Sketch to Photo Translation

Yuhang Li, Xuejin Chen, Xiangxiang Wang, Sing Bing Kang

Original idea

Sketch to Photo Translation

- Problem definition
- Why sketch?
- Characteristic of Sketch

Related works

- Sketch2Photo
- Sketch-based classification
- Sketch-based retrieval
- Image-to-image translation

Exploration

- CycleGAN
- DiscoGAN

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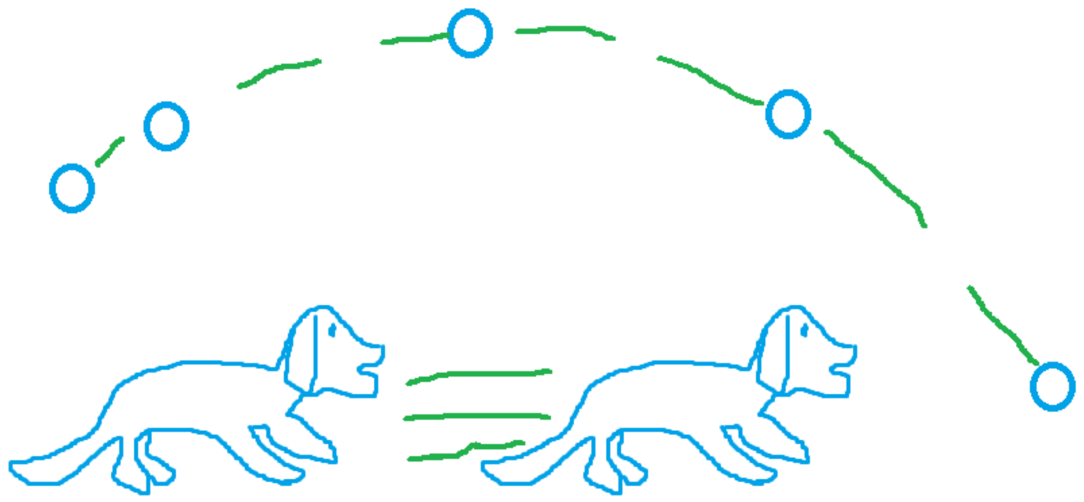
Original idea

Sketch to realistic video

Two kinds of strokes in a sketch:

- Object strokes
  - What object in the scene
- Motion strokes
  - How the object moves in the scene



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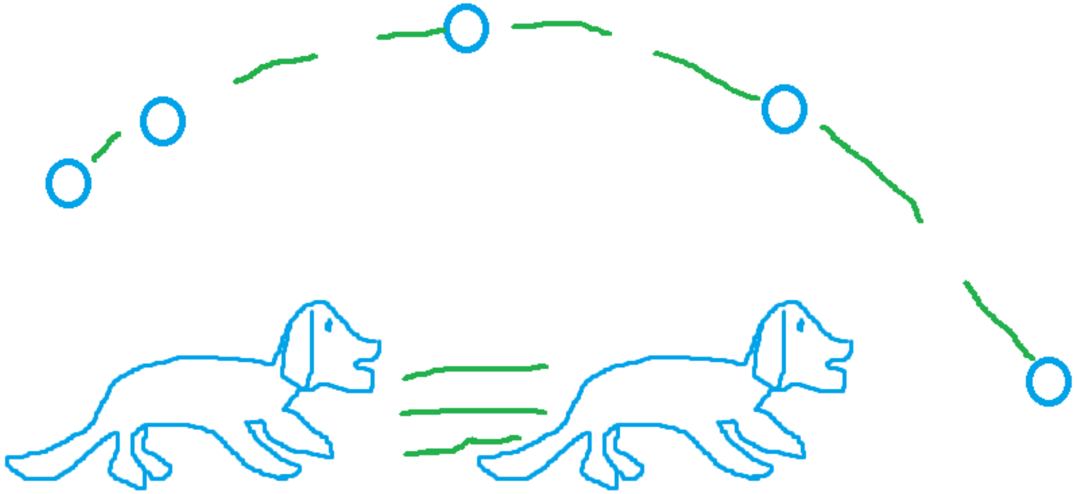

It is difficult to obtain corresponding videos that match both object strokes and motion strokes for training!

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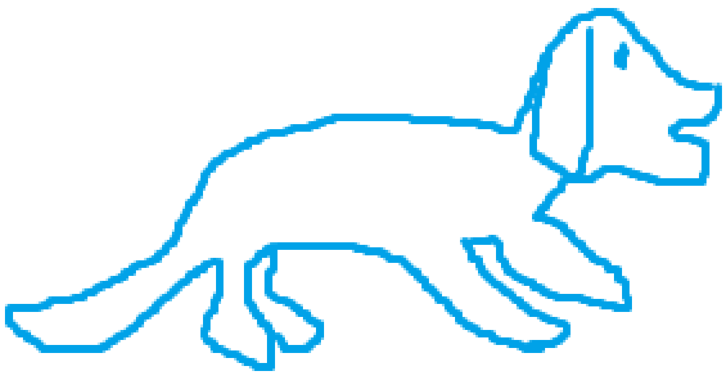

It is difficult to obtain corresponding videos that match both object strokes and motion strokes for training!

Focus on object strokes!

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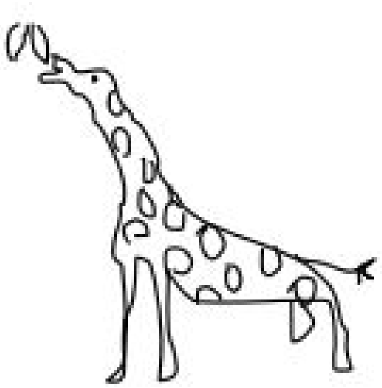
Problem definition

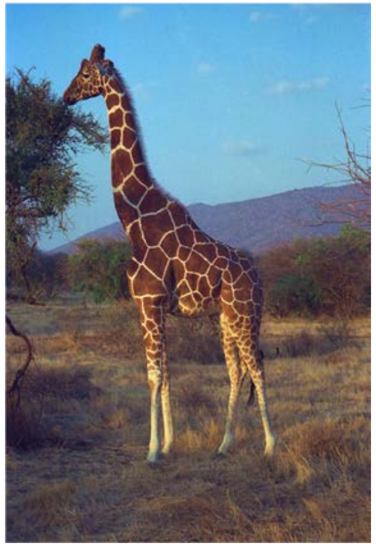
Sketch-based image generation

Given a sketch of **one** object, we want to generate a **new** but **realistic** image that preserves (Discuss)

- Object class: giraffe, elephant, chair or car
- View point
- Layout: size of the object, position in the image
- Pose: standing or sitting
- Background ?

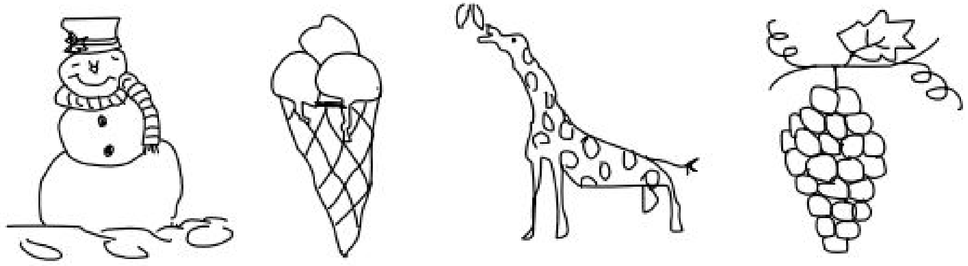
Shared information!





Sketch: why sketch?

