ISYE 6501, Week 14 HW

Question 1

Describe analytics models and data that could be used to make good recommendations to the retailer. How much shelf space should the company have, to maximize their sales or their profit?

Response –

The problem statement is to identify what data is needed, which models will be used and what results are to be analyzed for a retailer to maximize the sales or profits by better utilizing shelf space for a product.

1. Data

The data required for assessing the profits with shelf space utilization is –

- Sales data
- Sales history
- Inventory history (provides shelf space usage history)
- Total shelf space in stores
- Minimum shelf space required for a product
- Maximum shelf space allowed for a product

2. Models

The retailer assumes the following hypotheses –

1. More shelf space facilitates more sales
2. More sales of a product results in more sales of a complementary product
3. If complementary products are placed together, the sales will be higher

Multiple analytical models are required for this problem. The important aspects of the problem that are worth modeling are listed below.

- Extra sales with different amounts of shelf space
- A/B testing or Change detection model
    - Remove seasonality and trend using exponential smoothing
    - Factor based regression model to remove demographic effects
- Louvain algorithm for paired product sales using community-finding model
- Optimization to assign an amount of shelf space to each product type, to maximum total sales of profit
- Optimization to select the location in the store to maximize the profit

2.1. Hypothesis 1 testing

To analyze the effect of shelf space on the sales of a particular product, data can be acquired by varying the shelf usage in different stores and collect the sales data. Change detection model can be used to capture the change occurring in sales due to varied shelf space. Since the data is generated from

different stores, which in turn differ in location, type of customers and other demographical variations, seasonality and trend patterns in data can be removed using exponential smoothing. To remove the demographic effects, factor based regression model can be used. This final model will help in evaluating whether having more shelf space boosts the sales of the products

2.2. Hypothesis 2 testing

Hypothesis 2 testing can be done by categorizing the products into complementary products and statistical hypothesis testing can provide whether more sales of a product impacts the sales of a complementary product.

A/B testing can also be done to study the impact of sales on complementary products

2.3. Hypothesis 3 testing

Louvain algorithm can be used to analyze the complementary product sales to find the complementary products that should be placed close to each other. Optimization model can be used to assign the amount of shelf space to be allotted to each product type, to maximize the total sales. Further optimization can also be done to select the shelf spaces in the store for placement of the products.

A flow chart is shown in the following page to summarize the methodology explained above.

