



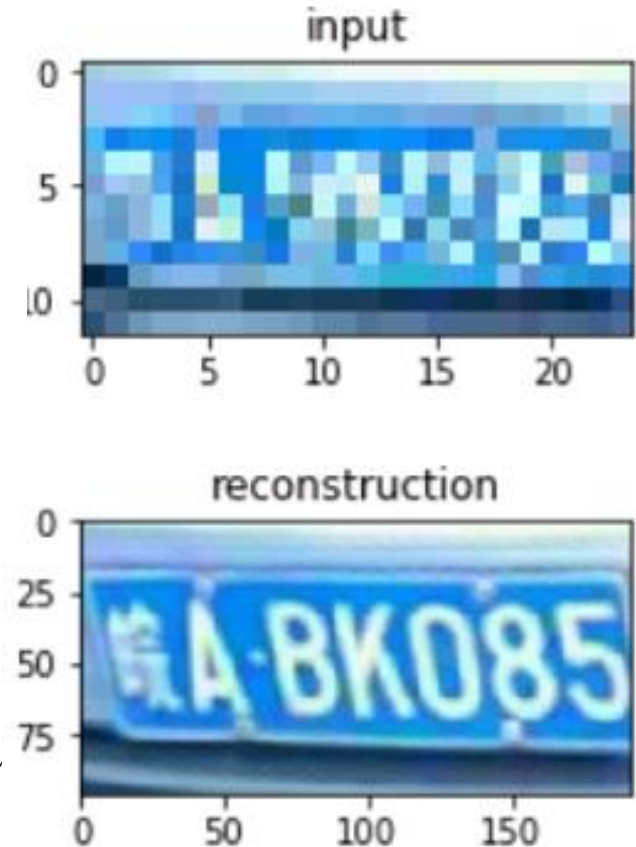
# A Case Study in ML/Algorithm

Image Super-Resolution Using  
Deep Learning

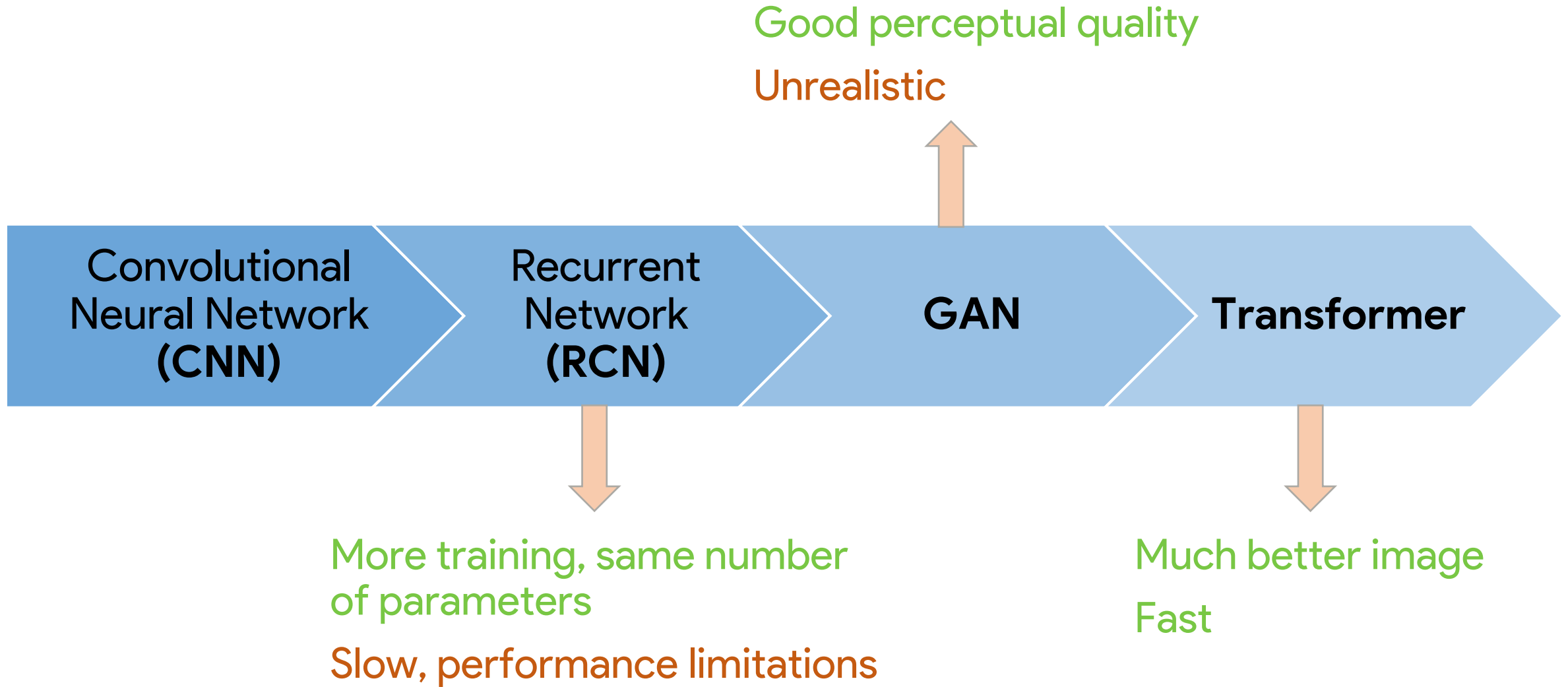
# INTRODUCTION

## Super-Resolution (SR)

- Get a high-resolution image from current low one
- **Image:** security camera, medical images
