Image Colorization -- LAB to RGB

Convolutional Neural Nets, Autoencoders, and Generative Adversarial Networks

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Florida Memory

State Library and Archives of Florida

-The online outreach program of the State Archives of Florida.

-Digitizes thousands of historic black and white photos a year.

Client-driven Top-Down approach

Colorization

- **Take in a B&W image of any format (.jpg, .jpeg, .png, .tiff) and return a colorized copy**

Object Detection

- **Informed by colorization, build a database of known objects.**
- **Archival merit, Metadata**

Portability

- **Web service**
- **API**
- **SaaS**
- **Organizational (IP cheaper, better than $ service; ContentDM)**

Purpose

Relevance

- Outreach program
- Capturing attention
- Online interactions

Funding

- State funded
- Determined by public interest
- Politics

Historic merit

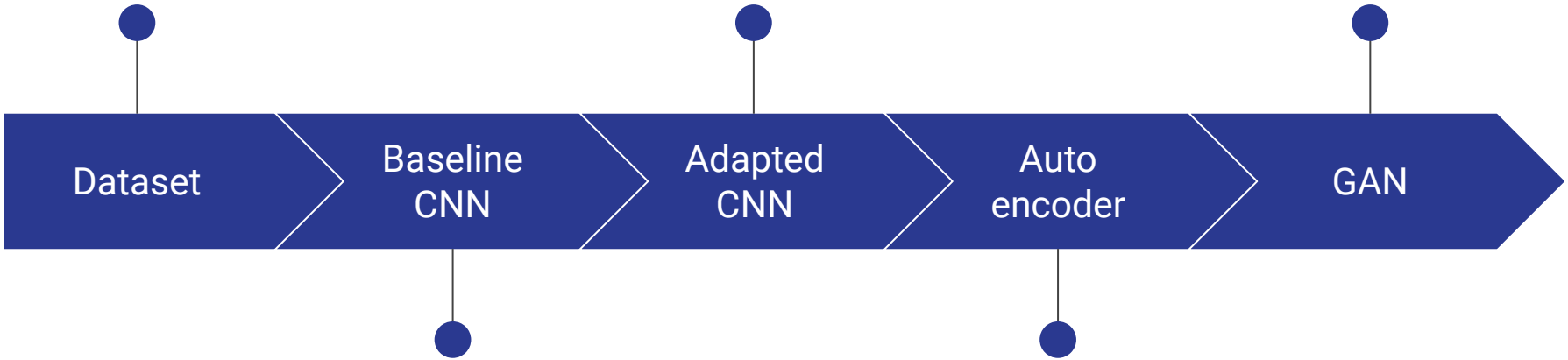
- Legibility
- Semantic Segmentation
- Accuracy

Colorization using Machine Learning

L, and AB .npy files from MIRFLICKR25k

ImageDataGenerator, greater feature mapping, greater epochs

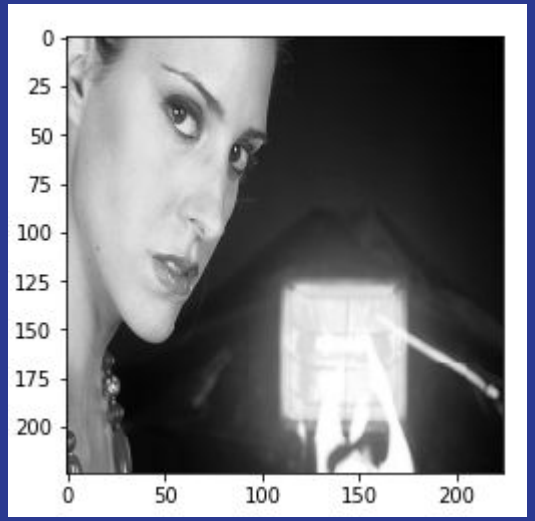
Generate colorized ‘fakes’ that ‘fool’ automized discriminator

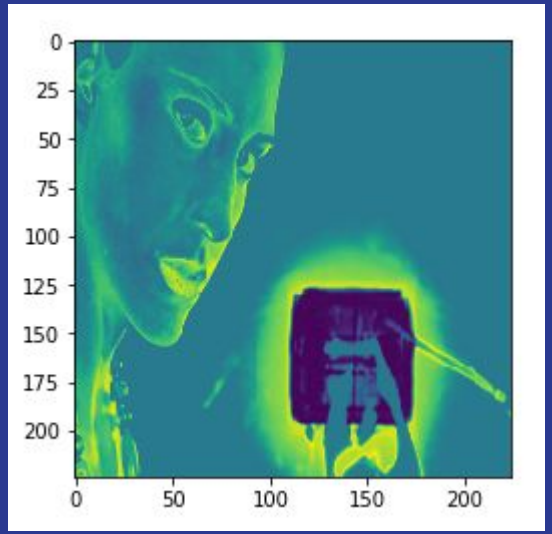


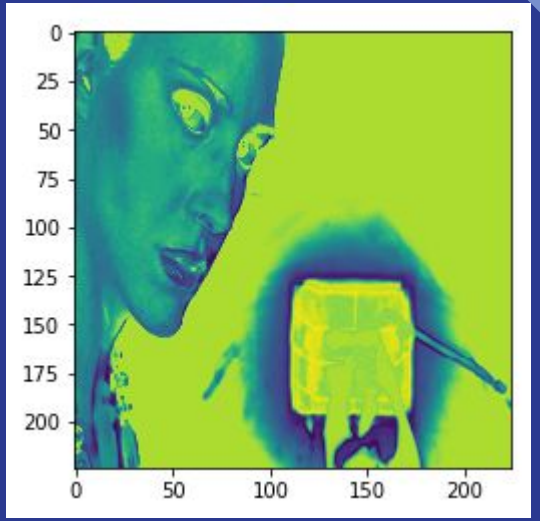
Fully connected layers, with and without upsampling, pooling, etc.

