



# AI based compression on Sentinel 2 data

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# The need for compression

## EO satellites

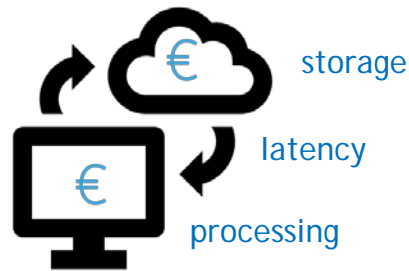


proba-v

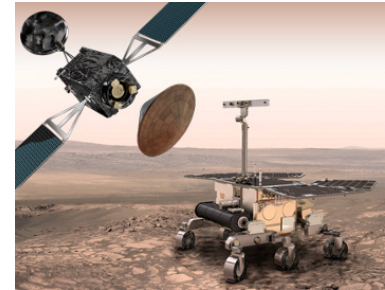


CSIMBA

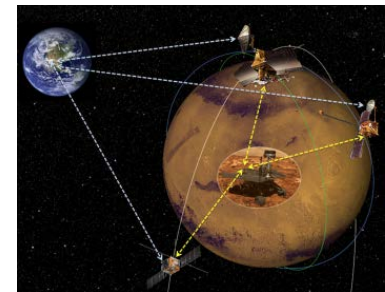
## EO cloud processing



## Beyond Earth Observation



NASA

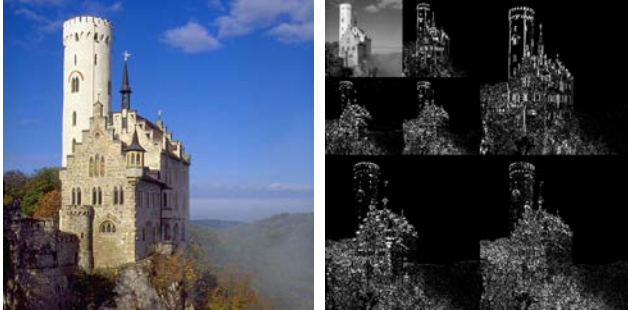


NASA



# Techniques for data reduction

## Classic image compression



### JPEG compression techniques

- Tuned for human perception
- Artefacts at high spatial frequencies

## Onboard data reduction with AI/ML techniques



### Phisat-1 and 2

- Onboard cloud detection
- Onboard information extraction



# Best of both worlds

High compression ratio's

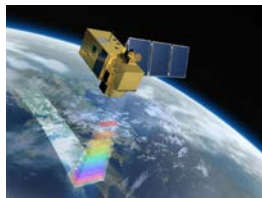
Near lossless imagery  
reconstruction

Meaningful AI compressed  
features for downstream  
applications





CORSA

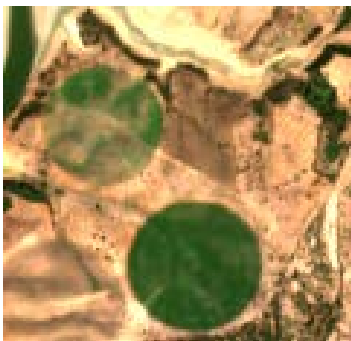


Sentinel-2

Classification  
Object detection  
Semantic Segmentation

Onboard/Onground

Sentinel-2 RGB-NIR



DL Encoder +  
Vector Quantisation

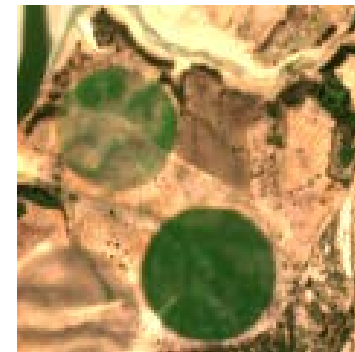
Self-supervised  
Learning for feature  
extraction

full latent vector  
(codebook)

File on disk:  
Vector Indices  
(codebook)

