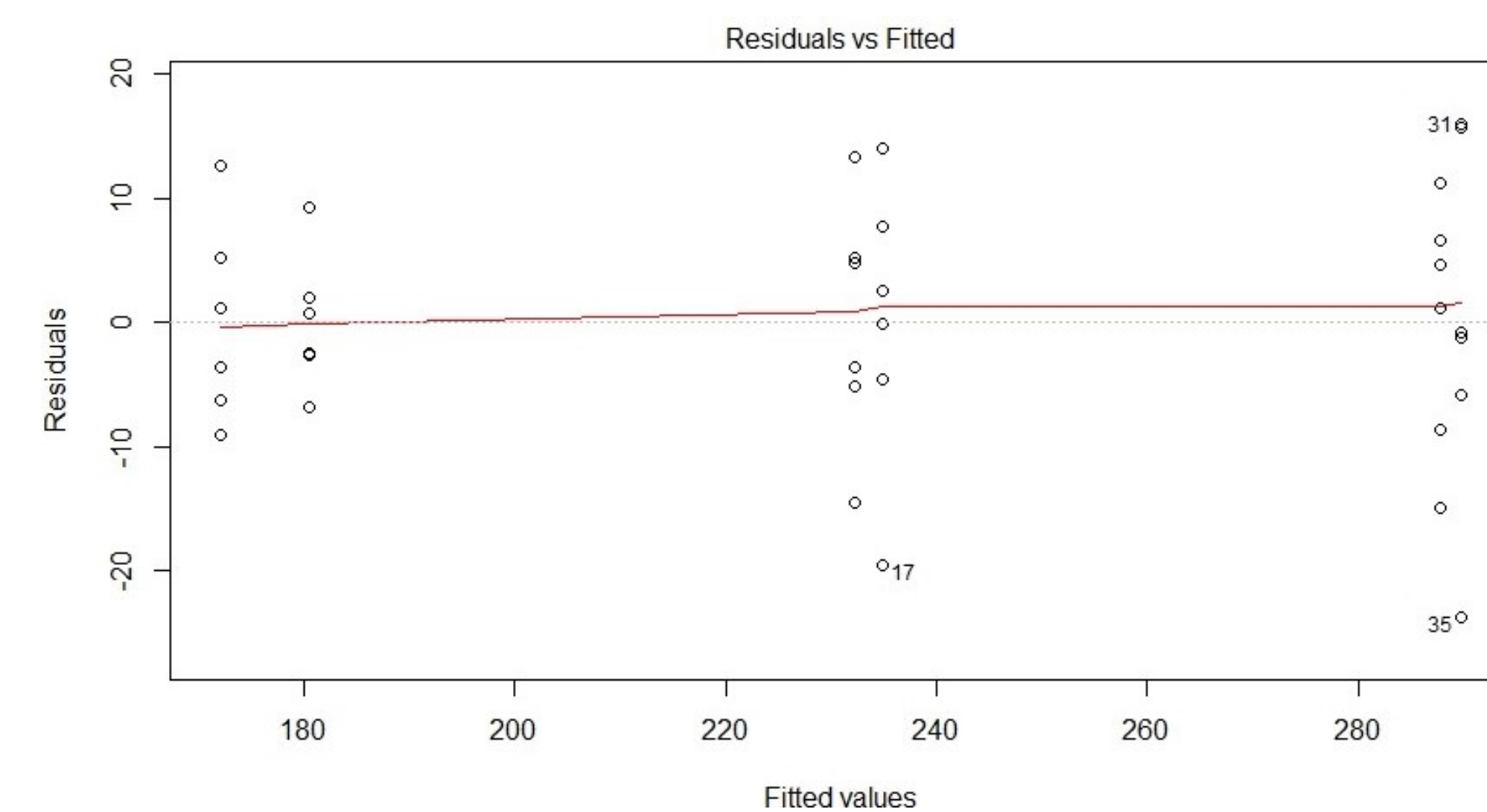
METHODOLOGY

- **Data collection:** enter recorded times into Excel
- **One dependent variable:** boiling time
- **Two independent variables:** Amount of water, liquid type
- **Two-Way Analysis of Variance (ANOVA):** statistical method used to answer the research question
- **RStudio:** statistical software used to analyze the data

RESULTS

First, we check assumptions.

