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# Data Analysis of Lossy Generative Data Compression for Robust Remote Deep Inference

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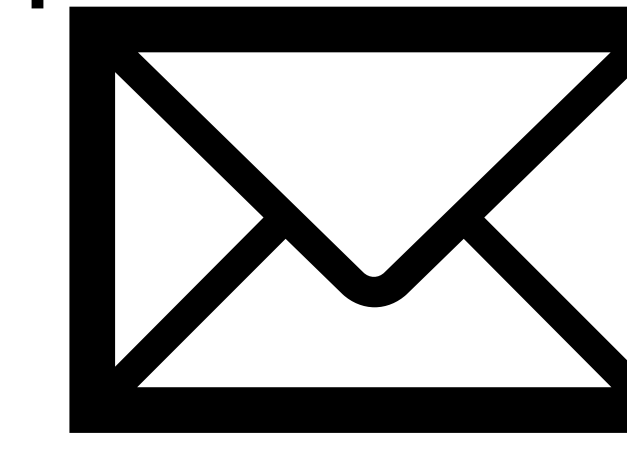
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IoT and 6G will transfer high data rates over limited channel bandwidth: compress with some distortion

**System Model** (compressing data to match communication bandwidth or storage capacity, decompressing remotely and classifying)

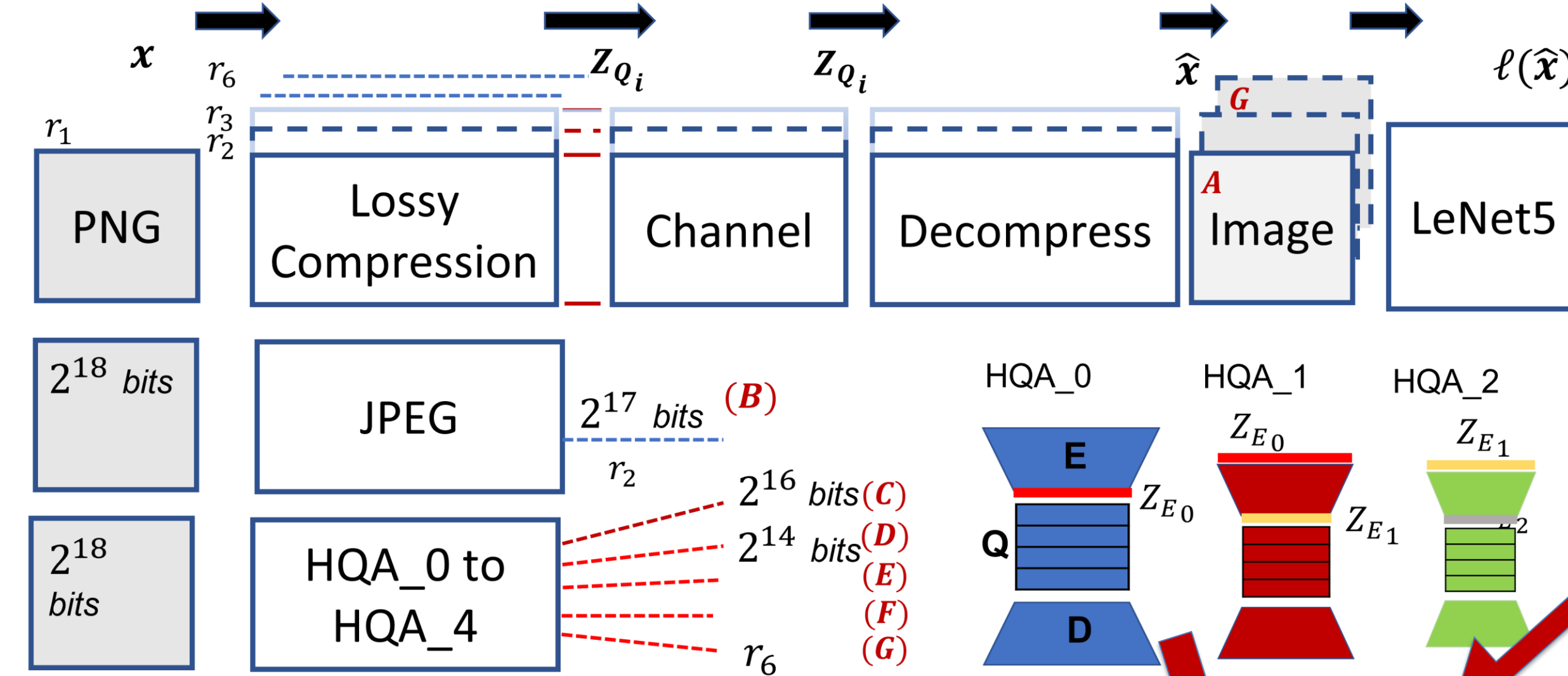
( LOSSY COMPRESSION)