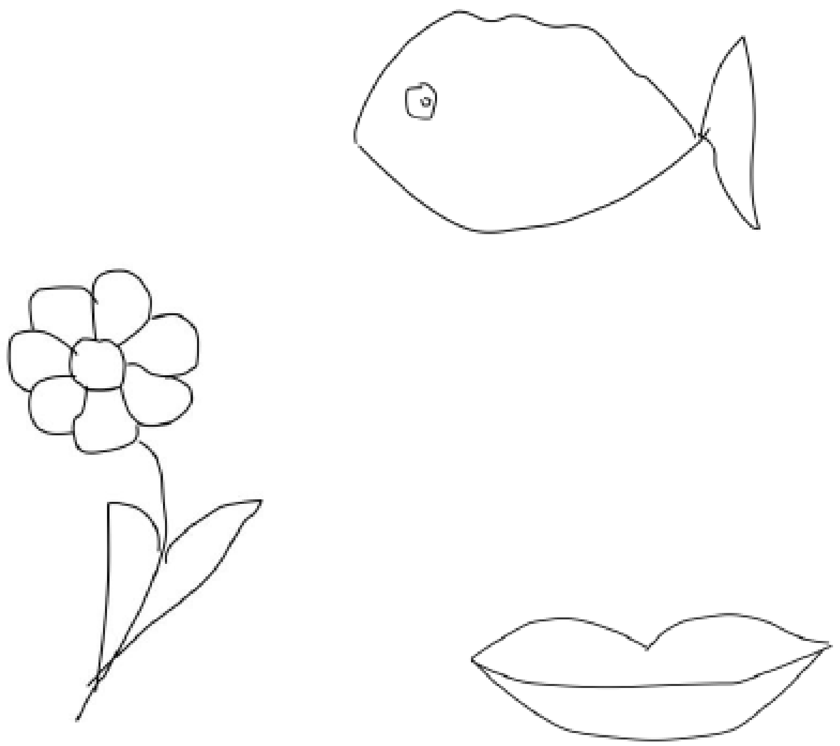
- A universal form of communication across nations and cultures
- Tracing back to prehistoric cave painting
- Conveying abstract concepts visually
- A *sketch* can speak a thousand words
- Becoming more important due to the popularity of touch devices



Characteristic of Sketch

- Iconic

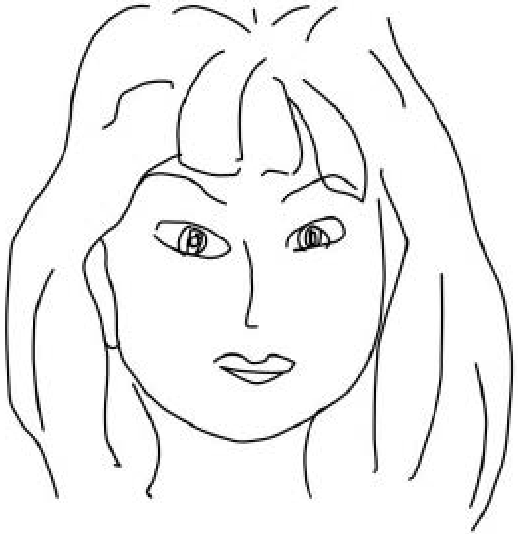
  Sketches can be highly abstract.



Characteristic of Sketch

- High intra-class variation

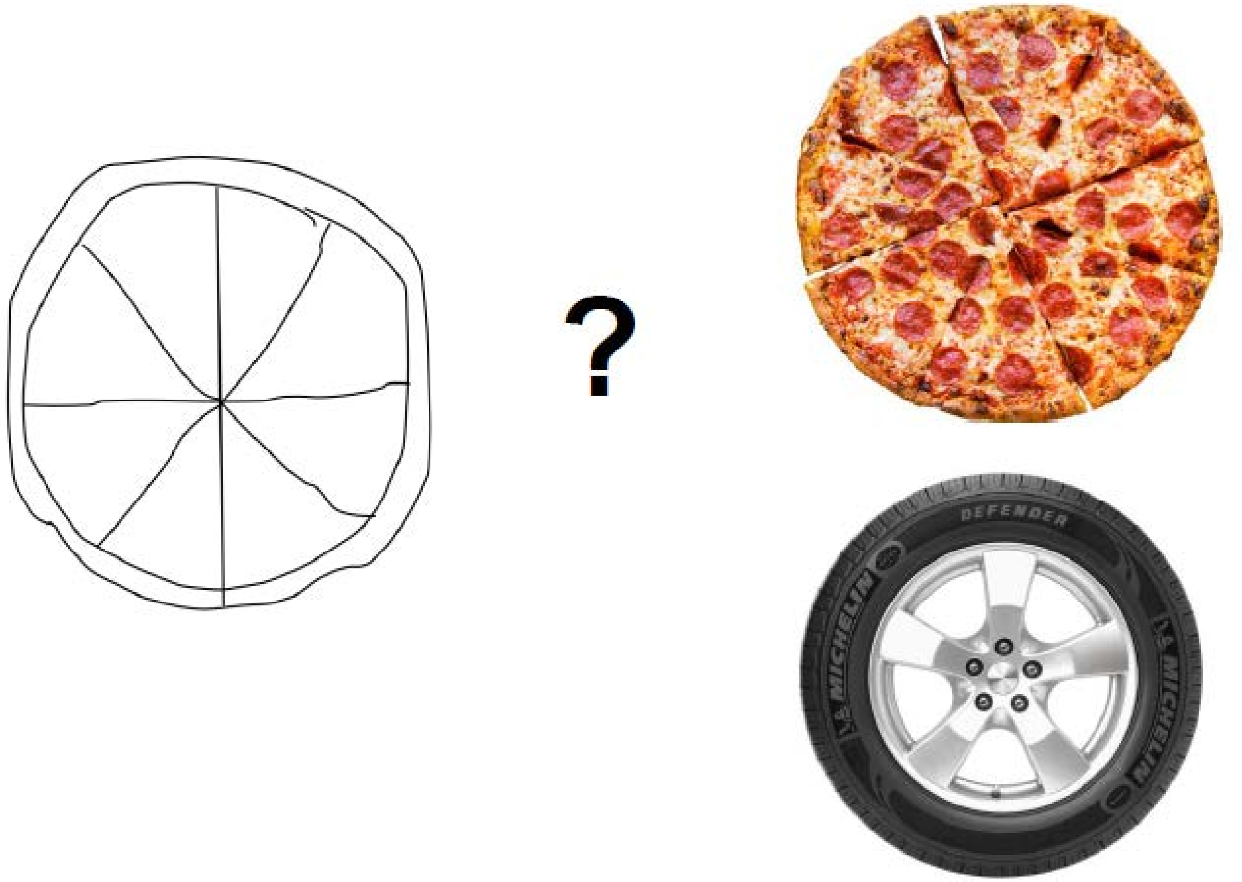
  Sketches drawn by different people vary in the level of abstraction or deformation.



Characteristic of Sketch

- Lack of visual cues

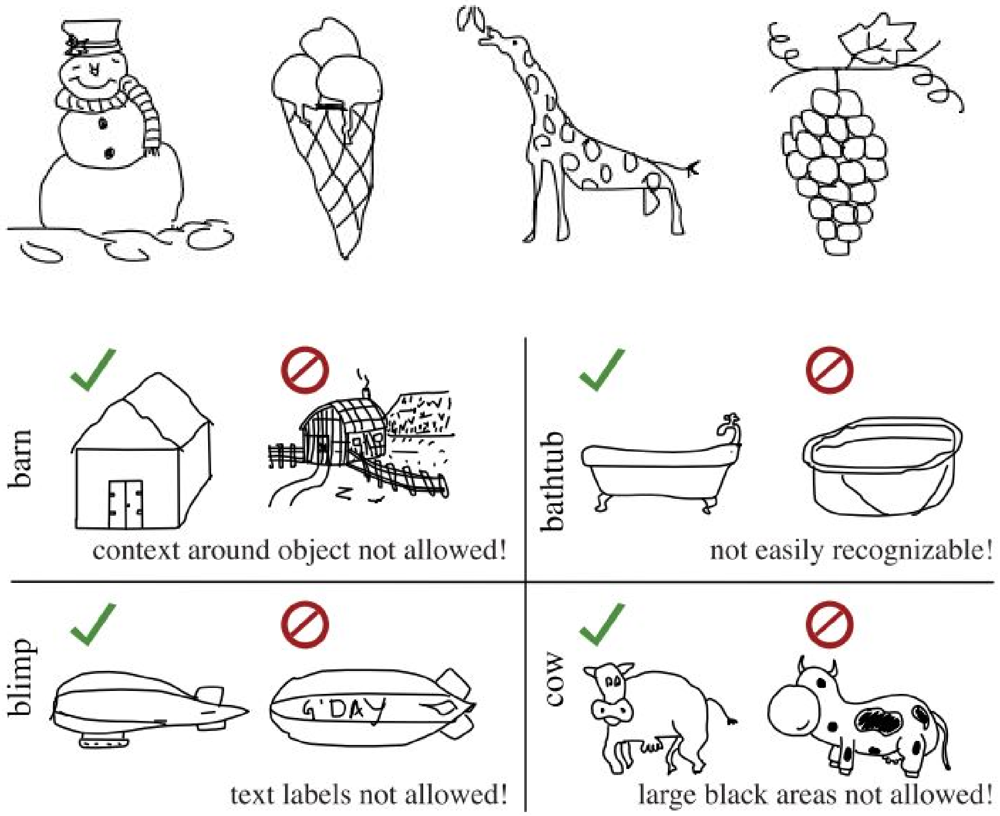
  Sketches are lack of colors and textures compared to photos.