- **Video:** server reduced quality to save data

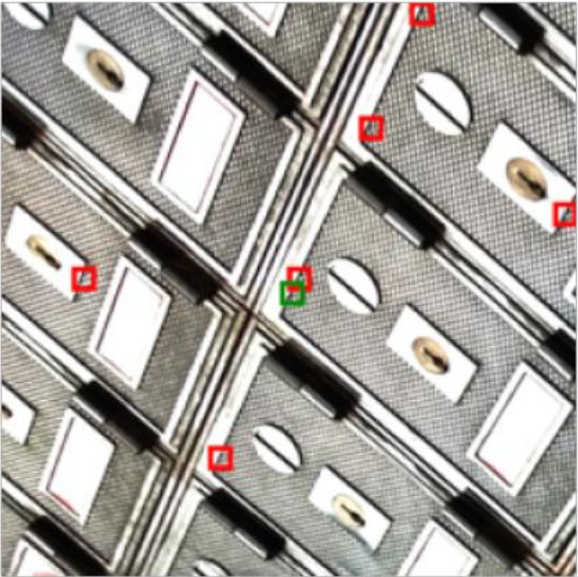


# BACKGROUND



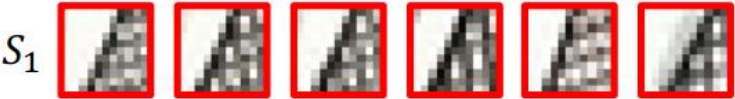
# BACKGROUND

Self-similarity-Natural images contain similar pattern



Can mining information

x1  
Target:  Matches:

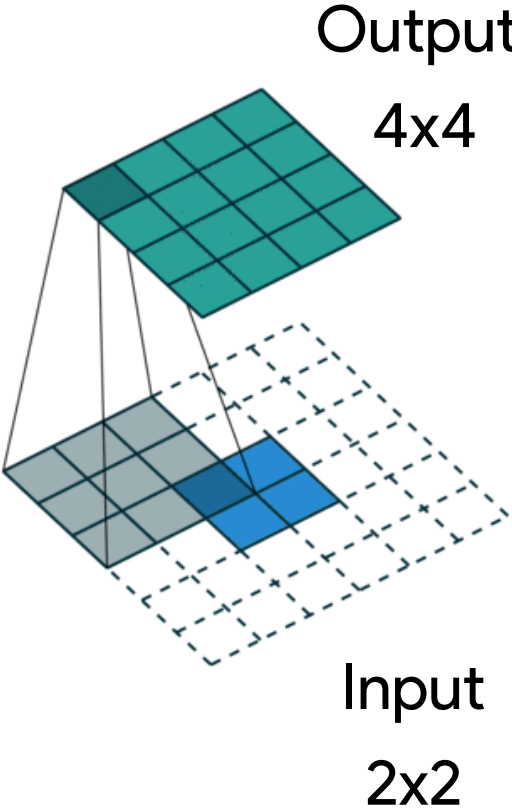
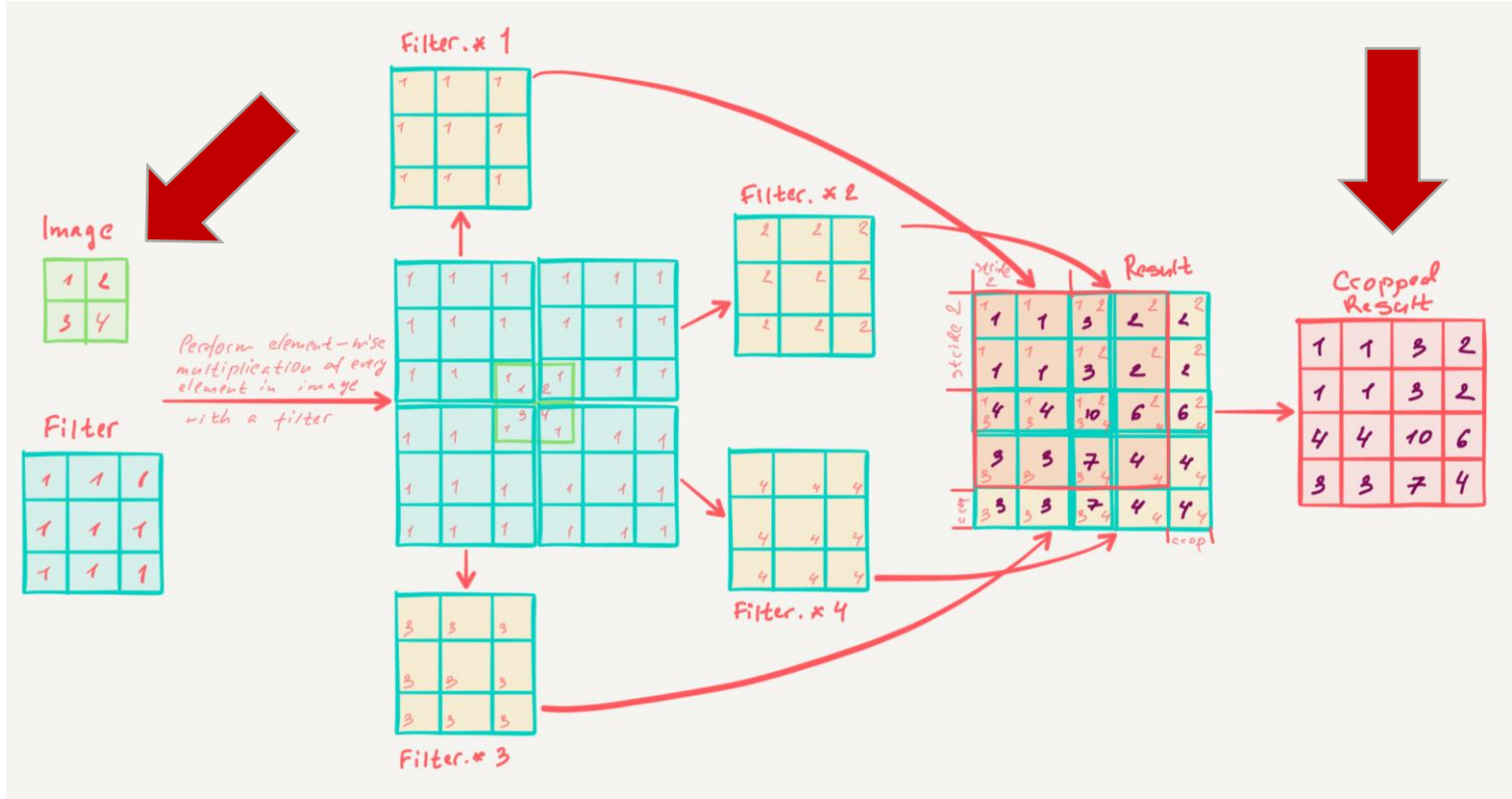


