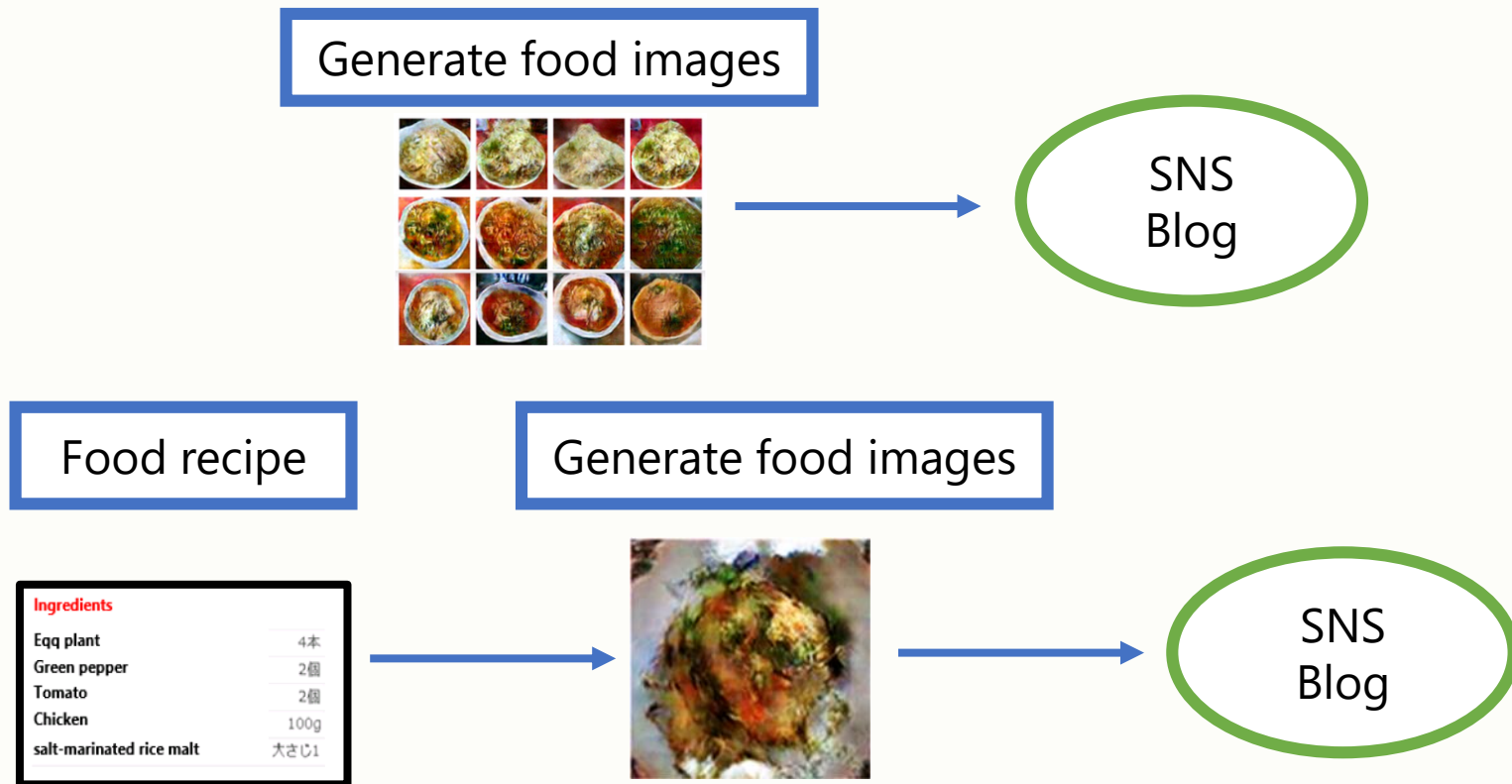


Food Image Generation using A Large Amount of Food Images with Conditional GAN: RamenGAN and RecipeGAN

Yoshifumi Ito, Wataru Shimoda, Keiji Yanai
The University of Electro-Communications,
Tokyo, Japan

