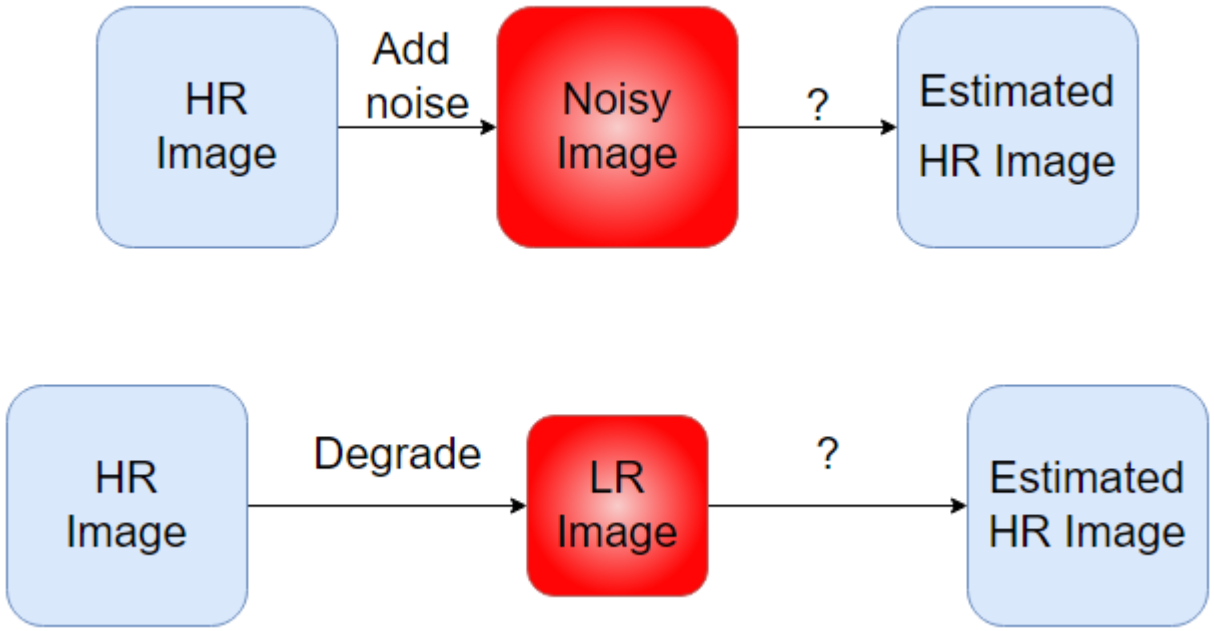
Data Challenge 6

Image super-resolution

Background

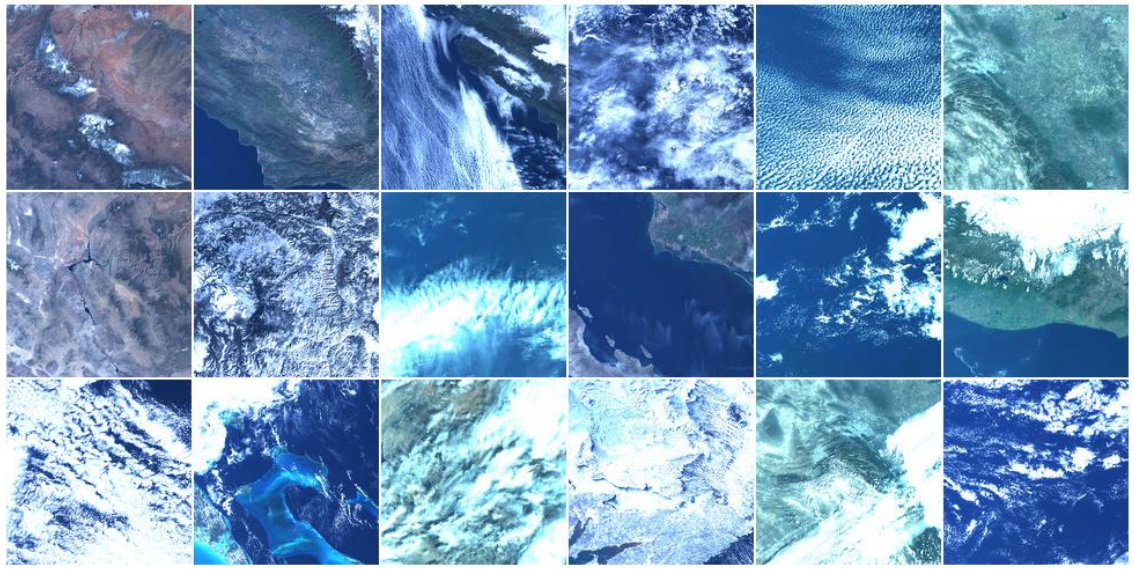
Task


HR Image
Add noise
Noisy Image
?
Estimated HR Image
HR Image
Degrade
LR Image
?
Estimated HR Image

Dataset

- SMCEFR (SMC's Earth Full Resolution)
- Data from the Ocean Land and Color Instrument (OLCI) on the Sentinel-3 project
- Mainly contain clouds, lands and sea
- 1024 x 1024 PNG images

