

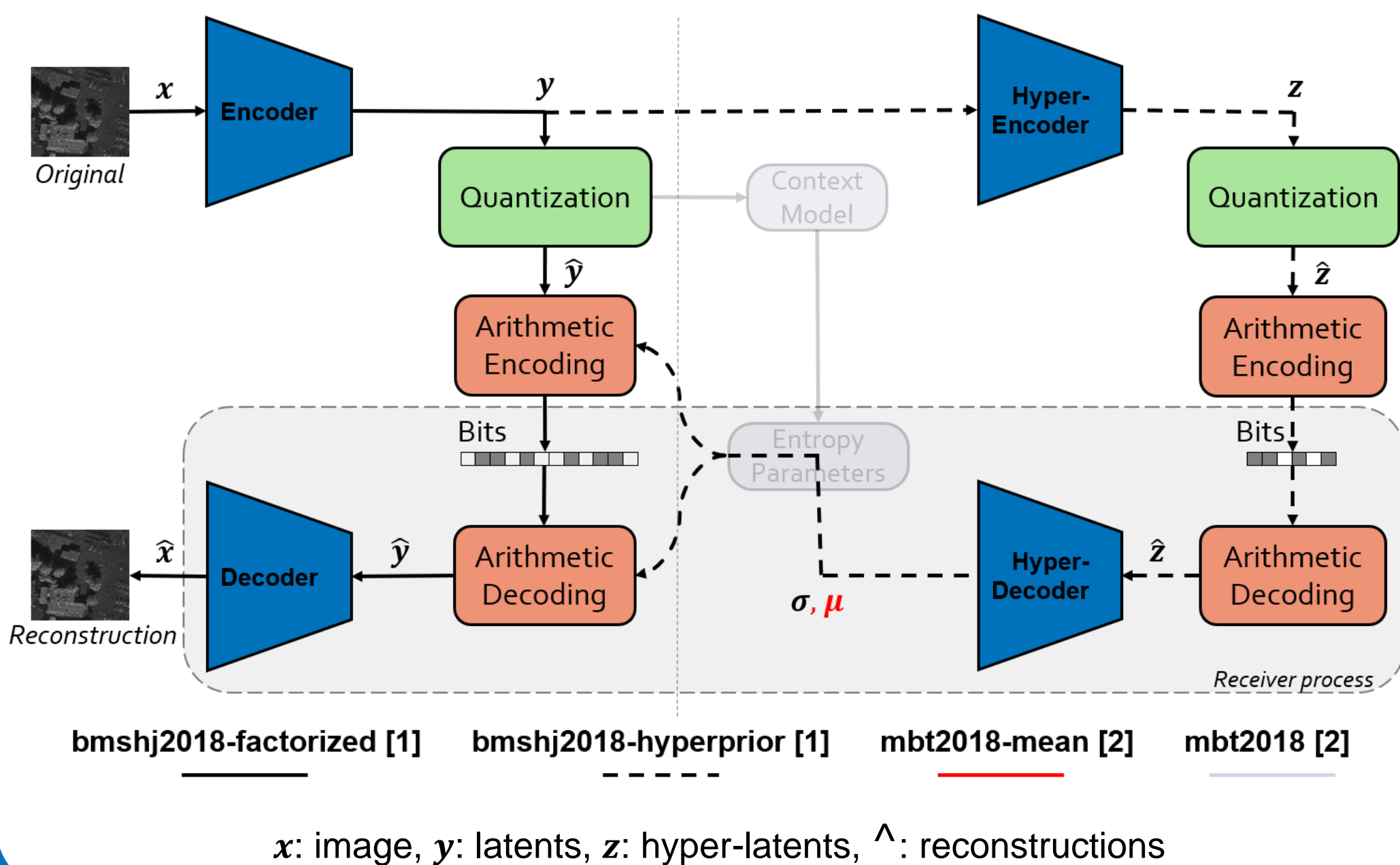


SAR GRD Data Compression using Mean-Scale Hyperprior architectures

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Autoencoders for Data Compression



