Operations Research Final Project

What to Eat For Lunch

Group 8：

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Agenda

01 Topic

02 Problem Description

03 Data and Formulation

04 Solution

05 Suggestion

Topic

When you're trying to decide where to eat

Source: me.me

Problem Description

Factors

Price

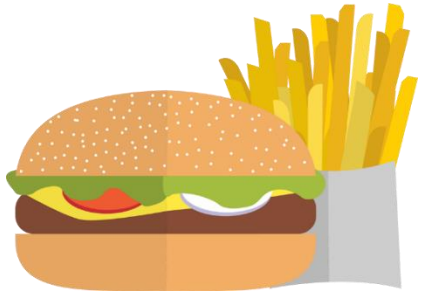
Time

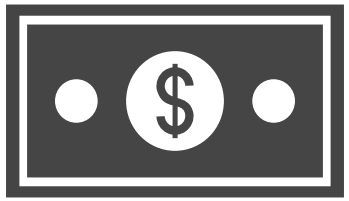
Days-off

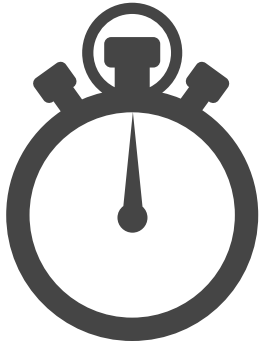
Frequency

Lunch appointments

The Objective







Food
Restaurant preferences.

Price
The amount of money saved

Time
The amount of time saved

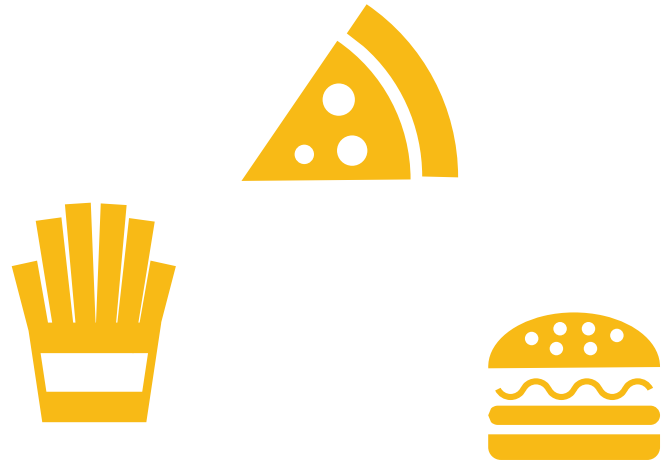
Goal: To maximize restaurant preferences + the amount of money saved + the amount of time saved

Data and Formulation

Data – Restaurant

We collected the information of 71 restaurants near NTU, including:

- The average price
- Days-off
- The average dining time
- The estimated traveling time



Also, we include a restaurant “None”

Data – Restaurant(Continued)

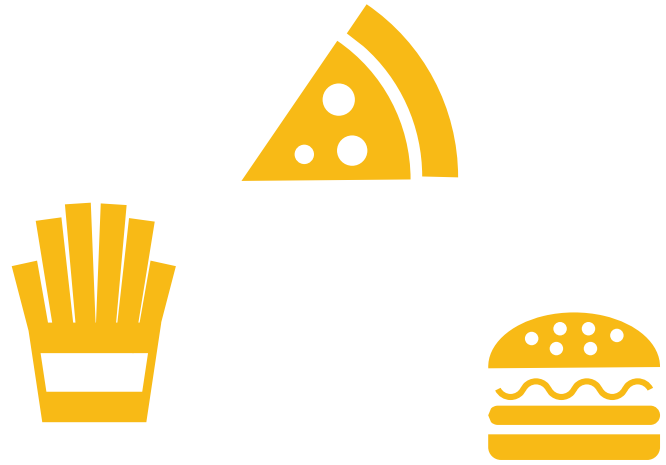
Name	Price	Days-off	Dining time	Traveling time*
鍋in	175	0	90	(4,5,6,3,7,6,6,5)
韓天閣	175	0	90	(4,5,6,3,6,6,7,4)
大埔鐵板燒	150	0	45	(4,5,6,3,7,6,6,5)
阿英滷肉飯	125	6	30	(4,4,4,4,4,6,8,3)
柒食貳	100	0	45	(4,4,4,4,4,6,7,3)
…	…	…	…	…

