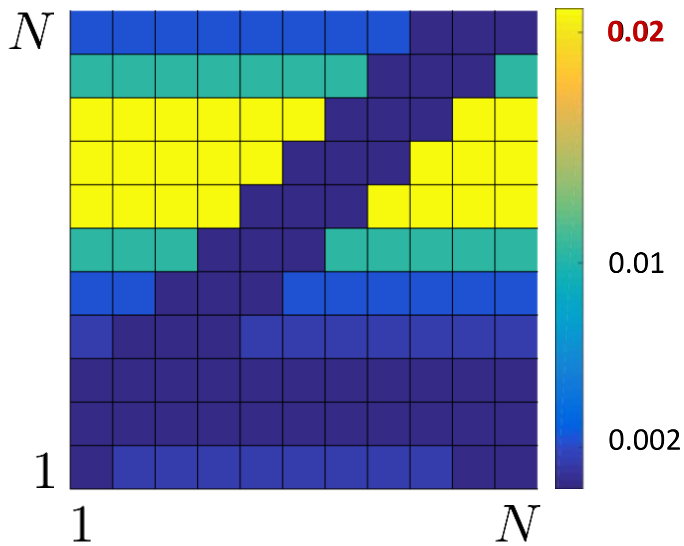
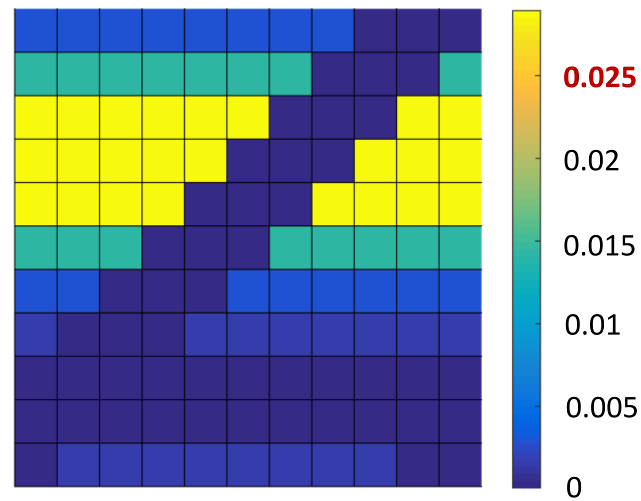
MLMF evidence

$$P(A_t, O | Y_{0:t}, u_{1:t}; \boldsymbol{\theta}_o^*, \boldsymbol{\theta}_a^*, \boldsymbol{\Psi}_{\mathbf{0:t}}, \boldsymbol{\alpha}_{\mathbf{0:t}}) = \frac{P(A_t, O, Y_{0:t} | u_{1:t}; \boldsymbol{\theta}_o^*, \boldsymbol{\theta}_a^*, \boldsymbol{\Psi}_{\mathbf{0:t}})}{P(Y_{0:t} | u_{1:t}; \boldsymbol{\alpha}_{\mathbf{0:t}})}$$

$P(A_2, O, Y_{0:2} | u_{1:2})$ $\propto$ $P(A_2, O | Y_{0:2}, u_{1:2}; \boldsymbol{\theta})$ **Histogram**