same scale

different scale

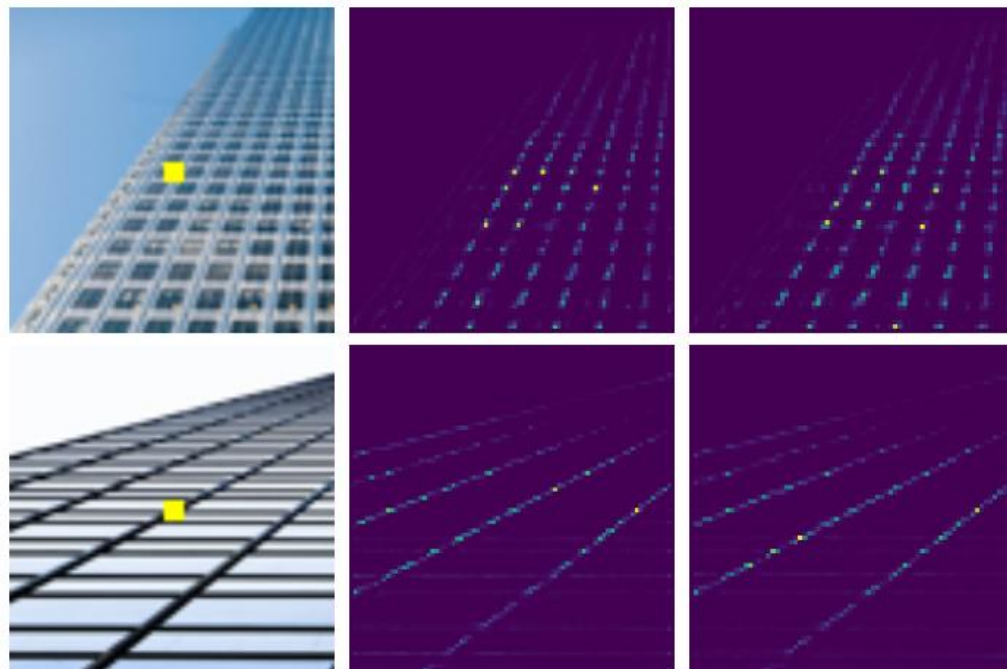
# METHODOLOGY

## Deep CNN-Deconvolution



# METHODOLOGY

## Transformer-Attention Mechanism



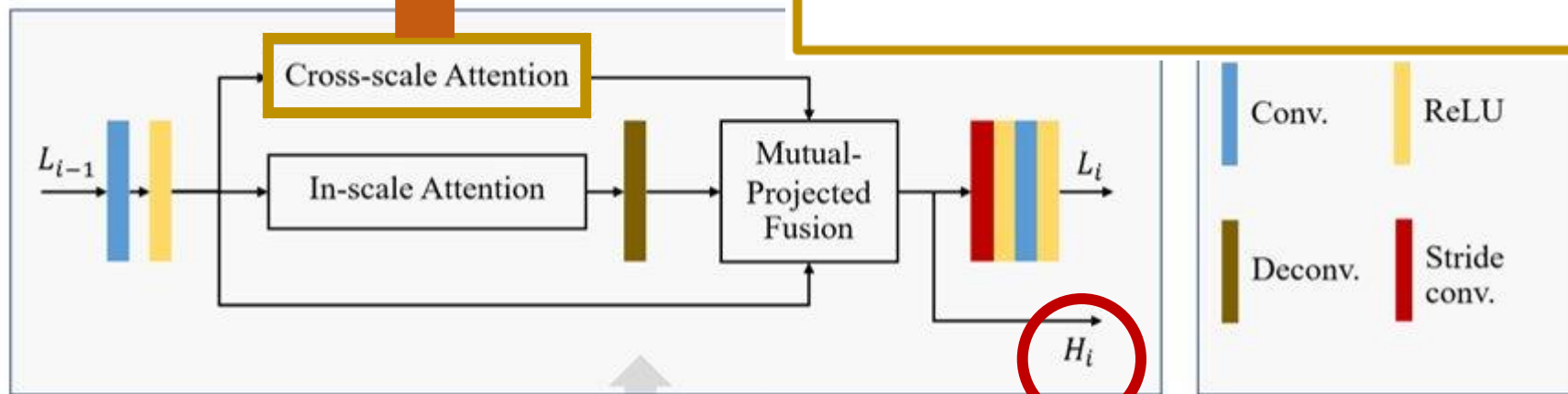
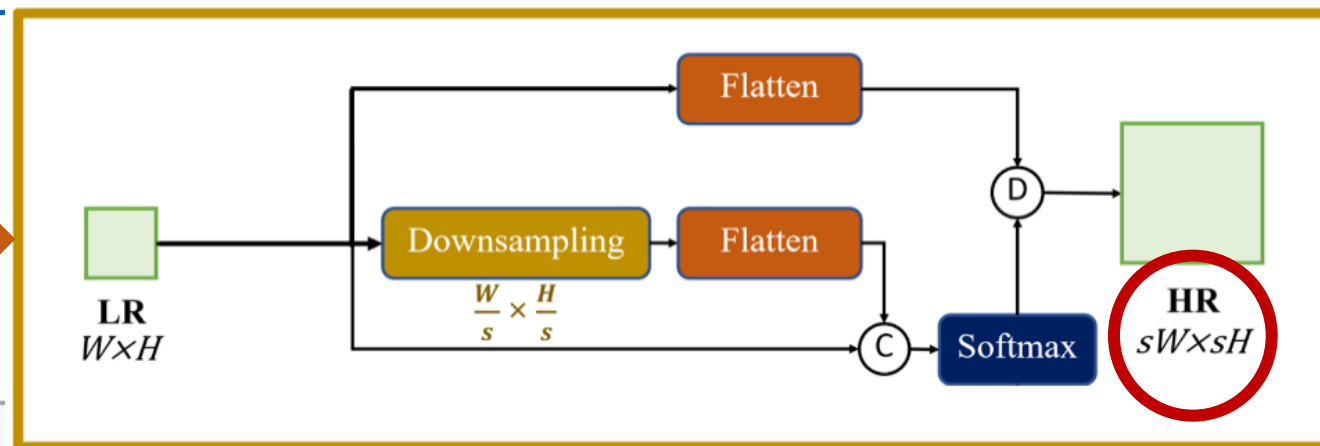
