Single Image Super Resolution (SISR)

Bharti Chaudhary

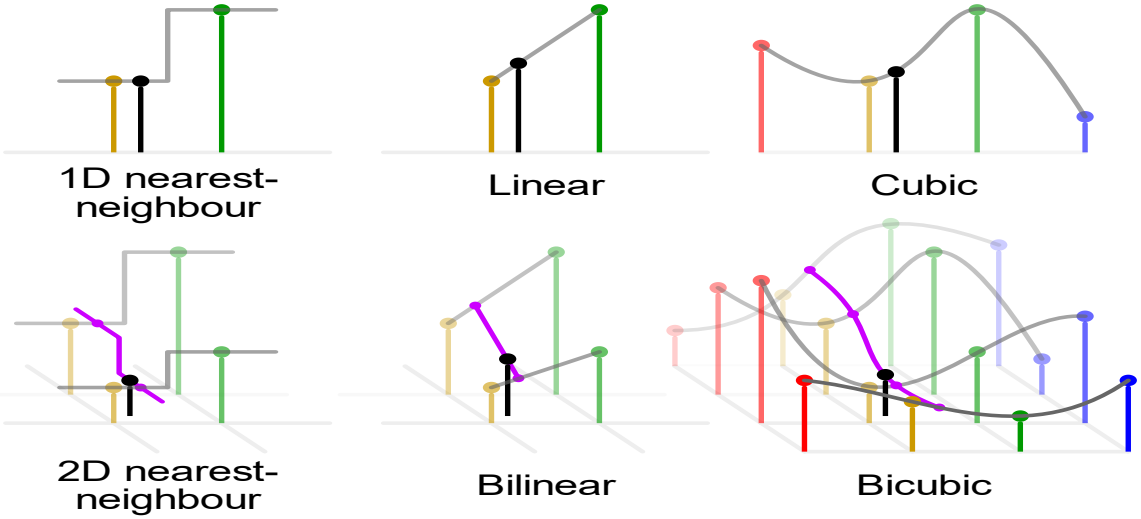
SISR

- Recover/Construct finer detail from Low-Resolution
- Obtain a learned LR to HR Image mapping using Convolutional Neural Network based approach
- Pixel-wise loss minimization between LR & HR images (Mean Square Error).
- PSNR Metric – Peak Signal To Noise Ratio
  - $PSNR = 10 \times \log_{10}\left(\frac{MAX^2}{MSE}\right) = 20 \times \log_{10}\left(\frac{MAX}{\sqrt{MSE}}\right)$
  - $MAX = 255$

