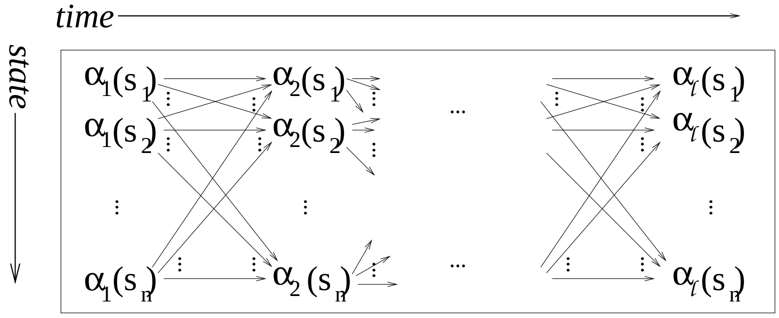
CS674, Spring 2002
Lecture Handout, 2/13/02

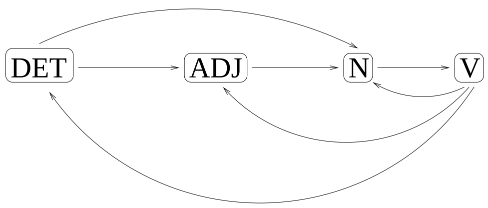
1. A trellis graph for organizing the forward-probabilities computations.



2. Useful auxiliary quantities.
Forward probabilities: $\alpha_t(s_i) = P(o_1 o_2 \cdots o_t, Q_t = s_i)$
Backward probabilities ($1 < t < \ell$):

$$\begin{aligned}\beta_t(s_i) &= P(o_{t+1}, o_{t+2}, \ldots, o_\ell | Q_t = s_i) \\ &= \sum_{j=1}^{n} P(s_j|s_i) P(o_{t+1}|s_j) \beta_{t+1}(s_j) \\ \beta_\ell(s_i) &= 1\end{aligned}$$

3. Underlying Markov chain (probabilities omitted) for a simple POS HMM.



4. Auxiliary quantities for inducing HMMs. The variable θ indicates the current HMM parameters.
Entrance probabilities: $\mathrm{IN}_t(s_i) = P(Q_t = s_i | o, \theta)$
Hop probabilities: $\mathrm{HOP}_t(s_i, s_j) = P(Q_t = s_i, Q_{t+1} = s_j | o, \theta)$, where $t < \ell$

5. Baum-Welch updates.

$$\begin{aligned}\widehat{P}(s_i) &:= \mathrm{IN}_1(s_i) \\ \widehat{P}(s_j|s_i) &:= \frac{\sum_{t=1}^{\ell-1} \mathrm{HOP}_t(s_i, s_j)}{\sum_{t=1}^{\ell-1} \mathrm{IN}_t(s_i)} \\ \widehat{P}(\sigma_j|s_i) &:= \frac{\sum_{t:\ O_t = \sigma_j} \mathrm{IN}_t(s_i)}{\sum_{t=1}^{\ell} \mathrm{IN}_t(s_i)}\end{aligned}$$