

Application of Machine Learning for Multimedia Systems

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Traditional Image Compression

Next few Images are courtesy of Johannes Balle, Google.

original



Traditional Image Compression

HEVC intra



Traditional Image Compression



Traditional Image Compression



Traditional Image Compression



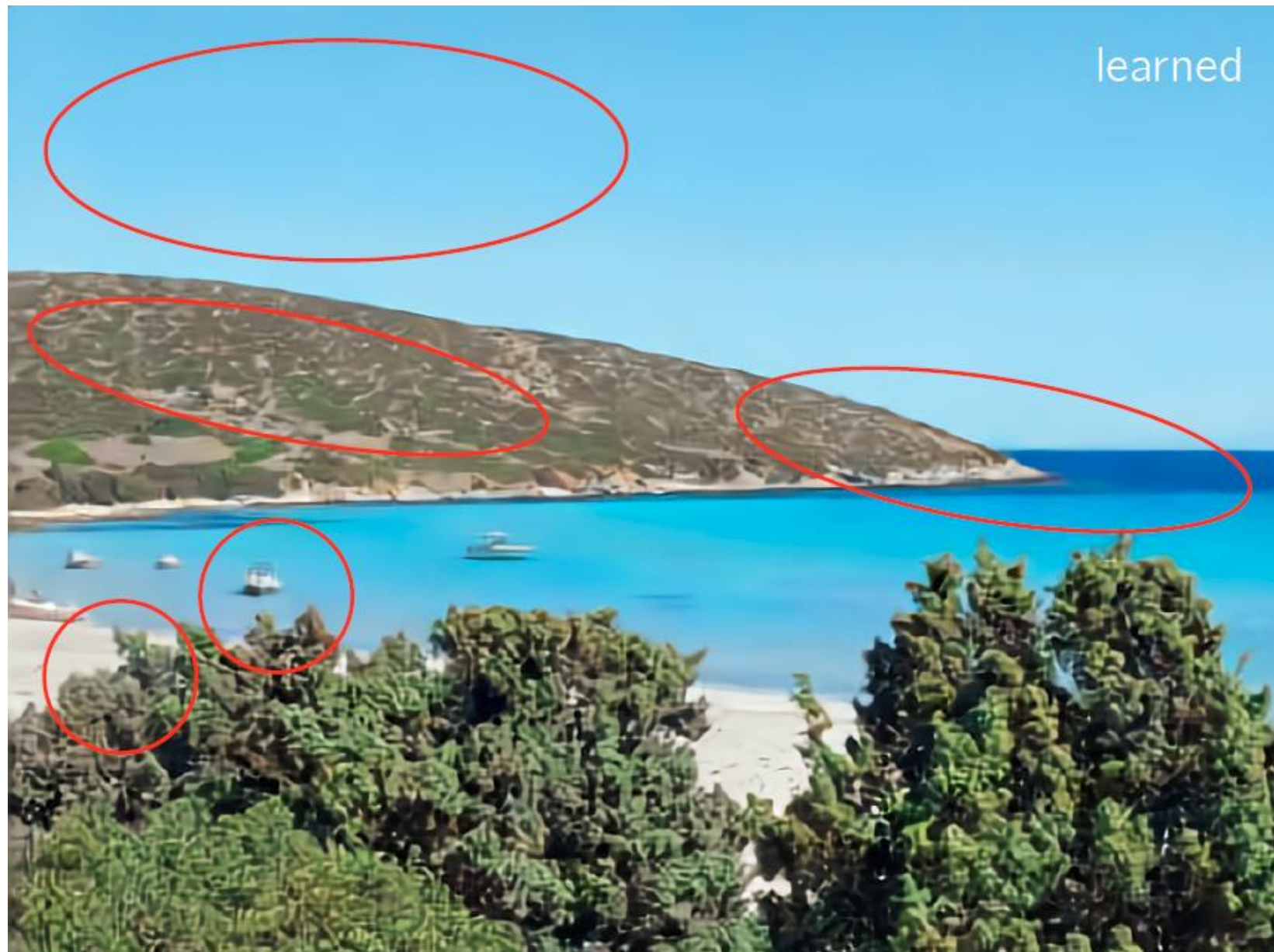
Traditional Image Compression



Traditional Image Compression



ML-based Image Compression



Linear vs. non-linear approximation

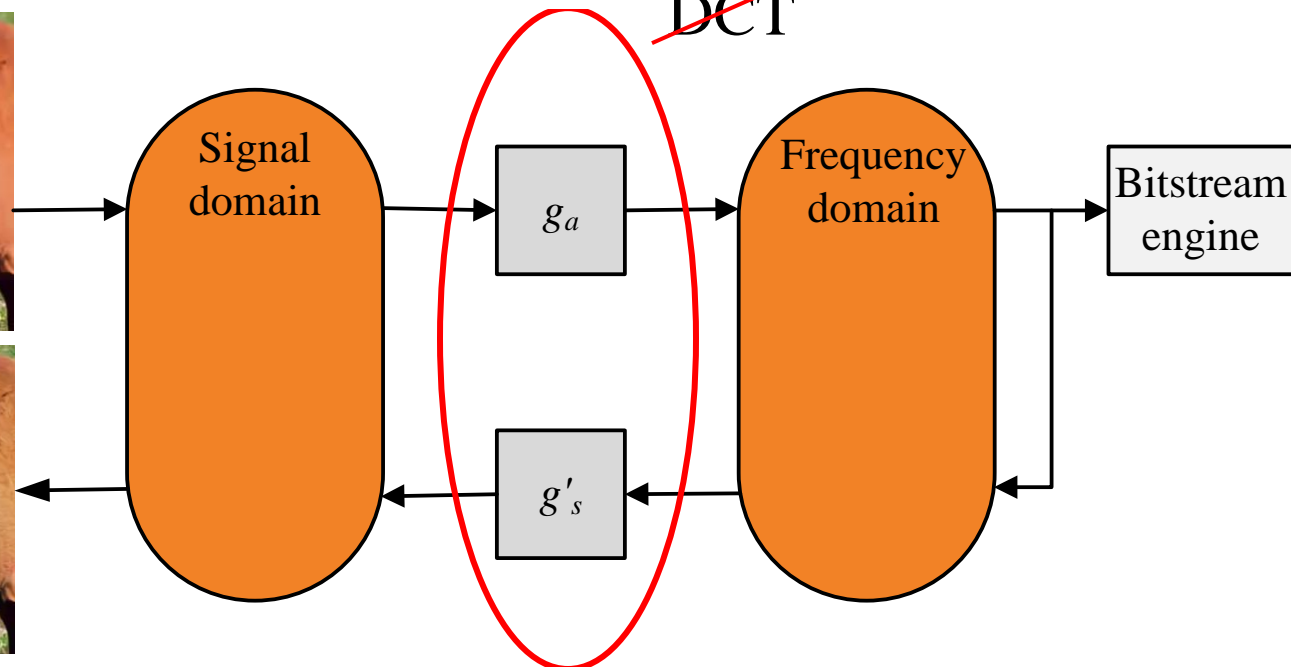


$x =$

(251, 181, 068, 041, 032, 071, 197,
196, 014, 132, 213, 187, 043, 041,
174, 011, 200, 254, 254, 232, 164,
202, 014, 012, 128, 242, 255, 255,
253, 212, 089, 005, 064, 196, 253,
255, 255, 251, 196, 030, 009, 165,
127, 162, 251, 254, 197, 009, 105,
062, 005, 100, 144, 097, 006, 170,
207, 083, 032, 051, 053, 134, 250)