Applications of SISR

- Satellite Imaging
- Medical Imaging
- Security Imaging

Classic Interpolation



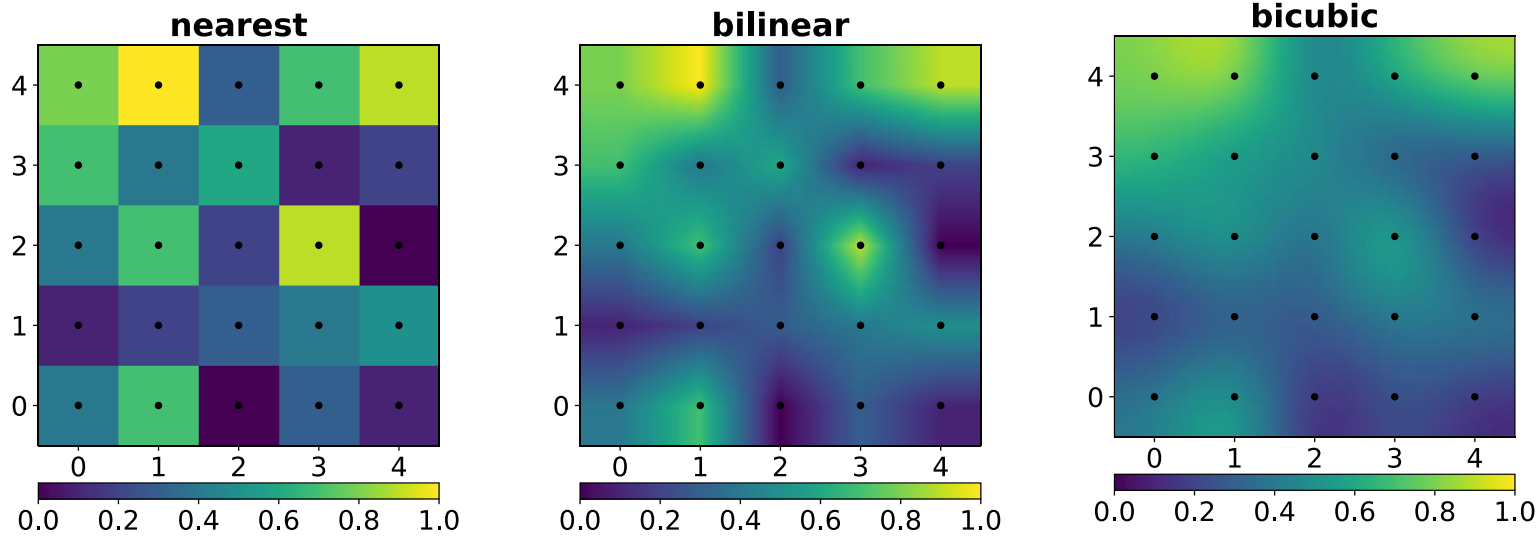


Image courtesy : https://en.wikipedia.org/wiki/Bicubic_interpolation

Training Datasets

- DIV2K: 800 images of 2K Resolution
- Flickr2K: 2650 2K images
- Challenge on Learned Image Compression (CLIC):
  - CLIC-professional: 585 images of 480p to 2K
  - CLIC-mobile: 1048 images of 320p to 2K

Testing Datasets

- PIRM Perceptual Image Super-Resolution Challenge
- BSDS100: 100 images
- Set5 & Set14: common SISR evaluation datasets
- Urban 100: FHD images of Urban scene
- Manga 109: Images of Anime comic covers
- Validation sets of DIV2K, CLIC

Data Preparation

- Datasets are of High-Resolution images
- Obtained Low Resolution via **bicubic** down-sampling
- Scale Factor: 4
- **Patches**
  - LR: 32x32
  - HR: 128x128
- **Patching Approach**
  - HR Image is first Down-sampled and divided into patches for further processing
  - HR Image is first divided into patches of desired size and then Down-sampled for further processing
  - First approach is used in our experiments
- Images of different resolution and formats