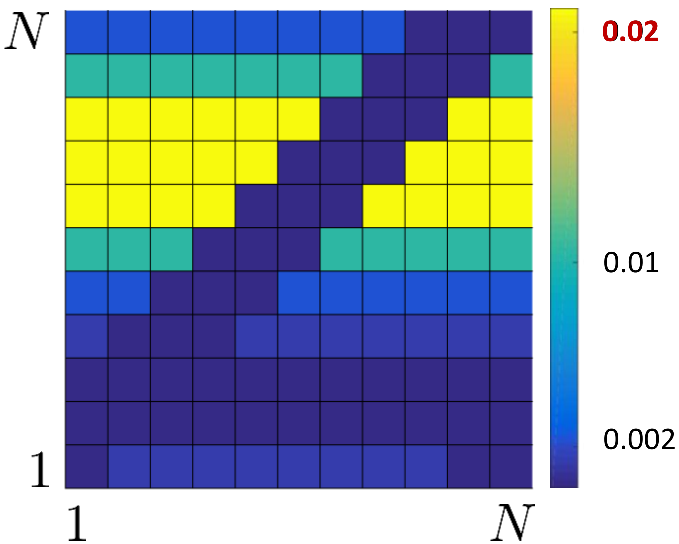


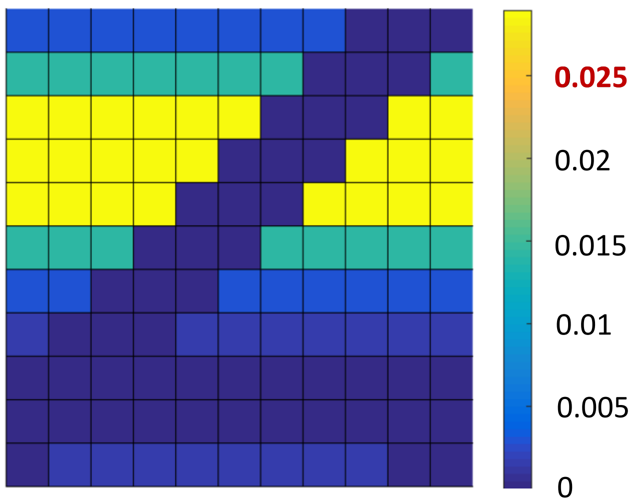


MLMF evidence

$$P(A_t, O | Y_{0:t}, u_{1:t}; \boldsymbol{\theta}_o^*, \boldsymbol{\theta}_a^*, \boldsymbol{\Psi}_{0:t}, \boldsymbol{\alpha}_{0:t}) = \frac{P(A_t, O, Y_{0:t} | u_{1:t}; \boldsymbol{\theta}_o^*, \boldsymbol{\theta}_a^*, \boldsymbol{\Psi}_{0:t})}{P(Y_{0:t} | u_{1:t}; \boldsymbol{\alpha}_{0:t})}$$

$P(A_2, O, Y_{0:2} | u_{1:2})$ $\propto$ $P(A_2, O | Y_{0:2}, u_{1:2}; \boldsymbol{\theta})$ **Histogram**



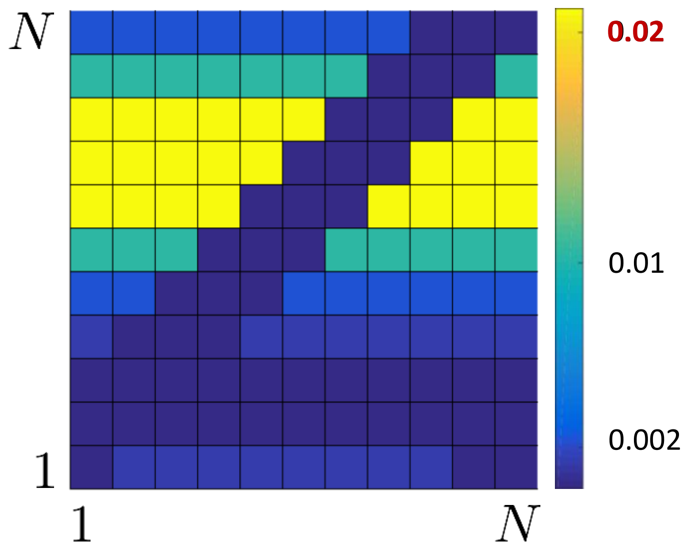


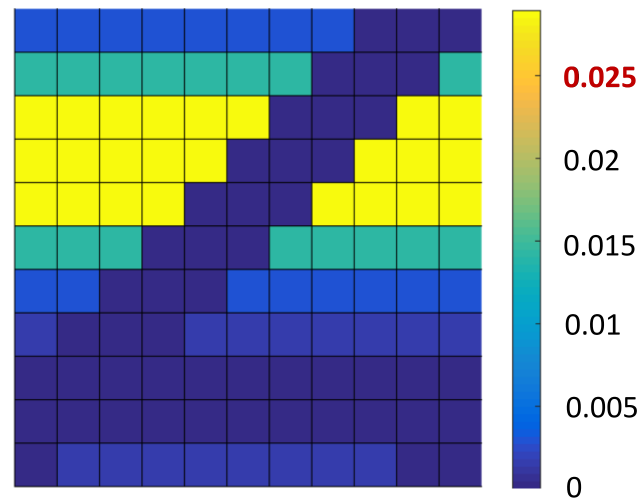
$$P(Y_{0:t} | u_{1:t}) = \sum_{A_t} \sum_{O} P(A_t, O, Y_{0:t} | u_{1:t})$$ ⬅ **cost** N^2