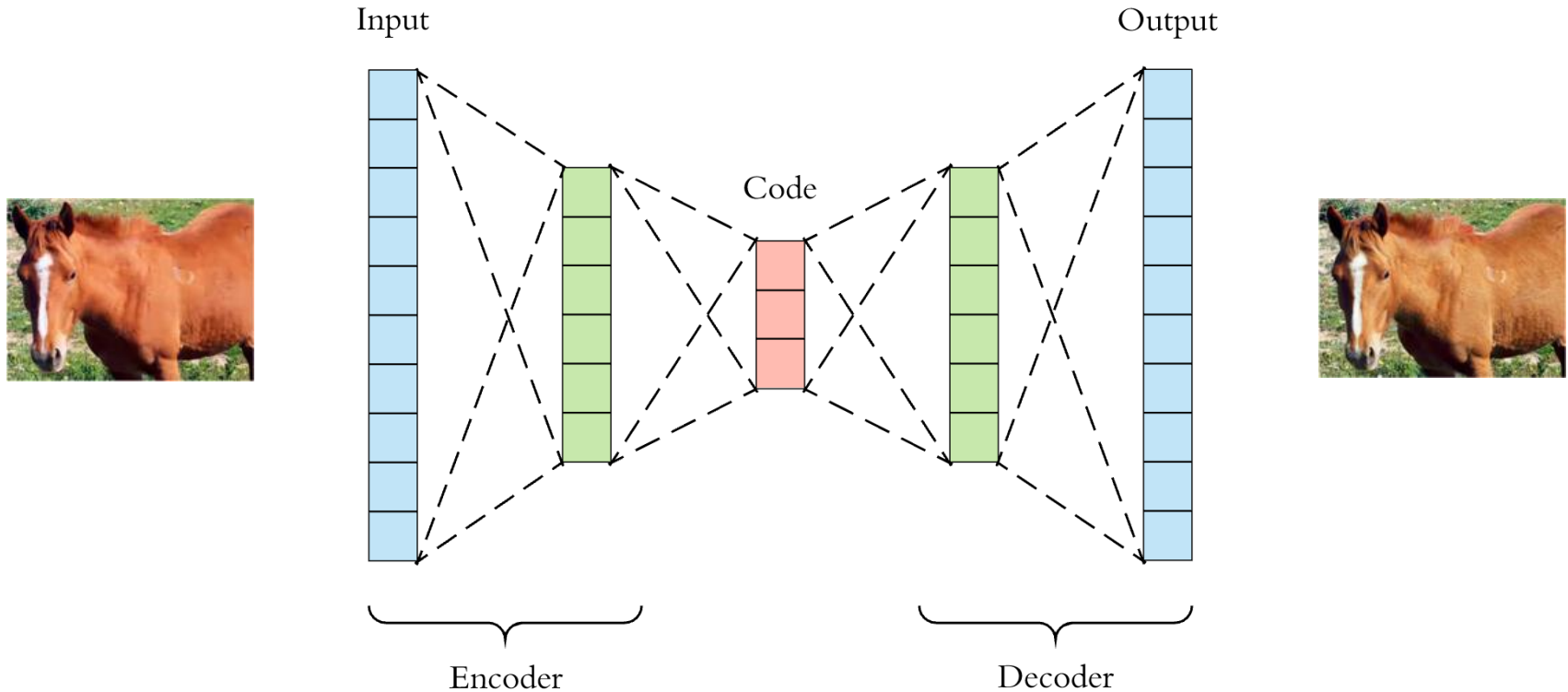
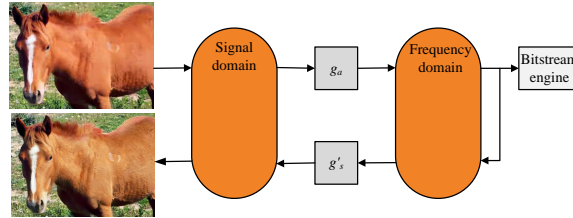
ANN

~~DCT~~



A Taste of CNN Compression

Auto-encoder based compression



ML-based Image Compression



HEVC intra



original



learned



Balle, "Efficient Nonlinear Transforms for Lossy Image Compression", PCS 2018.

How does it look?