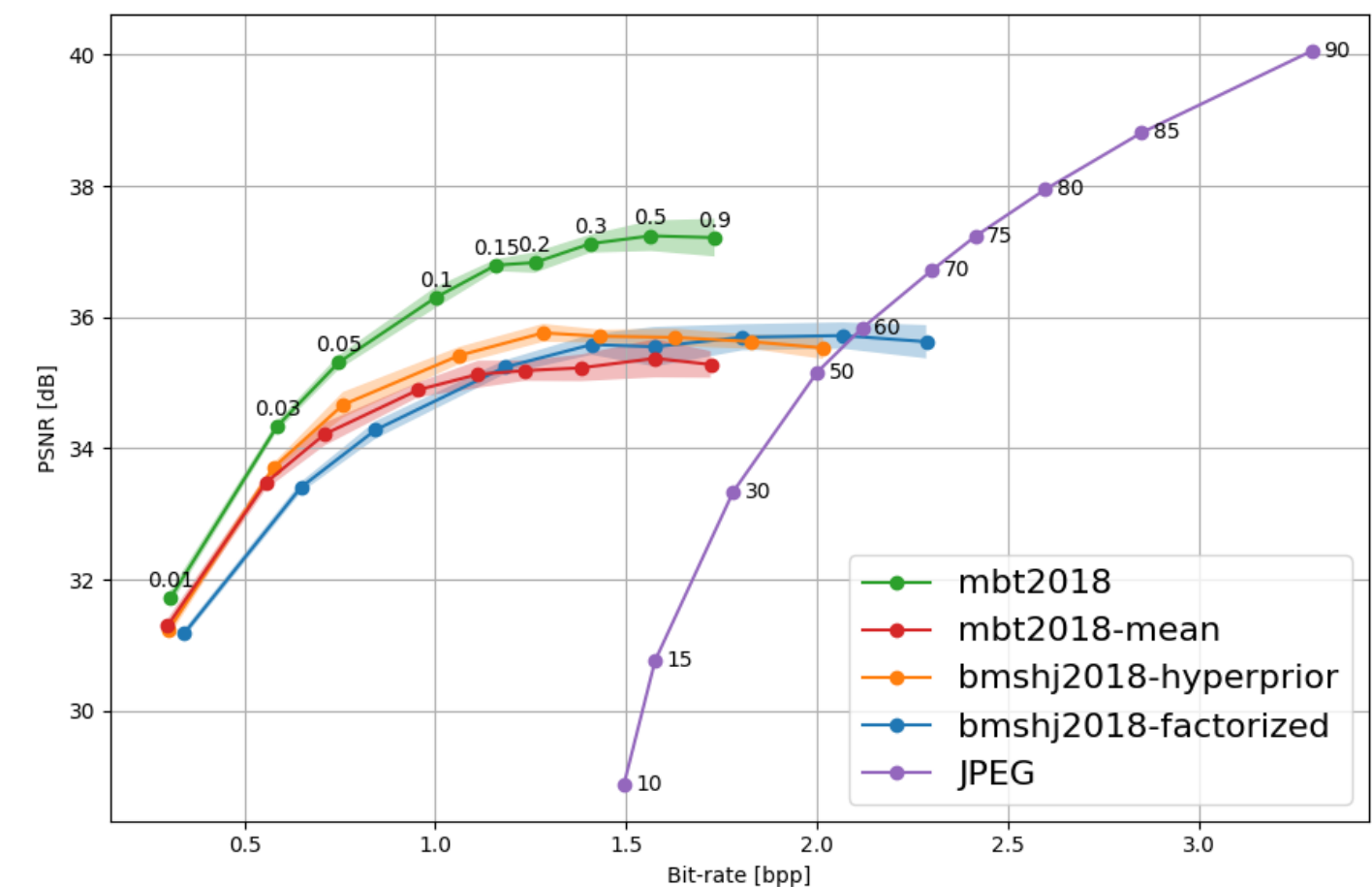
Rate-Distortion optimization

Objective function

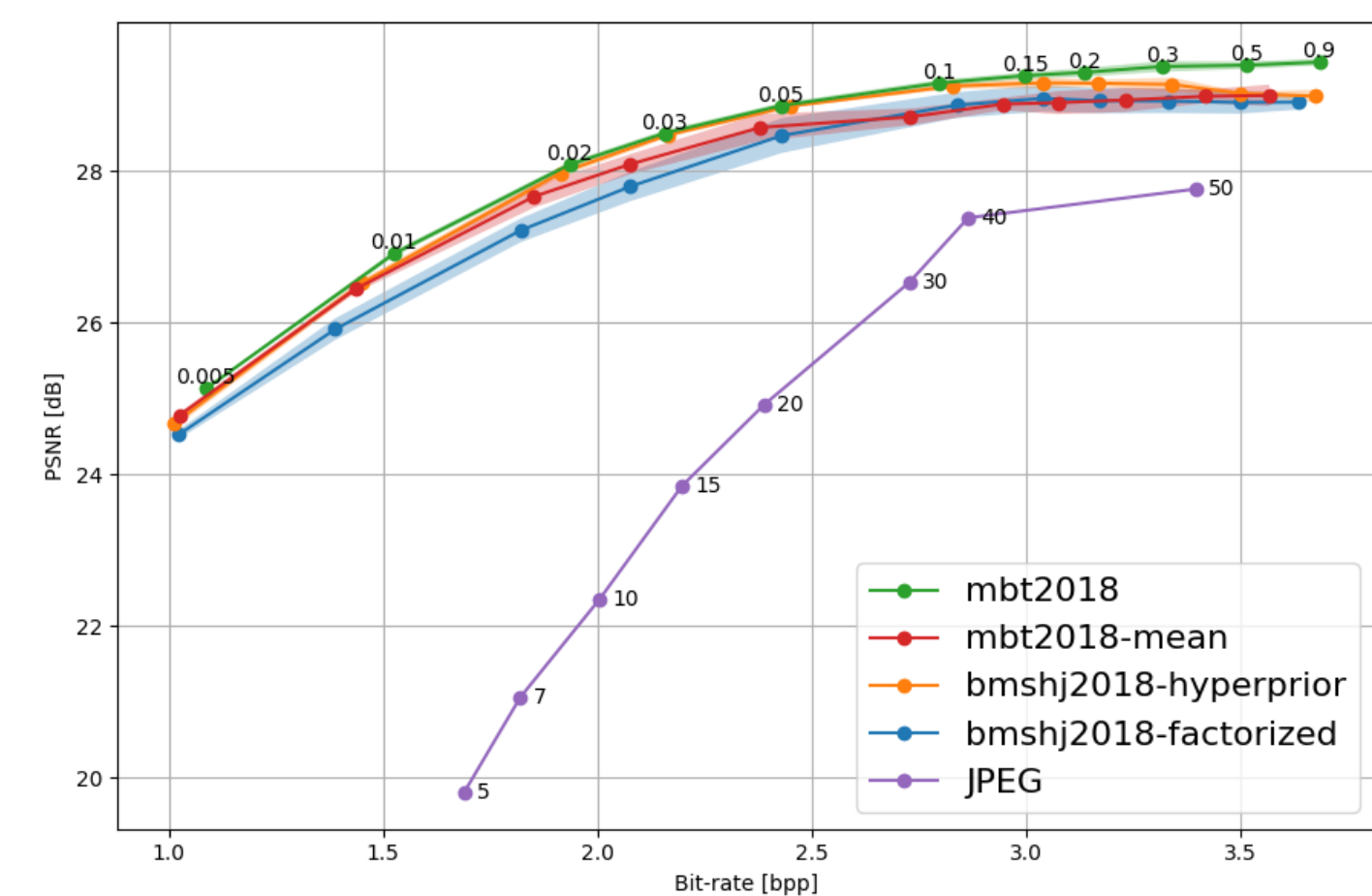
$$\mathcal{L} = \mathcal{R}(\hat{y}) + \mathcal{R}(\hat{z}) + \lambda \cdot \mathcal{D}(x, \hat{x})$$

- $\mathcal{R}()$ \Leftrightarrow bits-per-pixel (**bpp**)
- $\mathcal{D}()$ \Leftrightarrow Peak Signal to Noise Ratio (**PSNR**) or Structural Similarity Index Measure (**SSIM**)

EuroSAT-RGB



EuroSAT-SAR



All models are optimized for PSNR, implemented with [compressai](#) [3]
Labels are quality parameter values (λ or QP), 7 runs per datapoint