Dataset



A sample of 18 images from the smcefr-mini dataset

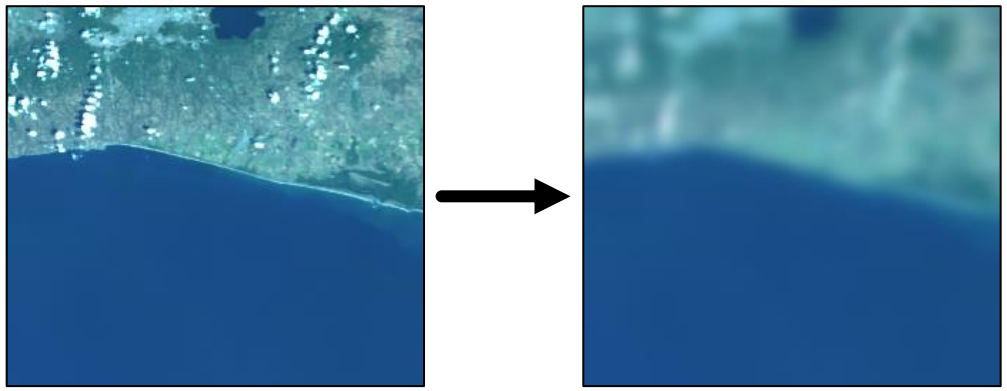
Image noise and degradation

Gaussian noise

- Values that the noise can take are Gaussian-distributed
- Sensor noise caused by:
  - Poor illumination
  - High temperature
  - Transmission

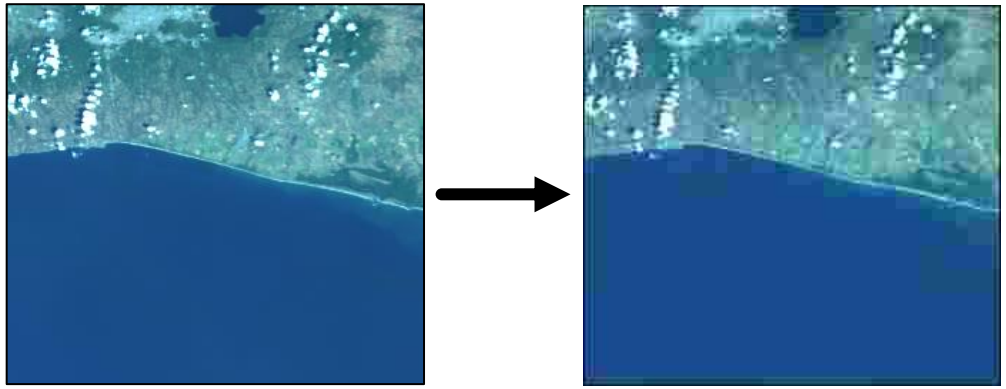
Gaussian blur

- Blurring an image by a Gaussian function
- Like viewing the image through a translucent screen
- Commonly used when reducing the size of an image



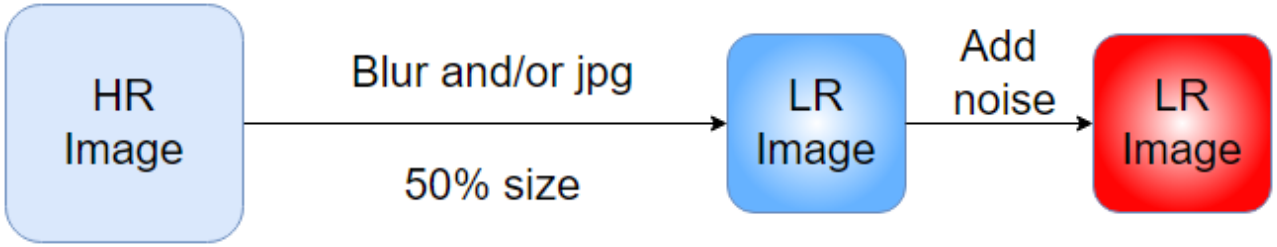
Jpg compression

- Commonly used method of lossy compression for digital images
- Typically achieves compression with little perceptible loss in image quality

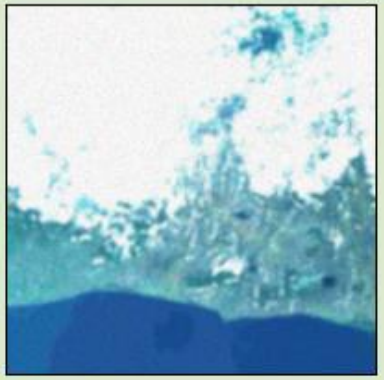
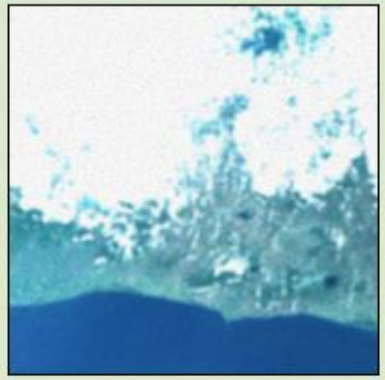
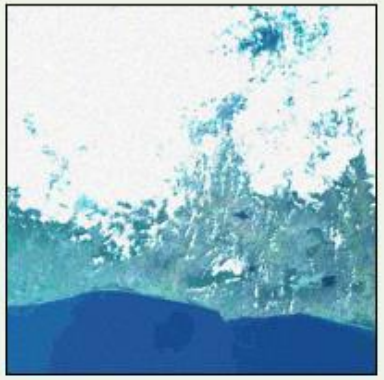
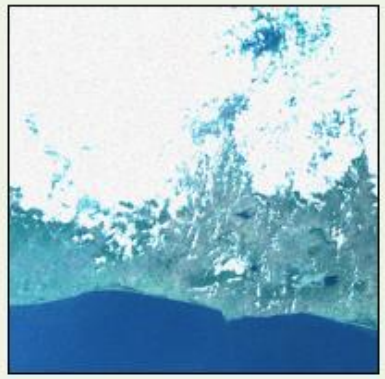