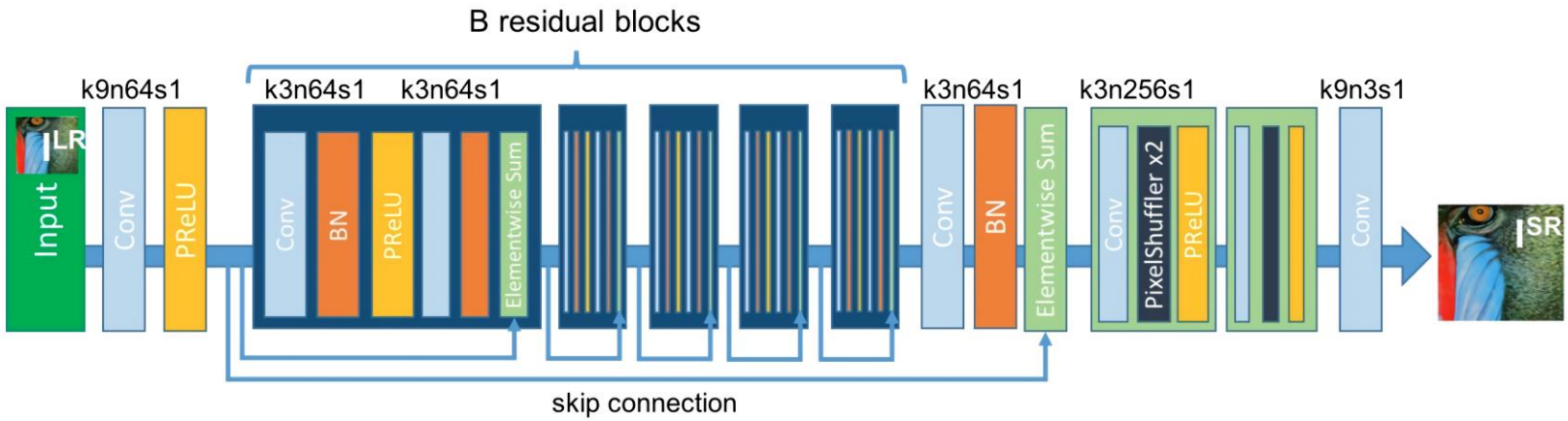
Experimental Setup

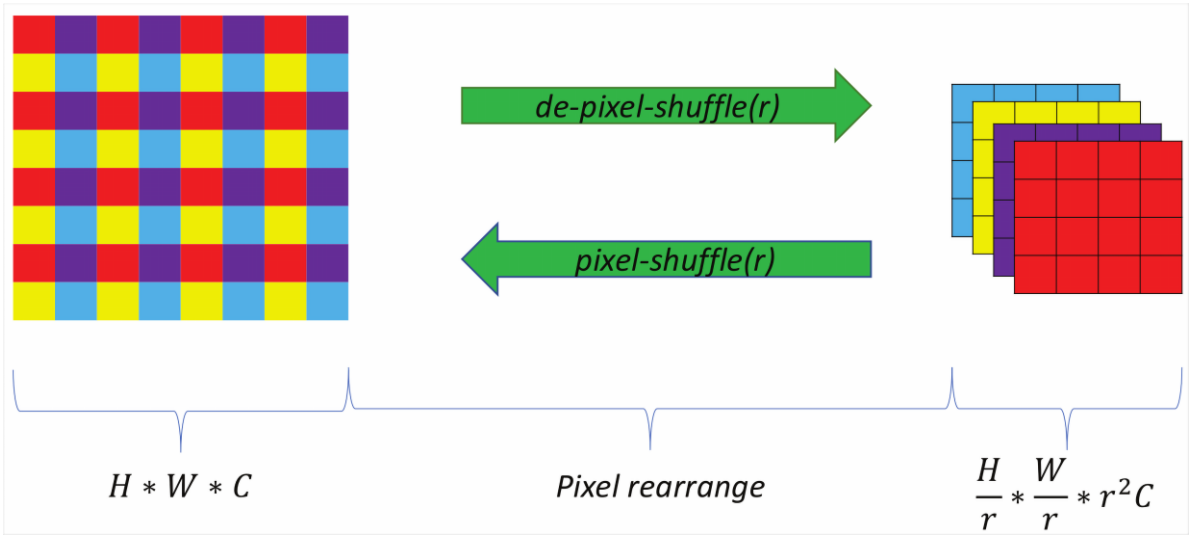
- Intel(R) Core(TM) i7-8700K CPU @ 3.70GHz
- 16 GB DDR4 2400MHz RAM
- 12 GB NVIDIA 1080Ti GPU

Model Selection (Exp 0.)

- Type 1: Takes interpolated LR image as input
  - High resource intensive & difficult to converge
- Type 2: Takes LR input, works on LR feature space, later find a learned up-sampling
  - Less resource intense & converges easily
- SRResNet is best in terms of accuracy & resource usage

SRResNet Architecture





Output images & PSNR values

30.83 dB
LR
(Bicubic)

