Superstore Sales Optimization

BANA 630

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Phase 1 - Superstore Orders (2017-2020)

Optimize order fulfillment and shipment efficiency in the United States with a goal of maximizing profitability.

Known Variables:

- Shipping metrics
- Store attributes
- Financial metrics
- Customer Demographics
- Operational costs

Unknown Variables:

- Future demand
- Market dynamics
- Unforeseen disruptions

Objective function:

aims to maximize profitability by determining the most efficient combination of product categories, regions and customer segments.

Key constraints:

- Demand Trends
- Shipping Times
- Resource availability
- Market Variability

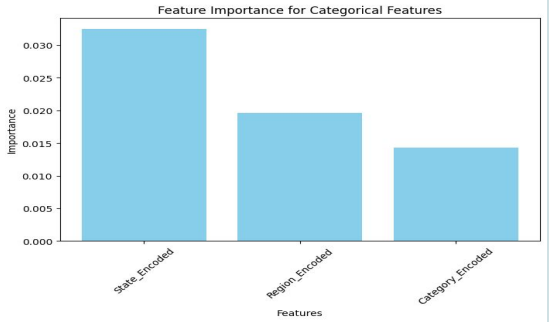
Phase 2: Predictive Analytics

Preprocessing Steps Taken:

- Feature Engineering
  - Days to Ship Difference
    - Days to Ship Actual - Days to Ship Scheduled
  - Categorize Profit Ratios
    - Loss, Low, Medium, High

Data Transformation:

- Categorical Variable Encoding
  - State, Region, Segment, Product Category
- Standardize Numerical Variables
  - Sales, Profit, Discount, Price

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Mapping for Segment:
{'Consumer': 0, 'Corporate': 1, 'Home Office': 2}

Mapping for State:
{'Alabama': 0, 'Arizona': 1, 'Arkansas': 2, 'California': 3, 'Color

Mapping for Region:
{'Central': 0, 'East': 1, 'South': 2, 'West': 3}

Mapping for Category:
{'Furniture': 0, 'Office Supplies': 1, 'Technology': 2}

Mapping for Sub-Category:
{'Accessories': 0, 'Appliances': 1, 'Art': 2, 'Binders': 3, 'Bookca
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	Sales	Profit	Discount	Price	Sales_Scaled	Profit_Scaled	\
0	16.0	6.0	20.0	8.00	-0.342894	-0.096391	
1	12.0	4.0	20.0	4.00	-0.349312	-0.104928	
2	273.0	-65.0	20.0	91.00	0.069432	-0.399437	
3	4.0	-5.0	80.0	2.00	-0.362147	-0.143342	
4	20.0	5.0	20.0	6.67	-0.336477	-0.100659	

	Discount_Scaled	Price_Scaled
0	0.211838	-0.370150
1	0.211838	-0.398128
2	0.211838	0.210391
3	3.117565	-0.412117
4	0.211838	-0.379453

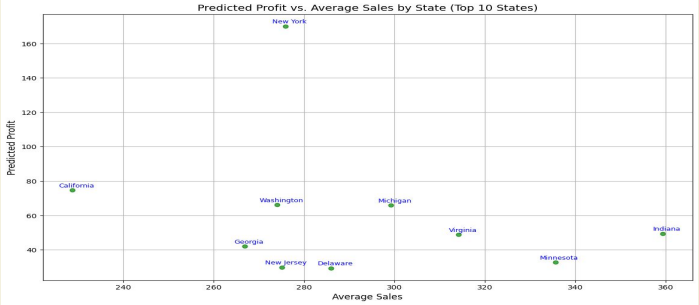
Phase 2: Predictive Analytics

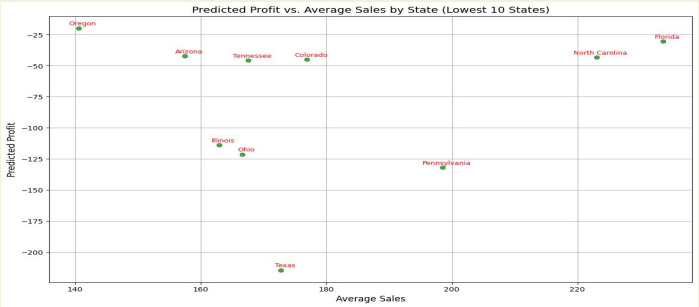
Predictive Model Development
X = Scaled Features + Categorical Encoded Features
Y= Profit_Scaled

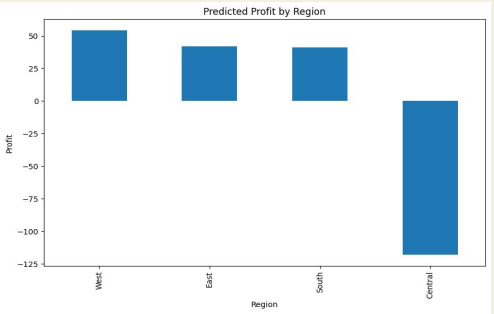
Models Selected:
- Random Forest Regression Model
- Hyperparameters tuned using GridSearchCV with a 5-fold cross-validation strategy

Validation Metrics:
- MSE: 1.057
- RMSE: 1.028
- R^2 (After GridSearch): 0.703

Recommendation for Phase 3:
- Focus on optimizing Region and Product Category distribution for Prescriptive Analysis
  - Where should the superstores prioritize which product categories?