*(共同,普通,新生,管一,新體,社科院,男一,女一), accordingly

Data – Student

As for the information of the student, we need :

- Where his/her morning class ends
- Where his/her afternoon class begins
- Available time for lunch
- Monthly budget
- The willingness to pay



Data – Student(Continued)

Weekdays	Mon	Tue	Wed	Thu	Fri
Available Time(mins)	Unlimited	Unlimited	120	70	10
Class-ending Location	無	管一	管一	管一	普通
Class-beginning Location	無	無	管一	新生	新體

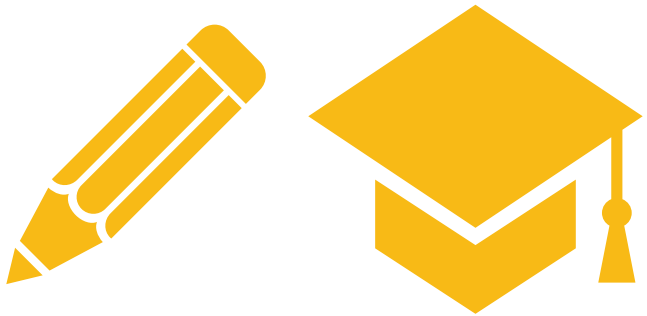
Name	Willingness to pay
鍋in	180
韓天閣	100
大埔鐵板燒	130
阿英滷肉飯	100
柒食貳	100
...	…

Budget(NTD/Month)
4000

Data – Student(Continued)

- We also consider whether the student will have a date with someone on some specific day.
- Usually, the restaurant will be decided beforehand.

- Ex. On date i the student has a date with his close friends at restaurant j, then the value of x_{ij} will be 1.



Variables

- $x_{ij} = 1$ if on date i restaurant j will be chosen, 0 otherwise.

Parameters

For restaurant:

- **Price** : R_j is the average price of restaurant j
- **Traveling time** : B_{jk} is the traveling time from location k to restaurant j
- **Days-off** : $O_{ij} = 1$ if on date i restaurant j will be open, 0 otherwise
- **Actual dining time** : $\mathrm{E_j}$ is the average dining time of restaurant j, based on historical data on google maps

Parameters(continued)

For student:

- **Class-ending location** : $S_{ik} = 1$ if on date i the student will finish his/her morning class at location k
- **Class-starting location** : $D_{ik} = 1$ if on date i the student will start his/her afternoon class at location k
- **Available time** : $\mathrm{T_i}$ is the available time for the student on date i, i.e. the time he/she have for a lunch break

Parameters(continued)

(continued)

- **Willingness to pay** : W_j is the price that the student is willing to pay for a meal of restaurant j
- **Budget** : M is the budget of the student (monthly)

Parameters(continued)

The others are:

- C_{i} is the number of weekdays on date i, 1 for Mondays, 7 for Sundays
- H is the basic hourly wage, in our model we set it to 158 NT dollars
- A is a constant used to calculate the decrease of willingness to pay

Notations

- i denotes date, from 1 to 31.
- j denotes the number of restaurants, from 1 to 71.
- k denotes the location where student have a class, from 1 to 9 (8 locations & no class).

