Foods Recommendation System for Meals-out in Nutrition Balance

The 11th workshop on Multimedia for Cooking and Eating Activities

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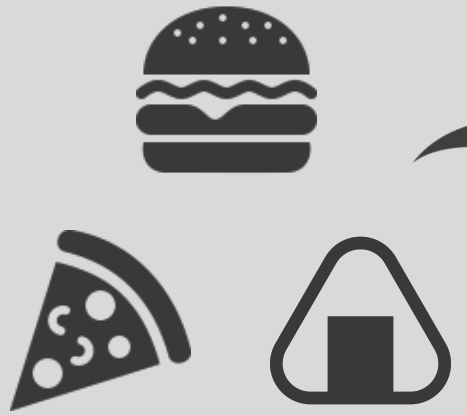
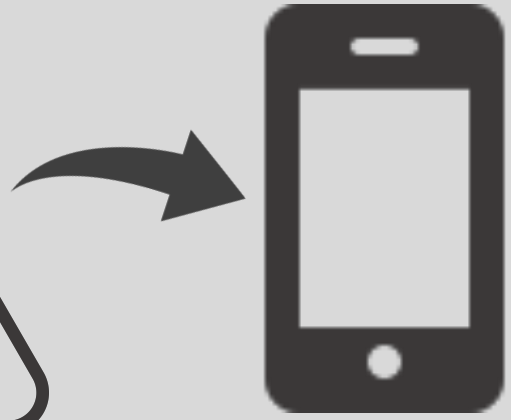
What the proposed system provides

Inputting food logs





Visualization of the amounts of intake nutrients

Recommending foods for meals-out in nutrient balance

The system can support users to **improve the nutrient balance.**

Background and purpose

Many people utilize **eating out** and **pre-cooked meals.**

Nutrients are not considered when people choose foods.

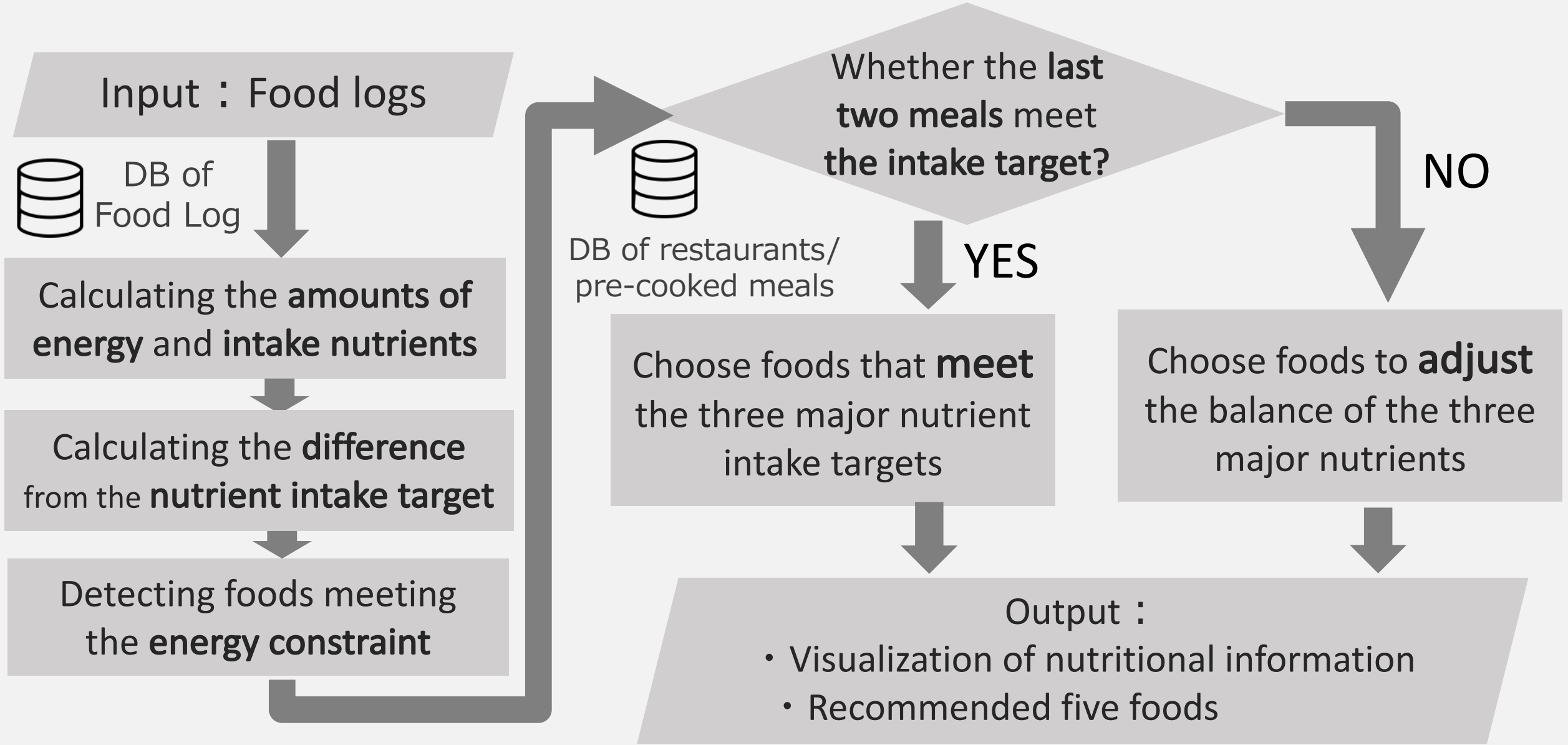
The deviation of nutrients happens.