Method

Prepare datasets



Degradation

	Jpg compression	No Jpg compression
blur		
No blur		

Noise adding

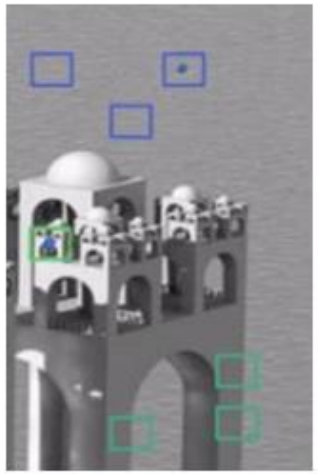
- sigma = 0.1
- Basic flow:

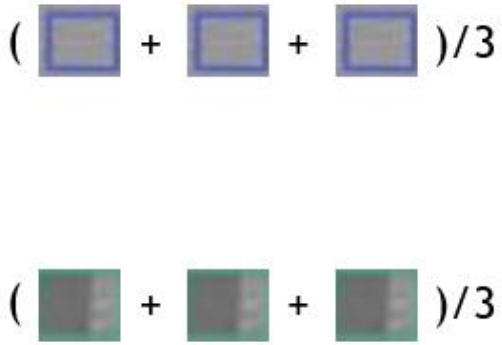
```
noise = np.random.normal(0.0, sigma)

Noisy_image = image + noise
```

Models

OpenCV

- Non-local Means Denoising algorithm
- cv.fastNlMeansDenoisingColored()
- The same pattern may be somewhere else in the image
- Using that to average out the noise

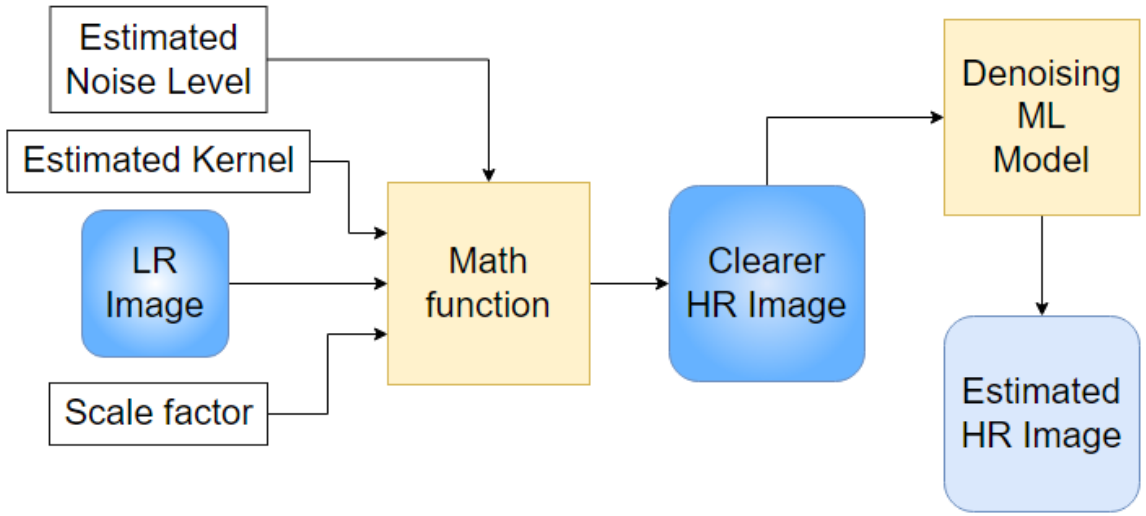




USRNet

K. Zhang, L. V. Gool, and R. Timofte, “Deep unfolding network for image super-resolution,” in CVPR, 2020, pp. 3214–3223.

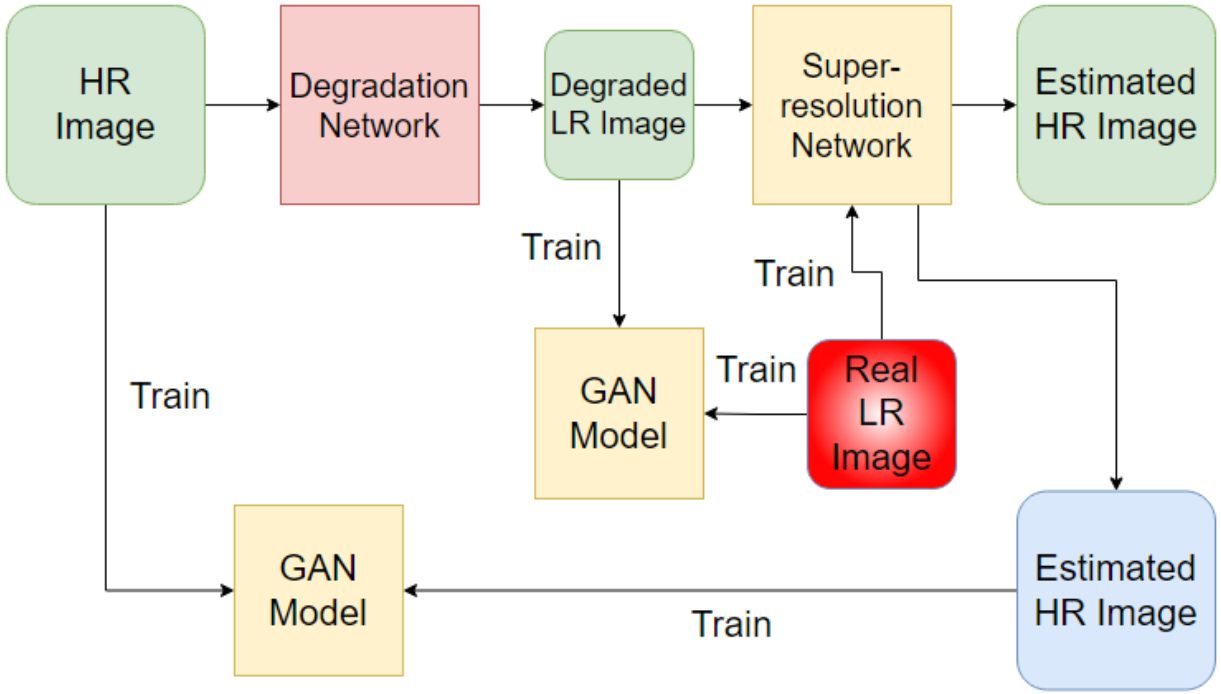
- Input:
  - LR image
  - Estimated Kernel
  - Estimated Noise Level
  - Scale factor



