Comparison of Two Approaches for Direct Food Calorie Estimation

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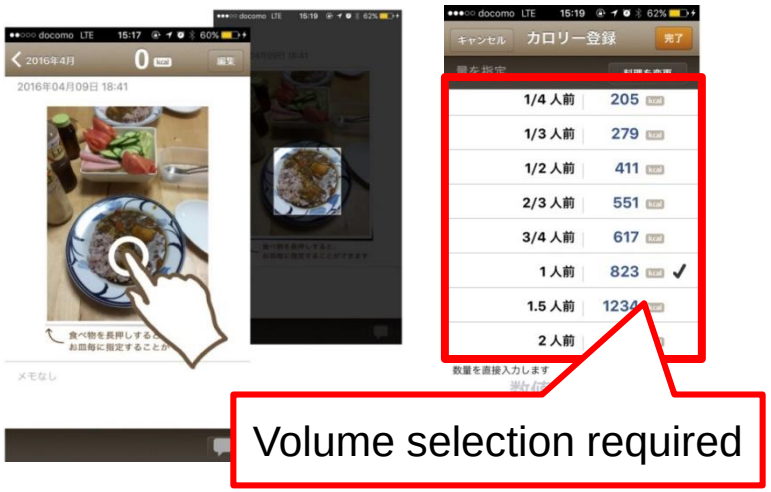
Direct food calorie estimation

Foodlog



Crop a dish
Food category recognition
Select volume **manually**, etc…

CaloNavi

Dietary advices by
nutrition professional.
Human cost ➡ **Pay service**

Fully-automatic food calorie estimation from a food photo has still remained as an unsolved problem.

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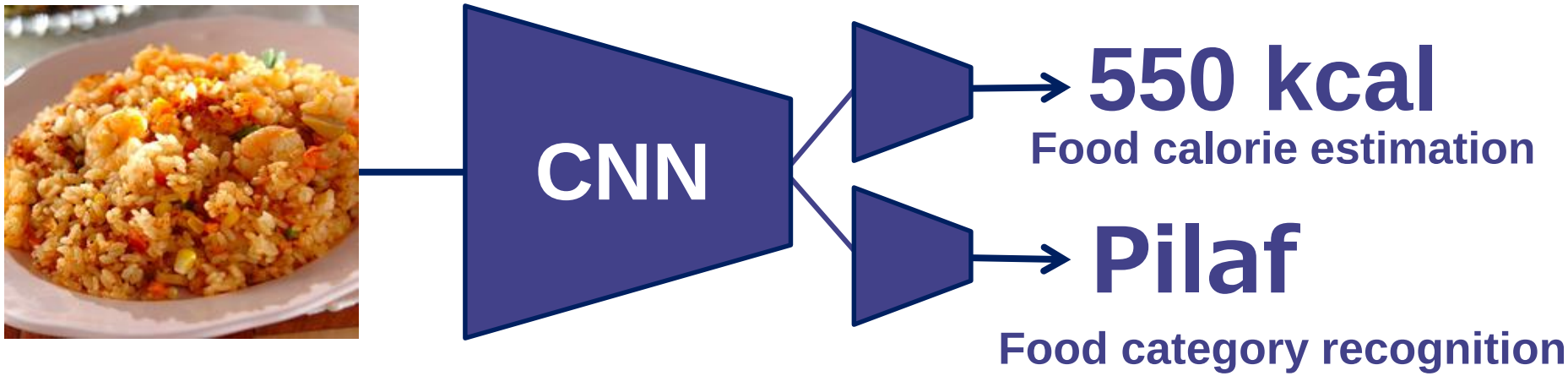
Previous work: Regression-based

- Regression-based direct calorie estimation.
  - Multi-task CNN of food categories and calories.
  - Create a new calorie-annotated food photo dataset.



Ege and Yanai. Simultaneous estimation of food categories and calories with multi-task cnn. In Proc. of IAPR International Conference on Machine Vision Applications(MVA), 2017.

