Lecture 24

-Hidden Markov Model (HMM)

HMM

- HMM: Hidden Markov Model
- Hidden states q (POS) and observed states o (output/words)
- $o_1, o_2, \ldots o_T$ constitute the output sentence
- $q_1, q_2, \ldots q_T$ constitute the hidden states at the back-end that produce the output sentence
- Transition probabilities (between hidden states)
- Output probabilities (for each output)
- *Task: there are different candidate output sentences (eg. Chatbot application) and you have to find the best sentence of all. The sentence with the maximum probability wins*
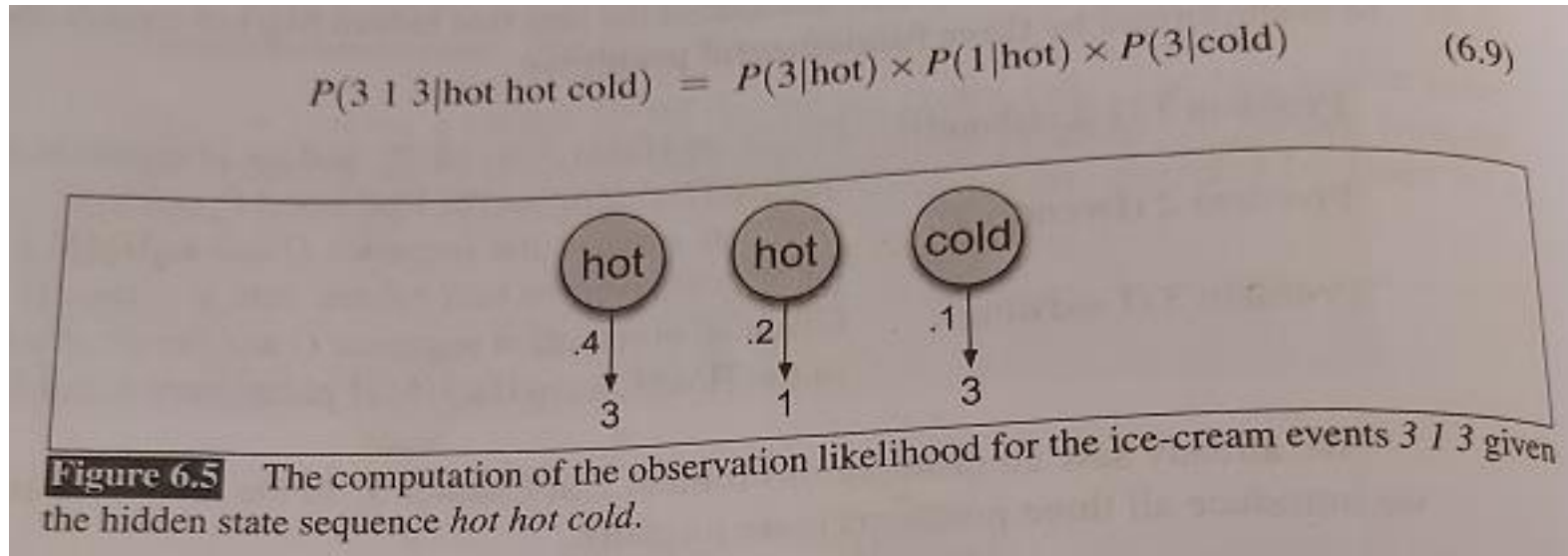
HMM probability calculations

- Joint probability

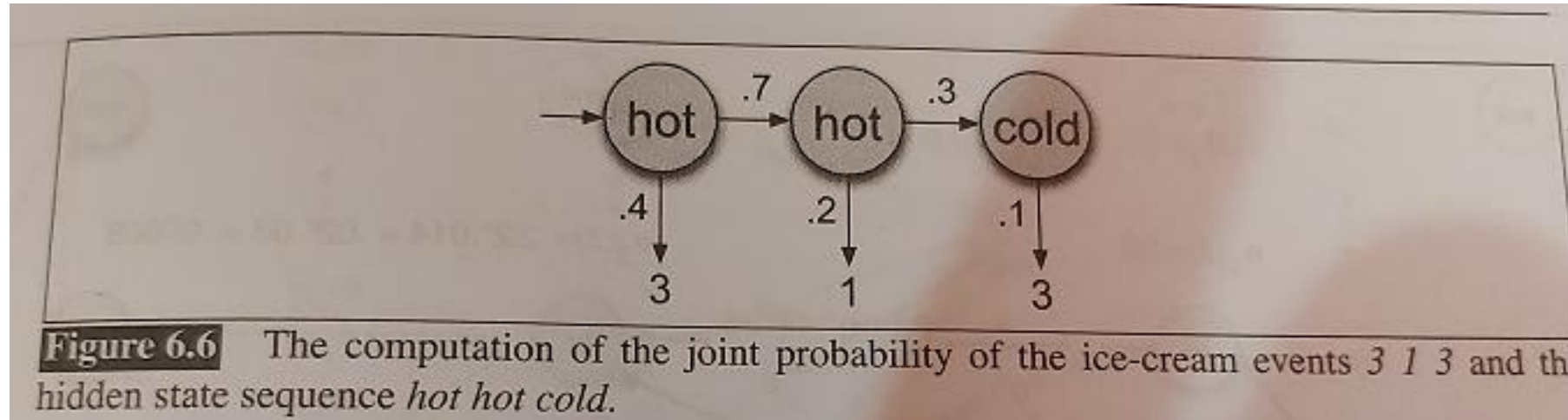$$P(O, Q) = P(O|Q) \times P(Q) = \prod_{i=1}^{n} P(o_i|q_i) \times \prod_{i=1}^{n} P(q_i|q_{i-1})$$