DASR

S. Y. Kim, H. Sim, and M. Kim, “Koalanet: Blind super-resolution using kernel-oriented adaptive local adjustment,” in Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), June 2021, pp. 10611–10620.

- Input LR image Only
- Also training the degradation estimation

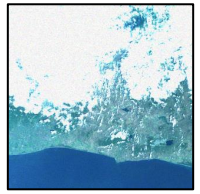


Performance measure

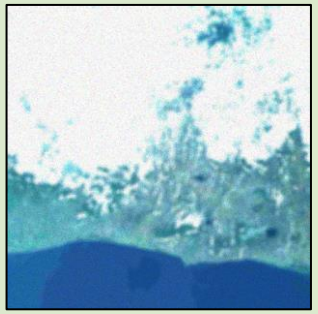
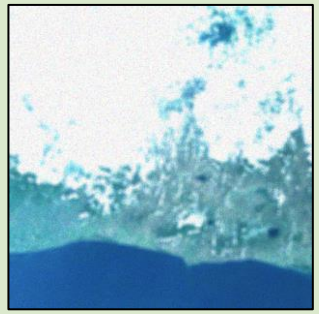
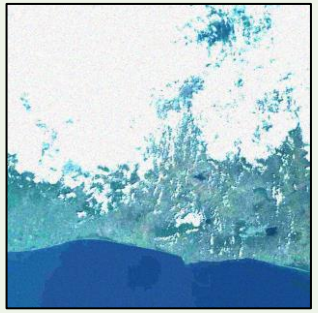
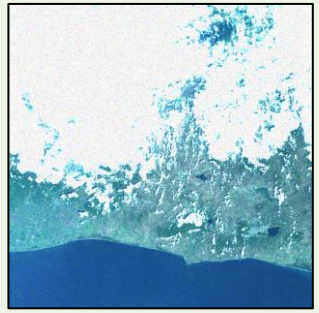
- Peak signal-to-noise ratio (PSNR)
  - Range from 0 to inf
  - Higher means less noise
- Structural similarity (SSIM)
  - Range from 0 to 1
  - Higher means more similar

Results

Estimated images – Bicubic resize

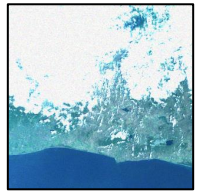


LR image

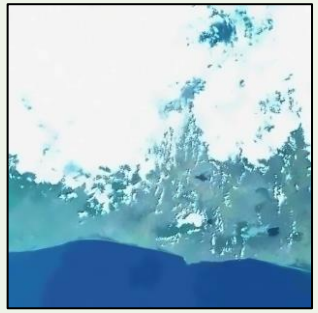
	Jpg Compression	No Jpg Compression
Blur	 PSNR 22.55dB SSIM 0.4906	 PSNR 20.07dB SSIM 0.3459
No blur	 PSNR 19.90dB SSIM 0.3401	 PSNR 23.88dB SSIM 0.5419

Average: 21.60dB 0.4296

Estimated images – OpenCV denoising

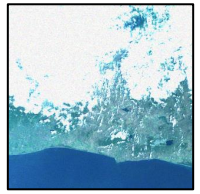


LR image

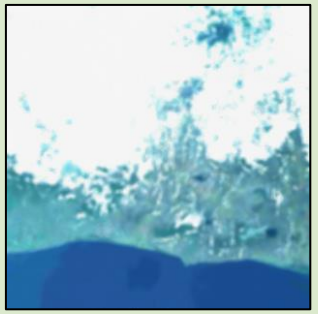
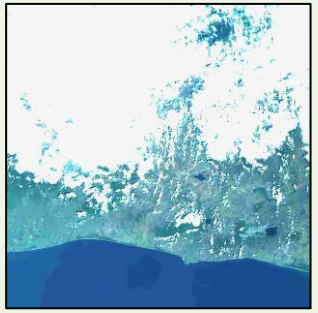
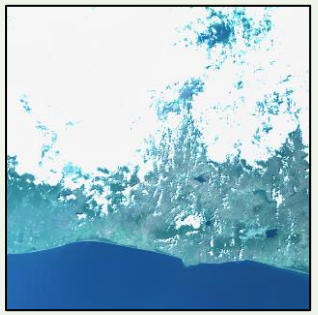
	Jpg Compression	No Jpg Compression
Blur	 PSNR 23.04dB SSIM 0.8045	 PSNR 20.59dB SSIM 0.7022
No blur	 PSNR 20.45dB SSIM 0.7007	 PSNR 23.46dB SSIM 0.8152