Latent representations, colorized outputs

MIRFLICKR25K

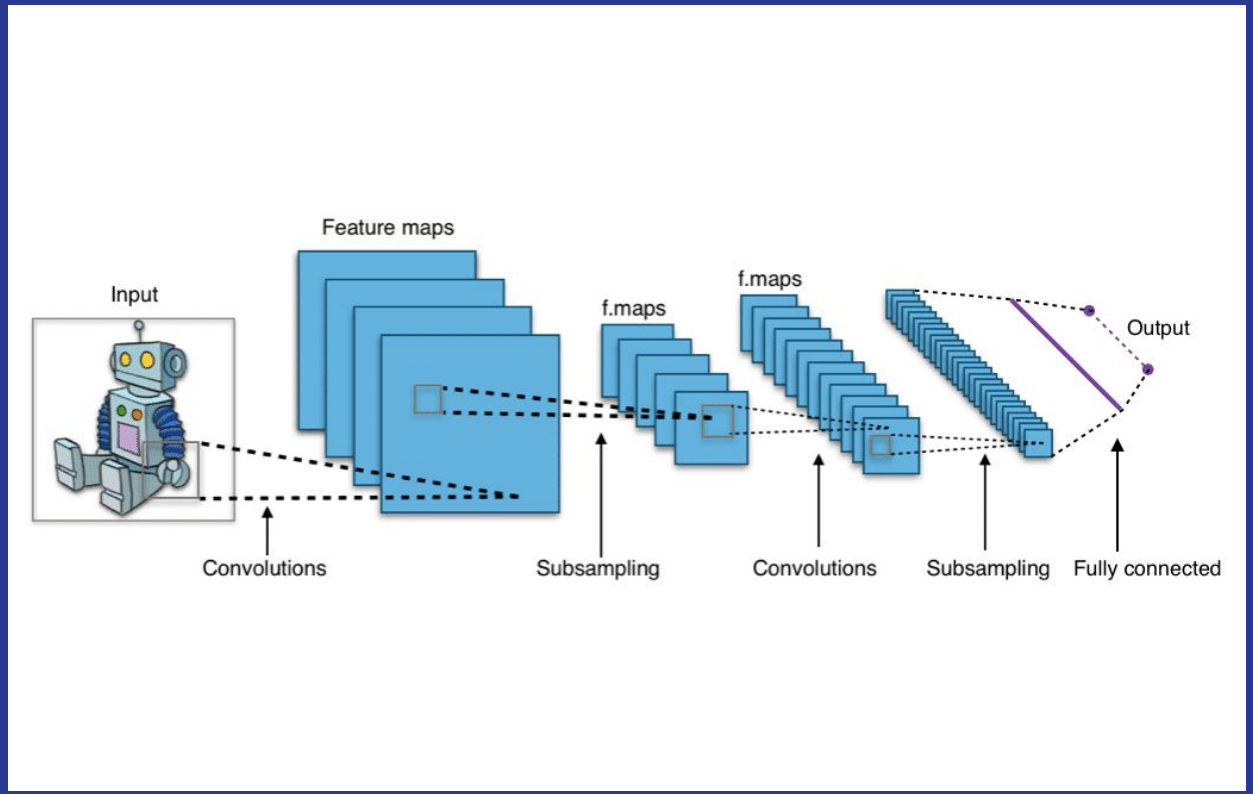






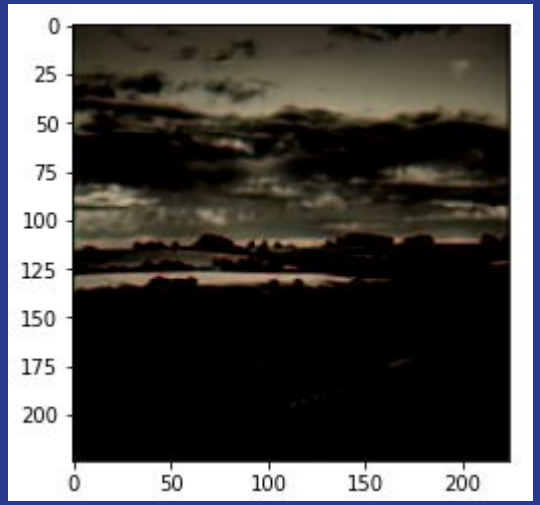
LAB and RGB Color Space

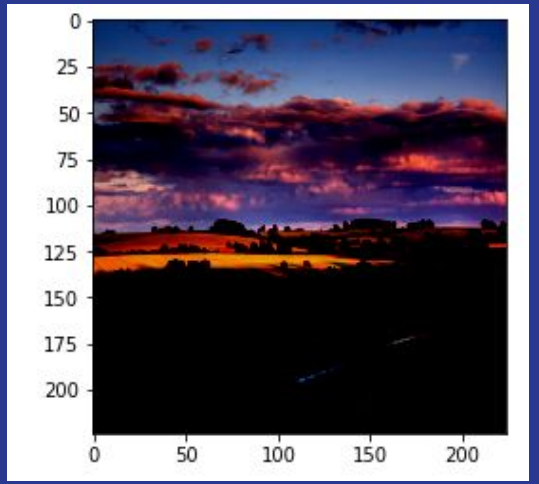
Convolutional Neural Network



Baseline CNN

- 2 Conv Layers
- 2 Conv2DTranspose
- 15 epochs