The purpose of our research is to support people having foods for **meal-out** to **adjust the nutritional balance.**

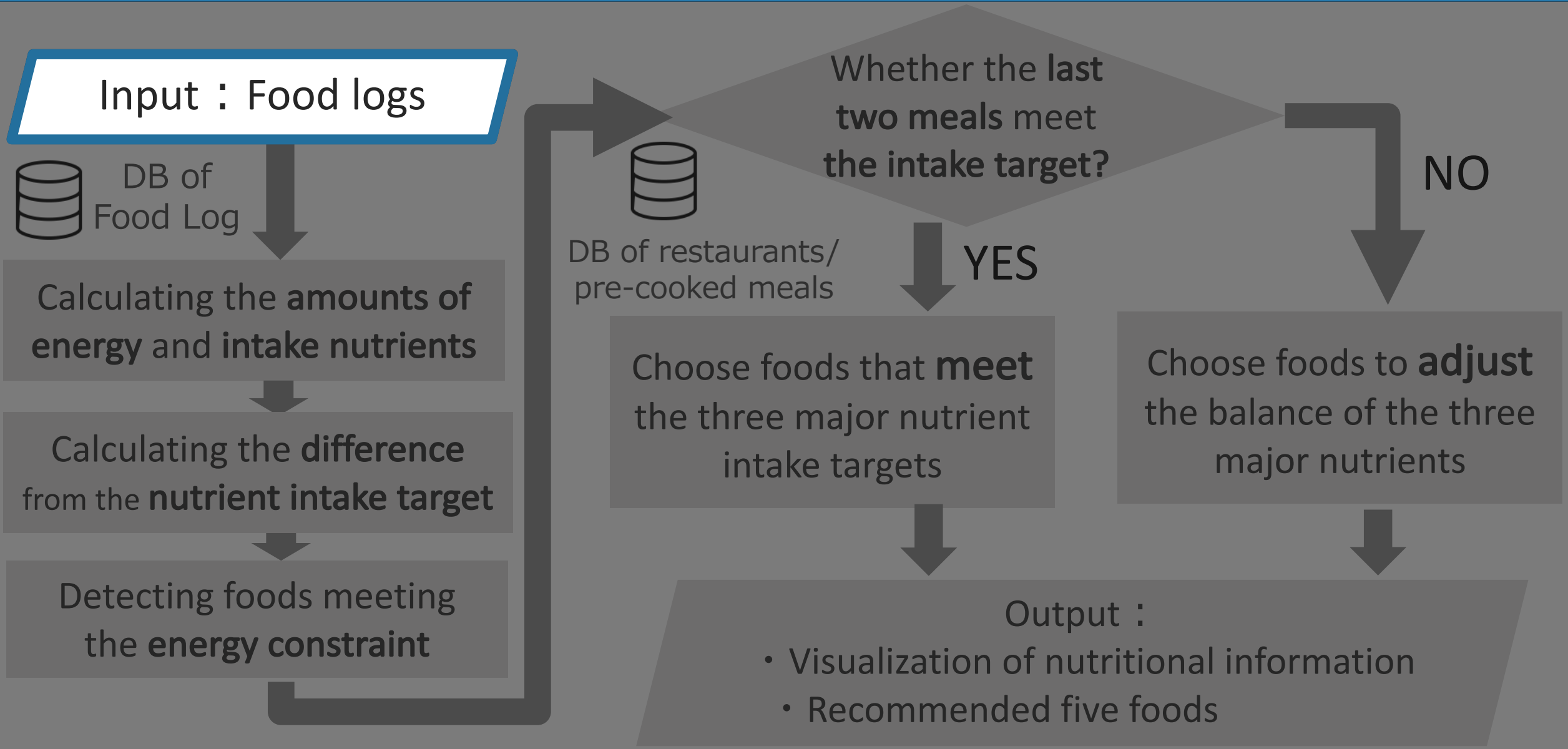
Demo movie


RitsHealth
ようこそ Ohata Takumi さん
食べたものを入力する
レシート
食品名検索
手動
最新の食事ログ
チーズバーガー(マクドナルド)
昼食で推薦する食品(上位５件)
１日に１回、昼食前にフォームの送信をお願いします。

The flow of the proposed system



The flow of the proposed system



Elements in a food log

The food log consists of the 10 elements.

- ✓ **Elements to identify users and foods**

  ①User ID, ②Stores/restaurants name, ③Name of the foods, ④Foods Size
  ⑤Date and the time when the user had, ⑥Date and time when the user logged

- ✓ **Elements of nutrients**

  ⑦The amount of **energy** (kcal), ⑧The amount of **protein** (gram)
  ⑨The amount of **fat** (gram), ⑩The amount of **carbohydrate**(gram)

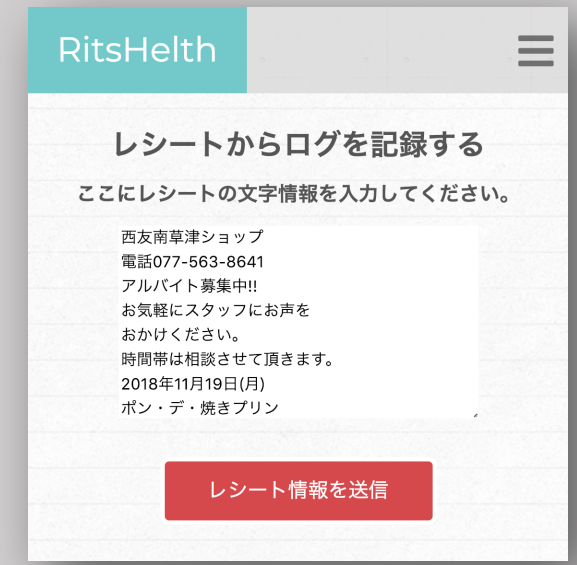
(example)

