Representation Learning for Point Clouds with Variational Autoencoders

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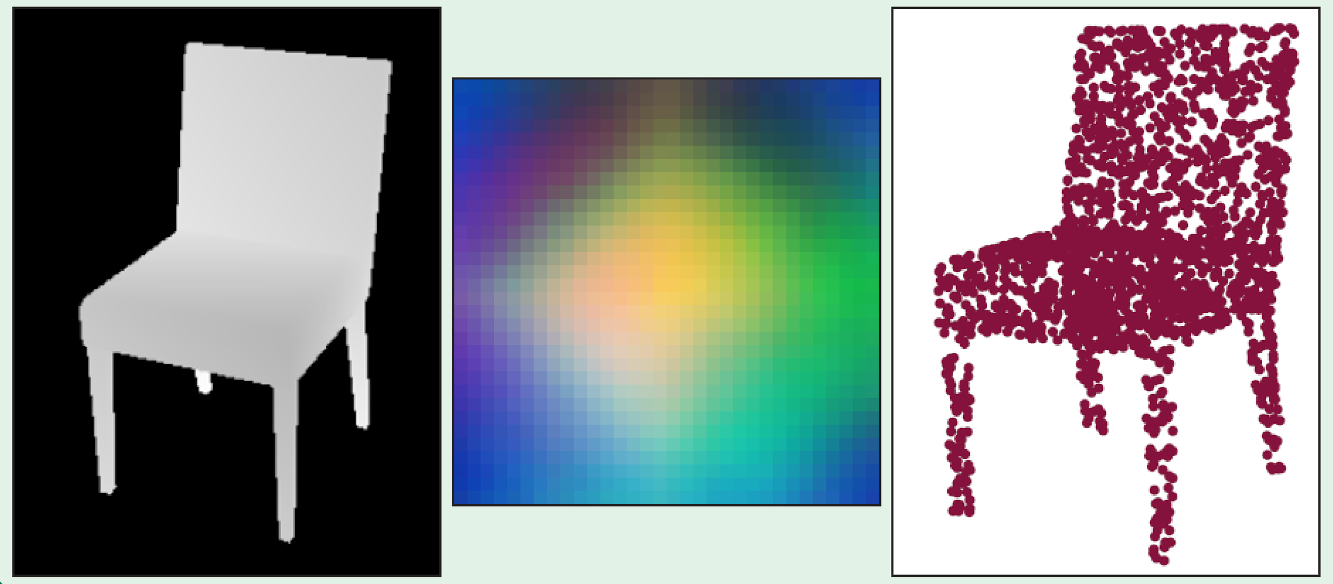
Context