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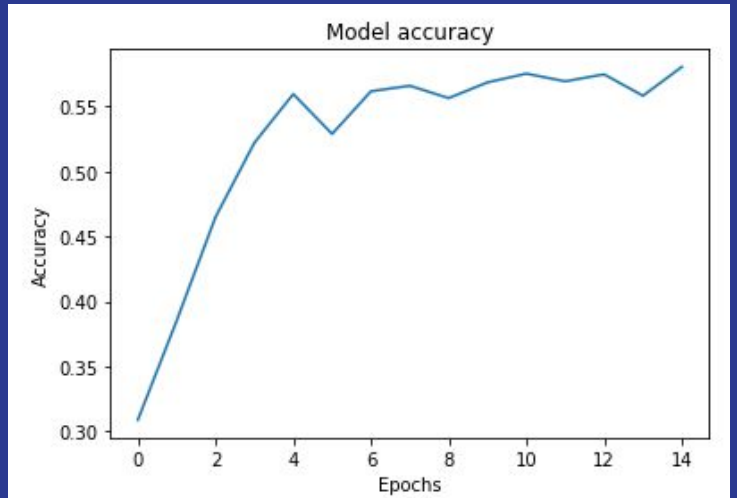
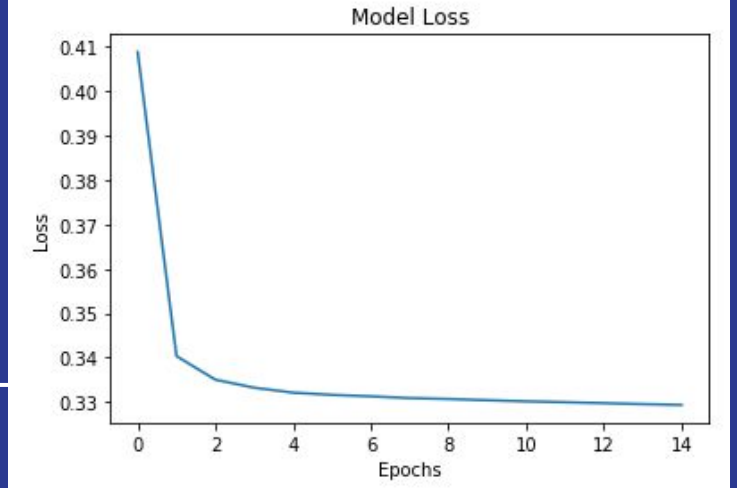
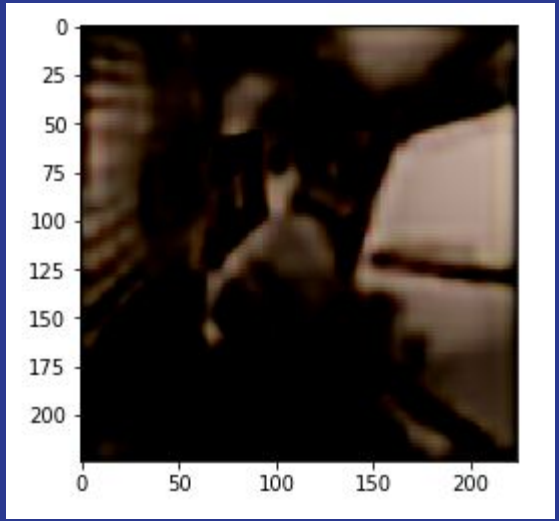
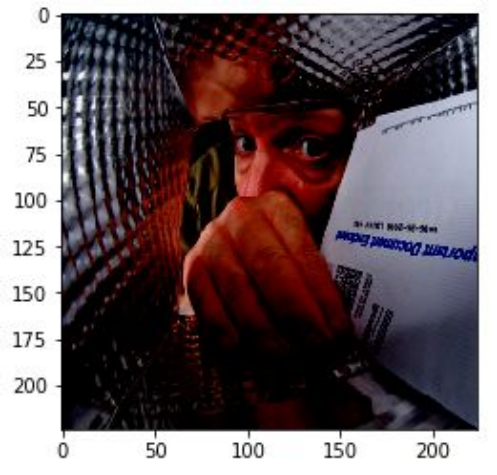




Updated CNN

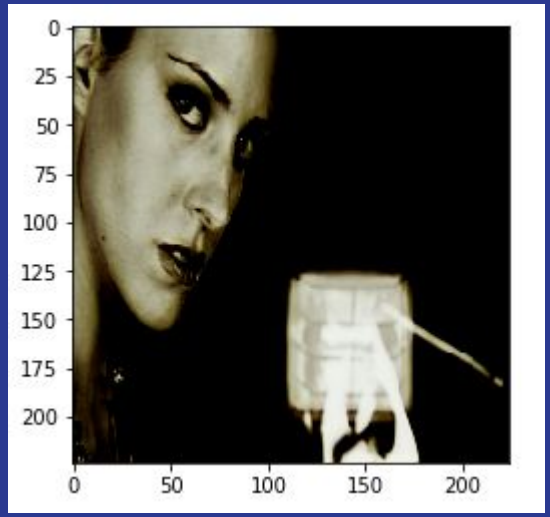
- 9 Conv Layers
- 3 Upsampling Layers
- 15 epochs