MLMF evidence

$$P(A_t, O | Y_{0:t}, u_{1:t}; \boldsymbol{\theta}_o^*, \boldsymbol{\theta}_a^*, \boldsymbol{\Psi}_{\mathbf{0}:t}, \boldsymbol{\alpha}_{\mathbf{0}:\mathbf{t}}) = \frac{P(A_t, O, Y_{0:t} | u_{1:t}; \boldsymbol{\theta}_o^*, \boldsymbol{\theta}_a^*, \boldsymbol{\Psi}_{\mathbf{0}:t})}{P(Y_{0:t} | u_{1:t}; \boldsymbol{\alpha}_{\mathbf{0}:\mathbf{t}})}$$

$P(A_2, O, Y_{0:2} | u_{1:2})$ $\propto$ $P(A_2, O | Y_{0:2}, u_{1:2}; \boldsymbol{\theta})$ **Histogram**



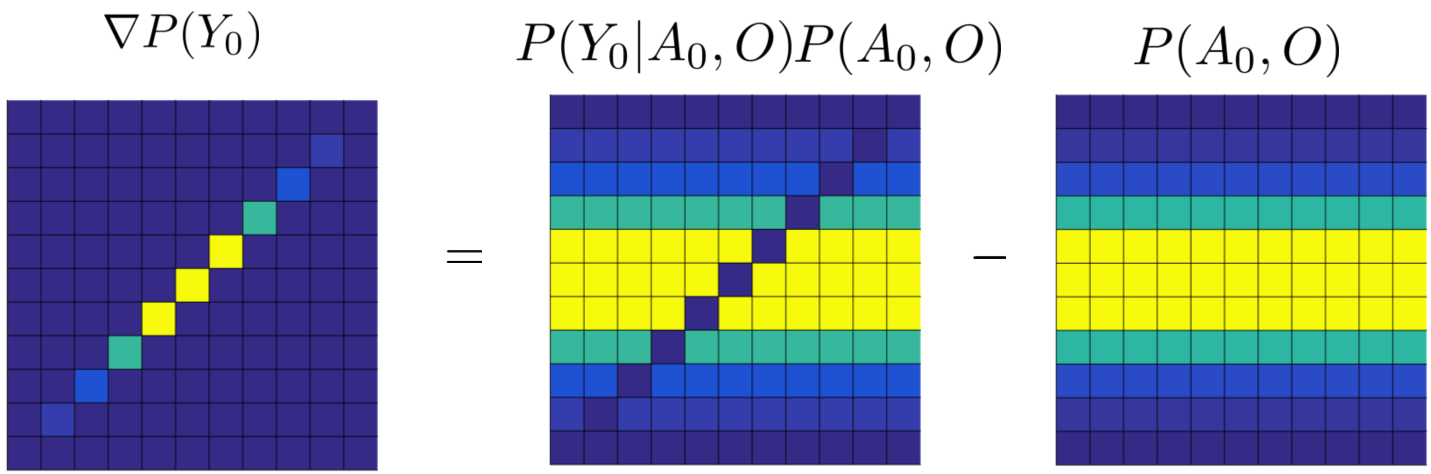


$$P(Y_{0:t} | u_{1:t}) = \sum_{A_t} \sum_{O} P(A_t, O, Y_{0:t} | u_{1:t})$$ ⬅ **cost** N^2

$$\nabla P(Y_{0:t} | u_{1:t}) = P(Y_{0:t} | u_{1:t}) - P(Y_{0:t-1} | u_{1:t})$$

MLMF evidence

$$P(A_t, O|Y_{0:t}, u_{1:t}; \boldsymbol{\theta}_o^*, \boldsymbol{\theta}_a^*, \boldsymbol{\Psi}_{0:t}, \boldsymbol{\alpha}_{0:t}) = \frac{P(A_t, O, Y_{0:t}|u_{1:t}; \boldsymbol{\theta}_o^*, \boldsymbol{\theta}_a^*, \boldsymbol{\Psi}_{0:t})}{P(Y_{0:t}|u_{1:t}; \boldsymbol{\alpha}_{0:t})}$$



