Prolog & Natural Language Processing

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Natural language Processing
Very Brief Introduction

- Input Text (or speech) in some language
- Ouput could be:
  - ✓Syntactic analysis: grammatical criteria
  - ✓A translation to another language
    - To a logic language
    - To a natural language
  - ✓Query answering
  - ✓Sentiment analysis, e.g. from social media

A Simple Syntactic Analysis

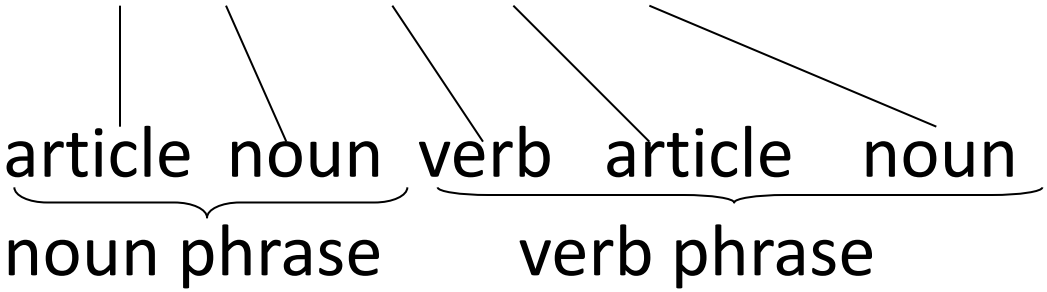
Phrase-structure grammar of very simple English:

sentence --> nounphrase, verb phrase

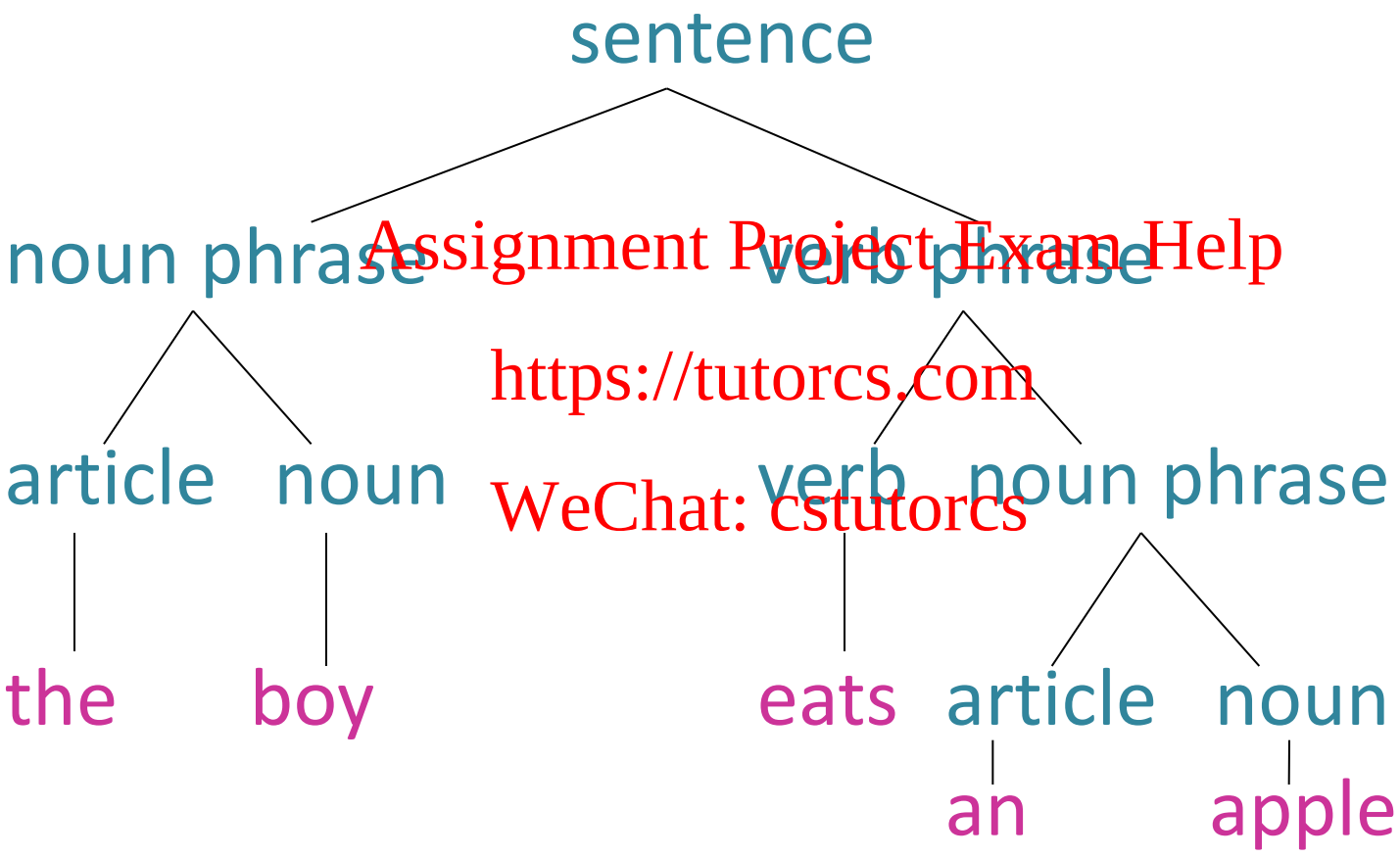
noun phrase --> article, noun

verb phrase --> verb, noun phrase

"The boy eats an apple."



