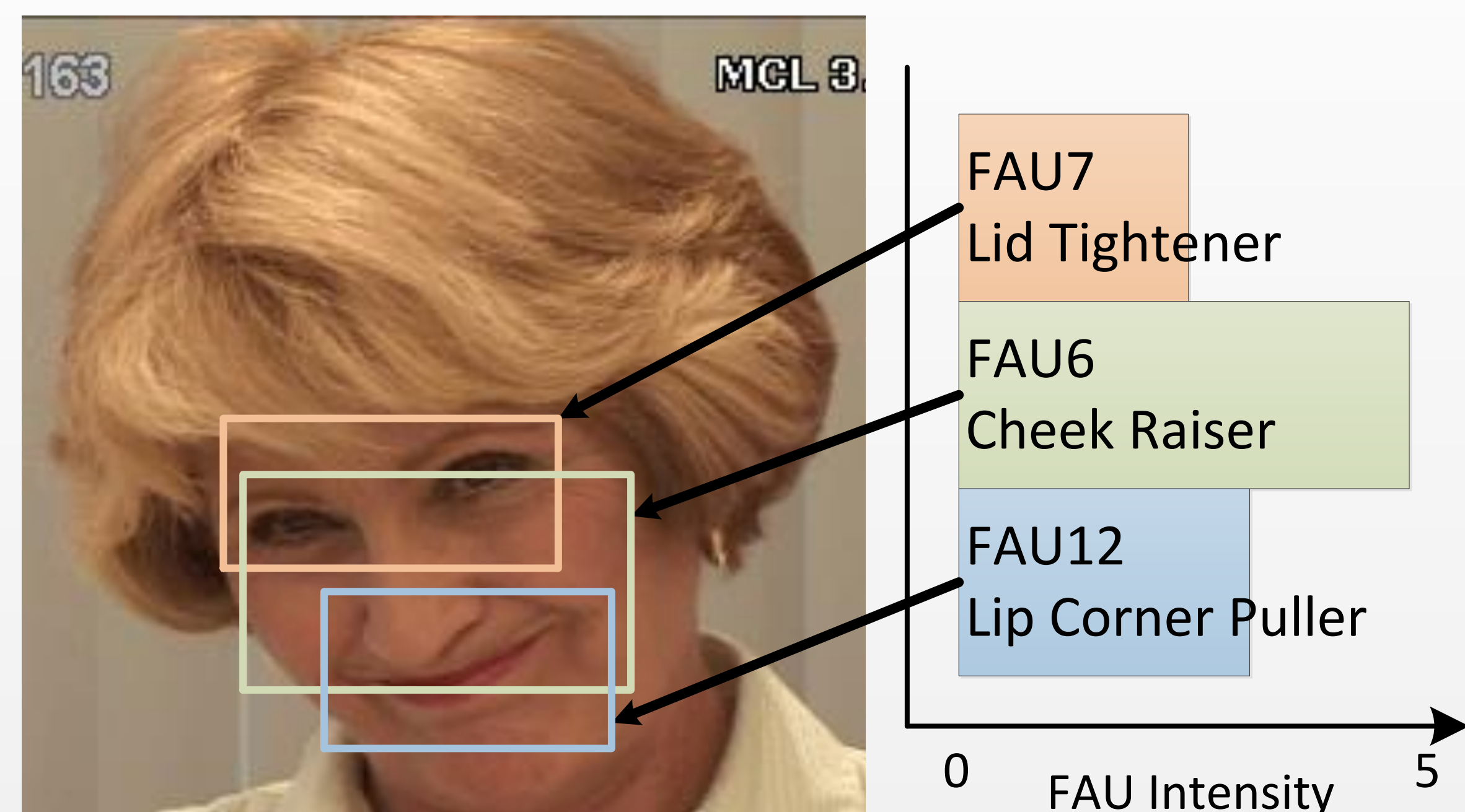
