IMAGE RESTORATION
WITH DEEP LEARNING

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PROBLEM STATEMENT

Can we use deep learning to restore old damaged images?

HTTPS://ARXIV.ORG/PDF/2009.07047V1.PDF

DATA COLLECTION AND DESCRIPTION

INPUT

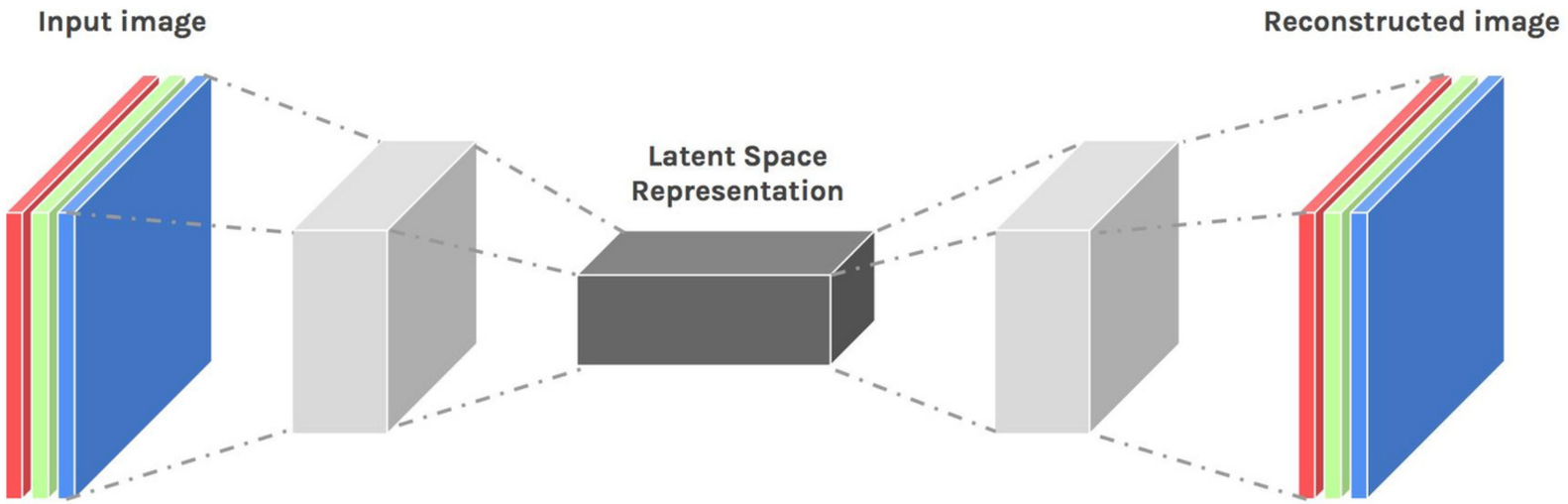
OUTPUT

STAR WARS IV: A NEW HOPE. DIRECTED BY GEORGE LUCAS, TWENTIETH CENTURY FOX

DATA SAMPLING, SPLITTING AND CLEANING

- Raw data: 31,801 paired images
- Three sample datasets: 2% - 636 paired images
  12% - 3,816 paired images
  32% - 10,176 paired images
- Splitting
  - 85% Train and Validation
    - 85 % Test
    - 15% Validation
  - 15 % Test
- Cleaning: Cross Examination of the image filenames in input and output folders and removing all lone images

MODELING: CONVOLUTIONAL AUTOENCODER



Model 1:
7 hidden layers
29,507 trainable parameters

Model 2:
14 hidden layers
374,406 trainable parameters

HTTPS://SEFIKS.COM/2018/03/23/CONVOLUTIONAL-AUTOENCODER-CLUSTERING-IMAGES-WITH-NEURAL-NETWORKS/

LOSS FUNCTION

MEAN SQUARED ERROR (MSE)

