Course #3:

Auto-encoders

Roadmap

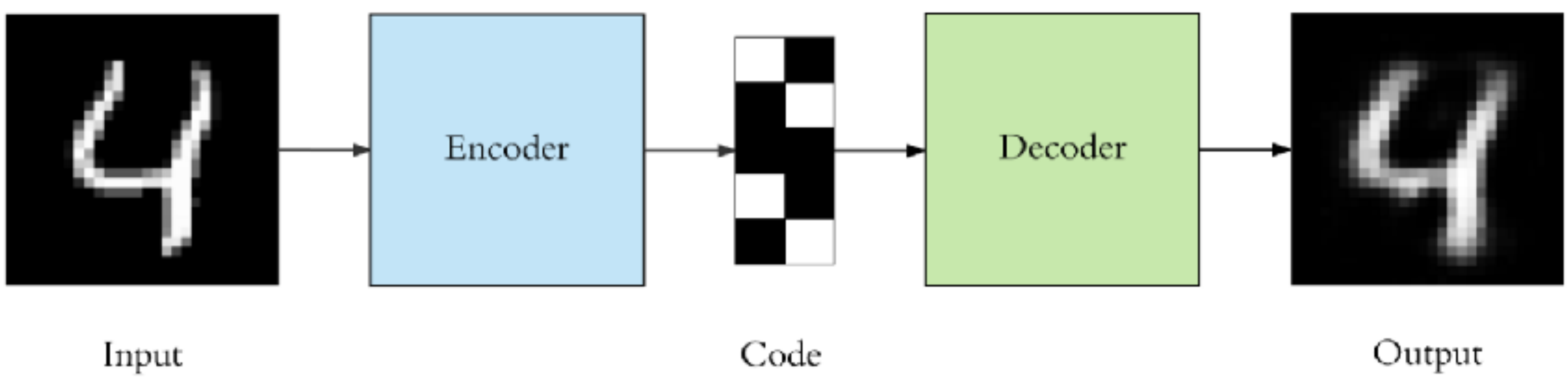
- Recap from course #2
- Auto-encoders
- PyTorch Lightning

Lecture. #2
Things to know

- Convolution layers
- Pooling layers
- Activation layers
- Dropout layers
- Padding and stride
- Fine-tuning
- Over-fitting
- Data augmentation
-