Phase 3: Prescriptive Analytics

Linear Programming Model Development

- **Objective Function:**
  - Maximize annual Profit Across All Regions and Product Categories
- **Decision Variables:**
  - Quantity of items ordered in each product category within each region
- **Constraints:**
  - Product Category Allocation must not exceed the Estimated Annual Inventory**
  - Category Allocation by Region must not exceed historical distribution

***Original dataset did not specify inventory levels, so annual inventory for the next year was calculated based on a 12-month moving average*

Region	Product Category	Average Monthly Quantity	Average Monthly Orders	Average Quantity/Order	Average Category Price	Quantity to Sell (Decision Variable)	%Allocation by Category	Discount	Calculated Profit
Central	Furniture	152	40	4	$87.04	1,826	23%	10%	$143,053.82
	Office Supplies	451	119	4	$31.47	2,211	14%	10%	$62,613.17
	Technology	129	35	4	$107.91	0	0%	10%	$0.00
East	Furniture	184	50	4	$91.05	467	6%	15%	$36,116.10
	Office Supplies	538	143	4	$32.26	5,412	34%	14%	$150,124.89
	Technology	162	45	4	$135.38	6,454	93%	14%	$751,437.09
South	Furniture	107	28	4	$88.31	3,779	47%	12%	$293,667.31
	Office Supplies	315	83	4	$34.55	7,239	45%	17%	$207,611.47
	Technology	93	24	4	$124.05	482	7%	11%	$53,171.25
West	Furniture	225	59	4	$94.42	1,944	24%	13%	$159,709.74
	Office Supplies	603	158	4	$31.28	1,114	24%	9%	$31,722.01
	Technology	194	50	4	$114.28	0	24%	13%	$0.00
									$1,889,226.84

	Estimated Annual Quantity	Average Annual Quantity (Next Year Inventory)
Furniture	8,016	8,016
Office Supplies	15,976	22,884
Technology	6,936	6,936

Category	Region	Volume Allocation of Category by Region	%Allocation of Category by Region
Furniture	Central	1,826	23%
	East	2,211	28%
	South	1,284	16%
	West	2,695	34%
Office Supplies	Central	5,412	24%
	East	6,454	28%
	South	3,779	17%
	West	7,239	32%
Technology	Central	1,546	22%
	East	1,944	28%
	South	1,114	16%
	West	2,332	34%

Phase 3: Prescriptive Analytics

Sensitivity Analysis

Central

East

South

West

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
H3	Furniture Quantity to Sell (Decision Variable)	1826	0.95	78.34	1E+30	0.95
H4	Office Supplies Quantity to Sell (Decision Variable)	2211	28.32	28.32	1E+30	28.32
H5	Technology Quantity to Sell (Decision Variable)	0	-13.28	97.12	13.28	1E+30
H6	Furniture Quantity to Sell (Decision Variable)	467	0.00	77.39	0.32	77.39
H7	Office Supplies Quantity to Sell (Decision Variable)	5412	27.74	27.74	1E+30	27.74
H8	Technology Quantity to Sell (Decision Variable)	6454	6.02	116.42	1E+30	6.02
H9	Furniture Quantity to Sell (Decision Variable)	3779	0.32	77.71	1E+30	0.32
H10	Office Supplies Quantity to Sell (Decision Variable)	7239	28.68	28.68	1E+30	28.68
H11	Technology Quantity to Sell (Decision Variable)	482	0.00	110.40	6.02	10.98
H12	Furniture Quantity to Sell (Decision Variable)	1944	4.76	82.14	1E+30	4.76
H13	Office Supplies Quantity to Sell (Decision Variable)	1114	28.47	28.47	1E+30	28.47
H14	Technology Quantity to Sell (Decision Variable)	0	-10.98	99.42	10.98	1E+30

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
D18	Furniture Estimated Annual Quantity	8016	77.39	8016	2227.97	466.69
D19	Office Supplies Estimated Annual Quantity	15976	0.00	22884	1E+30	6908.18
D20	Technology Estimated Annual Quantity	6936	110.40	6936	1064.17	481.62

Conclusion & Learnings

- Central and West Technology not included in optimization solution to fulfill orders and maximize profits.
- Shadow Prices for Furniture and Technology would increase our optimal solution by their respective unit increase.
- Superstore should focus their efforts for each region and product category
- Dataset was limited so we had to create a scenario that could reflect real world plausibility
- Company needs to keep an eye out on giving discounts to regions that already have lower product category prices