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Evaluation & Conclusion

### SALADSTOP

- First and largest healthy food chain in Asia
- Full access to the nutritional facts, serving portions and carbon footprint information
- Create Your Own Salad Menu contains a selection of:
  - 4 different greens bases
  - 4 wraps
  - o 2 grain bowls
  - 57 toppings
  - o 19 dressings





# PROBLEM 1: SELECTION OF SALAD INGREDIENTS



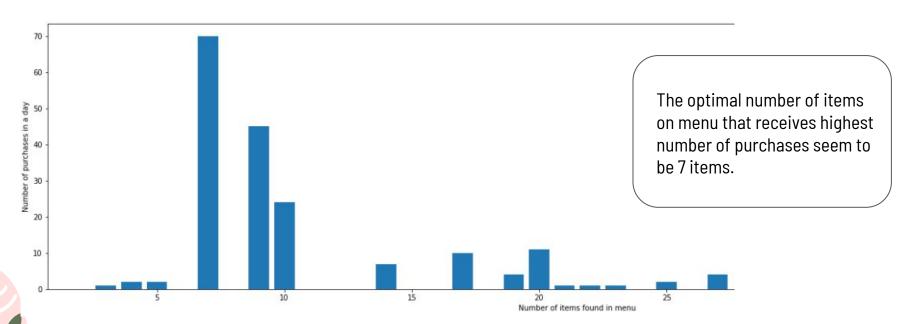
#### **Customer Pain Points**

- Large number of 87 ingredients to pick from
- Customers face difficulty making the most optimum choice based on their own requirements
- Some customers will also have specific dietary and allergy requirements to consider

- Too much choices are given to their customers
- Computationally hard to come up with an order that truly matches their needs
   → given access to nutritional information by Salad Stop
- Short time frame of queuing and ordering

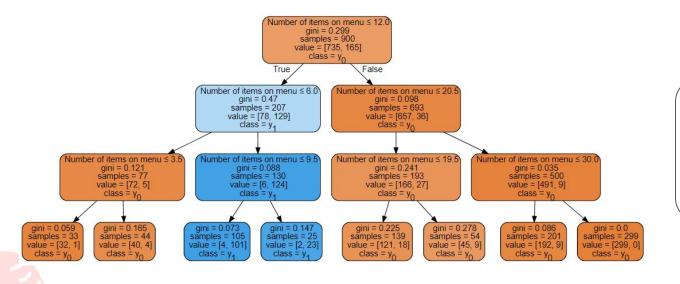












Probability of purchase is the highest when: 6 <= # menu options <= 12

Goodness of Fit of Model Classification Accuracy

Goodness of Fit of Model Classification Accuracy Train Dataset

: 0.947777777777778

Test Dataset : 0.94



# SOLUTION 1: SALAD LINEAR OPTIMIZER

# Satisfy customer needs

- Selected ingredients for the salad will meet customer's unique diet and nutritional needs
- Within customer's budget limit
- Consider other dietary requirements



# Provide fewer menu options

- Select the ingredients and come up with a few salad menu options
- Customers will not have to pick from all 87 ingredients
- Increase purchase probability and sales





#### Data:

We recorded the 87 ingredients from SaladStop!'s Create your Own web page.

- 2 standard bases
- 2 premium bases
- 4 wrap options
- 2 grain bowl options
- 34 standard toppings
- 24 premium toppings
- 19 types of salad dressings.

For each of the ingredients, we stored nutritional information such as:

- Serving size
- Calories
- Carbohydrates
- Protein
- Fat
- Sugar

#### We also noted if ingredients were:

- Vegan
- Vegetarian
- Gluten-free
- Containing nuts
- Containing dairy
- Spicy





#### **Model Objective:**

To minimize cost paid by customer while meeting the customers' input constraints.

- Aid customers in the presence of too many choices

model.min((9.9\*s + 11.9\*t + sum(x[i]\*data\_input["price"][i] for i in range(n) if data\_input["ingredient\_type"][i] in ['Premium Topping'])))

#### Variables:

Variable X - a binary variable to decide if the ingredient is to be included in the salad.

Variable S - a binary variable to decide if a salad should contain a standard salad base.

Variable T - a binary variable to decide if a salad should contain a premium salad base.