Auto-encoders

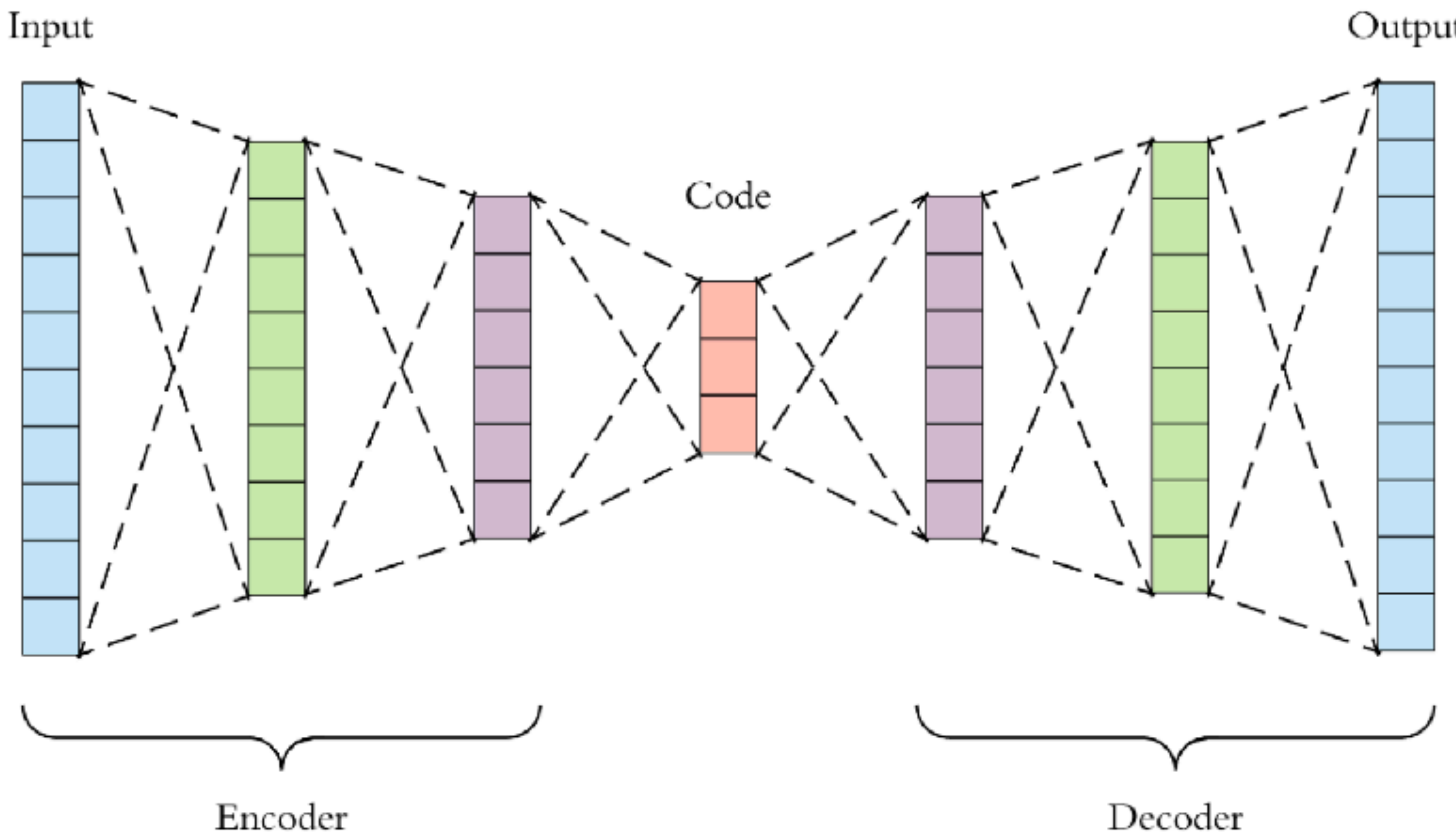
Auto-encoders



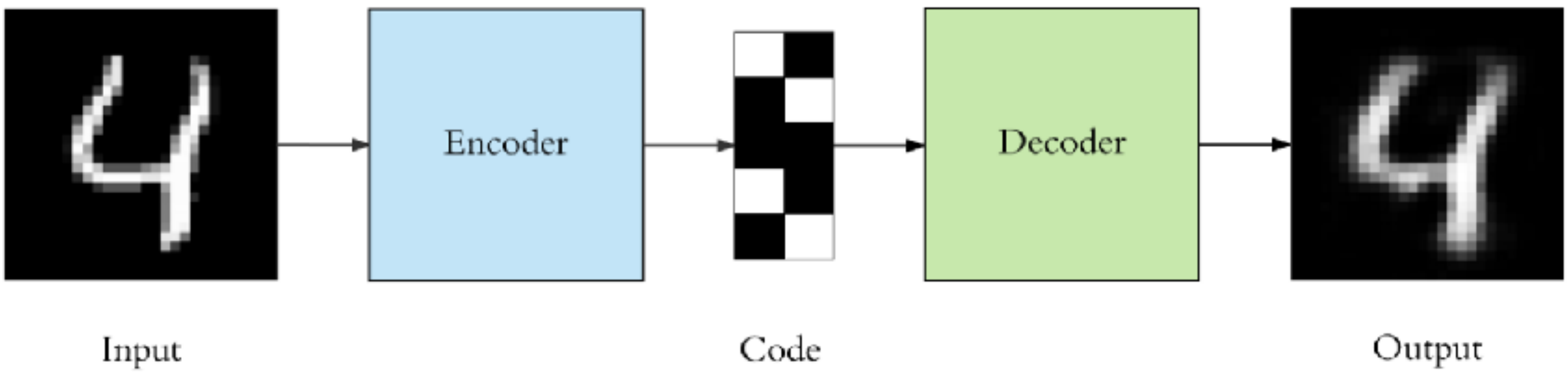
Output with the same shape as the input

Application ?