- AVERAGE DIFFERNCE OF THE OUTPUT AND GROUND TRUTH
- LOW MSE -> HIGH SIMILARITY BETWEEN MODEL OUTPUT AND GROUND TRUTH

EVALUATION METRICS

PEAK SIGNAL TO NOISE RATIO

- COMPARING LOW-LEVEL DIFFERNCES OF THE MODEL OUTPUT AND GROUND TRUTH
- HIGH PSNR -> HIGH IMAGE QUALITY

STRUCTURAL SIMILARITY INDEX MEASURE (SSIM)

- COMPARING LOW-LEVEL DIFFERNCES OF THE MODEL OUTPUT AND GROUND TRUTH
- HIGH SSIM -> HIGH IMAGE QUALITY

MODEL 1 RESULTS

Epochs		TRAIN			VALIDATION			TEST		
		MSE	PSNR	SSIM	MSE	PSNR	SSIM	MSE	PSNR	SSIM
100	2% sample dataset	0.0012	30.44	0.8877	0.0013	30.06	0.8922	0.0013	30.06	0.8834
	12% sample dataset	0.0012	30.48	0.8922	0.0013	30.29	0.8877	0.0013	30.31	0.8876
	32% sample dataset	0.0009	31.86	0.9124	0.0009	31.74	0.9098	0.0009	31.77	0.9113
300	2% sample dataset	0.00087	32.09	0.9137	0.0009	31.77	0.9156	0.0009	31.68	0.9075
	12% sample dataset	0.00084	32.29	0.9195	0.00085	32.16	0.9163	0.0008	32.16	0.9173
200	32% sample dataset	0.0009	31.86	0.9130	0.0009	31.91	0.9134	0.0009	31.77	0.9113

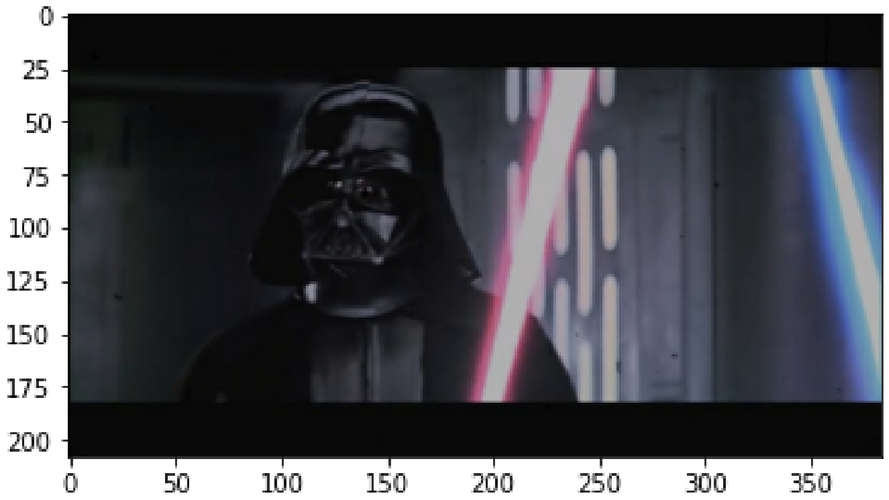
7 hidden layers
29,507 trainable parameters

