

Introduction to Hidden Markov Model

隐式马尔可夫模型

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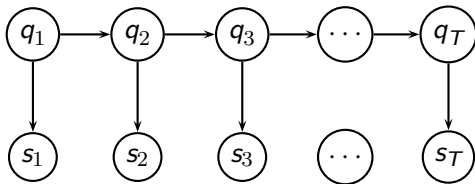
Introduction

HMM Overview

Three basic
problems of HMMs

A concrete example

References



- a Markov process with unobserved (hidden) states
- state is not directly visible
- output, depend on the states, is visible

- Speech recognition
 - Recognizing spoken words and phrases
- Text processing
 - Parsing raw records into structured records
- Bioinformatics
 - Protein sequence prediction
- Financial
 - Stock market forecasts (price pattern prediction)
 - Comparison shopping services

- Machine learning method
- Makes use of state machines
- Based on probabilistic models
- Useful in problems having sequential steps
- Can only observe output from states, not the states themselves

Specification of an HMM

definition

Full HMM is thus specified as a triplet:

$$\lambda = (N, M, A, B, \pi)$$

States

N—number of states

- $Q = \{q_1, q_2, \dots, q_T\}$

Symbols

M – number of symbols

- $O = \{o_1, o_2, \dots, o_T\}$

Specification of an HMM

Transition Probability

- A - the state transition probability matrix
 - $a_{ij} = P(q_{t+1} = j | q_t = i)$

Observation Probability

- B- observation probability distribution
 - $b_j(k) = P(O_t = k | q_t = j)$

Initial State Distribution

- π - the initial state distribution

Three basic problems of HMMs

Given an HMM λ and a sequence of observations

$$O = o_1, o_2, \dots, o_T$$

1. The Evaluation Problem

what is the probability that the observations are generated by the model, $P(O|\lambda)$?

2. The Decoding Problem

what is the most likely state sequence in the model that produced the observations?

Three basic problems of HMMs

3. The Study Problem

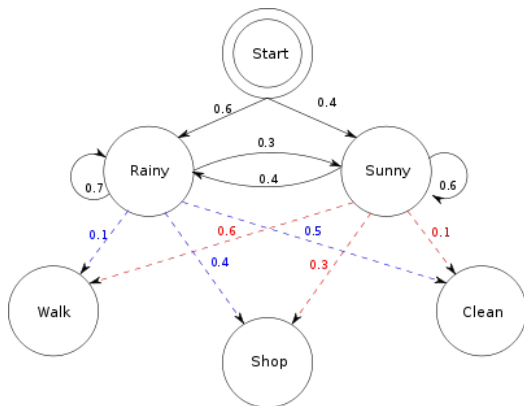
how should we adjust the model parameters $\{\lambda, A, B\}$
in order to maximize $P(O|\lambda)$

A concrete example

Case Description

- Alice and Bob, who live far apart from each other
- Bom is only interested in three activities: walk, shop, clean.
- Bom's choice is exclusively based on the weather.
- Alice tries to guess what the weather is like there.

A concrete example



A concrete example

Find the Most Likely Sequence of Hidden States

- get Bom's activities : $\{walk, walk, clean, run\}$
- trying to guess the most likely weather sequence there

Solution

- ① Forward Algorithm
- ② Back Algorithm
- ③ Viterbi Algorithm

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Hidden markov models

 [L Rabiner, B Juang - ASSP Magazine, IEEE, 1986]

An introduction to hidden Markov models

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统计学习方法