Correlation maps for attention, brighter indicates higher engagement

The	big	red	dog
The	big	red	dog
The	big	red	dog
The	big	red	dog

Self-attention in language translation

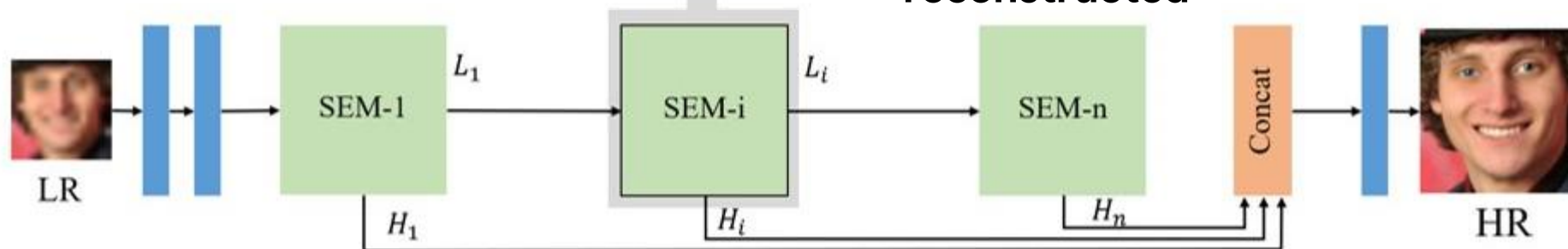
- ignore irrelevant
- focus on important information