Dense auto-encoders



PCA/EOF



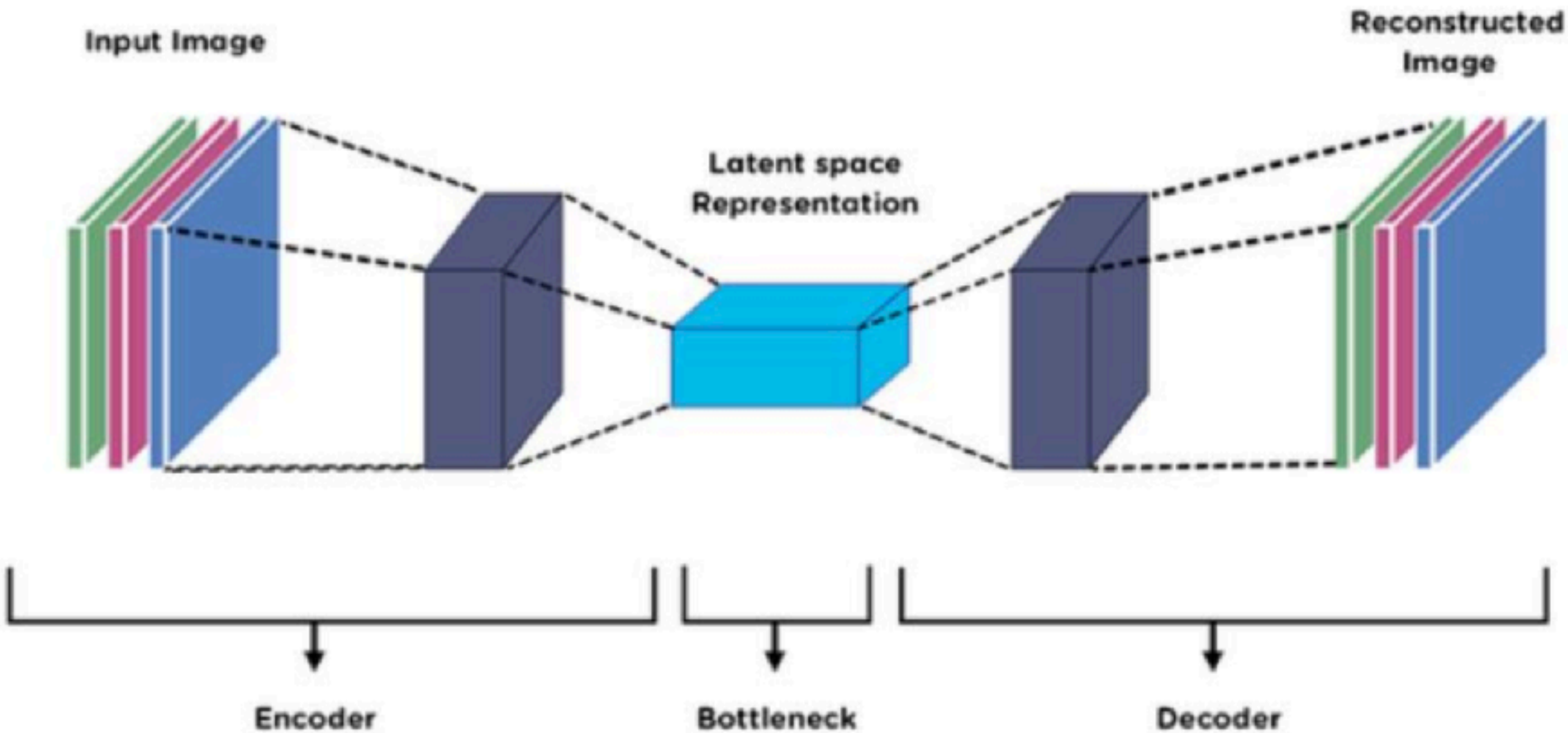
X $\longrightarrow$ Z $\longrightarrow$ $\tilde{X}$

$$Z = A \cdot X \qquad \tilde{X} = A^t \cdot Z$$

PCA as a linear auto-encoder architecture.

Which additional constraint ?