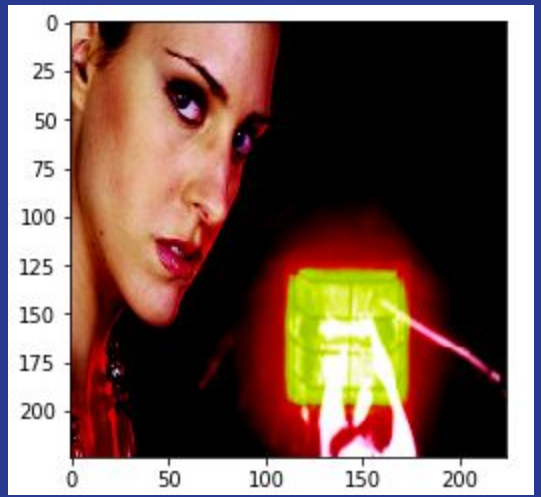




Improved CNN

- 9 Conv Layers
- Accuracy early stopping
- 100 epochs





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- 9 Conv Layers
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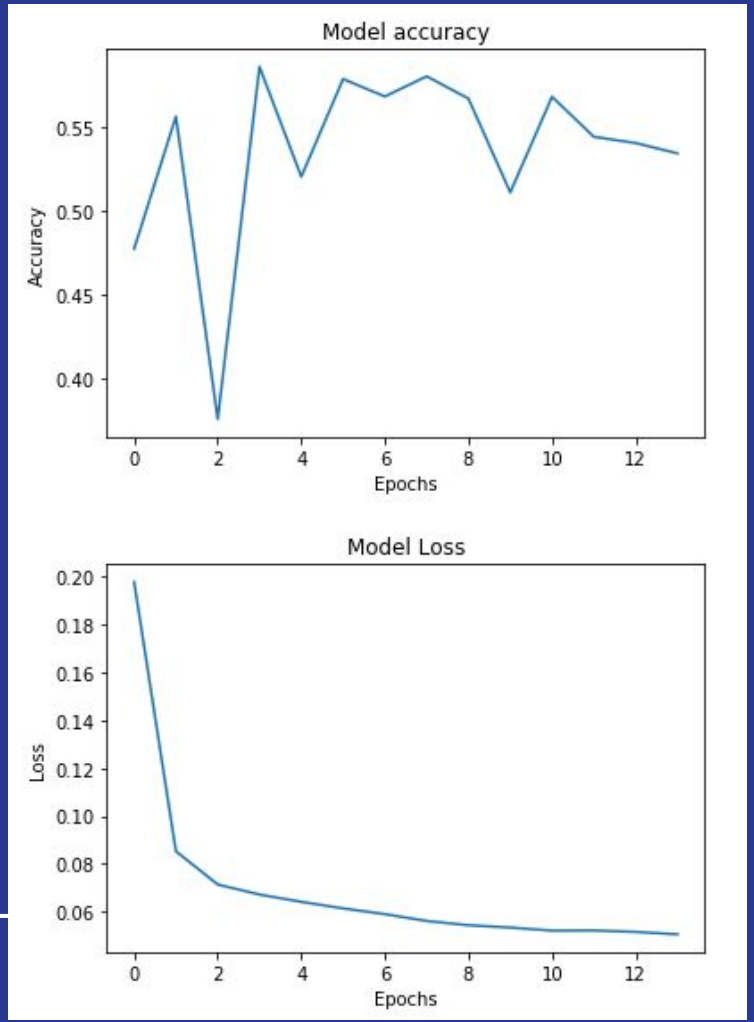
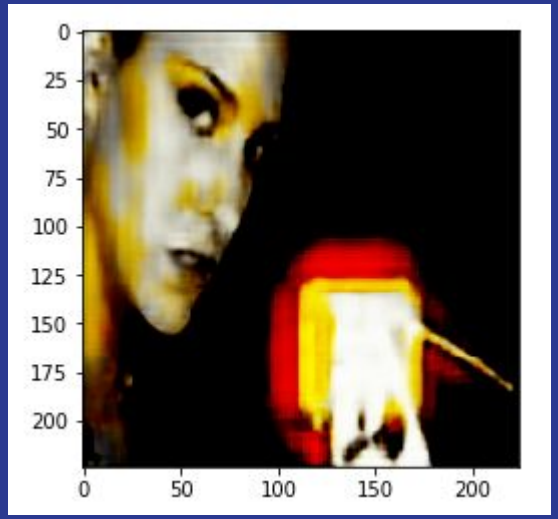
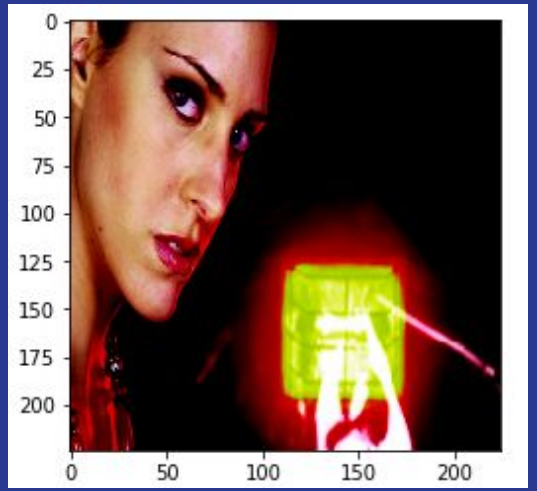


