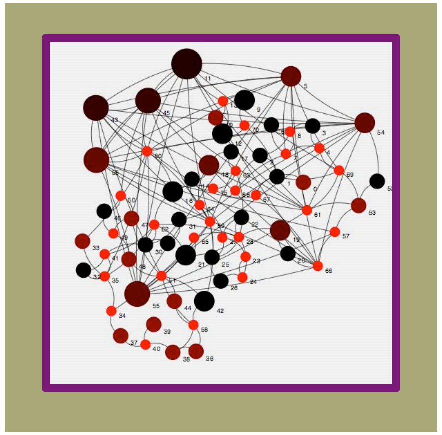
COMP40020 Human Language Technologies

Grammars, Rules and Parsers

February 2019



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+ HLT6

Contents:

- Introduction to Syntactic Parsing
- Definitions and Examples

Aim:

- To give a brief introduction to language parsing strategies based on constituency and dependency. We will look at practical examples using NLTK at Workshop 2 on Wednesday.

+ HLT6

Contents:

- Introduction to Syntactic Parsing
- Definitions and Examples

Aim:

- To give a brief introduction to linguistic parsing strategies based on constituency and dependency. We will look at practical examples using NLTK at Workshop 2 next Monday. There will be a short assignment based on the workshop [illegible] worth 5%.

Primarily knowledge-based approach

Analysis & Generation

- Analysis
  - a representation constructed while checking whether a sentence can be accepted or rejected is an **analysis** (→ derivational history)
- Generation
  - a string is said to be generated by a grammar if there is a derivation of the grammar leading to it (→ can be several distinct derivations)

Grammar & Lexicon

- Grammar
  - representation
    (→ for now, CF-phrase structure rules)
  - acquisition

- Lexicon
  - representation
    (→ for now, terminal vocabulary V_T)
  - acquisition

+ Grammar & Lexicon

- Grammar
  - representation

    (→ for now, CF-phrase stru
  - acquisition

Syntactic Rules

S → NP VP

NP → Det N

NP → Det Adj N

VP → V NP

- Lexicon
  - representation

    (→ for now, termina
  - acquisition

Lexicon

Det → the

N → author | novel |orange | rabbit | cat

Adj → orange

V → wrote | chased

+ Parsing as Search

- Syntactic parsing is often regarded as searching through the space of all possible parse trees to find the correct parse tree for the sentence.

→Search space of possible parses is defined by the grammar

→The goal is to find all trees whose root is S and which cover exactly the words in the input

→Regardless of the search algorithm, there are two kinds of constraints that can help guide the search