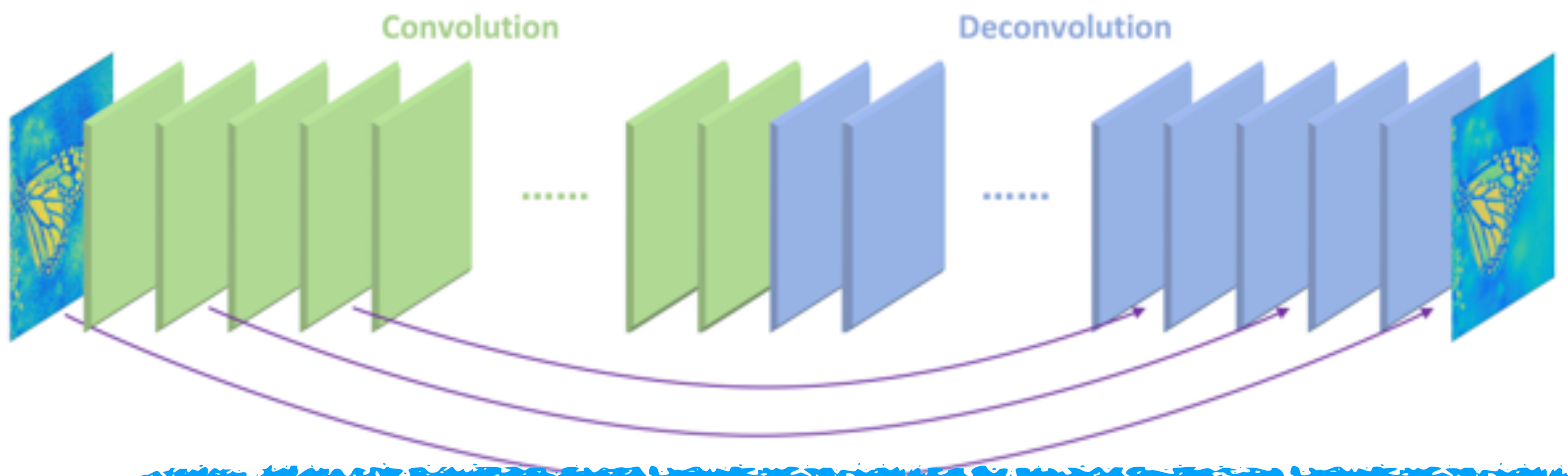
Convolutional auto-encoders



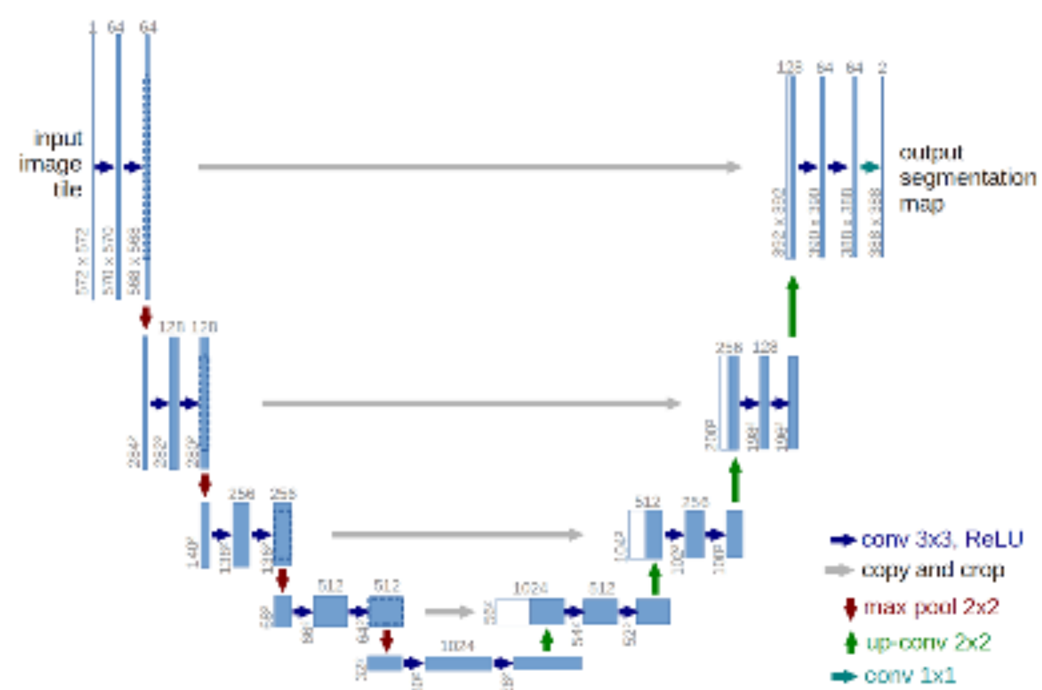
Source: https://www.analyticsvidhya.com/

Convolutional AE Zoo

Many applications do not require a low-dimensional representation
(e.g., densoising, interpolation, super-resolution,….)



