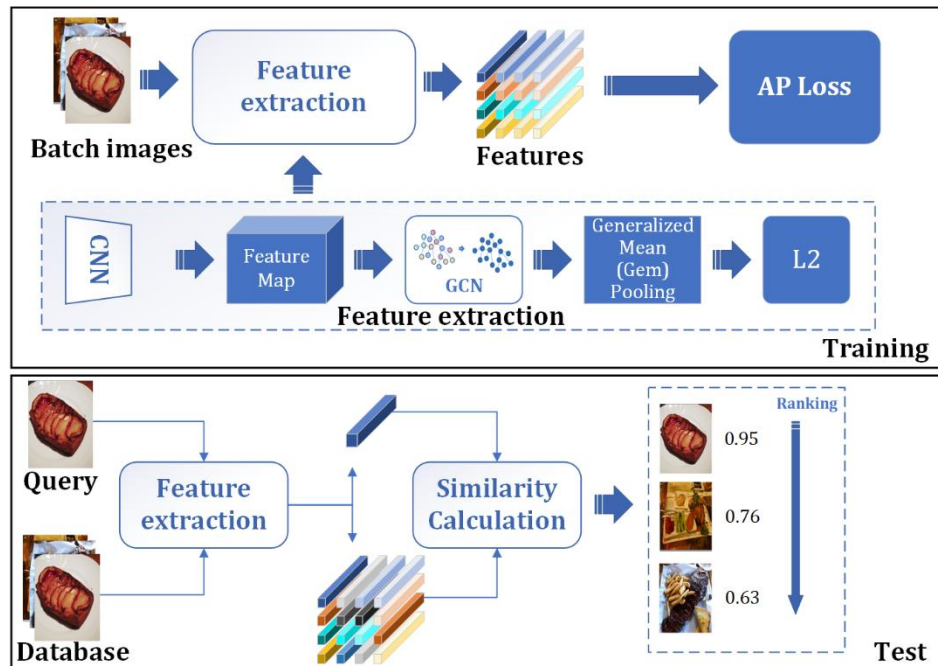# Part 3 Food Retrieval &Recommendation

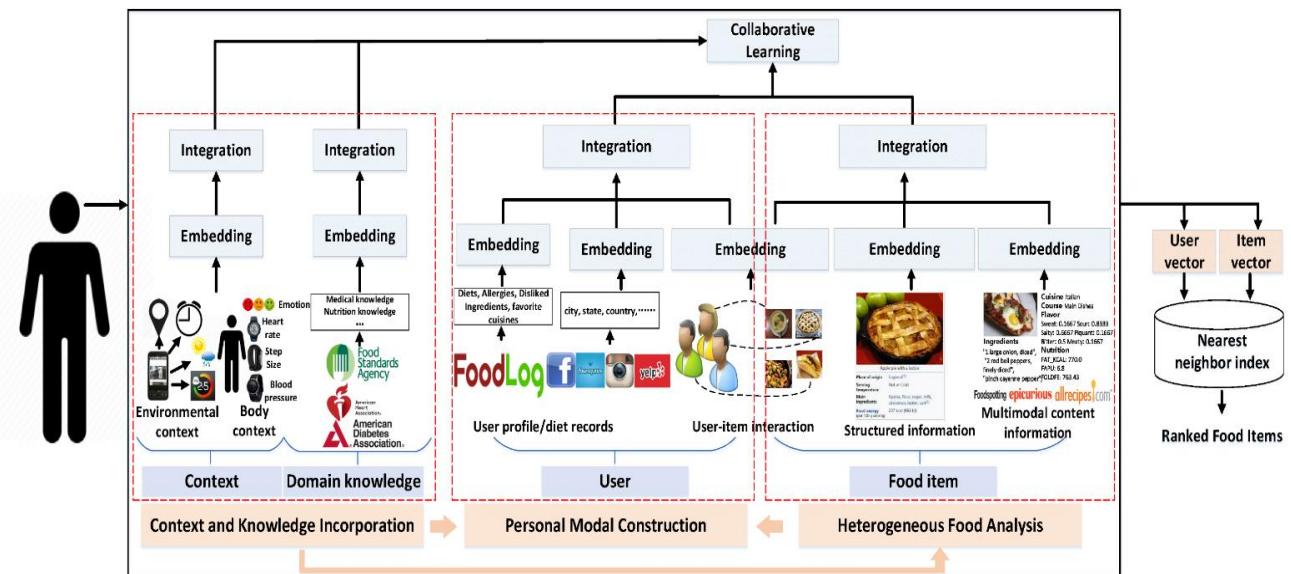# **Part 3** Food Retrieval &Recommendation