	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
Elements	User ID	Store name	Food name	Size	Eat date	Log date	**Energy**	**Carbohydrate**	**Protein**	**Fat**
Example	User A	Store A	Curry and rice	L	2019-01-12 22:53	2019-01-12 22:30	518.0	5.8	27.3	62.4

Input methods of a food log

1.Scanning receipts

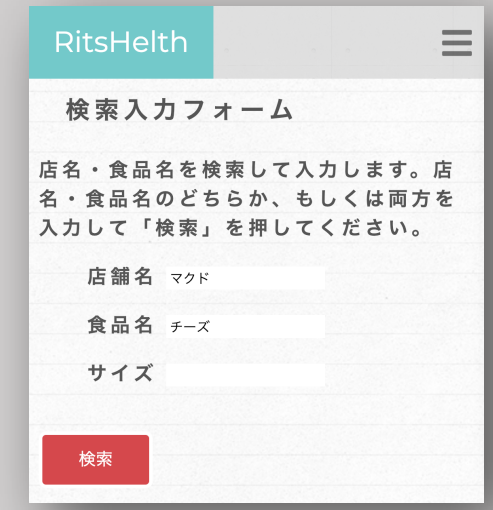
Input **all strings** scanned from receipts

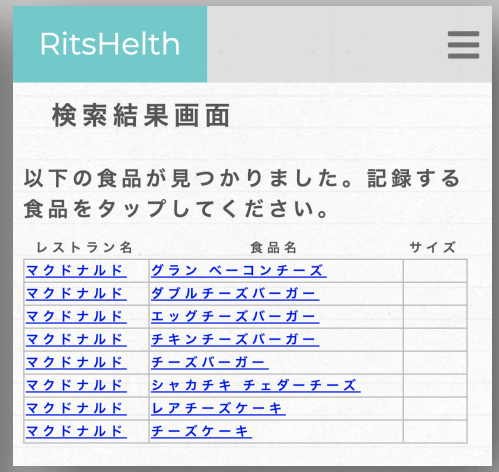


2.Choosing options

Narrow down the foods by **stores** and the **foods name**

The user selects one food from the **search result** as the input.

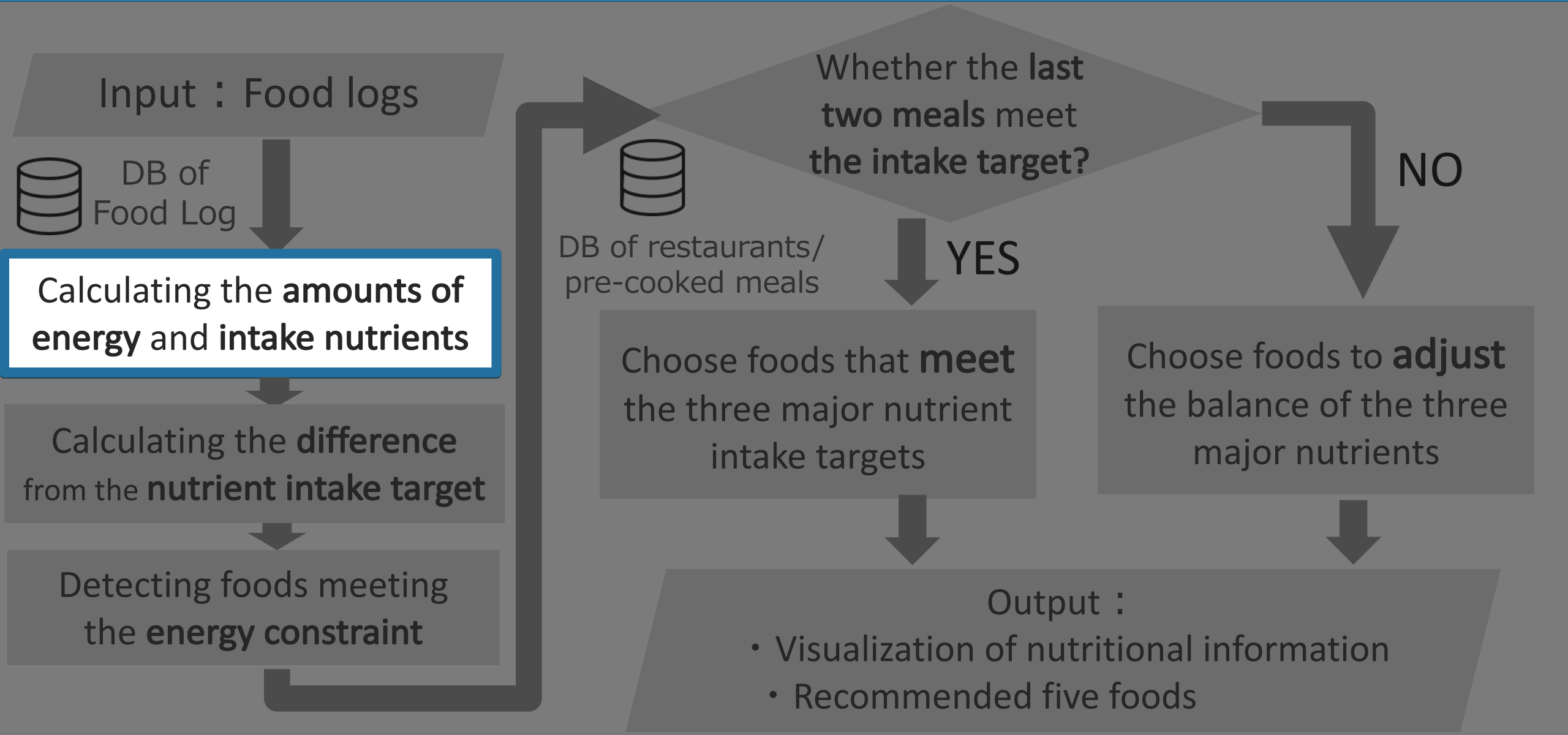




3.Texting

Manually input the store name, the food name, the **energy**, and **three major nutrients**

The flow of the proposed system



Calculate the amounts of nutrients

Using a food log for **the last two meals**, the system calculates **the total value** of the three major nutrients and **the energy composition rate** from DB of Food log.

