

Alignment of Time Course Microarray Data with Hidden Markov Models

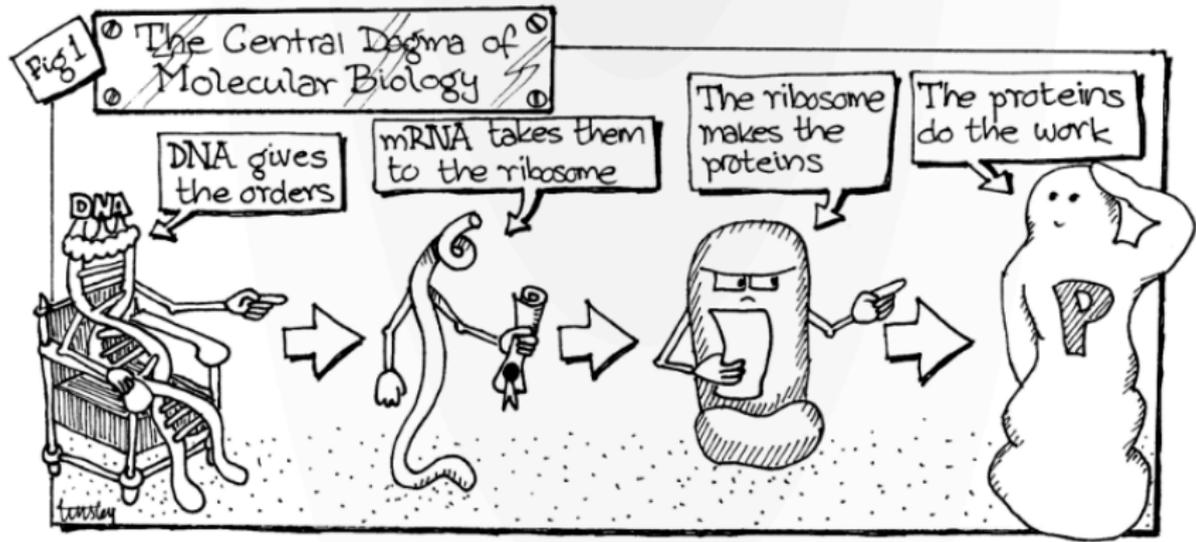
Sean Robinson

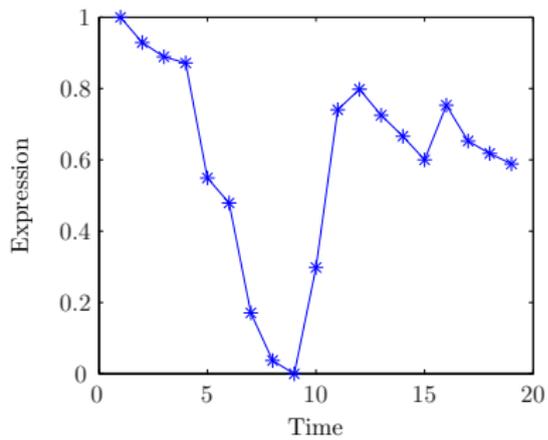
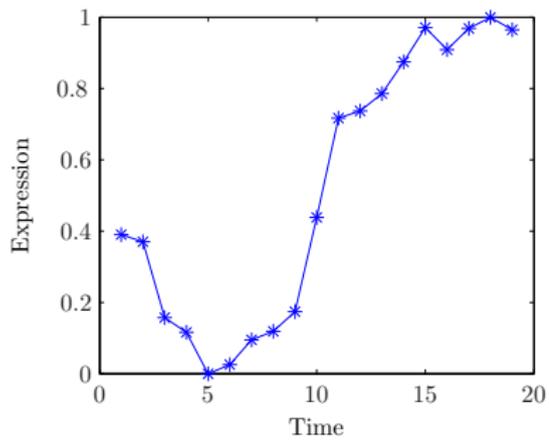
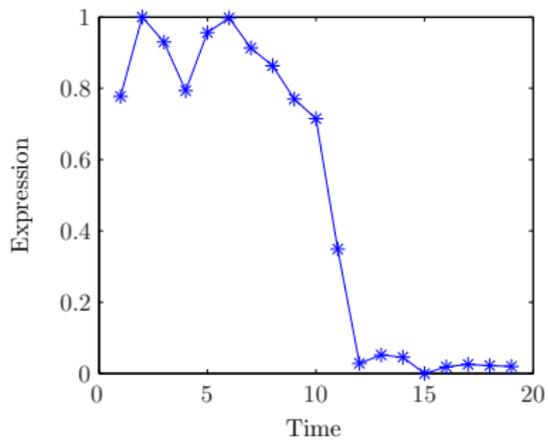
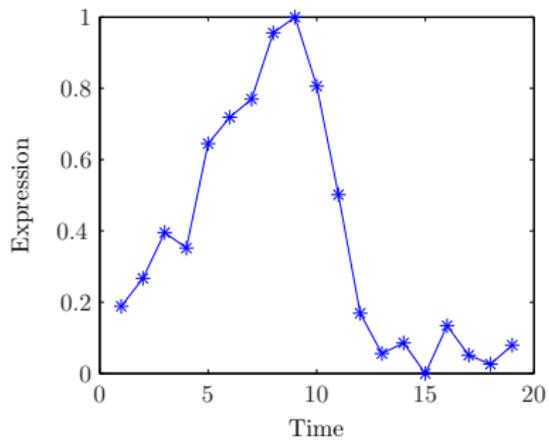
Supervisors: A/Prof Gary Glonek and A/Prof Inge Koch,
the University of Adelaide

