

Final Exam

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$$P(\mathbf{s}|\mathbf{o}) = \frac{1}{Z_{\mathbf{s}}} \exp \left(\sum_{t=1}^T \sum_k \lambda_k f_k(s_{t-1}, s_t, o_t) \right) \quad (1)$$

$$Z_{\mathbf{s}} = \sum_{\mathbf{s}} \exp \left(\sum_{t=1}^T \sum_k \lambda_k f_k(s_{t-1}, s_t, o_t) \right) \quad (2)$$

$$L = \sum_{n=1}^N \log P(\mathbf{s}^{(n)}|\mathbf{o}^{(n)}) - \sum_k \frac{\lambda_k^2}{2\sigma} \quad (3)$$

$$\frac{\partial L}{\partial \lambda_k} = \sum_{n=1}^N \left(F_k(\mathbf{s}^{(n)}, \mathbf{o}^{(n)}) - \sum_{\mathbf{s}} P(\mathbf{s}|\mathbf{o}^{(n)}) F_k(\mathbf{s}, \mathbf{o}^{(n)}) \right) \quad (4)$$

$$\sum_{\mathbf{s}} P(\mathbf{s}|\mathbf{o}^{(n)}) F_k(\mathbf{s}, \mathbf{o}^{(n)}) = E_{p(\mathbf{s}|\mathbf{o}^{(n)})}[F_k(\mathbf{s}, \mathbf{o}^{(n)})] \quad (5)$$

$$E_{p(\mathbf{s}|\mathbf{o}^{(n)})}[F_k(\mathbf{s}, \mathbf{o}^{(n)})] = \frac{\sum_{t=1}^T \sum_{s_{t-1}, s_t} \alpha(t-1, s_{t-1}) f_k(s_{t-1}, s_t, o_t^{(n)}) \exp^{\lambda_k f_k(s_{t-1}, s_t, o_t^{(n)})} \beta(t, s_t)}{Z_{\mathbf{s}}} \quad (6)$$

$$Z_{\mathbf{s}} = \beta(1, 0) + \beta(1, 1) = \alpha(N, 0) + \alpha(N, 1) \quad (7)$$

$$V(t, s) = \begin{cases} \max_{s'} (V(t-1, s') \exp(\sum_k \lambda_k f_k(s', s, \mathbf{o}_t))) & t > 1 \\ s == 1 & t = 1 \end{cases} \quad (8)$$

$$V(t, s) = \begin{cases} \max_{s'} (V(t-1, s') + \sum_k \lambda_k f_k(s', s, \mathbf{o}_t)) & t > 1 \\ V(1, 0) = -\infty, V(1, 1) = 0 & t = 1 \end{cases} \quad (9)$$

$$\alpha(t, s) = \sum_{s'} \alpha(t-1, s') \exp \left(\sum_k \lambda_k f_k(s', s, \mathbf{o}_t) \right) \quad (10)$$

$$\beta(t, s) = \sum_{s'} \beta(t+1, s') \exp \left(\sum_k \lambda_k f_k(s, s', \mathbf{o}_{t+1}) \right) \quad (11)$$