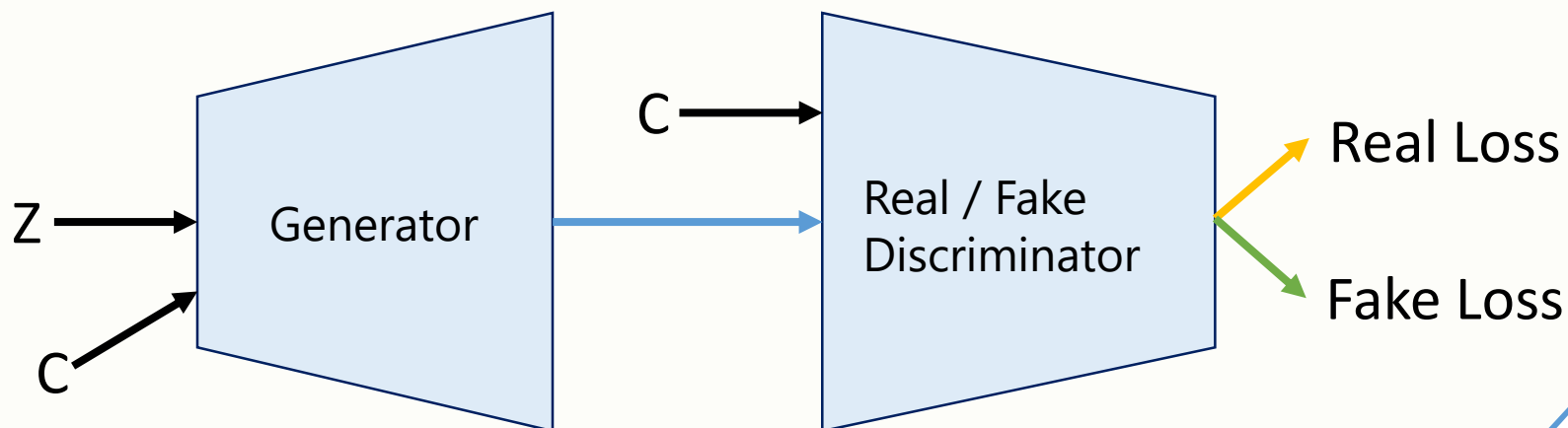


Objective



Method

- Conditional GAN [Mirza et al. arXiv 2014]
 - input
 - Random vector z
 - Condition vector c
 - Output
 - Generated image which is specific for condition vector c



Conditional GAN with WGAN-GP

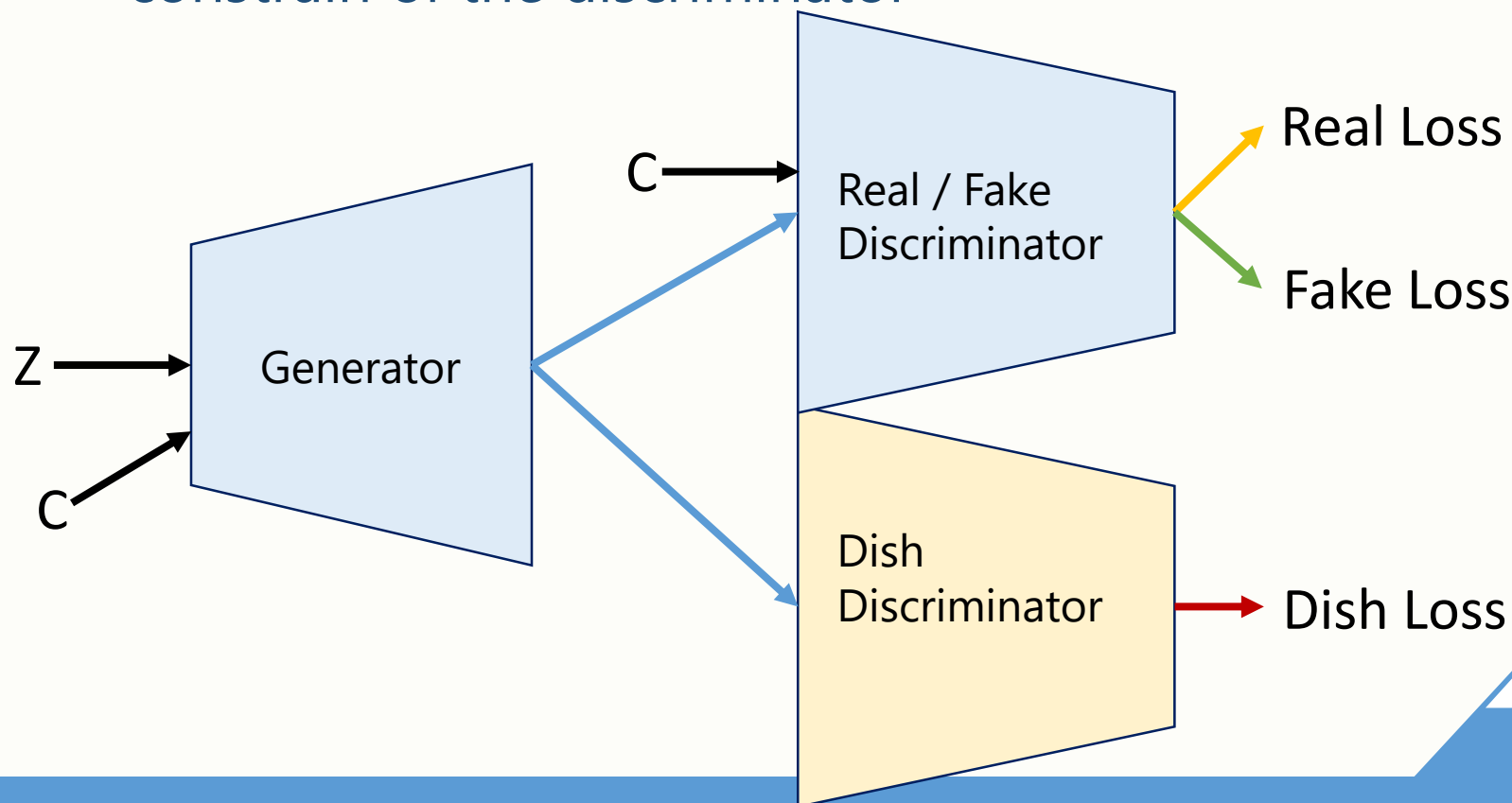
- WGAN [Arjovsky et al. arXiv 2017]
 - Minimize Wasserstein distance
- WGAN-gp [Gulrajani et al. arXiv 2017]
 - Generate High quality image
 - Reduce training of computational cost of WGAN
- Loss function

