

1: **Variational parameter initializations** {initial value, constraint}:

$g_{\text{mean}} \leftarrow \{5, \mathbb{R}_{>0}\}; g_{\text{beta}} \leftarrow \{100, \mathbb{R}_{>0}\}$   
 $\sigma_{\text{mean}}^{xy} \leftarrow \{0, (0, (P+1)/\sqrt{12})\}; \sigma_{\text{beta}}^{xy} \leftarrow \{100, \mathbb{R}_{>2}\}$   
 $\pi_{\text{mean}} \leftarrow \{0.5, [0, 1]\}; \pi_{\text{size}} \leftarrow \{2, \mathbb{R}_{>2}\}$   
 $\lambda_{\text{mean}} \leftarrow \{0.5, \mathbb{R}_{>0}\}; \lambda_{\text{beta}} \leftarrow \{100, \mathbb{R}_{>0}\}$   
 $\mu_{\text{mean}}^b \leftarrow \{\text{mean}(D)^{\text{AOI}[N]}, \mathbb{R}_{>0}\}; \sigma_{\text{mean}}^b \leftarrow \{1^{\text{AOI}[N]}, \mathbb{R}_{>0}\}$   
 $b_{\text{mean}} \leftarrow \{\text{mean}(D)^{\text{AOI}[N] \times \text{frame}[F]}, \mathbb{R}_{>0}\}$   
 $b_{\text{beta}} \leftarrow \{1^{\text{AOI}[N] \times \text{frame}[F]}, \mathbb{R}_{>0}\}$   
 $m_{\text{prob}} \leftarrow \{0.5^{\text{spot}[K] \times \text{AOI}[N] \times \text{frame}[F]}, [0, 1]\}$   
 $h_{\text{mean}} \leftarrow \{2000^{\text{spot}[K] \times \text{AOI}[N] \times \text{frame}[F]}, \mathbb{R}_{>0}\}$   
 $h_{\text{beta}} \leftarrow \{0.001^{\text{spot}[K] \times \text{AOI}[N] \times \text{frame}[F]}, \mathbb{R}_{>0}\}$   
 $w_{\text{mean}} \leftarrow \{1.5^{\text{spot}[K] \times \text{AOI}[N] \times \text{frame}[F]}, [0.75, 2.25]\}$   
 $w_{\text{size}} \leftarrow \{100^{\text{spot}[K] \times \text{AOI}[N] \times \text{frame}[F]}, \mathbb{R}_{>2}\}$   
 $x_{\text{mean}} \leftarrow \{0^{\text{spot}[K] \times \text{AOI}[N] \times \text{frame}[F]}, [-(P+1)/2, (P+1)/2]\}$   
 $y_{\text{mean}} \leftarrow \{0^{\text{spot}[K] \times \text{AOI}[N] \times \text{frame}[F]}, [-(P+1)/2, (P+1)/2]\}$   
 $x_{\text{size}}^{y_{\text{size}}} \leftarrow \{200^{\text{spot}[K] \times \text{AOI}[N] \times \text{frame}[F]}, \mathbb{R}_{>2}\}$

2:  $g \sim \mathbf{Gamma}(g_{\text{mean}}, \sqrt{g_{\text{mean}}/g_{\text{beta}}})$  ▷ camera gain  
3:  $\sigma^{xy} \sim \mathbf{AffineBeta}(\sigma_{\text{mean}}^{xy}, \sigma_{\text{size}}^{xy}, 0, (P+1)/\sqrt{12})$  ▷ std of on-target spot position (pixels)  
4:  $\pi \sim \mathbf{Beta}(\pi_{\text{mean}}, \pi_{\text{size}})$  ▷ average specific binding probability  
5:  $\lambda \sim \mathbf{Gamma}(\lambda_{\text{mean}}, \sqrt{\lambda_{\text{mean}}/\lambda_{\text{beta}}})$  ▷ non-specific binding density  
6: **for all** AOI[ $N + N_c$ ] **do**  
7:      $\mu^b \sim \mathbf{Delta}(\mu_{\text{mean}}^b)$  ▷ mean background intensity  
8:      $\sigma^b \sim \mathbf{Delta}(\sigma_{\text{mean}}^b)$  ▷ std of background intensity  
9:     **for all** frame[ $F$ ] **do**  
10:          $b \sim \mathbf{Gamma}(b_{\text{mean}}, \sqrt{b_{\text{mean}}/b_{\text{beta}}})$  ▷ background intensity  
11:         **for all** spot[ $K$ ] **do**  
12:              $m \sim \mathbf{Bernoulli}(m_{\text{prob}})$  ▷ spot presence  
13:             **if**  $m = 1$  **then**  
14:                  $h \sim \mathbf{Gamma}(h_{\text{mean}}, \sqrt{h_{\text{mean}}/h_{\text{beta}}})$  ▷ spot intensity  
15:                  $w \sim \mathbf{AffineBeta}(w_{\text{mean}}, w_{\text{size}}, 0.75, 2.25)$  ▷ spot width  
16:                  $x \sim \mathbf{AffineBeta}(x_{\text{mean}}, x_{\text{size}}, -(P+1)/2, (P+1)/2)$  ▷ x-axis center  
17:                  $y \sim \mathbf{AffineBeta}(y_{\text{mean}}, y_{\text{size}}, -(P+1)/2, (P+1)/2)$  ▷ y-axis center  
18:             **else if**  $m = 0$  **then**  
19:                  $h \sim \mathbf{HalfNormal}(10000)$   
20:                  $w \sim \mathbf{Uniform}(0.75, 2.25)$   
21:                  $x \sim \mathbf{Uniform}(-(P+1)/2, (P+1)/2)$   
22:                  $y \sim \mathbf{Uniform}(-(P+1)/2, (P+1)/2)$