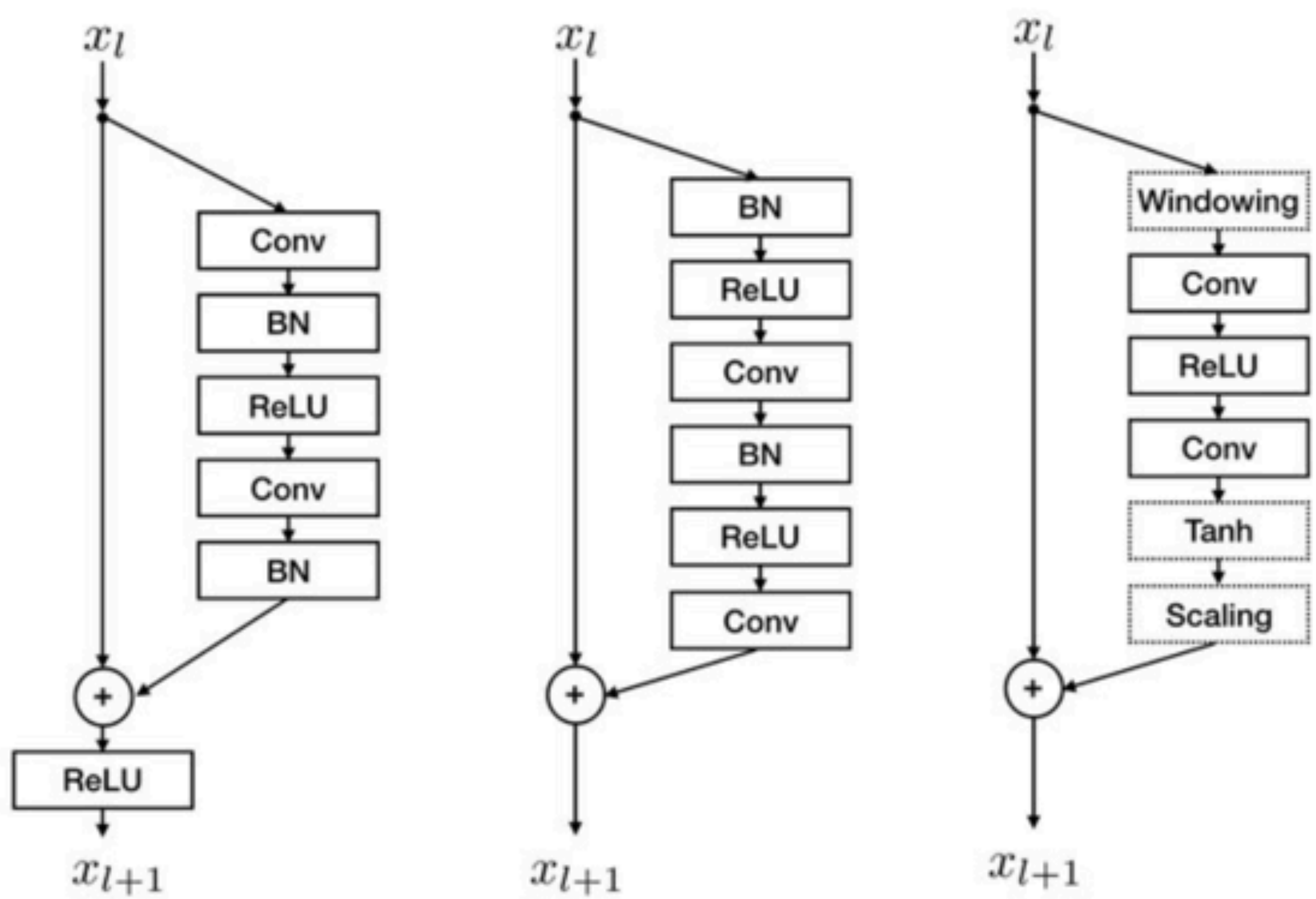
https://arxiv.org/pdf/1606.08921.pdf



UNet

Ronneberger et al., 2015

Convolutional AE Zoo



Residual Block
(ResNet)