# Cross-Scale Non-Local Attention



High-resolution reconstructed

High-resolution reconstructed





# ANOTHER BACKGROUND



16x16



Original

128x128

- **Based model** can do up to 4x
- **Face images** are worth to explore
- Upscaling to **8x** is popular now
- Other techniques could be applied
  - Feedback, Dense, GAN, etc.

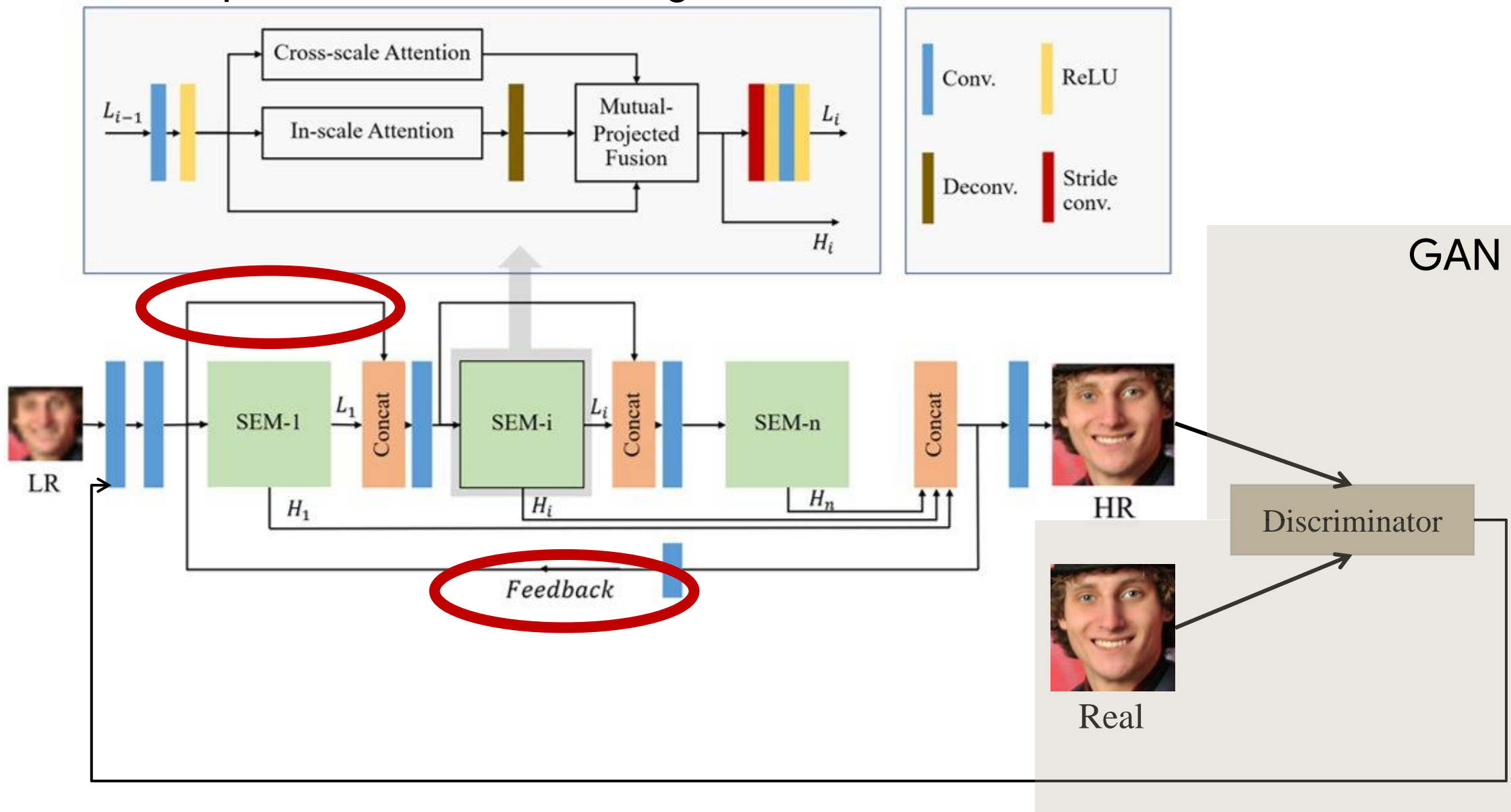