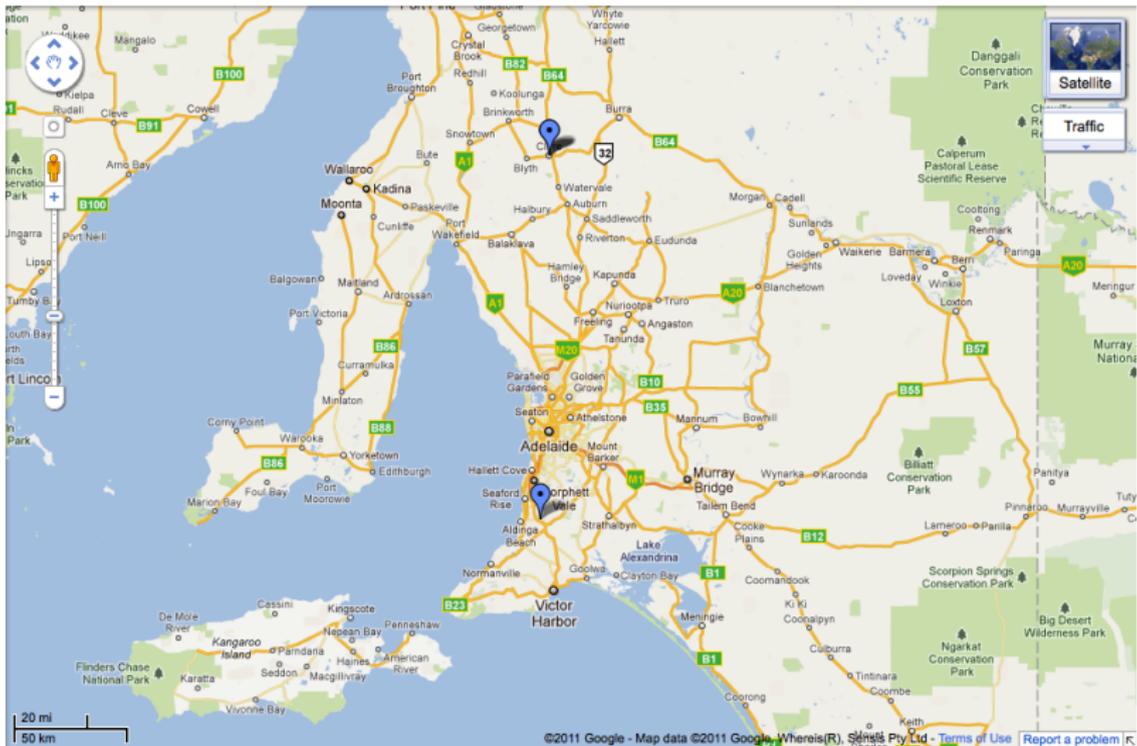
July 10, 2013

Gene expression

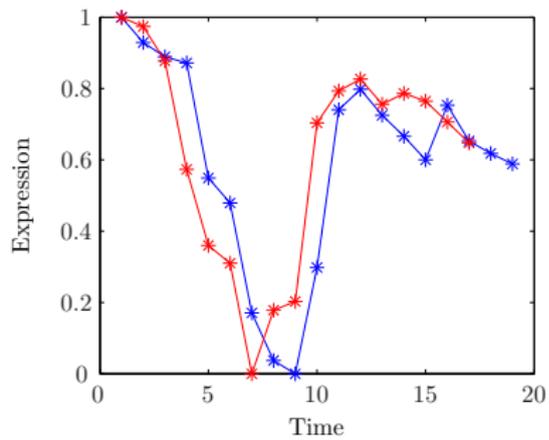
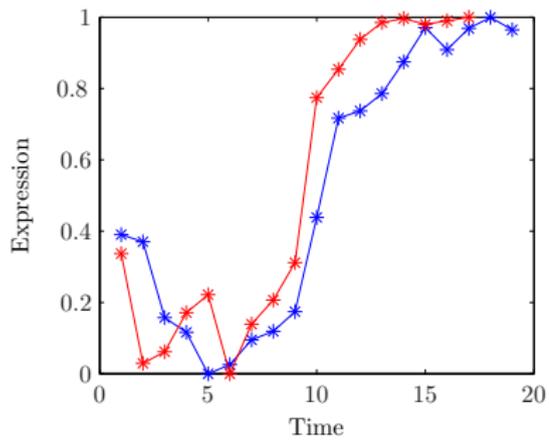