32.50 dB
SRResNet

∞ dB
Ground Truth

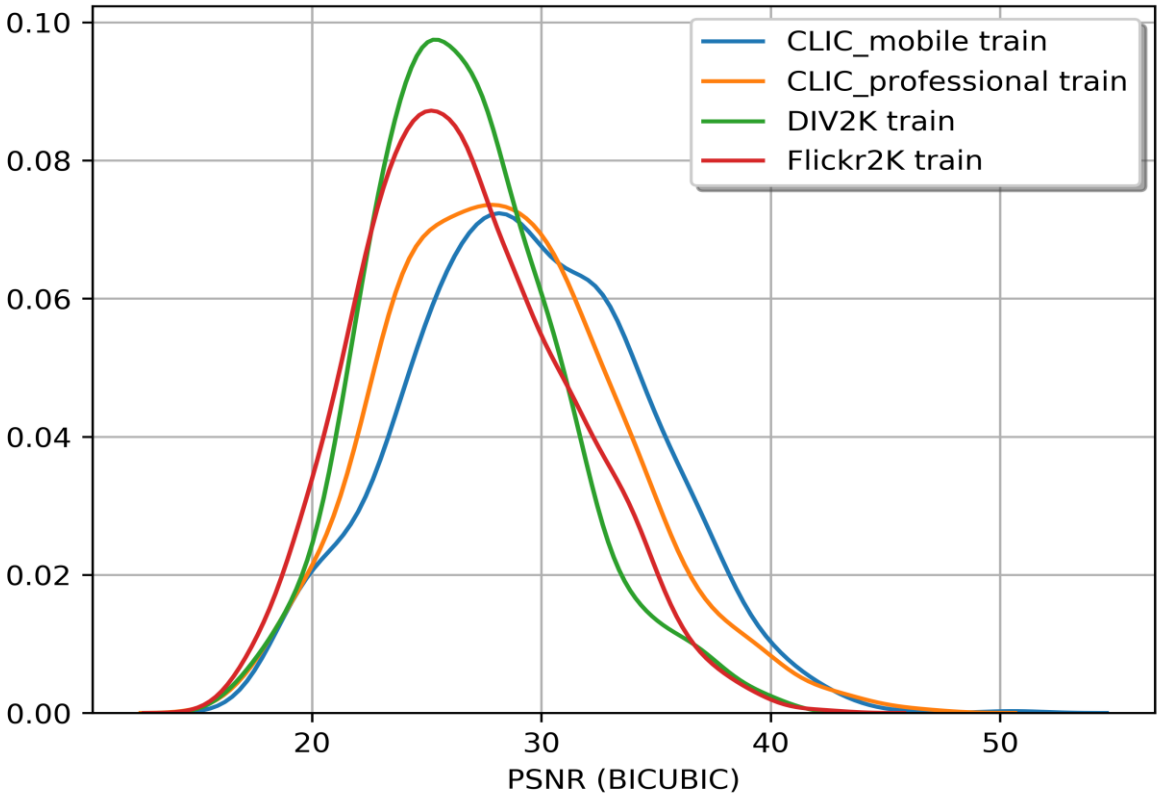
PSNR Gain 1.67 dB

Mean PSNR Gain over Bicubic on separate SRResNet instances

Test/Valid Dataset	DIV2K	Flickr2K	CLIC-professional	CLIC-mobile	Min Diff
CLIC-mobile	1.43	1.28	1.34	1.16	0.09
CLIC-professional	1.64	0.88	1.49	1.20	0.15
DIV2K	1.55	1.11	1.27	1.12	0.28
BSDS100	1.73	1.39	1.44	1.32	0.29
Manga109	4.01	3.75	3.39	3.03	0.26
PIRM	1.40	1.27	1.25	1.08	0.13
PIRM	1.37	1.24	1.19	1.02	0.13
Set5	1.79	1.65	1.57	1.38	0.14
Set14	2.77	2.33	2.45	1.98	0.32
Urban100	2.00	1.86	1.78	1.57	0.14

Data-Set Ranking (Exp 1.)

- Why (& How) training on different dataset matter?
- Fine details are difficult to recover from Bicubic



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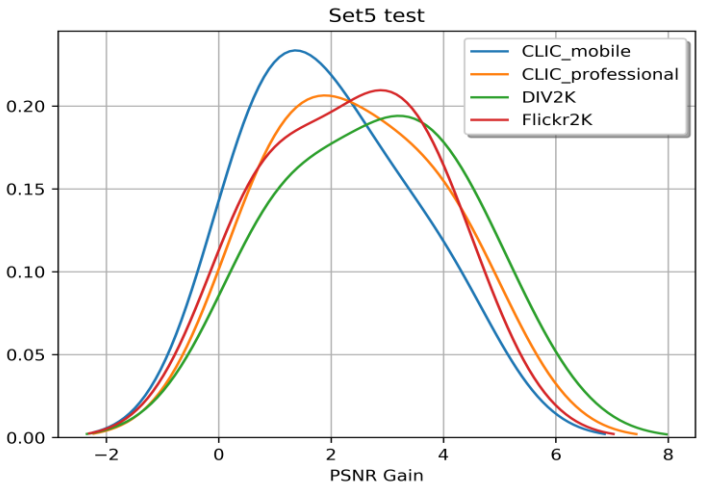