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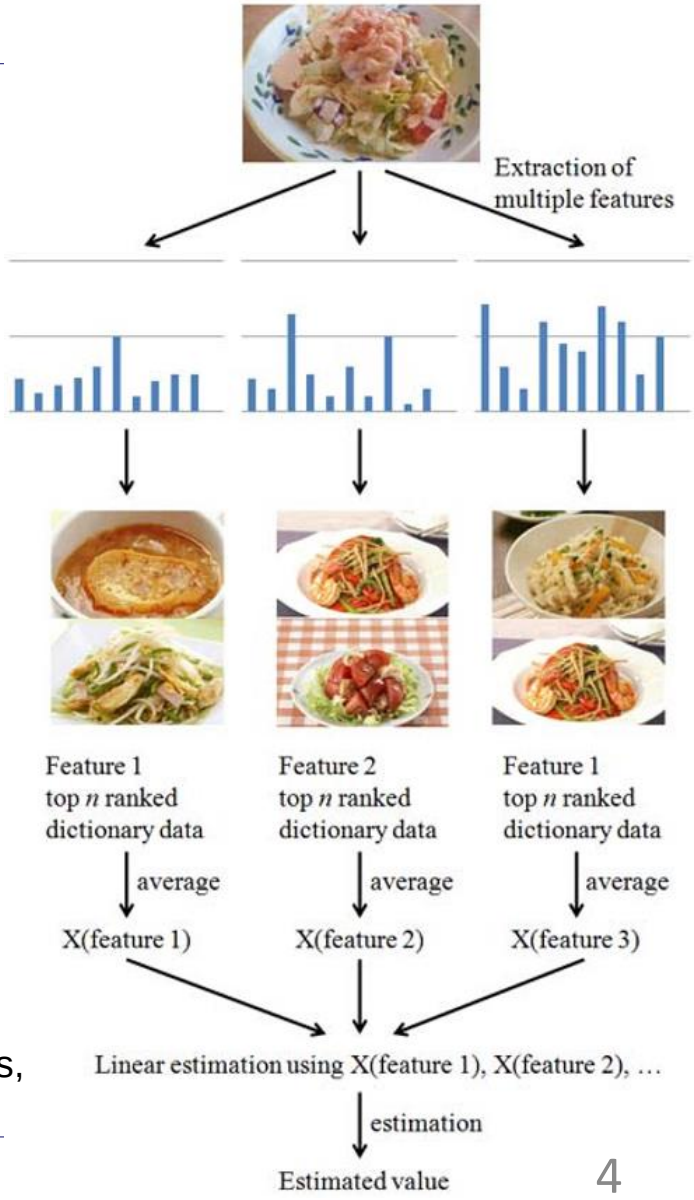
Previous work: Search-based

- Search-based food calorie estimation.
  - Similar image search based on hand-crafted features such as SURF-based BoF and color histograms.
  - Create a new calorie-annotated food photo dataset.



Miyazaki et al. Image - based Calorie Content Estimation for Dietary Assessment, Workshop on Multimedia for Cooking and Eating Activities, 2011.

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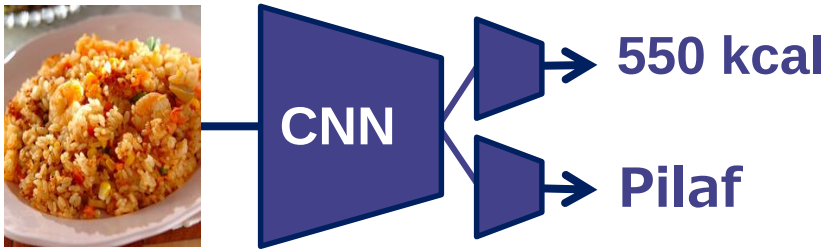
Comparison of two methods

Regression-based

- Regression-based direct calorie estimation.
  - Multi-task learning of food categories and calories.
  - Create a new calorie-annotated food photo dataset.