#### **User inputs:**

Nutritional preferences - Minimum and maximum of:

- Calories
- Carbohydrates
- Proteins
- Fat
- Sugar

#### Cost-related preferences:

- Budget
- Minimum amount of premium toppings

#### Dietary preferences:

- Vegan
- Vegetarian
- Gluten-free
- Nuts
- Dairy
- Spice

#### **Constraints:**

- 1. Ingredients with 0 quantity left will not be selected
- 2. Optimizer will select ingredients of the same category as the type of base selected.
- 3. Exactly **1** of **either** a standard or premium base is selected.
- 4. **Exactly 7** toppings will be selected unless the user elects to have more.
- 5. **Only 2** salad dressings will be included in the salad unless the user elects to have more.
- 6. The selection of the ingredients meets the nutritional requirements of the customer.
- 7. The selection of the ingredients meets the dietary requirements of the customer.
- 8. The number of premium toppings selected meet the requirements of the customer.
- 9. The total cost of the salad is within the customer's budget.





# Linear Model: Live Demo









#### **Person A's inputs:**

#### Nutritional preferences:

- Calories (kcals) [200, 600]
- Carbohydrates (g) [20, 120]
- Proteins (g) [10, 80]
- Fat (g) [5, 35]
- Sugars (mg)[10, 50]

#### Dietary preferences:

- Not vegan
- Not vegetarian
- Non Gluten-free
- Nuts
- No Dairy
- Can take spice

#### Cost-related:

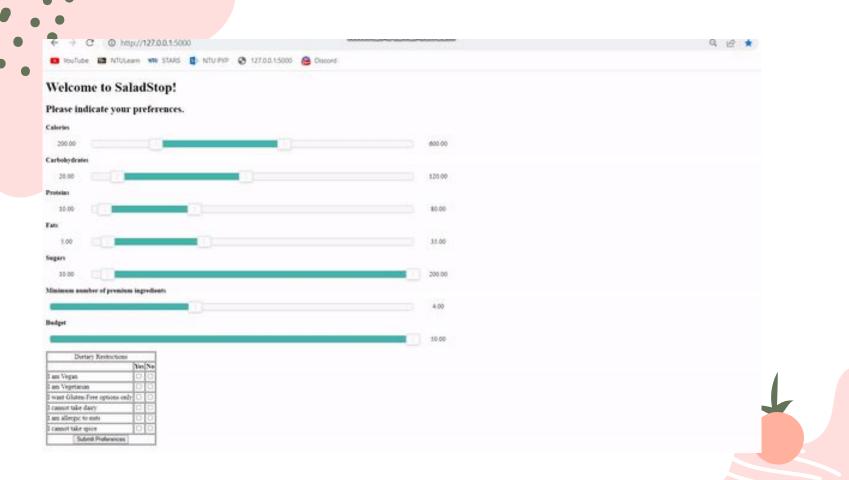
- Minimum premium ingredients = 4
- Budget = \$15

### Other results

#### Here's our recommendations based on your preferences









#### **Person B's inputs:**

#### Nutritional preferences:

- Calories (kcals) [100, 500]
- Carbohydrates (g)[0, 20]
- Proteins (g)[0, 90]
- Fat (g) [0, 20]
- Sugars (mg)[0, 200]

#### Dietary preferences:

- Not vegan
- Not vegetarian
- Gluten-free
- Nuts
- Dairy
- Can take spice

#### Cost-related:

- Minimum premium ingredients = 0
- Budget = \$18

### Other results

Here's our recommendations based on your preferences







#### **Person C's inputs:**

#### Nutritional preferences:

- Calories (kcals) [100, 250]
- Carbohydrates (g) [10, 40]
- Proteins (g)[10, 30]
- Fat (g) [0, 10]
- Sugars (mg)[0, 60]

#### Dietary preferences:

- Vegan
- Not vegetarian
- Gluten-free
- Nuts
- Dairy
- Cannot take spice

#### Cost-related:

- Minimum premium ingredients = 1
- Budget = \$15

### Other results

#### Here's our recommendations based on your preferences

Ingredients for your salad

Cauliflower Rice, Grain Bowl

Furikake, Standard Topping

Cucumber Pickles, Standard Topping

Lime Wedge, Standard Topping

Chickpeas, Standard Topping

Cherry Tomatoes, Standard Topping

Capsicum, Standard Topping

Beetroot, Standard Topping

Roasted Brussel Sprouts, Premium Topping

Japanese Miso, Dressing (Asian)

Smoked Pimento, Dressing (Western)

Your salad will cost: \$11.4





#### **Person D's inputs:**

#### Nutritional preferences:

- Calories (kcals) [200, 700]
- Carbohydrates (g) [20, 250]
- Proteins (g)[60, 250]
- Fat (g) [10, 50]
- Sugars (mg)[0, 200]

#### Dietary preferences:

- Not vegan
- Not vegetarian
- Non Gluten-free
- **No** Nuts
- No Dairy
- Cannot take spice

