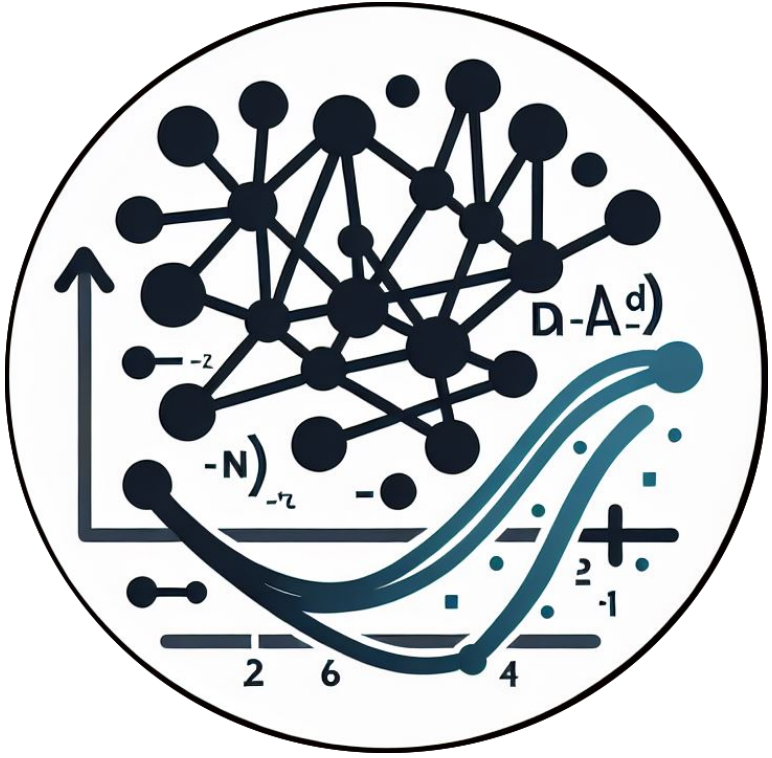
Autoencoders



Deep Learning for Engineers

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