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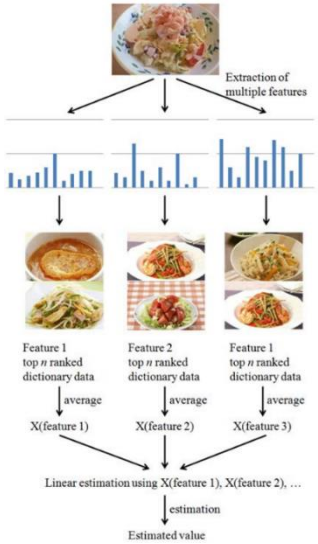

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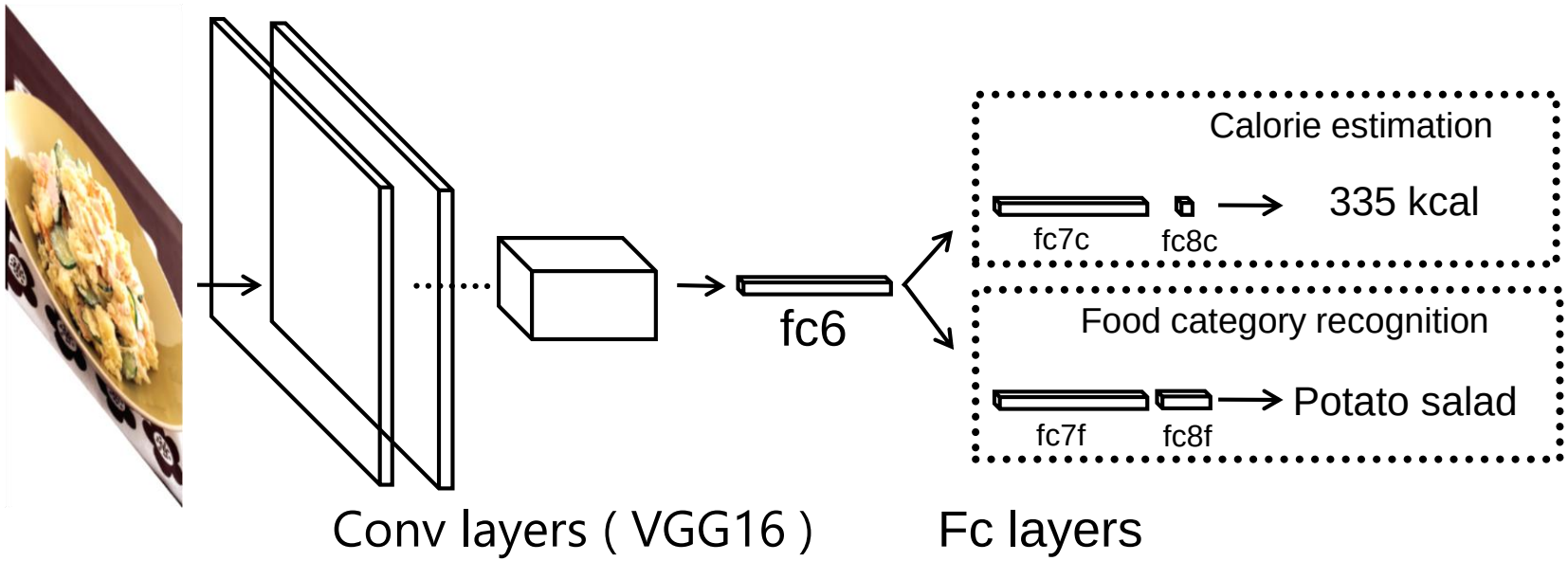
Regression-based

- Multi-task learning of food categories and calories.
- The architecture is based on VGG16.



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Regression-based

- Loss function is a linear combination of food calorie estimation loss L_{cal} and classification loss L_{cat} .
  - Food calorie estimation loss L_{cal} is a linear combination of a relative error L_{re} and an absolute error L_{ab}.

$$L_{ab} = |y_i - g_i| \qquad L_{re} = \frac{|y_i - g_i|}{g_i}$$

    Let y_i as the estimated value of an image x_i and g_i as the ground-truth.

