Research on Super Resolution

Alex Nishio
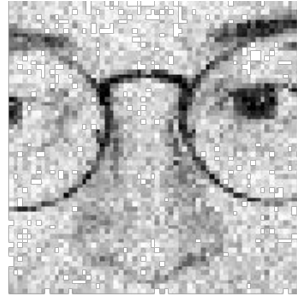
PSNR (peak signal to noise ratio)

PSNR = 40 dB   PSNR = 30 dB   PSNR = 20 dB

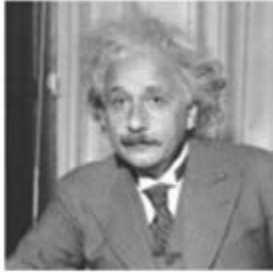PSNR = 10 dB   PSNR = 0 dB
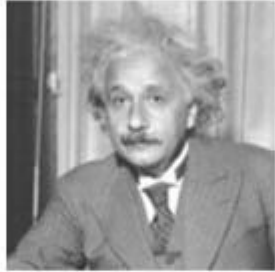
Note from Future Self
- PSNR is an outdated metric, making this slide redundant
- Example:
    - SUPIR has a lower PSNR value but the output quality is very good
    - See Page 6 in SUPIR paper

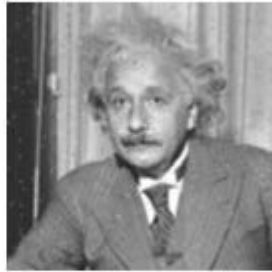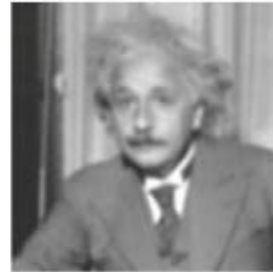# SSIM (structure similarity index measure)

Original
SSIM=1

PSNR=26.547
SSIM=0.988

PSNR=26.547
SSIM=0.840

PSNR=26.547
SSIM=0.694

Note from Future Self
- Same as PSNR in Slide 2, SSIM is also redundant for the same reasons as evident in the SUPIR model

Different Methods

- Convolutional Neural Networks (CNNS)
  - First Upsample
  - Learn Hierarchical Representations of Features
    - Produce Feature Map
    - Transform Feature Map to High Dimension Vector
    - Combine Feature Map

(A) Linear Connections

(a) Early Upsampling Connection

(b) Late Upsampling Connection
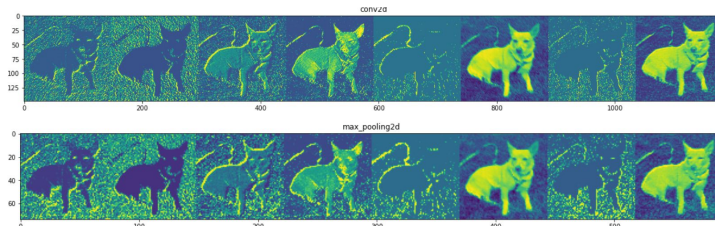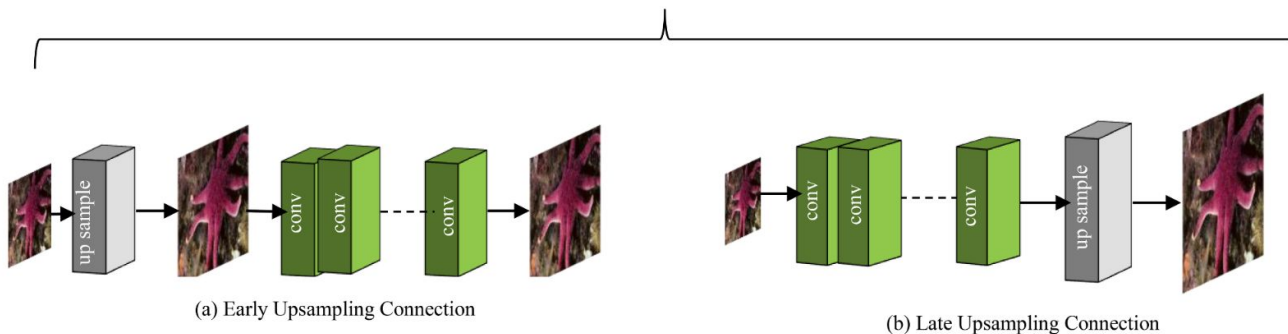
Alternative Methods