Rousseau et al.,
2019

Often used to address vanishing gradients ("very" deep networks)

Auto-encoders for image denoising and image generation

Pytorch version
https://github.com/CIA-Oceanix/DLOA2023/blob/main/lectures/notebooks/notebook_MNIST_AutoEncoder_students.ipynb

Lightning version
https://github.com/CIA-Oceanix/DLOA2023/blob/main/lectures/notebooks/notebook_PytorchLightning_MNIST_AutoEncoder_students.ipynb

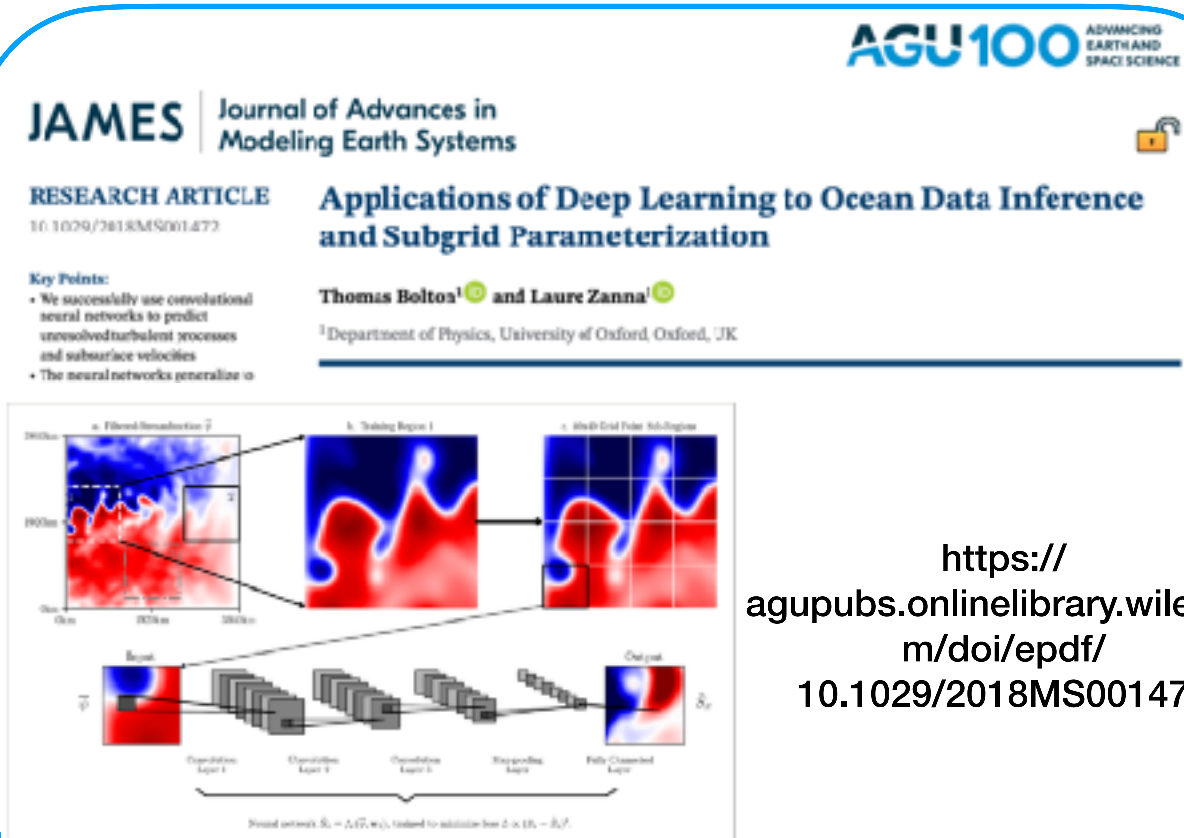
Question 1. Fill in the architecture of the dense encoder module to train a dense auto-encoder

