Project Report: ACME Sales Forecasting Model

Github Link: https://github.com/Shiva250503ss/Acme_Product_Analysis

Executive Summary

ACME is focused on enhancing its ability to predict sales across various markets scientifically. This project involves the development of a sophisticated algorithm that can forecast sales under different scenarios, considering multiple constraints at various levels of the company's hierarchy. This tool will aid in strategic decision-making, allowing ACME's leadership to set realistic growth targets based on data-driven insights.

Problem Statement

ACME needs a robust predictive model that can accurately forecast sales across its diverse product lines and market segments. The challenge is to build a model that not only predicts these sales with high accuracy but also incorporates various internal constraints and market dynamics. These predictions must align with the hierarchical structure of ACME, ranging from individual segments up to the portfolio level.

Objectives

1. Generate a Synthetic Dataset: Create a synthetic dataset that mimics the structure and constraints of ACME, providing a realistic foundation for algorithm testing.

2. Develop Sales Maximization Scenarios: Construct scenarios where the algorithm seeks to maximize sales within the set constraints.

3. Optimize for Margin: Adjust the model to also focus on maximizing profit margins, not just sales.

4. Target Achievement Modules: Create model outputs that show how set sales or margin targets can be achieved, while also optimizing for the other metric.

5. Long-term Forecasting: Enable the model to make projections over a five-year period, allowing for annual adjustments in constraints.

Company Structure

ACME is organized into several hierarchical levels:

- Portfolio
- Geography
- Category
- Brand
- Segment

Each level has distinct units with specific data points such as sales, margin, trends, and contributions. The sum of the segment-level data aggregates up to the brand level and subsequently up through the higher levels to the portfolio.

Definitions and Constraints

- Sales: Total sales for each unit.
- Margin: Profit margin for each unit.
- Trend: Expected growth rate for each unit, which can be positive or negative.
- Contribution: Percentage contribution of each unit to its respective category.
- Constraints: Minimum and maximum limits for trend growth and contributions within each segment.

Methodology

1. Data Preparation:
   - Generate a synthetic dataset reflecting the real structure and operational constraints of ACME.
   - Include realistic sales and margin figures, along with varying constraints for different scenarios.

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Sample of generated dataset:
                         Portfolio        Geography          Category  \
0                        Hair/APDO             Asia              Tools
1                        Hair/APDO    South America     Face Make-Up
2                        Hair/APDO           Europe              Tools
3                        Skin/Body    North America    Make Up Brushes
4                        Hair/APDO    South America         Hair Dye
5    Fragrance + Color Cosmetics           Europe     Face Make-Up
6                        Hair/APDO    South America              Tools
7    Fragrance + Color Cosmetics           Europe         Hair Dye
8                        Hair/APDO             Asia    Make Up Brushes
9    Fragrance + Color Cosmetics             Asia    Make Up Brushes

              Brand      Segment   Initial Sales   Margin %   Min Trend %  \
0           Balmain    Fragrance         2734489         50            -5
1           Balmain    Fragrance         1739911         33            -5
2    Frederic Malle      Bronzer         3844769         59            -3
3    Frederic Malle    Fragrance         1417040         41            -3
4       Bobbi Brown      Bronzer         2000942         45            -1
5       Bobbi Brown      Bronzer         2928388         54            -1
6            Kilian      Mascara         3916664         33            -5
7            Kilian      Mascara         2325665         50            -5
8             Aveda        Toner         2370928         43            -5
9    Frederic Malle      Mascara          771836         33            -3
...
8                15                         5                   30
9                 4                         5                   40
```

2. Model Development:
   - Use statistical and machine learning techniques to develop a model that predicts sales and margin based on the input constraints.
   - Ensure the model adheres to the hierarchical data aggregation structure of ACME.

3. Scenario Testing:
   - Test the model across different predefined scenarios to evaluate its effectiveness in various operational settings.
   - Adjust the model parameters based on the outputs to align with ACME's strategic goals.

4. Optimization:
   - Implement optimization algorithms to find the best mix of product sales and margins that maximize overall revenue or profit.
   - Develop a user interface that allows executives to input different target scenarios and view the potential outcomes.

5. Projection and Adjustment:
   - Enable the model to forecast sales and margins over a five-year period.
   - Provide functionality to adjust constraints annually based on changing market conditions and internal strategy shifts.

Output Screenshots:

Maximize Sales:


```
Total Maximum Sales Achievable: $2,853,990,961.86
The achievable sales meet/exceed the expected sales by $1,853,990,961.86.