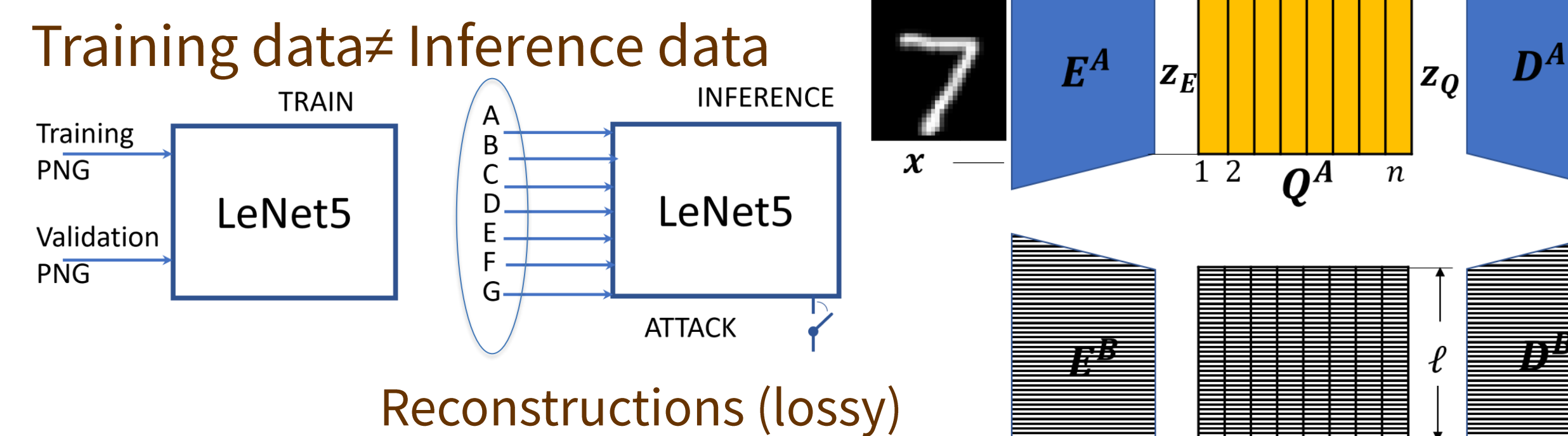
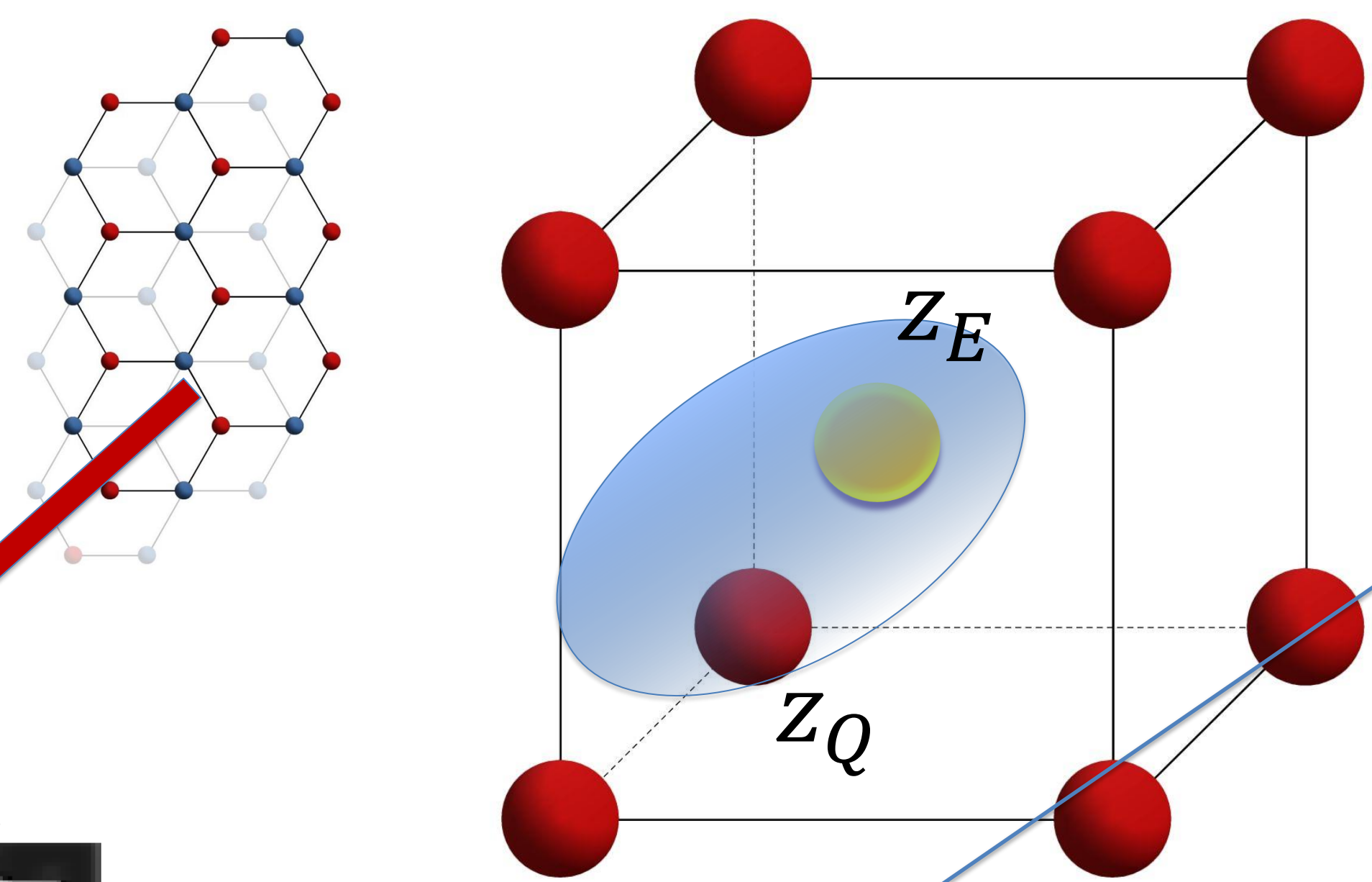
Submitted to  
ACM WiseML'23  
w/ CS students:  
Mathew Williams  
Armani Rodriguez