$$L_D^{CWGAN-GP} = \mathbb{E}[D(x|c)] - \mathbb{E}[D(G(z|c))] + \lambda \mathbb{E}[(|\nabla D(\alpha x - (1 - \alpha)G(z|c))| - 1)^2]$$

$$L_G^{CWGAN-GP} = \mathbb{E}[D(G(z|c))]$$

Improved c-GAN: Discriminator of dish plate

- We use a discriminator for dish plate outline
 - Dish plates of generated images will be round by the constrain of the discriminator



Discriminator of dish plate outline

- Learn the concept of dish plate shape



Experimental data

- Ramen Dataset

Target category	Image number
Plane ramen	790
Jiro ramen	5,901
lekei ramen	2,836
Spicy ramen	3,578
Taiwan ramen	1,567
Onomichi ramen	1,228
total	15,900



Experimental results

- Ramen GAN
 - Conditional GAN



Experimental results

- Ramen GAN
 - WGAN-GP+Discriminator of dish plate



Experimental data

- Cookpad dataset has 500k recipes.
 - We used several ingredient categories which is frequently used.



cookpad

豚の角煮

🍴 レシピを保存



煮れば煮るほどやわらかくなります。しかも余分なあぶらもとれるので、ヘルシーかも申しんない。時間はかかるけど、おいしいよ。



材料 (4人分)

しょうが	お好みで
ニンニク	お好みで
ねぎ	1本
豚肉	バラのブロック2パック
砂糖	小さじ1から2くらい
酒	たくさん (安い日本酒でいい)
醤油	適量 (味見しながらね)
みりん	大さじ3くらい