Formulation

Objective Function → maximize total benefit

$$max \sum_{i=1}^{31}\sum_{j=1}^{71} x_{ij}(W_j - R_j) + (\mathrm{M} - \sum_{i=1}^{31}\sum_{j=1}^{71}(x_{ij}R_j)) - \sum_{i=1}^{31}\sum_{j=1}^{71}\sum_{k=1}^{9}(S_{ik} + D_{ik})B_{jk}x_{ij}H +$$

$$\sum_{i=1}^{31}\sum_{j=1}^{71} x_{ij}H(T_i - E_j) - A \times \frac{1}{2}(\sum_{j=1}^{71}((\sum_{i=1}^{31} x_{ij} - 1)(\sum_{i=1}^{31} x_{ij})))$$

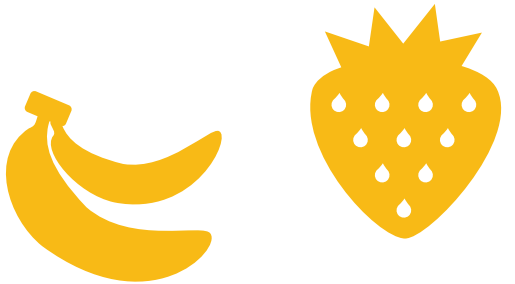
Formulation(continued)

Objective Function(1)

Willingness-to-pay – actual pay = customer surplus

$$max \sum_{i=1}^{31}\sum_{j=1}^{71} x_{ij}(W_j - R_j) + (\mathrm{M} - \sum_{i=1}^{31}\sum_{j=1}^{71}(x_{ij}R_j)) - \sum_{i=1}^{31}\sum_{j=1}^{71}\sum_{k=1}^{9}(S_{ik} + D_{ik})B_{jk}x_{ij}H +$$

$$\sum_{i=1}^{31}\sum_{j=1}^{71} x_{ij}H(T_i - E_j) - A \times \frac{1}{2}(\sum_{j=1}^{71}((\sum_{i=1}^{31} x_{ij} - 1)(\sum_{i=1}^{31} x_{ij})))$$



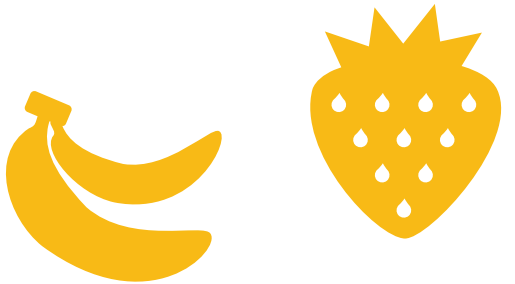
Formulation(continued)

Objective Function(2)

Budget – total actual pay = the money you saved

$$max \sum_{i=1}^{31}\sum_{j=1}^{71} x_{ij}(W_j - R_j) + (\mathrm{M} - \sum_{i=1}^{31}\sum_{j=1}^{71}(x_{ij}R_j)) - \sum_{i=1}^{31}\sum_{j=1}^{71}\sum_{k=1}^{9}(S_{ik} + D_{ik})B_{jk}x_{ij}H +$$

$$\sum_{i=1}^{31}\sum_{j=1}^{71} x_{ij}H(T_i - E_j) - A \times \frac{1}{2}(\sum_{j=1}^{71}((\sum_{i=1}^{31} x_{ij} - 1)(\sum_{i=1}^{31} x_{ij})))$$



Formulation(continued)

Objective Function(3)

Total travel time

$$max \sum_{i=1}^{31}\sum_{j=1}^{71} x_{ij}(W_j - R_j) + (\mathrm{M} - \sum_{i=1}^{31}\sum_{j=1}^{71}(x_{ij}R_j)) - \sum_{i=1}^{31}\sum_{j=1}^{71}\sum_{k=1}^{9}(S_{ik} + D_{ik})B_{jk}x_{ij}H +$$

$$\sum_{i=1}^{31}\sum_{j=1}^{71} x_{ij}H(T_i - E_j) - A \times \frac{1}{2}(\sum_{j=1}^{71}((\sum_{i=1}^{31} x_{ij} - 1)(\sum_{i=1}^{31} x_{ij})))$$

Location parameters (binary)

Basic hourly wage

biking time between locations

Formulation(continued)

Objective Function(4)