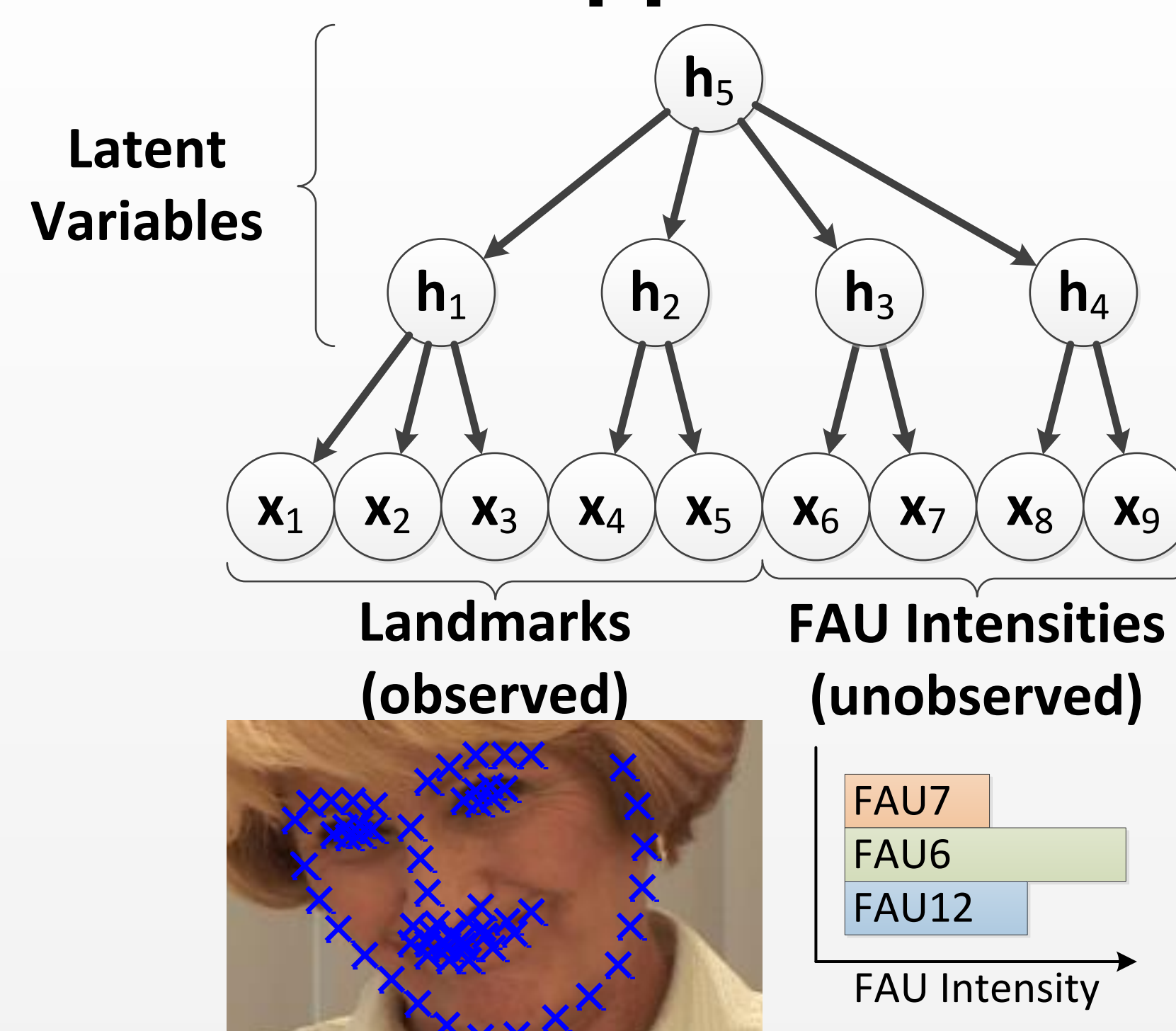