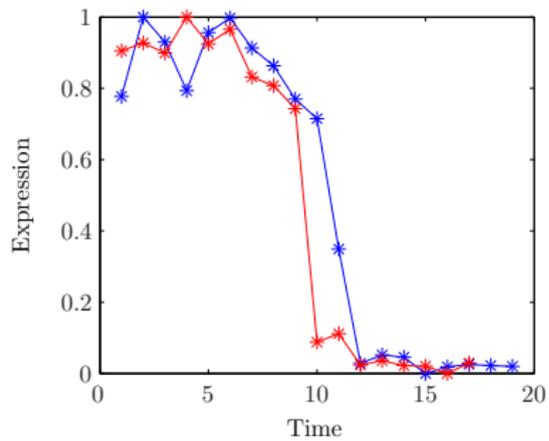
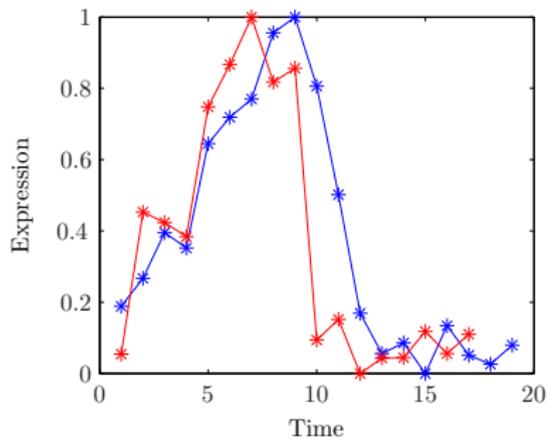
Gene expression { DNA is transcribed into mRNA
mRNA is translated into protein