  - Classification loss L_{cat} is softmax cross entropy.

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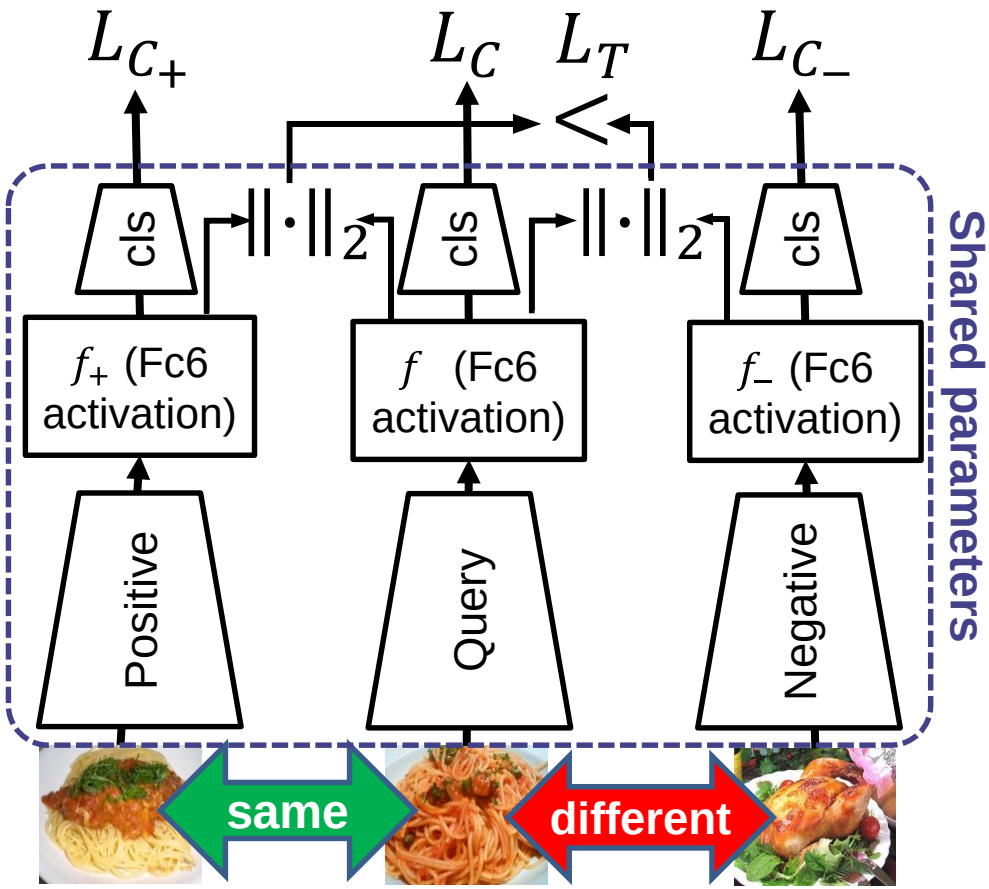
Search-based

- Search similar images from the database and use the food calorie of the images.
- For searching similar images, we use fc6 activation of VGG16 trained with triplet loss L_T and classification loss L_{C_+}, L_C and L_{C_-}.



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Search-based

- Loss function is a linear combination of L_T, L_{C_+}, L_C and L_{C_-}.
  - Triplet loss L_T

$$L_T = max(0, g + \|f_+ - f\|_2 - \|f_- - f\|_2)$$

$\|f_+ - f\|_2$: Euclidean distance between fc6 activations of the **same category** images.

$\|f_- - f\|_2$: Euclidean distance between fc6 activations of the **different category** images.

  - Classification loss L_{C_+}, L_C and L_{C_-} are softmax cross entropy.