Optimized Results (first 5 rows):
   Portfolio      Geography           Category        Brand    Segment  Initial_Sales  New_Sales  Margin (%)  Applied_Trend (%)  Contribution (%)  Min_Trend  Max_Trend  Min_Contribution
0  Hair/APDO          Asia               Tools      Balmain  Fragrance        2734489  3144662.4          50          15.000002         15.799760          0         15                 4
1  Hair/APDO  South America       Face Make-Up      Balmain  Fragrance        1739911  2000897.7          33          15.000003         10.198746          0         15                 4
2  Hair/APDO        Europe               Tools  Frederic Malle  Bronzer      3844769  3998559.8          59           4.000001         46.999958         -3          4                 4
3  Skin/Body  North America  Make Up Brushes  Frederic Malle  Fragrance     1417040  1473721.6          41           4.000000         13.951869         -3          4                 5
4  Hair/APDO  South America            Hair Dye   Bobbi Brown    Bronzer     2000942  2060970.3          45           3.000002         17.367500         -1          3                 7

Results have been saved to 'Optimized_Sales_Results.csv'.
```

Maximize Origin:


```
Total Maximized Margin: $1,305,233,348.23
Great news! The optimized margin meets/exceeds your target by $1,305,183,348.23.

Optimized Results (first 10 rows):
                      Portfolio       Geography          Category  \
0                     Hair/APDO            Asia             Tools
1                     Hair/APDO   South America      Face Make-Up
2                     Hair/APDO          Europe             Tools
3                     Skin/Body   North America  Make Up Brushes
4                     Hair/APDO   South America          Hair Dye
5  Fragrance + Color Cosmetics          Europe      Face Make-Up
6                     Hair/APDO   South America             Tools
7  Fragrance + Color Cosmetics          Europe          Hair Dye
8                     Hair/APDO            Asia  Make Up Brushes
9  Fragrance + Color Cosmetics            Asia  Make Up Brushes

            Brand    Segment  Initial_Sales   New_Sales  Margin (%)  \
0         Balmain  Fragrance        2734489  3144662.40          50
1         Balmain  Fragrance        1739911  2000897.70          33
2  Frederic Malle    Bronzer        3844769  3998559.80          59
3  Frederic Malle  Fragrance        1417040  1473721.60          41
4     Bobbi Brown    Bronzer        2000942  2060970.30          45
5     Bobbi Brown    Bronzer        2928388  3016239.60          54
6          Kilian    Mascara        3916664        0.00          33
...
8               4                 30
9               5                 40

Detailed results have been saved to 'Optimized_Margin_Results.csv'.
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```

Hit A Sales Target While Maximizing Margin:

```
Sales Target: $5,000,000,000,000.00
Total Achieved Margin: $1,305,233,346.16

Optimized Results (first 10 rows):
                      Portfolio     Geography          Category  \
0                     Hair/APDO          Asia             Tools
1                     Hair/APDO South America     Face Make-Up
2                     Hair/APDO        Europe             Tools
3                     Skin/Body North America  Make Up Brushes
4                     Hair/APDO South America         Hair Dye
5  Fragrance + Color Cosmetics        Europe     Face Make-Up
6                     Hair/APDO South America            Tools
7  Fragrance + Color Cosmetics        Europe         Hair Dye
8                     Hair/APDO          Asia  Make Up Brushes
9  Fragrance + Color Cosmetics          Asia  Make Up Brushes

            Brand    Segment  Initial_Sales   New_Sales  Margin (%)  \
0         Balmain  Fragrance       2734489   3144662.40          50
1         Balmain  Fragrance       1739911   2000897.70          33
2  Frederic Malle    Bronzer       3844769   3998559.80          59
3  Frederic Malle  Fragrance       1417040   1473721.60          41
4     Bobbi Brown    Bronzer       2000942   2060970.30          45
5     Bobbi Brown    Bronzer       2928388   3016239.60          54
6          Kilian    Mascara       3916664         0.00          33
...
8                        4              30
9                        5              40

Detailed results saved to 'HitSalesTarget_MaxMargin_Results.csv'.
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Hit A Margin Target While Maximizing Sales:

```
Requested Minimum Margin: $34,355,555.00
Optimized Total Sales:    $2,853,990,957.36
Achieved Total Margin:    $1,305,233,346.16

Optimized Results (first 10 rows):
                      Portfolio     Geography          Category  \
0                     Hair/APDO          Asia             Tools
1                     Hair/APDO South America     Face Make-Up
2                     Hair/APDO        Europe             Tools
3                     Skin/Body North America  Make Up Brushes
4                     Hair/APDO South America         Hair Dye
5  Fragrance + Color Cosmetics        Europe     Face Make-Up
6                     Hair/APDO South America            Tools
7  Fragrance + Color Cosmetics        Europe         Hair Dye
8                     Hair/APDO          Asia  Make Up Brushes
9  Fragrance + Color Cosmetics          Asia  Make Up Brushes

            Brand    Segment  Initial_Sales   New_Sales  Margin (%)  \
0         Balmain  Fragrance       2734489   3144662.40          50
1         Balmain  Fragrance       1739911   2000897.70          33
2  Frederic Malle    Bronzer       3844769   3998559.80          59
3  Frederic Malle  Fragrance       1417040   1473721.60          41
4     Bobbi Brown    Bronzer       2000942   2060970.30          45
5     Bobbi Brown    Bronzer       2928388   3016239.60          54
...
8                        4              30
9                        5              40

Results saved to 'HitMarginTarget_MaxSales_Results.csv'.
Output is truncated. View as a scrollable element or open in a text editor. Adjust cell output settings...
```

Projections for Each Year Over a 5 Year Period

```
--- 5-Year Projection Sample ---
   Year  Portfolio      Geography        Category         Brand   Segment  \
0     1  Hair/APDO           Asia            Tools       Balmain  Fragrance
1     1  Hair/APDO  South America     Face Make-Up        Balmain  Fragrance
2     1  Hair/APDO         Europe            Tools  Frederic Malle   Bronzer
3     1  Skin/Body  North America  Make Up Brushes  Frederic Malle  Fragrance
4     1  Hair/APDO  South America         Hair Dye     Bobbi Brown   Bronzer

   Initial_Sales  New_Sales  Margin (%)  Applied_Trend (%)  Contribution (%)  \
0      2734489.0  3144662.4          50          15.000002         15.799760
1      1739911.0  2000897.7          33          15.000003         10.198746
2      3844769.0  3998559.8          59           4.000001         46.999958
3      1417040.0  1473721.6          41           4.000000         13.951869
4      2000942.0  2060970.3          45           3.000002         17.367500
...
1              0         15           4                 30
2             -3          4           4                 30
3             -3          4           5                 40
4             -1          3           7                 14
Output is truncated. View as a scrollable element or open in a text editor. Adjust cell output settings...
```

Expected Deliverables

- A fully functional sales forecasting tool.
- Detailed documentation on model usage and scenario adjustments.
- A comprehensive report outlining model performance across various tests.
- All updated Values has been stored in a new CSV

Conclusion

The ACME Sales Forecasting Model is designed to empower the leadership team with data-driven insights, facilitating more informed decision-making regarding future sales strategies and market positioning. By integrating detailed sales predictions aligned with strategic constraints, ACME can better navigate market dynamics and optimize for both growth and profitability.