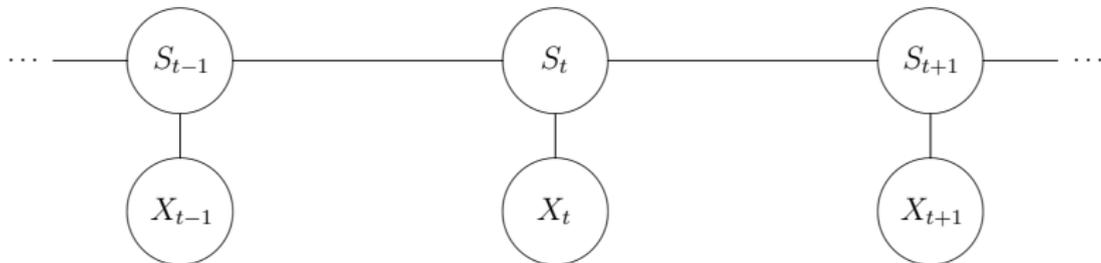
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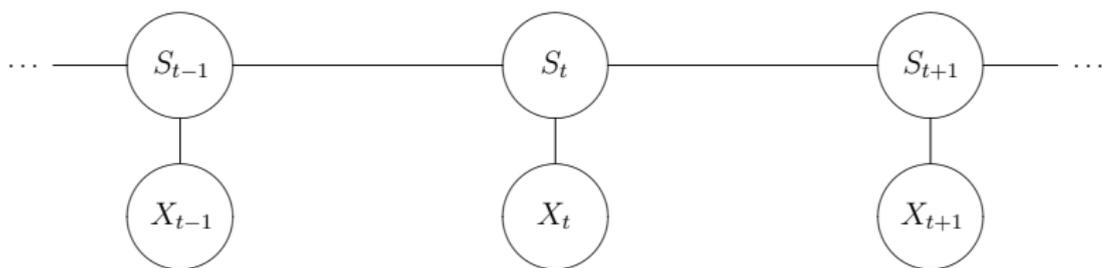
Hidden Markov model

A hidden Markov model (HMM) is a collection of RVs that form:

- 1 A Markov chain, S_1, S_2, \dots - 'state sequence'
- 2 An additional sequence, X_1, X_2, \dots - 'emission sequence'



Hidden Markov model



$$p(x_{1:T}, s_{1:T} | \lambda) = a_{s_1} \prod_{t=2}^T a_{s_{t-1}s_t} \left(\prod_{t=1}^T f(x_t | \mu_{s_t}, \sigma_{s_t}^2) \right)$$

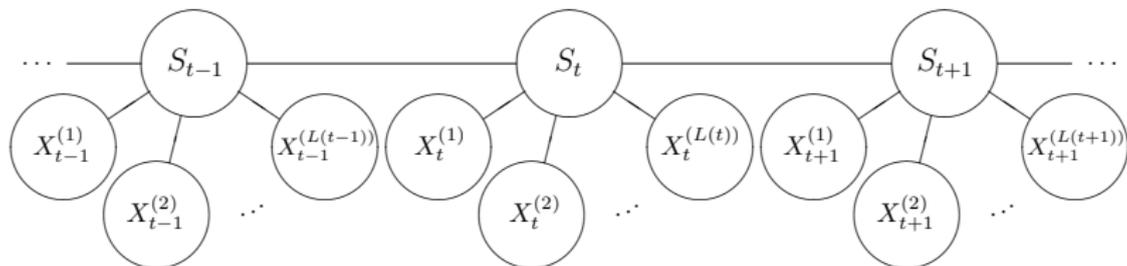
where

$$\lambda = \{a, A, \mu_1, \sigma_1^2, \mu_2, \sigma_2^2, \dots, \mu_N, \sigma_N^2\}.$$

HMM framework

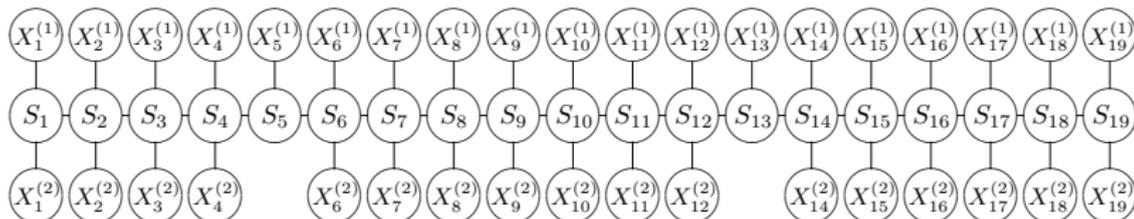
Model	Data
emission sequence	expression profile
state sequence	underlying behaviour of gene