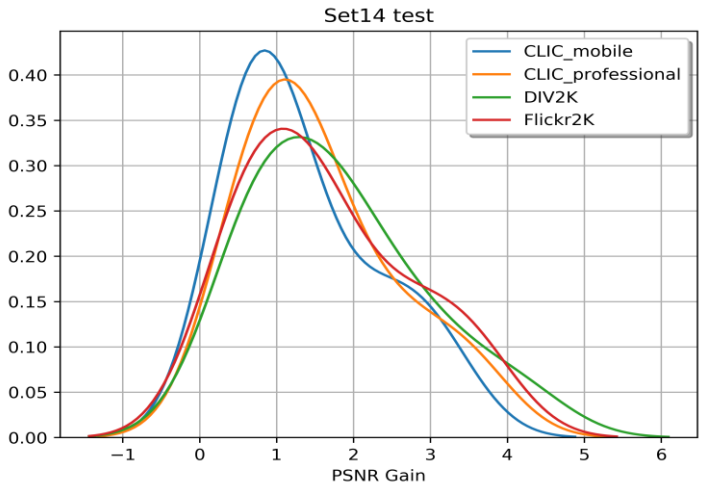

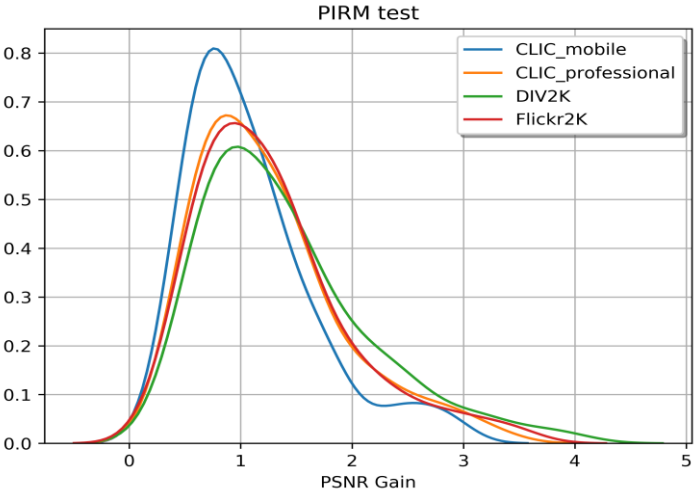

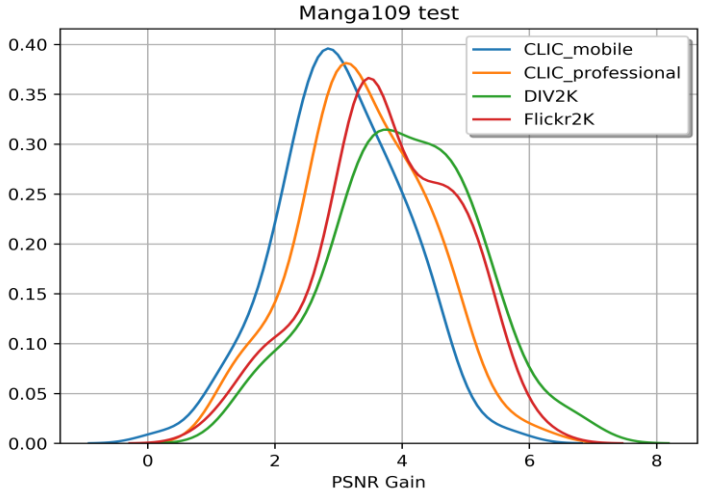

Core Findings & Conclusion

- Dataset-Ranking approach helps obtaining better performance
- Combining all datasets will saturate in practice

- Analysed various SISR models from the literature
- Characterize training datasets for best performance

Future Work

- Similar **Dataset Ranking** approaches can be used for other low-level vision applications like Compression Artefacts Removal, De-noising.,

References

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- CLIC Challenge - https://www.compression.cc/challenge/

Thank You!

Questions?