Dataset

- TU-Berlin sketch dataset: a sketch dataset containing 250 categories and 80 sketches in each category.
- Fine-grain sketch dataset: paired fine-grain sketch and image of shoes and chairs.

Fine-grain sketch dataset



TU-Berlin sketch dataset

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Sketch2Photo: Internet Image Montage

- Generate a realistic image using a simple freehand sketch annotated with text labels.
- Text labeled sketch
- Seamlessly stitching several photograph

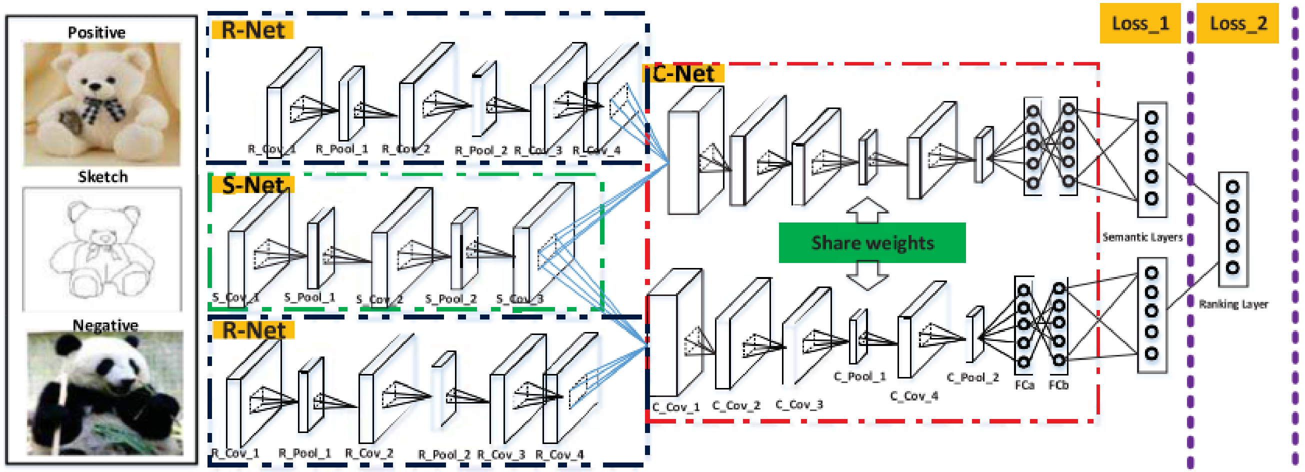
Sketch2Photo: Internet Image Montage

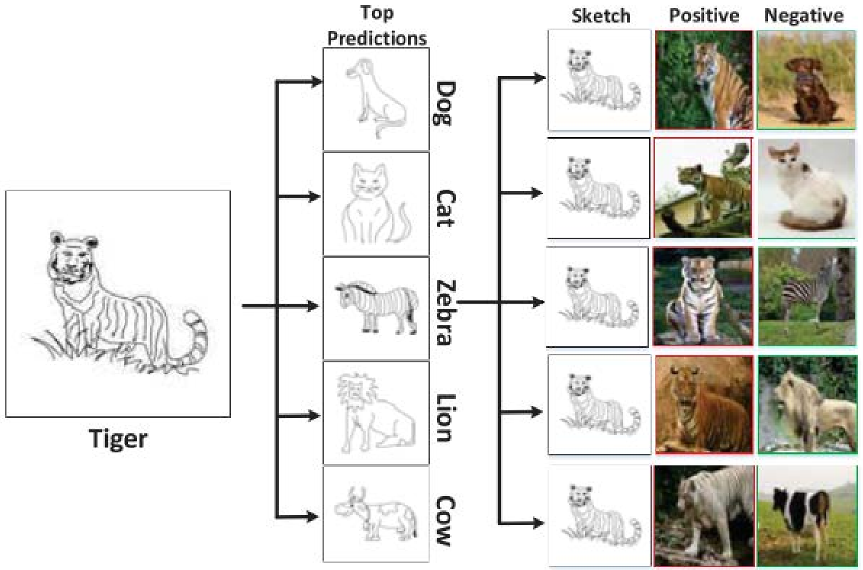
- Generate a realistic image using a simple freehand sketch annotated with text labels.

- Text labeled sketch
  - Labeling should be done automatically! (sketch classification)
- Seamlessly stitching several photograph
  - We want generate a totally **new** image, rather than a combination of existing image parts.

Sketch classification: SketchNet

- Discover the discriminative structures of sketch images
- Triplet networks based on Siamese nets
- Weekly supervised: with the help of photo images

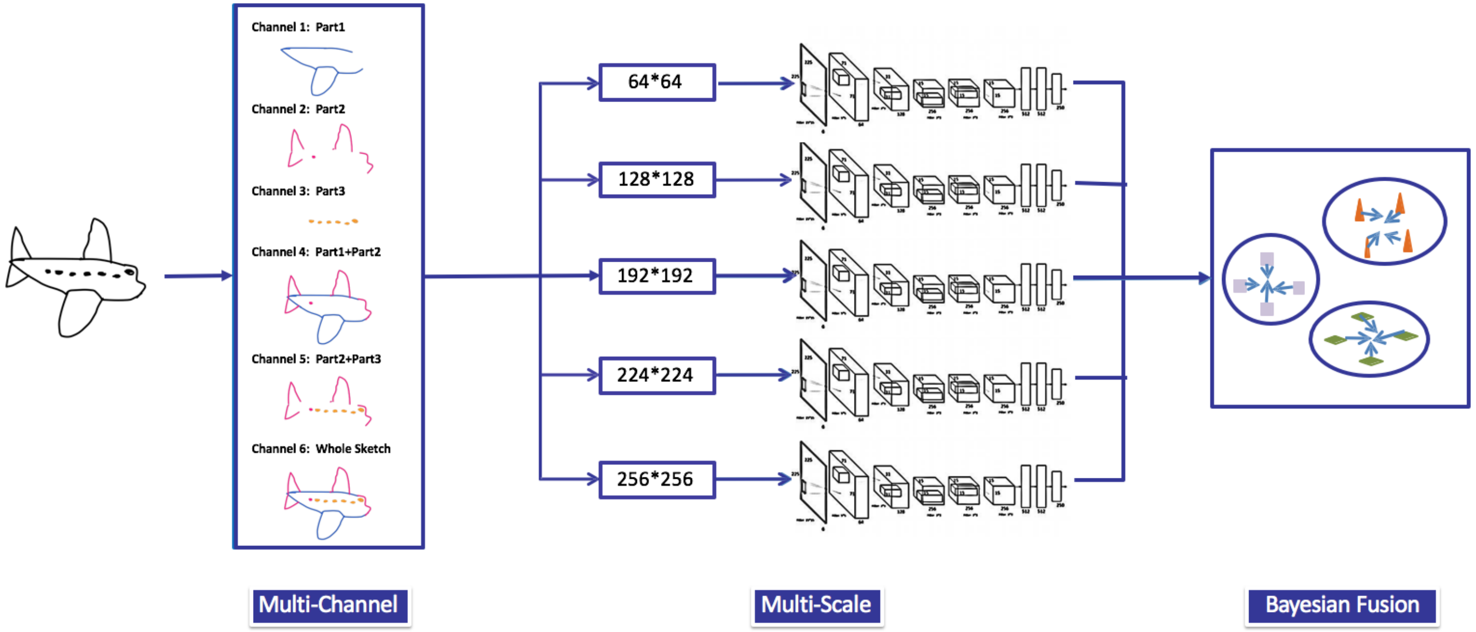




H. Zhang *2016*

Sketch classification: Sketch-a-Net

- A novel method of data augmentation
- Bayesian fusion
- Multiple models of different scales
- Beats human in sketch classification performance