Problem

Input Video Frame → Which FAUs are active and their intensity



Approach



We model landmarks and FAU intensities jointly as leave nodes of a Latent Tree (LT)

Contributions

- Joint estimation of multiple FAUs using LT
- Efficient model structure learning
- Evaluation under noisy conditions

LT - Model

Edge Distributions:

$$p(\mathbf{h}_l | \mathbf{h}_{Pa(l)}) \sim \text{Cat.}$$

$$p(\mathbf{x}_m | \mathbf{h}_{Pa(m)}) \sim \text{Cat. or Gauss.}$$

Conditional Likelihood Node s :

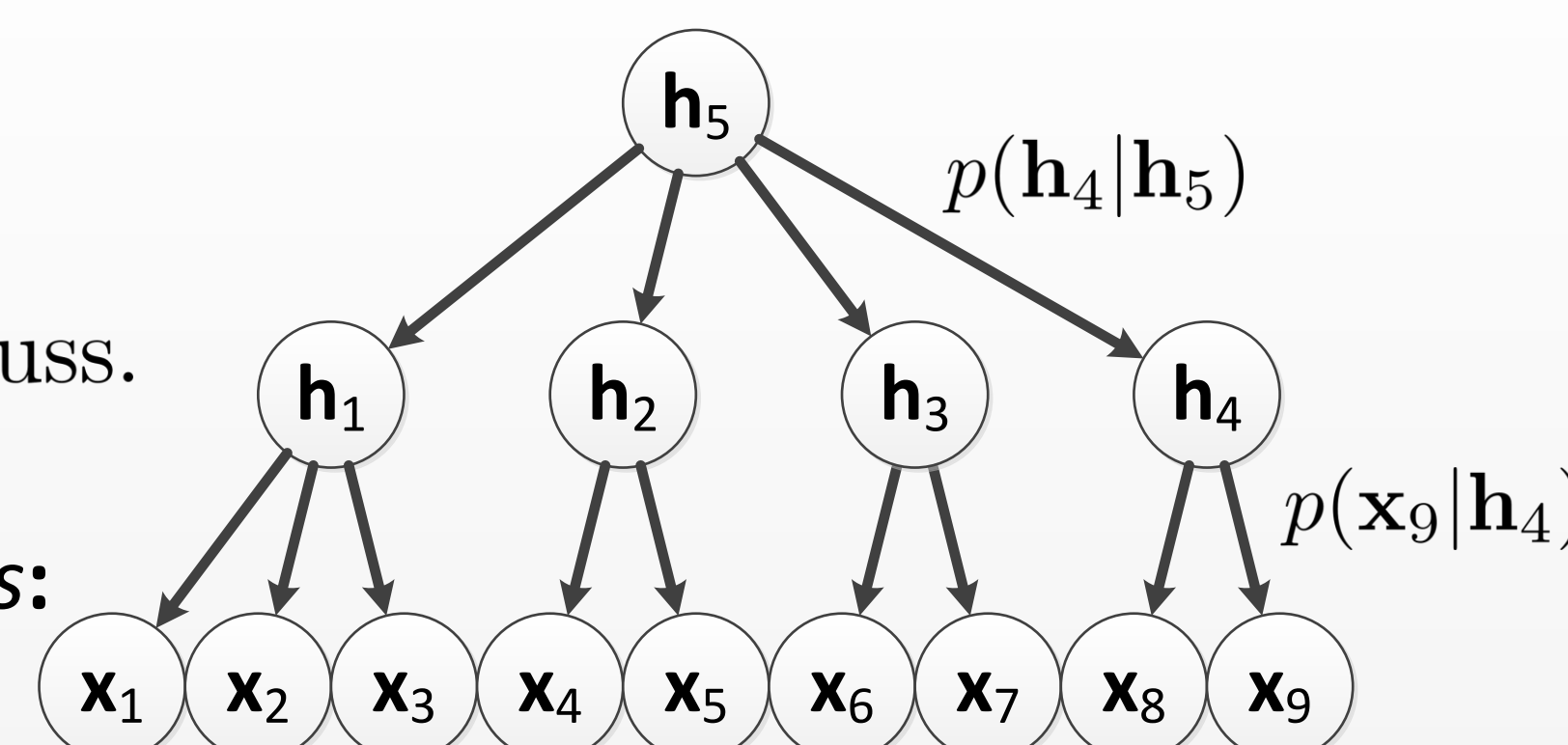
$$\mathcal{C}_s = p(\mathbf{x}_{Desc(s)} | \mathbf{x}_{NotDesc(s)})$$

Likelihood:

$$\mathcal{L} = \sum_{\mathbf{H}} \prod_{m,l} p(\mathbf{x}_m | \mathbf{h}_{Pa(m)}) p(\mathbf{h}_l | \mathbf{h}_{Pa(l)})$$