Food Retrieval
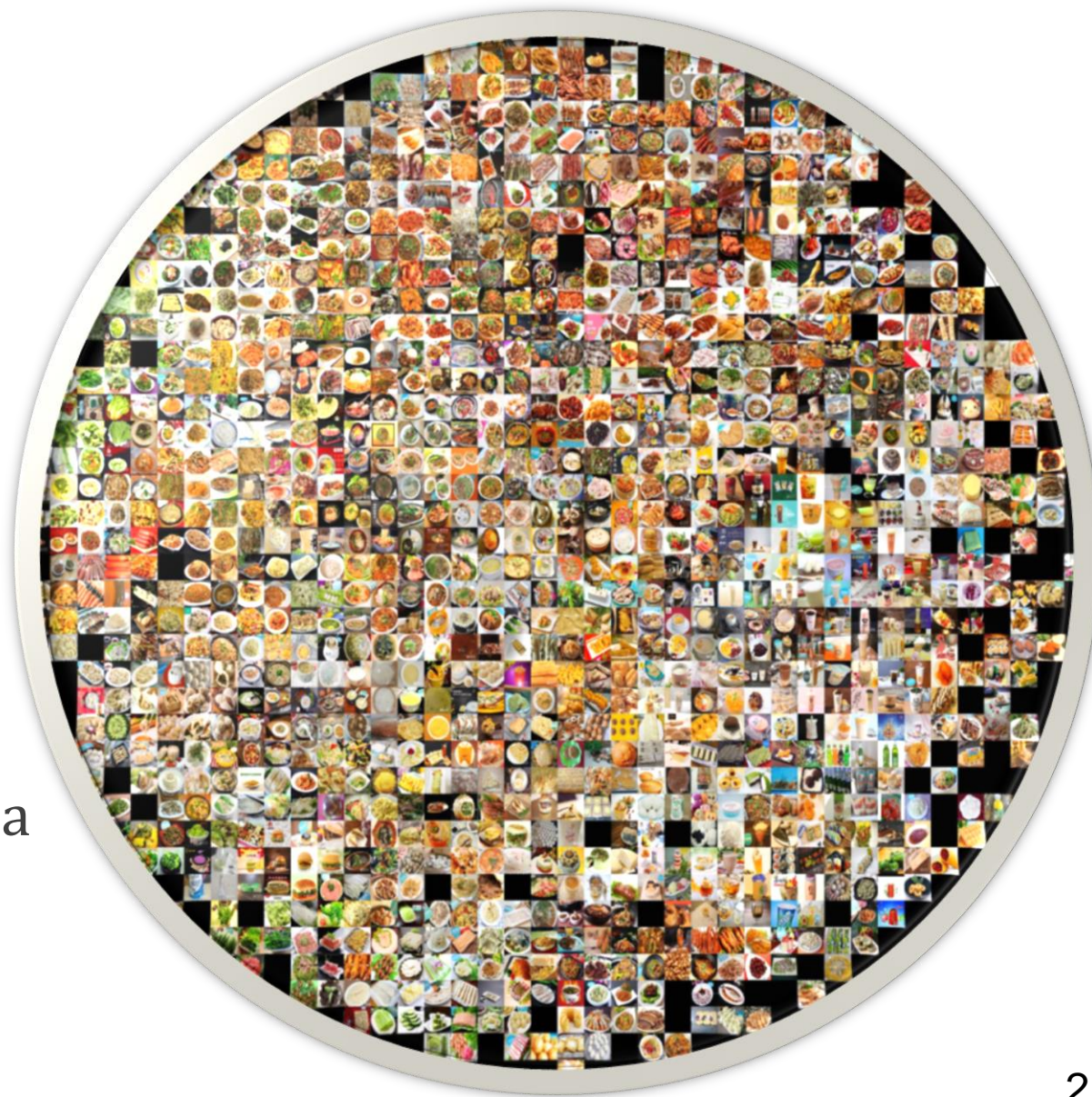
Food Recommendation

(Weiqing Min, *et al.* TMM'19)

Motivation
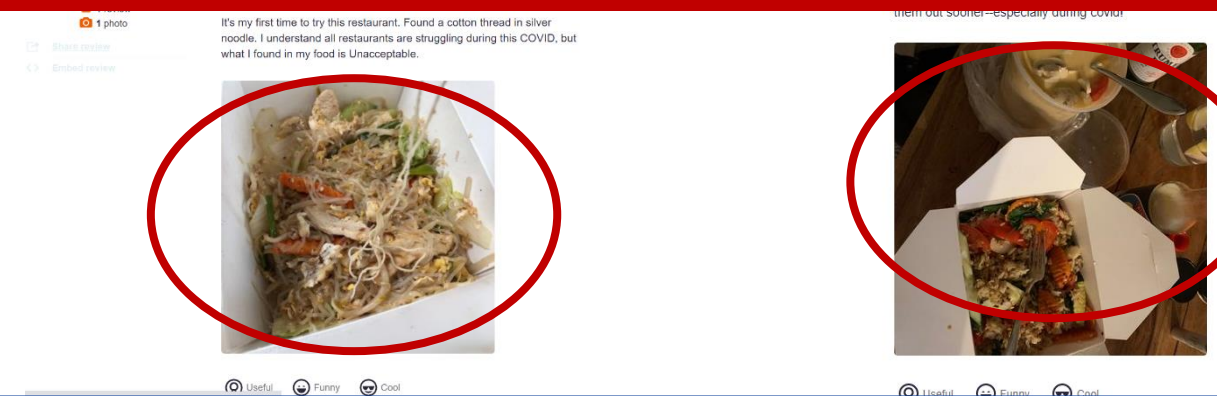
□ Thousands of food classes in the world

□ There doesn't exist a unified ontology for food classes, like WordNet

□ Food retrieval can be used to find similar foods among available ones and to suggest a possible food class
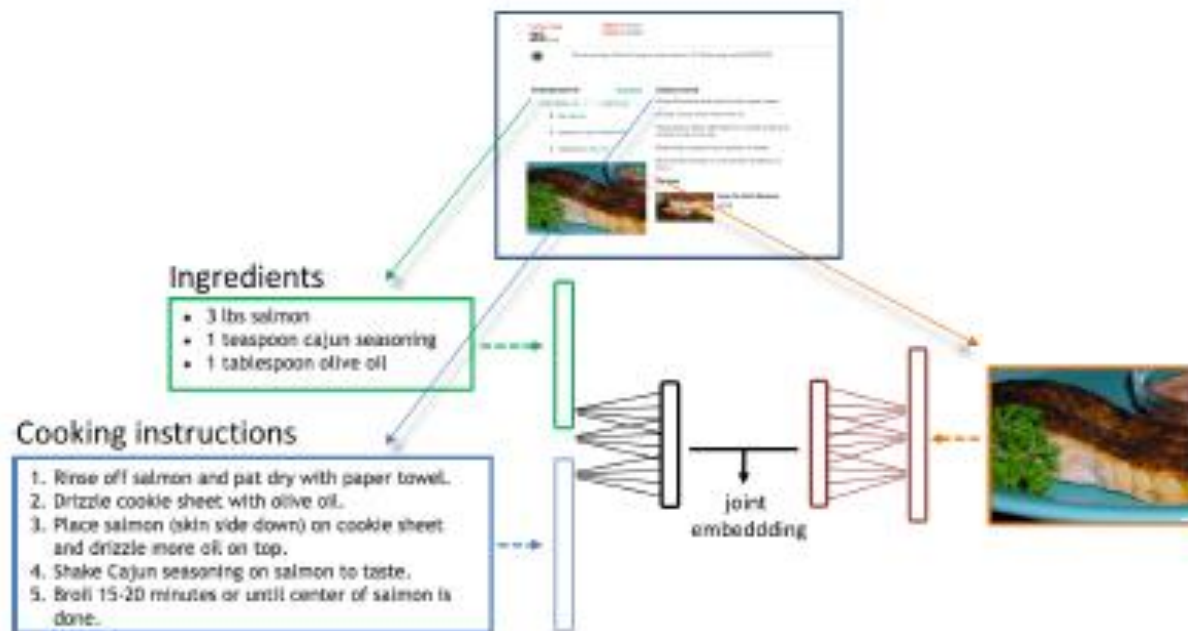
Motivation

people upload comments with dish images

□ For the same dish, different restaurants often gave different dish names. Food recognition can not work