Average: 21.89dB 0.7557

Estimated images – USRNet

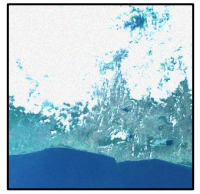


LR image

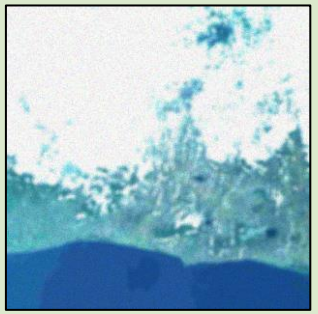
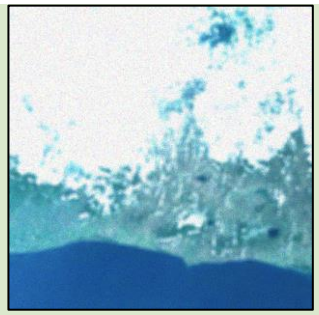
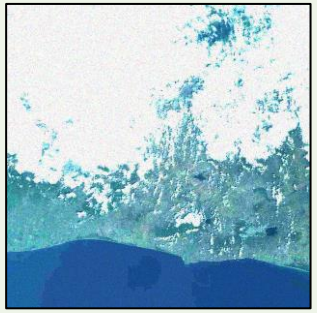
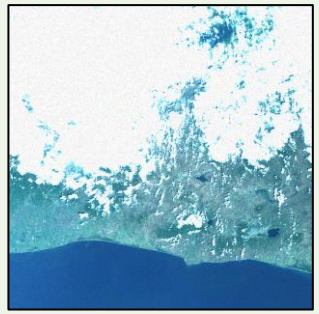
	Jpg Compression	No Jpg Compression
Blur	 PSNR 23.05dB SSIM 0.8219	 PSNR 21.35dB SSIM 0.7094
No blur	 PSNR 21.18dB SSIM 0.7073	 PSNR 24.54dB SSIM 0.8772

Average: 22.53dB 0.7790

Estimated images – DASR



LR image

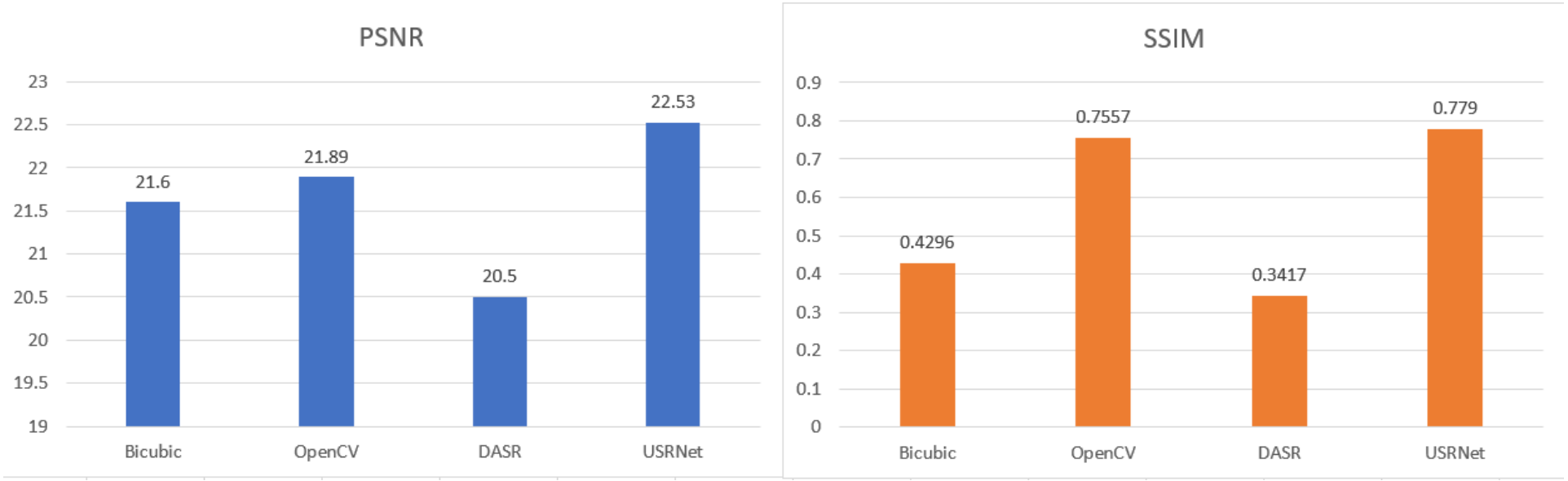
	Jpg Compression	No Jpg Compression
Blur	 PSNR 20.46dB SSIM 0.3621	 PSNR 19.00dB SSIM 0.2392
No blur	 PSNR 18.85dB SSIM 0.2338	 PSNR 23.67dB SSIM 0.5316

Average: 20.50dB 0.3417

Performance

	Average result
bicubic	PSNR: 21.60dB SSIM: 0.4296
OpenCV	PSNR: 21.89dB SSIM: 0.7557
DASR	PSNR: 20.50dB SSIM: 0.3417
USRNet	PSNR: 22.53dB SSIM: 0.7790

