Wine and Obesity Data Analysis

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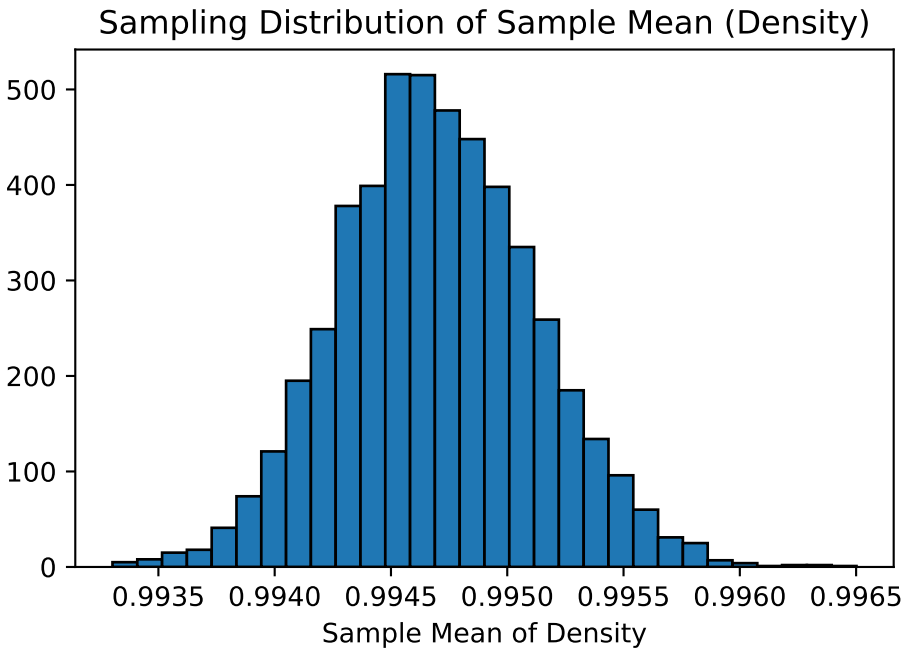
1. Dataset Overview

Wine Quality Dataset

- **Collection Year:** 2009
- **Description:** Physiochemical properties for red and white Portuguese "Vinho Verde" wines.
- **Size:** 6497 rows, 12 columns
- **Variables:** `fixed_acidity`, `volatile_acidity`, `citric_acid`, `residual_sugar`, `chlorides`, `free_sulfur_dioxide`, `total_sulfur_dioxide`, `density`, `ph`, `sulphates`, `alcohol`, `quality`, `color`
- **Study Type:** Observational; each wine sample measured independently.

Sampling Distribution of Density

The following histogram shows the bootstrap sampling distribution of the **sample mean of the `density` variable**.



Obesity Dataset

- **Collection Year:** 2019
- **Description:** Estimation of obesity levels in individuals from Mexico, Peru, and Colombia, based on eating habits and physical condition.
- **Size:** 2111 rows, 16 columns
- **Variables:** `Gender`, `Age`, `Height`, `Weight`, `Family_history_with_overweight`, `FAVC`, `FCVC`, `NCP`, `CAEC`, `SMOKE`, `CH2O`, `SCC`, `FAF`, `TUE`, `CALC`, `MTRANS`, `NObeyesdad`
- **Study Type:** Observational; each individual measured independently.

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2. One-Sample T-Test: Wine Alcohol Content

Research Question: Is the average alcohol content of red and white wine greater than 10.5%?

Hypotheses:
- (H_0: = 10.5)
- (H_a: > 10.5)

Results:
- Sample mean: 10.4918
- t-statistic: -0.5541
- Critical t-value (= 0.05): 1.6451
- One-tailed p-value: 0.7102
- 95% Confidence Interval: (10.4628, 10.5208)

Conclusion: Fail to reject (H_0). There is insufficient evidence that the mean alcohol content exceeds 10.5%.