**Curiosity:**  
VQ-VAE part  
of OpenAI  
DALL-E 2

How does compression affect  
topological data features  
and can that be related to  
classification accuracy?



**Vector Quantization (VQ):** conceptual description  
This is a 3-D lattice, but imagine multidimensional



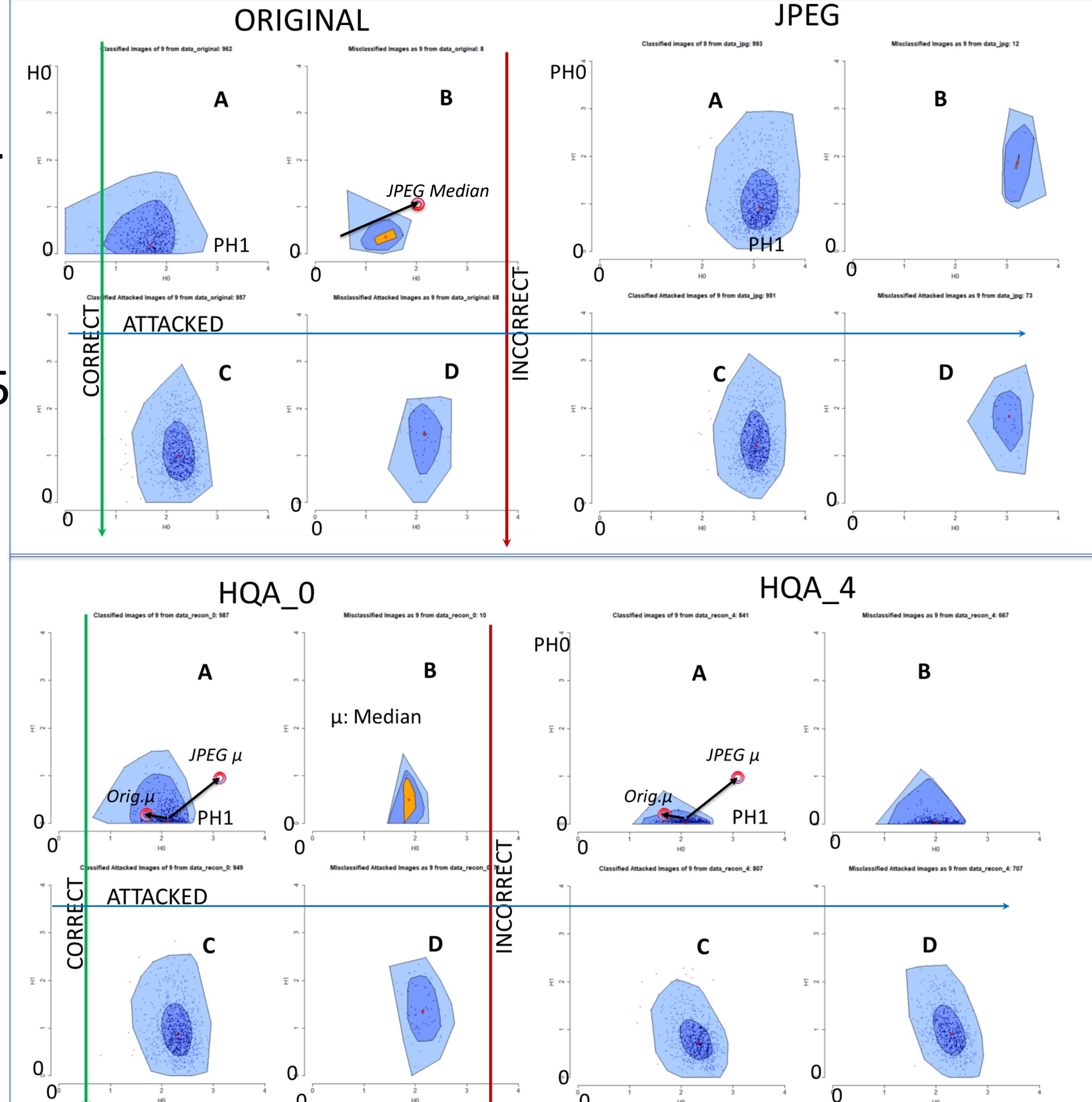
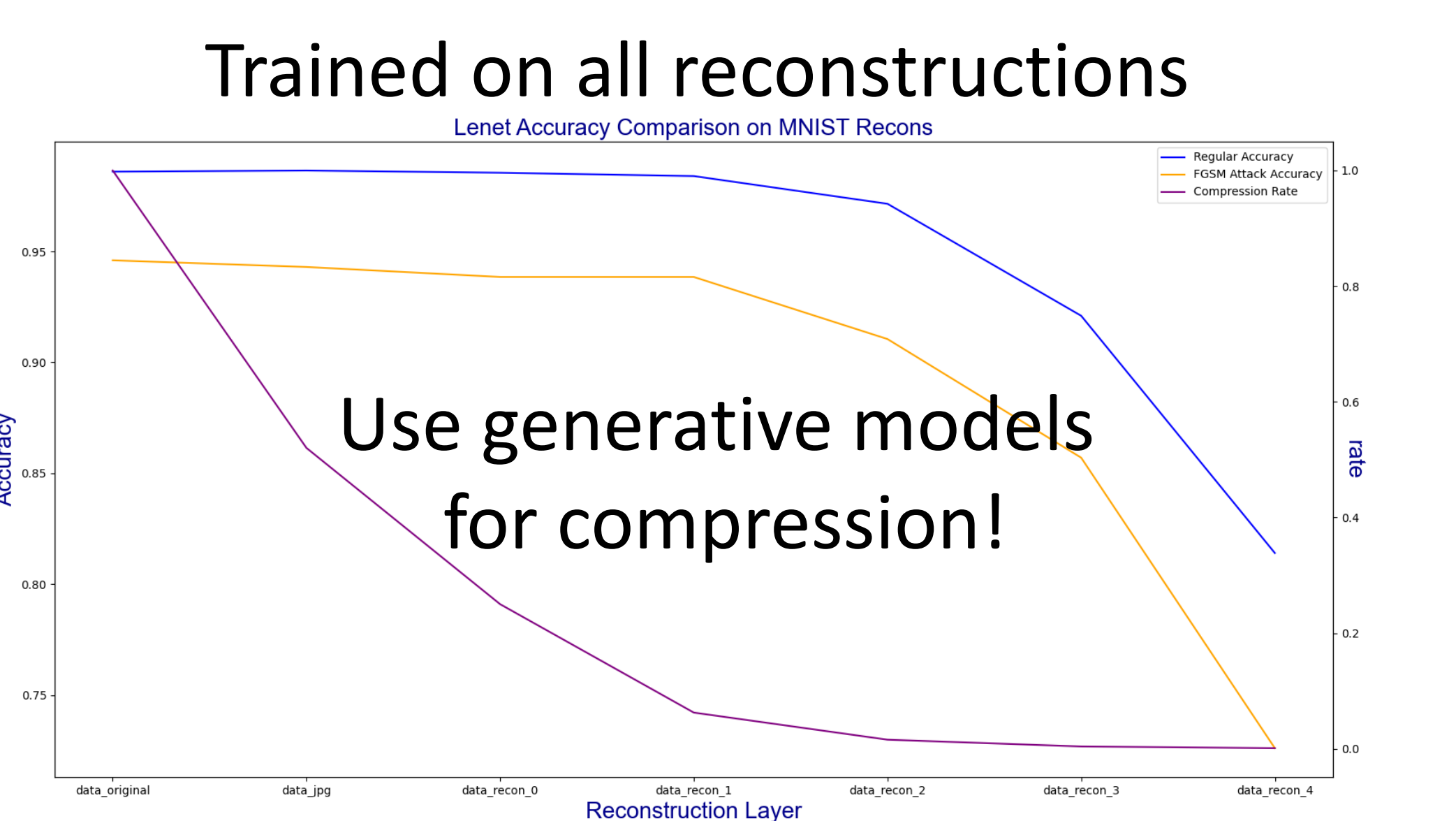
