Inside–outside algorithm

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(Redirected from Inside-outside algorithm)

This article **provides insufficient context for those unfamiliar with the subject**. Please help improve the article with a good introductory style. *(June 2012)*

In computer science, the **inside–outside algorithm** is a way of re-estimating production probabilities in a probabilistic context-free grammar. It was introduced James K. Baker in 1979 as a generalization of the forward–backward algorithm for parameter estimation on hidden Markov models to stochastic context-free grammars. It is used to compute expectations, for example as part of the expectation–maximization algorithm (an unsupervised learning algorithm).

Inside and outside probabilities [edit]

The inside probability $\beta_j(p,q)$ is the total probability of generating words $w_p \cdots w_q$, given the root nonterminal N^j and a grammar G:[1]

$$\beta_j(p,q) = P(w_{pq}|N^j_{pq}, G)$$

The outside probability $\alpha_j(p,q)$ is the total probability of beginning with the start symbol N^1 and generating the nonterminal N^j_{pq} and all the words outside $w_p \cdots w_q$, given a grammar G:[1]

$$\alpha_j(p,q) = P(w_{1(p-1)}, N^j_{pq}, w_{(q+1)m}|G)$$

Computing Inside probabilities [edit]

Base Case:

$$\beta_j(p,p) = P(w_p|N^j, G)$$

General Case:

Suppose there is a rule $N_j \rightarrow N_r N_s$ in the grammar, then the probability of generating $w_p \cdots w_q$ starting with a subtree rooted at N_j is:

$$\sum_{k=p}^{k=q-1} P(N_j \rightarrow N_r N_s)\beta_r(p,k)\beta_s(k+1,q)$$

The inside probability $\beta_j(p,q)$ is just the sum over all such possible rules:

$$\beta_j(p,q) = \sum_{N_r,N_s} \sum_{k=p}^{k=q-1} P(N_j \rightarrow N_r N_s)\beta_r(p,k)\beta_s(k+1,q)$$

Computing Outside probabilities [edit]

Base Case:

$$\alpha_j(1,n) = \begin{cases} 1 & \text{if } j = 1 \\ 0 & \text{otherwise} \end{cases}$$

Here the start symbol is N_1.

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External links [edit]

- Inside-outside algorithm - Fei Xia
- The Inside-Outside Algorithm - Michael Collins

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