Quantization-free Lossy Image Compression Using Integer Matrix Factorization

Pooya Ashtari[1*†]
pooya.ashtari@esat.kuleuven.be

Pourya Behmandpoor[1†]
pooya.ashtari@esat.kuleuven.be

Fateme Nateghi Haredasht[2]
fnateghi@stanford.edu

Jonathan H. Chen[2]
jonc101@stanford.edu

Lieven De Lathauwer[1]
lieven.delathauwer@kuleuven.be

Sabine Van Huffel[1]
sabine.vanhuffel@esat.kuleuven.be

[1]Department of Electrical Engineering (ESAT), STADIUS Center, KU Leuven, Belgium
[2]Department of Medicine, Stanford University, Stanford, CA, USA

Abstract

one paragraph

1 Introduction

2 Related Work

3 Method

3.1 Overall Framework

Encoder.

Decoder.

3.2 Integer Matrix Factorization (IMF)

3.3 Block Coordinate Descent Scheme for IMF

Theorem 1. *The IMF cost function, $\|\boldsymbol{X} - \boldsymbol{U}\boldsymbol{V}^{\mathsf{T}}\|_F^2$, is monotonically nonincreasing under each of the multiplicative update rules.*

Proof. See Appendix A for the proof. □

*Corresponding author. Emails:pooya.ashtari@esat.kuleuven.be, pooya.ash@gmail.com
†Equal contribution

Preprint. Under review.

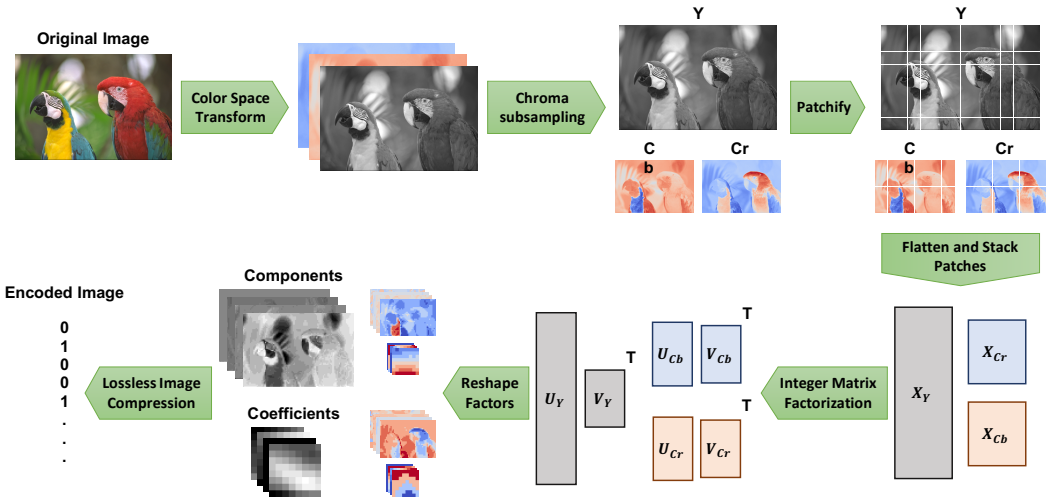


Figure 1 An illustration of our image compression method based on integer matrix factorization.

(a) **(b)**

Figure 2 Rate-distortion performance on the Kodak dataset. In panels (a) and (b), the average PSNR and SSIM are plotted against bits per pixel (bpp), respectively.

3.4 Implementation Details

4 Experiments

4.1 Rate-Distortion Performance

4.2 ImageNet Classification Performance

4.3 Ablation Studies

Patchification. without patchification, patch size 4, 8, 16, 32

Factor bounds.

BCD iteration.

Color space.

5 Conclusion and Future Work

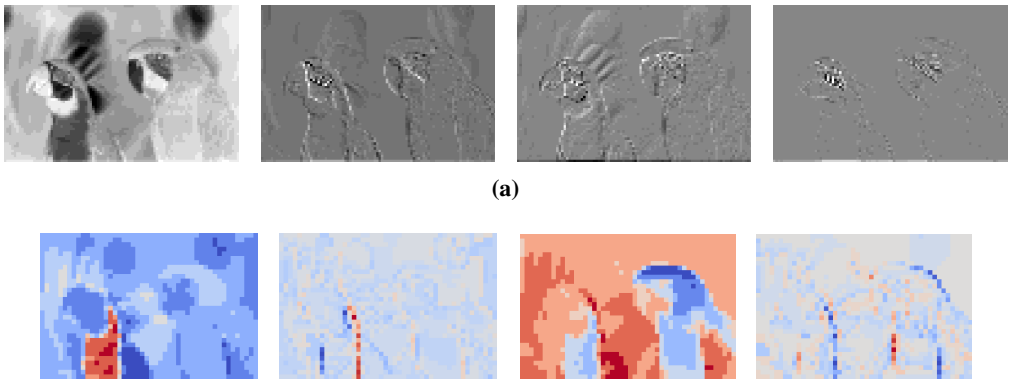
Acknowledgments and Disclosure of Funding

References

[1] Justin Fu, Aviral Kumar, Ofir Nachum, George Tucker, and Sergey Levine. D4RL: Datasets for deep data-driven reinforcement learning. *arXiv preprint arXiv:2004.07219*, Apr 2020.

(a) **(b)**

Figure 3 Rate-distortion performance on the CLIC dataset. In panels (a) and (b), the average PSNR and SSIM are plotted against bits per pixel (bpp), respectively.



(a)

(b) **(c)**

Figure 4 IMF components of the `kodim23` image from the Kodak dataset. Panels (a), (b), and (c) show the IMF components corresponding to luma (Y), blue-difference (Cb), and red-difference (Cr) chroma, respectively.

(a) **(b)**

Figure 5 Impact of different compression methods on ImageNet classification accuracy. Panels (a) and (b) show the validation top-1 and top-5 accuracy plotted against bits per pixel (bpp), respectively. A ResNet-50 model pretrained on the original ImageNet images was evaluated using validation images compressed by different methods.

(a) **(b)**

(c) **(d)**

Figure 6 Ablation experiments for the IMF compression method. In all cases, we plot PSNR as a function of bits per pixel (bpp) on the Kodak dataset. (a) Compares IMF compression performance without patchification and different patch sizes. (b) Compares IMF compression performance for different bound values of factor matrices. (c) Compares IMF compression performance for different numbers of BCD iterations. (d) Compares IMF compression performance between RGB and YCbCr color space transform.

A Proof of Theorem 1