□ Food retrieval provides one reasonable way to solve this problem

3

Existing works

☐ **Existing works mainly focus on cross-modal recipe-food image retrieval**

(Javier Marin et al. TPAMI'19)

Content-based food image retrieval is also useful in many scenarios

Motivation

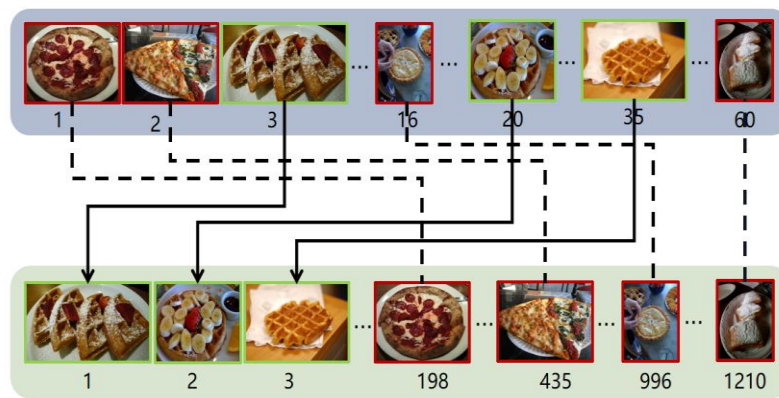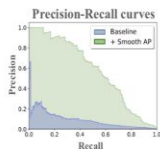**01**

Discriminative feature extraction

02

Gap between metric learning and retrieval

Internal consistency of each part

Interference with side dishes
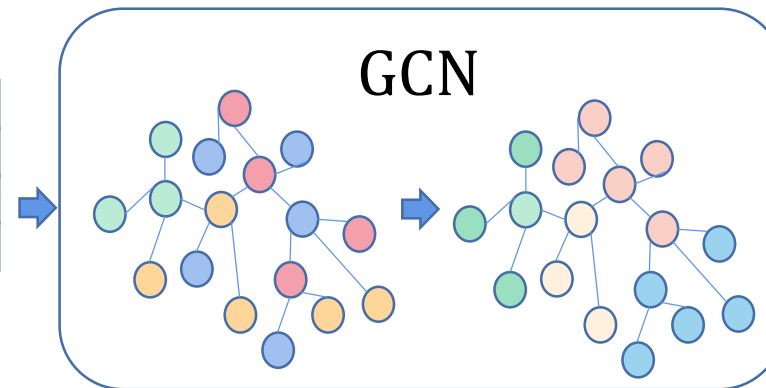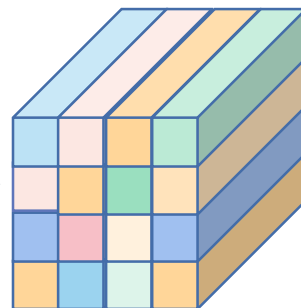
Precision-Recall curves

5

Idea

01

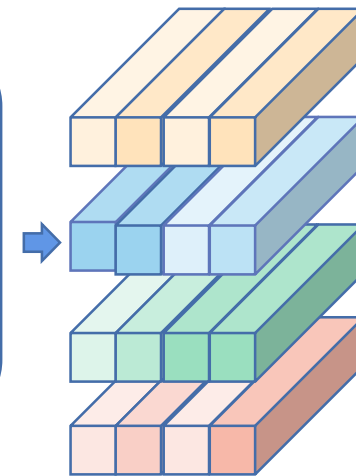Discriminative feature extraction

Internal consistency of each part
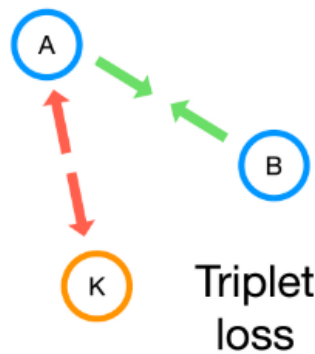
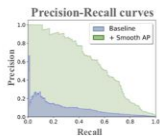Interference with side dishes

GCN

GCN based feature cluster

Idea

02

Gap between metric learning and retrieval

Embedding

Triplet loss

Average Precision (AP) Loss

AP loss

Method

Batch images → **Feature extraction** → **Features** → **AP Loss**

CNN → Feature Map → GCN → Generalized Mean (Gem) Pooling → L2

Feature extraction

Training

Query / **Database** → **Feature extraction** → **Similarity Calculation** → **Ranking**

0.95
0.76
0.63

Test

8

Method

Method

Batch images → **Feature extraction** → **Features** → **AP Loss**

AP loss

A →

B →

... ...