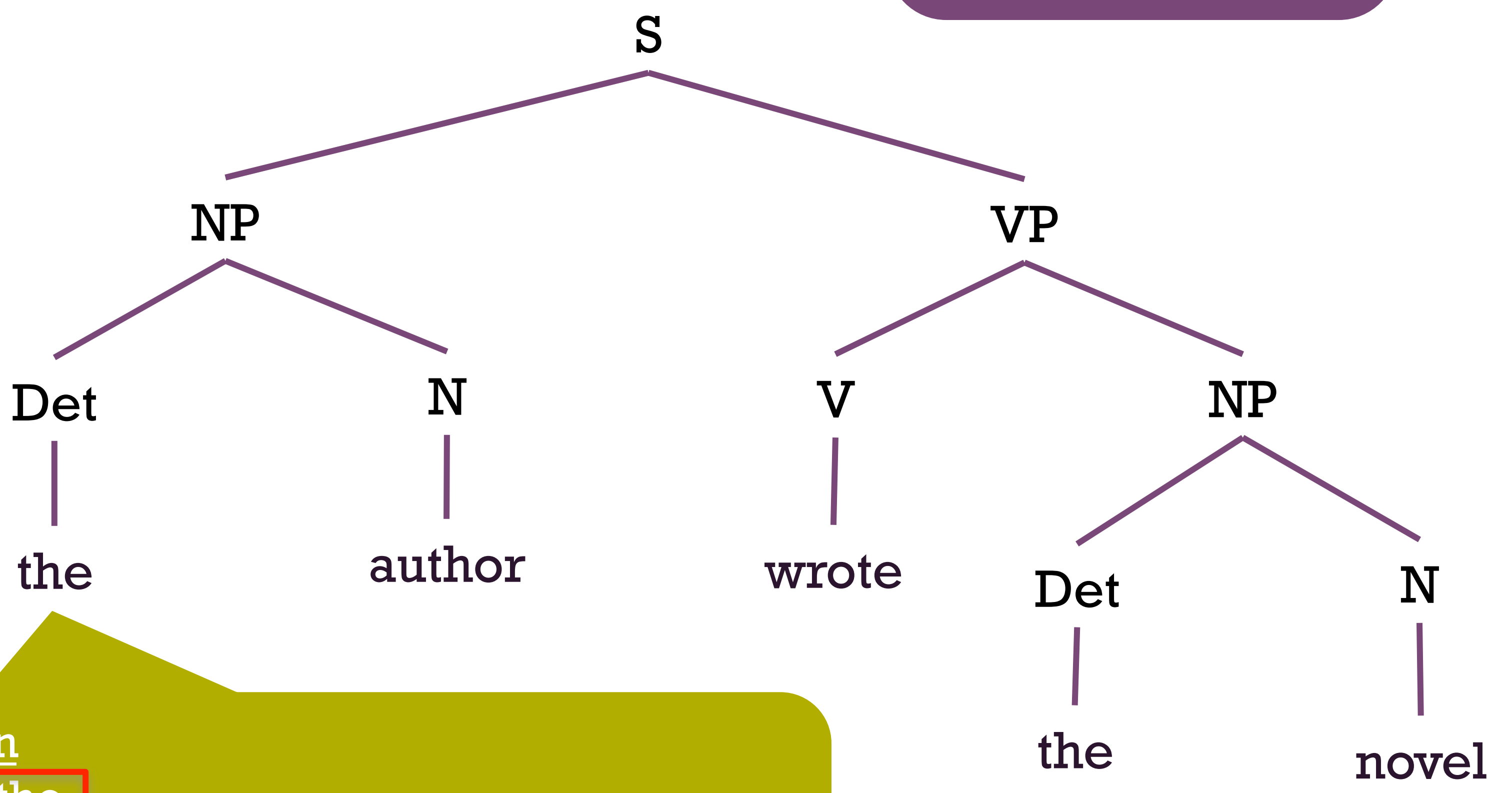
  → Using the input (→ bottom-up → input-driven)

  → Using the grammar (→ top-down → goal-driven)

(Jurafsky & Martin, 2008)