Sketch-a-Net, Q. Yu 2016

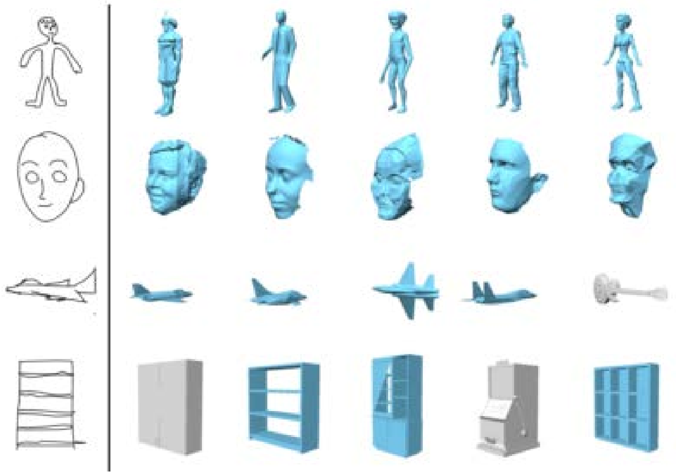
Sketch classification

Summary and inspirations

- Deep neural networks are able to handle sketch classification.
- Sketches with high intra-class variance are still able to mapped together in specific embedding space.
- There should be no need to annotate the sketch with text label.

Sketch-based retrieval

- Sketch-based 3D model retrieval
- Sketch-based image retrieval
- Sketch-based fine-grain image retrieval



3D model retrieval, F. Wang et al 2015

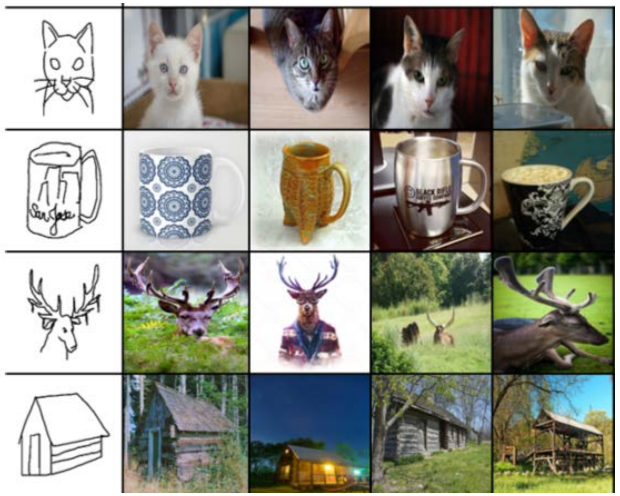


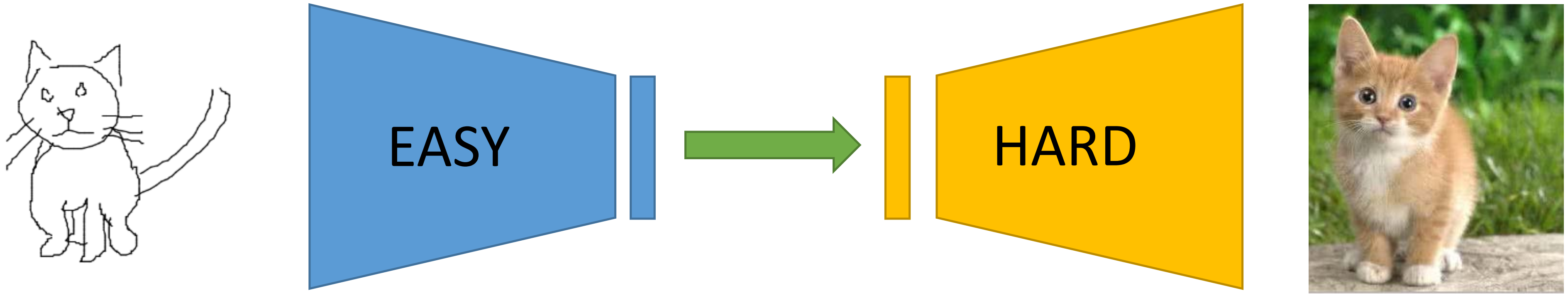
Image retrieval, P. Sangkloy et al 2016

Fine-grain image retrieval, Q. Yu et al 2016

Sketch-based retrieval

Summary and inspirations

- Minimize the distance between sketch and photo in embedding space
- A sketch and a similar photo are able to mapped close to each other in specific embedding space.



Inspired architecture of sketch-to-photo translation

Image-to-image translation

- Based on generative adversarial nets (GANs)
- Paired images for training
- A framework for multiple applications, only switching the training sets.