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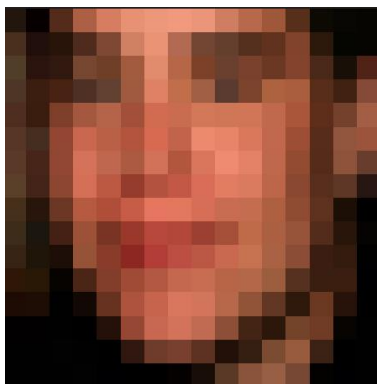
- Modify model to **8x**
- Train with **face dataset**
- CSNL modified
- CSNL modified+GAN

Upscale 2x for 3 times to get 8x

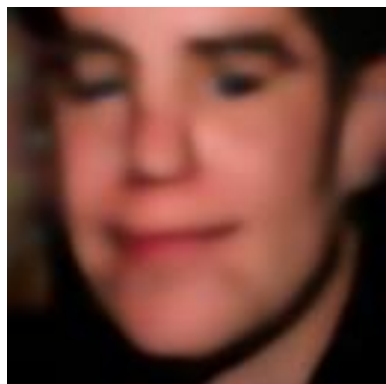


# RESULTS-PSNR (HIGHER=BETTER)

16x16

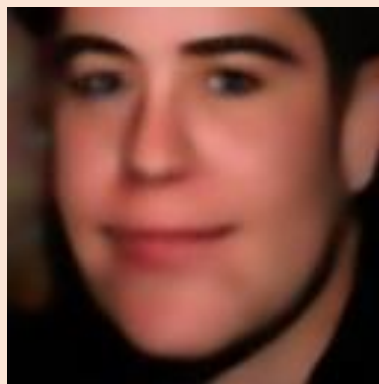


CSNL



25.75

modified



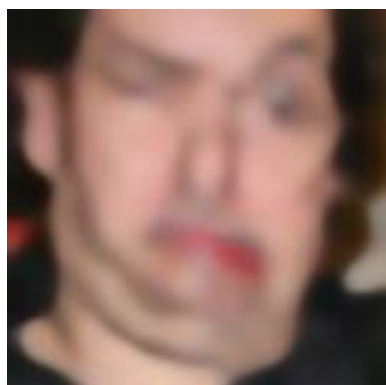
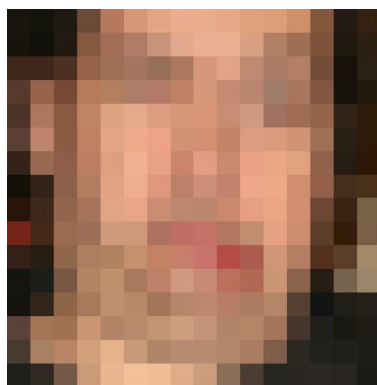
26.45

