Using Autoencoders for Reduced Order Modeling

Layer Options and Framework

Deep learning framework

- Tensorflow with Keras

Layer Options

- Using three dense layers for encoding and decoding.
- Activation function for each layer:"relu" - rectified linear unit
- reducing the input from (8000x25) to (32x25) (25 timesteps)
- Optimizer "adadelta" $\rightarrow$ learning rate is adapted automatically compared to sgd
- Loss-function "binary-crossentropy"

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Training and Results

Training

- After 200 epochs of training using the 241 snapshots (Kn $=$ 0.00001) as training data and the 25 Snapshots (Kn $=$ 0.00001) as validation data
- maximum loss of training data and validation data: 9.6×10^{-4}

Results

- The Autoencoder is not yet capable of performing the reduction properly

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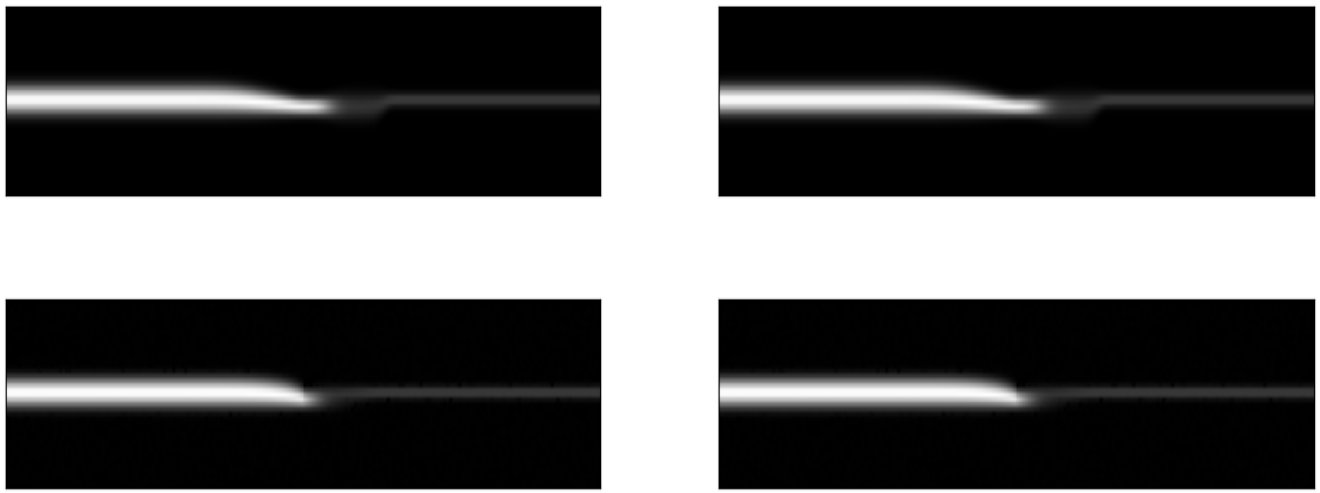
Results

The figure shows the results of this simple autoencoder. The upper images show the original data in velocoty space, the lower two are the reconstructions.



The structure of the velocity space can be recovered after the dimension reduction, but the timely developement is not beeing recognized.

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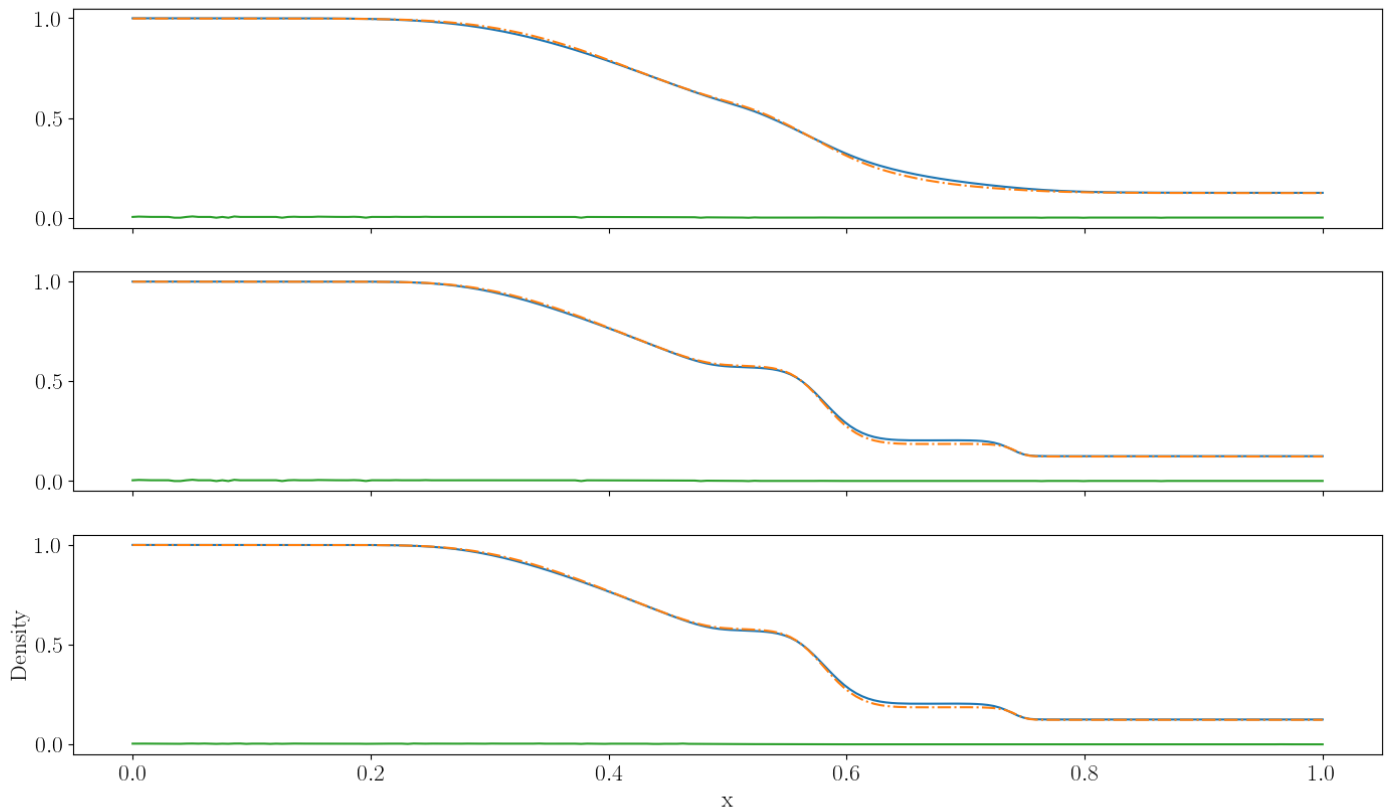
Results

The figure shows the Density at the last timestep of the original data (blue), the SVD data (red dotted) and the recovered data from the autoencoder(green).



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Literature and Questions

Questions and further approches

- Concolutional Autoencoder?, Variational Autoencoder?, Sequence-to-Sequence Autoencoder?
- More training data necessary or change of Autoencoder-Architecture sufficent?

Literature

- Model reduction od dynamical systems on nonlinear manifolds using deep convolutional autoencoders, Kookjin Lee, Kevin T. Carlberg (2019)
- Deep Learning, MIT Press book, Goodfellow et al.
- ...