$Pa(\cdot)$ – Parent

$Desc(\cdot)$ – Descendant



Inference - Bottom-up/Top-down

Bottom-up:

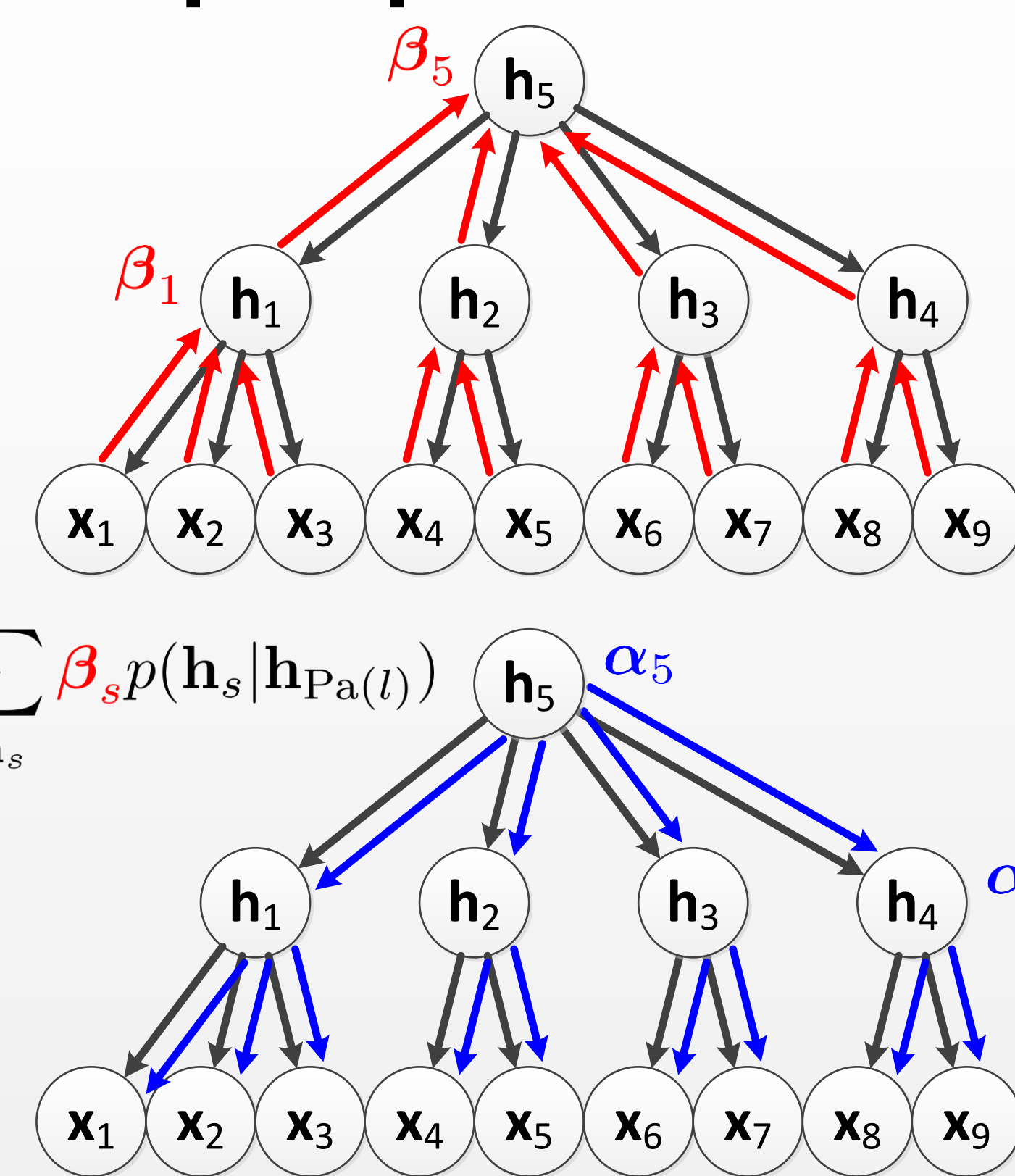
$$\beta_l = \prod_{c \text{ Child}(l)} (\sum_{\mathbf{h}_c} \beta_c p(\mathbf{h}_c | \mathbf{h}_l))$$