$L(t)$ -fold HMM



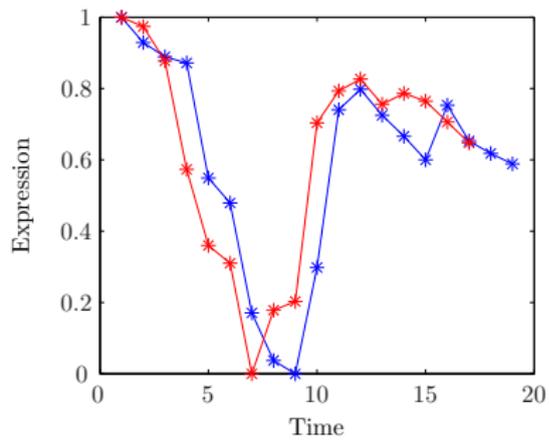
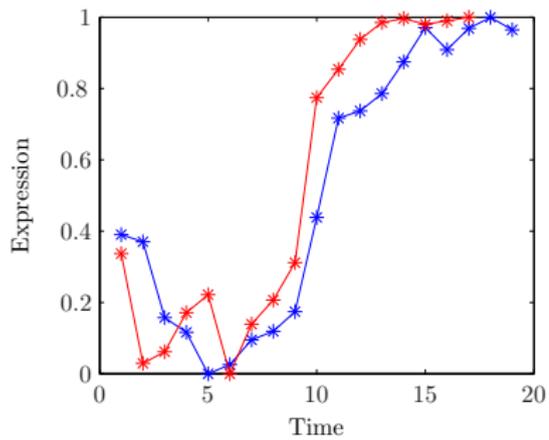
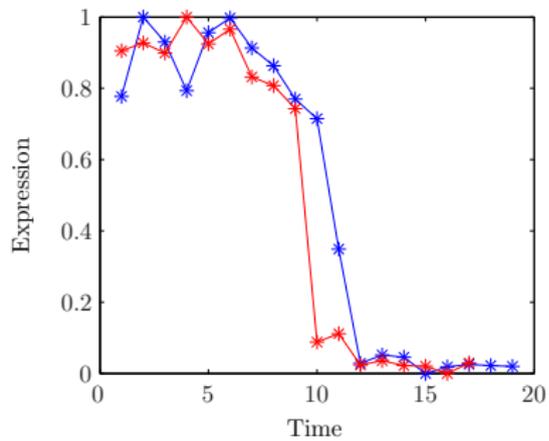
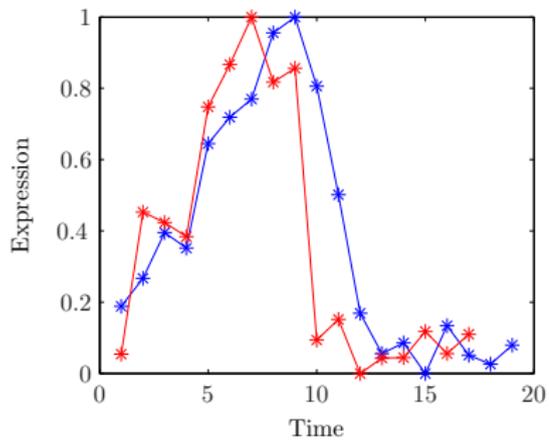
$$p(\mathbf{x}_{1:T}, s_{1:T} | \lambda) = a_{s_1} \prod_{t=2}^T a_{s_{t-1}s_t} \left(\prod_{t=1}^T \prod_{l=1}^{L(t)} f(x_t^{(l)} | \mu_{s_t}, \sigma_{s_t}^2) \right).$$