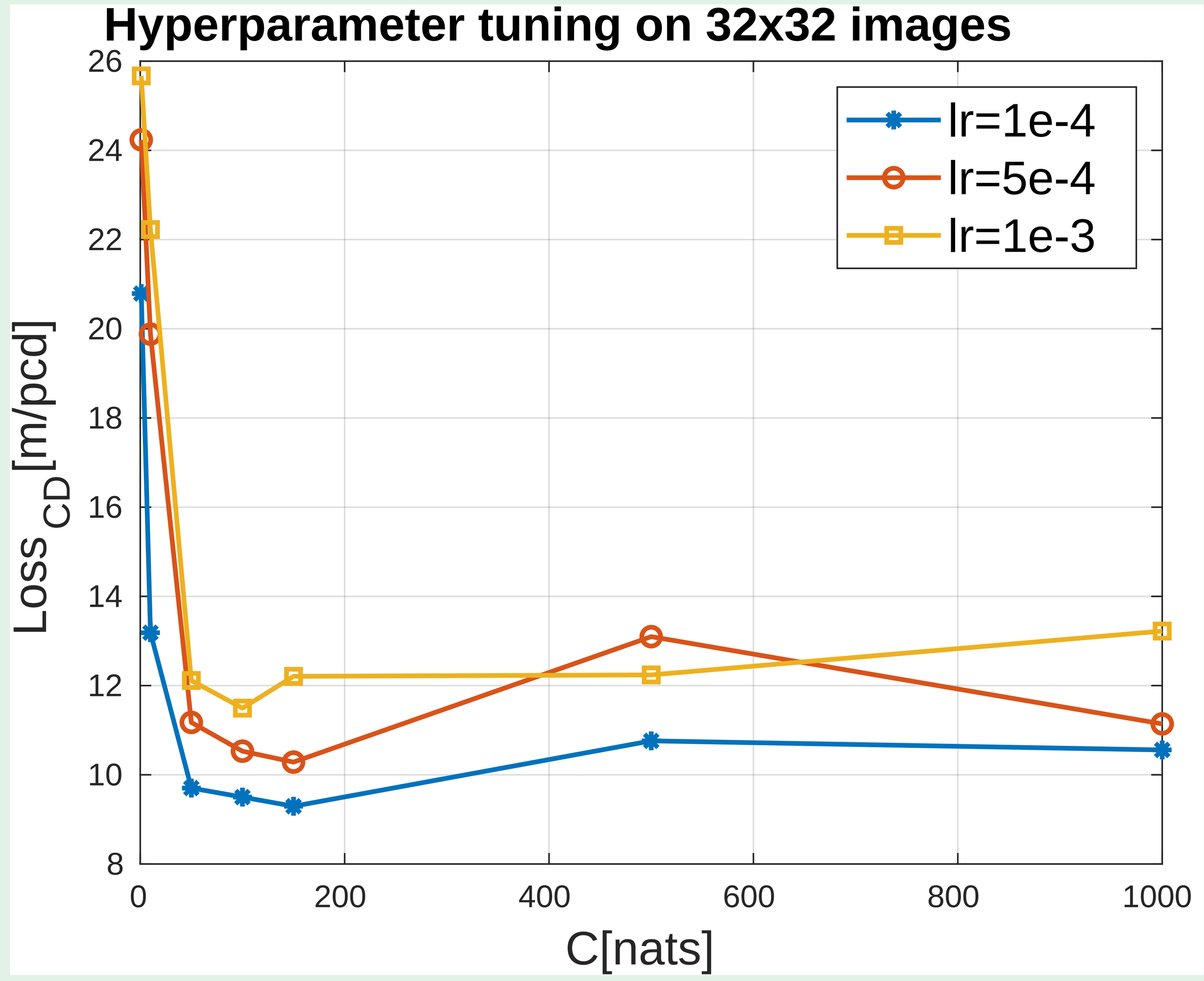
Main motivation

- Generative models
- 3D representation
- Speed / Robustness
- Embedded performance

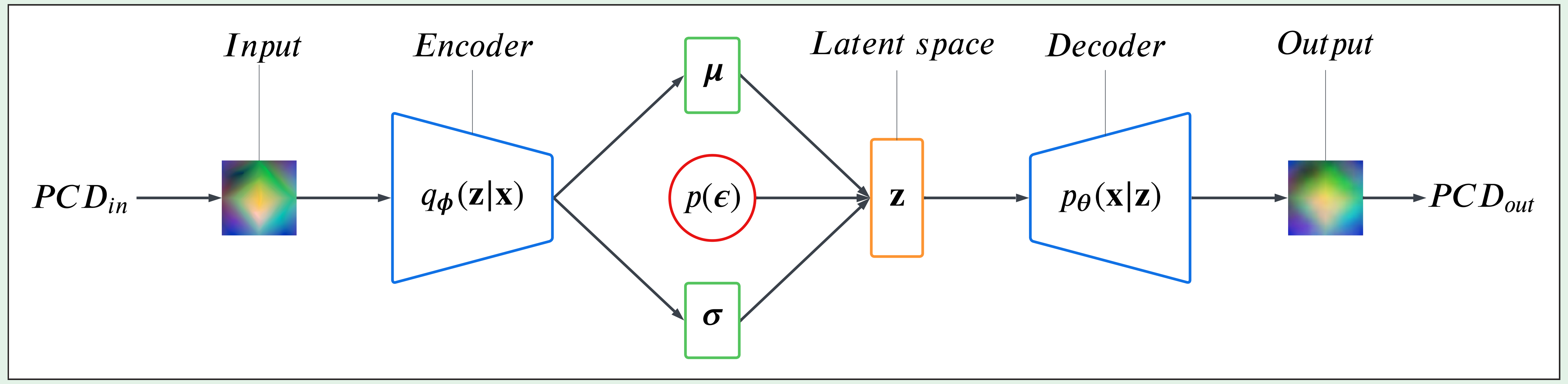


Hyperparameter tuning

- Learning Rate
- D_{KL} - Kullback-Leibler divergence
- β, C - equilibrium of the latent space
- RayTune for tuning