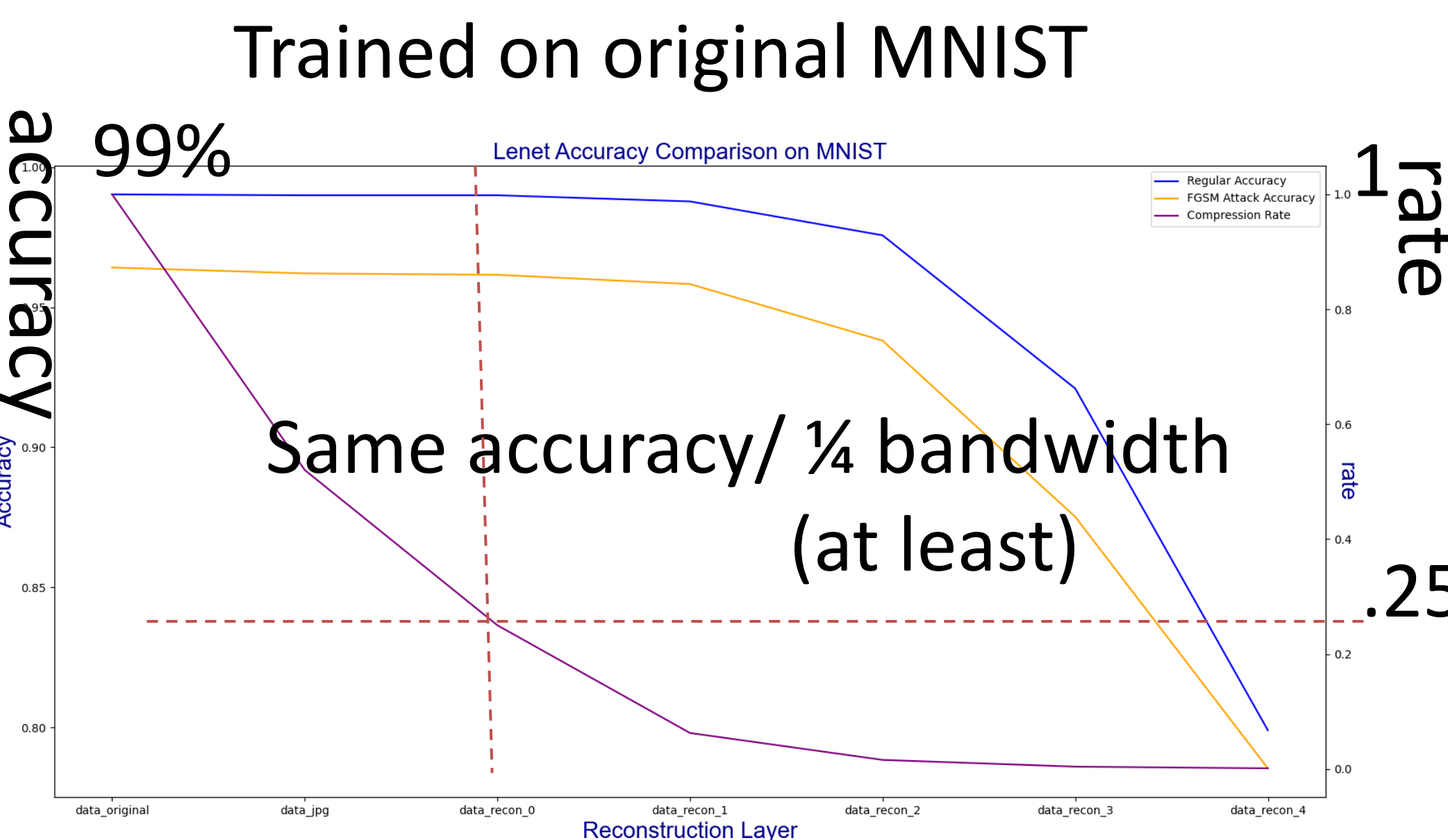
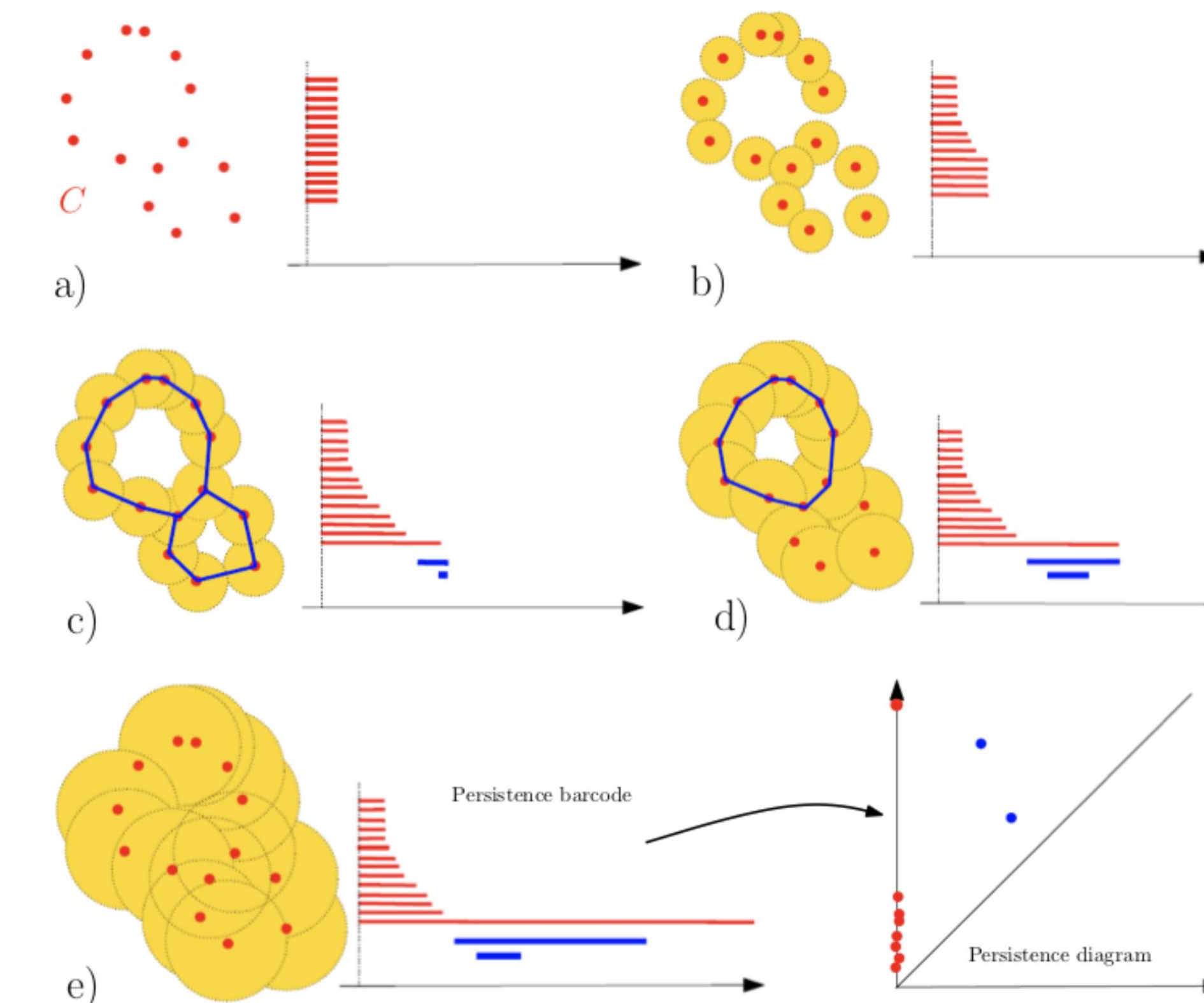
VQ-VAE & HQA<sup>1</sup> are 'learned compression'  
as opposed to JPEG (classical lossy compression)

1. How lossy reconstruction affects inference accuracy?

Robustness:  
2. Do lossy reconstructions cause distribution shifts in adversarial attacks?

VAE (variational autoencoder): generative model

our reconstructions are random (fake)  
datapoints of the same class (produced generatively)



**Persistent Homologies**

topological analysis of reconstructions and their neural net projections with and without an adversarial attack  
PH0: entropy of 0<sup>th</sup> order homology (connected components)  
PH1: entropy of 1<sup>th</sup> order homology (holes)  
There is potential for attack detection but more research needed.

**Conclusion**

VQ-VAE saves **4x bandwidth** for the same accuracy, equal robustness to attacks, and has the possibility of full accuracy for the same bandwidth due to its generative nature

[1] W. Williams et al., "Hierarchical quantized autoencoders," in Intern. Conf. on Neural Information Processing Systems (NIPS), 2020.