Top-down:

$$\alpha_l = \sum_{\mathbf{h}_{Pa(l)}} p(\mathbf{h}_l | \mathbf{h}_{Pa(l)}) \alpha_{Pa(l)} \prod_{s \text{ Sibling}(l)} \sum_{\mathbf{h}_s} \beta_s p(\mathbf{h}_s | \mathbf{h}_{Pa(l)})$$

Node marginal posterior:

$$p(\mathbf{h}_l | \mathbf{x}_1, \dots, \mathbf{x}_9) = \frac{\beta_l \alpha_l}{\sum_{\mathbf{h}_l} \beta_l \alpha_l}$$



Model Structure Learning

Repeat until $\Delta \mathcal{L} < c$

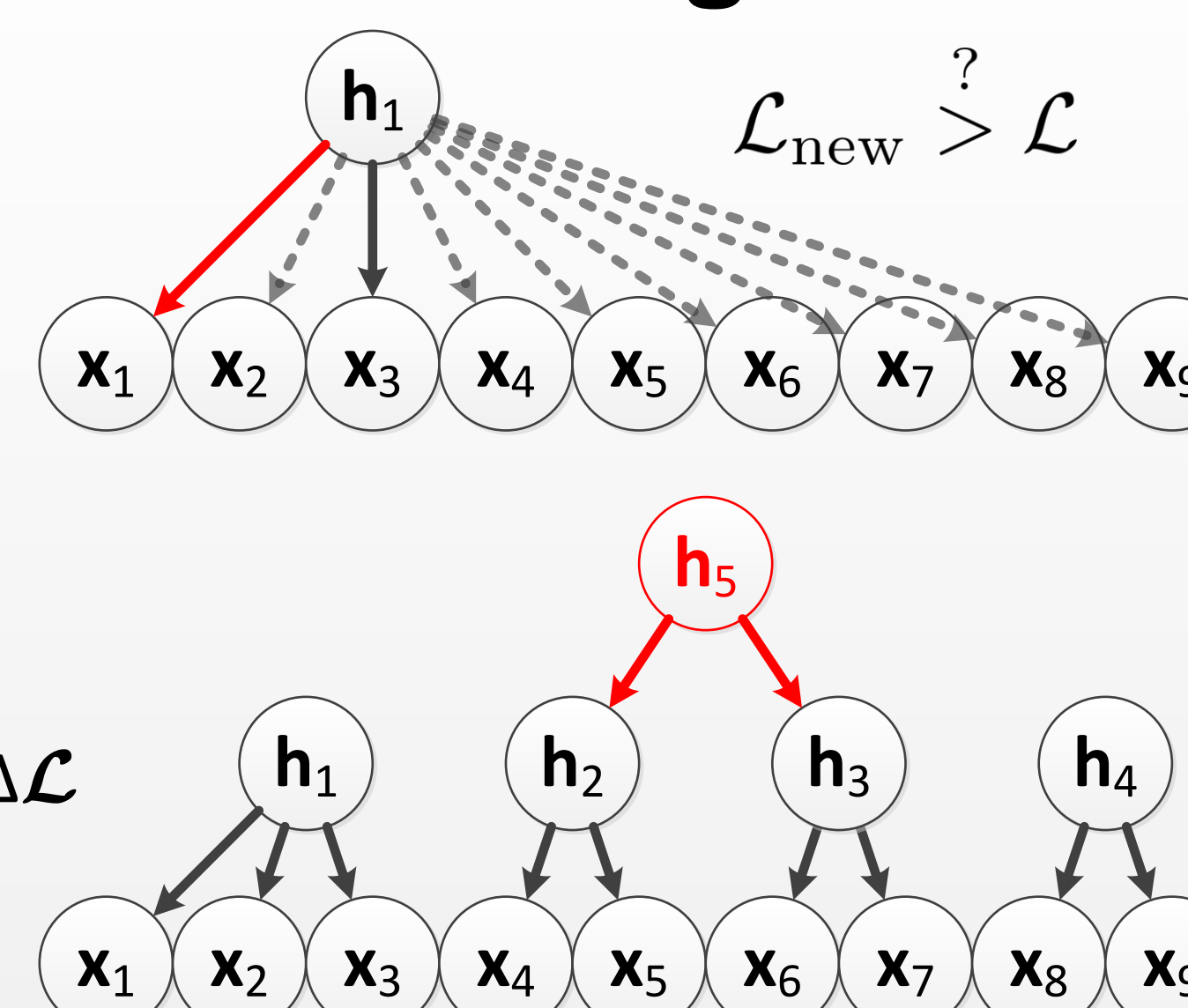
Try:

(1) Add **new edge**:

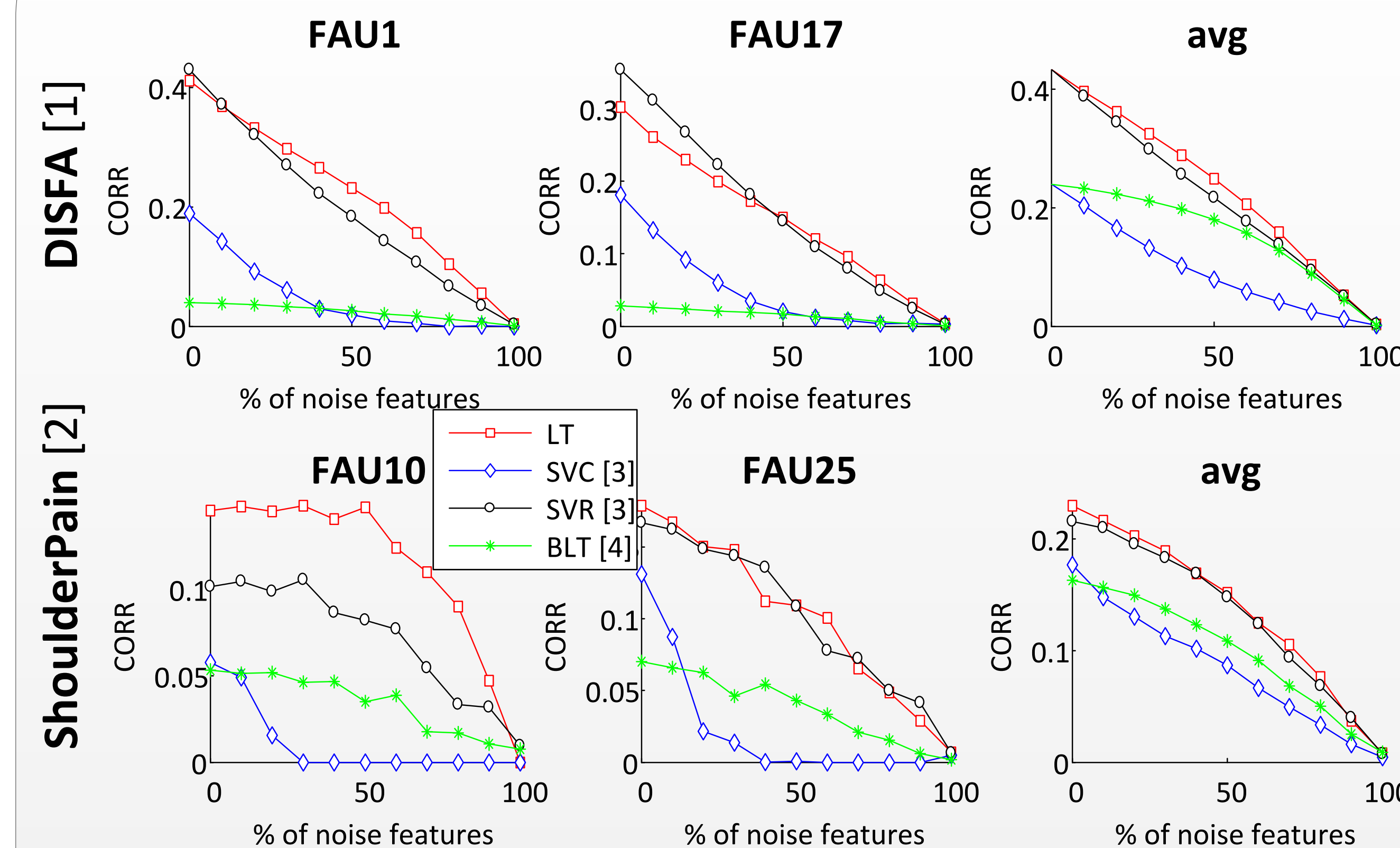
- select edge with max $\Delta \mathcal{L}$
- require $\Delta \mathcal{C}_s \geq t$ for all siblings s