Compression ratio ~20

Reconstruct  
image using  
decoder



Quality: SSIM, PSNR

image Compression for Remote Sensing using vector-quantized Autoencoders (CORSA)

ESA Phi-Lab call for research projects through the Science for Society Open Call, Under activity line "Evolving Shared Technical Platform Capabilities"

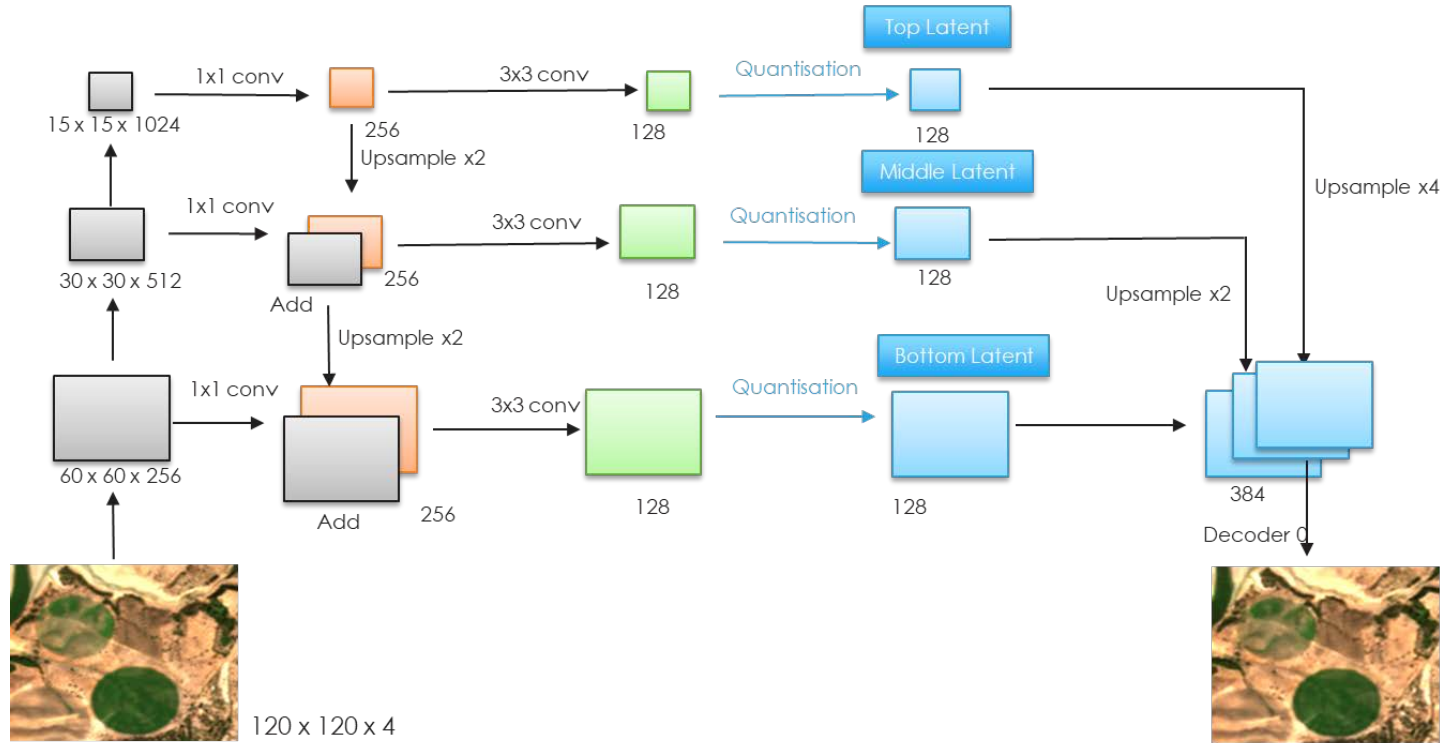
# Training Data set: BigEarthNet



Test Images	True Multi-Label	Inception-v2	S-CNN-RGB	S-CNN-All
	pastures, peatbogs	non-irrigated arable land, coniferous forest, mixed forest, transitional woodland/shrub	non-irrigated arable land, land occupied by agriculture, mixed forest	pastures, peatbogs
	pastures, land occupied by agriculture, water bodies	coniferous forest, mixed forest, transitional woodland/shrub	non-irrigated arable land, land occupied by agriculture	pastures, land occupied by agriculture, water bodies