Z →
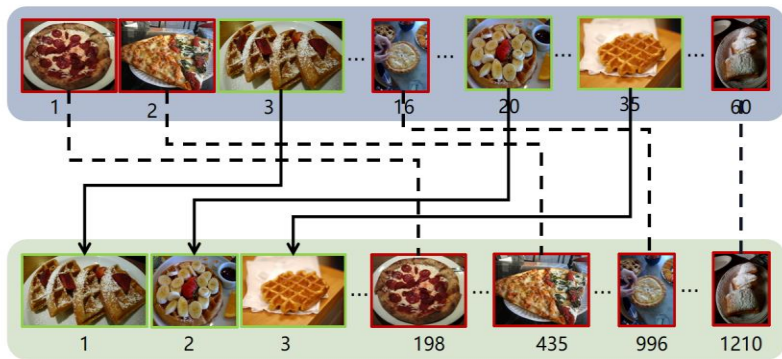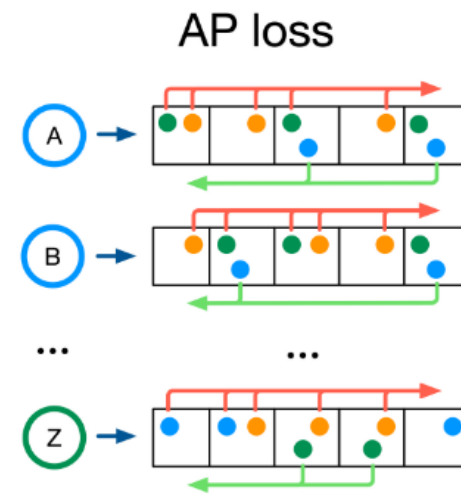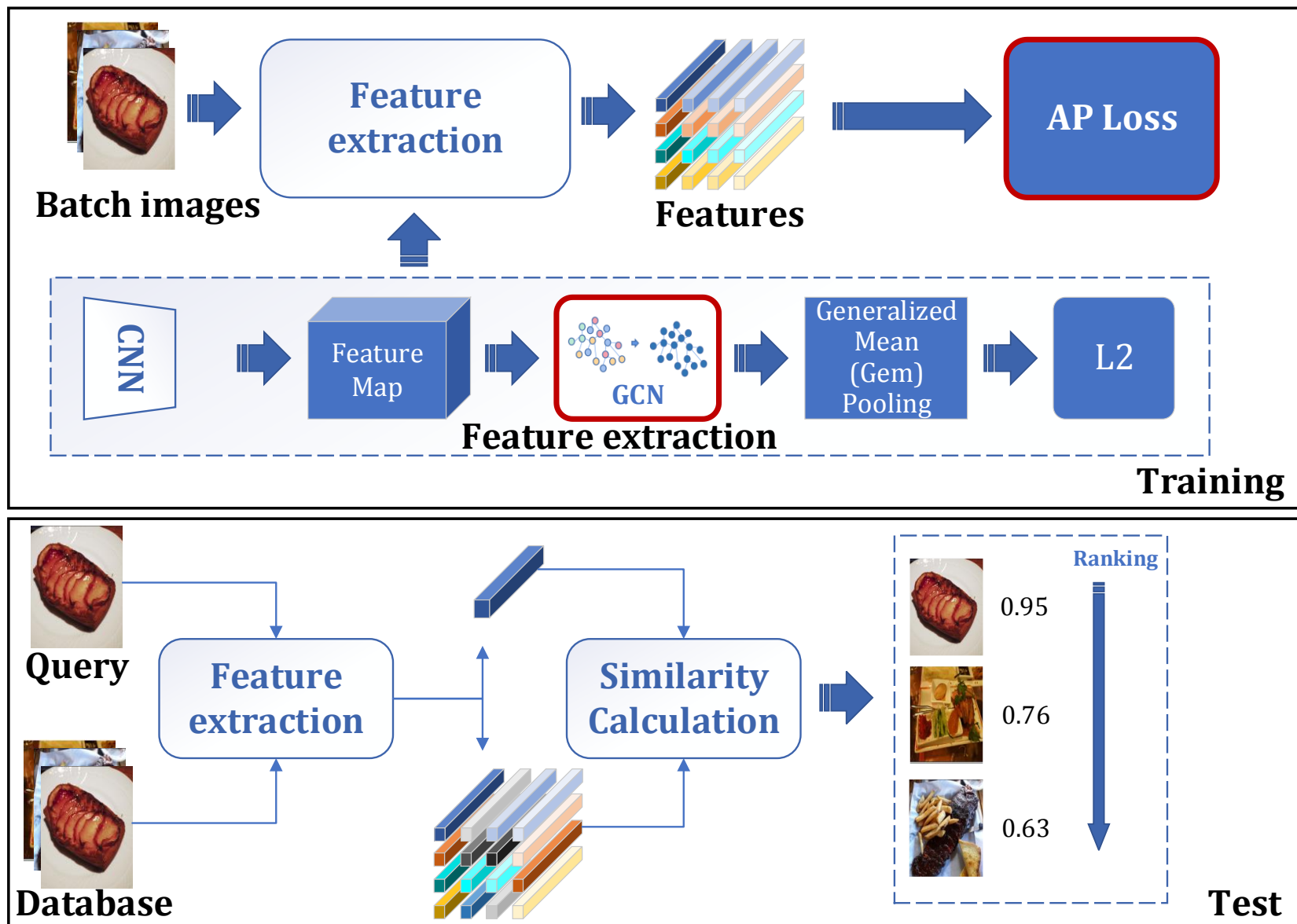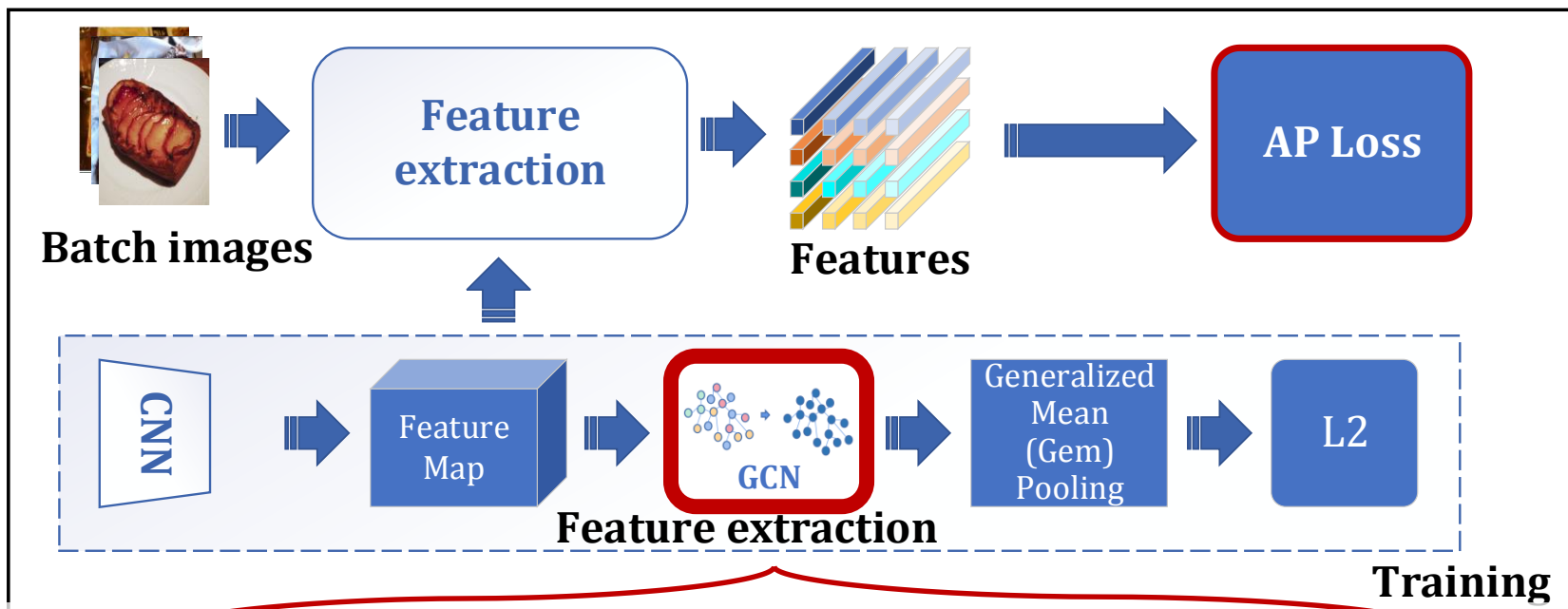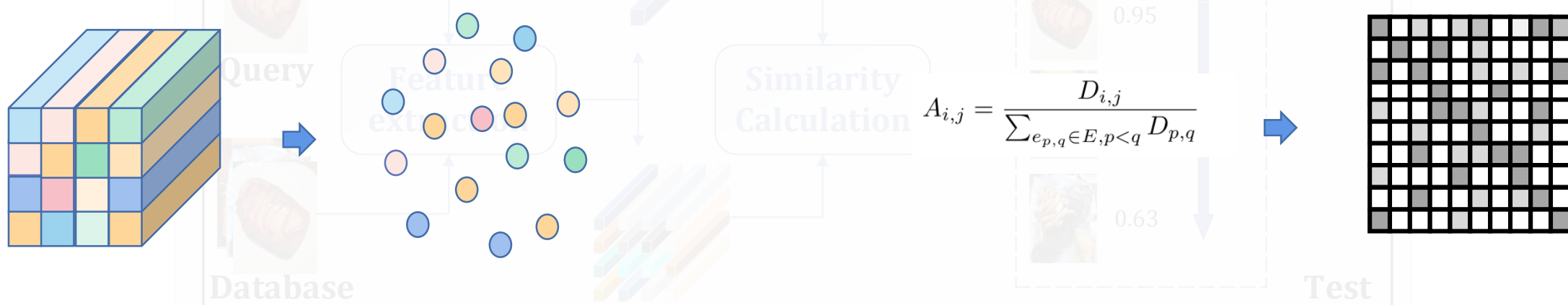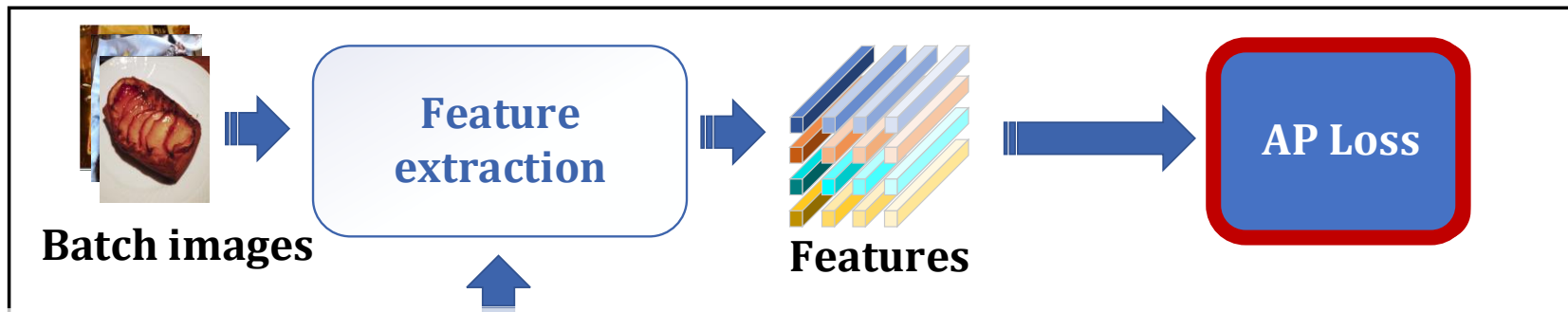
Approximating Average Precision (AP)