original



nonlinear transform



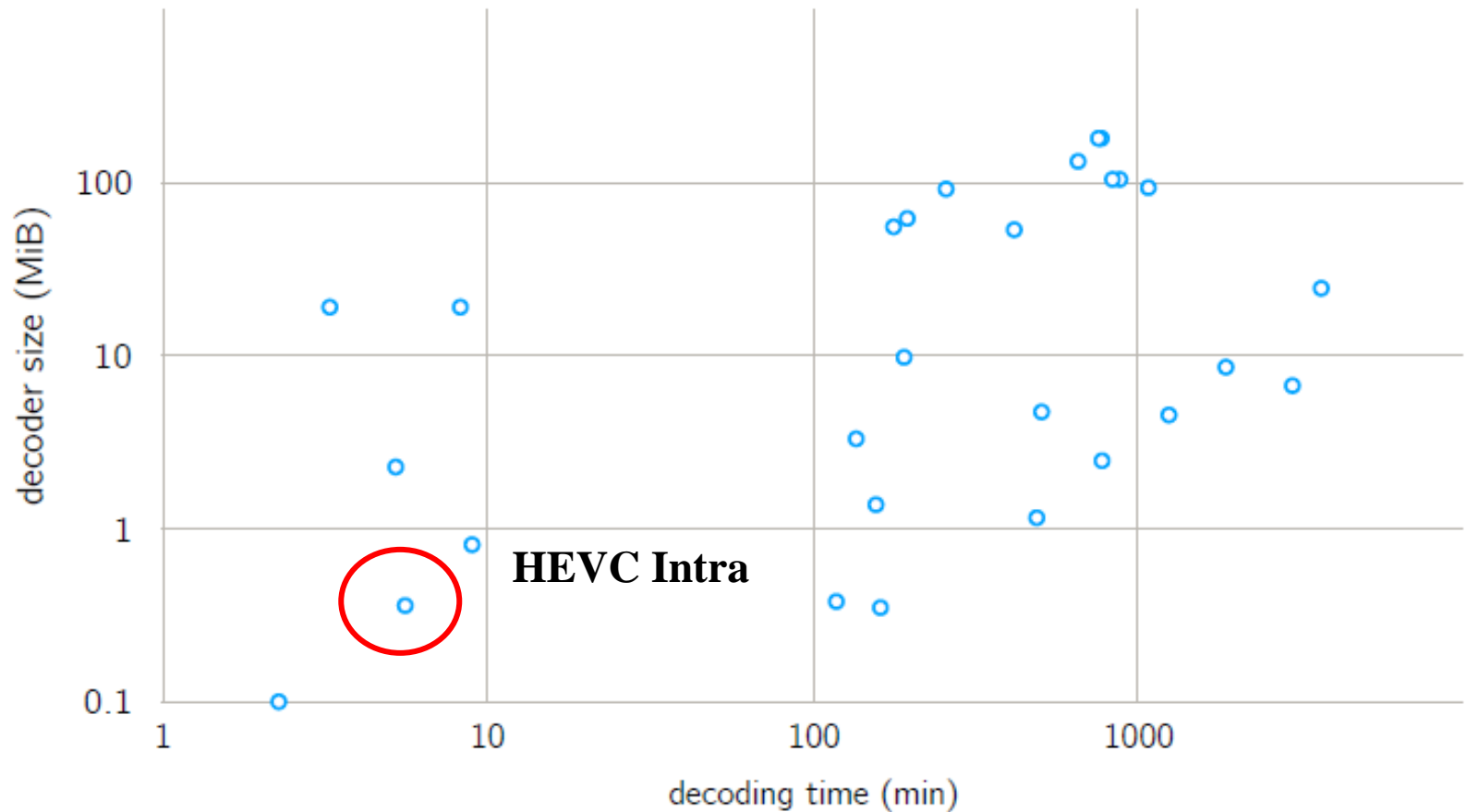
JPEG



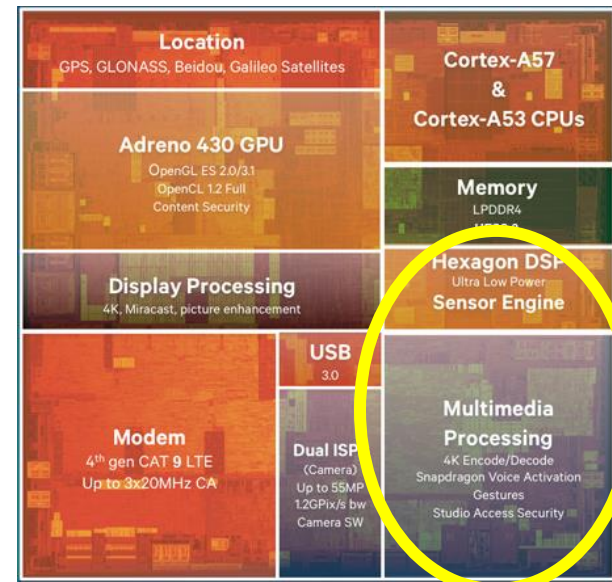
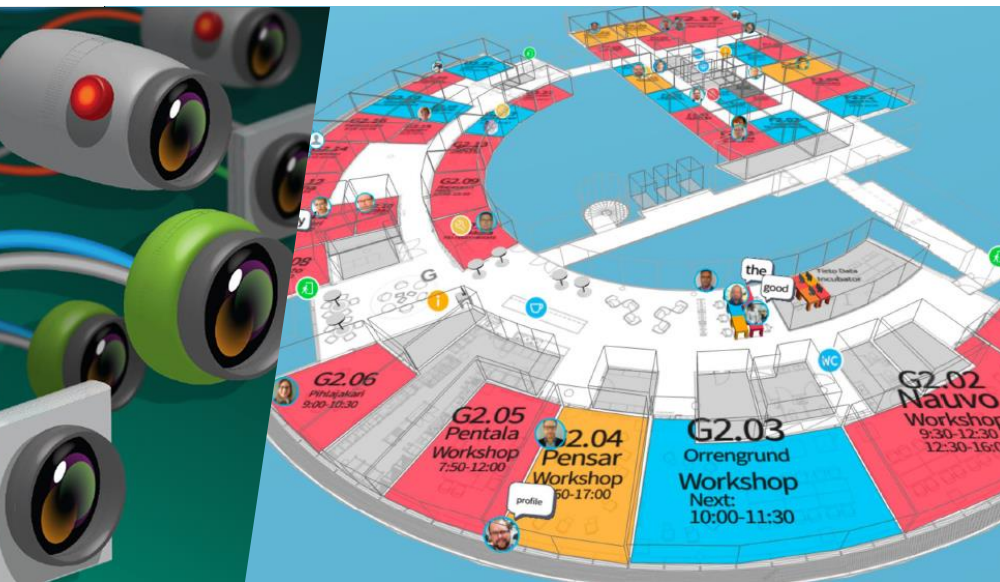
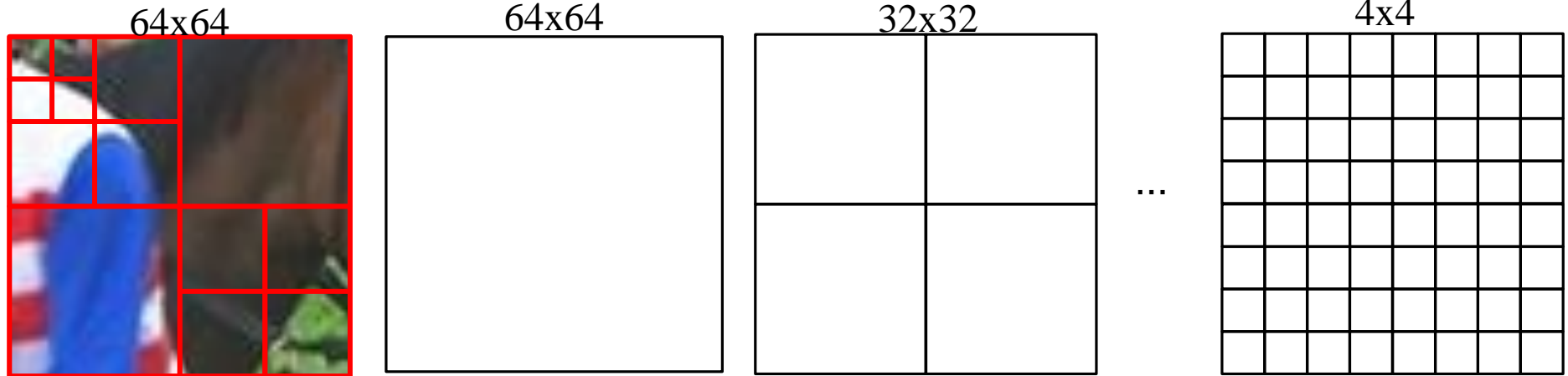
JPEG 2000

Balle, "Efficient Nonlinear Transforms for Lossy Image Compression", PCS 2018.

How fast is it?

