1. Leveraging Mathematical Modeling for Marketing Campaign Optimization

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Project Overview:
In today's competitive business landscape, effective marketing campaigns are crucial for driving growth. However, determining the optimal allocation of resources across various marketing channels remains a complex challenge. This research initiative aims to develop a sophisticated mathematical model to optimize marketing budget distribution, with the goal of maximizing return on investment (ROI) while adhering to various operational constraints.

Key considerations:
Our research will focus on creating a comprehensive linear programming model that takes into account multiple factors affecting marketing campaign performance. Key considerations include:

1. Financial limitations of the overall marketing budget
2. Expenditure associated with individual marketing platforms
3. Potential audience reach for each marketing avenue
4. Efficacy of different channels in achieving desired outcomes
5. Restrictions on minimum and maximum spending per channel
6. Requirements for reaching specific demographic or geographic segments

Data Requirements:
To ensure the robustness and real-world applicability of our model, we will utilize a diverse dataset comprising:
- Historical performance metrics from major digital advertising platforms
- Comprehensive data on past marketing initiatives, including expenditure, reach, and ROI metrics

Data sources -
https://www.kaggle.com/datasets/jsonk11/social-media-advertising-dataset
https://www.kaggle.com/datasets/sinderpreet/analyze-the-marketing-spending
https://www.kaggle.com/datasets/manishabhatt22/marketing-campaign-performance-dataset

* Supplementary synthetic data to address any gaps in real-world information

Methodological Framework:

At the core of our approach lies a linear programming model designed to optimize marketing budget allocation. This model will incorporate:

Variables:

1. **Budget Allocation**:
    - x_i: Budget for marketing channel i
2. **Parameters**:
    - B: Total marketing budget.
    - c_i: Cost per unit on channel i
    - r_i: Audience reach per unit on channel i
    - e_i: ROI for channel i
    - L_i: Minimum spending on channel i
    - U_i: Maximum spending on channel i
    - D_j: Minimum audience reach for segment j

Objective:

- **Maximize ROI**: Sum of (ROI * budget) across all channels.

Constraints:

1. **Budget**: Total spending across channels ≤ Total budget.

2. **Spending Limits**: Budget for each channel between minimum and maximum limits.

3. **Audience Reach**: Total audience reach across channels ≥ Minimum reach for each segment.

Potential Challenges:
We anticipate several key challenges in developing this model:
1. Acquiring accurate and comprehensive real-world data
2. Capturing the nuanced relationships between marketing spend and outcomes within a linear framework
3. Accounting for the dynamic nature of marketing effectiveness across different channels

2. Supply Chain Optimization for a FMCG Company

Team Member names:

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Brief Description of the Problem:

In the fast-moving consumer goods (FMCG) sector, efficient supply chain management is crucial for maintaining profitability and meeting customer demand. This project aims to develop a mathematical model to optimize the supply chain of a leading FMCG company specializing in instant noodles. Using the provided FMCG_data.csv dataset, we will analyze various factors influencing supply chain performance and devise strategies to minimize inventory costs and maximize overall profitability. Our model will address key challenges such as warehouse capacity constraints, transportation issues, and demand variability across different regions.

Data Sources:

The primary dataset for this project is [FMCG_data.csv](), which contains comprehensive information about the company's instant noodles business. The dataset includes the following columns:

- Ware_house_ID
- WH_Manager_ID
- Location_type
- WH_capacity_size
- zone
- WH_regional_zone
- num_refill_req_l3m
- transport_issue_l1y
- Competitor_in_mkt
- retail_shop_num
- wh_owner_type
- distributor_num
- flood_impacted
- flood_proof
- electric_supply
- dist_from_hub
- workers_num
- wh_est_year
- storage_issue_reported_l3m
- temp_reg_mach
- approved_wh_govt_certificate
- wh_breakdown_l3m
- govt_check_l3m
- product_wg_ton

This dataset offers valuable insights into the demand and supply dynamics within the instant noodles business.

Type of Model:
Mixed-Integer Linear Programming (MILP)

Approximate Count of Variables and Constraints:

- **Variables:**
  - Allocation of products to each warehouse
  - Transportation routes and quantities
  - Inventory levels at each warehouse
- **Constraints:**
  - Warehouse capacity limits (WH_capacity_size)
  - Transportation constraints (transport_issue_l1y, dist_from_hub)
  - Demand satisfaction for retail shops (retail_shop_num)
  - Regional distribution constraints (zone, WH_regional_zone)
  - Operational constraints (electric_supply, flood_proof, temp_reg_mach)
  - Regulatory compliance (approved_wh_govt_certificate, govt_check_l3m)
  - Workforce availability (workers_num)

<u>3. Price Optimization for a Multi-Category Retail Store</u>

Team Member Names:

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Brief Description of the Problem:
A multi-category retail store, similar to large department stores like Walmart or Target, sells a wide range of products including health items, beds, garden supplies, computers, furniture, watches, and perfumery. The store faces the challenge of setting optimal prices that maximize profitability while maintaining customer satisfaction and competitiveness. This project aims to develop a price optimization model using historical sales data to find the most appropriate prices for different products. The model will consider various factors such as demand, competition, seasonality, and customer behavior.

Data Sources:
The dataset for this project is sourced from Kaggle called [retail_price.csv]() and includes the following columns:

- **product_id:** Unique identifier for each product.
- **product_category_name:** Category to which the product belongs.
- **month_year:** Month and year of the sales record.
- **qty:** Quantity sold.
- **total_price:** Total sales price.
- **freight_price:** Cost of shipping the product.
- **unit_price:** Price per unit of the product.
- **product_name_lenght:** Length of the product name.
- **product_description_lenght:** Length of the product description.
- **product_photos_qty:** Number of photos of the product.
- **product_weight_g:** Weight of the product in grams.
- **product_score:** Customer rating of the product.
- **customers:** Number of customers who purchased the product.
- **weekday:** Indicates if the sale occurred on a weekday.
- **weekend:** Indicates if the sale occurred on a weekend.
- **holiday:** Indicates if the sale occurred on a holiday.
- **month:** Month of the sale.
- **year:** Year of the sale.
- **s:** Indicates seasonality.

- **volume:** Sales volume.
- **comp_1, comp_2, comp_3:** Prices of similar products offered by competitors.
- **ps1, ps2, ps3:** Competitor price scores.
- **fp1, fp2, fp3:** Freight prices for competitor products.
- **lag_price:** Previous price of the product.

This dataset provides comprehensive information necessary for conducting exploratory data analysis, data visualization, demand forecasting, and price optimization.

Type of Model:
Mixed-Integer Linear Programming (MILP)

Approximate Count of Variables and Constraints:

- **Variables:**
  - Prices for each product.
  - Demand forecasts for each product.
  - Competitor price indices.
  - Customer segment-specific pricing.
- **Constraints:**
  - Price elasticity constraints to ensure demand responsiveness.
  - Inventory balance constraints to avoid overstocking and understocking.
  - Seasonal and trend adjustments.
  - Competitor price matching or undercutting strategies.
  - Profit margin requirements.