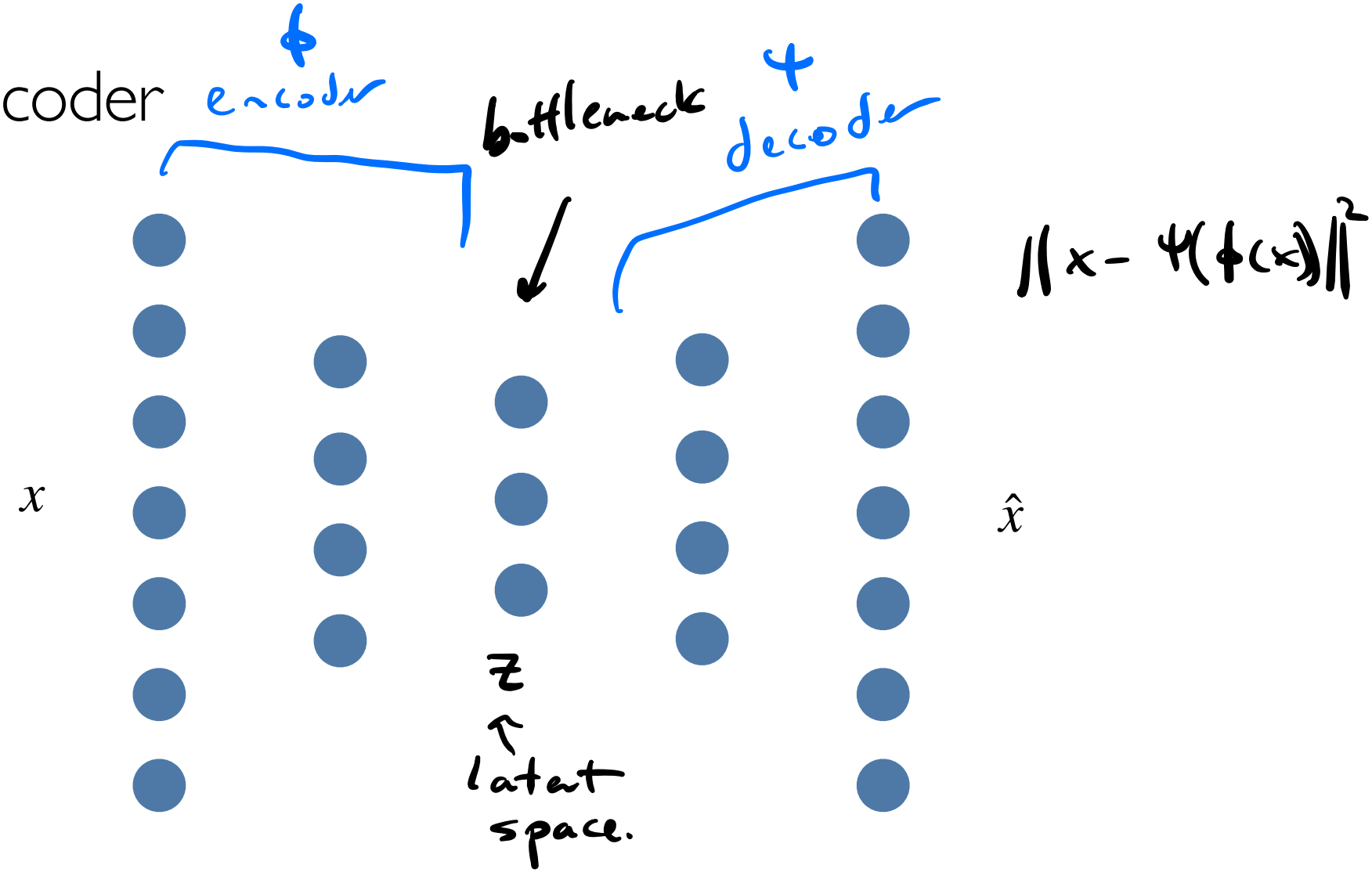
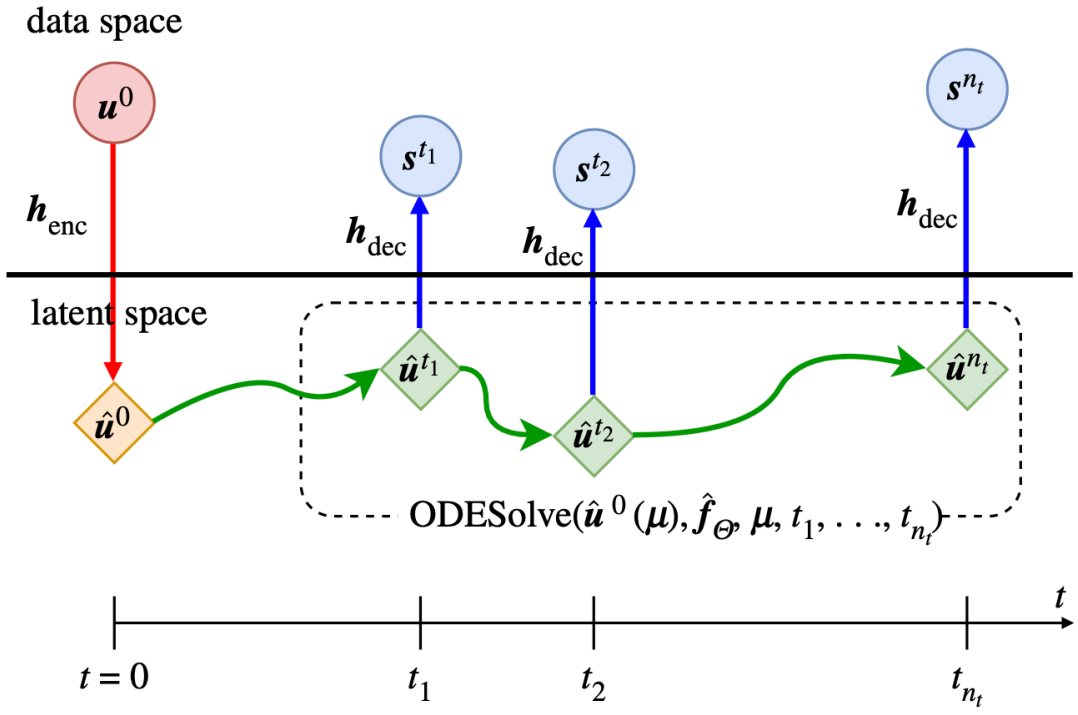
Autoencoder