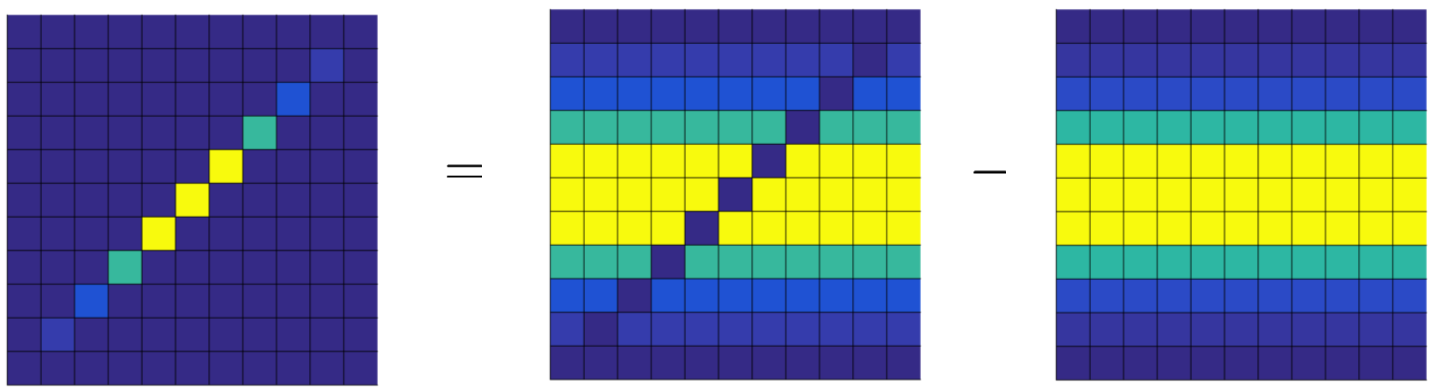
$$P(Y_{0:t}|u_{1:t}) = \sum_{A_t}\sum_{O} P(A_t, O, Y_{0:t}|u_{1:t})$$ ⬅ **cost N^2**

$$\nabla P(Y_{0:t}|u_{1:t}) = P(Y_{0:t}|u_{1:t}) - P(Y_{0:t-1}|u_{1:t})$$

$$\nabla P(Y_0) = \sum_{A_0}\sum_{O} \left(P(Y_0|A_0, O) - 1\right) P(A_0, O)$$

MLMF evidence

$$P(A_t, O | Y_{0:t}, u_{1:t}; \boldsymbol{\theta}_o^*, \boldsymbol{\theta}_a^*, \boldsymbol{\Psi}_{0:t}, \boldsymbol{\alpha}_{0:t}) = \frac{P(A_t, O, Y_{0:t} | u_{1:t}; \boldsymbol{\theta}_o^*, \boldsymbol{\theta}_a^*, \boldsymbol{\Psi}_{0:t})}{P(Y_{0:t} | u_{1:t}; \boldsymbol{\alpha}_{0:t})}$$

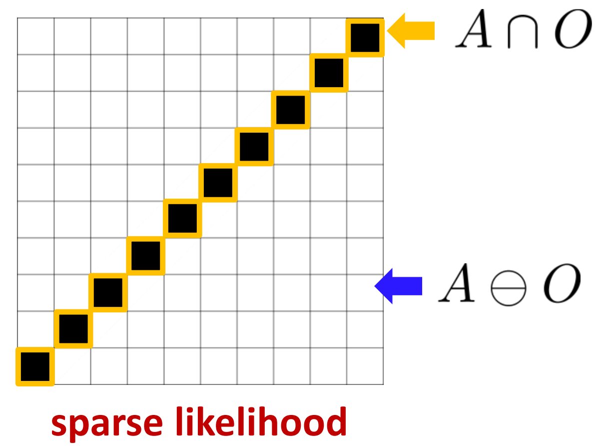


$$P(Y_{0:t}|u_{1:t}) = \sum_{A_t}\sum_{O} P(A_t, O, Y_{0:t}|u_{1:t})$$ ← cost N^2