- Probability of the output sentence

$$P(O) = \sum_{Q} P(O, Q) = \sum_{Q} P(O|Q)P(Q)$$

Demo 1

$$P(3\ 1\ 3|hot\ hot\ cold) = P(3|hot) \times P(1|hot) \times P(3|cold) \qquad (6.9)$$

Figure 6.5 The computation of the observation likelihood for the ice-cream events *3 1 3* given the hidden state sequence *hot hot cold*.

Demo 2

Figure 6.6 The computation of the joint probability of the ice-cream events *3 1 3* and the hidden state sequence *hot hot cold*.

$$P(3\ 1\ 3) = P(3\ 1\ 3, \text{cold cold cold}) + P(3\ 1\ 3, \text{cold cold hot}) + P(3\ 1\ 3, \text{hot hot cold}) + \dots$$

Assignment
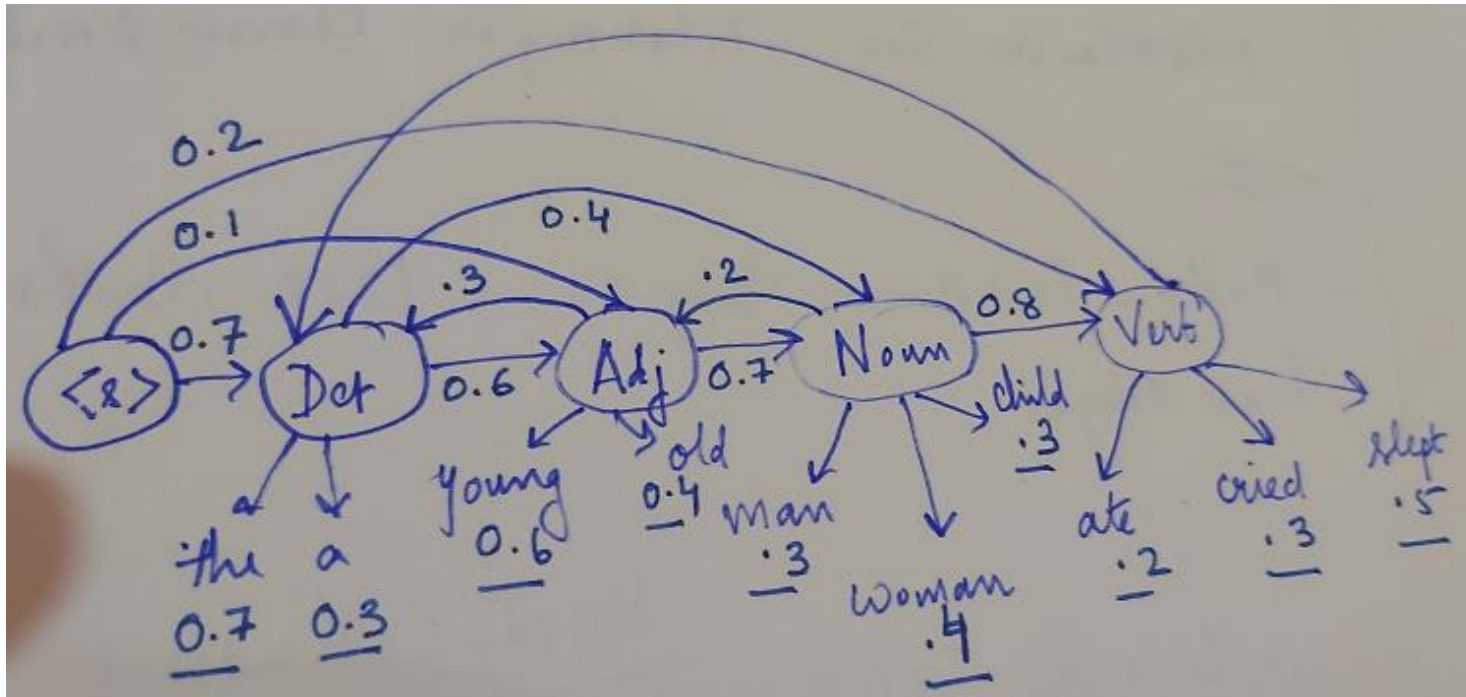
- Find the best output sentence: O: the old woman ate /the young child slept
  Q: <s>Det Adj Noun Verb