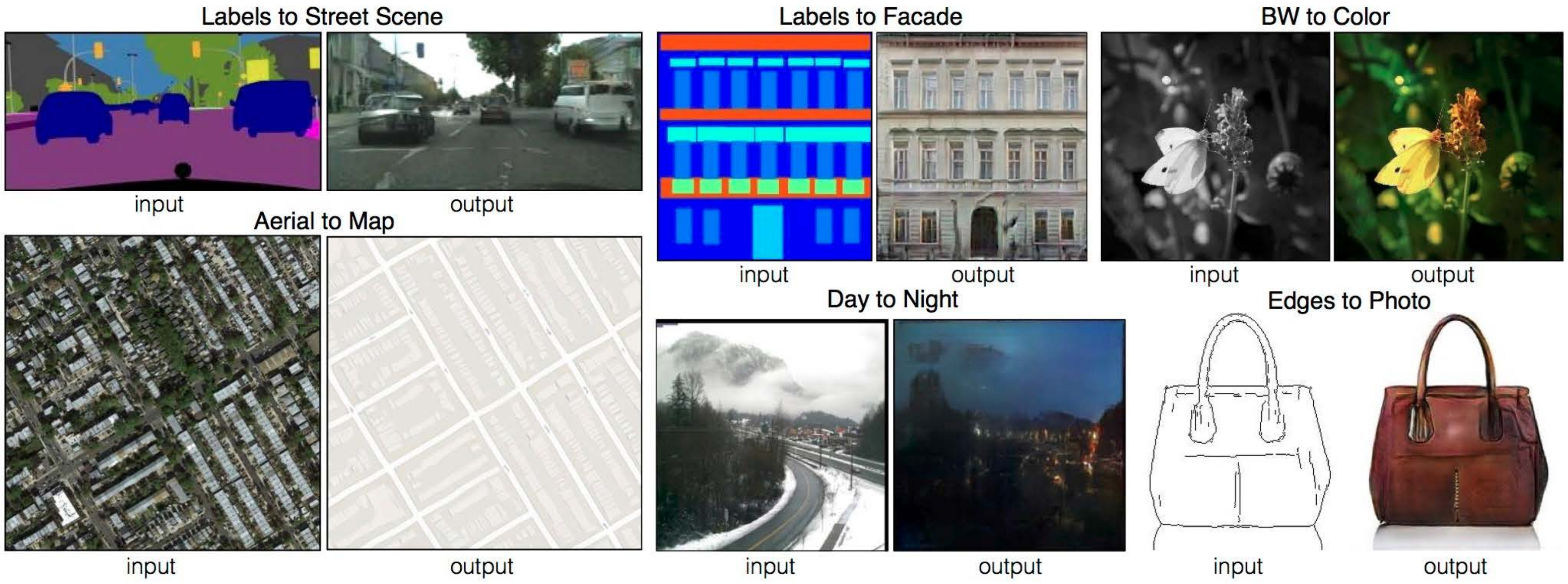


Image-to-image translation, P. Isola et al 2016

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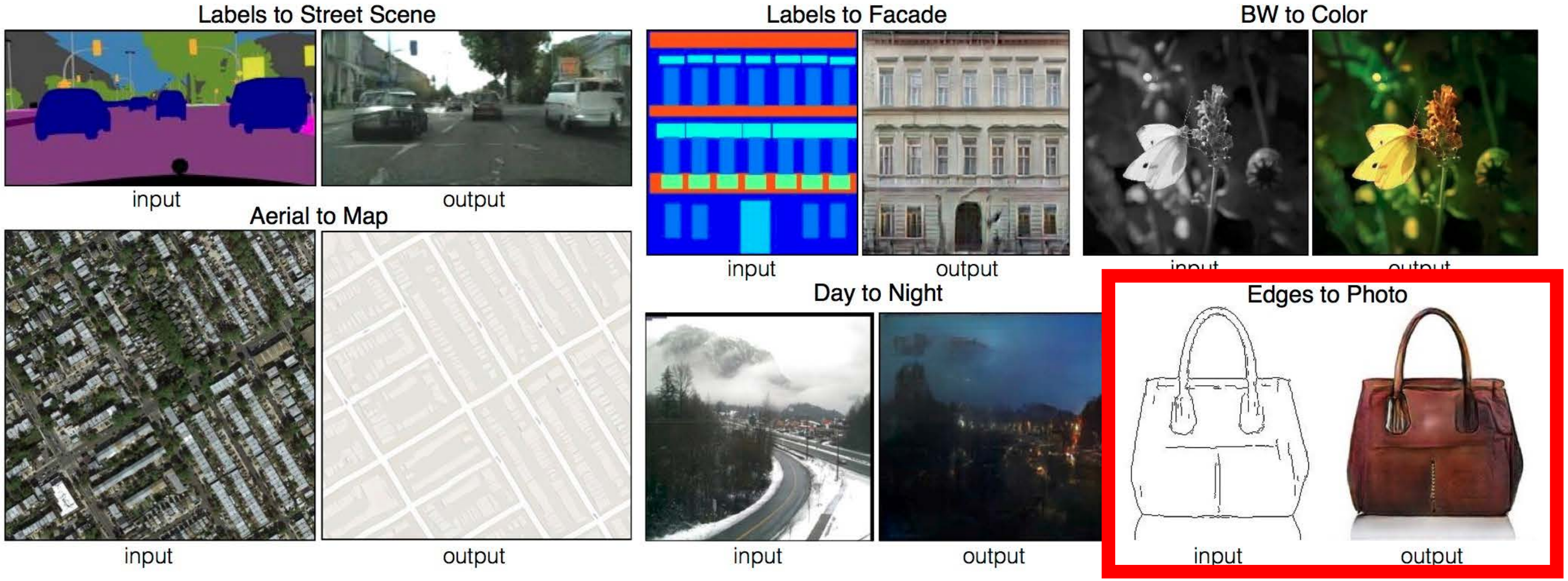


Image-to-image translation, P. Isola et al 2016

Image-to-image translation

Edge map to photo, P. Isola et al 2016

Image-to-image translation

- Paired images are required
  - Highly complex, expensive to obtain
  - Sometimes, not even well–defined
- Generated images are aligned to the edges. (Not only in the application of edge-to-photo)
- Not able to generate good results from abstract sketches

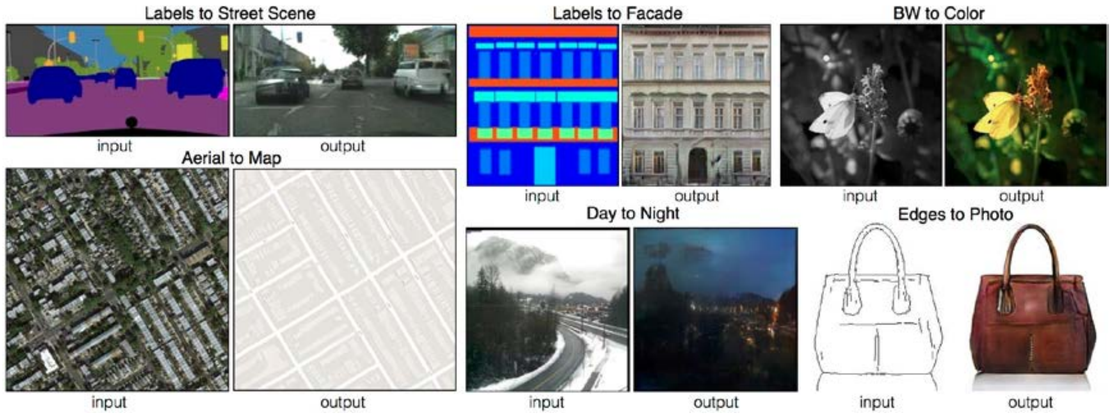


Image-to-image translation, P. Isola et al 2016

Input abstract sketch   Output image   Expected output

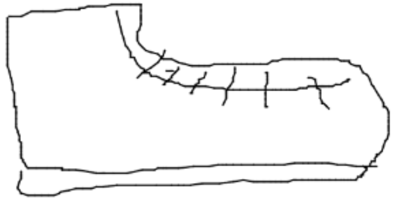
Image-to-image translation

- Paired images are required
  - Highly complex, expensive to obtain
  - Sometimes, not even well–defined
- Generated images are aligned to the edges. (Not only in the application of edge-to-photo)
- Not able to generate good results from abstract sketches