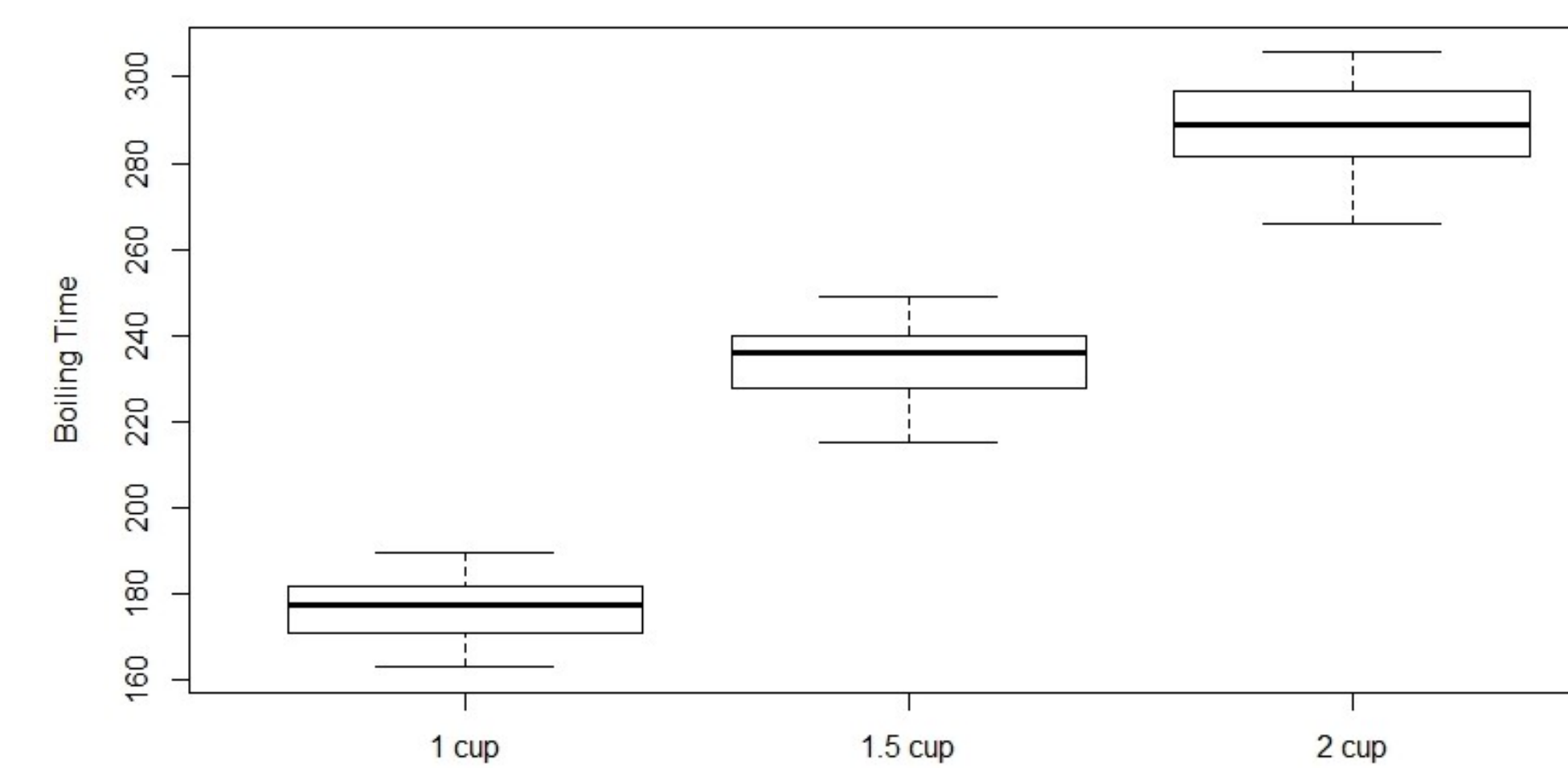
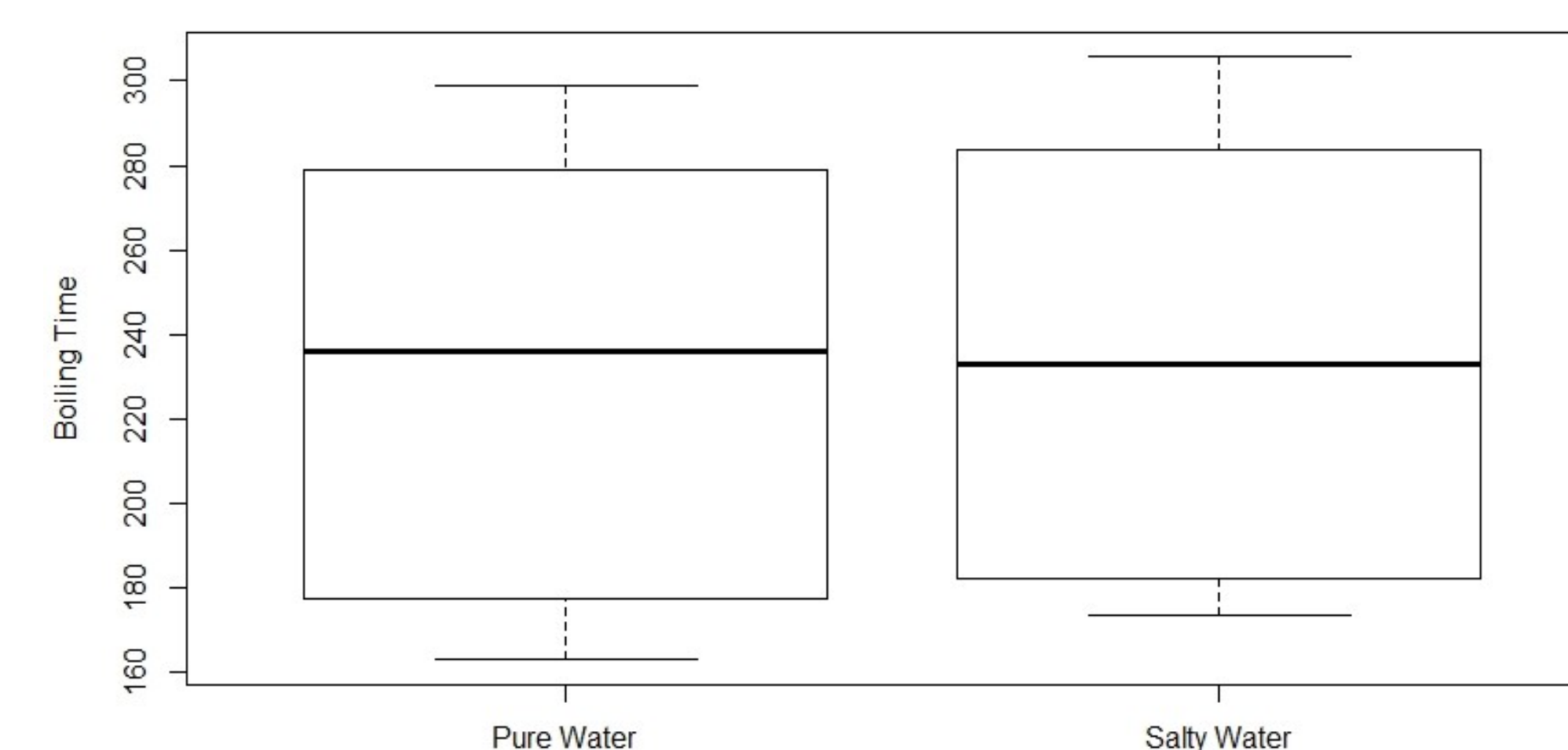
- **Independence of data:** OK ✓
 1. Run orders are random.
 2. Additional factors (e.g., time gap between two consecutive runs) have been controlled.
- **Equal Variance and Normality:** OK ✓



