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Faculté Informatique et Communication
Introduction to Natural Language Processing (Ms; CS-431)
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CS-431 Hands On Part-of-Speech tagging (part 2)
Solutions

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QUESTION I **[2 pt]**

For this question, *one or more* assertions can be correct. Tick only the correct assertion(s). There will be a penalty for wrong assertions ticked.

Consider two sequences of discrete random variables $(X_1, X_2, \ldots)$ and $(Y_1, Y_2, \ldots)$, with possibles values respectively $(x_1, x_2, \ldots)$ in V, $(y_1, y_2, \ldots)$ in T.

Indicate which of the following statements are always true (without any further assumption):

[✔] $\sum_{(x_1,x_2,\ldots,x_n)\in V^n} P(X_1 = x_1, X_2 = x_2, \ldots, X_n = x_n \,|\, Y_1 = y_1, Y_s = y_2, \ldots, Y_n = y_n) = 1$

[ ] $\sum_{(y_1,y_2,\ldots,y_n)\in T^n} P(X_1 = x_1, X_2 = x_2, \ldots, X_n = x_n \,|\, Y_1 = y_1, Y_s = y_2, \ldots, Y_n = y_n) = 1$

[✔] $P(Y_1, Y_2, \ldots, Y_n) = P(Y_n) \cdot P(Y_{n-1}|Y_n) \cdot \cdots \cdot P(Y_2|Y_3, \ldots, Y_n) \cdot P(Y_1|Y_2, \ldots, Y_n)$

[ ] $P(X_i|X_1, \ldots, X_{i-1}, Y_1, Y_2, \ldots, Y_n) = P(X_i|Y_i)$, for all i between 2 and n.

continues on back ☞

QUESTION II [1 pt]

When using Hidden Markov Models to perform PoS tagging:

① What do the observables of the HMM model correspond to? words

② What do the hidden states of the HMM model correspond to? Part-of-Speech tags

QUESTION III [2 pt]

For this question, *one or more* assertions can be correct. Tick only the correct assertion(s). There will be a penalty for wrong assertions ticked.

Indicate which of the following statements are true, when using Hidden Markov Models to perform PoS tagging:

[ ] the Viterbi algorithm can be used to efficiently train an HMM model on supervised data;

[✔] the Baum-Welch algorithm can be used to efficiently train an HMM model on unsupervised data;

[ ] provided that enough unsupervised data are available, the Baum-Welch algorithm is always able to learn the best possible HMM model;

[ ] when an order-1 HMM is used, the assignment of a tag to a word only depends on the tag, the word, and the previous tag.

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QUESTION IV [7 pt]

Indicate the sequence of PoS tags assigned by an order-1 HMM to the word sequence "*iron shaped cloth*", if the following information is available:

Lexicon excerpt: (but no other tag for the provided words)
"*iron*": `Noun`, `Verb` "*shaped*": `Adj`, `Verb` "*cloth*": `Noun`

(some) Parameters:
$P_I(\texttt{Noun}) = 2 \cdot 10^{-9}$ $P_I(\texttt{Verb}) = 1 \cdot 10^{-9}$ $P_I(\texttt{Adj}) = 3 \cdot 10^{-9}$

$P(\text{"}\textit{iron}\text{"}|\texttt{Noun}) = 3 \cdot 10^{-9}$ $P(\text{"}\textit{shaped}\text{"}|\texttt{Adj}) = 2 \cdot 10^{-9}$
$P(\text{"}\textit{iron}\text{"}|\texttt{Verb}) = 2 \cdot 10^{-9}$ $P(\text{"}\textit{shaped}\text{"}|\texttt{Verb}) = 3 \cdot 10^{-9}$

$P(\texttt{Adj}|\texttt{Noun}) = 1 \cdot 10^{-9}$ $P(\texttt{Adj}|\texttt{Verb}) = 2 \cdot 10^{-9}$
$P(\texttt{Verb}|\texttt{Noun}) = 2 \cdot 10^{-9}$ $P(\texttt{Verb}|\texttt{Verb}) = 1 \cdot 10^{-9}$
$P(\texttt{Noun}|\texttt{Verb}) = 2 \cdot 10^{-9}$ $P(\texttt{Noun}|\texttt{Adj}) = 5 \cdot 10^{-9}$

Answer: `Noun, Verb, Noun:`