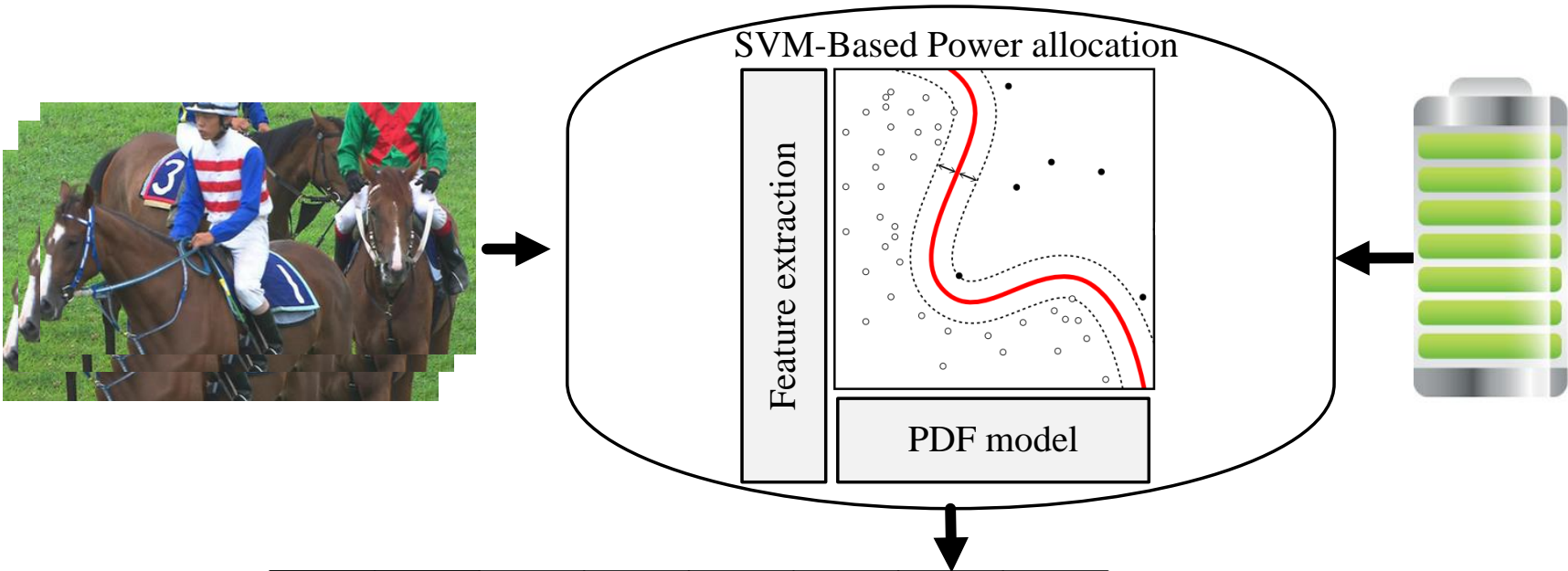


Resource-Aware Computing



Tieto Empathic Building: <https://www.tieto.com/en/what-we-do/data-and-ai/tieto-empathic-building/>

Power Constrained Video Coding



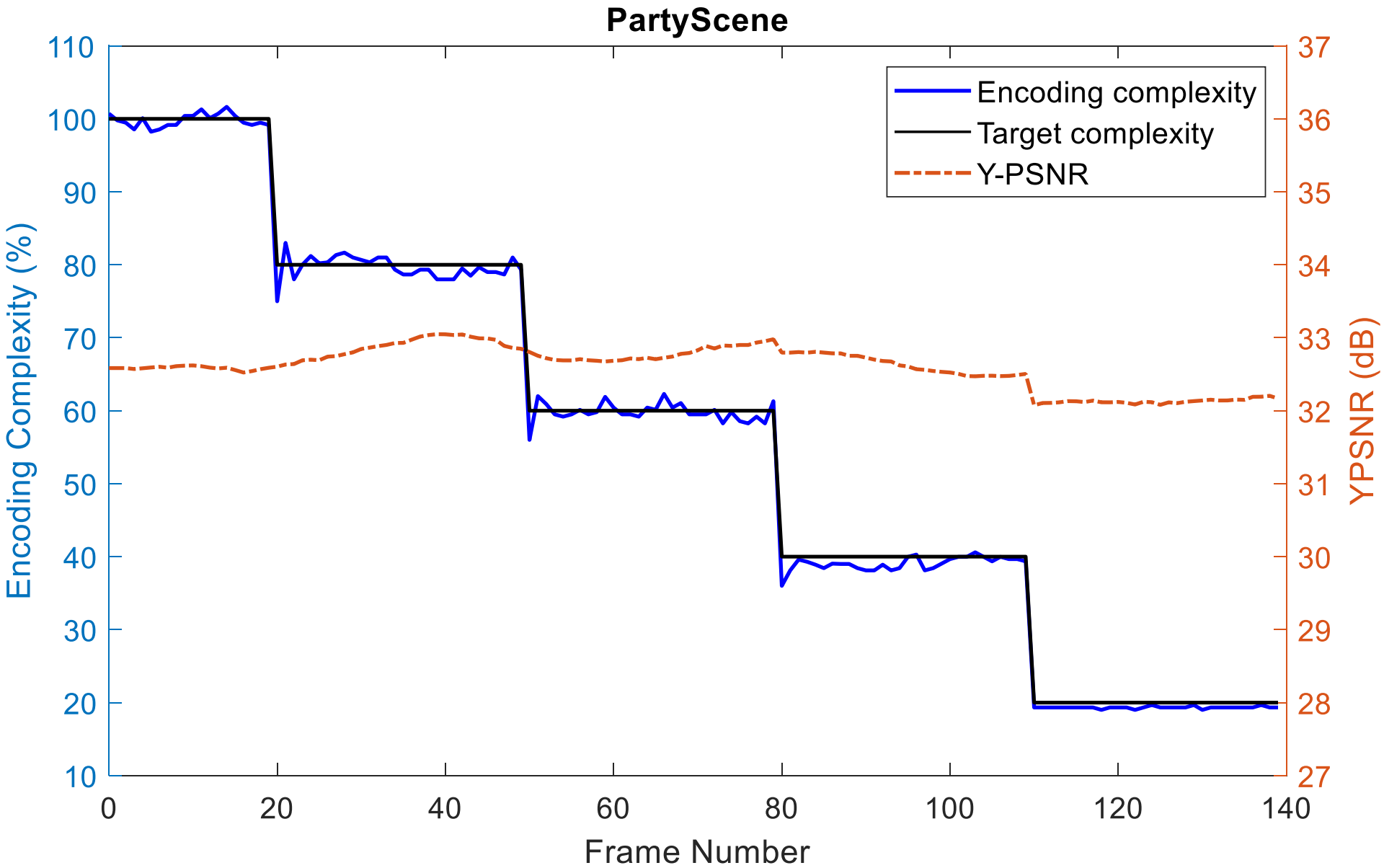
1.4%	2.7%	4.1%	2.7%	2.7%	5.5%	1.4%	1.4%
5.5%	2.7%	2.7%	2.7%	4.1%	2.7%	4.1%	4.1%
4.1%	1.4%	4.1%	2.7%	4.1%	2.7%	2.7%	4.1%
6.9%	4.1%	2.7%	6.9%	4.1%	1.4%	1.4%	4.1%



