Goal

A fast food chain introduced a new menu item and tested three different promotional campaigns across randomly selected store locations.
The objective was to identify which promotion drives higher sales performance.

Hypotheses

- **Null hypothesis (H_0)** : There is no statistically significant difference in mean weekly sales between the three promotions.
- **Alternate hypothesis (H_1)** : At least one promotion has a statistically significant difference in mean weekly sales.

Target Metric

Average weekly sales per store, measured over a four-week period, to capture steady performance rather than short-term fluctuations.

Data aggregation
- LocationID (store-level aggregation)
- Promotion (Promotion 1, 2 and 3)

Statistical testing approach
- Because weekly sales is a continuous metric and three promotions were tested simultaneously, a one-way ANOVA was used to test for overall difference between groups.
- After detecting a significant ANOVA result, pairwise t-tests were conducted to identify which promotions differed.
- A 99% confidence level was applied to account for multiple comparisons and reduce the risk of pfalse positives.

Calculations

Data preparation (SQL)
Final inputs for ANOVA and t-tests were calculated in SQL by aggregating weekly sales per location and promotion.
Full queries are available in the repository (/sql).

Results: Descriptive statistics
Before running statistical tests, aggregated weekly sales were reviewed to understand baseline differences between promotions.

- Promotion 1 shows highest mean weekly sales per location
- Promotion 3 has comparable average performance but higher variability
- Promotion 2 underperforms on both mean sales and total revenue

Summary statistics shown below for reference.

promotion	total_sales	avg_sales	stddev_sales	total_orders
1	9993.03	58.1	16.55	172
2	8897.93	47.33	15.11	188
3	10408.52	55.36	16.77	188

Statistical Testing

ANOVA (overall test)
A one-way ANOVA was conducted to test whether mean weekly sales differed across the three promotions.

- F-statistic: 5.85
- p-value : 0.0037
- Significance level: 0.01

Since the p-value is below the chosen significance level, the null hypothesis was rejected.
This indicates that at least one promotion performs differently in terms of mean weekly sales.

Pairwise T-tests (99% confidence level)
To identify which promotions differed, pairwise t-tests were conducted using a 99% confidence level to control for multiple comparisons.

- Promotion 1 vs Promotion 2
    - Mean difference: +10.77
    - p-value: 0.004
    - Result: Promotion 1 performs significantly better than promotion 2

- Promotion 1 vs Promotion 3
    - Mean difference: +5.3
    - p-value: 0.068
    - Result: No statistically significant difference at the 99% confidence level

- Promotion 2 vs Promotion 3
    - Mean difference: -5.4
    - p-value: 0.09
    - Result: No statistically significant difference at the 99% confidence level

Decision

Based on the statistical analysis:
- The null hypothesis was rejected, confirming that not all promotions perform equally.

- Promotion 1 significantly outperforms Promotion 2 in mean weekly sales at a 99% confidence level.
- No statistically significant difference was found between Promotion 1 and Promotion 3 at the same confidence level, despite Promotion 3 having the highest total sales.

Business decision
- Promotion 2 should not be rolled out, as it consistently underperforms relative to the other two campaigns.
- Promotion 1 and Promotion 3 should be treated as the top-performing options, as their difference in performance is not statistically reliable.
- The final choice between Promotion 1 and Promotion 3 should be made based on non-statistical factors, such as:
    - Promotion cost
    - Operational complexity
    - Margin impact
    - Scalability across locations

Next Steps
If the business requires a single clear winner:
- Run a follow-up experiment with higher statistical power focused only on Promotions 1 and 3
- Alternatively, evaluate downstream metrics (profit, repeat purchases, customer satisfaction) to inform the decision.