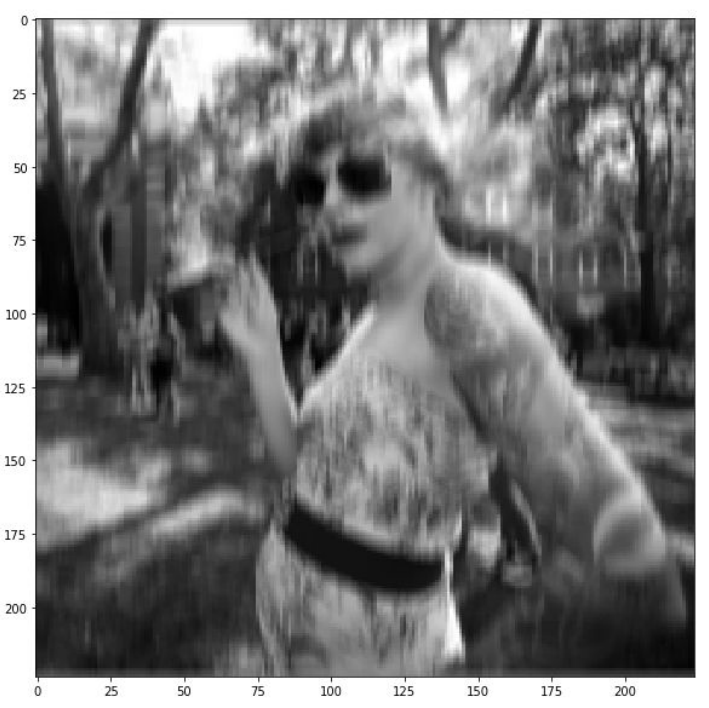
Final CNN

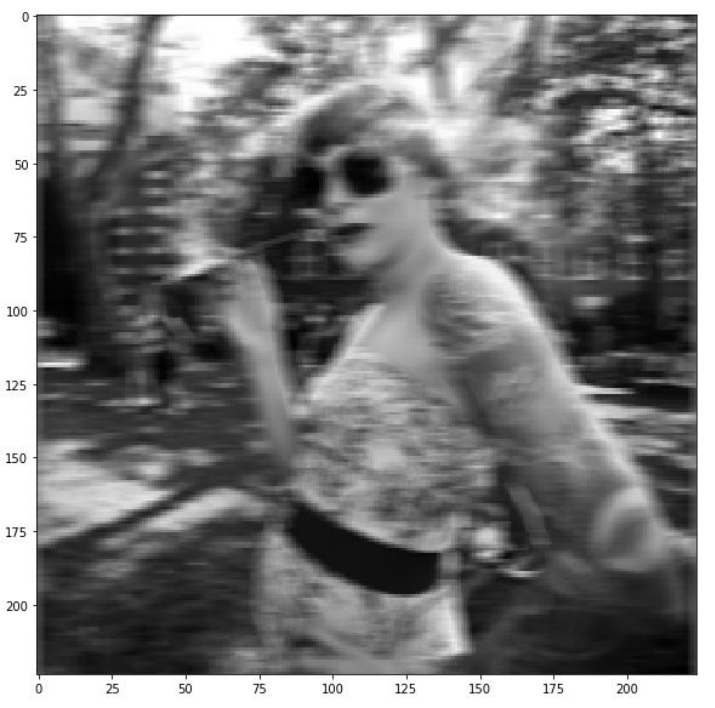
- 9 Conv Layers
- Accuracy early stopping
- 1000 epochs