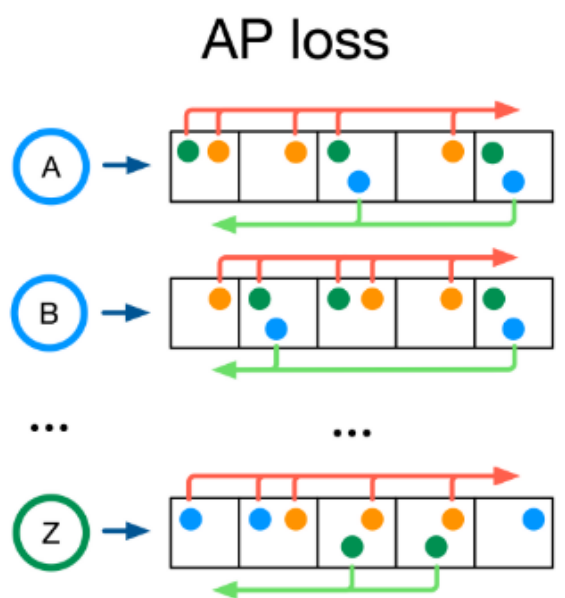
$$AP_q = \frac{1}{|\mathcal{S}_P|} \sum_{i \in \mathcal{S}_P} \frac{1 + \sum_{j \in \mathcal{S}_p, j \neq i} \mathbb{1}\{D_{ij} > 0\}}{1 + \sum_{j \in \mathcal{S}_P, j \neq i} \mathbb{1}\{D_{ij} > 0\} + \sum_{j \in \mathcal{S}_N} \mathbb{1}\{D_{ij} > 0\}}$$