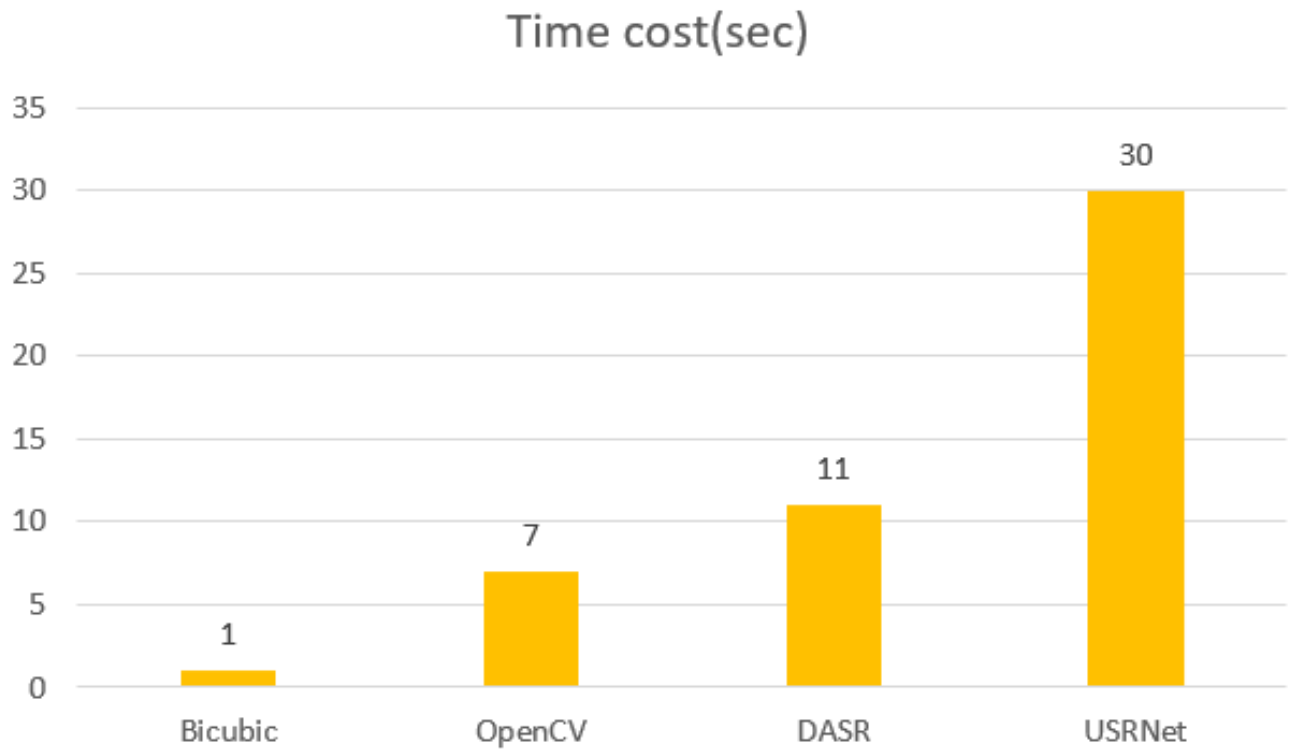
Performance



Time cost

	Time cost for processing 16 images
bicubic	1 sec
OpenCV	7 sec
DASR	11 sec
USRNet	30 sec