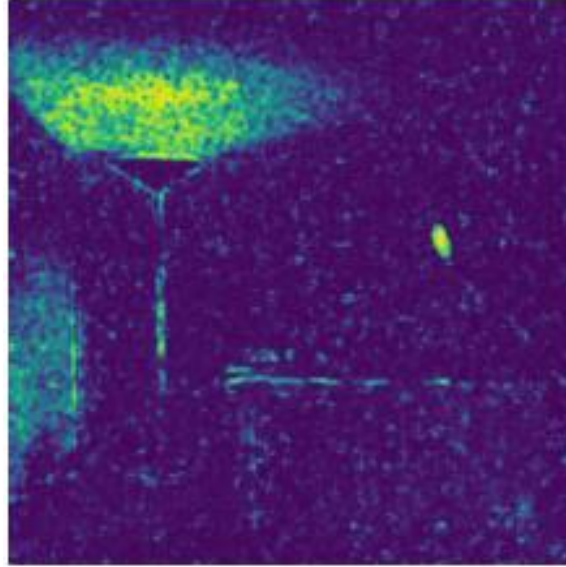
BUSINESS
FINLAND

Tampere University

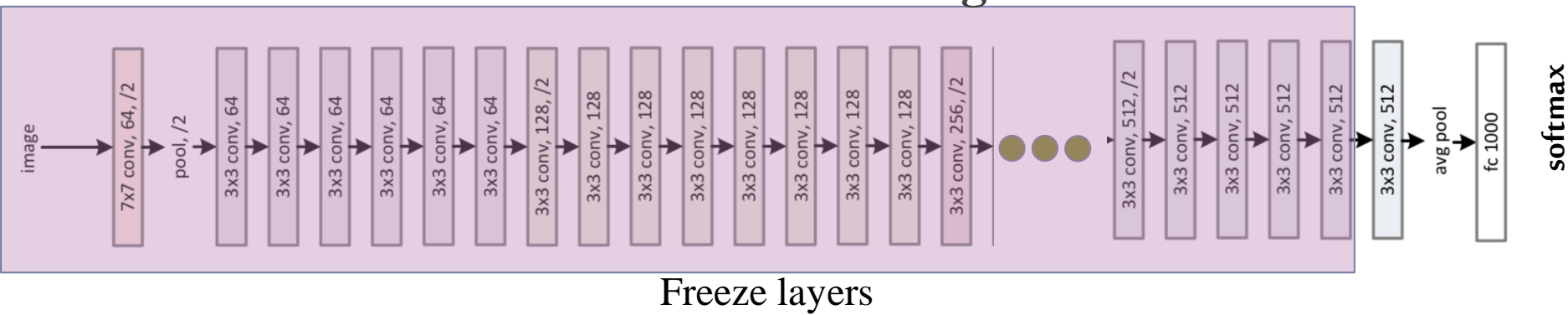
Power Constrained Video Coding



Learned Quality Assessment



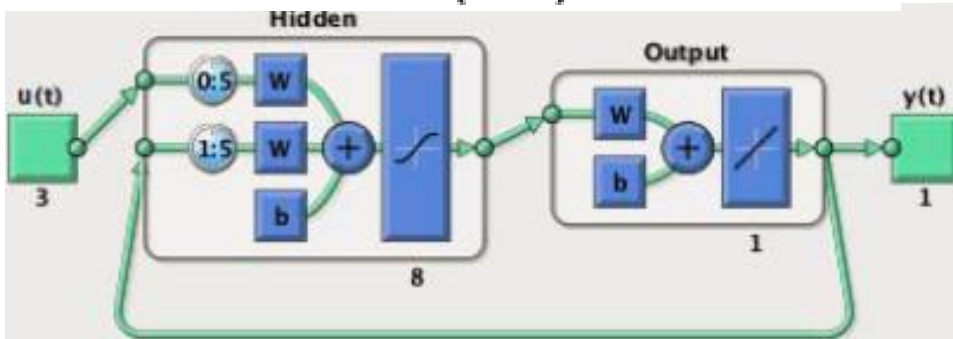
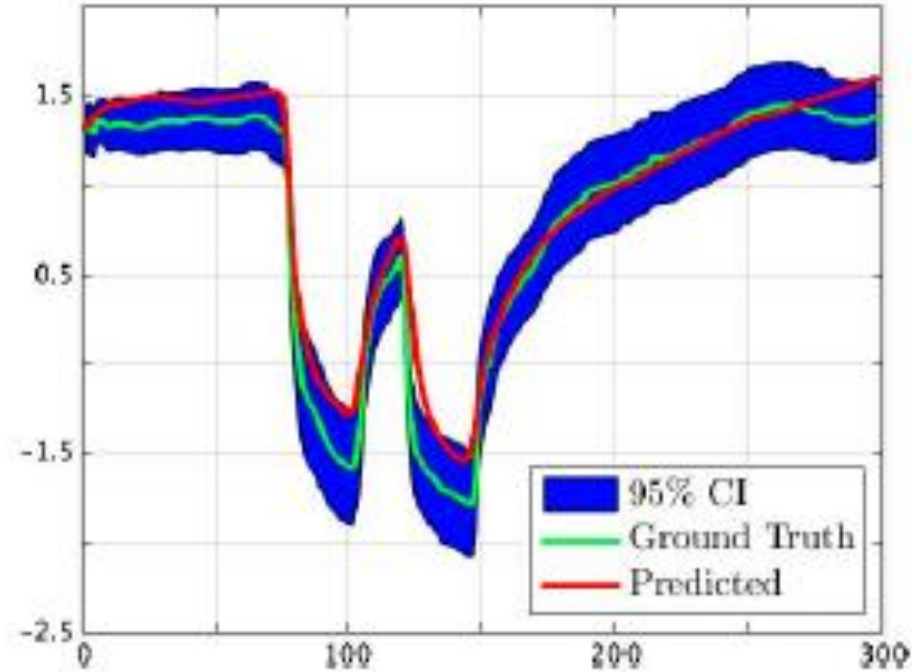
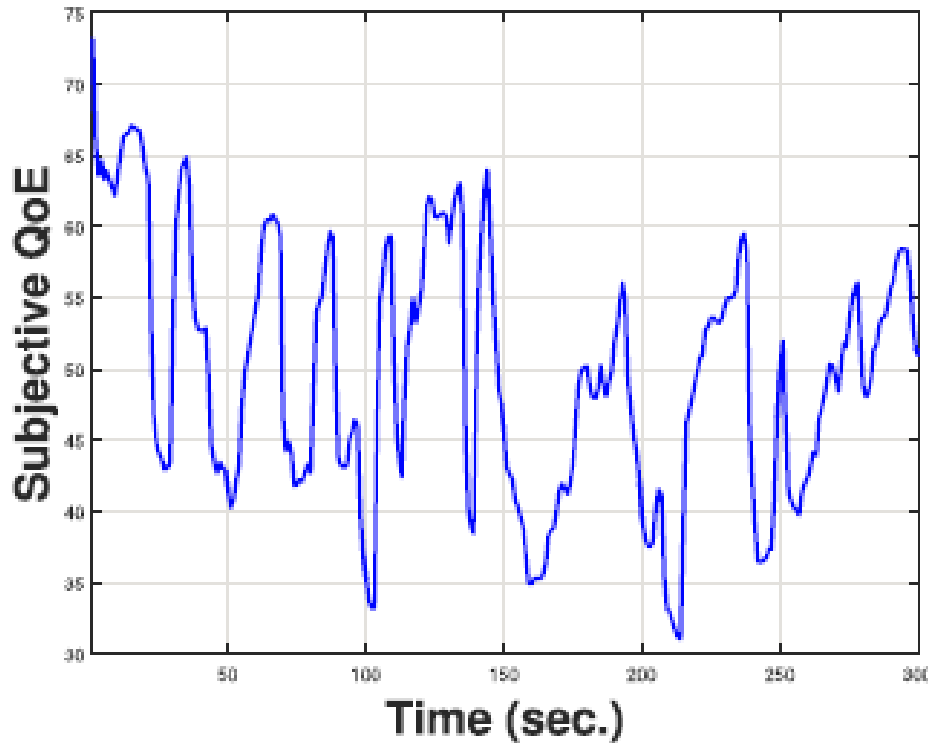
Transfer Learning