POD/PCA

Autoencoder with Neural ODE



i.c. in latent space

encoder

i.c.

$$\hat{u}^0 = h_{enc}(u^0)$$

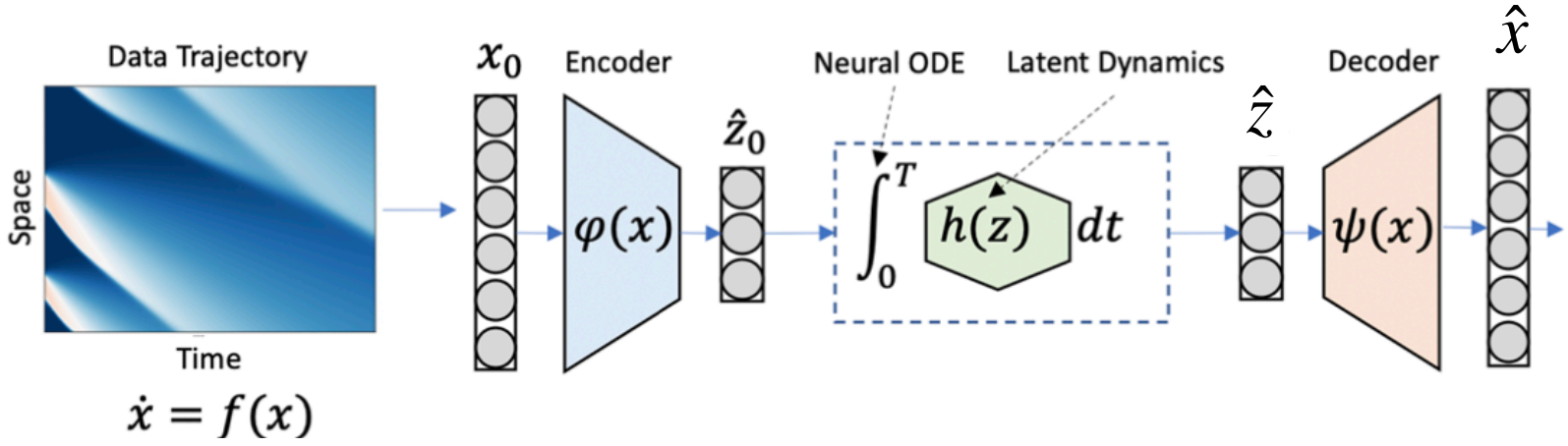
$$\hat{u} = \text{odesolve}(\hat{u}^0)$$

$$u = h_{dec}(\hat{u})$$

decode.

Parameterized neural ordinary differential equations: applications to computational physics problems

PINODE



$$L_{data} = \|x - \hat{x}\| + \|x - \psi(\phi(x))\|$$

Physics-informed neural ODE (PINODE): embedding physics into models using collocation points