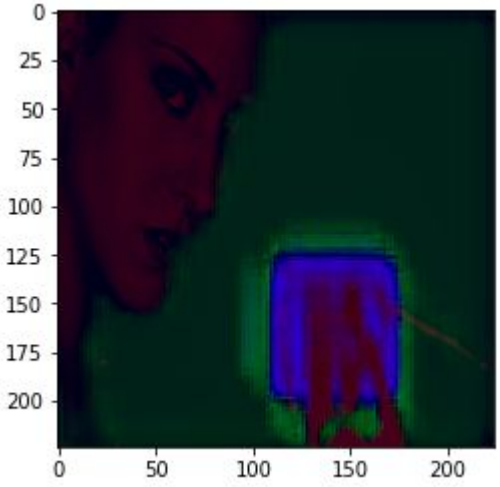
ImageDataGenerator & Feature Mapping



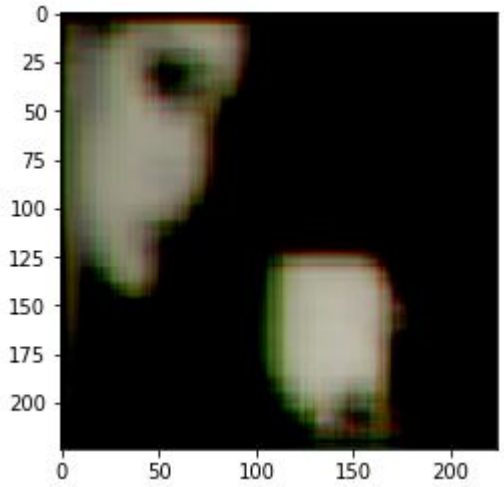


Multiple attempts, progress

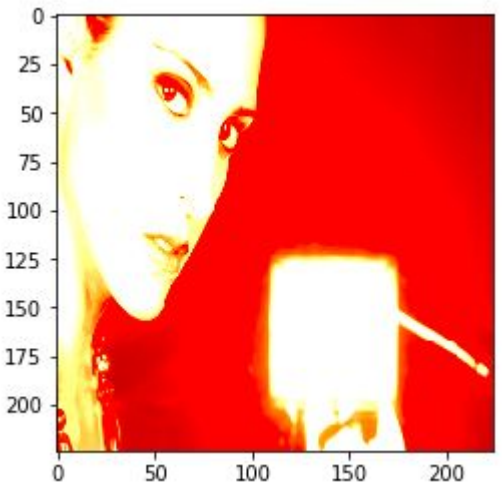
ImageDataGenerator



IDG Second Attempt

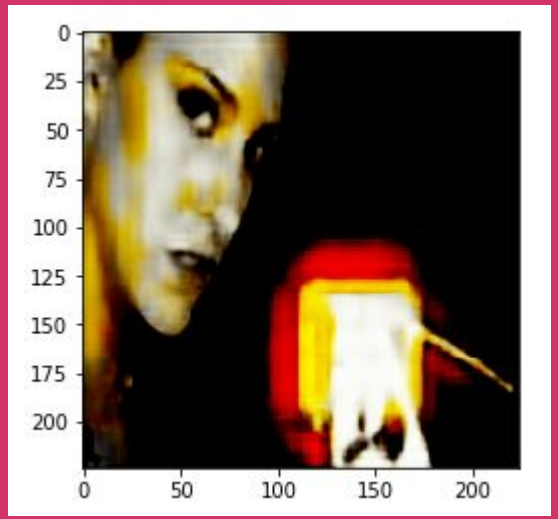


Normalized AB,
No IDG

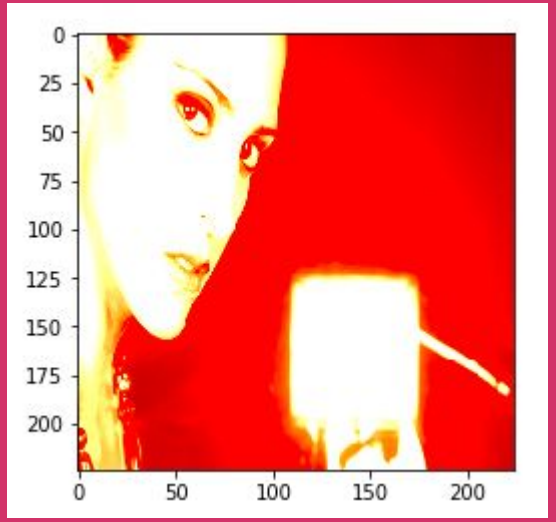


Comparisons:

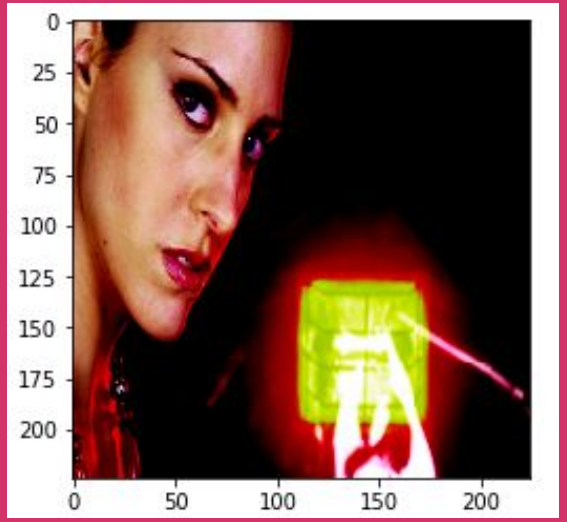
Deep CNN, 1000 epochs



Normalized, Upsampled, 1000 epochs



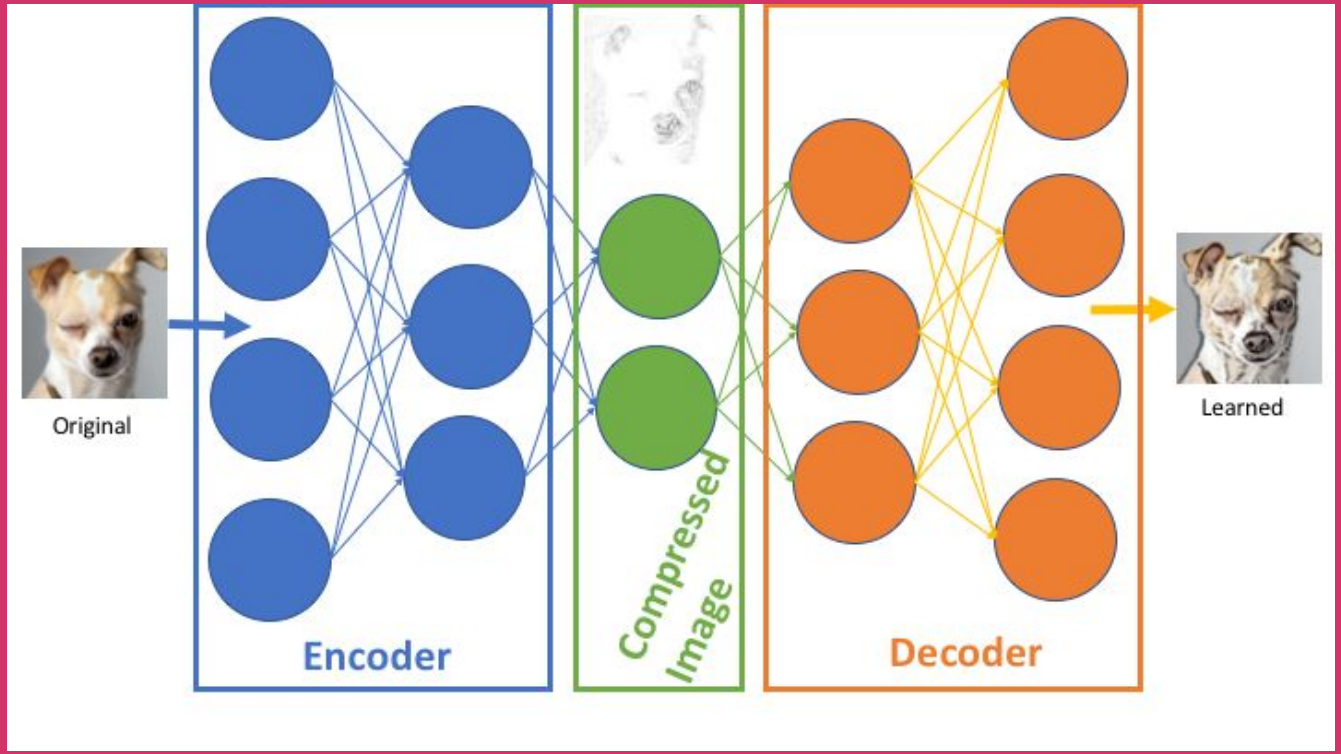
Actual Target

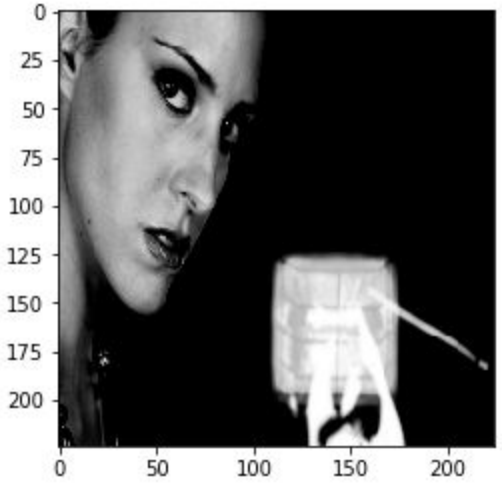


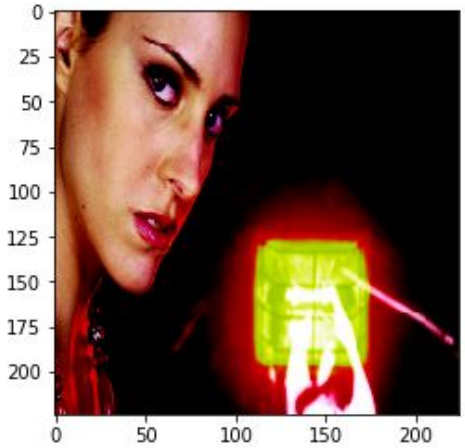
CNN Conclusion:

- Minimal data augmentation seemed to perform best.
- Time inefficient, impractical.
- CNN may eventually work, but best method?

Second Attempt: Autoencoding







Intake full Black&White photo as X, and RGB copy as Y during training.

Using B&W/Color images as validation data

Encoder:

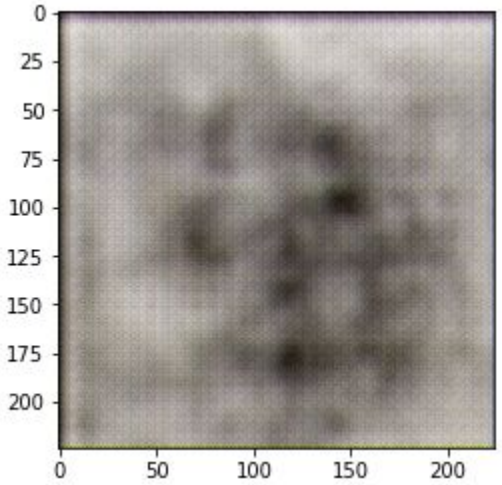
- 3 Conv Layers
- 1 Flatten Layer

Decoder:

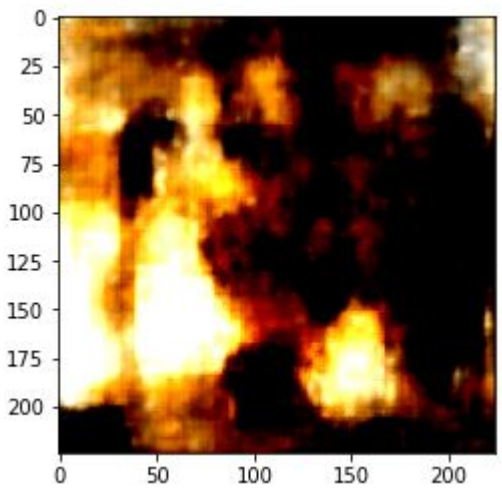
- 1 Dense
- 1 Reshape
- 3 Conv2DTranspose