Edge map to photo, P. Isola et al 2016

Input edge map

Good result



Input abstract sketch

Bad result

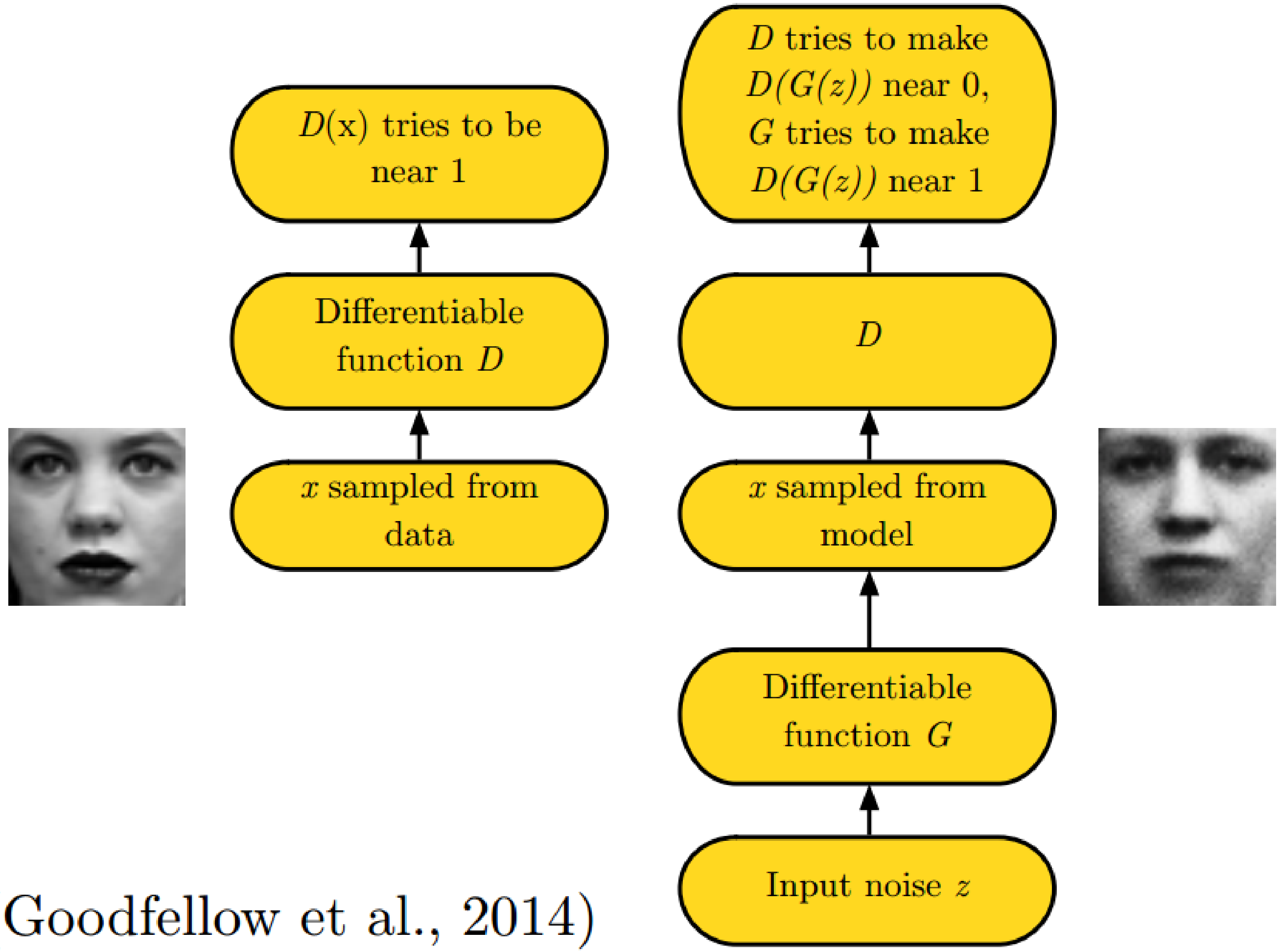
Image-to-image translation

Summary and inspirations

- GAN is a powerful framework to generate images.
- Images generated by image-conditional GANs tend to remember the edge maps of the input images.

Generative Adversarial Nets (GANs)

- Generate images of a given dataset by adversarial training
- Discriminator
- Generator
- Minmax game

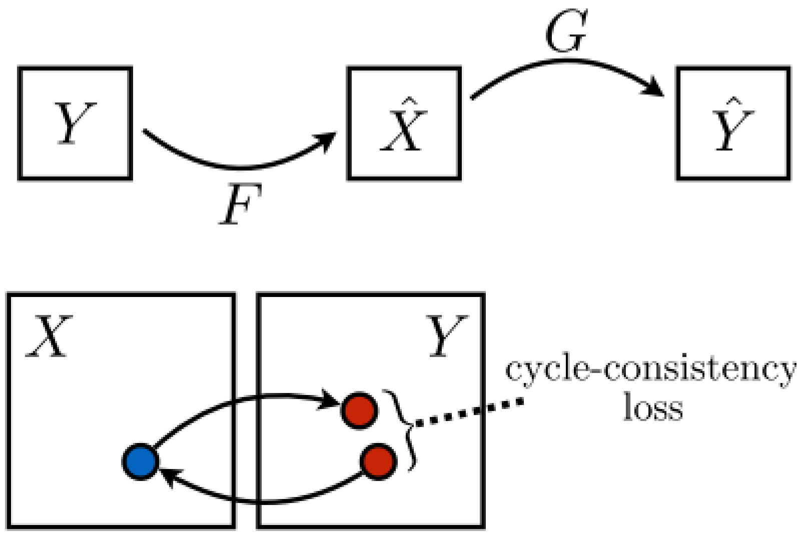


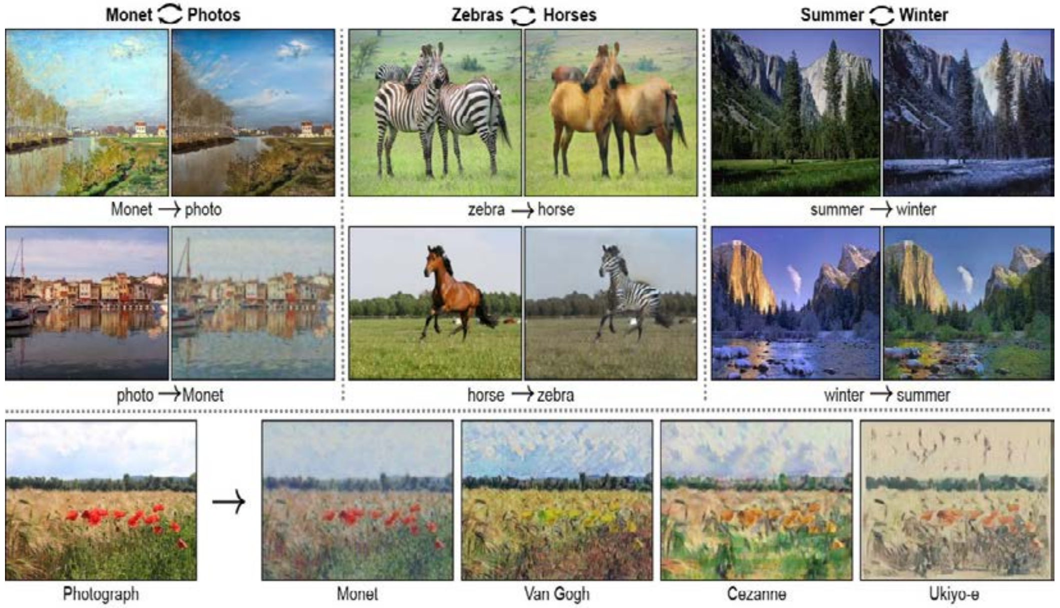
(Goodfellow et al., 2014)

Unpaired image translation

- Unpaired images datasets
- Cycle consistency

  Reconstruct the input image from generated image



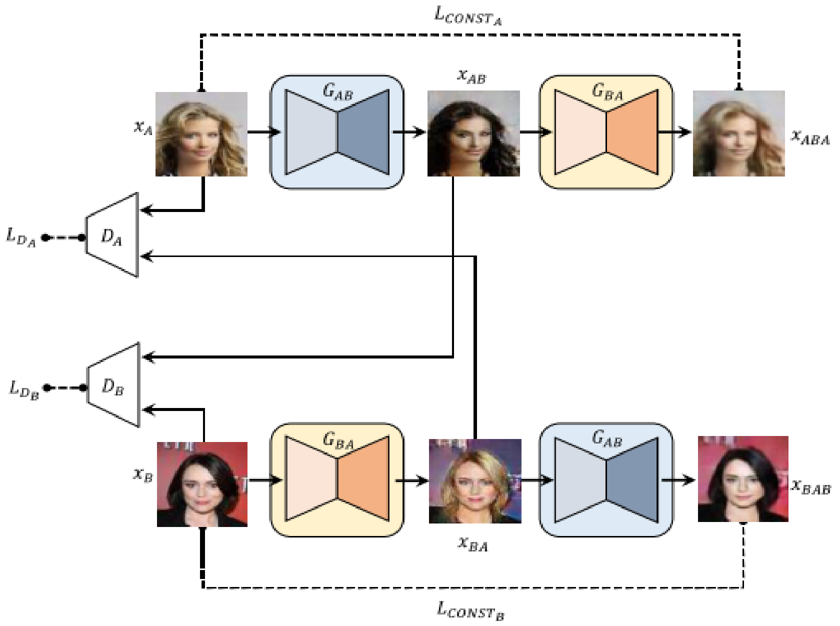


CycleGAN, J. Zhu et al 2017

Unpaired image translation

- Unpaired images datasets
- Cycle consistency (same idea)

  Reconstruct the input image from generated image



(a) Learning cross-domain relations **without any extra label**

(b) Handbag images (input) & **Generated** shoe images (output)

(c) Shoe images (input) & **Generated** handbag images (output)