- Transformer Based Methods
    - Very Robust from Exploding
    - Useful even when data is scarce
    - Grown In Popularity
        - AdaFormer

Comparison In Results (4x)

1. CNN (CVANet)

Method	Set5		Set14		B100		Urban100	
	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM
SMSR (Wang et al., 2021)	32.12	0.8932	28.55	0.7808	27.55	0.7351	26.11	0.7868
WMRN (Sun et al., 2021)	32.00	0.8925	28.47	0.7786	27.49	0.7328	25.89	0.7789
MGAN (Wu et al., 2021)	32.57	0.8993	28.85	0.7874	27.75	0.7415	26.68	0.8027
DDistill (Wang, Su, et al., 2022)	32.29	0.8961	28.69	0.7833	27.65	0.7385	26.26	0.7893
SRGAT (Yan et al., 2021)	32.57	0.8997	28.86	0.7879	26.76	0.7421	26.76	0.8052
ShuffleMixer (Sun et al., 2022)	32.21	0.8953	28.66	0.7827	27.61	0.7366	26.08	0.7835
HNCT (Fang et al., 2022)	32.31	0.8957	28.71	0.7834	27.63	0.7381	26.20	0.7896
LGAN (Song & Zhong, 2022)	32.48	0.8984	28.83	0.7864	27.71	0.7416	26.63	0.8022
TPCNN (Esmaeilzehi et al., 2022)	32.14	0.8957	28.72	0.7846	27.62	0.7381	26.00	0.7835
WDRN (Xin et al., 2022)	32.43	0.8985	28.75	0.7862	27.65	0.7384	26.41	0.7975
CVANet	32.59	0.9001	28.92	0.7896	27.77	0.7437	26.96	0.8116

2. Transformer (AdaFormer)

Method	Set5			Set14			B100			Urban100		
	PSNR	SSIM	Latency(ms)	PSNR	SSIM	Latency(ms)	PSNR	SSIM	Latency(ms)	PSNR	SSIM	Latency(ms)
IMDN	32.21	0.9605	8.40	28.58	0.7811	8.78	27.56	0.7353	6.92	26.04	0.7838	12.22
LAPAR-A	32.15	0.8944	12.28	28.61	0.7818	17.75	27.61	0.766	12.89	26.14	0.7871	37.14
RFDN	32.28	0.8957	44.22	28.61	0.7818	19.55	27.58	0.7363	17.96	26.20	0.7883	29.55
RLFN	32.24	0.8952	-	28.62	0.7813	-	27.60	0.7364	-	26.17	0.7877	-
ETDS	31.69	0.8889	11.19	28.31	0.7751	11.39	27.37	0.7302	13.22	25.47	0.7643	8.49
SwinIR-light	**32.44**	**0.8976**	54.41	28.77	0.7858	79.83	27.69	0.7406	64.02	26.47	0.7980	202.21
ESRT	32.19	0.8947	22.75	28.69	0.7833	26.60	27.69	0.7379	21.54	26.39	0.7962	88.22
ELAN-light	32.43	0.8975	36.06	28.78	0.7858	29.52	27.69	0.7406	27.06	**26.54**	0.7982	59.11
N-Gram	32.33	0.8963	82.76	28.78	**0.7859**	116.05	27.66	0.7396	96.26	26.45	0.7963	238.51
AdaFormer (ours)	32.43	0.8974	**22.28**	**28.80**	0.7858	**25.28**	27.70	**0.7407**	**20.87**	26.48	**0.7982**	**55.05**

