Is Image Super-resolution Helpful for Other Vision Tasks?
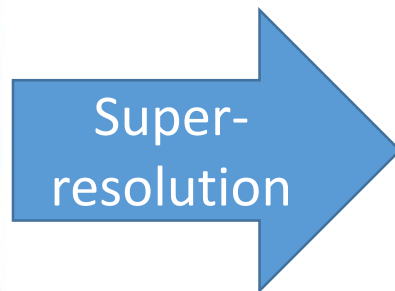
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Motivation: methods merely evaluated perceptually

Low-Resolution → Super-resolution → High-Resolution

❶ *Is image super-resolution helpful for other vision tasks?*

❷ *How the usefulness correlate to perceptual quality?*
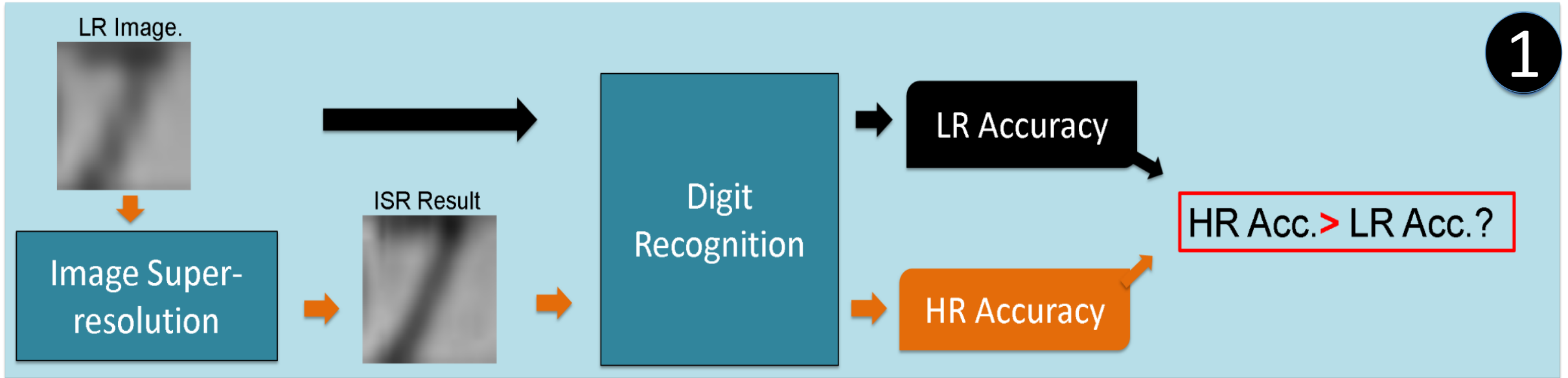
Motivation: why it should work

Low-resolution

Super-resolved

❑ Features & models are often learned with images of normal resolution

❑ Super-resolving input images to the proper resolution should help
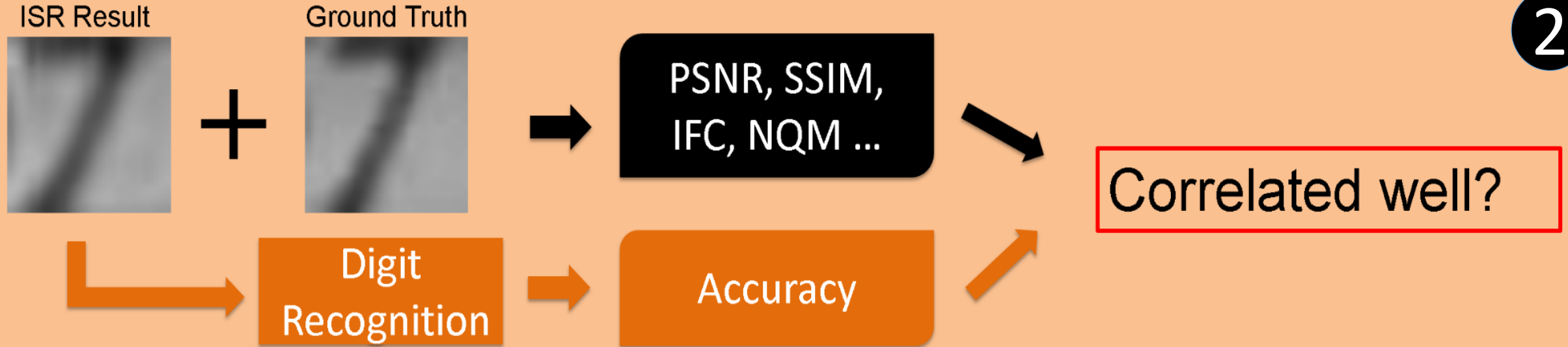
Evaluation 1: Helpful to other vision task?

- Same algorithm
- Two versions of input images

Evaluation 2: Correlation with perceptual criteria

- Same super-resolved image
- Two evaluation methods: perceptual quality and usefulness
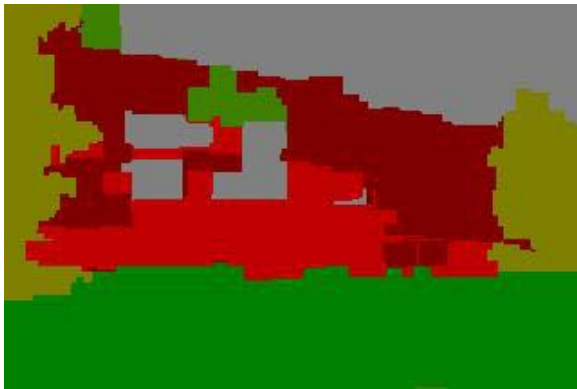
Evaluation: Summary

❑ **<u>Six</u>** image super-resolution methods: Zeyde, ANR, A+, SRCNN, JOR, and SRF