DiscoGAN, T. Kim et al 2017

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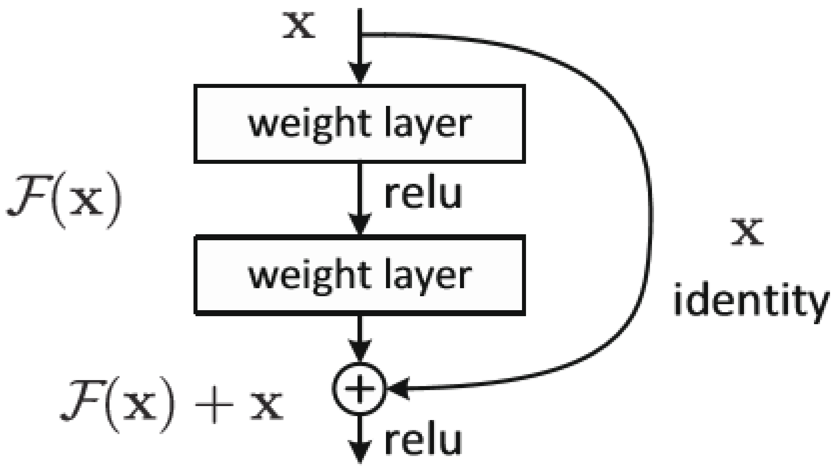
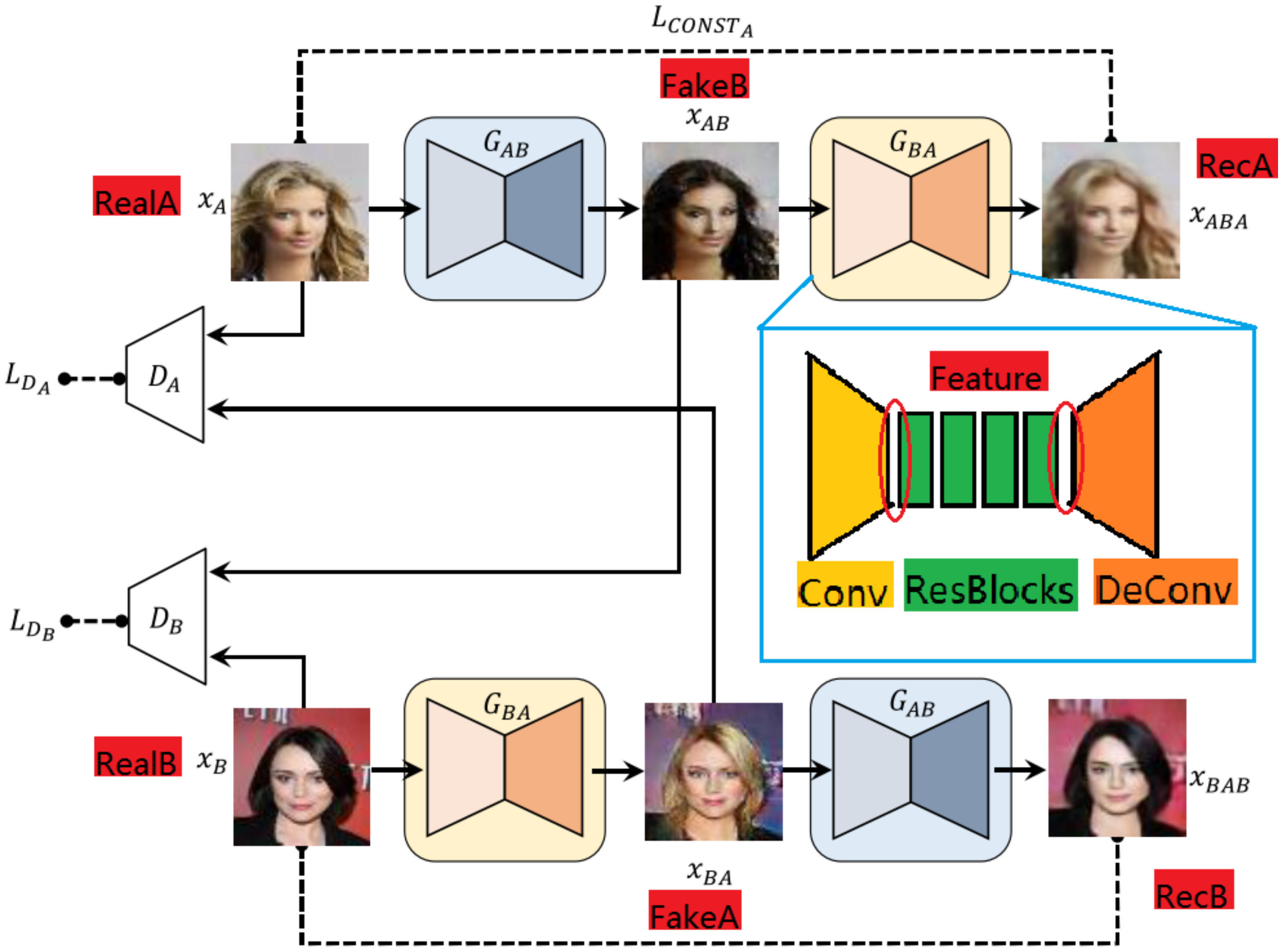
Exploration: CycleGAN

Architecture details

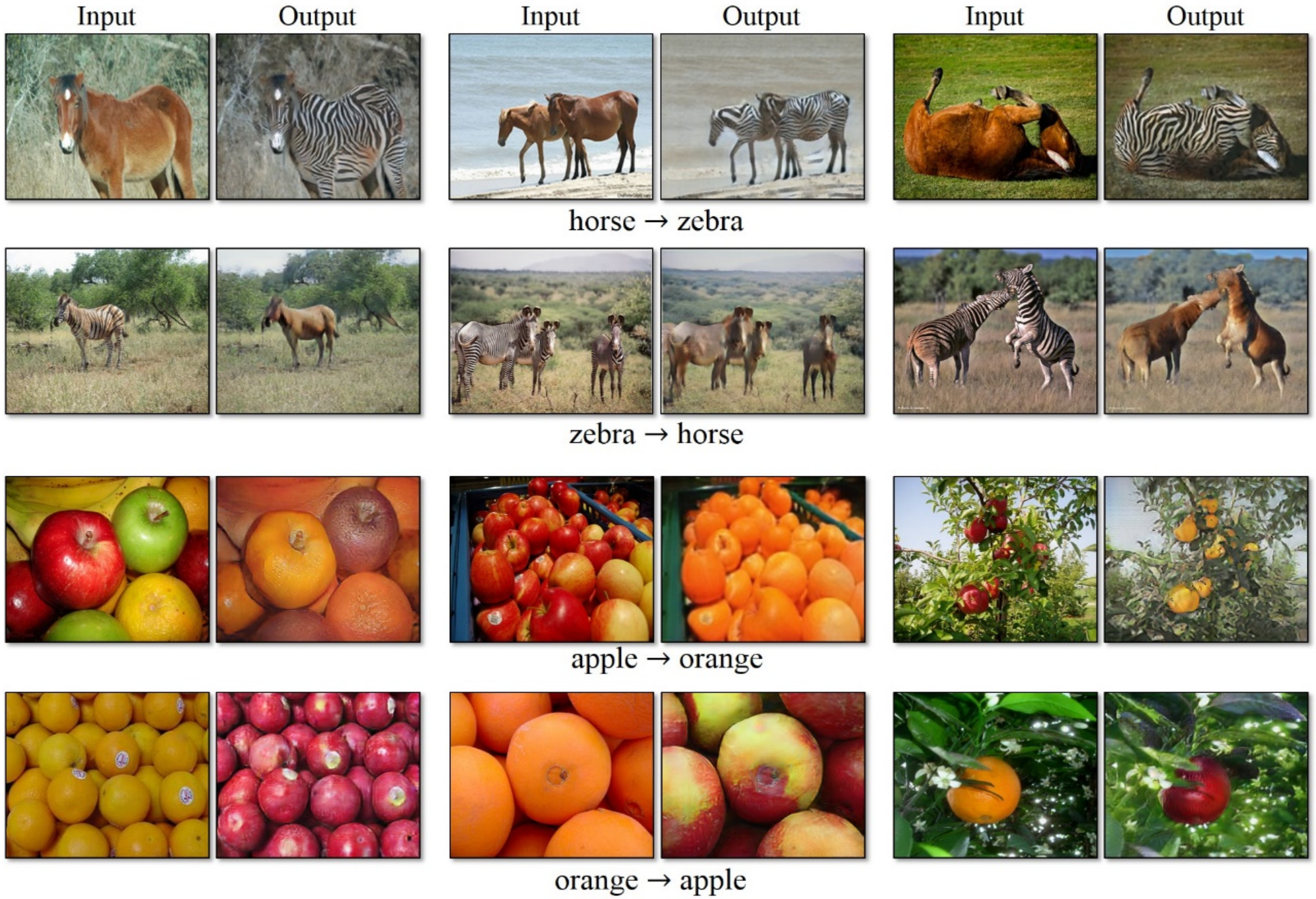
- Residual blocks
- Instance normalization
- Generated image pool