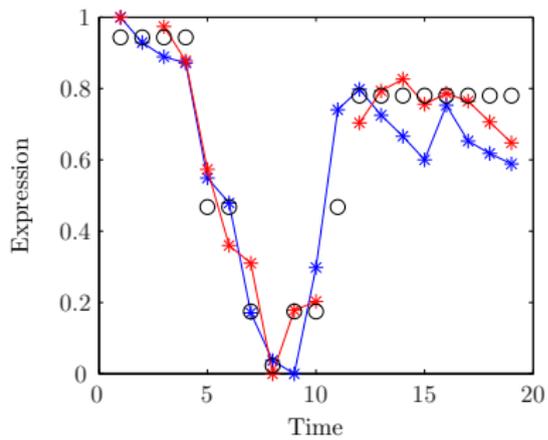
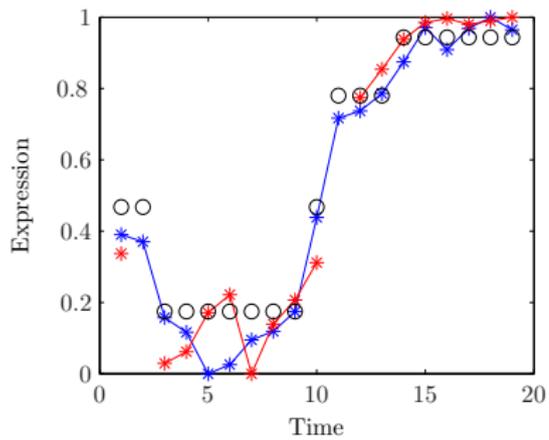
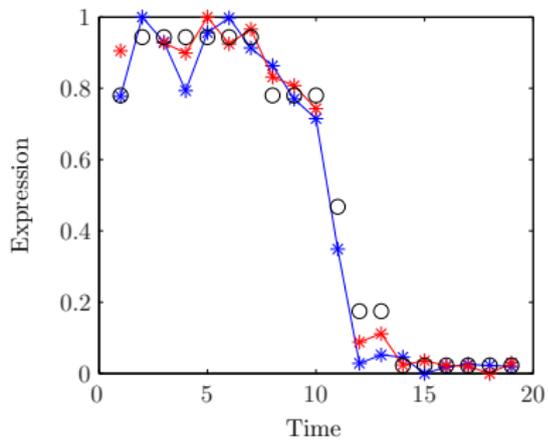
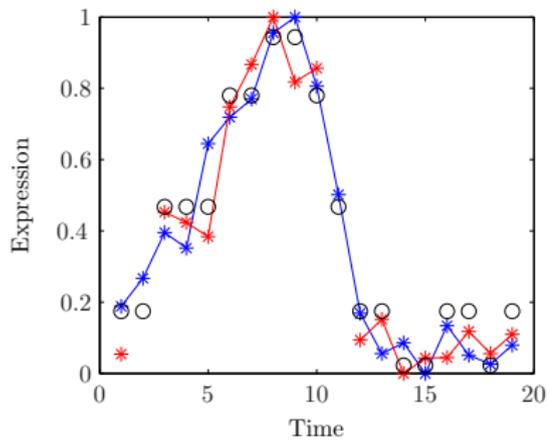
Alignment model



$$L(t) = \begin{cases} 1 & \text{if } t = G_1 \text{ or } G_2 \\ 2 & \text{otherwise.} \end{cases}$$