$$AP_q \approx \frac{1}{|\mathcal{S}_P|} \sum_{i \in \mathcal{S}_P} \frac{1 + \sum_{j \in \mathcal{S}_P} \mathcal{G}(D_{ij}; \tau)}{1 + \sum_{j \in \mathcal{S}_P} \mathcal{G}(D_{ij}; \tau) + \sum_{j \in \mathcal{S}_N} \mathcal{G}(D_{ij}; \tau)}$$

$$D = \begin{bmatrix} s_1 & \dots & s_m \\ \vdots & \ddots & \vdots \\ s_1 & \dots & s_m \end{bmatrix} - \begin{bmatrix} s_1 & \dots & s_1 \\ \vdots & \ddots & \vdots \\ s_m & \dots & s_m \end{bmatrix} \qquad \mathcal{G}(x; \tau) = \frac{1}{1 + e^{\frac{-x}{\tau}}}.$$

Final Loss function

$$\mathcal{L}_{AP} = \frac{1}{m} \sum_{k=1}^{m} (1 - AP_k)$$

10
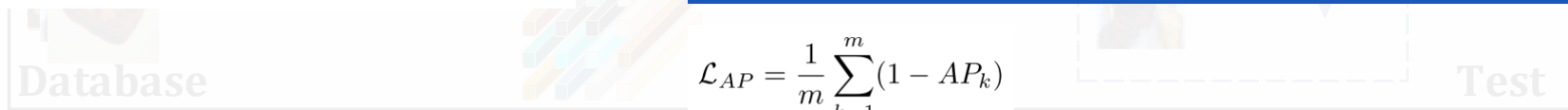
Evaluation

Dataset: ETHZ Food-101

Dataset	#Classes	#Images
ETHZ Food-101	101	101,000

Splitting:

Train	Query	Test Database
75,750	25,250	25,250

Metrics: Mean average precision(mAP), Top-k Recall (Top-k rec.)

Evaluation

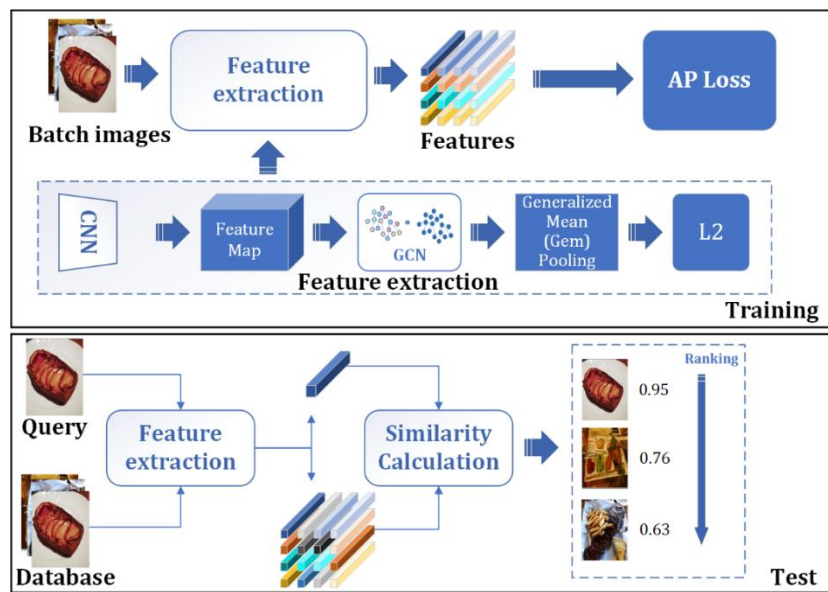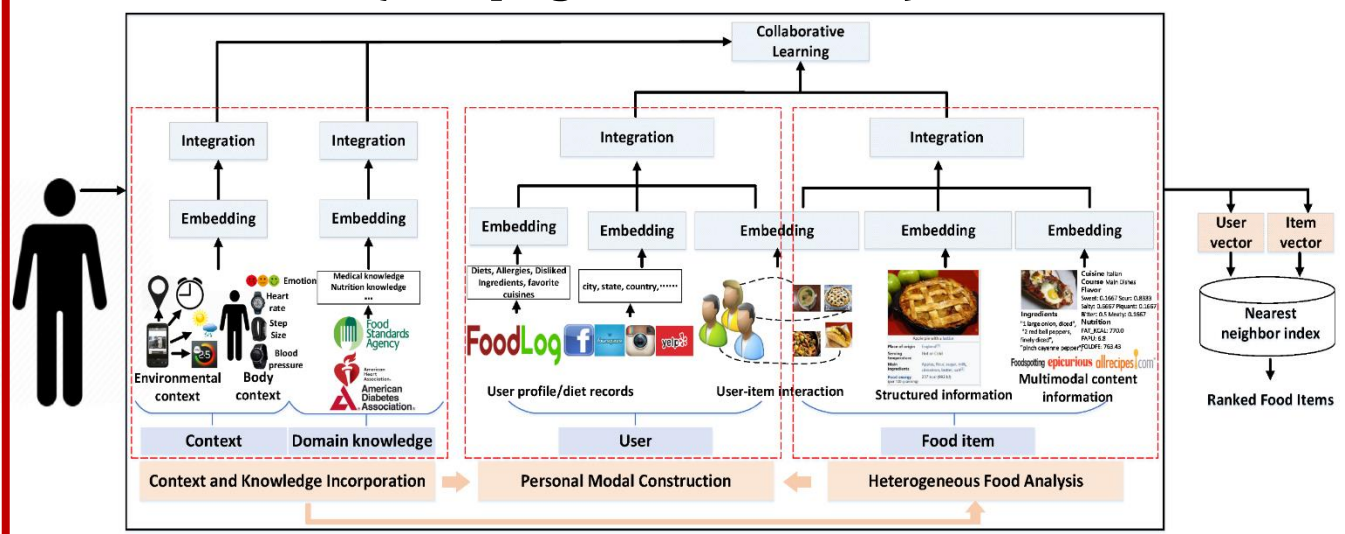| Performance comparison on different losses (%)				
Method	**mAP**	**Top-1 rec.**	**Top-5 rec.**	**Top-10 rec.**
Triplet	63.21	73.56	85.32	88.36
Contrastive	59.52	72.44	85.54	88.59
Smooth AP	76.53	83.71	91.28	93.07
Circle loss	72.02	80.42	89.93	92.19
Triplet(GCN)	70.11	79.82	89.18	91.25
Smooth AP(GCN)	75.28	81.85	89.90	91.71