Time cost

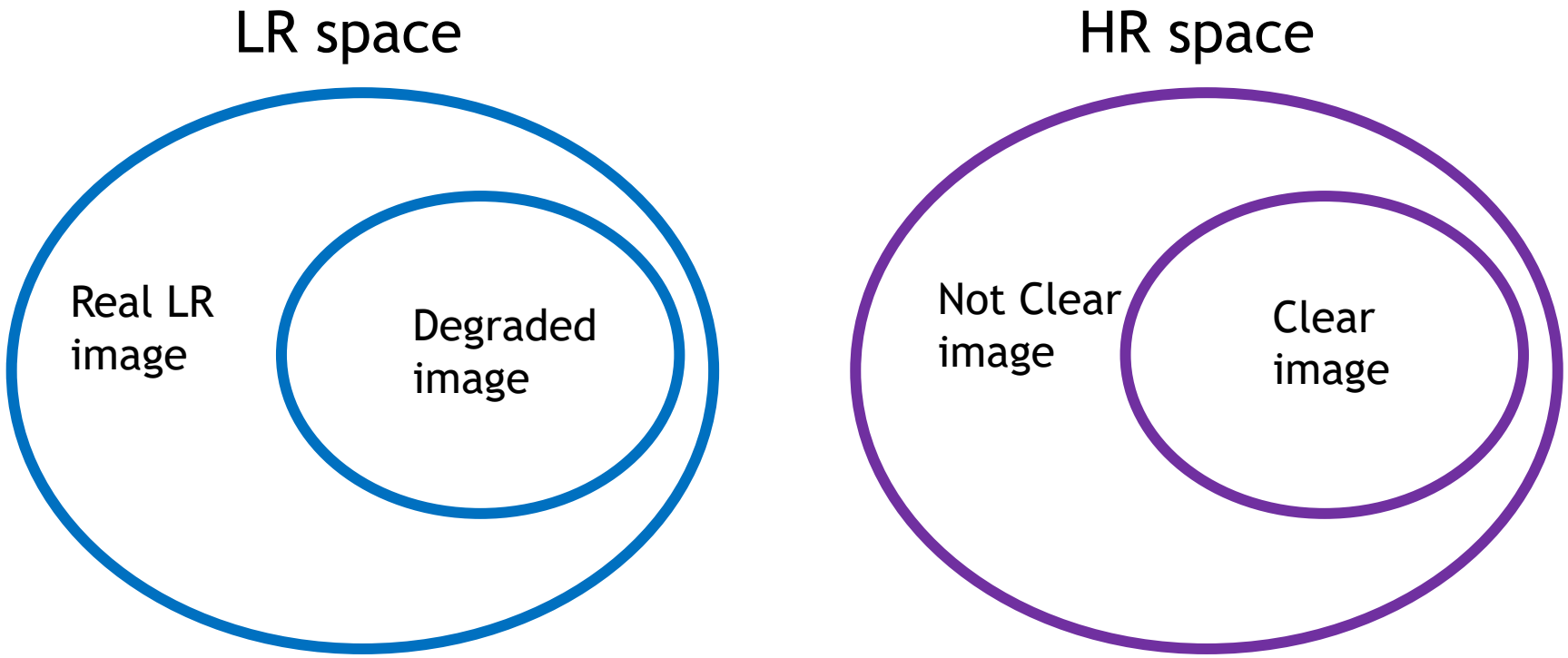

Time cost(sec)
35
30
25
20
15
10
5
0
1
7
11
30
Bicubic
OpenCV
DASR
USRNet

Discussion

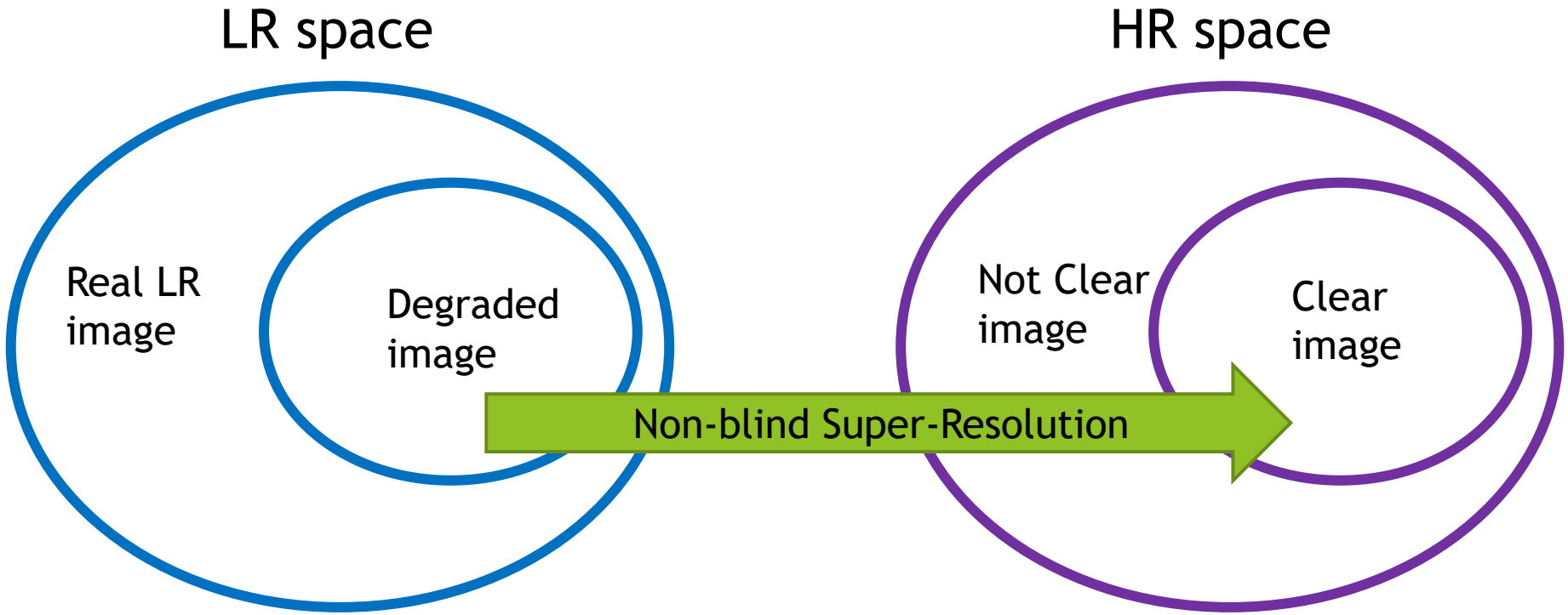
Model generalization

- Specific dataset vs general dataset
- Cloud image is similar → specific dataset
- Degradation type is similar