Physics informed loss

recall:

$$\frac{dx}{dt} = f(x), \qquad z = \phi(x)$$

encoder

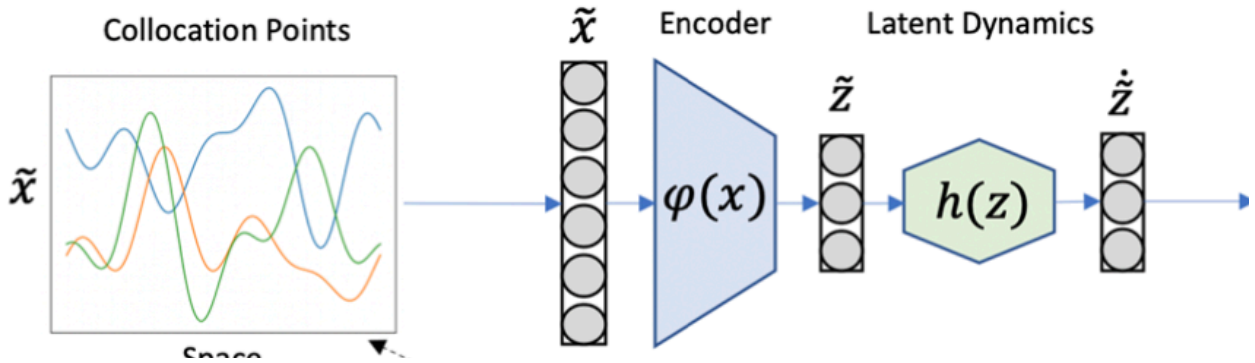
$$\frac{dz}{dt} = h(z)$$

then:

$$\frac{dz}{dt} = \frac{\partial z}{\partial x}\frac{dx}{dt} = \frac{d\phi}{dx} f(x)$$

$$\frac{dz}{dt} = h(\phi(x))$$

$$\Rightarrow \quad \frac{d\phi}{dx} f(x) = h(\phi(x))$$

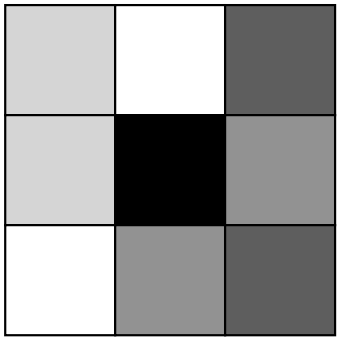


$$L_{physics} = \left\| \dot{\tilde{z}} - \frac{d\phi}{d\tilde{x}} f(\tilde{x}) \right\| + \left\| \tilde{x} - \psi(\phi(\tilde{x})) \right\|$$

latent gradient loss

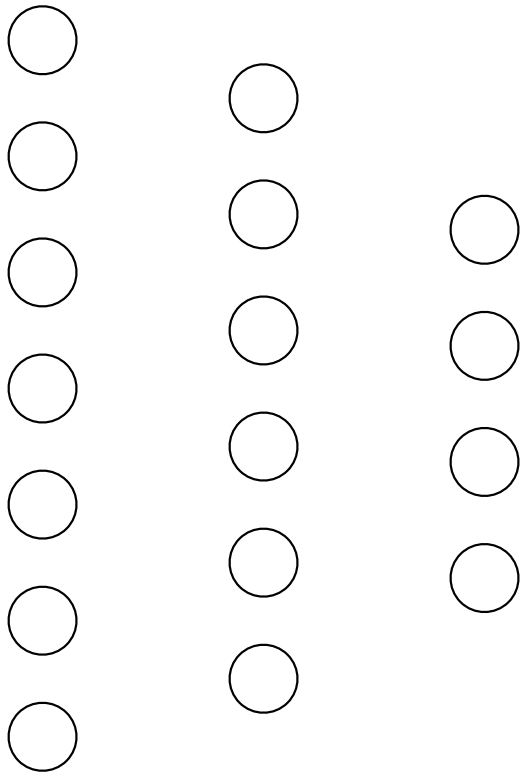
collocation reconstruction loss

Running on a GPU



.25	0	.75
.25	1	.5
0	.5	.75

.25
0
.75
.25
1
.5
0
.5
.75



https://pytorch.org/tutorials/beginner/basics/quickstart_tutorial.html