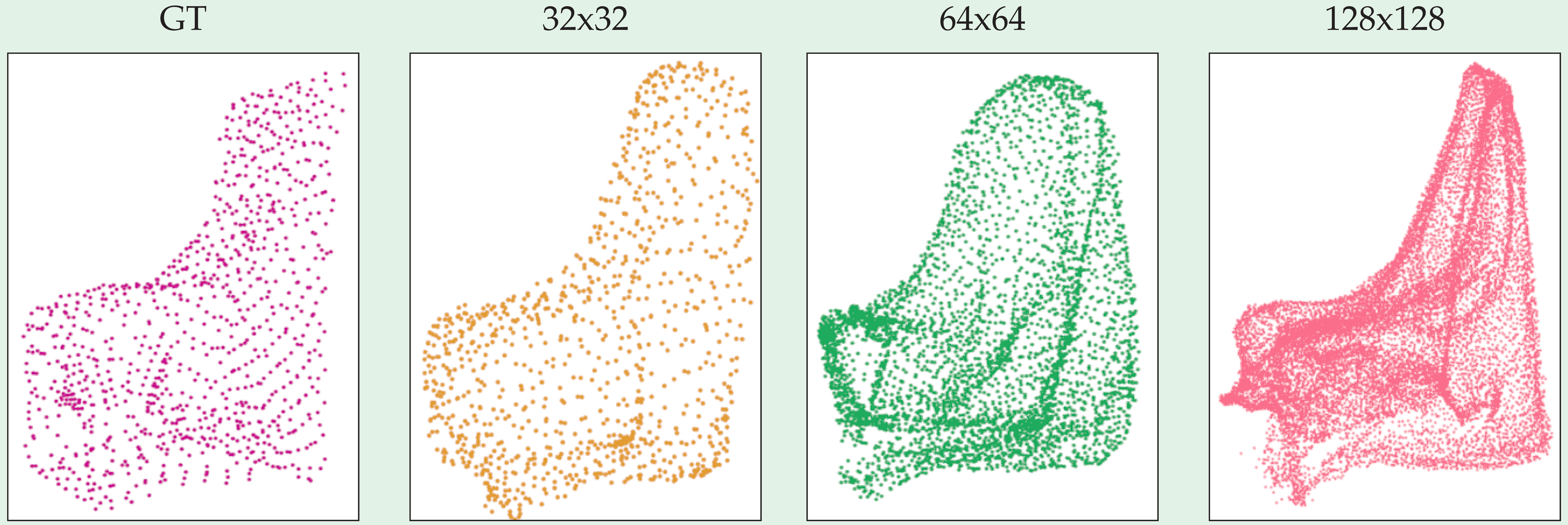


Architecture - Variational Autoencoder



$$Loss = Loss_{GIM} + Loss_{CD} + \beta|D_{KL}(q(\mathbf{z}|\mathbf{x})||p(\mathbf{z})) - C|$$

Size comparison



Training losses

	$Loss_{CD}$	$\beta - loss$	$Loss_{L1}$	C [nats]	learning rate
Best 32×32	9.295	100	424	150	10^{-4}
Worst 32×32	25.1	254.1	754.5	1	10^{-3}
Best 64×64	47.03	267	1919	100	10^{-4}
Best 128×128	213.8	124	8337	50	10^{-4}

GIM vs PCD representation for VAE

Noise type	Own	3D-AAE [a]
Without noise	9.6	**3.8**
Gaussian noise (5cm)	**9.7**	11.5
Gaussian noise (7.5cm)	**9.8**	22.2
Gaussian noise (10cm)	**10**	37.38
Time (on server) [ms]	**0.9**	1.3
Time (Jetson NX) [ms]	**5.4**	12.5

[a] Zamorski, M., Zięba, M., Klukowski, P., Nowak, R., et al.: Adversarial Autoencoders for Compact Representations of 3D Point Clouds. Computer Vision and Image Understanding 193, 102921 (2020)

Future work

- Controlled form generation
- Optimize data compression
- Optimize for embedded systems

References

More details in: *Szilárd Molnár and Levente Tamás. Representation Learning for Point Clouds with Variational Autoencoders. InProceedings of the European Conference on Computer Vision Workshop, Tel-Aviv , Israel, October 2022.*

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