Results (Images)

1. CNN (CVANet)

(a) HR   (b) DRCN   (c) LapSRN   (d) VDSR   (e) CARN   (f) CARN_M

Woman from Set5

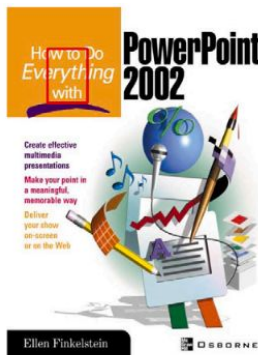(g) IDN   (h) MSRN   (i) WMRN   (j) ShuffleMixer   (k) ShuffleMixer_T   (i) CVANet

(a) HR   (b) DRCN   (c) LapSRN   (d) VDSR   (e) CARN   (f) CARN_M

Ppt3 from Set14

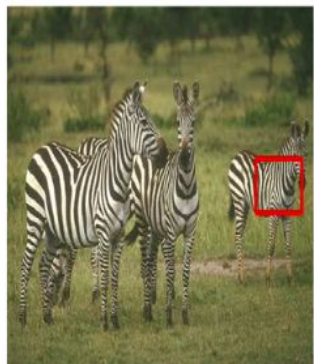(g) IDN   (h) MSRN   (i) WMRN   (j) ShuffleMixer   (k) ShuffleMixer_T   (i) CVANet

Results (Images) (cont)

1. CNN (CVANet) (cont)

Results (Images) (cont)

1. CNN (CVANet) (cont)

(a) HR (b) DRCN (c) LapSRN (d) VDSR (e) CARN (f) CARN_M

Img005 from Urban100 (g) IDN (h) MSRN (i) WMRN (j) ShuffleMixer (k) ShuffleMixer_T (i) CVANet
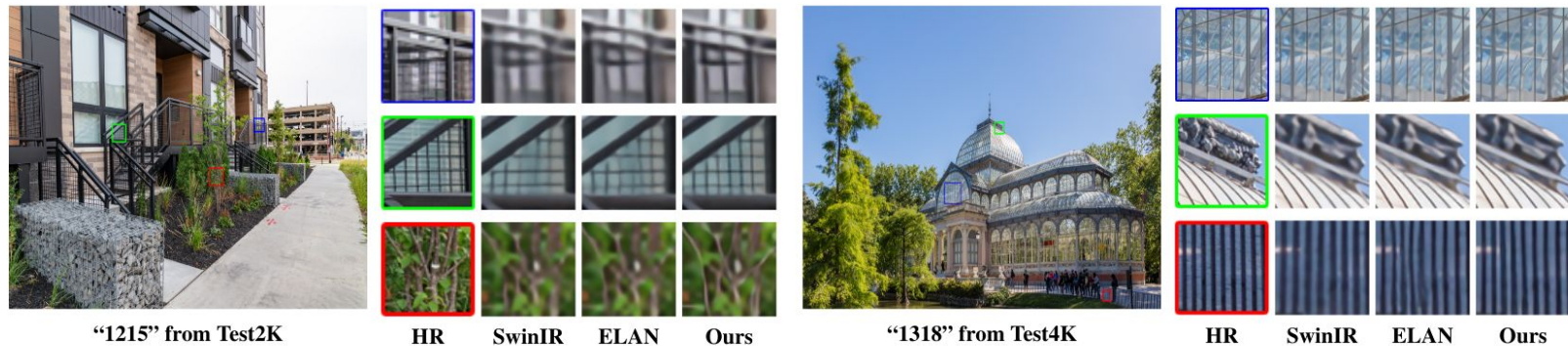
2. Transformer (AdaFormer)

"1215" from Test2K HR SwinIR ELAN Ours

"1318" from Test4K HR SwinIR ELAN Ours

General Results

- Results do not look extremely promising
- Will need to perform more research in order to find a model that can truly enhance image quality