DB of Food log

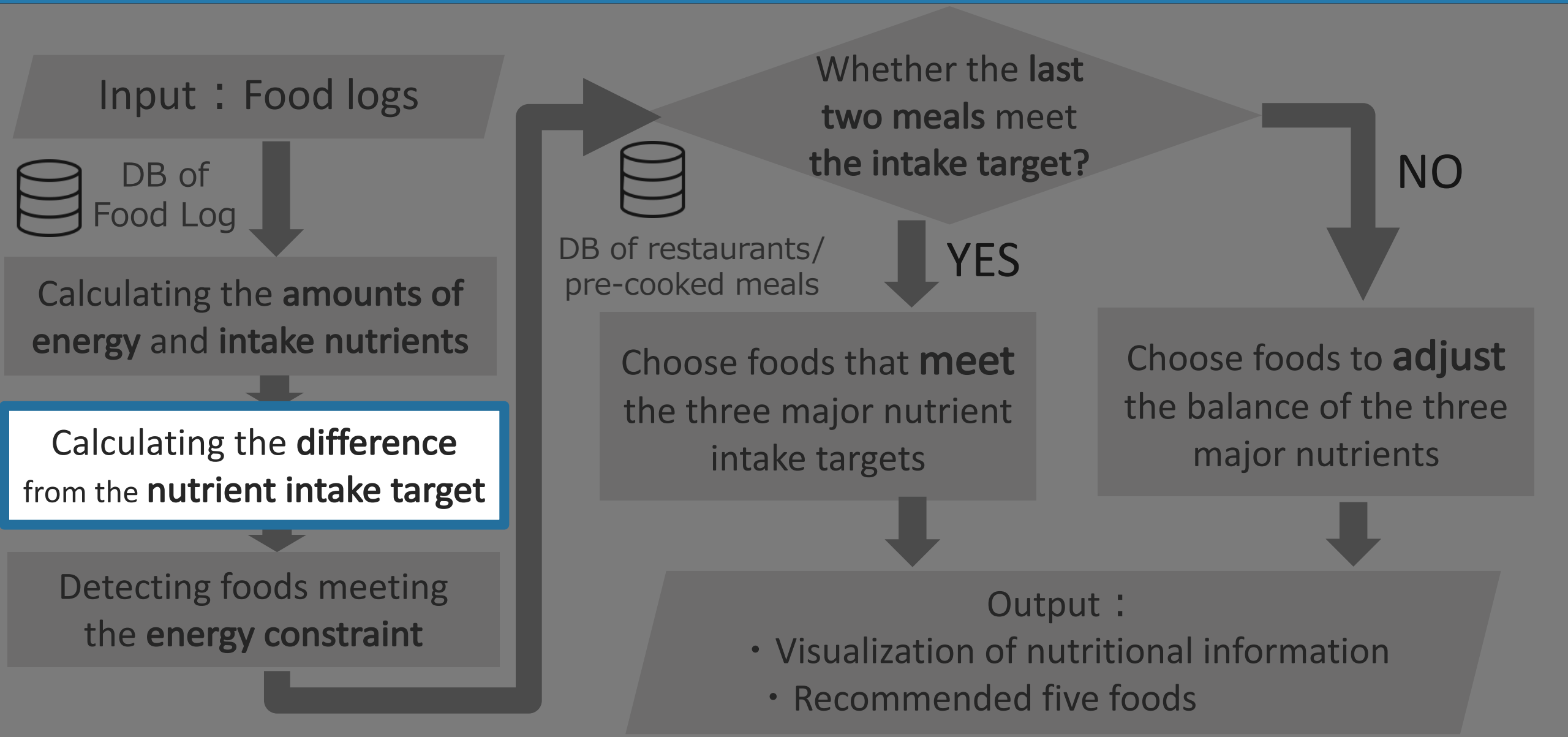
✓ The total value

Protein(P)	16(g)
Fat(F)	32(g)
Carbohydrate(C)	98.8(g)

✓ The energy composition rate

P_{rate}	: 8(%)
F_{rate}	: 39(%)
C_{rate}	: 53(%)

The flow of the proposed system



Calculate the difference from the target

Calculate the difference from the nutrient intake target.