Autoencoder Progress

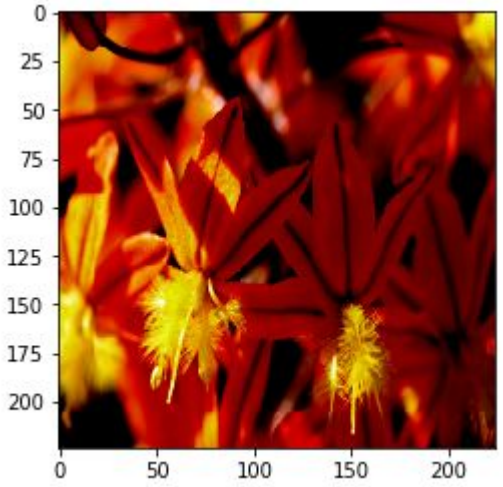
1st Attempt



2nd Attempt



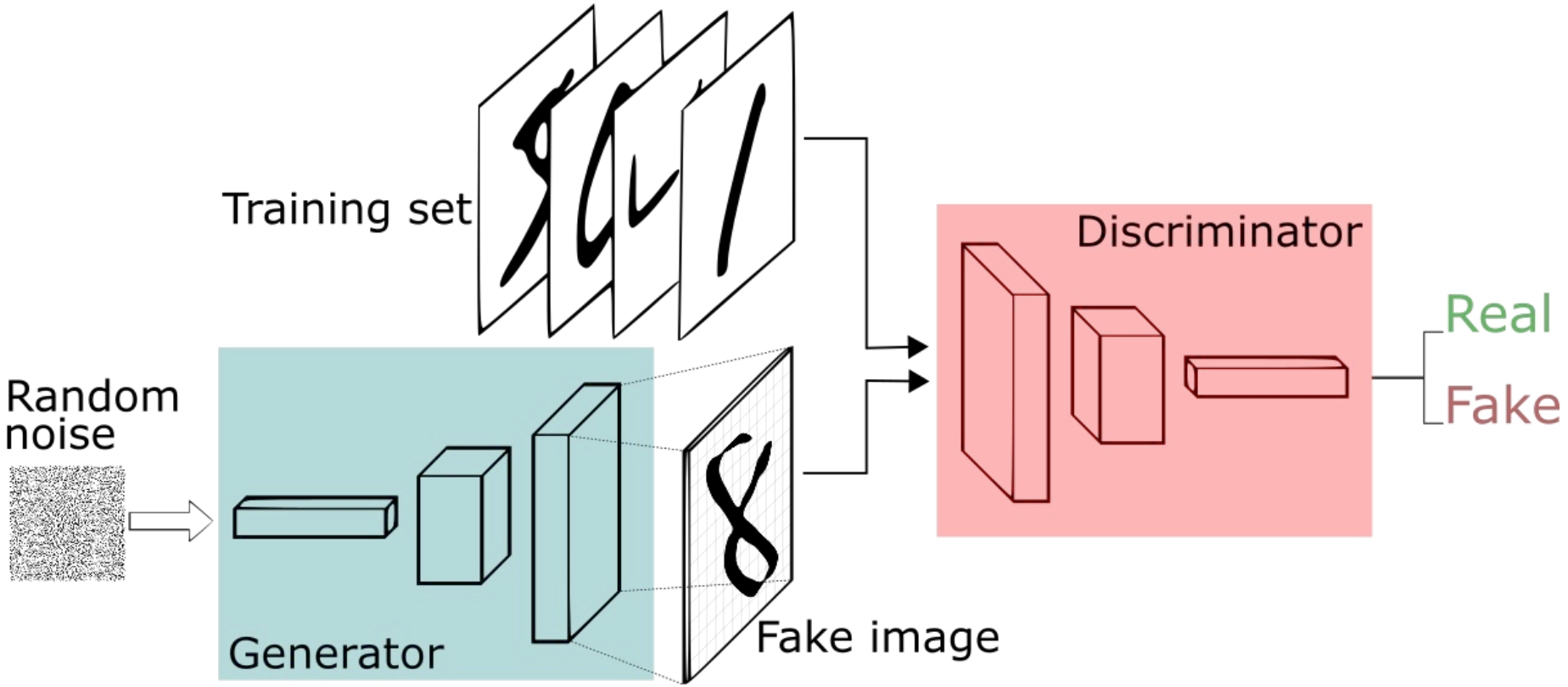
Actual Target



Autoencoder Conclusion:

- “The generated images (of Autoencoders) are usually fuzzy and not entirely realistic.”
- “Reconstructions may be lossy. We may need to train the model for longer, or make the encoder and decoder deeper, or make the codings larger.”

Generative Adversarial Network Approach:



Recommendations

Florida Memory:

- Blogs about progress of model
- Maintain public interest
- In-house knowledge/recs
- Custom datasets (Favs)

For the Data Scientist:

- More time and research is needed.
- Autoencoder model can be made to perform better.
- GAN can reinforce good learning, representations with historic integrity.
- Different data may be useful.