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# Appendix for "Modeling multiple event streams with latent semi-Markov processes"

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## 1. Graphical model

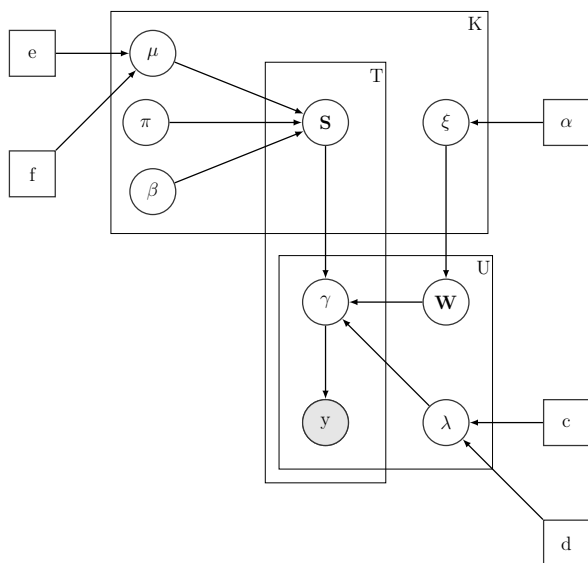


Figure 1. The graphical representation of the proposed model

## 2. Generative process for bsMJP

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**Algorithm 1** Generative process for a K-dimensional bsMJP path in  $[0, T]$

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**Input:** Hazard function of each state and each latent feature  $h_{0k}(\cdot), h_{1k}(\cdot), k = 1, \dots, K$ , constant hazard rates  $\Omega_{0k}, \Omega_{1k}$ , and initial state distribution  $\pi_0$ .

**Output:** A K-dimensional sMJP path  $\{\phi_k, \mathbf{s}_k(\phi_k)\}$

- 1: **while**  $k \in \{1, 2, \dots, K\}$  **do**
  - 2: Initialize  $l_0 = 0, i = 0, \tilde{\phi}_{k,0} = 0, \phi_k = \{\tilde{\phi}_{k,0}\}, \tilde{\mathbf{s}}_k(\tilde{\phi}_{k,0}) \sim \pi_0$ ,
  - 3: **while**  $\tilde{\phi}_{k,i} < T$  **do**
  - 4: increment  $i$
  - 5: Sample  $\Delta_i \sim H_{\tilde{\mathbf{s}}_k(\tilde{\phi}_{k,i-1}),k}(\cdot)$ . Set  $\tilde{\phi}_{k,i} = \tilde{\phi}_{k,i-1} + \Delta_i$ .
  - 6: Draw  $\delta \sim \text{Unif}(0, 1)$
  - 7: **if**  $\delta < \frac{h_{\tilde{\mathbf{s}}_k(\tilde{\phi}_{k,i-1}),k}(l_{i-1} + \Delta_i)}{h_{\tilde{\mathbf{s}}_k(\tilde{\phi}_{k,i-1}),k}(l_{i-1} + \Delta_i) + \Omega_{\tilde{\mathbf{s}}_k(\tilde{\phi}_{k,i-1}),k}}$  **then**
  - 8: Set  $l_i = 0, \tilde{\mathbf{s}}_k(\tilde{\phi}_{k,i}) = 1 - \tilde{\mathbf{s}}_k(\tilde{\phi}_{k,i-1}), \phi_k = \phi_k \cup \{\tilde{\phi}_{k,i}\}$
  - 9: **else**
  - 10: Set  $l_i = l_{i-1} + \Delta_i, \tilde{\mathbf{s}}_k(\tilde{\phi}_{k,i}) = \tilde{\mathbf{s}}_k(\tilde{\phi}_{k,i-1})$
  - 11: **end if**
  - 12: **end while**
  - 13:  $\phi_k = \phi_k \cup \{T\}, \{\phi_k, \mathbf{s}_k = \tilde{\mathbf{s}}_k(t), t \in \phi_k\}$  is a generated bsMJP path.
  - 14: **end while**
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