FYS5429/9429 February 5

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Solving ordinary differential eqs (ODES) and Partial differential equations (PDEs)

$$\frac{dx}{dt} = \lambda x(t)$$

$$x(t_0) = x_0$$

Discretize

$$t \rightarrow t_i = t_0 + i\Delta t$$

$$i = 0, 1, 2, \ldots n$$

$$x(t) \rightarrow x(t_i) = x_i$$

$$\frac{dx(t)}{dt} = \frac{dx}{dt} = ?$$

$$x(t_i \pm \Delta t) = x(t_i) \pm \Delta t \left.\frac{dx}{dt}\right|_{t=t_i} + \frac{1}{2!}(\Delta t)^2 \left.\frac{d^2x}{dt^2}\right|_{t=t_i} + O(\Delta t^3)$$

$$\frac{dx}{dt} = \frac{x(t_i + \Delta t) - x(t_i)}{\Delta t} + O(\Delta t)$$

$$\frac{dx}{dt} \approx \frac{x_{i+1} - x_i}{\Delta t} \longrightarrow$$

$$x_{i+1} = x_i + \Delta t \frac{dx}{dt} \sim \lambda x_i$$

$$g(x) = \left(\frac{dx}{dt} - \lambda x\right)$$

cost function

$$C(x) = \frac{1}{n} \sum_{i=0}^{n-1} \left(\frac{dx}{dt}\Big|_{t=t_i} - \lambda x_i \right)^2$$

ansatz :

$$x_i = \underbrace{h_1(t_i)}_{x_0} + \underbrace{h_2(t_i)}_{t_i NN(t_i; \theta)}$$