	discontinuous urban fabric, industrial or commercial units	coniferous forest, mixed forest, transitional woodland/shrub	discontinuous urban fabric, land occupied by agriculture, broad-leaved forest, coniferous forest, mixed forest	discontinuous urban fabric, industrial or commercial units

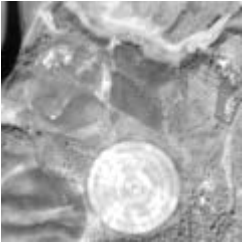
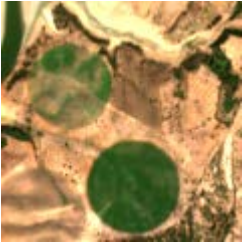


# VQVAE-FPN-3 Network architecture

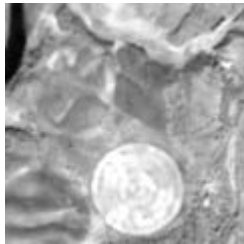
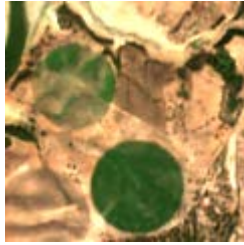


# VQVAE-FPN-3 reconstruction quality on Test Set

Original image

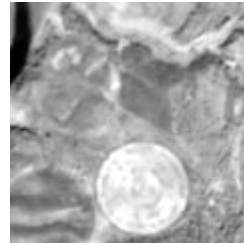
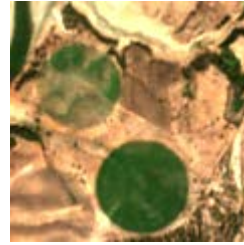


VQVAE-3 ED 256



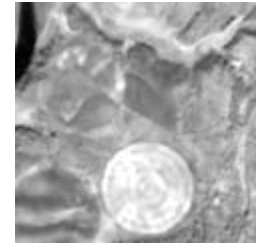
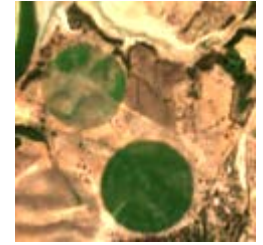
SSIM = 0.956  
PSNR = 13.724

