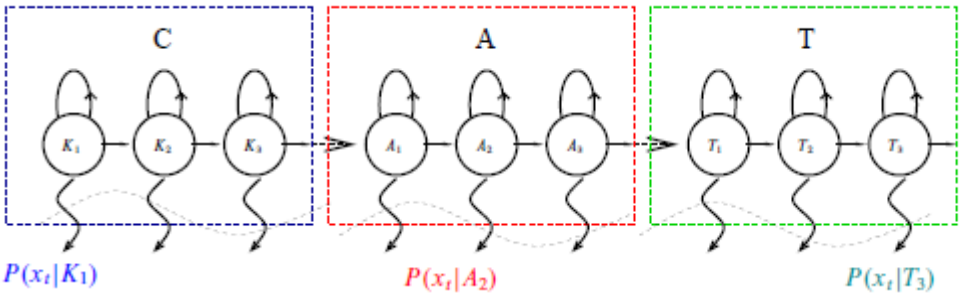
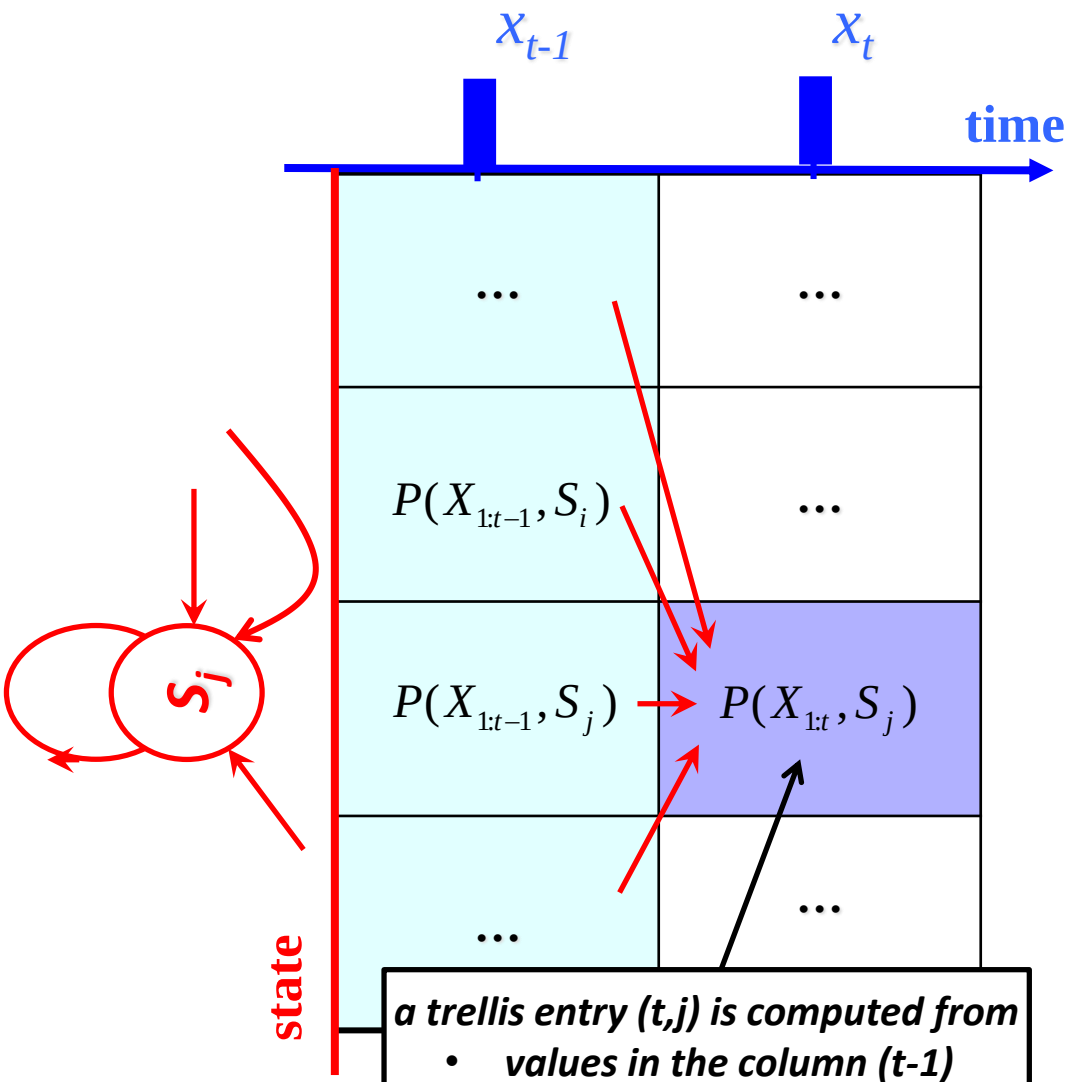
Exercises on

Computing with HMMs

Hidden Markov Models



Trellis Computations



a trellis entry (t,j) is computed from

- *values in the column (t-1)*
- *current input x_t*
- *model parameters A, B*

Forward Recursion

$$P(t, j) = \left(\sum_i P(t-i, i) a_{ij} \right) b_j(x_t)$$

Viterbi Recursion

$$P(t, j) = \left(\max_i P(t-1, i) a_{ij} \right) b_j(x_t)$$

Viterbi Recursion (log)

$$L(t, j) = \max_i \left(L(t-1, i) + \log(a_{ij}) \right) + \log(b_j(x_t))$$

sequence of computations: column by column

HMM – Questions 1
Computations with discrete densities

PROBLEM DESCRIPTION:

A silence-speech detector classifies incoming data as either speech or silence, depending on the short-time energy E of the input signal.

The measured energy is labelled (quantized) as follows :

Use an HMM with 2 states to model this process.

TASKS:

1. **Make a drawing of the HMM, indicate all probabilities.**
2. **Make a Trellis diagram and compute both the Forward Pass score and the Viterbi score for observation [15 35 60 25] assuming it corresponds to an utterance embedded in silence.**
3. **Align the observations against the states for the Viterbi case**

HMM – Question 3
Viterbi Training of an HMM

Do a Viterbi training for the discrete model of exercise 1, given following training data:

sample 1: data from exercise 1

sample 2: [B A B B C A] with alignment [SIL SIL SP SP SP SIL]

sample 3: [A B C B C A C A] with alignment [SIL SP SP SP SP SIL SIL SIL]