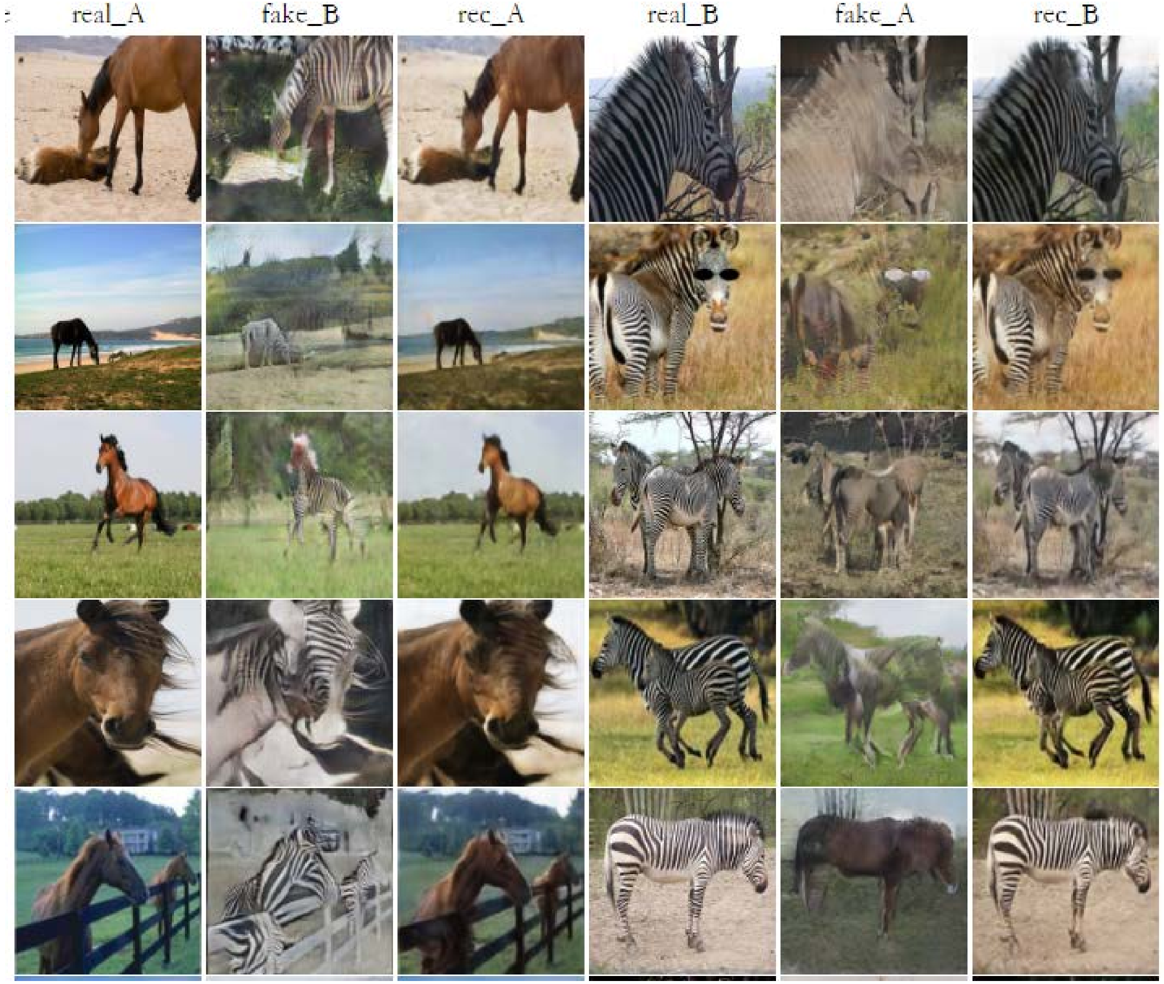
Exploration: CycleGAN

Reported results



Exploration: CycleGAN

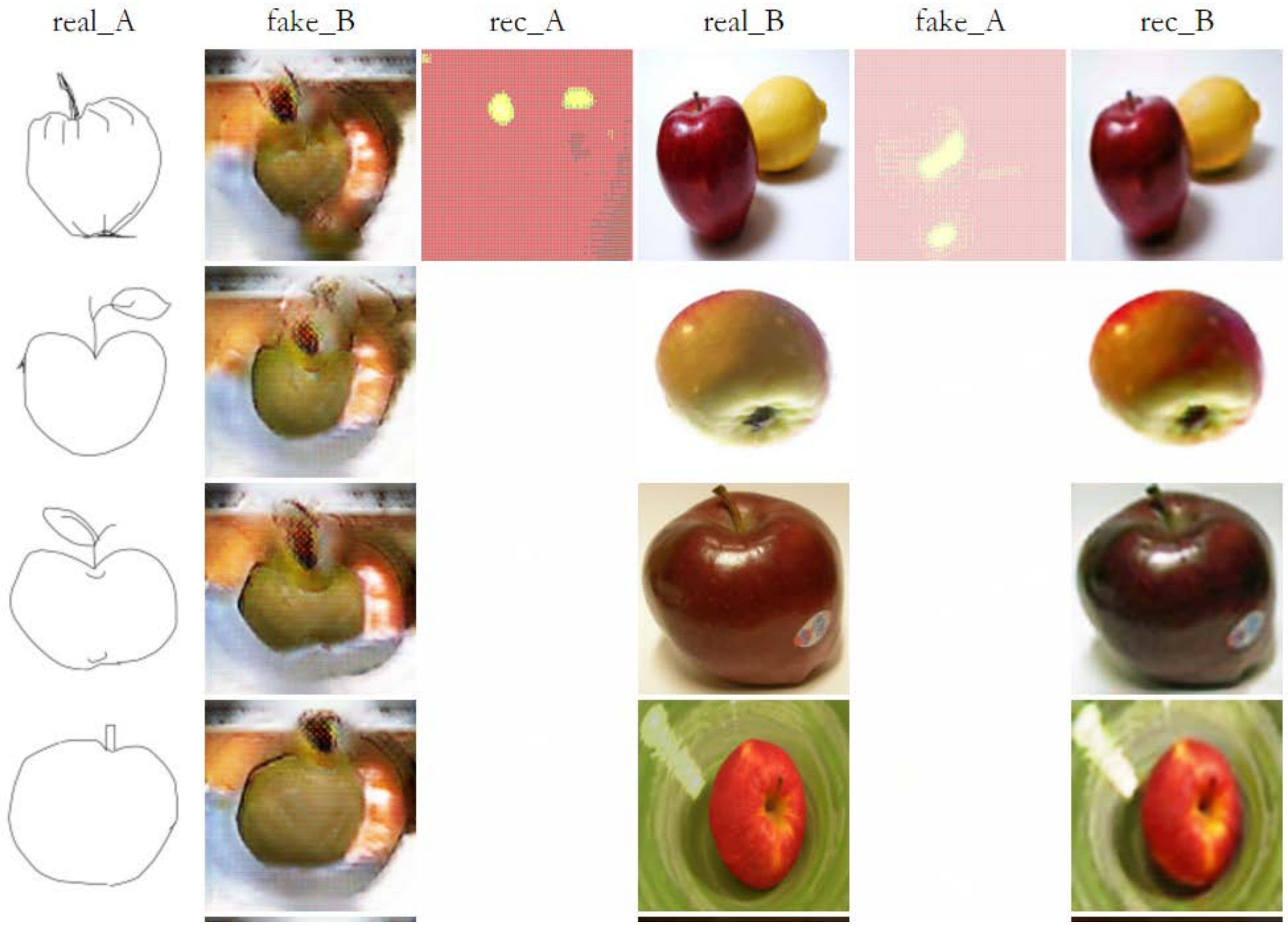
Results by training after 200 epochs with the official torch implementation. Horse to zebra dataset.



Exploration: CycleGAN

Results by training after 200 epochs with the official torch implementation. Sketch to photo (apple) dataset.

- Mode collapse (sketch to photo)
- All white (photo to sketch)



Exploration: CycleGAN

Results by training after 200 epochs with the official torch implementation. Sketch to photo (airplane) dataset.