

Generative model

$$\begin{aligned}
F &= p(s|\mu_x)p(\mu'_x|\mu_x,\nu) \\
s &= \mu_{x_3} + \omega_s \\
\dot{\mathbf{x}} &= \begin{bmatrix} \phi\mu_{x_2} \\ -\mu_{x_1} \\ \mu_\nu\mu_{x_1} - \mu_{x_3} \end{bmatrix} + \boldsymbol{\omega}_x \\
\nu &= \mu_\nu + \omega_\nu
\end{aligned}$$

Gradients

$$\begin{aligned}
-\frac{\partial F}{\partial \begin{bmatrix} \mu_{x_1} \\ \mu_{x_2} \\ \mu_{x_3} \end{bmatrix}} &= \begin{bmatrix} -\frac{\mu_\nu(\mu_\nu\mu_{x_1}-\mu_{x_3}-d\mu_{x_3})+\mu_{x_1}+d\mu_{x_2}}{\phi(\phi\mu_{x_2}+d\mu_{x_1})} \\ \frac{s-\mu_{x_3}}{\sigma_s^2} - \frac{d\mu_{x_3}-(\mu_\nu\mu_{x_1}+\mu_{x_3})}{\sigma_x} \end{bmatrix} \\
-\frac{\partial F}{\partial \begin{bmatrix} d\mu_{x_1} \\ d\mu_{x_2} \\ d\mu_{x_3} \end{bmatrix}} &= \begin{bmatrix} -\frac{d\mu_{x_1}-\phi\mu_{x_2}}{\mu_{x_1}+d\mu_{x_2}} \\ \frac{\sigma_x}{d\mu_{x_3}-(\mu_\nu\mu_{x_1}-\mu_{x_3})} \end{bmatrix} \\
-\frac{\partial F}{\partial a} &= -\frac{(-\mu_{x_3}+s(a))\frac{d}{da}s(a)}{\sigma_s^2}
\end{aligned}$$

Updates

$$\dot{\boldsymbol{\mu}} = d\boldsymbol{\mu} - \frac{\partial F}{\partial \begin{bmatrix} \mu_{x_1} \\ \mu_{x_2} \\ \mu_{x_3} \end{bmatrix}} \quad d\dot{\boldsymbol{\mu}} = -\frac{\partial F}{\partial \begin{bmatrix} d\mu_{x_1} \\ d\mu_{x_2} \\ d\mu_{x_3} \end{bmatrix}} \quad \dot{a} = -\frac{\partial F}{\partial a} \quad \dot{\boldsymbol{\mu}}_\nu = \dot{a}$$