✓ Energy composition ratio

P_{rate} : 8(%)
F_{rate} : 39(%)
C_{rate} : 53(%)

	Lower limit(%)	Upper limit(%)
P_{rate}	13	20
F_{rate}	20	30
C_{rate}	50	65

(https://www.mhlw.go.jp/stf/houdou/0000041733.html)

✓ Differences from the nutrient intake target

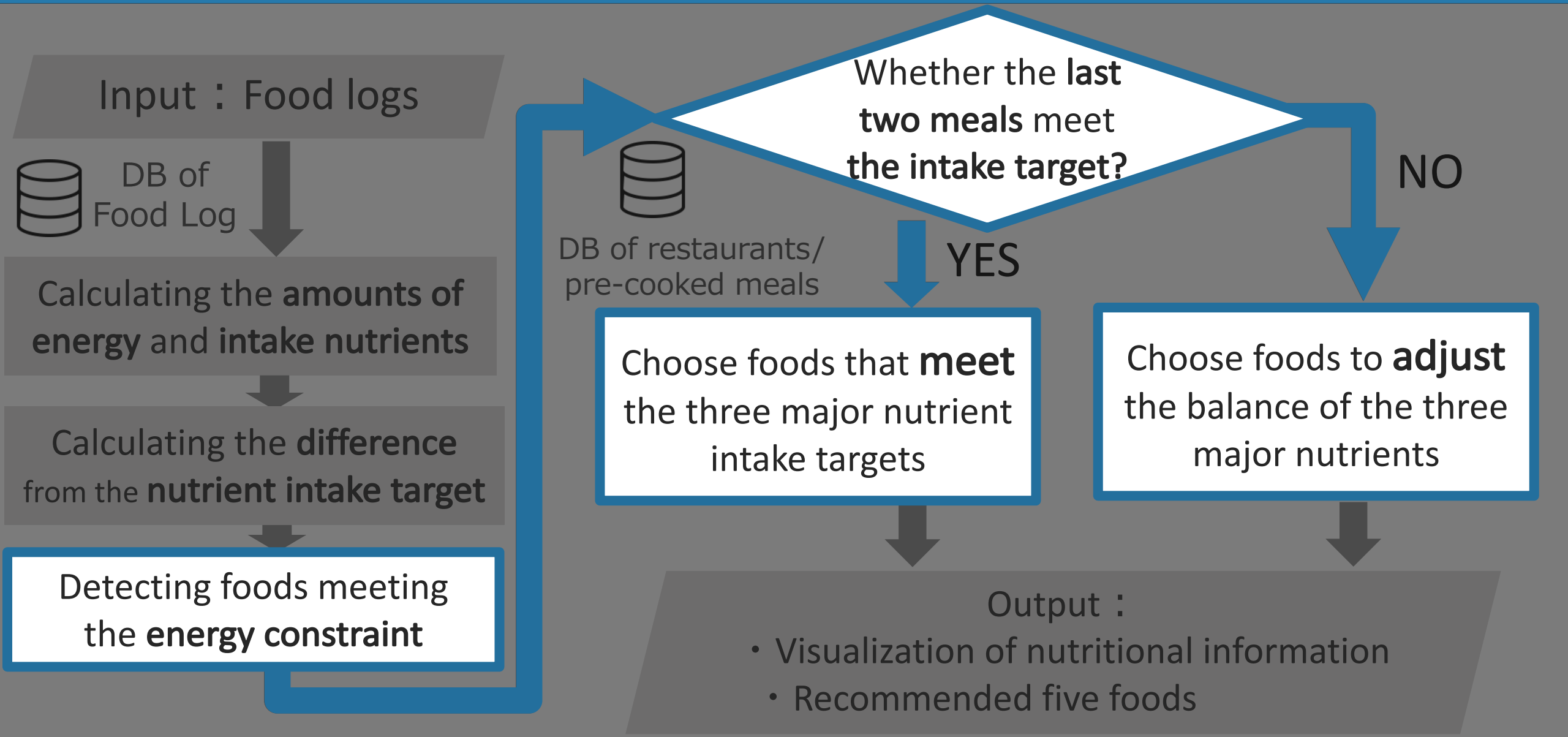
$P_{diff} = -5$
$F_{diff} = +9$
$C_{diff} = \pm 0$

✓ Sum of differences

$$PFC_{diff} = |P_{diff}| + |F_{diff}| + |C_{diff}| = 5 + 9 + 0 = 14$$

The **smaller**, the closer to **the nutrient intake target**.

The flow of the proposed system



Choose foods to adjust the nutrients balance

In order to **minimize** PFC_{diff}, the system chooses 5 foods in order to adjust the nutrient with the largest difference.

Differences from the nutrient intake target

P_{diff} = −5(%)
F_{diff} = +9(%)
C_{diff} = ±0(%)