Datasets

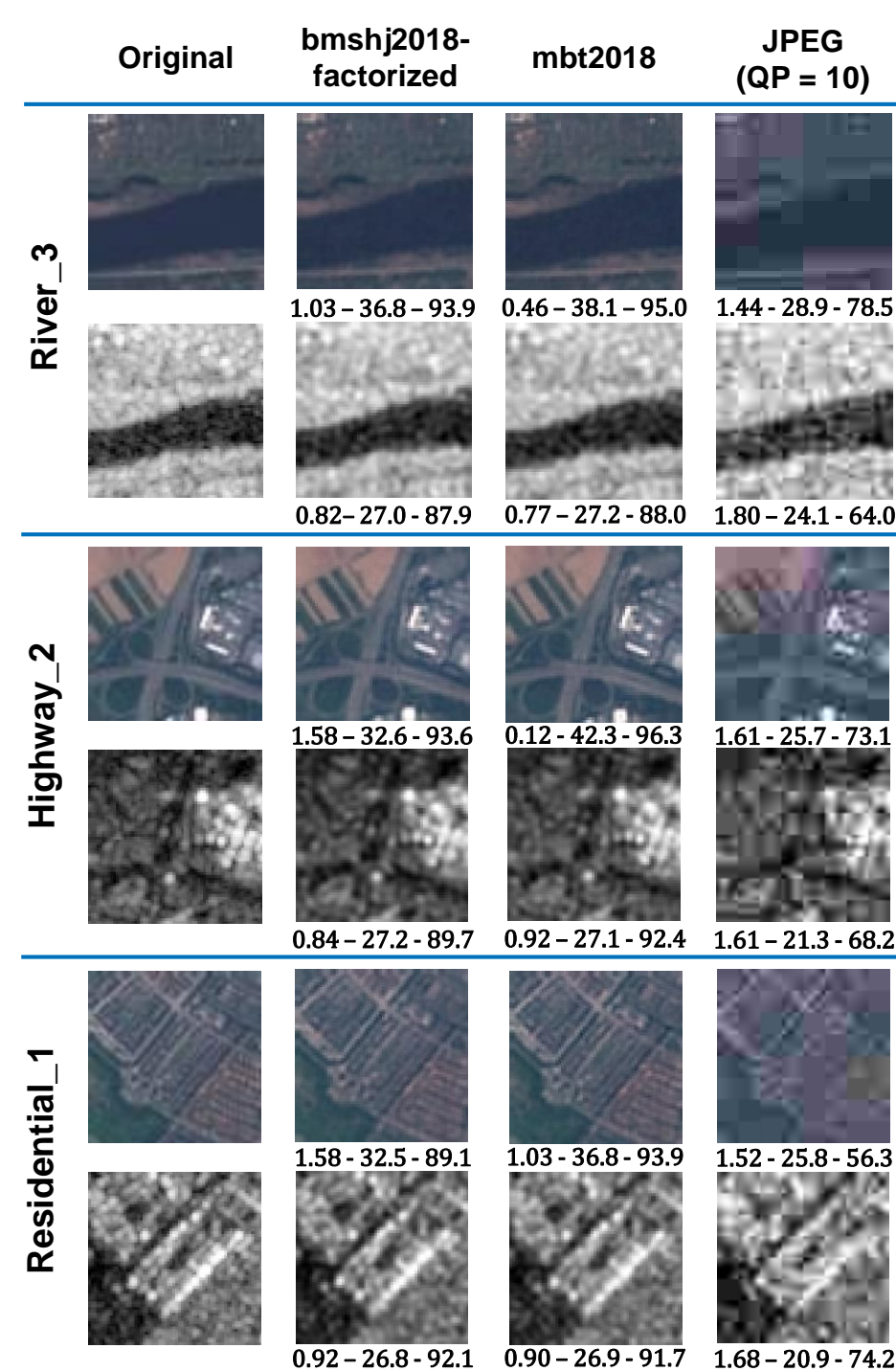
EuroSAT-RGB

- CIFAR or Kodak-like Remote Sensing dataset
- 27.000 images
- 64x64 patches
- 10 classes
- 3 Bands of Sentinel-2

EuroSAT-SAR

- SAR version of EuroSAT [4]
- Sentinel-1 patches matched to each Sentinel-2
- Dual-pol: VV and VH
- GRD images

Reconstructions



Scores

	bmsj2018-factorized	bmsj2018-hyperprior	mbt2018-mean	mbt2018	JPEG
λ / QP	0.1	0.1	0.15	0.1	10
bpp	1.182	1.063	1.112	1.001	1.494
PSNR [dB]	35.24	35.42	35.13	36.30	28.88
SSIM [%]	94.31	94.86	94.84	95.47	77.86

EuroSAT-RGB model scores comparison, ~ 1 bpp

	bmsj2018-factorized	bmsj2018-hyperprior	mbt2018-mean	mbt2018	JPEG
λ / QP	0.005	0.005	0.005	0.005	10
bpp	1.023	1.012	1.024	1.087	1.491
PSNR [dB]	24.53	24.67	24.78	25.13	17.49
SSIM [%]	89.66	89.86	90.14	90.90	50.21

EuroSAT-SAR model scores comparison, ~ 1 bpp

Discussion

- “Roof effect” on RD Curve for Remote Sensing images
- Significant drop in reconstruction quality for GRD images
- Very low bit-rates possible
- Are the statistics used in the Hyperpriors suitable for SAR? What about spatial and channel redundancies?
- SAR specific image quality metrics?

References

- [1] J. Ballé, D. Minnen, S. Singh, S. J. Hwang, and N. Johnston, “Variational image compression with a scale hyperprior,” presented at the *International Conference on Learning Representations*, Feb. 2018.
- [2] D. Minnen, J. Ballé, and G. D. Toderici, “Joint Autoregressive and Hierarchical Priors for Learned Image Compression,” in *Advances in Neural Information Processing Systems*, Curran Associates, Inc., 2018.
- [3] J. Bégin, F. Racapé, S. Feltman, and A. Pushparaja, “CompressAI: a PyTorch library and evaluation platform for end-to-end compression research.” *arXiv*, Nov. 05, 2020.
- [4] Y. Wang, H. H. Hernández, C. M. Albrecht, and X. X. Zhu, “Feature Guided Masked Autoencoder for Self-supervised Learning in Remote Sensing.” *arXiv*, Oct. 28, 2023.