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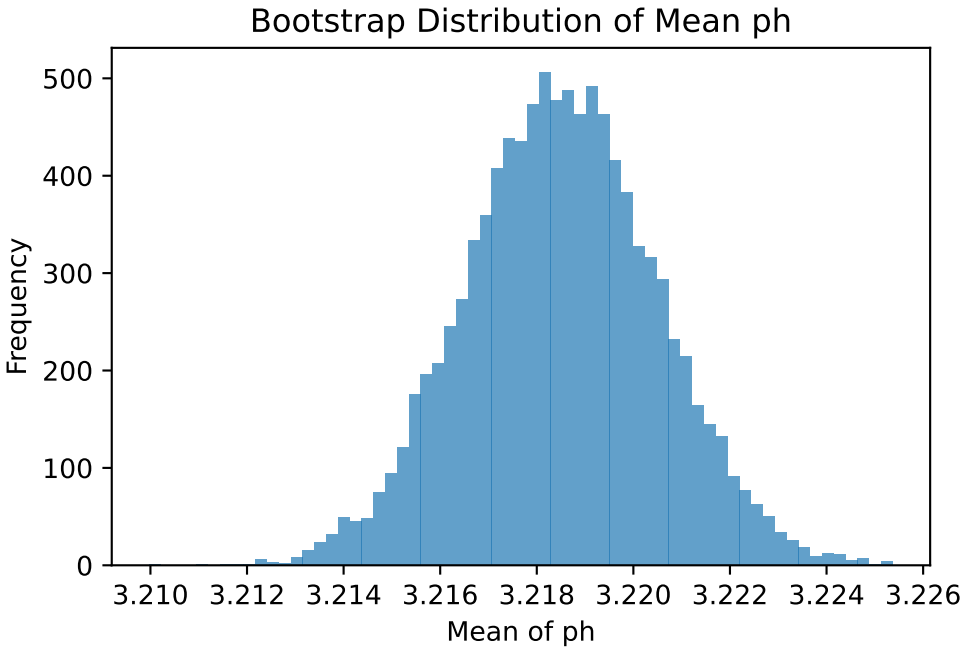
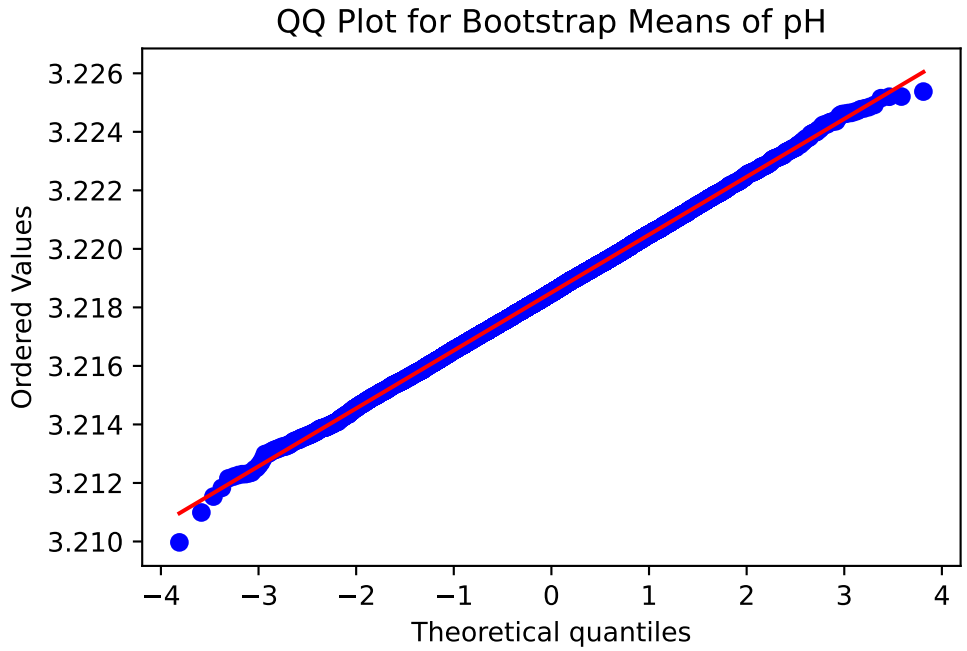
3. Bootstrap Approach: Wine pH

Bootstrap Distribution



QQ Plot for Bootstrap



95% Bootstrap Confidence Interval

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(3.214666615360936, 3.2224027243343083)
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Conclusion: We are 95% confident that the true population mean pH lies between 3.215 and 3.222.

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4. Analysis of Variance (Wine Dataset)

F Test

ANOVA Table

AVOVA Assumptions Check

Conclusion

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5. Multiple Comparisons (Obesity Dataset)

ANOVA Model and Assumptions

- Two-way ANOVA with interaction: `Weight ~ MTRANS * CAEC`.

