

$$T_{\text{em}}(n_{\text{iter}}) = n_{\text{iter}} (\text{inference (eStep)} + \text{Learning (mStep)} + \text{ini} + \text{oll back}) + \text{inference (eStep, re)}$$

$$\rightarrow \text{ini} \sim n_{\text{Trials}} + \text{op} = \text{on array} \Rightarrow O(n_{\text{Trials}})$$

$$\rightarrow \text{oll back} \sim O(1)$$

$$\rightarrow \text{inference (eStep iter)} \sim \text{see Gauss Markov Lagrange} (\text{xdim}, \text{kernel}, \text{learn rate}, \text{dstep})$$

$$\text{inference} = \text{ini} + n_{\text{Trials}} \times \text{eStep iter} (\text{run single inference})$$

$$\hookrightarrow \text{ini} \sim O(n_{\text{Trials}})$$

\hookrightarrow run single inference

$$\hookrightarrow \text{solve Forward: Forward Euler } O(\text{Total time} / \text{time step})$$

$$\hookrightarrow \text{expected grad: Compute gradient} \rightarrow \text{op on matrix (trial, neuron, spike)}$$

$$\hookrightarrow \text{solve Backward: op on matrix} + \text{Forward Euler } O(\text{Total time} / \text{time step})$$

on Rank

$$\Rightarrow \text{inference} \sim O(n_{\text{Trials}} \times \text{eStep iter} \times \left(\frac{\text{Total time}}{\text{Time step}} \right) \times (\# \text{ Trial} \times \text{Neuron} \times \text{Spike})^k)$$

with k probably ≥ 2 or 3 as some matrix multiplication \nearrow exact k, l and if diff for them need to look in more details

\rightarrow learning \sim see point Process GPSDE model

$$\text{learning} = n_{\text{Trials}} + \text{closed form update} + \text{train model} + \text{refresh}$$

\hookrightarrow no closed form update in our case

\hookrightarrow refresh \rightarrow only seems to recompute the kernel

\hookrightarrow Train model \rightarrow Torch. LBFGS with max iter M iteration

\hookrightarrow say that seems faster than Adams

but if M iter too big \rightarrow instabilities

R_i : # roots

D_i : # Neurons

N_{spike} : # spike

T_i : Time

k : $\frac{k_{max}}{dt}$?

for range niter:

→ inference

for range eStepiter

↳ Forward Euler

↳ Expected gradient

↳ Backward

↳ Kullback div

↳ 1

↳ 2

↳ 3

↳ 4

↳ Forward Euler

→ Learning

↳ Compute kernel refresh

↳ torch.LBFGG (maxiter: onStepiter)