#### Cost-related:

- Minimum premium ingredients = 2
- Budget = \$30

### Other results

#### Here's our recommendations based on your preferences

Ingredients for your salad Cauliflower Rice, Grain Bowl Grated Eggs, Standard Topping Tofu, Standard Topping Soba Noodles, Standard Topping Black Beans, Standard Topping Chickpeas, Standard Topping Edamame, Standard Topping French Beans, Standard Topping Tandoori Chicken, Premium Topping Roasted Chicken, Premium Topping Cashew Mint, Dressing (Western) Smoked Pimento, Dressing (Western) Your salad will cost: \$14.9



# HOW THE LINEAR OPTIMIZATION MODEL HELPS SALAD STOP

### CUSTOMER-SIDE

Optimize the buying process for customers by fitting their preferences and requirements.

SaladStop! can expect higher customer satisfaction.



### BUSINESS-SIDE

Improve customer conversion rate as salad sales are more likely when customers are not overwhelmed by choices.

The increase in demand for salad then provides another opportunity for optimization - ingredient orders.





# Motivations - Changes in demand





Population tastes & preferences



Cost-efficient ingredients



### Solution - Machine Learning + Stochastic Optimisation

- We will first use machine learning in order to predict the amount of ingredients used in the future
- If we can forecasted demand of ingredients,
   Salad Stop will know roughly how much ingredients to order in the following month



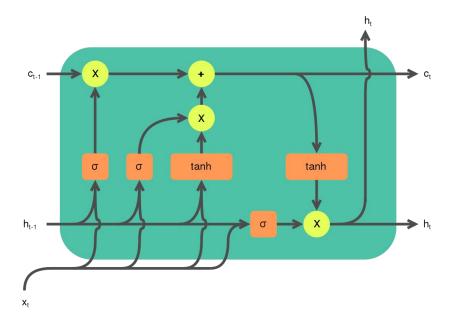




### Dataset

```
Import dataset and formatting
 ingredient demand = pd.read csv("../data/demand kaggle.csv", index col=0)
 # ingredient demand transform = ingredient demand.set index('Date')
 ingredient demand transform = ingredient demand
 ingredient demand transform.head()
         Red &
                                                                                                                              Mixed
                               Baby Wholemeal Spinach Tortilla Tomato Cauliflower
                                                                                            Cashew Classic Honey Lemon
                                                                                                                                           Salt &
                                                                                                                             Berries
         White Romaine Kale
                                                                                 Quinoa ...
                                                                            Rice
                             Spinach
                                          Wrap
                                                  Wrap
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  05
```

### Model Generation





### Model Limitation

Using the results from our LSTM model is insufficient given that it does not account for external factors such as the issue of space.

We will further need to optimise the results using a Stochastic Model, based on the multi-item newsvendor problem





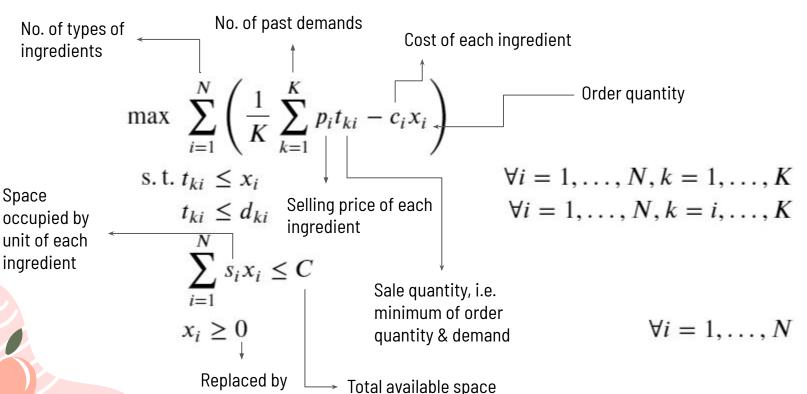


Ingredient	Red & White Cabbage	Romaine	Kale	Baby Spinach	Wholemeal Wrap	Spinach Wrap	Tortilla Wrap	Tomato Wrap	Cauliflower Rice	Quinoa	 Classic Caesar	Honey Dijor
COGS	0.53	1.86	3.75	0.56	0.99	1.4	0.79	0.67	1.47	1.01	 0.83	0.75
Ingredient_Type	Standard Base	Standard Base	Premium Base	Premium Base	Wrap	Wrap	Wrap	Wrap	Grain Bowl	Grain Bowl	 Dressing (Western)	Dressinç (Western
Additional_Price_For_Premium_Toppings	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	 NaN	NaN
Space	0.92	0.36	0.2	0.24	0.94	0.2	0.43	0.43	0.34	0.12	 0.97	0.95
Price	0.99	0.99	2.99	2.99	0.99	0.99	0.99	0.99	0.99	0.99	 0.99	0.99
Min_order	24	13	8	4	3	5	14	4	14	16	 13	15