Question 2. Add dropout layers in the convolutional encoder and decoder

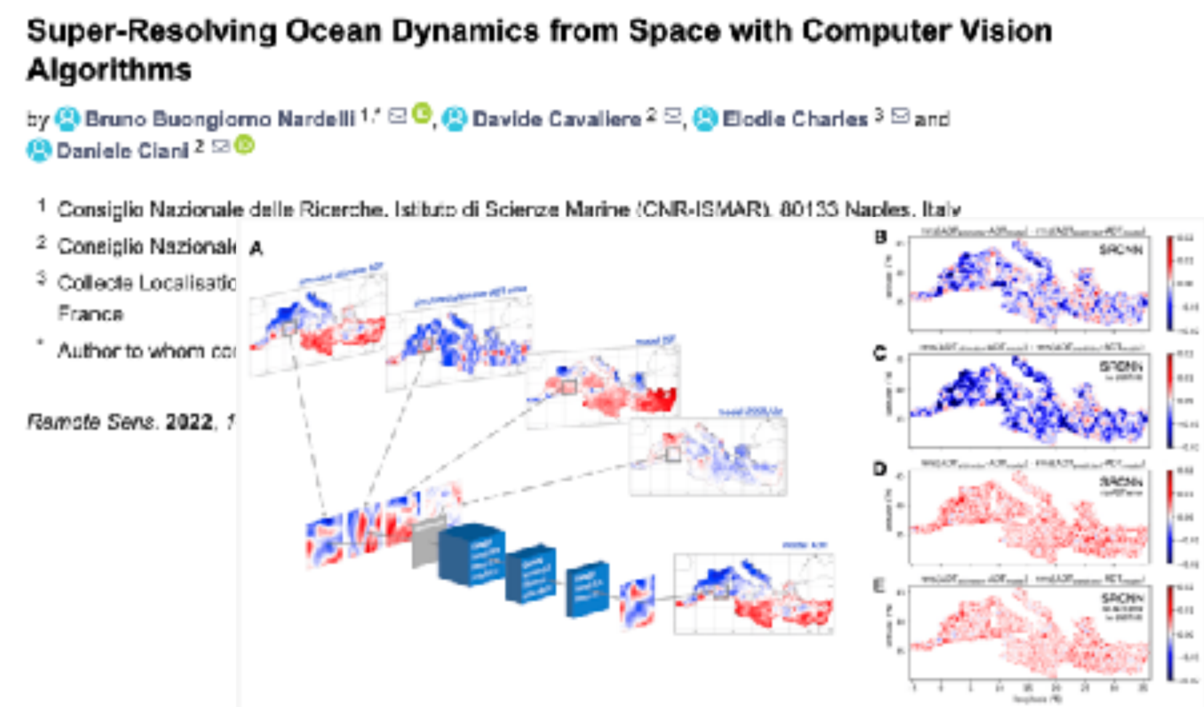
Question 3. Modify the code to test a linear auto-encoder (cf. AE and PCA)

