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Building our intuition:-
about RNNs

$$m\frac{d^2x}{dt^2} + \eta\frac{dx}{dt} + x(t) = F(t)$$

$\frac{d^2x}{dt^2}$: acceleration; $\frac{dx}{dt}$: velocity; $F(t)$: external force

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

$$m\frac{dv}{dt} + \eta \cdot v + x = F$$

$$x(t_0) = x_0 \quad \wedge \quad v(t_0) = v_0$$

$$\frac{dv}{dt} = -\frac{\eta}{m}v - \frac{x}{m} + F/m$$

$m = 1$

Discretize : $v \Rightarrow v_i' = v(t_i')$

$x \Rightarrow x_i' = x(t_i')$

$t_i' = t_0 + \Delta t \cdot i' \qquad i' = 0, 1, 2, \ldots n$

$\Delta t = \dfrac{t_n - t_0}{n}$

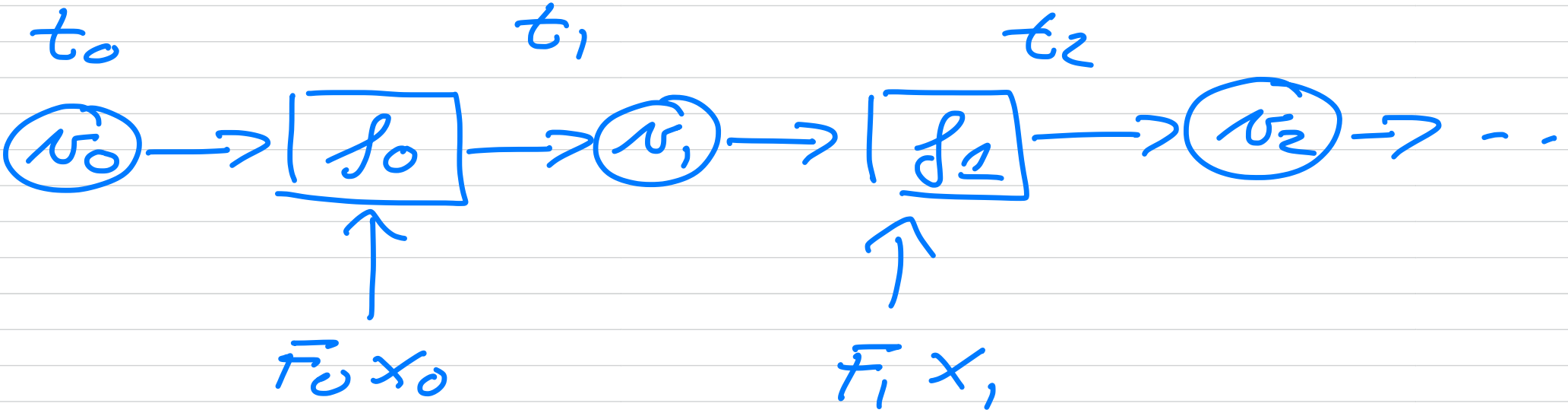