VQVAE-3 ED 512



SSIM = 0.958  
PSNR = 13.9039

VQVAE-3 ED 1024



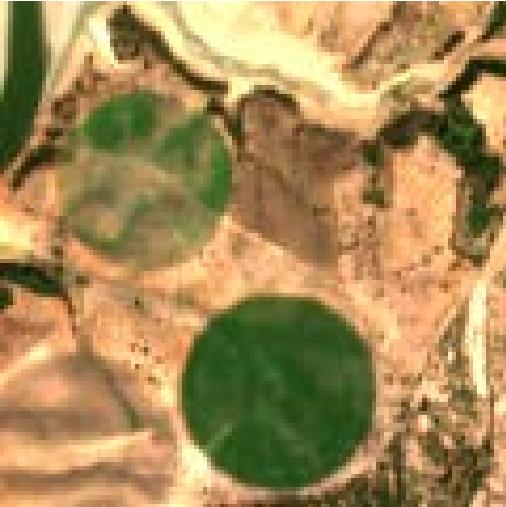
SSIM = 0.962  
PSNR = 14.5056



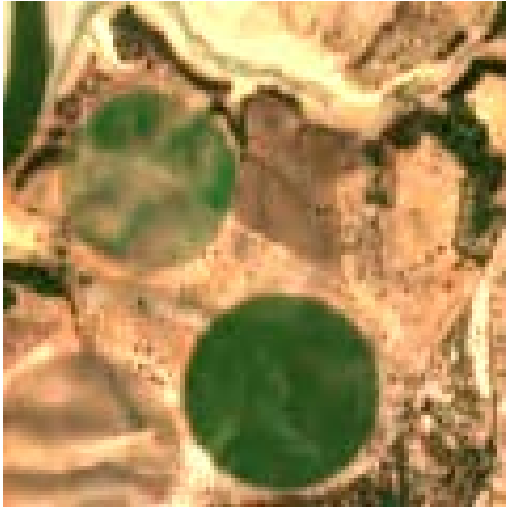
SEE  
THE  
BIGGER  
PICTURE

# VQVAE-FPN-3 reconstruction quality on Test Set

Original image

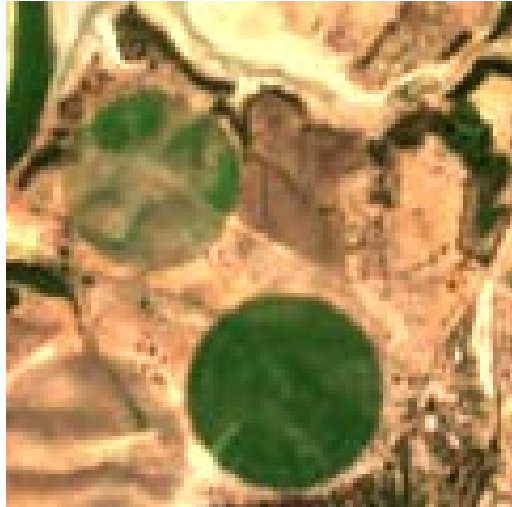


JPEG2000 CR=20 (no NIR)



SSIM = 0.956  
PSNR = 16.0386

VQVAE-3 ED 1024



SSIM = 0.962  
PSNR = 14.5056



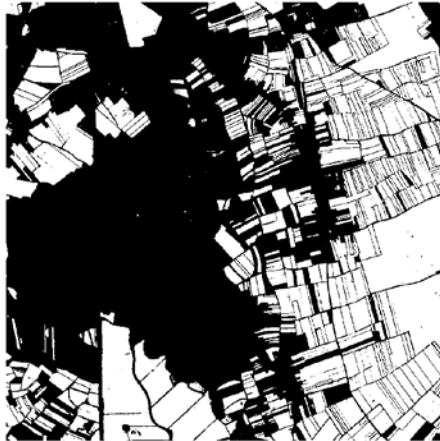
# Downstream application validation:

Parcel delineation

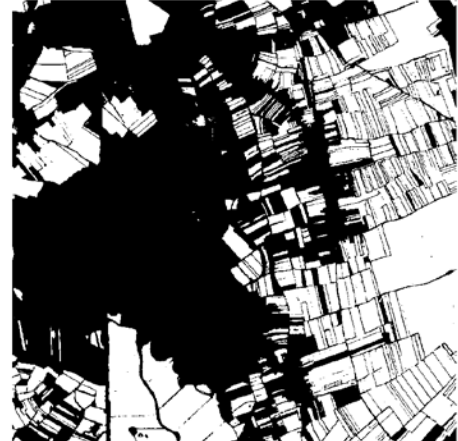
4x Superresolution + Semantic segmentation (AI4EO challenge)



Original



Segmentation result  
Original



Segmentation result  
Reconstructed

Differences noticed only at subpixel level (2.5m)



# Conclusions

- AI based compression is a promising alternative for classic compression techniques.
- Provides similar reconstruction accuracies while preserving information details for downstream applications.
- Compressed features correspond to meaningful image representations, that can be used as input for light weight AI applications with less training data.

# THANK YOU

[remotesensing.vito.be](http://remotesensing.vito.be)

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