Ling 5701: Lecture Notes 8
A Probabilistic Model of Hierarchic Events

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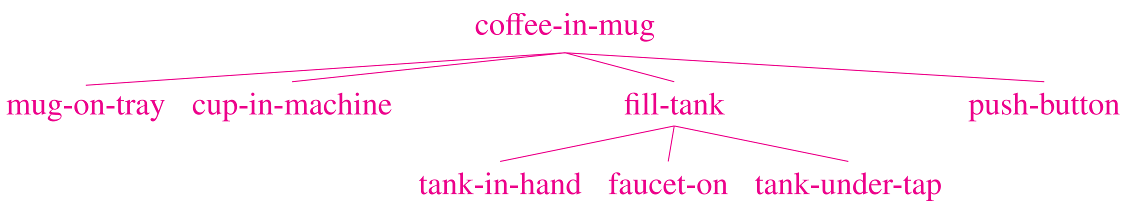
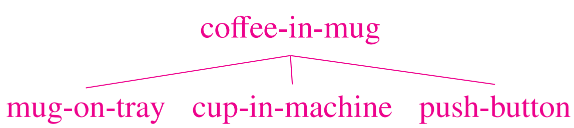
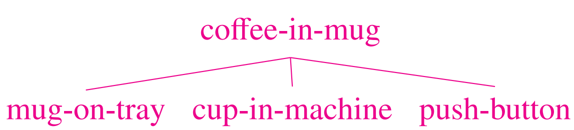
8.1 Event sequences can be hierarchic

We may observe some events with sub-structure:







8.2 Sub-sequence probabilities

We can define probabilities over hierarchic event sequences using a stochastic branching process.

Probabilities are of sequence of subordinate 'child' types given a superordinate 'parent' type:

- $\mathsf{P}(\text{coffee-in-mug} \rightarrow \text{mug-on-tray cup-in-machine fill-tank push-button} \mid \text{coffee-in-mug}) = 0.33$
- $\mathsf{P}(\text{coffee-in-mug} \rightarrow \text{mug-on-tray cup-in-machine push-button} \mid \text{coffee-in-mug}) = 0.67$
- $\mathsf{P}(\text{fill-tank} \rightarrow \text{tank-in-hand faucet-on tank-under-tap} \mid \text{fill-tank}) = 1.0$
- $\mathsf{P}(\text{mug-on-tray} \rightarrow \text{(observed)} \mid \text{mug-on-tray}) = 1.0$

- P(cup-in-machine → (observed) | cup-in-machine) = 1.0
- P(tank-in-hand → (observed) | tank-in-hand) = 1.0
- P(faucet-on → (observed) | faucet-on) = 1.0
- P(tank-under-tap → (observed) | tank-under-tap) = 1.0
- P(push-button → (observed) | push-button) = 1.0

These probabilities can be estimated from data, e.g. the trees above.

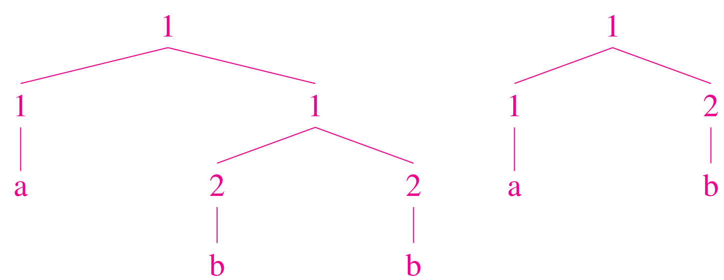
8.3 Joint probabilities of event sequences

A 'joint' probability for the entire set of trees can then be estimated as the product of all used rules:

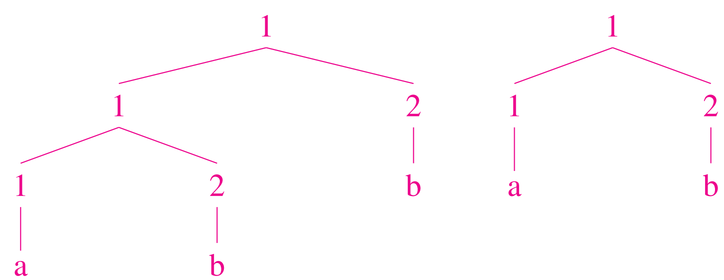
$.33 \times .67 \times .67 \times 1.0 \times 1.0 \times 1.0 \times 1.0 \times 1.0 \times 1.0 = 0.1481$

8.4 Practice

1. Calculate a probabilistic grammar based on the below evidence:



2. Calculate a probabilistic grammar based on the below evidence:



8.5 Practice

Which of the tree sets in the above problem has a lower probability?