PyTorch Lightning

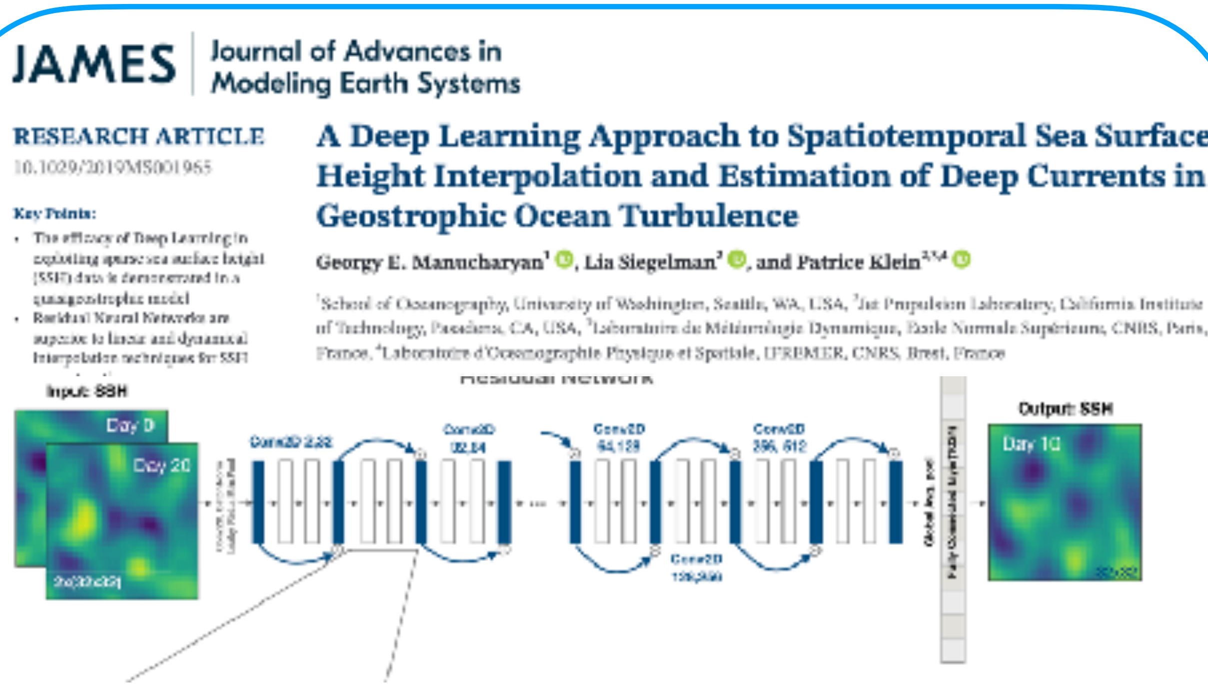
ConvAE & Ocean Dynamics



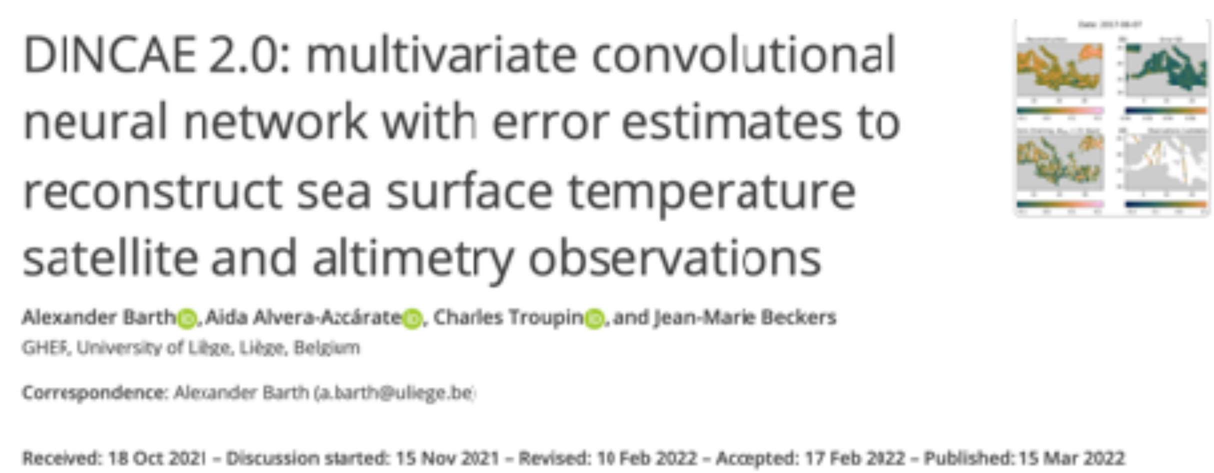
https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2018MS001472



https://www.mdpi.com/2072-4292/14/5/1159



https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2019MS001965



https://gmd.copernicus.org/articles/15/2183/2022/

ConvAE & Ocean Dynamics
Literature review

Considered papers:
Topic#1 https://gmd.copernicus.org/articles/15/2183/2022/
Topic#2 https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2018MS001472
Topic#3 https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2019MS001965
Topic#4 https://arxiv.org/abs/2010.04663

Questions:
- Which problem ?
- Which convolutional architecture ?
- Comments ?

ConvAE architectures for Ocean Dynamics ?

Lecture. #3
Things to know (AE)

- Auto-encoder
- Latent variable
- UNet
- ResNet