

a

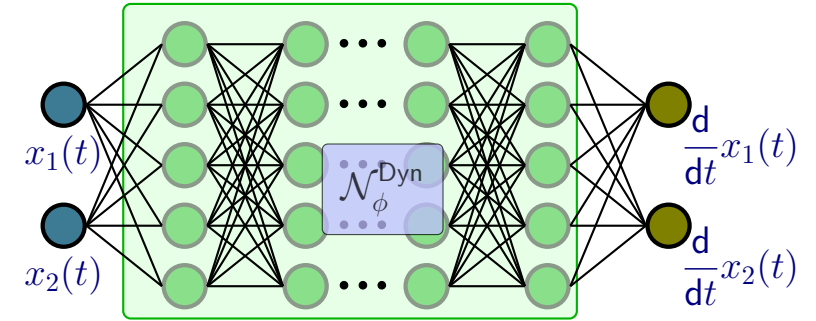
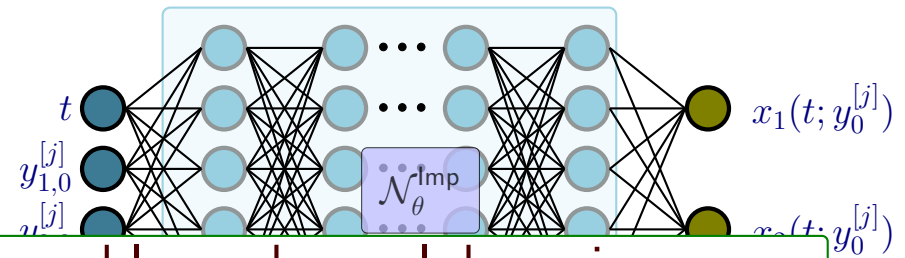
Noisy data

./main_diag1.pdf



b

Learning implicit representation and governing equations



Denoised data and learned neural dynamics

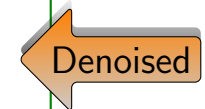
./main_diag2.pdf

$$\mathbf{x}(t) = \mathcal{N}_\theta^{\text{Imp}}(t),$$

and

$$\frac{d}{dt}\mathbf{x}(t) \approx \mathcal{N}_\phi^{\text{Dyn}}(\mathbf{x}(t))$$

d



Objective (loss) function :=

c

$$\begin{aligned} & \lambda_{\text{MSE}} \underbrace{\left\| \mathbf{y}_{\text{data}}(t) - \mathcal{N}_\phi^{\text{Dyn}}(t)\mathbf{x}(t) \right\|}_{\text{Implicit loss}} \\ & + \lambda_{\text{Integral}} \underbrace{\left\| \mathbf{x}(t_j) - \mathbf{x}(t_i) - \int_{t_i}^{t_j} \mathcal{N}_\phi^{\text{Dyn}}(\mathbf{x}(\tau)) d\tau \right\|}_{\text{prediction mismatch loss}} \\ & + \lambda_{\text{Grad}} \underbrace{\left\| \frac{d}{dt}\mathbf{x} - \mathcal{N}_\phi^{\text{Dyn}}(\mathbf{x}) \right\|}_{\text{Gradient loss}}, \text{ where } \mathcal{N}_\phi^{\text{Dyn}}(t) = \mathbf{x}(t) \end{aligned}$$