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Calorie-annotated food image dataset

We use calorie-annotated 15 food category dataset. [Ege and Yanai, 2017]

Recipe info. cites

AJINOMOTO Park E・レシピ

kikkoman おいしい記憶をつくりたい。

レタスクラブニュース

みんなのきょうの料理 NHKエデュケーショナル

今日のレシピが必ず決まる! オレンジページnet

A food photo

Food Calorie

	(260g)
じゃがいも・小	3個
ブロッコリー	1/4個
レモン・輪切り	4枚
	適量
小麦粉	適量
A 「AJINOMOTO 胚芽の恵みコーン	大さじ1

(1)さけは「コンソメ」をふって両面になじませ、小麦粉をまぶす。

(2)フライパンにAを熱し、(1)のさけの両面を中火で色よく焼き、弱火にしてフタをし、約3分蒸し焼きにする。

(3)じゃがいもは皮をむいて3等分にし、水に10分ほどさらして水気をきる。鍋に入れ、ヒタヒタの水を加えて火にかけ、煮立ったら弱火にし、フタをしてやわらかくなるまで約10分ゆで、ザルに上げる。

(4)空鍋を火にかけ、(3)のじゃがいもを戻し入れ、鍋を揺すりながら粉をふかせて塩をふる。

About **83,000** recipes were collected.

Calorie-annotated food image dataset

Labeling on 100 meals of UEC food-100 [1].

Noise removal.

Remove categories with fewer than 100 samples.

Food **15** categories.

A total of **4877** images.


Pilaf


Curry


Fried rice


Fried noodle


Spaghetti


Gratin


Miso soup


Stew


Simmered meat and potatoes


Hamburg steak


Cold tofu


Sushi bowl


Omelet with fried rice


Potato salad


Mixed rice

[1] Matsuda et al. Recognition of multiple-food images by detecting candidate regions. In Proc. of IEEE International Conference on Multimedia and Expo, 2012.

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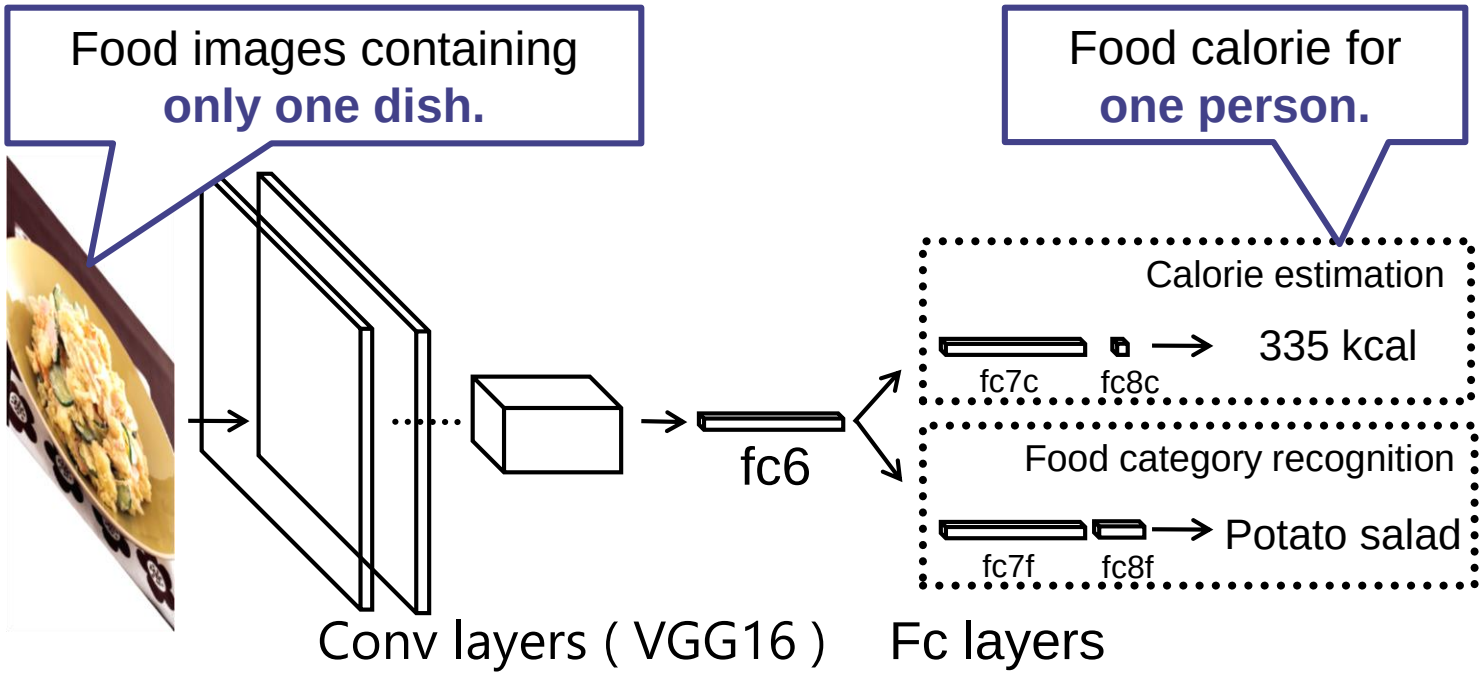
Experiment : Regression-based

