# 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

(prefer to let )

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:

form the blocks of the full dynamic matrix . To reduce the number of parameters, assume blocks are independent to each other, and update it block by block.

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

Denote and

Assume , , , are all independent to each other. To give a clear writing, update them separately.

# Conditional Priors

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

Where and

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 :

Where and

Where and

1. Process noise :

Where and .

(To make the mean of loosely centered around )

# MCMC iteration

1. Update : 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/ max point, but in adaptive filtering, it is evaluated at the prior…

In the future, may need replace adaptive smoothing with exact Laplace approximation.

1. Update :

Denote row of and as and , the observation for neuron in cluster as , with

The log-likelihood is

Use Laplace approximation:

Use Newton-Raphson to find and

1. Update (or equivalently ):

Notice , then the problem is reduced to update for a vector.

Denote

Still use the Laplace approximation: .

Use Newton-Raphson to find and

1. Update :

By conjugacy,

1. Update :

By conjugacy,

When assuming (for clusters):

1. Update (or equivalently ):

Let and . Further, let and .

The problem is reduced to regular Bayesian linear regression:

1. Update

Again, let . Then,

By conjugacy,

Where

1. Update :

Let

By conjugacy,