# Notations (common)

Each row is the recording for neuron , , Denote the cluster index for neuron as . The number of neurons in cluster is , and .

# Model

The recording for neuron in cluster at time is , . All observations in cluster , , where . Denote the latent vector in cluster as . For simplicity, assume all .

Where and .

and only depend on neuron itself, and they will not change with cluster assignment.

The latent states evolve linearly with Gaussian noise

Further, define

and . The row block of is . Then, .

The parameters need to estimate:

1. Latent vectors:
2. Linear mapping for latent vectors:
3. Initials for latent vectors:
4. Linear dynamics for latent vectors:
5. Process noise:

Since the progress noise is independent in the model, , where is the Poisson density and is the parameters in cluster .

Denote , and .

# Conditional Priors

1. Latent vectors : the conditional prior is defined by
2. Linear mapping for latent vectors :

Where and

1. Initials for latent vectors :

Where and

Where and

(To make the mean of loosely centered around

1. Linear dynamics for latent vectors :

(If the number of cluster is )

Where and

1. Process noise :

Where and .

(To make the mean of loosely centered around )

# MCMC iteration

To help with writing (also for coding), write all the things cluster-weise.

1. Update and initials :

use local Normal approximation at prior, i.e. update by adaptive smoothing.

Notice: adaptive filtering is not the “exact Laplace approximation”. In Laplace approximation, we are evaluating at the mode/ maximum of posterior, but in adaptive filtering, it is evaluated at the prior… In the future, we may need replace adaptive smoothing with exact Laplace approximation.

1. Update (or equivalently ):

Notice , then the problem is reduced to Bayesian Poisson regression. Denote and .

Here, to get an efficient update, I use the Laplace approximation:

Where is Poisson log-likelihood.

Use Newton-Raphson to find and

1. Update (or equivalently ):

Again, notice , then the problem is reduced to Bayesian linear regression. Denote , and . Then

By conjugacy:

1. Update :

Let

By conjugacy,