6 rows × 88 columns







min\_order





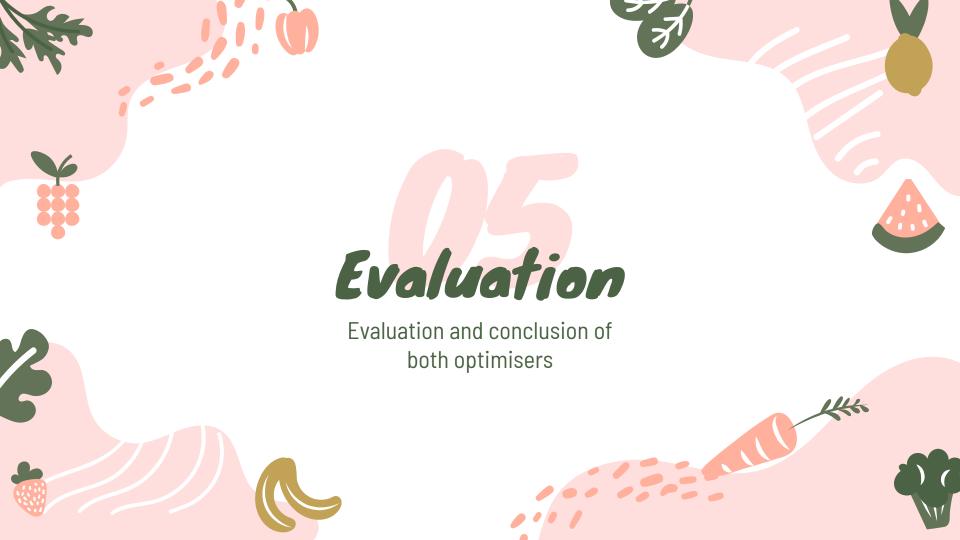
# Stochastic Model: Model Explanation











### Salad Choices

### Normal Order



Computationally hard to manually calculate calories and macronutrients





### Optimised order

More control over macronutrients and calories

No accidental inclusion of disliked preferences (Spicy, Vegan,

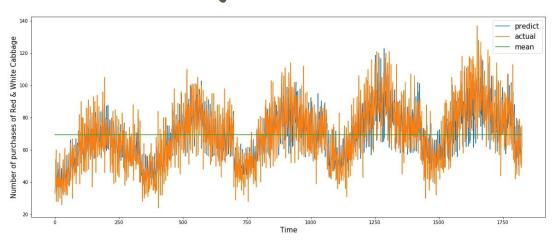
Vegetarian)

<u>Lowered costs</u> for Salad Stop

<u>Less control</u> over ingredients/ taste



# Quantity to Order



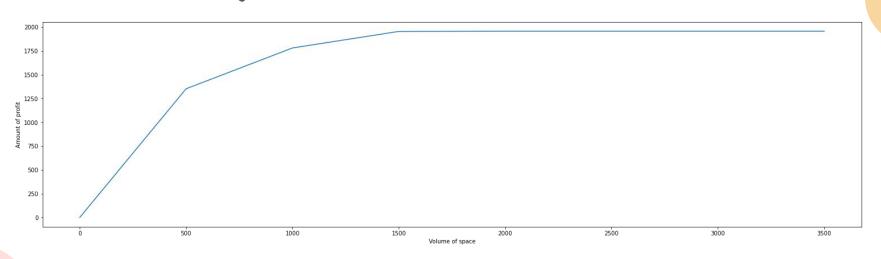
Validation set RMSE for all ingredients: 0.1337422397754162 Train set RMSE for all ingredients: 0.14023381946249544 Highly Accurate Prediction through the use of Neural Networks



Use of mean to repeatedly order the same amount every



# Quantity to Order





From this plot we have also observed that **profit plateaus once Space > 1500**Marginal Benefit once Space of store >1500

Ideal storage space of store should be at 1500 units



## Areas Of Improvement/ Expansion

### Use of Better Data

- Use of derived demand data
- Inaccuracies in the COGS

### Applicability of Models

- Salad Optimizer and Stock Optimizer can be used on other businesses directly; Subway, Wok/Pasta Express, Maki Sushi
- Potential use after modifications in other businesses to help lower costs and solve their own multiple newsvendor problem



### Constraints in model

 Inclusion of Carbon footprint of salad & Ingredients

### Sensitivity Analysis

- Finding shadow price of Salad Ingredients
- Inclusion of price differentiation based off customers' order