Amount of time saved

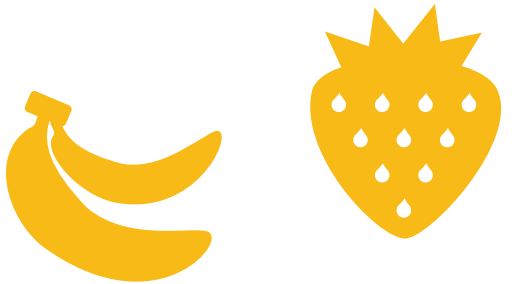
$$max \sum_{i=}^{31} \sum^{71} x_{ij}(W_j - R_j) + (\mathrm{M} - \sum_{i=1}^{31} \sum_{j=1}^{71} (x_{ij} R_j)) - \sum_{i=1}^{31} \sum_{j=1}^{71} \sum_{k=1}^{9} (S_{ik} + D_{ik}) B_{jk} x_{ij} H +$$

$$\sum_{i=1}^{31} \sum_{j=1}^{71} x_{ij} H (T_i - E_j) - A \times \frac{1}{2} (\sum_{j=1}^{71} ((\sum_{i=1}^{31} x_{ij} - 1)(\sum_{i=1}^{31} x_{ij})))$$

Available time

Dining Time

Basic hourly wage



Formulation(continued)

Objective Function(5)

The decreasing amount of willingness-to-pay

The total decrease in willingness-to-pay:

$$A \times (0 + 1 + \ldots + \sum_{i=1}^{31} x_{ij})$$

$$max \sum_{i=1}^{31}\sum_{j=1}^{71} x_{ij}(W_j - R_j) + (\mathrm{M} - \sum_{i=1}^{31}\sum_{j=1}^{71}(x_{ij}R_j)) - \sum_{i=1}^{31}\sum_{j=1}^{71}\sum_{k=1}^{9}(S_{ik} + D_{ik})B_{jk}x_{ij}H +$$

$$\sum_{i=1}^{31}\sum_{j=1}^{71} x_{ij}H(T_i - E_j) - A \times \frac{1}{2}(\sum_{j=1}^{71}((\sum_{i=1}^{31} x_{ij} - 1)(\sum_{i=1}^{31} x_{ij})))$$

Const (In our model, A = $10)

Formulation(continued)

Constraints(1)

- Time Constraints

$$\sum_{j=1}^{71}(E_j x_{ij}) + \sum_{k=1}^{9}((S_{ik} + D_{ik})B_{jk}x_{ij}) \leq T_i, \forall i$$

- Budget Constraint

$$\sum_{j=1}^{71}\sum_{i=1}^{31}(x_{ij})R_j \leq M$$

- Days-off Constraint

$$O_{ij} \geq x_{ij}, \forall i, j$$

Formulation(continued)

Constraints(2)

- Date Constraints

  $x_{ij} = 1$, for some i and j

- Consecutive Constraint

  $$\sum_{i=n}^{n+6} x_{ij} \leq 1, \forall n = 1, 2...i - 6$$

- Single Choosing Constraint

  $\sum_{j=1}^{71} x_{ij} = 1$, if date i is weekday

  $\sum_{j=1}^{71} x_{ij} = 0$, if date i is holiday

Solution

Solution

Date (Day)	Name of Restaurant	Date (Day)	Name of Restaurant
1 (Monday)	四面八方	8 (Monday)	四面八方
2 (Tuesday)	安好食 (新生)	9 (Tuesday)	咖哩戰線
3 (Wednesday)	鳳城燒臘	10 (Wednesday)	安好食 (新生)
4 (Thursday)	五九麵館	11 (Thursday)	鳳城燒臘
5 (Friday)	不吃	12 (Friday)	不吃

Objective (Total Benefit): 7060.767 NT dollars

Suggestion

Suggestions

- Oversimplified the matter

add more parameters, e.g. the weather, whether the student is with companions

- Program effectiveness

Thank you