- We train CNN with relative error and absolute error on calorie-annotated food image dataset.
  - Training: 70%, Testing: 30%



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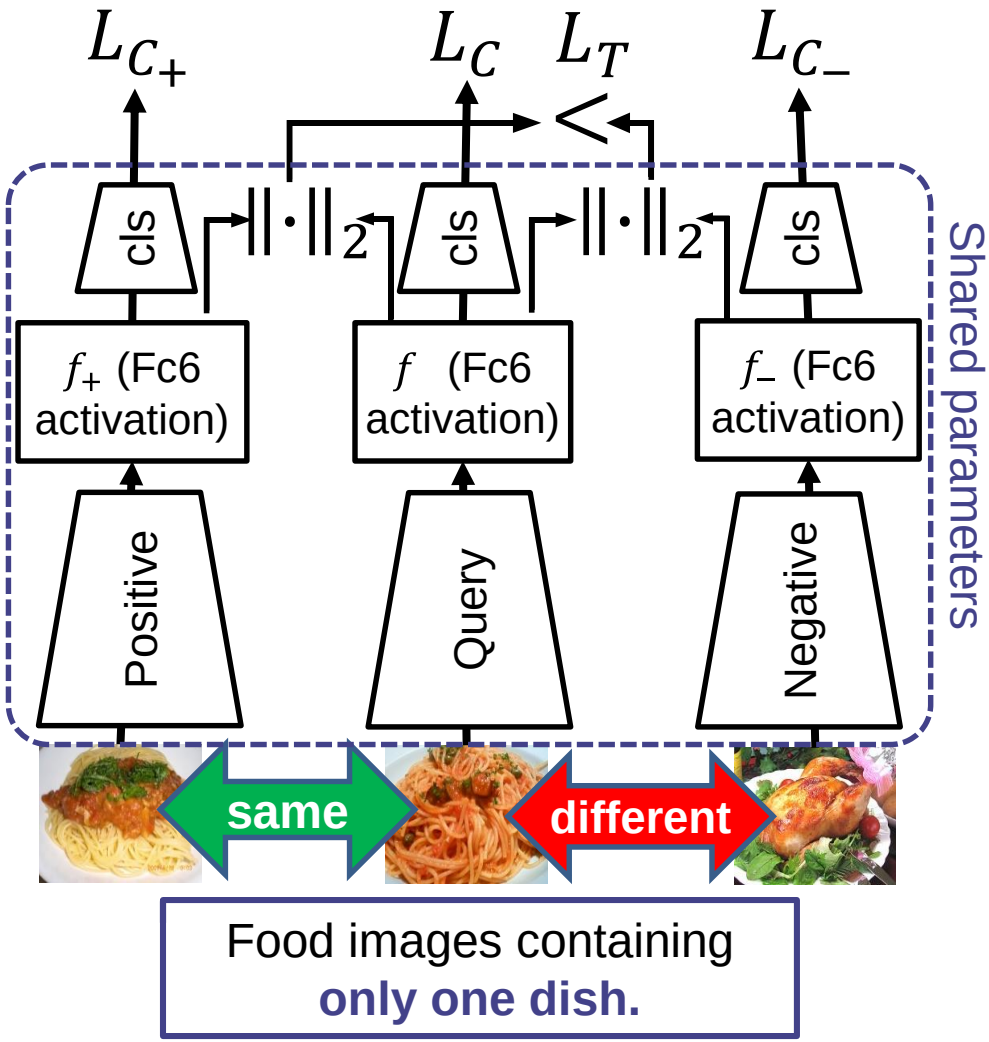
Experiment : Search-based

