Generative Adversarial Networks for Automatic Image Colorization

Team: Yet Another Layer - YAL

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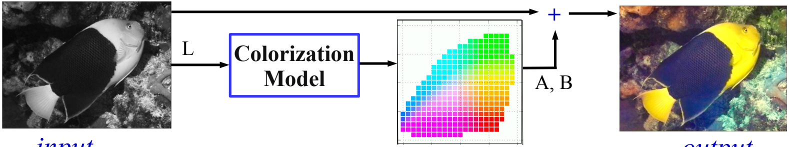
Image Colorization

Problem: produce a *realistic* coloring of gray-scale images



input *generated color channels* *output*

Applications

Colorizing old photos and movies

Colorizing underwater images

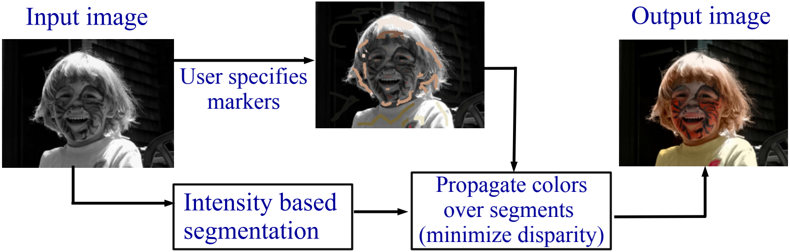
Figure sources: [1], [2], [3]

Background

- Algorithmic choices:
  - **Image-to-image translation**
  - Classification
- Colorspace choices:
  - **LAB**, RGB
- Approaches
  - Classical
  - Deep learning based
    - Generative models
    - **Adversarial model**

Classical Approaches

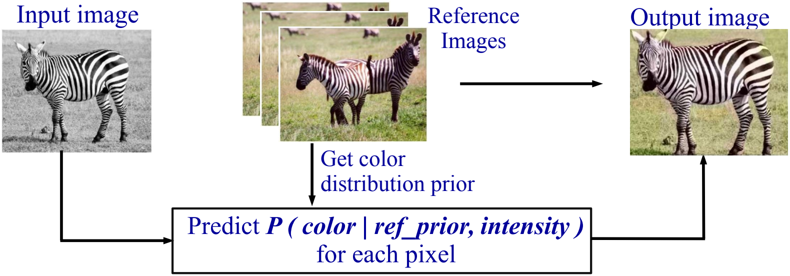
Colorization using User-specified Prior [4]



Pros	**Cons**
Fast	Not automatic
Reliable	Not scalable

Classical Approaches

Colorization using Multi-modal Prediction [5]



Pros

Automatic

Handles multimodality

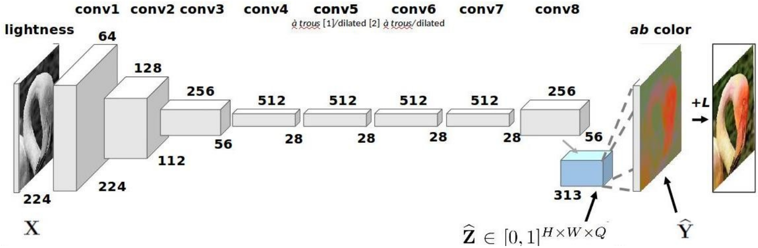
Cons

Depends heavily on reference prior

Not practical

Generative Approach

Colorful Image Colorization model [1]



Model Changes	Original model	Adopted model
Output	Classification Probabilities	Image
Trained on	ImageNet	CelebA, Places2
Implementation	Caffe	Tensor-flow

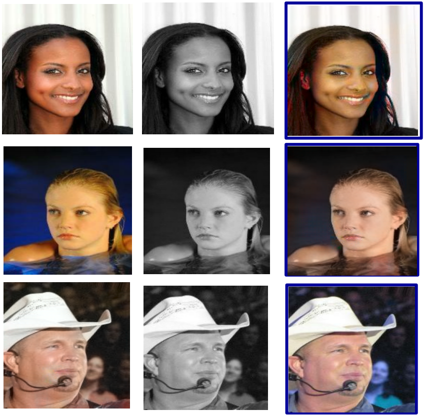
Results

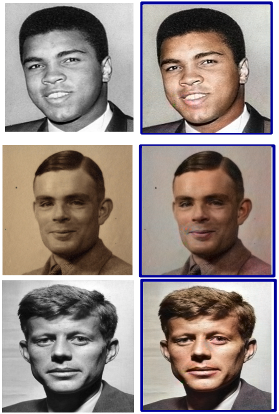
Colorful Image Colorization model as generator only

Loss functions: **L1 loss**, L2 loss, Least-squared loss

Results

Colorful Image Colorization model as generator in a GAN





Legacy Photos!

Generative Adversarial Networks (GANs)

- Two player minimax game
  - Discriminator **D**
  - Generator **G**

- D is trained to discriminate between a real image and a generated image
- G is trained to generate an image that will fool D
- Both G and D are neural networks

$$\min_G \max_D \mathbb{E}_{x \sim p_{data(x)}}[log D(\mathbf{x})] + \mathbb{E}_{z \sim p_z(z)}[log(1 - D(G(z)))]$$

- Conditional GANs generate images given conditional information, such as a class label.

GAN Variations

- Deep Convolutional GANs (DCGANs)
  - Bridge the gap between GANs and Deep Learning
- Least Squares GANs (LSGANs)
  - Use a least squares loss for the discriminator
- Energy-Based GANs (EBGANs)
  - Model the discriminator as an energy function
- Wasserstein GAN (WGAN)
  - Minimizes the Earth Mover distance between two distributions

References

1. Richard Zhang, Phillip Isola, and Alexei A Efros. Colorful image colorization. In European Conference on Computer Vision, pages 649666. Springer, 2016.
2. Huimin Lu, Yujie Li, and Seiichi Serikawa. Underwater image enhancement using guided trigonometric bilateral filter and fast automatic color correction. In Image Processing (ICIP), 2013 20th IEEE International Conference on, pages 34123416. IEEE, 2013.
3. Luz A Torres-Mendez and Gregory Dudek. Color correction of underwater images for aquatic robot inspection. In International Workshop on Energy Minimization Methods in Computer Vision and Pattern Recognition, pages 6073. Springer, 2005.