CSNL+GAN

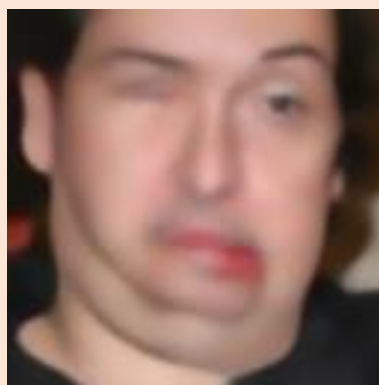


23.47

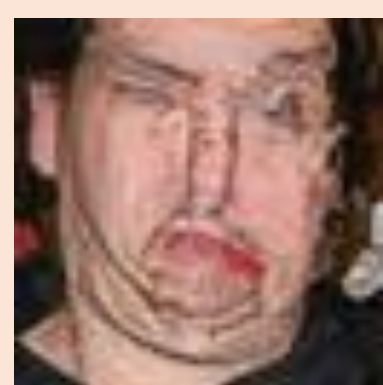
Original 128x128



23.76



24.59

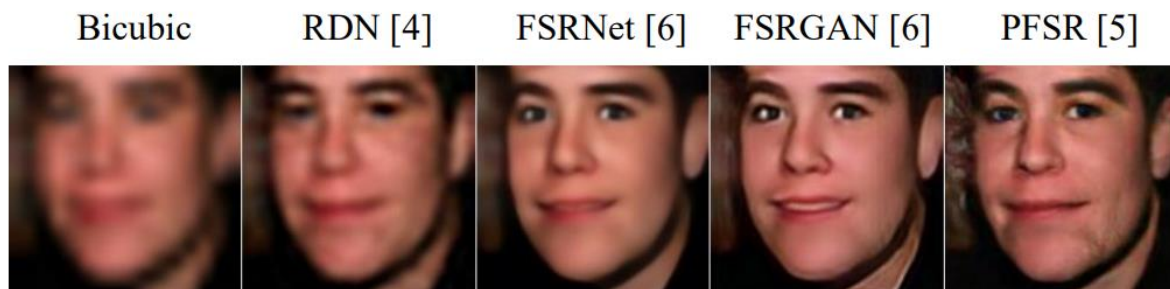


22.00

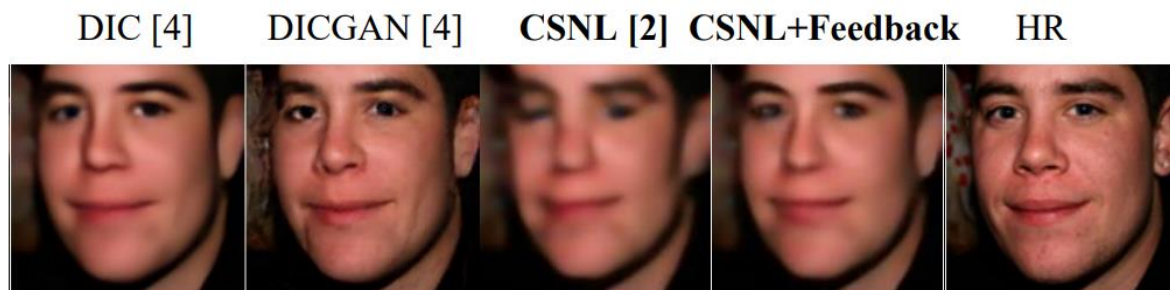


# RESULTS-PSNR (HIGHER=BETTER)

16.5M parameters for 8x  
(others use 15M-200M)



23.89      25.34      25.90      24.99      24.73



**26.69**      25.96      25.75      **26.45**      HR

	PSNR (dB)
Bicubic	23.89
SRResNet [1]	25.30
URDGN [8]	24.22
RDN [5]	25.34
PFSR [6]	24.73
FSRNet [7]	25.90
FSRGAN [7]	24.99
DIC [4]	<b>26.69</b>
DICGAN [4]	25.96
CSNL [2]	25.75
CSNL+Feedback	<b>26.45</b>

2<sup>nd</sup> best in table

# DISCUSSION

Modified model to <b>8x</b> Train with <b>face dataset</b>	These ideas work fine with <b>face images</b>
Modified network	Can perform <b>8x upsampling</b> Image quality improved <b>Oversmoothed</b>
Using as GAN's generator	<b>More details</b> <b>Need to be tuned more</b>
Time & Efficiency	<b>More than original ~15%</b> <b>Loops take time to upsampling</b>

# CONCLUSION

- **Process of researching, understanding concepts**
- How to deal with long code
- Preparing data
- **Used new tools (PyTorch, environments, MATLAB, Scikit)**
- Hands-on learning



THANK YOU