Largest difference is F_{diff}

DB of restaurants/ pre-cooked meals

✓ **Minimize** PFC_{diff}
✓ Meet **calorie limit**

Select 5 foods

The salad

F_diff = −20

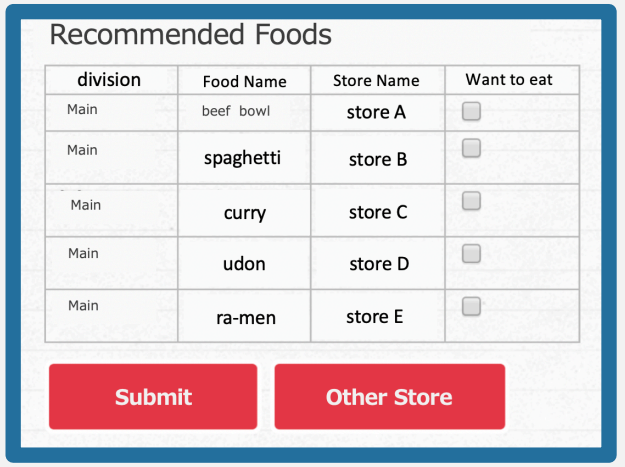
The kelp rice ball

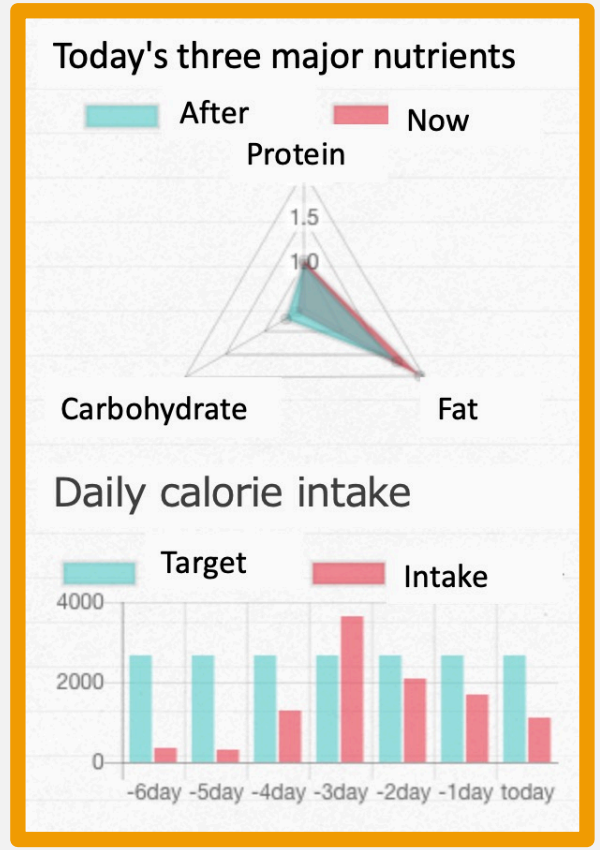
F_diff = −16.7

Experiments | Settings

○ Experimental procedure

1. All subjects use a website with the functions for 5 days.
2. Group A subjects answered that they wanted to eat the recommended food for lunch.





○ The subjects

21 men aged 18-29

Group A (7 subjects) : Food Log + Visualization + **Recommendation**

Group B (7 subjects) : Food Log + Visualization

Group C (7 subjects) : Only Food Log

○ Evaluation

(1) The effectiveness of foods recommendation:

If PFC_{diff} has become **smaller** after lunch, the **recommendation is evaluated** as effective.

(2) The effectiveness of visualization:

The same way in the above.

Results | Effects of foods recommendation

	Group A (With Recommendation)	Group B (No Recommendation)
The number of days when PFC_{diff} became smaller at lunch	14／35	12／35
Average PFC_{diff} per day	42.90	49.13

Foods recommendation could improved the three major nutrient balances.

Results | Effects of foods recommendation

	Group A (With Recommendation)	Group B (No Recommendation)

We confirmed
the foods recommendation was **effective.**

Foods recommendation function has improved the three major nutrient balances.

Results | Effects of nutrient visualization

	Group B (With Visualization)	Group C (No Visualization)
The number of days when PFC_{diff} became smaller at lunch	12／35	12／35
Average PFC_{diff} per day	49.13	44.98

Nutrient visualization could not improved the three major nutrient balances.

Results | Effects of nutrient visualization

	Group B (With Visualization)	Group C (No Visualization)

We found the nutrient visualization was not effective.

Nutrient visualization could not improved the three major nutrient balances.

Discussion | About Food Recommendation

The subjects of Group A wanted to eat the recommended foods.
BUT, they did not eat the foods.

	Wanted to eat	**Ate**
Average	1.38 / 5	0 / 5

Discussion | About Food Recommendation

There was a case that the food similar to the recommended food was ingested.

	Food Name	P_{diff}	F_{diff}	C_{diff}
Recommendation	A kelp rice ball	-5.57	-16.77	24.34
Intake	A bonito rice ball	-4.32	-18.13	24.45

Subjects made lunch choices with an awareness of the recommended food.
→ It **led to the improvement** of the balance of the three major nutrients.

Discussion | About nutrient visualization

We could not confirmed that the nutrient visualization was effective.
The food log shows that the subjects in ALL GROUPS often skipped breakfasts.
Therefore, nutrient visualization had not effect on their eating behaviors.

One day's food log of the subject of Group B

Food name	Division	Eat date	Energy	Carbohydrate	Protein	Fat
Curry and rice	**dinner**	2019-01-12 22:53	518.0	5.8	27.3	62.4
Donut	**dinner**	2019-01-12 22:58	372.0	12.9	10.5	57.9
Gummi	**dinner**	2019-01-12 22:58	267.0	9.8	13.6	26.9
Jelly	**dinner**	2019-01-12 23:00	18.0	0.00	0.00	4.40
Rice ball	**lunch**	2019-01-13 10:18	608.0	25.3	19.5	82.3

We should consider eating habits more.

Future work

- ✓ Make recommendations based on **personal preferences**.
- ✓ Recommend meals as not only one dish but also a **menu** which included staple food, main dish, side dish.
- ✓ Generate a food log automatically by taking a **picture** of the meal.

Summary

- We proposed a support system to improve nutrient balance based on user's food log.

- Evaluation experiment using the proposed system and two comparative systems for 5 days.

✓ The group using the food recommendation had improved nutrient balances.

✓ **We confirmed the effectiveness of the food recommendation.**

Discussion | About nutrient visualization

Average energy intake per day for each group

	Group A (with both)	Group B (with visualization)	Group C
Energy intake (kcal)	1692.2	1408.1	1450.5

Group A had more energy than other groups.

→ They were trying to make up for missing energy at lunch.

We should consider eating habits more.