$$1 < G_1 < G_2 \leq 19$$



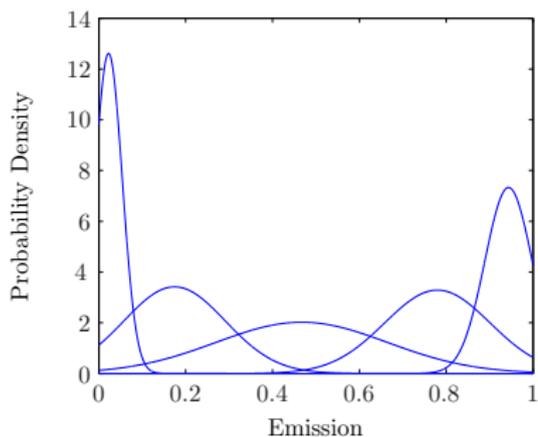


Parameter estimates

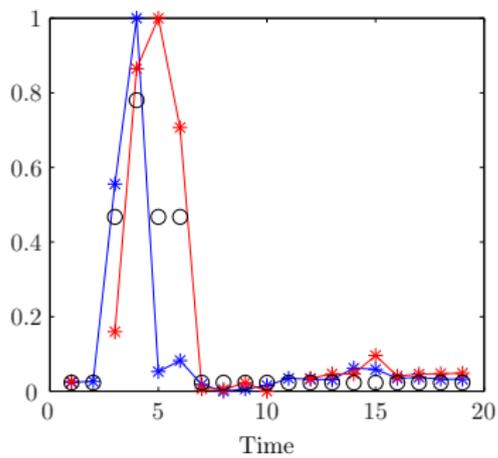
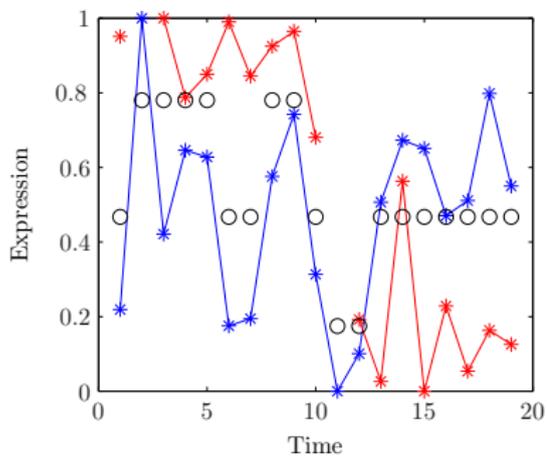
$$N = 5$$

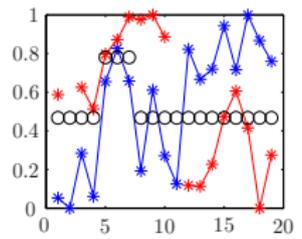
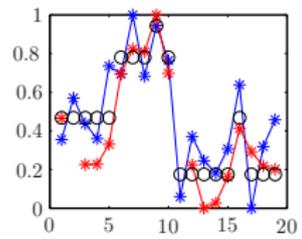
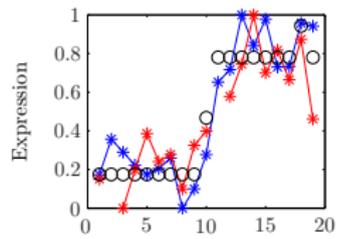
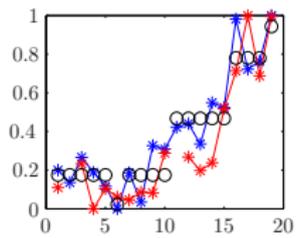
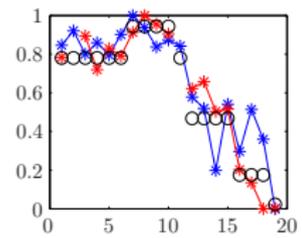
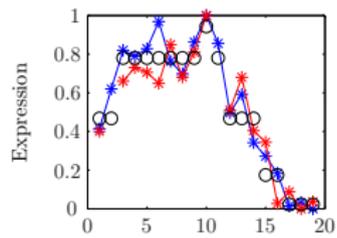
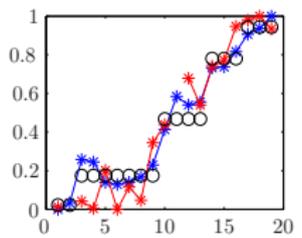
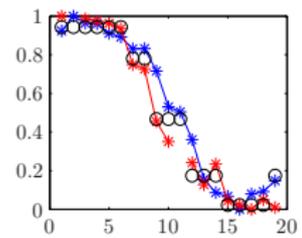
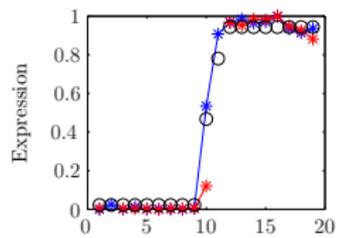
$$\hat{G}_1 = 2, \hat{G}_2 = 11$$