Experimental results

- Recipe GAN
 - Conditional GAN



Experimental results

- Recipe GAN
 - Conditional GAN+WGAN-GP



Experimental results

- Recipe GAN
 - CGAN+WGAN-GP+ Dish plate discriminator



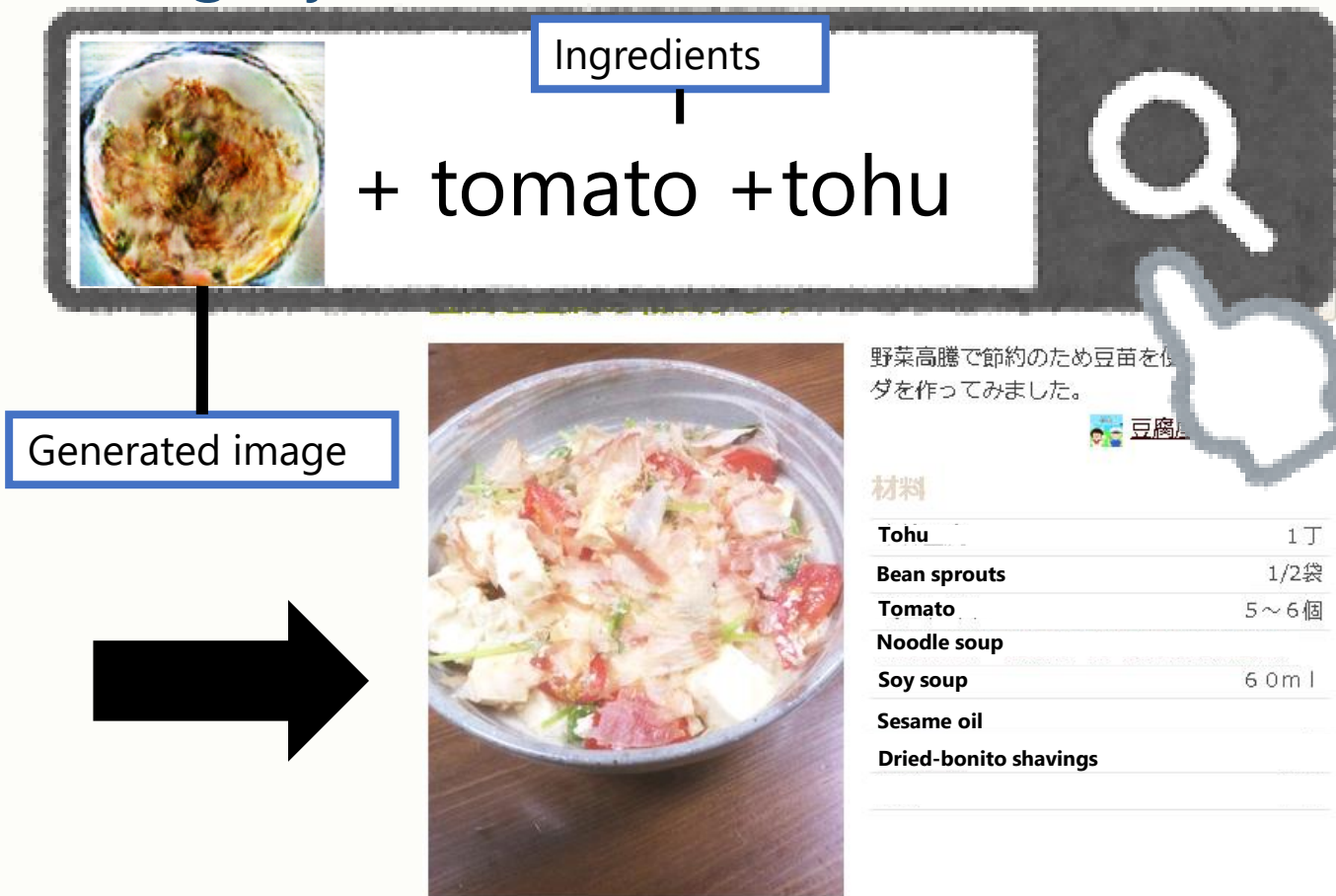
Experimental results

- Specific food category image generation
- | Category | Generated images | | | |
|----------|------------------|--|--|--|
|----------|------------------|--|--|--|



Image retrieval using generated image

- Image retrieval with generated image and category name



The diagram illustrates the image retrieval process. At the top, a search bar contains a generated image of a bowl of food, the text '+ tomato +tohu', and a magnifying glass icon. A hand cursor points to the magnifying glass. Below the search bar, a large black arrow points to a retrieved image of a bowl of food. To the right of the retrieved image is a recipe card with Japanese text and a list of ingredients.

Ingredients

+ tomato +tohu

Generated image

野菜高騰で節約のため豆苗を代わりに使ってみました。

豆腐

材料

Tohu	1丁
Bean sprouts	1/2袋
Tomato	5～6個
Noodle soup	
Soy soup	60ml
Sesame oil	
Dried-bonito shavings	

Image retrieval using generated image

Query image



Tomato+Chicken

Search result

Query



Input ingredients
Tomato + Chicken

鶏肉とトマトのてりやき！



Search result

レシピを保存

トマトを入れることで、あっさり食べられます。冷めても美味しくいただけます。

クック☆ミニオン

Ingredients

Eqq plant	4本
Green pepper	2個
Tomato	2個
Chicken	100g
salt-marinated rice malt	大さじ1

Conclusion and future work

- Conclusion
 - Food image generation using conditional GAN
 - Ramen GAN
 - Recipe GAN
 - The dish plate discriminator and WGAN-GP are effective for food image domain
- Future work
 - improvement of further quality
 - clean up dataset
 - Dividing current category into more detailed category
 - Numerical results