Recommended foods example | over P_{diff}

✓ Foods log

Store name	Food name
Self	Pot-au-feu
Self	Curry and rice
Self	Lunch box for athlete

✓ Recommended foods

Store name	Food name	P_{diff}	F_{diff}	C_{diff}
Gyudon restaurant A	Beef curry rice	-3.73	0.00	1.07
Gyudon restaurant A	Set meal of salmon	-0.14	-1.25	3.39
Hamburger restaurant A	Petit Pancake	-2.85	0.00	1.34
Hamburger restaurant B	Tomato pasta	-2.97	5.10	0.00
Udon restaurant	Salted pork and egg udon	0.00	-0.76	1.46

✓ Over P_{diff}

P_{diff}	F_{diff}	C_{diff}
2.2	0.0	-0.3

Reduce P_{diff}

Recommended foods example | Shortage P_{diff}

✓ Foods log

Store name	Food name
Convenience store	Instant udon
Convenience store	Steamed cake
Convenience store	Chicken mayonnaise rice ball

✓ Shortage P_{diff}

P_{diff}	F_{diff}	C_{diff}
-4.91	3.82	0.00

✓ Recommended foods

Store name	Food name	P_{diff}	F_{diff}	C_{diff}
School cafeteria	Salt-grilled salmon	7.85	0.00	0.00
Hamburger restaurant A	Hamburger	6.97	0.00	0.00
Gyudon restaurant	Natto set meal	0.00	-1.85	1.72
Donuts restaurant	Soba with seafood and vegetables	0.00	-0.59	1.68
Hamburger restaurant B	Hamburger	0.00	0.00	1.09

Increase P_{diff}

Recommended foods example | over C_{diff}

✓ Foods log

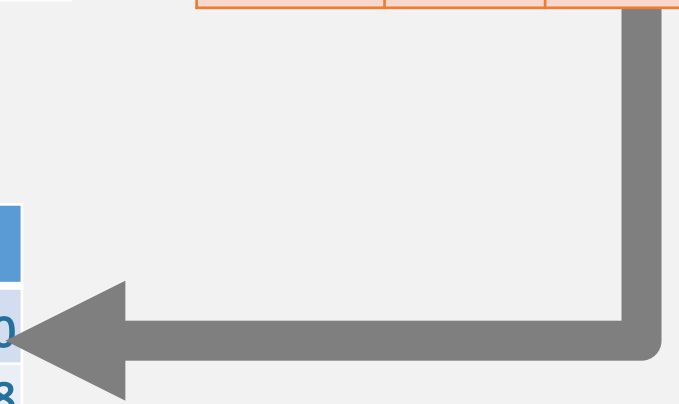
Store name	Food name
Udon restaurant	Kamadama udon

✓ Over C_{diff}

P_{diff}	F_{diff}	C_{diff}
-13.0	-20.0	**35.0**

✓ Recommended foods

Store name	Food name	P_{diff}	F_{diff}	C_{diff}
School cafeteria	Pumpkin salad	7.72	42.18	-49.90
Gyudon restaurant A	Cheese	8.85	39.23	-48.08
Udon restaurant	Tofu	8.61	37.64	-46.24
Gyudon restaurant B	Leaf mustard spicy pollack roe mayonnaise	-6.61	49.41	-35.80
Hamburger restaurant	Soft-boiled eggs	12.38	33.21	-45.60



Recommended foods example | over F_{diff}

✓ Foods log

Store name	Food name
Self	Fried rice
Self	Corned beef

✓ over F_{diff}

P_{diff}	F_{diff}	C_{diff}
-4.49	27.24	-15.75

✓ Recommended foods

Store name	Food name	P_{diff}	F_{diff}	C_{diff}
Udon restaurant	A kelp rice ball	-5.57	-16.77	24.34
Hamburger restaurant	Beef patties	13.21	-17.73	0.00
Gyudon restaurant A	Salmon set meal	-0.14	-1.25	3.39
Gyudon restaurant B	Vegetable set meal	-4.31	0.00	0.00
Hamburger restaurant	Omar shrimp bisque	0.00	0.00	1.09

Reduce F_{diff}

Recommended foods example | shortage F_{diff}

✓ Foods log

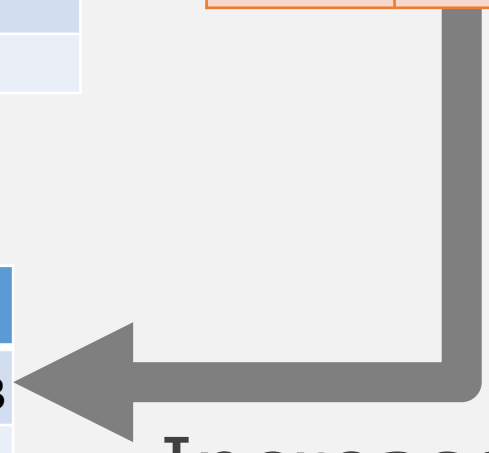
Store name	Food name
Convenience store	Super spicy fried rice
Convenience store	Salad chicken
Self	Rice
Self	Miso soup

✓ Shortage F_{diff}

P_{diff}	F_{diff}	C_{diff}
0.0	-5.1	0.55

✓ Recommended foods

Store name	Food name	P_{diff}	F_{diff}	C_{diff}
School cafeteria	Spinach with Hijiki	0.00	52.84	-46.93
Gyudon restaurant A	Leaf mustard spicy pollack roe mayonnaise	-6.61	49.41	-35.80
Gyudon restaurant B	Calvi beef bowl	-2.64	7.30	0.00
Hamburger restaurant	Hamburger	0.00	5.70	-3.93
Udon restaurant	Salted pork and egg udon	0.00	4.40	-4.25



Increase F_{diff}

Detect foods meeting the energy constraint

Many foods for meals-out have high energy content.
Narrow down foods for meals-out with only energy constraint.