Two-Way ANOVA Table:

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F	p - value
Liquid Type	1	58	58	0.542	0.468
Water Amount	2	75992	37996	355.464	$< 2 \times 10^{-16}$
Interaction	2	185	93	0.866	0.431
Residuals	30	3207	107		
Total	35	79442			

Boxplots:



CONCLUSIONS

- **Interaction Factor:** p-value greater than 0.05, so it is NOT statistically significant. The relationship between liquid type and boiling time is NOT affected by the amount of water, and vice versa. It is OK to individually interpret each of our independent variables.
- **Liquid type:** p-value greater than 0.05, so it is NOT statistically significant. The data does NOT have evidence that adding salt influences boiling time of water.
 - The first boxplot reflects the same trend. The difference in boiling times is minimal.
 - On an average, pure water has a slightly higher boiling time.
 - In other words, on an average, salty water boils only slightly faster than pure water.
- **Water Amount:** p-value smaller than 0.05, so it is statistically significant. The data has evidence that varying the amount of water affects boiling time of water.
 - The second boxplot reflects the same trend. The difference in boiling times is substantial.
 - On an average, 1 cup of water has the lowest boiling time.
 - On an average, 2 cups of water has the highest boiling time.

FUTURE RESEARCH

This experiment did NOT test the boiling times based on other factors such as:

- pan material (various types)
- burner size (small, large)
- cover for pan (yes, no)
- height of the location from sea level
- humidity

These could be potential future studies.

ACKNOWLEDGMENT

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