Case 7 - End-to-End Analytics at Rue La La (Part II)

Assignment 7

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Price Optimization

1. Linear Regression vs Regression Tree

i. Train Test Split

```
prediction_data <- df[, 2:17]
set.seed(19)
index <- createDataPartition(prediction_data$price, p = 0.8, list = FALSE)
train_data <- prediction_data[index, ]
test_data <- prediction_data[-index, ]
```

ii. Regression Trees

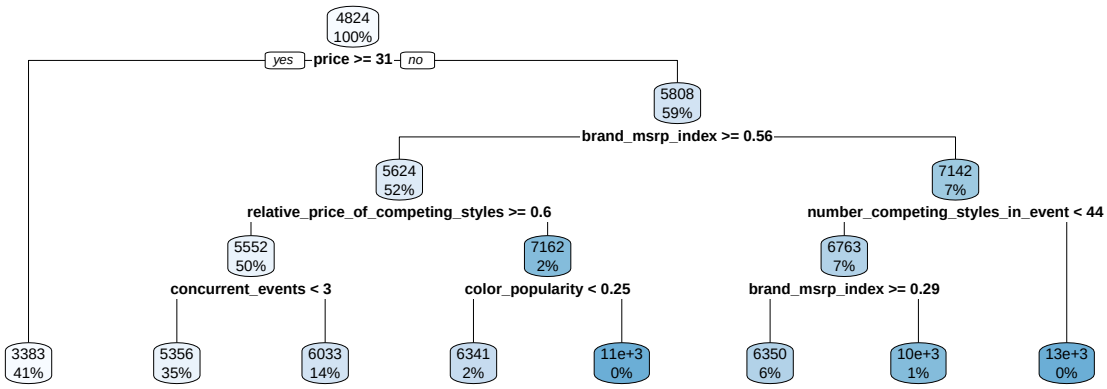

Figure 1: Regression Tree of Training Data

iii. Linear Regression

Table 1: Regression Model Coefficients

term	estimate
(Intercept)	12190
price	-218
beginning_of_season	97
weekend	34
event_length	377
morning	-627

iv. MSE Comparison

Table 2: MSE for Predicted Values

MSE Linear Regression	MSE Regression Tree
2,685,391	2,366,873

Conclusion:

The MSE for Regression Tree predictions is lower, and therefore performs significantly better.

2. Optimal Price

$$\text{Max} \sum_{i \in N} \sum_{j \in M} p_j \widehat{D}_{ijk} x_{ij}$$

$$\text{s.t}$$

$$\sum_{j \in M} x_{ij} = 1 \quad \forall i \in N$$

$$\sum_{i \in N} \sum_{j \in M} p_j x_{ij} = k$$

$$x_{ij} \in \{0, 1\}$$

i. Defining the list of prices

ii. Preparing variables

iii. Possible k values

iv. Initializing model

v. Solving the model for Regression Trees

Table 3: Optimal Price Solutions for Regression Tree

									Objectives
1	0	0	1	0	0	1	0	0	426,569
1	0	0	0	1	0	1	0	0	458,319
0	1	0	0	1	0	1	0	0	485,101
0	1	0	0	1	0	0	1	0	511,882
0	0	1	0	1	0	0	1	0	469,608
0	0	1	0	1	0	0	0	1	427,333
0	0	1	0	0	1	0	0	1	355,242

vi. Initializing model for Linear Regression

vii. Solving the model for Linear Regression

Table 4: Optimal Price Solutions for Linear Regression Model

									Objectives
1	0	0	1	0	0	1	0	0	506,025
0	1	0	1	0	0	1	0	0	507,037
0	1	0	0	1	0	1	0	0	508,058
0	1	0	0	1	0	0	1	0	509,117
0	0	1	0	1	0	0	1	0	499,314
0	0	1	0	0	1	0	1	0	489,424
0	0	1	0	0	1	0	0	1	479,504

Conclusion:

The optimal price is not changing between the two models. However since the predicted demand is different, the revenue is maximized for the linear regression model.

3. Optimal Prices with Assumptions

Constraints:
1. Items B & C cannot be sold for $35
2. Item A cannot be sold for $25

i. Defining the list of prices

ii. Preparing variables

iii. Possible k values

iv. Initializing model

v. Solving the model for Regression Trees with the assumptions

Table 5: Optimal Price Solutions for Regression Tree with Constraints

						Objectives2
1	0	0	1	1	0	485,101
1	0	0	1	0	1	511,882
0	1	0	1	0	1	469,608
1	0	1	0	0	1	480,131

Conclusion:

The objective value is equal to 511,882.