Let E_{before} : the amount of energy of two meals
$E_{suggest}$: the amount of energy of food in the database
E_{target} : the amount of objective energy to be ingested

DB of restaurants/
pre-cooked meals

The food satisfying

$$E_{before} + E_{suggest} < E_{target}$$

Let the list of the **candidates for the recommendation** be S_{list}

S_{list}

Whether meet the intake target

The last two meal satisfying

$$PFC_{diff} = 0$$

Yes → **Meet** the three major nutrient intake targets

No → **Adjust** the balance of the three major nutrients

Differences from the nutrient intake target

P_{diff} = −5(%)
F_{diff} = +9(%)
C_{diff} = ±0(%)

Sum of differences

$$PFC_{diff} = |P_{diff}| + |F_{diff}| + |C_{diff}|$$
$$= 3 + 0 + 1 = 4$$

PFC_diff≠0
Case “No”

Choose foods to adjust the nutrients balance

In order to **minimize** PFC_{diff}, select 5 foods in order to adjust the nutrient with the largest difference

Differences from the nutrient intake target

P_{diff} = −5(%)

F_{diff} = +9(%)

C_{dif} = +0(%)

Largest difference is F_{diff}

S_{list}

Make smaller F_{diff}

The salad (L)

F_diff = −20

The kelp rice ball

F_diff = −16.7

Experiments | Settings

○The subjects

21 men aged 18-29

Group A（7名）

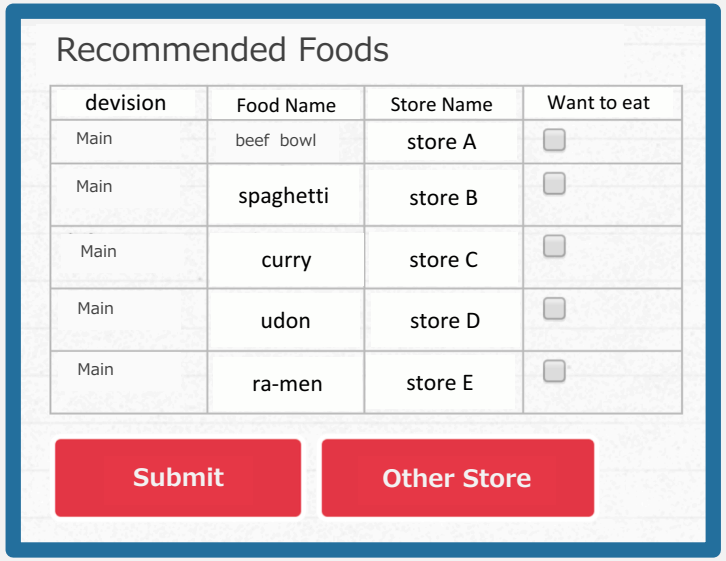
Food Log＋Visualization＋**Recommendation**

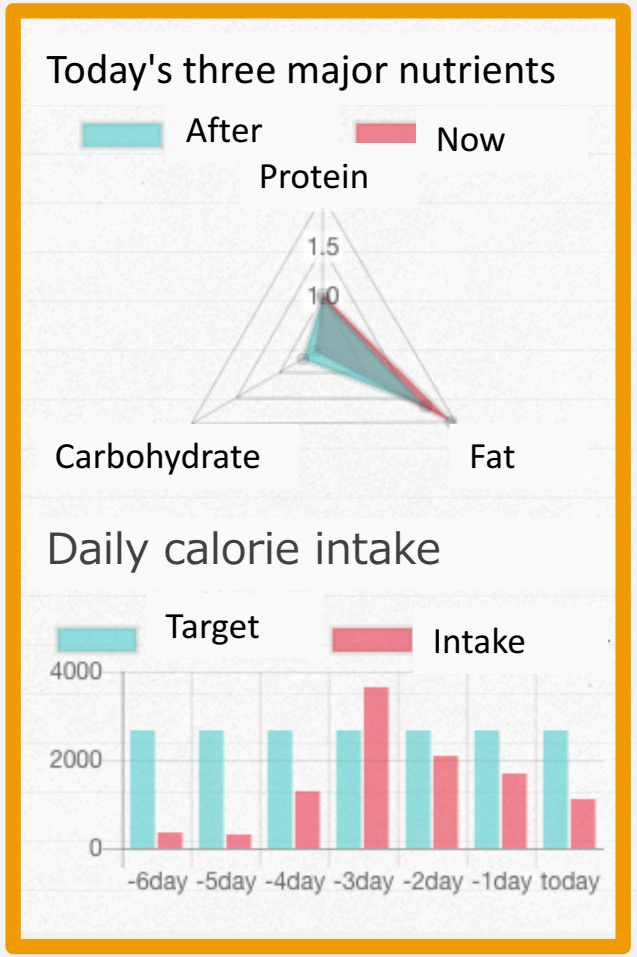
Group B（7名）

Food Log＋ Visualization

Group C（7名）

Only Food Log





○ Experimental procedure

1. Use a website with the functions of each group for 5 days.
2. Group A subjects answered that they wanted to eat recommended food for lunch.

○ Evaluation

Whether PFC_{diff} has become smaller after lunch.

Experiments | Purpose

1. The function of **food recommendation** for meals-out to adjust the nutritional balance.
2. The function of **visualize the amounts of the three nutrients and amount of energy** that the user has had.
3. The function of **input Food Log**.

Evaluating whether the above three functions can support **improvement of balance of the three major nutrients** and **amount of energy**.

ACKNOWLEDGEMENTS

Funding from the Skylark Foundation is gratefully acknowledged.