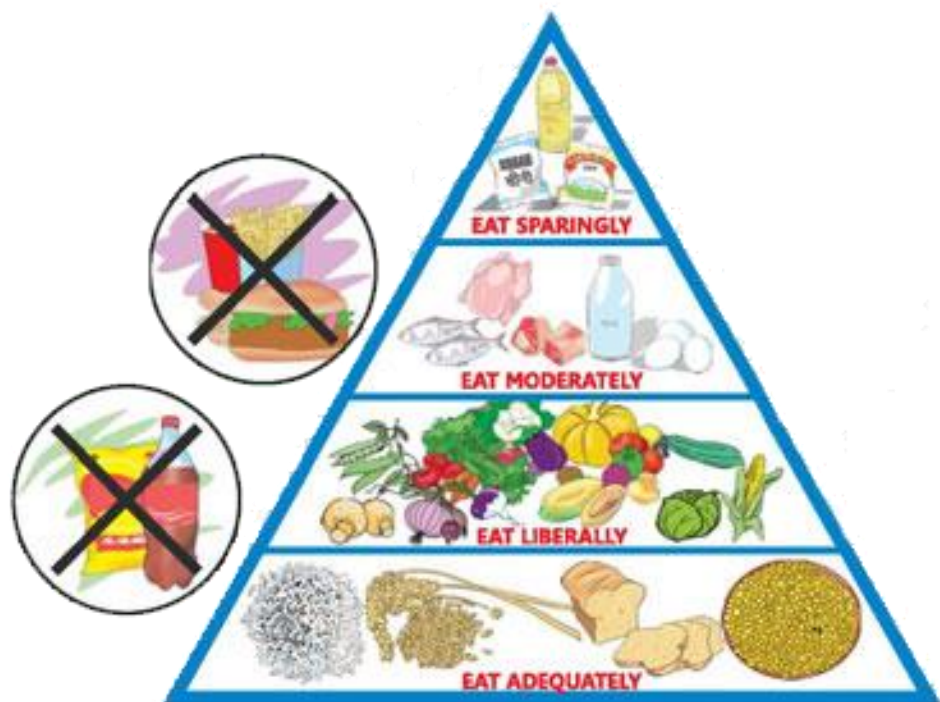# Part 3 Food Retrieval &Recommendation

Food Retrieval

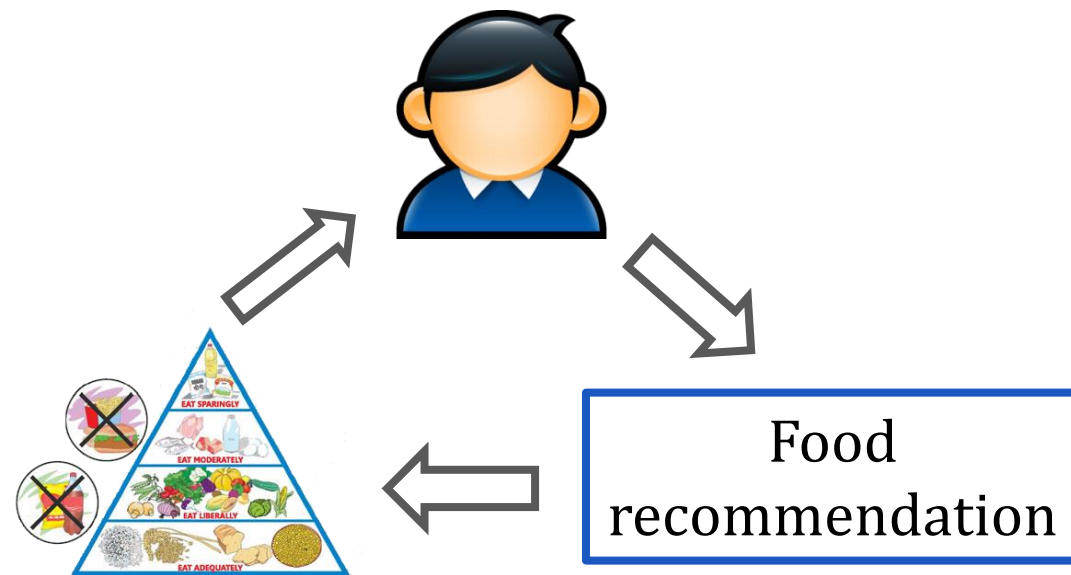**Food Recommendation**
(Weiqing Min, TMM'20)