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<Figure size 3600x2400 with 0 Axes>
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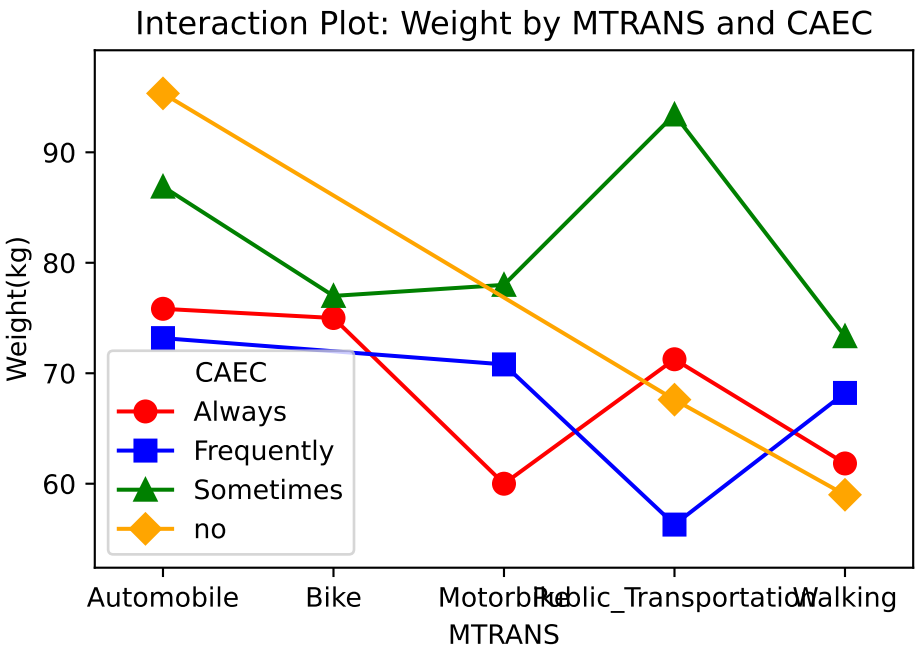
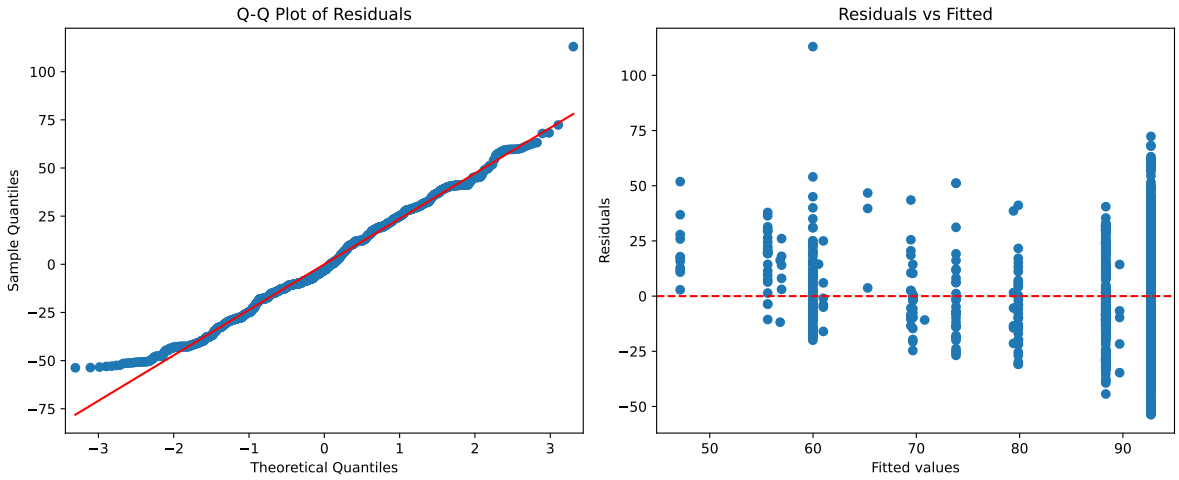


QQ Plot and Residual Analysis:



- QQ plot shows approximate normality.
- Residual plot shows no clear pattern.
- **Conclusion:** ANOVA assumptions satisfied (normality, independence, equal variance).

F-Tests for Factors

Factor	F-statistic	F-critical	p-value	Conclusion
MTRANS	6.85	2.376	1.78×10	Reject H : At least one group mean differs
CAEC	149.69	2.609	1.11×10^{1}	Reject H : At least one group mean differs

Interpretation: Both MTRANS and CAEC significantly affect Weight; differences between group means are unlikely due to chance.

References

Cortez, Paulo, et al. “Wine Quality.” UCI Machine Learning Repository, 2009, https://doi.org/10.24432/C56S3T. “Estimation of Obesity Levels Based On Eating Habits and Physical Condition .” UCI Machine Learning Repository, 2019, https://doi.org/10.24432/C5H31Z.

Code Appendix