❑ **<u>Five</u>** vision tasks: Boundary Detection, Semantic Image Segmentation, Digit Recognition, Scene Recognition, and Face Detection

❑ **<u>Four</u>** perceptual criteria: PSNR, SSIM, IFC, and NQM

Result: Semantic Segmentation

Bicubic	ANR	SRF	High Res. Image

PSNR / 17.49   PSNR / 17.83   PSNR / 17.85
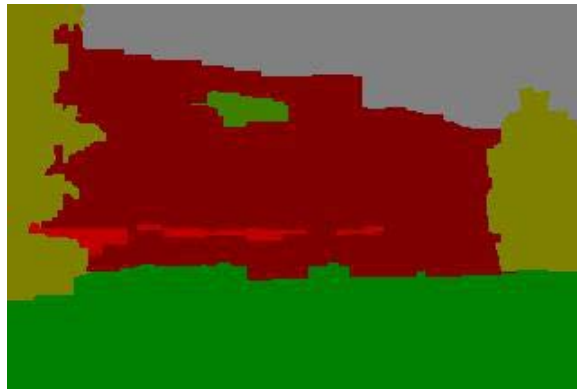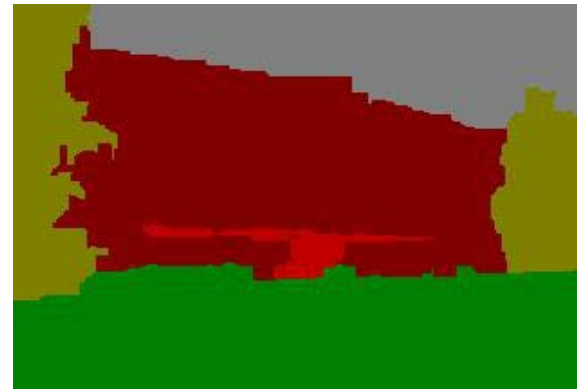
APP / 0.639   APP / 0.893   APP / 0.909   APP / 0.937

Larger=Better, Helpful & Correlated

APP=Average Pixel Precision

Result: Boundary Detection

Bicubic

PSNR / 26.94

Result: Boundary Detection

ANR

PSNR / 28.06

Result: Boundary Detection

A+

PSNR / 28.93

Result: Boundary Detection

High Res.
Image

Result: Boundary Detection

Bicubic

AUC / 0.861

Result: Boundary Detection

ANR

AUC / 0.870

Result: Boundary Detection

A+

AUC / 0.885

Result: Boundary Detection

High Res.
Image
AUC / 0.891

Result: Boundary Detection

BSDS300		Bicubic	Zeyde *et al.* [48]	ANR[38]	SRCNN[10]	A+[39]	JOR[6]	SRF[31]	Original
×3	PSNR	27.15	27.87	27.88	28.10	**28.18**	28.17	28.17	—
	SSIM	0.736	0.770	0.773	0.777	**0.781**	**0.781**	0.780	—
	IFC	2.742	3.203	3.248	3.131	**3.374**	3.360	3.366	—
	NQM	27.42	31.80	31.95	31.28	32.35	**32.41**	32.40	—
	AUC	0.647	**0.675**	0.665	0.668	**0.675**	0.674	0.674	0.696
×4	PSNR	25.92	26.51	26.51	26.66	**26.77**	26.74	26.74	—
	SSIM	0.667	0.697	0.699	0.702	**0.709**	0.707	0.707	—
	IFC	1.839	2.195	2.231	2.117	**2.325**	2.316	2.293	—
	NQM	21.15	24.30	24.37	24.19	**24.98**	24.96	**24.98**	—
	AUC	0.595	0.647	0.635	0.650	**0.656**	0.655	0.652	0.696

❑ ISR is Helpful for Boundary Detection (BD)

❑ The Perceptual Criteria Correlate Well with the Usefulness of ISR: consistent in trend

Result: Semantic Image Segmentation

MSRC-21		Bicubic	Zeyde et al. [48]	ANR[38]	SRCNN[10]	A+[39]	JOR[6]	SRF[31]	Original
×3	PSNR	25.29	26.02	26.00	26.21	26.28	26.28	**26.35**	—
	SSIM	0.689	0.726	0.728	0.733	0.737	0.737	**0.738**	—
	IFC	2.677	3.214	3.250	3.131	3.390	3.396	**3.640**	—
	NQM	19.56	22.48	22.47	22.64	23.10	23.16	**23.20**	—
	APP	0.692	0.762	0.770	0.777	0.780	**0.783**	0.782	0.844
	APC	0.592	0.662	0.674	0.681	0.684	**0.687**	0.685	0.743
×4	PSNR	24.04	24.65	24.63	24.77	24.88	24.86	**24.90**	—
	SSIM	0.608	0.641	0.643	0.646	0.654	0.652	**0.660**	—
	IFC	1.694	2.043	2.066	1.992	2.171	2.151	**2.301**	—
	NQM	14.75	16.56	16.55	16.73	17.10	**17.12**	16.99	—
	APP	0.582	0.665	0.677	0.673	**0.682**	0.674	0.674	0.844
	APC	0.505	0.569	0.584	0.588	0.591	0.586	**0.605**	0.743

❏ ISR is Helpful for Semantic Image Segmentation (SIS)

❏ The Perceptual Criteria Correlate Well with the Usefulness of ISR: consistent in trend

Conclusion

❑ Image super-resolution is **helpful** for other vision tasks

❑ Perceptual criteria correlate **quite well** with the usefulness of ISR to other vision tasks

❑ Still a gap between super-resolved images and high res. images, better ISR methods needed

❑ The **code** and **data** will be made available soon

Thanks for your attention!