MODEL 2 RESULTS

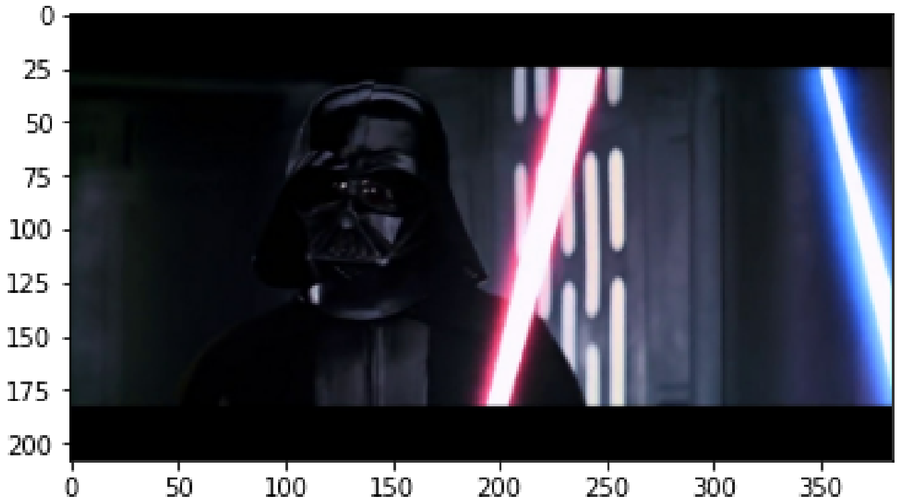
Epochs		TRAIN			VALIDATION			TEST		
		MSE	PSNR	SSIM	MSE	PSNR	SSIM	MSE	PSNR	SSIM
100	2% sample dataset	0.0035	25.82	0.7628	0.0038	25.46	0.7631	0.0035	25.69	0.7627
	12% sample dataset	0.0023	27.79	0.8141	0.0023	27.72	0.8109	0.0023	27.67	0.81
200	2% sample dataset	0.0025	27.456	0.8007	0.0027	27.00	0.8048	0.0025	27.11	0.7971
	12% sample dataset	0.0018	28.78	0.8381	0.0019	28.40	0.8333	0.0020	28.41	0.8324