- We train VGG16 with triplet loss and classification loss on UECFOOD100.
- We use an activation signals of fully connected layers of the trained network as CNN features.
- We create CNN feature database on calorie-annotated food image dataset.
  - Database : 70%, Testing : 30%



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Result : Comparison of two methods

- Baseline (Classification)
  - Use of fixed calorie value of each category.

	model	Rel. err. (kcal)	Abs. err. (%)	Correlation	< 20 % rel. err. (%)
	Baseline	32.4	**93.6**	0.784	**50.0**
Reg.	VGG16 single-task	29.2	100.4	0.783	46.0
Reg.	VGG16 multi-task	**28.0**	96.5	**0.805**	47.2
Sea.	VGG16(uecfood100) fc6	38.0	101.0	0.764	47.2
Sea.	VGG16(uecfood100) fc6 triplet	38.4	101.5	0.754	45.9
Sea.	VGG16(uecfood100) fc6 triplet + cls	36.7	98.6	0.777	48.1

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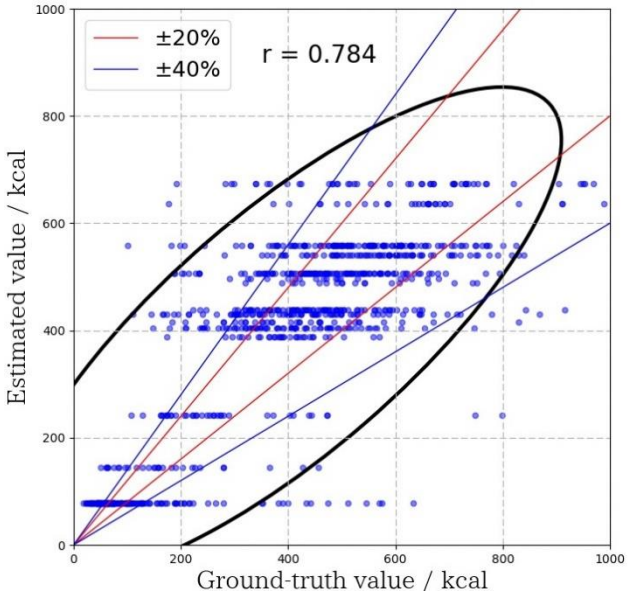
Result : Comparison of two methods

