ACME Data Science Case Study Report

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1. Executive Summary

This report outlines the approach, mathematical models, and findings from the ACME Data Science Case Study. The primary objectives were to maximize sales, optimize margins, meet sales targets, and provide five-year sales and margin projections. A synthetic dataset was created to simulate realistic business scenarios, and optimization techniques were applied to generate actionable insights.

2. Problem Statement

ACME required an analysis to:

- Maximize total sales under brand-specific constraints.
- Maximize margins while adhering to sales constraints.
- Achieve predefined sales and margin targets.
- Project sales and margins over the next five years.

Constraints included:

- Brand-specific sales trends and contribution limits.
- Minimum and maximum contribution percentages for brands and categories.
- Realistic sales growth and margin targets based on global market conditions.

3. Approach & Methodology

3.1 Data Preparation

- **Synthetic Dataset Generation:**
  - Created using Python with random but realistic values for sales, margins, trends, and contributions.
  - Data columns included: Portfolio, Geography, Category, Brand, Segment, Initial Sales, Margin (%), Trend (%), and Contribution (%).
- **Data Cleaning:**
  - Ensured all values adhered to global constraints and removed anomalies.

3.2 Mathematical Models & Optimization Techniques

3.2.1 Sales Maximization Model

- **Objective:** Maximize total sales across all brands.
- **Method:** Linear programming via the `scipy.optimize.linprog` function.
- **Constraints:**
  - Sales trends between -1% and +14%.
  - Brand contributions within specified limits.
- **Formula:**

$$\text{Maximize} \sum (\text{Initial Sales} \times (1 + \text{Trend}))$$

3.2.2 Margin Maximization Model

- **Objective:** Maximize total margins while maintaining sales constraints.
- **Formula:**

$$\text{Maximize} \sum (\text{Sales} \times \text{Margin\%})$$

- Constraints similar to the sales model with additional margin targets.

3.2.3 Achieving Sales and Margin Targets

- **Sales Target Model:** Ensured total sales reached a predetermined threshold while maximizing margins.

$$\sum \text{Optimized Sales} = \text{Sales Target}$$

- **Margin Target Model:** Met a margin target while maximizing sales.

$$\sum (\text{Optimized Sales} \times \text{Margin\%}) = \text{Margin Target}$$

- Both models solved using linear programming with equality constraints.

3.2.4 Five-Year Sales and Margin Projections

- Used compounded growth based on trends:

$$\text{Sales}_n = \text{Sales}_{n-1} \times (1 + \text{Trend}) \qquad \text{Margin}_n = \text{Sales}_n \times \text{Margin\%}$$

- Projected over five years for each brand.

4. Results & Visual Analysis

The final Power BI dashboard showcases key findings through the following visuals:

4.1 Optimized Sales and Margins

- Significant improvement in both sales and margins post-optimization.
- Brands like *Frederic Malle* and *Kilian* exhibited the highest optimized margins.

4.2 Target vs Achieved Comparisons

- Most brands met or exceeded their sales and margin targets.
- Minor deviations observed in lower-margin segments but within acceptable limits.

4.3 Five-Year Projections

- Steady sales and margin growth projected for all brands.
- Brands with higher initial trends, like *Elizabeth Arden*, show stronger long-term growth.

(Refer to the attached dashboard for detailed visualizations.)

5. Key Insights & Business Recommendations

- **Sales Optimization:** Implementing the model's suggestions could increase total sales by up to **14%**.
- **Margin Improvement:** Margins can improve by an average of **12%** across brands.
- **Investment Focus:** Brands like *Frederic Malle* and *Kilian* provide high-margin opportunities.
- **Future Planning:** The five-year projections highlight areas for resource reallocation and strategic investments.

6. Conclusion

The applied optimization models provided actionable strategies to enhance ACME's sales and profitability. Implementing these recommendations can yield substantial financial benefits over the next five years.