14 hidden layers
374,406 trainable parameters

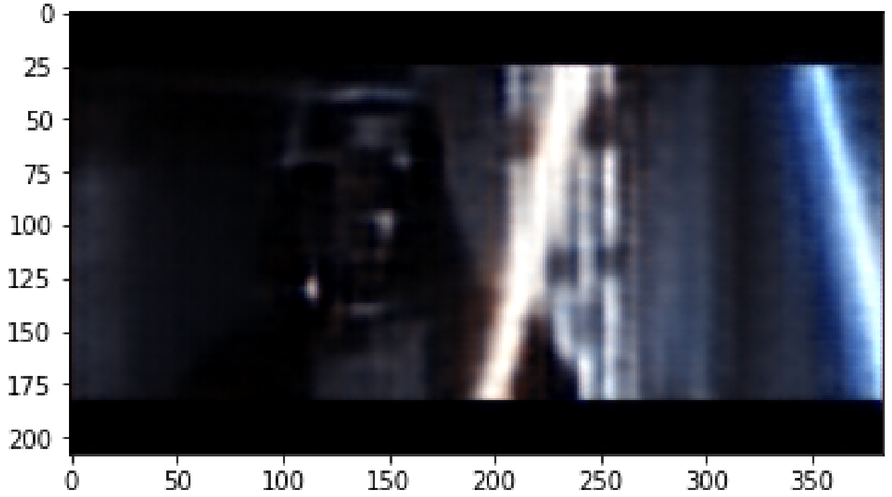
MODELING RESULTS - BAD



Model Input



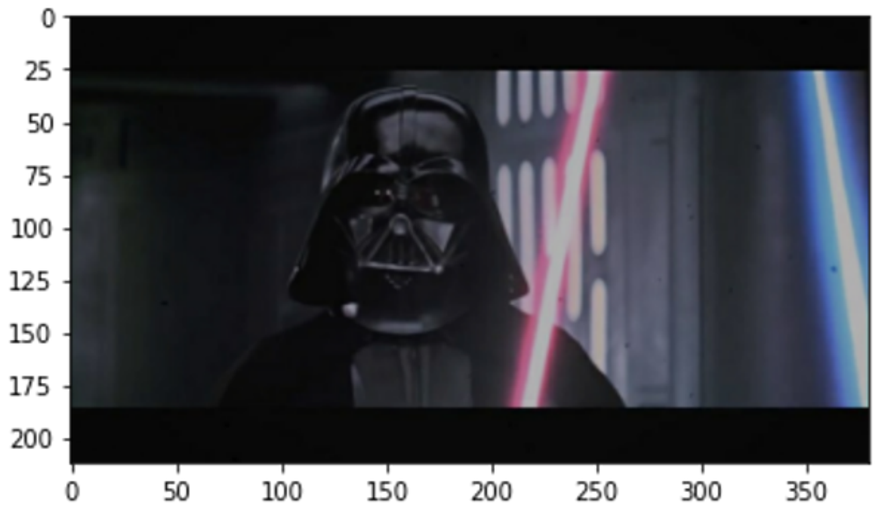
Model Ground Truth



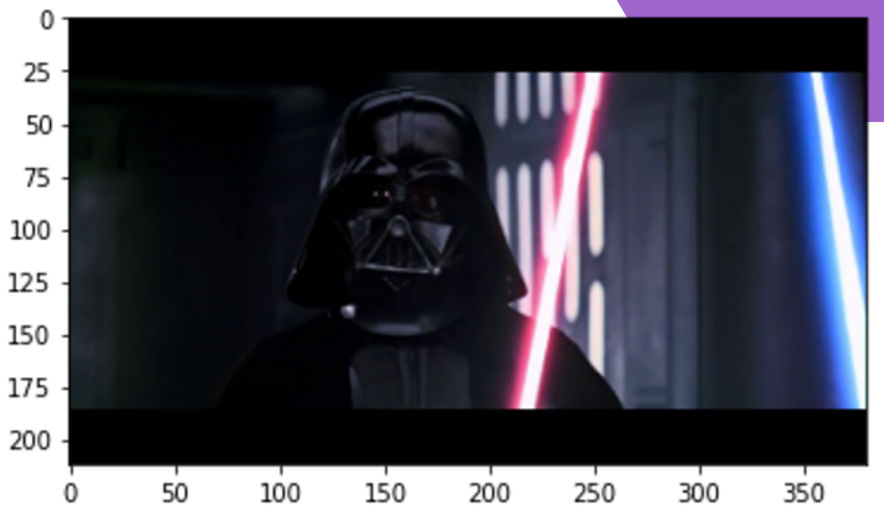
Model Output

Model 2,
2 % sample dataset
trained for 100 epochs

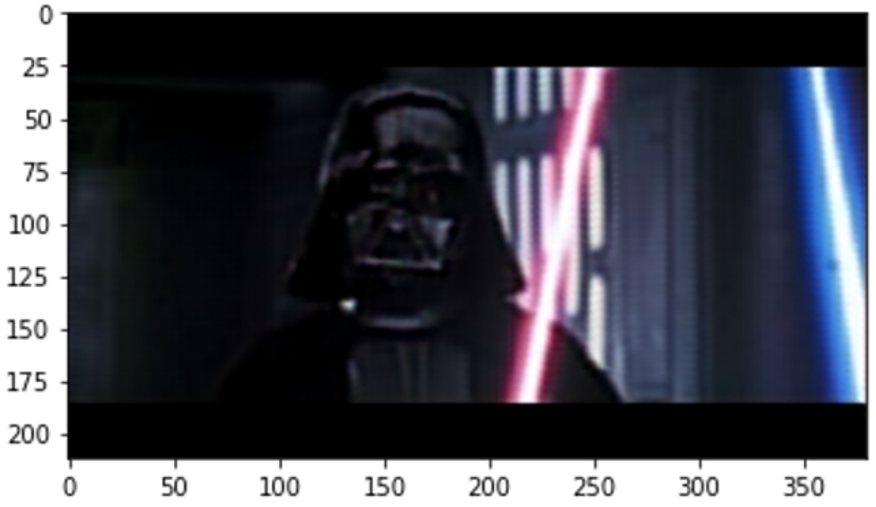
MODELING RESULTS - GOOD



Model Input



Model Ground Truth



Model Output

Model 1,
12 % sample dataset
trained for 300 epochs

CONCLUSIONS

- When the structure of the model is more complicated and number of trainable parameters is higher, a larger dataset and longer training duration is required.

- Based on the results from our modeling, we can conclude that if we had more time and computational resources, we were able to improve the model performance significantly by using a larger sample or the total dataset and training the model for longer durations.

FUTURE STEPS:

Run the second model for longer training periods with a higher number of images.

Implement transfer learning into our modeling - Find a model that has been pretrained on a similar problem such as denoising, deblurring

QUESTIONS?