Parse Tree



A Simple Syntactic Analysis cntd.

A simple Lexicon:

article --> the | a | an

noun --> boy | apple | song | cow | grass

verb --> eats | sings | kicks

With this grammar, for example:

"the boy eats an apple"

is a grammatically correct sentence, but

"the boy eats a eats"

is not.

Of course, the grammar is too simple, and

"an apple eats a boy"

is also a grammatically correct sentence!

Never mind for now.

Exercise: For the Tutorial Syntactic Analysis in Prolog

With what you know of Prolog so far:

- you can write an ordinary Prolog program
- to check whether or not an English sentence is grammatically correct, according to the grammar given in previous slides, and
- that can also generate grammatically correct sentences.

Exercise: For the Tutorial cntd.

- You can represent sentences as a list of words, e.g. [the, boy, eats, an, apple].
- Define a predicate *sentence/1*, and any other auxiliary predicate you need, such that *sentence(S)* succeeds if *S* is a correct grammatical sentence

So for example:

?- sentence([a, cow, eats, the, grass]).

Gets the answer yes.

Extending Your Grammar

Then you can extend your grammar so it is more sophisticated:

- Avoid *a, apple* and *an boy* as noun phrases.

- Make sure the verb and the noun agree in being both singular or both plural, e.g.

the boys eats an apple.

- Avoid "non-active" nouns pairing with "active" verbs, e.g.

the apple eats a boy.

the carrot sings.

Language Processing with DCG Grammar Rules in Prolog

- Many Prolog implementations, including Sicstus Prolog, provide specialised notation for language processing.

- This notation is called *DCG – Definite Clause Grammars*.

- This allows writing parsers in Prolog very easily and elegantly.

Prolog DCG Rules

These can be written in the form:

head --> body.

For example:

sentence --> noun_phrase, verb_phrase.

Example of Prolog DCG Notation

```
sentence --> noun_phrase, verb_phrase.

noun_phrase --> article, noun.
verb_phrase --> verb.
verb_phrase --> verb, noun_phrase.

article--> [a].
article--> [the].
article-->[an].

noun--> [boy].
noun--> [apple].

verb--> [eats].
```

- The DCG can be entered as a Prolog program directly and is itself a parsing program.
- Prolog automatically transforms this into a Prolog program that can be queried:


```
?- sentence([a,boy,eats,an,apple], []).
yes.

?- sentence([a,boy,apple,eats], []).
no.

?- sentence(X, []).
X=[a,boy,eats] .....
```

Some notes

- Notice the use of sentence/2.
- DCG implementations in Prolog expect this notation in the queries.
- *Difference lists* used by DCG parsers for efficiency.
- *Difference lists* are beyond the scope of this course.

Extended Example: matching article to noun

✔ a boy

✔ the boy

✔ the boys

✘ a boys

```
noun_phrase --> article(N), noun(N).
article(single)--> [a].
article(single)--> [the].
article(multi)--> [the].
noun(single)--> [boy].
noun(multi)-->[boys].
| ?- noun_phrase([a, boys],[]).
no
```

A DCG for a Simple Formal Language

A formal language, e.g. logic or mathematics, is a set of strings, made up according to a clear grammar.

Consider a simple language S.

Suppose S has two symbols: *a* and *b*.

Suppose a sentence is S is of the form

$a^n b^n$,

i.e. a string of *a*s of length n≥1, followed by a string of *b*s of the same length.

For example

ab , aabb , aaabbb and aaaabbbb

are correct sentences, but aabbb is not.

Lets define this grammar in Prolog DCG.

Base case: s --> [a,b].

Recursive case s --> firsta, s, lastb.

Note recursion

firsta --> [a].

lastb --> [b].

```
| ?- s(X, []).
X= [a,b] ? ;
X = [a,a,b,b] ? ;
X = [a,a,a,b,b,b] ? ;
X = [a,a,a,a,b,b,b,b] ? ;
X = [a,a,a,a,a,b,b,b,b,b] ? ;
X = [a,a,a,a,a,a,b,b,b,b|...] ? ;
X = [a,a,a,a,a,a,a,b,b,b|...] ?
```