$$\nabla P(Y_{0:t}|u_{1:t}) = P(Y_{0:t}|u_{1:t}) - P(Y_{0:t-1}|u_{1:t})$$

$$\nabla P(Y_0) = \sum_{A_0}\sum_{O} (P(Y_0|A_0, O) - 1)\, P(A_0, O)$$

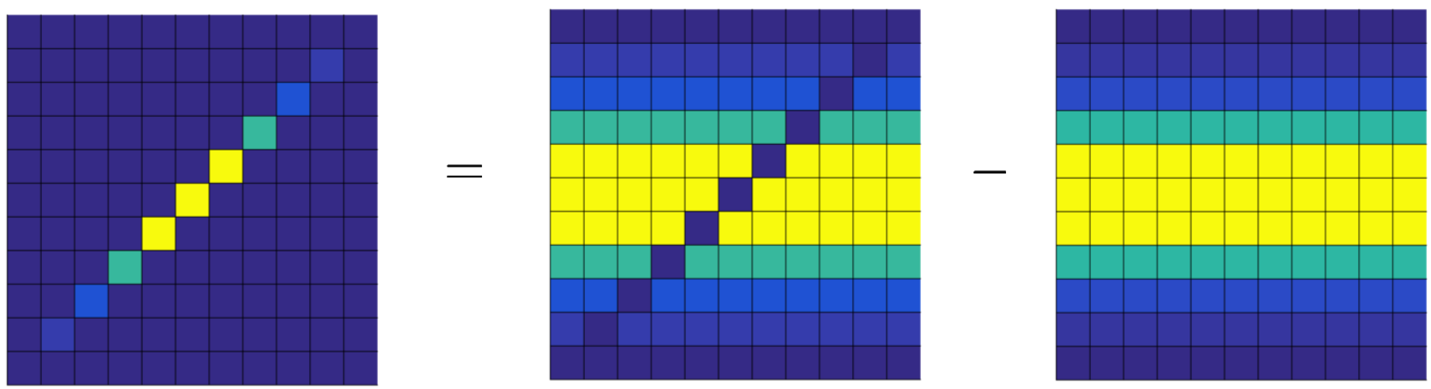
cost N $$= \sum_{A_0}\sum_{O} (P(Y_0|A_0, O) - 1)\, P_{\cap}(A_0, O)$$



MLMF evidence

$$P(A_t, O|Y_{0:t}, u_{1:t}; \boldsymbol{\theta}_o^*, \boldsymbol{\theta}_a^*, \boldsymbol{\Psi}_{0:t}, \boldsymbol{\alpha}_{0:t}) = \frac{P(A_t, O, Y_{0:t}|u_{1:t}; \boldsymbol{\theta}_o^*, \boldsymbol{\theta}_a^*, \boldsymbol{\Psi}_{0:t})}{P(Y_{0:t}|u_{1:t}; \boldsymbol{\alpha}_{0:t})}$$

$\nabla P(Y_0)$ = $P(Y_0|A_0, O)P(A_0, O)$ − $P(A_0, O)$



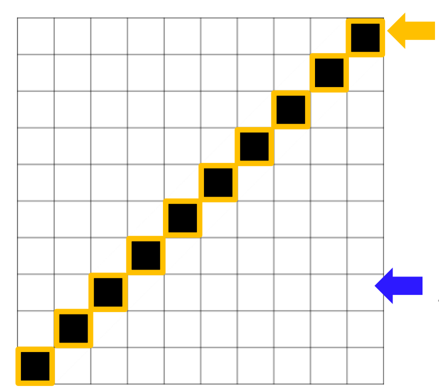
$$P(Y_{0:t}|u_{1:t}; \boldsymbol{\alpha}_{0:t}) = 1 + \sum_{i=0}^{t} \nabla P(Y_{0:i}|u_{1:i})$$

$$\nabla P(Y_{0:t}|u_{1:t}) = P(Y_{0:t}|u_{1:t}) - P(Y_{0:t-1}|u_{1:t})$$

$$\nabla P(Y_0) = \sum_{A_0} \sum_{O} \left(P(Y_0|A_0, O) - 1\right) P(A_0, O)$$

cost N

$$= \sum_{A_0} \sum_{O} \left(P(Y_0|A_0, O) - 1\right) P_{\cap}(A_0, O)$$



sparse likelihood