Otherwise:

(2) Add **new parent** with the max $\Delta \mathcal{L}$

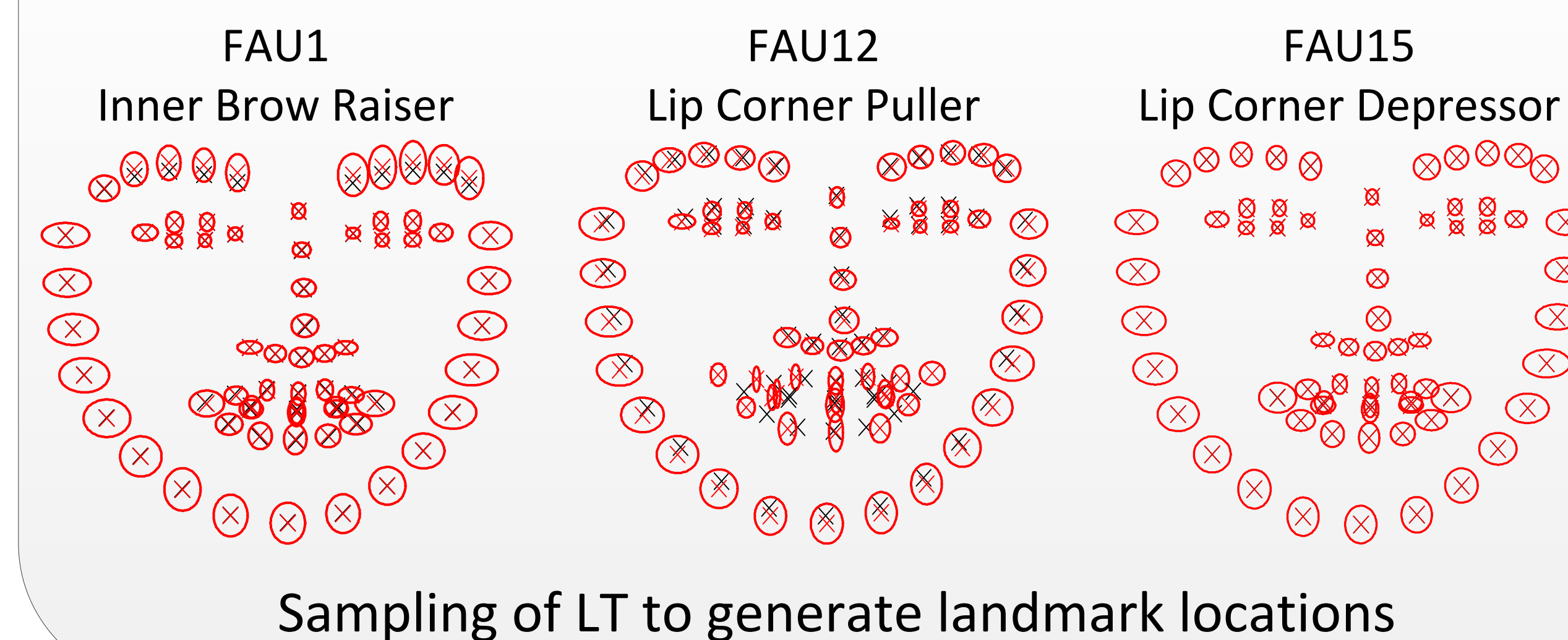


Quantitative Results



Evaluation on the DISFA [1] and ShoulderPain [2] datasets under the varying amount of noise in features

Qualitative Results



References

- [1] S. Mavadati et. al., TAC '13
- [2] P. Lucey et. al., FG '11
- [3] C.-C. Chang, C.-J. Lin, TIST '11
- [4] S. Harmeling, C.K.I. Williams, PAMI '11

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