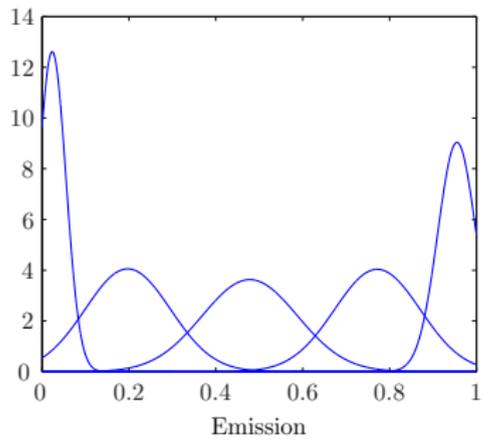
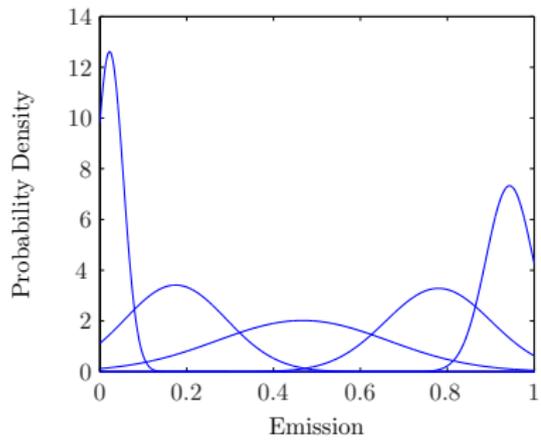
Markov chain parameters: \hat{a}, \hat{A}

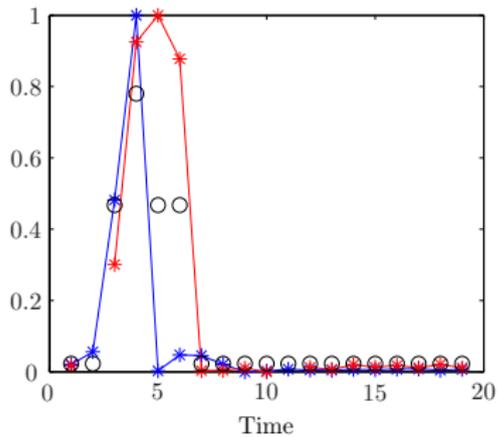
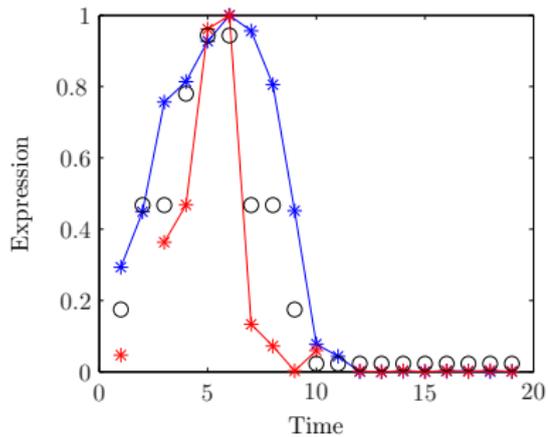
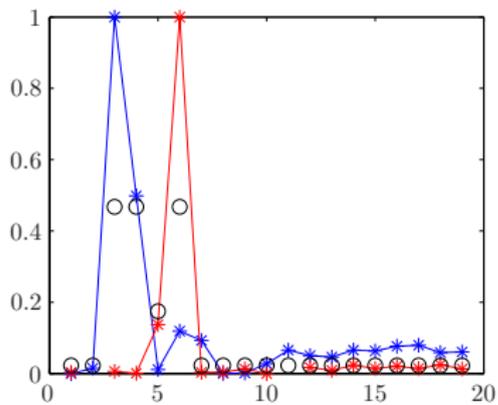
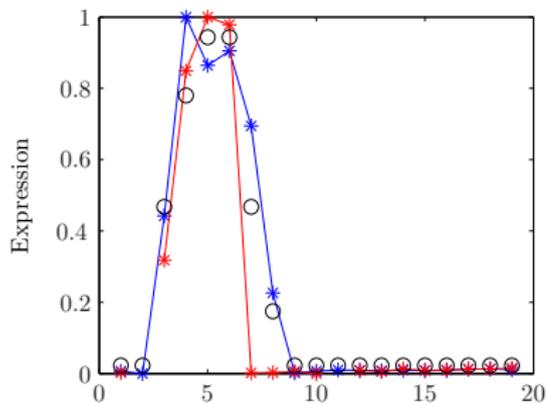


Diagnostics









Bibliography

HMMs in general

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HMMs in MATLAB

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