NLP Assignment
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1.a P(N at t=1) = 1 (certain)
P(V at t=1) = 0 (impossible)

1.b P(N->N) = ⅖
P(N->V) = ⅕
P(N->STOP) = ⅖
P(V -> V) = 0
P(V -> N) = 0
P(V -> STOP) = 1

1.c raises/V my/N purses/N

1.d Initialization:

- $\text{Viterbi}(N,1)=\log P(N)+\log P(\text{he}\mid N)=-1+-2=-3$
- $\text{Viterbi}(V,1)=\log P(V)+\log P(\text{he}\mid V)=-1+-7=-8$

Max for this step: N

Recursion:

For "raises":

- $\text{Viterbi}(N,2)=\max(\text{Viterbi}(N,1)+\log P(N\rightarrow N)+\log P(\text{raises}\mid N),\text{Viterbi}(V,1)+\log P(V\rightarrow N)+\log P(\text{raises}\mid N))=\max(-3-1-3,-8-2-3)=\max(-7,-13)=-7$
- $\text{Viterbi}(V,2)=\max(\text{Viterbi}(V,1)+\log P(V\rightarrow V)+\log P(\text{raises}\mid V),\text{Viterbi}(N,1)+\log P(N\rightarrow V)+\log P(\text{raises}\mid V))=\max(-8-2.5-2,-3-1.5-2)=\max(-12.5,-6.5)=-6.5$

Max for this step: N

For “purses”:

- $\text{Viterbi}(N,3)=\max(\text{Viterbi}(N,2)+\log P(N\rightarrow N)+\log P(\text{purses}\mid N),\text{Viterbi}(V,2)+\log P(V\rightarrow N)+\log P(\text{raises}\mid N))=\max(-7-1-2,-6.5-2-2)=\max(-10,-10.5)=-10$
- $\text{Viterbi}(V,3)=\max(\text{Viterbi}(V,2)+\log P(V\rightarrow V)+\log P(\text{purses}\mid V),\text{Viterbi}(N,2)+\log P(N\rightarrow V)+\log P(\text{purses}\mid V))=\max(-6.5-2.5-4,-7-1.5-4)=\max(-13,-12.5)=-12.5$

Max for this step: N

The most likely sequence is the one with the highest final Viterbi variable, which is **N-N-N.**

1.e For "he raises purses":

- Viterbi(N,1) = -3
- Viterbi(N,2) = -7
- Viterbi(N,3) = -10

- Transition to STOP from N = log P(STOP|N) = -2

So, the total probability of the sequence ending with N is: -10 + -2 = **-12.**

For "he raises purses":

- Viterbi(V,1) = -8
- Viterbi(V,2) = -6.5
- Viterbi(V,3) = -12.5
- Transition to STOP from V = log P(STOP|V) = -0.5

So, the total probability of the sequence ending with V is: -12.5 + (-0.5) = **-13.**
Comparing the probabilities, the sequence ending with N has a higher posterior probability (-12) than the sequence ending with V (-13). Therefore, the highest posterior probability tag sequence for the sentence "he raises purses" is "N N N STOP".

2.a (1) For sentence ***I ate spaghetti with chopsticks*****:**

As per the constituency tree of the parser the interpretation of the sentence is the I ate spaghetti using chopsticks. This interpretation is correct

For sentence, ***I ate spaghetti with meatballs*****:**

As per the constituency tree of the parser the interpretation of the sentence is - I ate spaghetti using meatballs. This interpretation is notcorrect.

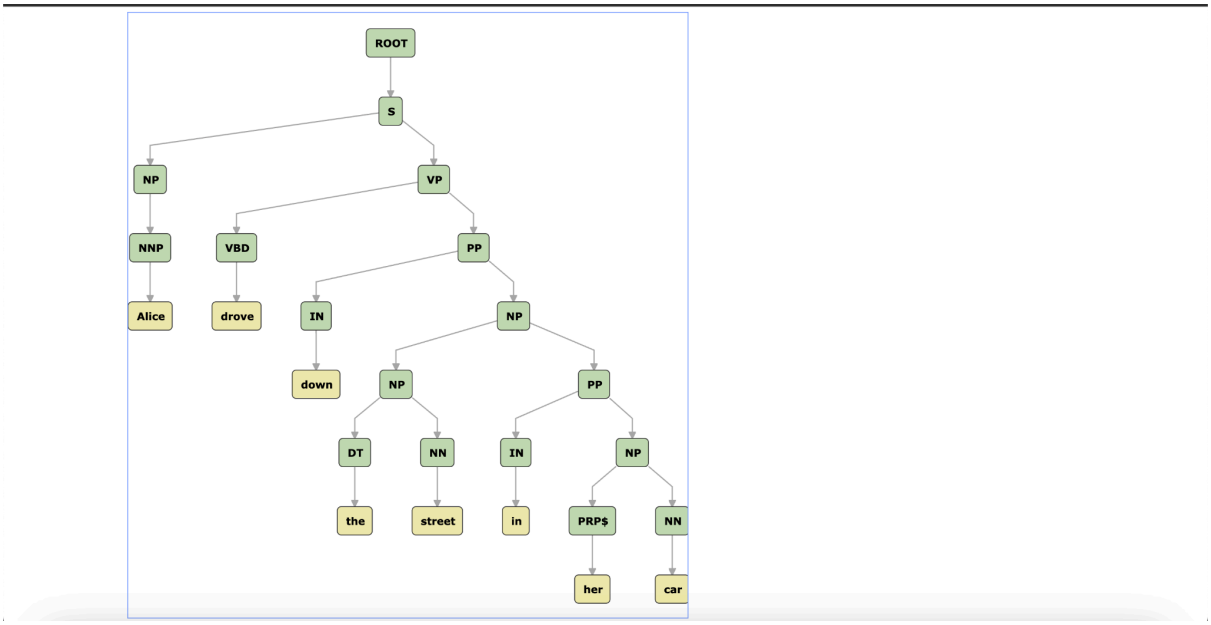
2.a (2) For sentence ***I ate spaghetti with chopsticks*****:**