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┌─────────────────────┐                                    ┌──────────────────────────┐
│     Collect Data     │                                    │  Louvain algorithm to find the  │
└──────────┬──────────┘                                    │  clusters of complementary       │
           │                                                │  products to be placed           │
           ▼                                                │  together                        │
┌─────────────────────┐                                    └────────────┬─────────────┘
│ Change detection model to │                                           │
│ analyze the impact of shelf│                                          ▼
│     space on sales    │                                    ┌──────────────────────────┐
└──────────┬──────────┘                                    │  Optimization model to     │
           │                                                │  determine the shelf space to│
    ┌──────┴───────┐                                        │  be assigned maximize sales │
    ▼              ▼                                         └────────────┬─────────────┘
┌──────────┐  ┌──────────────┐                                           │
│ Exponential │  │ Factor based   │                                      ▼
│ smoothing to│  │ regression model│                          ┌──────────────────────────┐
│ remove effects│ │ to remove      │                          │  Optimization model to    │
│ of seasons   │  │ demographic    │                          │  select the location of   │
│ and trends   │  │ effects        │                          │  shelfs for the products  │
└──────┬──────┘  └───────┬──────┘                             │  to be placed             │
       │                 │                                     └──────────────────────────┘
       └────────┬────────┘
                ▼
       ┌──────────────────┐
       │ Model which shows │
       │ the effects of shelf│
       │  space on sales   │
       └─────────┬────────┘
                 ▼
       ┌────────────────────────┐
       │ Hypothesis testing to find│
       │  the products that are    │
       │ complementary to each other│
       └────────────────────────┘
```
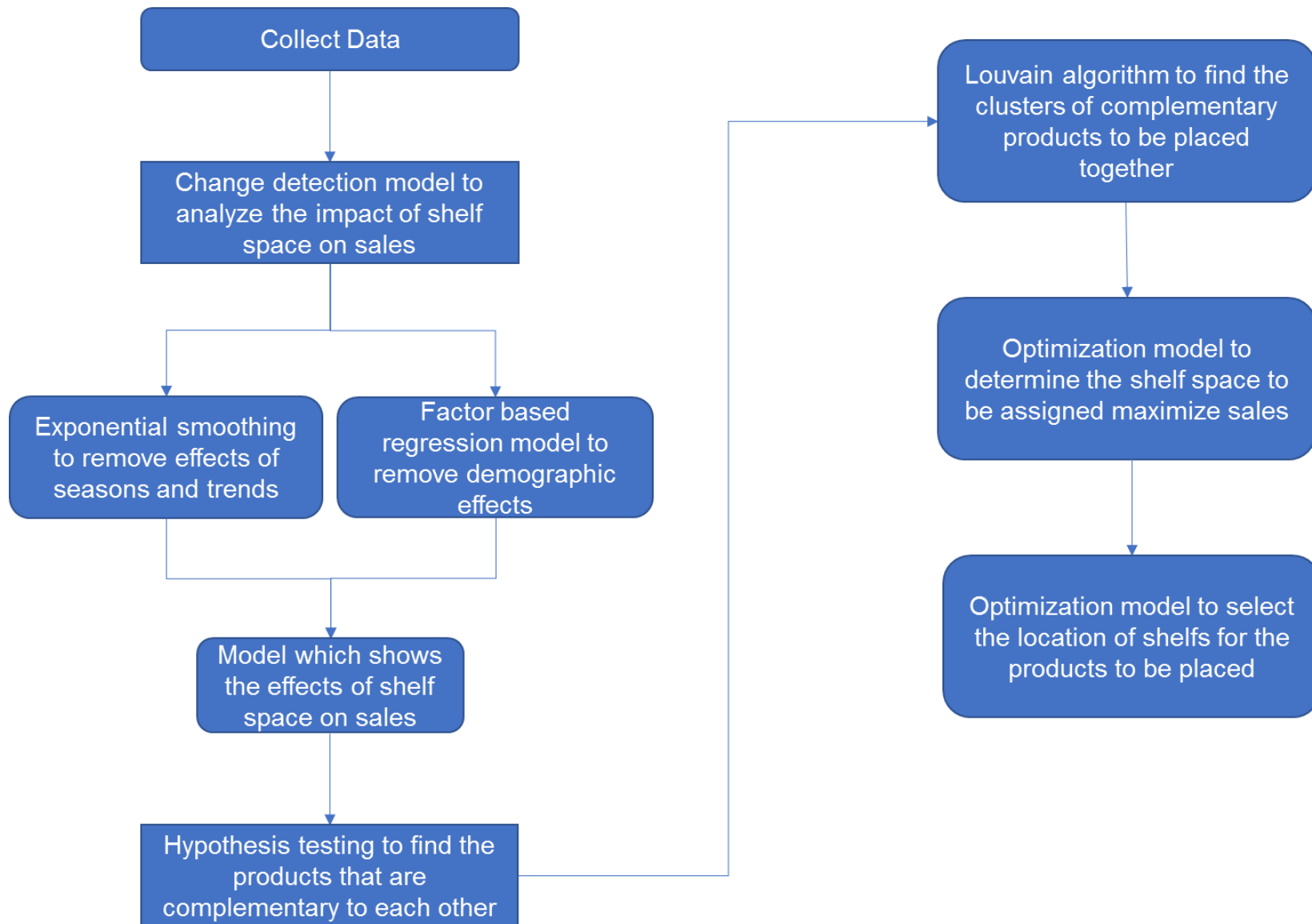
Figure 1 Flowchart for retailer problem to identify the effect of shelf space usage for maximum sales