Motivation

☐ **Healthy diet helps to prevent malnutrition**

☐ **Food recommendation intends to find suitable food items for users to meet their personalized needs, and thus plays a critical role in human dietary choice**
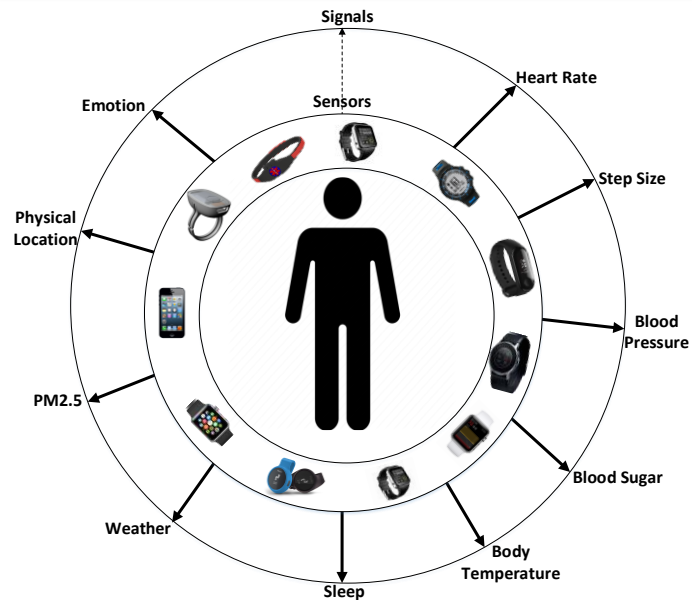

Healthy diet

Food recommendation

Three unique aspects

rich context & knowledge

Relevant to user's health

Diabetic **VS** Sweet food

Hypertension **VS** Meat
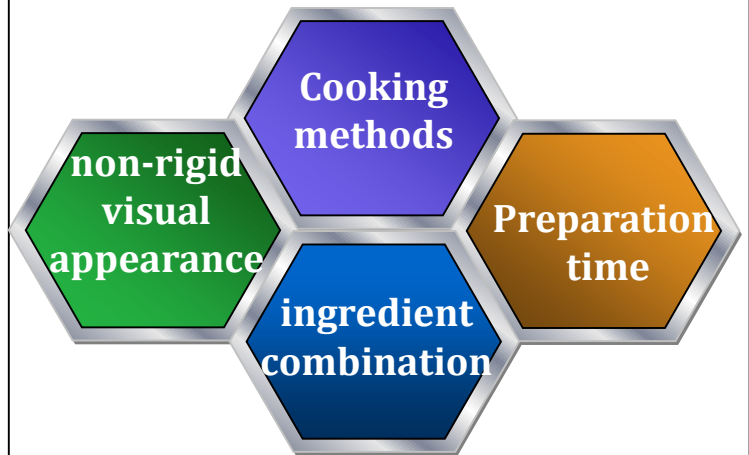
Build a trade-off between personalized food preference and personalized health requirement

Unique factors from food

Unique factors

non-rigid visual appearance

Cooking methods

Preparation time

ingredient combination

Multimodal food

Cuisine Italian
Course Main Dishes
Flavor
Sweet: 0.1667 Sour: 0.8333
Salty: 0.6667 Piquant: 0.1667
Bitter: 0.5 Meaty: 0.1667
Nutrition
FAT_KCAL: 770.0
FAPU: 6.8
FOLDFE: 763.43

"1 large onion, diced",
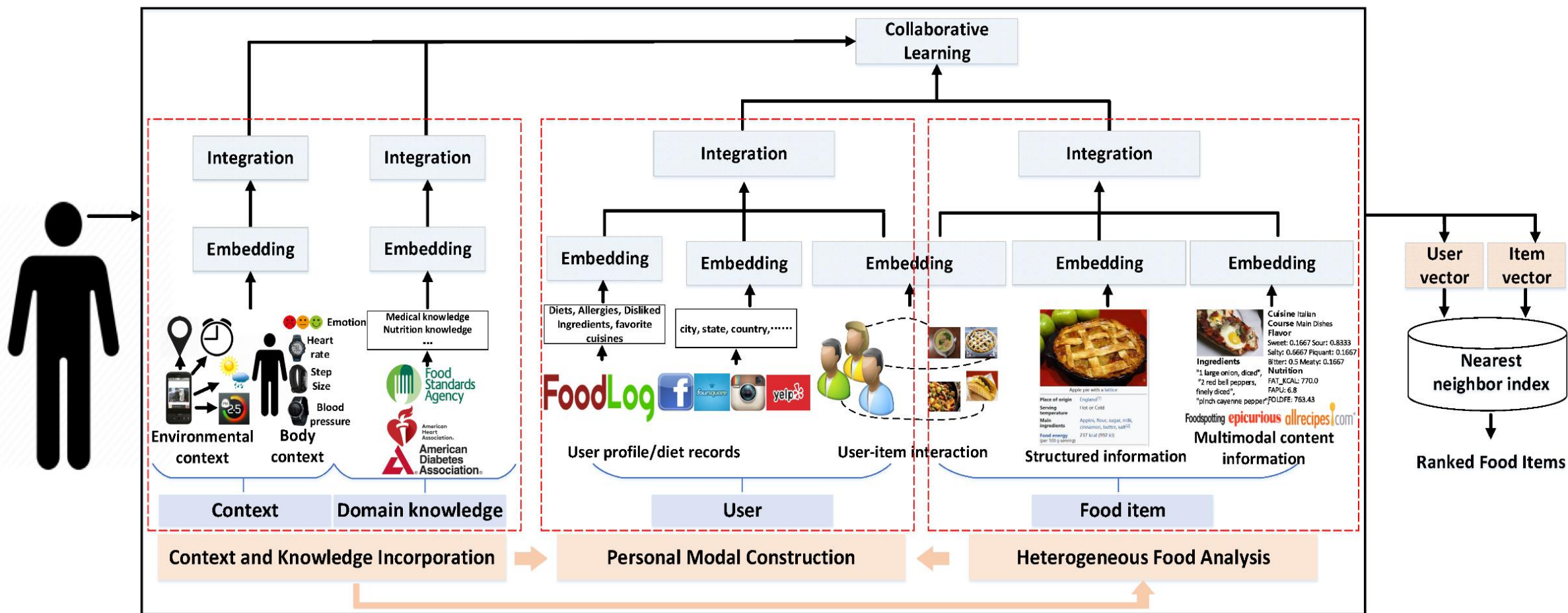"2 red bell peppers,
finely diced",
"pinch cayenne pepper"

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Idea

(1) Incorporating various context and domain knowledge

(2) Building the personal model

(3) Analyzing unique food characteristics

Framework

A unified food recommendation framework

Thanks