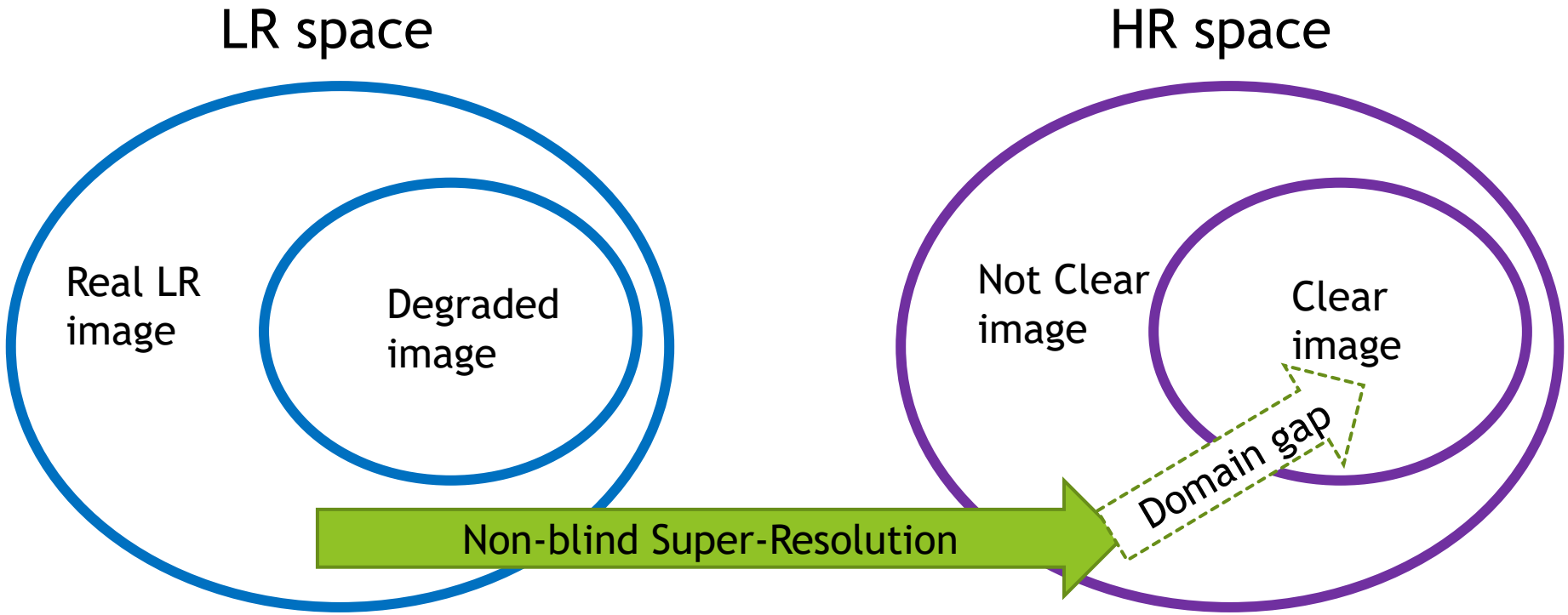
Blind super-resolution



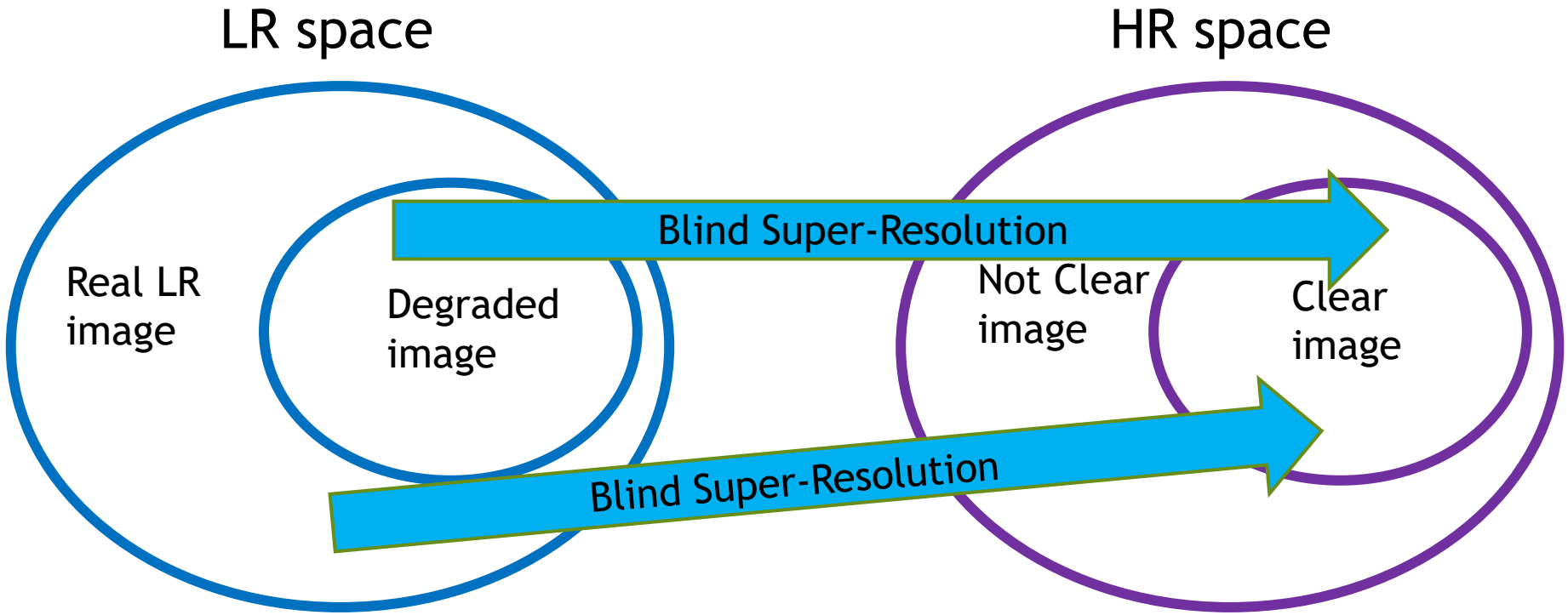
Blind super-resolution



Blind super-resolution



Blind super-resolution



Computational Power

- Time vs performance trade-off
- Time ↑ Performance ↑
- Some environment need fast/less computation
  - Portable device
  - Instant result

The End