- Correlation between estimated value and ground-truth



Baseline
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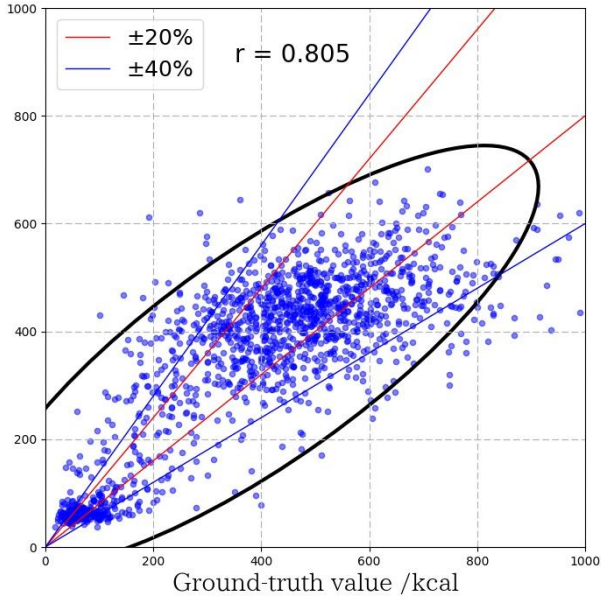
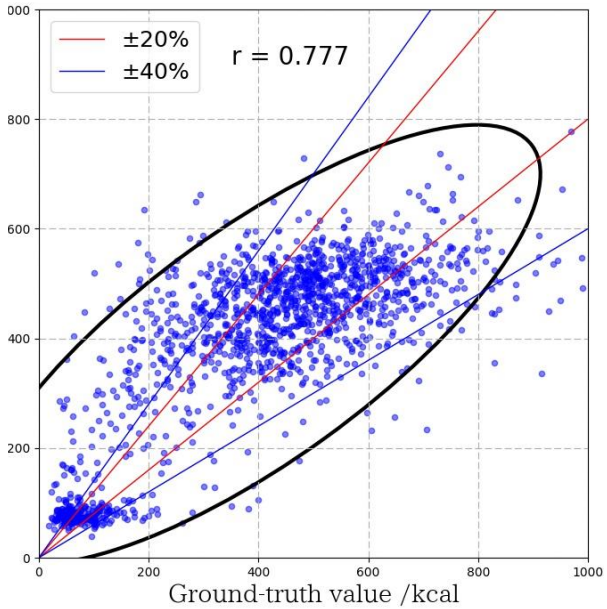


Regression-based
(VGG16 multi-task)



Search-based
(VGG16(UECFOOD100)
fc6 triplet + cls)

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Conclusion

- We compared two methods for direct food calorie estimation.
- Regression-based method is better than others, however it is not reliable results.
- It is necessary to consider food ingredients as well as food categories.

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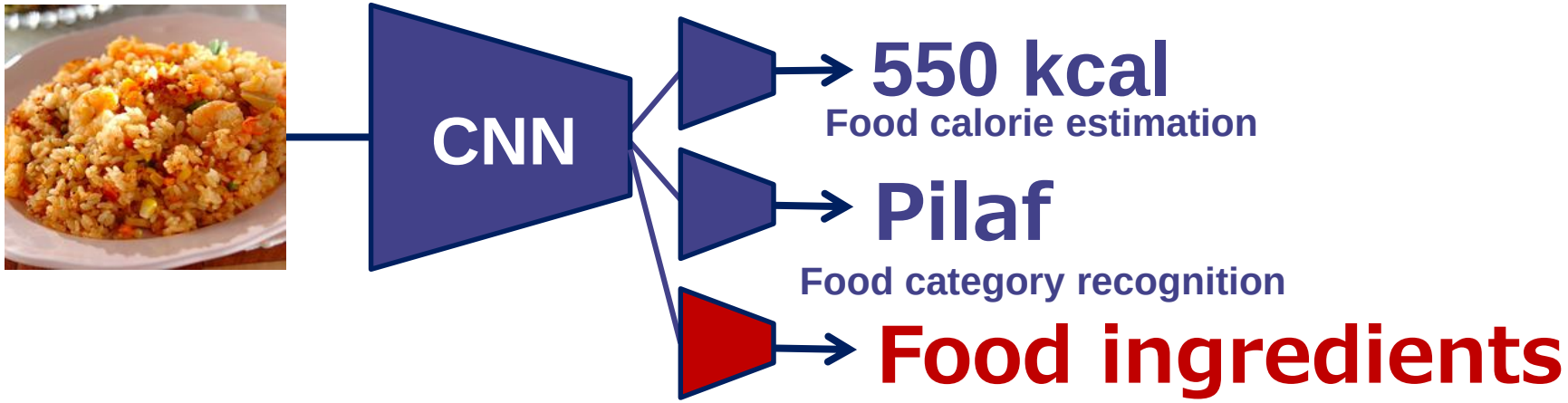
Future work

- We use food ingredients information on recipe data.
- In order to realize highly accurate food calorie estimation, we create new datasets.



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