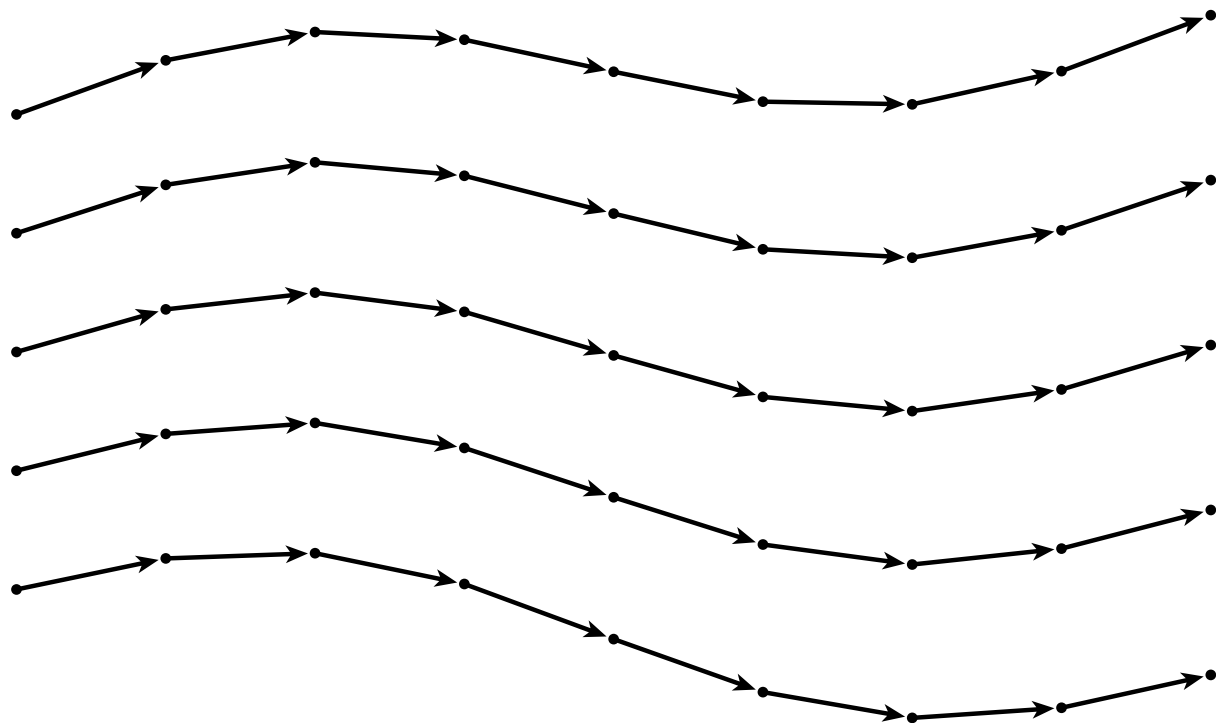$$\mathbf{x}_{k+1} = \mathbf{f}_k(\mathbf{x}_k) := \mathbf{x}_k + \mathbf{v}_{\boldsymbol{\phi}_k}(\mathbf{x}_k, k)$$

$$\frac{\mathrm{d}\mathbf{x}(t)}{\mathrm{d}t} = \mathbf{v}_{\boldsymbol{\phi}}(\mathbf{x}(t), t)$$