As per the dependency tree of the parser the interpretation of the sentence is the I ate spaghetti using chopsticks. This interpretation is correct

For sentence, ***I ate spaghetti with meatballs*****:**

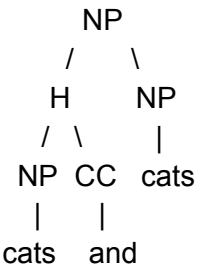
As per the dependency tree of the parser the interpretation of the sentence is - I ate spaghetti using meatballs. This interpretation is notcorrect.

2.b Sam drove down the street in his car.



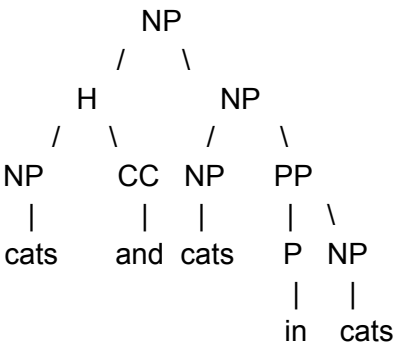
The explanation as per the constituency parser is Alice drove down to the street which is located in her car.

3.a There's only one valid syntactic parses for the sentence cats and cats, and that is as follows:

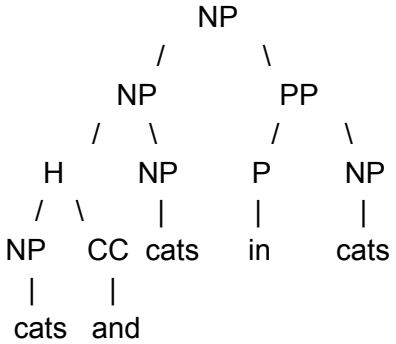


3.b There's two valid syntactic parses for the sentence cats and cats in cats, and that is as follows:

Parser 1:



Parser 2:



4. Step 1: Initialize the stack and buffer with the words from the sentence.

- Stack: [ROOT]
- Buffer: [The, cat, chased, the, mouse, through, the, garden]

Step 2: Perform transition actions

1. Shift "The":
    a. Stack: ["The"]
    b. Input buffer: ["cat", "chased", "the", "mouse", "through", "the", "garden"]
2. Shift "cat":
    a. Stack: ["The", "cat"]
    b. Input buffer: ["chased", "the", "mouse", "through", "the", "garden"]
3. Shift "chased":
    a. Stack: ["The", "cat", "chased"]
    b. Input buffer: ["the", "mouse", "through", "the", "garden"]
4. Reduce "cat" -> "chased":
    a. This creates a dependency relation between "cat" and "chased", where "cat" is the subject (nsubj) of "chased".
    b. Stack: ["The", "chased"]
    c. Input buffer: ["the", "mouse", "through", "the", "garden"]
5. Shift "the":
    a. Stack: ["The", "chased", "the"]
    b. Input buffer: ["mouse", "through", "the", "garden"]
6. Shift "mouse":
    a. Stack: ["The", "chased", "the", "mouse"]
    b. Input buffer: ["through", "the", "garden"]
7. Reduce "the" -> "mouse":
    a. This creates a dependency relation between "the" and "mouse", where "the" is the determiner (det) of "mouse".

    b. Stack: ["The", "chased", "mouse"]
    c. Input buffer: ["through", "the", "garden"]
8. Reduce "mouse" -> "chased":
    a. This creates a dependency relation between "mouse" and "chased", where "mouse" is the direct object (obj) of "chased".
    b. Stack: ["The", "chased"]
    c. Input buffer: ["through", "the", "garden"]
9. Shift "through":
    a. Stack: ["The", "chased", "through"]
    b. Input buffer: ["the", "garden"]
10. Shift "the":
    a. Stack: ["The", "chased", "through", "the"]
    b. Input buffer: ["garden"]
11. Shift "garden":
    a. Stack: ["The", "chased", "through", "the", "garden"]
    b. Input buffer: []
12. Reduce "the" -> "garden":
    a. This creates a dependency relation between "the" and "garden", where "the" is the determiner (det) of "garden".
    b. Stack: ["The", "chased", "through", "garden"]
    c. Input buffer: []
13. Reduce "garden" -> "through":
    a. This creates a dependency relation between "garden" and "through", where "garden" is the object (obl) of "through".
    b. Stack: ["The", "chased", "through"]
    c. Input buffer: []
14. Reduce "through" -> "chased":
    a. This creates a dependency relation between "through" and "chased", where "through" is the adverbial modifier (advmod) of "chased".
    b. Stack: ["The", "chased"]
    c. Input buffer: []
15. Reduce "The" -> "chased":
    a. This creates a dependency relation between "The" and "chased", where "The" is the determiner (det) of "cat".
    b. Stack: ["chased"]
    c. Input buffer: []
16. Terminate the parsing process:
    a. The stack now contains the root of the dependency tree, which is "chased".

The dependency relations are:

- "The" is the determiner (det) of "cat"
- "cat" is the subject (nsubj) of "chased"
- "chased" is the root of the sentence
- "the" is the determiner (det) of "mouse"
- "mouse" is the object (obj) of "chased"
- "through" is the adverbial modifier (advmod) of "chased"
- "the" is the determiner (det) of "garden"
- "garden" is the object (obl) of "through"