Euler's method

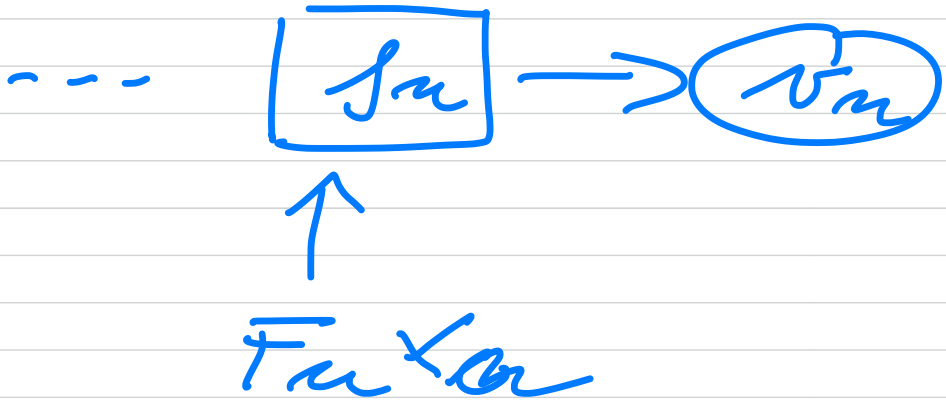
$x_{i'+1} = x_{i'} + \Delta t\, v_{i'}$

$v_{i'+1} = v_{i'} + \Delta t(F_{i'} - \eta v_{i'} - x_{i'})$

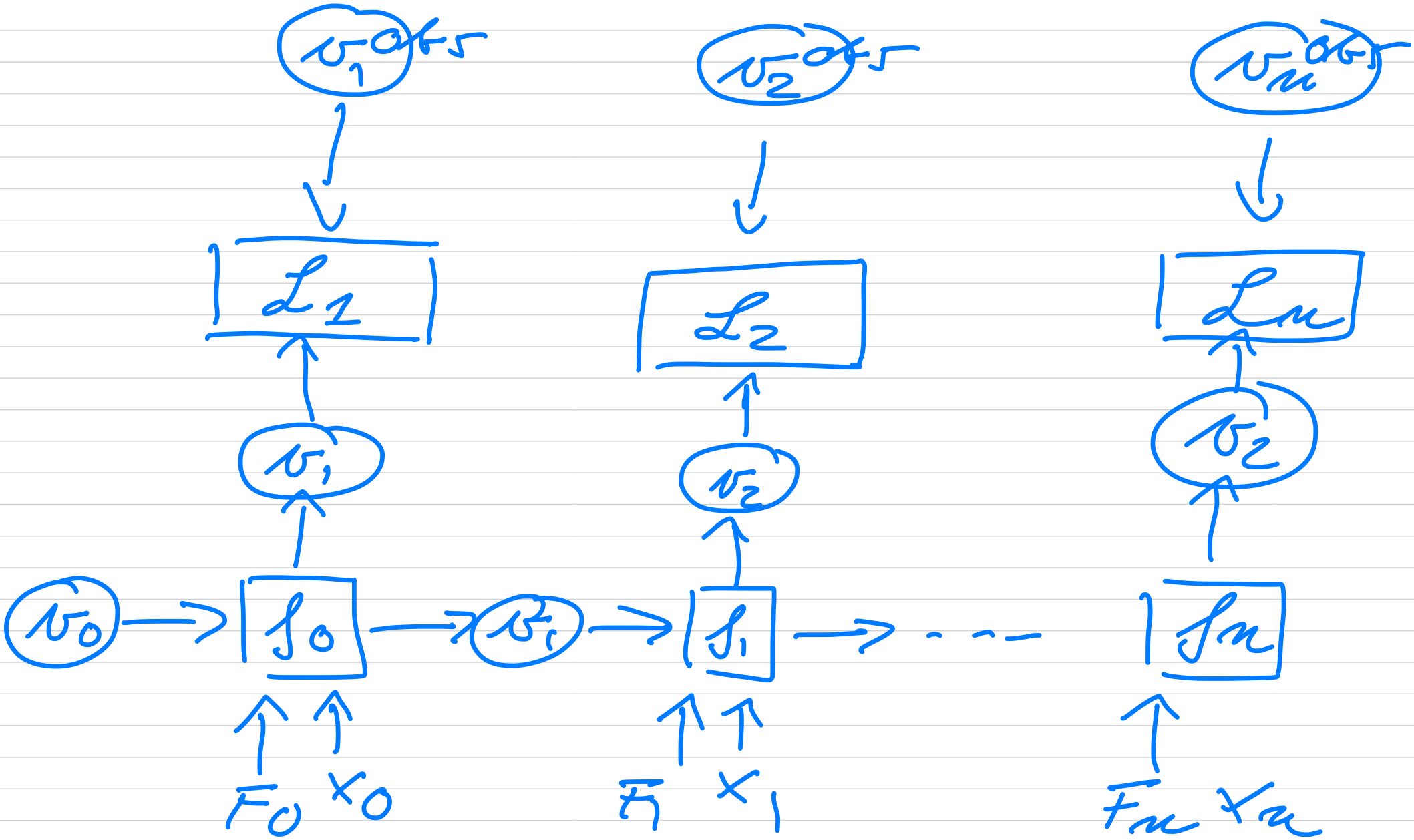
$v_{i'+1} = v_{i'} + f(v_{i'}, x_{i'}, \Delta t, F_{i'})$

Graphical representation





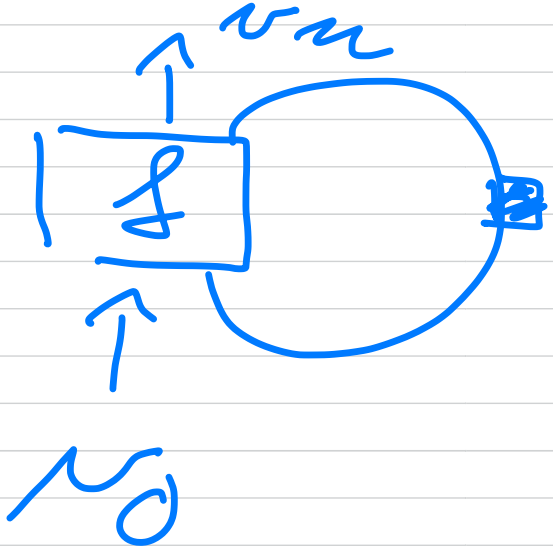
Can modify


v_1 obj
v_2 obj
v_n obj
$\mathcal{L}_1$
$\mathcal{L}_2$
$\mathcal{L}_n$
v_1
v_2
v_2
v_0
f_0
v_1
f_1
f_n
F_0
x_0
F_1
x_1
F_n
x_n

$$\mathcal{L}(\theta) = \sum_{i=1}^{n} \mathcal{L}_i(\theta)$$

$$\hat{\theta} = \operatorname{argmin}_{\theta \in \mathbb{R}^p} \mathcal{L}(\theta)$$

more compact rep



different operations