J. Whittle, *et al.* "A deep learning approach to no-reference image quality assessment for Monte Carlo rendered images." *CGVC*, 2018.

QoE Estimation using RNN

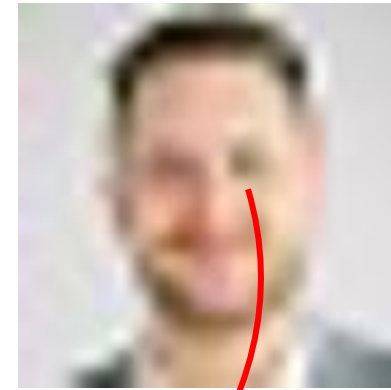
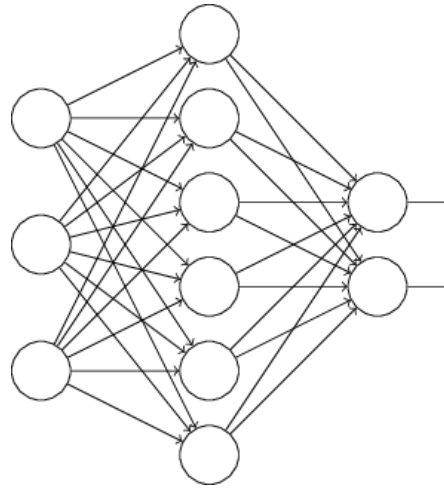
Video #10, D_1



C. G. Bampis, et al, "Recurrent and Dynamic Models for Predicting Streaming Video Quality of Experience," in *IEEE TIP*, 2018.



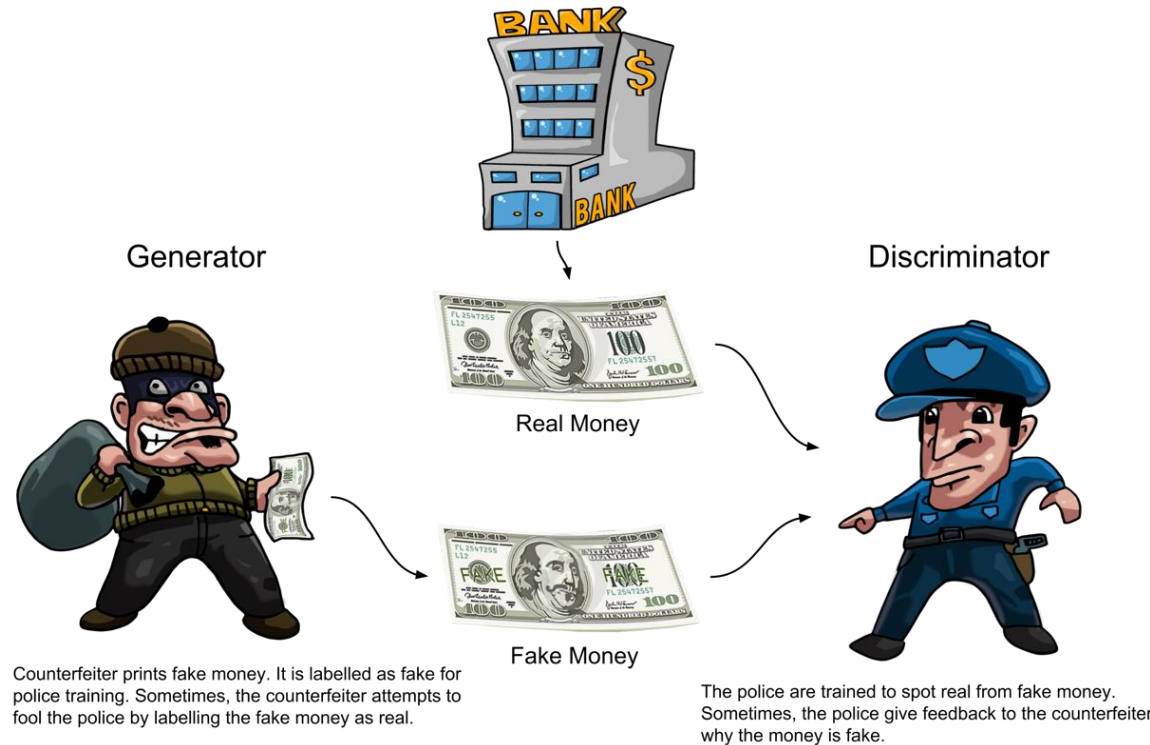
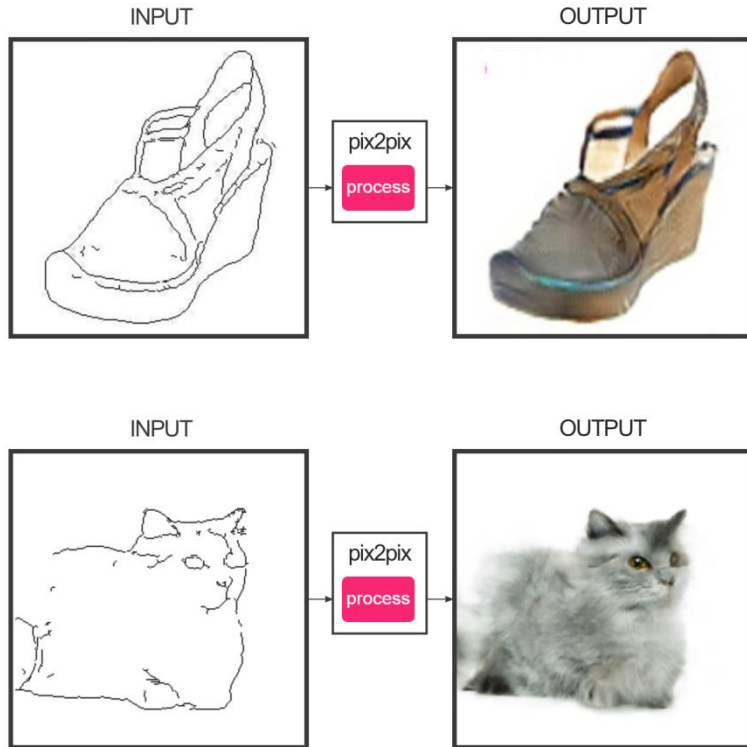
Quality Enhancement/Restoration



$$\mathcal{L} = \frac{1}{n} \sum_{i=1}^n |y^{(i)} - \hat{y}^{(i)}|$$

Generative Adversarial Network (GAN)

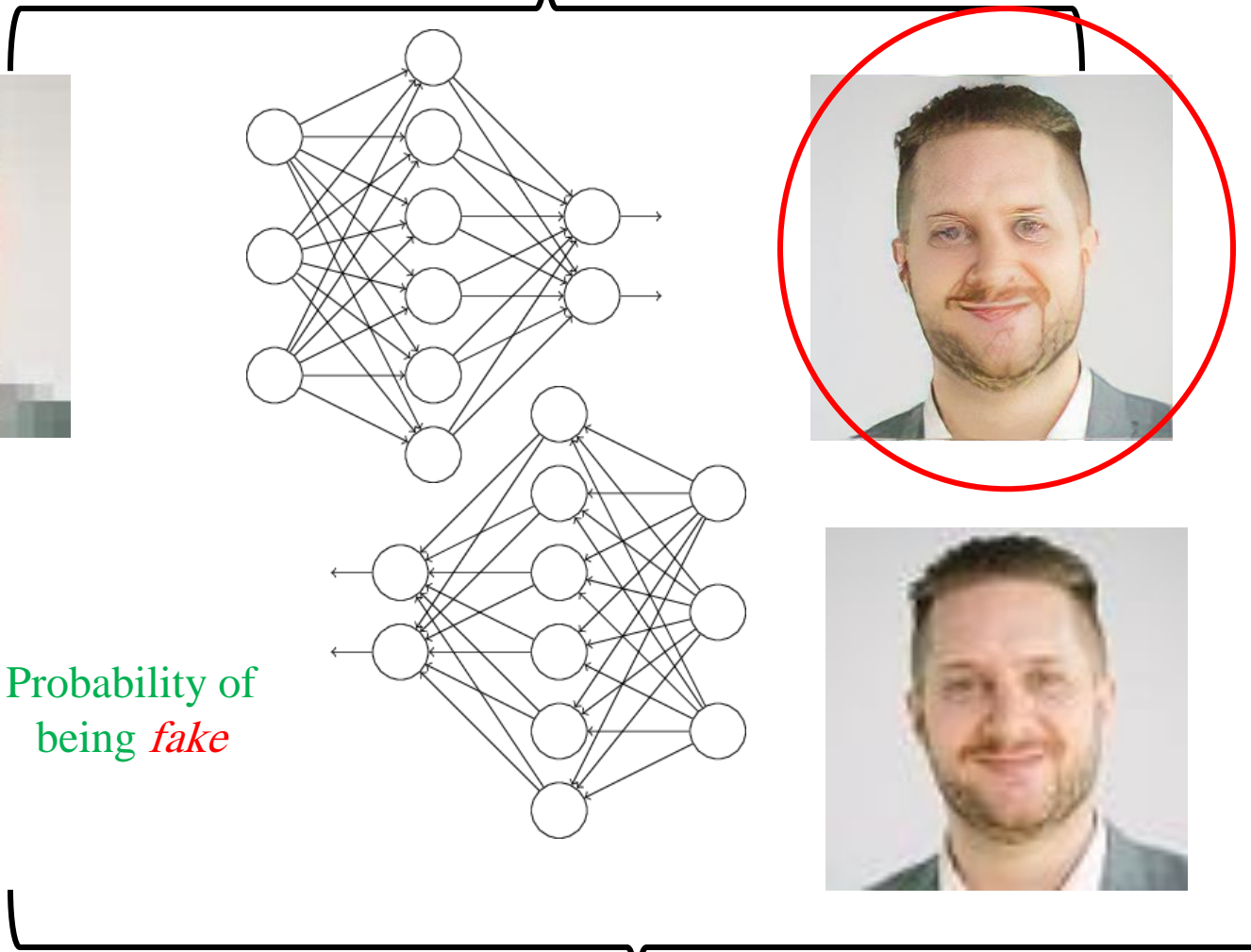
<https://affinlayer.com/pixsrv/>



<https://dzone.com/articles/working-principles-of-generative-adversarial-netwo>

Image Enhancement using GAN

Generator

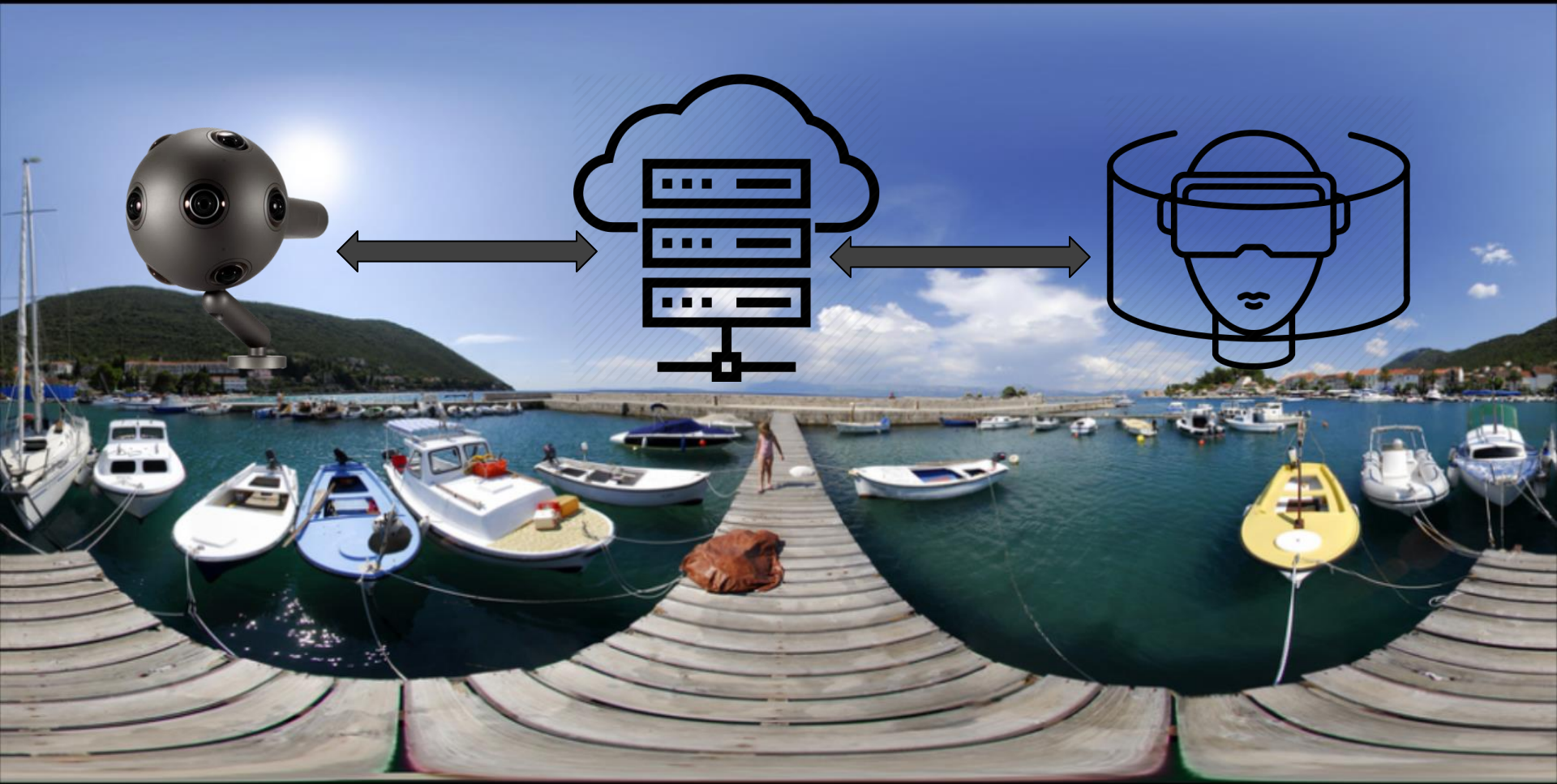


Probability of
being *fake*

Discriminator

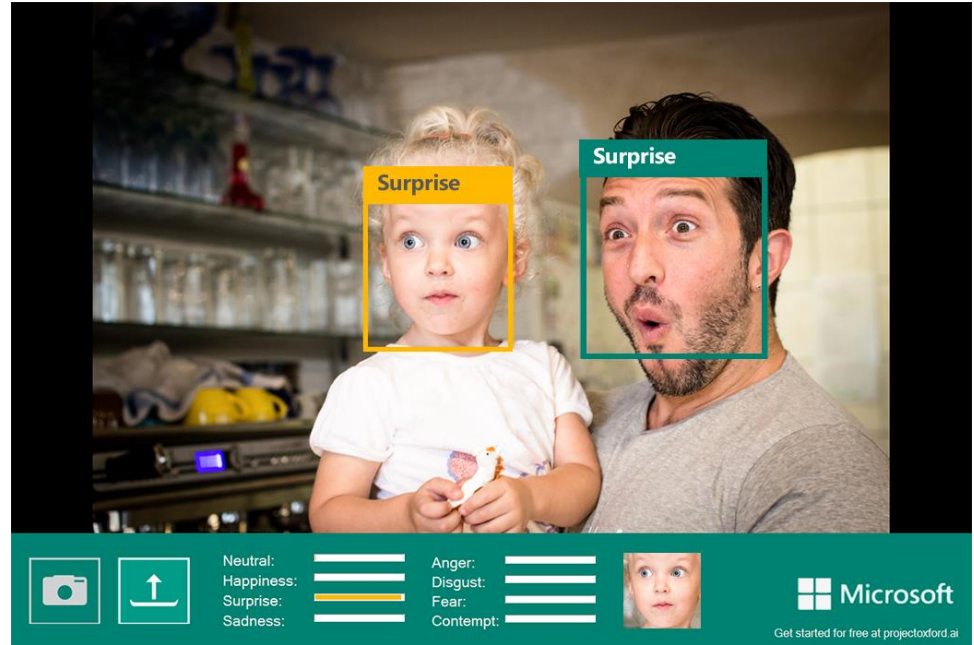
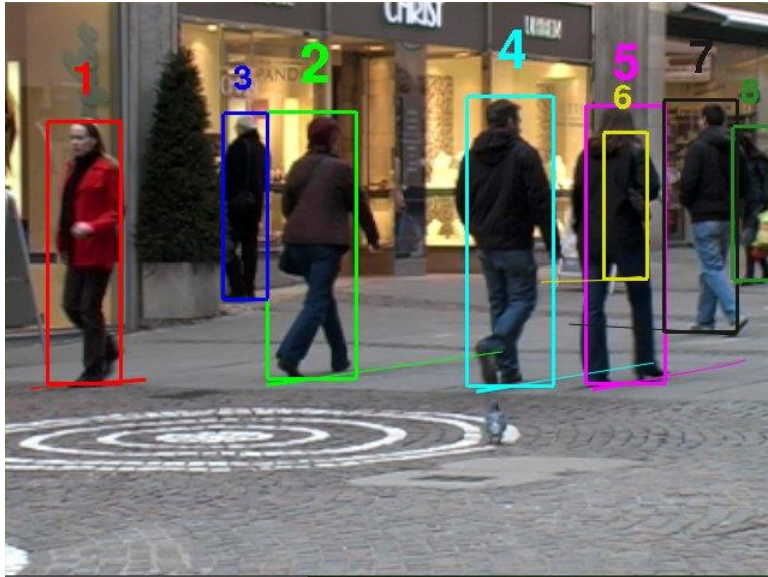
C. Ledig *et al.*, "Photo-Realistic Single Image Super-Resolution Using a Generative Adversarial Network," *CVPR 2017*.

VR Streaming



L. Yu, *et al* ‘Convolutional Neural Network for IntermediateView Enhancement in Multiview Streaming’ TMM 2018.

Multimedia Content Analysis



References

- [1] Balle, “Efficient Nonlinear Transforms for Lossy Image Compression”, PCS 2018.
- [2] J. Whittle, *et al.* "A deep learning approach to no-reference image quality assessment for Monte Carlo rendered images.“ *CGVC*, 2018.
- [3] C. G. Bampis, *et al.*, "Recurrent and Dynamic Models for Predicting Streaming Video Quality of Experience,“ in *IEEE TIP*, 2018.
- [4] <https://dzone.com/articles/working-principles-of-generative-adversarial-netwo>
- [5] C. Ledig *et al.*, "Photo-Realistic Single Image Super-Resolution Using a Generative Adversarial Network," in *CVPR 2017*.
- [6] L. Yu, *et al.* “Convolutional Neural Network for Intermediate View Enhancement in Multiview Streaming” in TMM 2018.