+ Top-Down Parsing

Syntactic Rules
S → NP VP
NP → Det N
NP → Det Adj N
VP → V NP



Lexicon
Det → the
N → author | novel | orange | rabbit | cat
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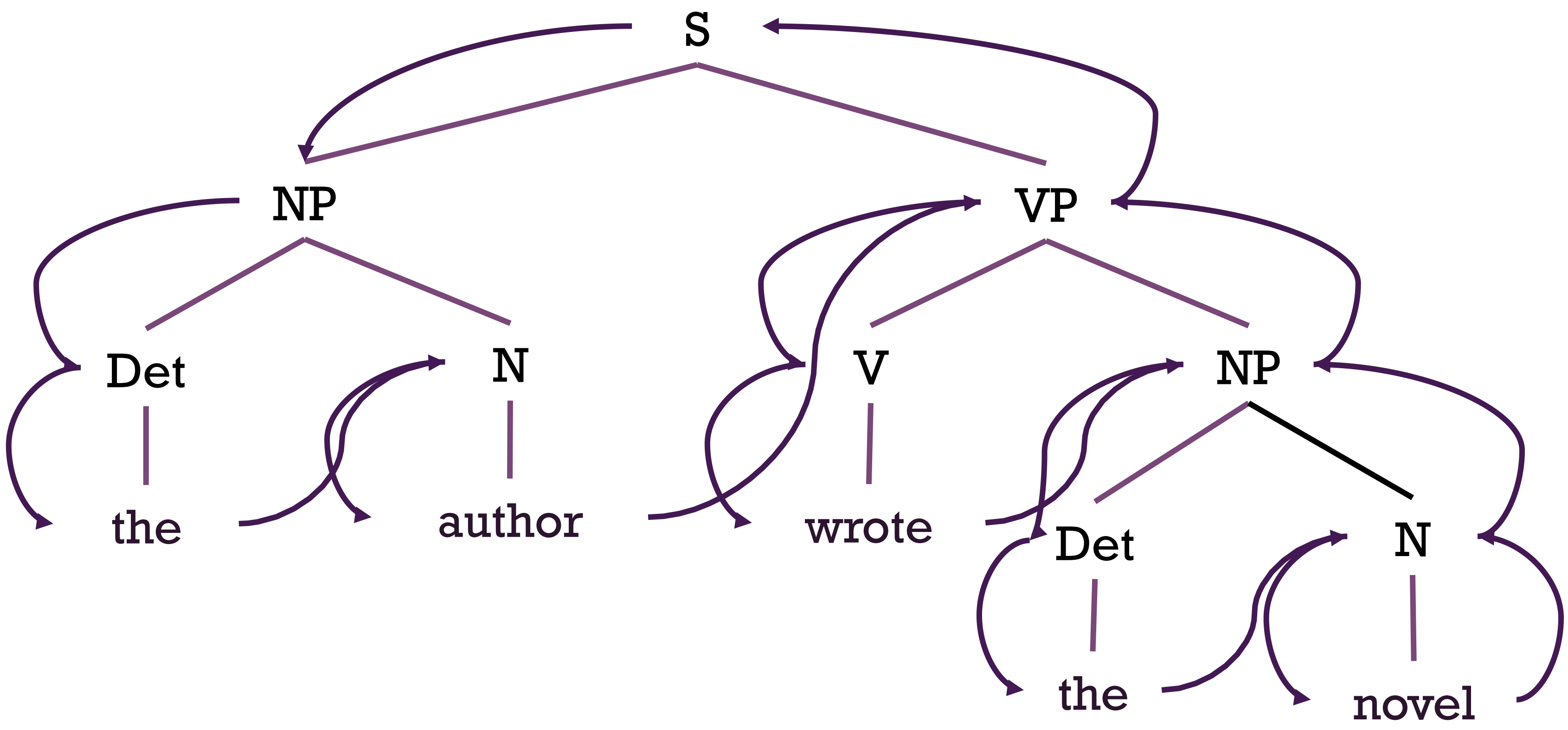
Top-Down Parsing

- Top-down, depth-first, left-to-right



- Starting with the grammar

+ Top-Down Parsing

- *the orange rabbit* chased th

Syntactic Rules

S → NP VP
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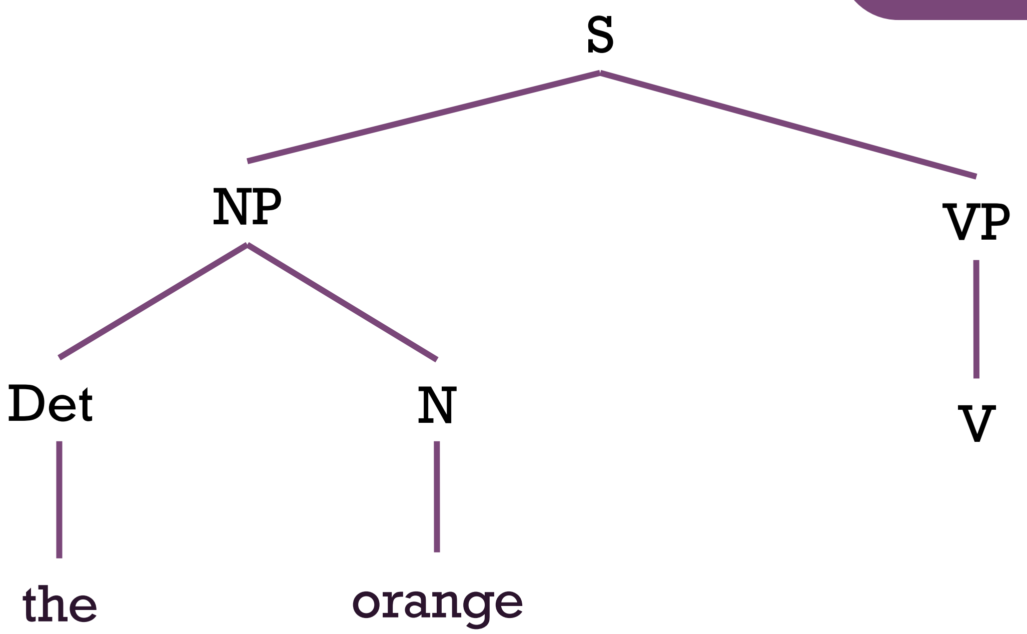

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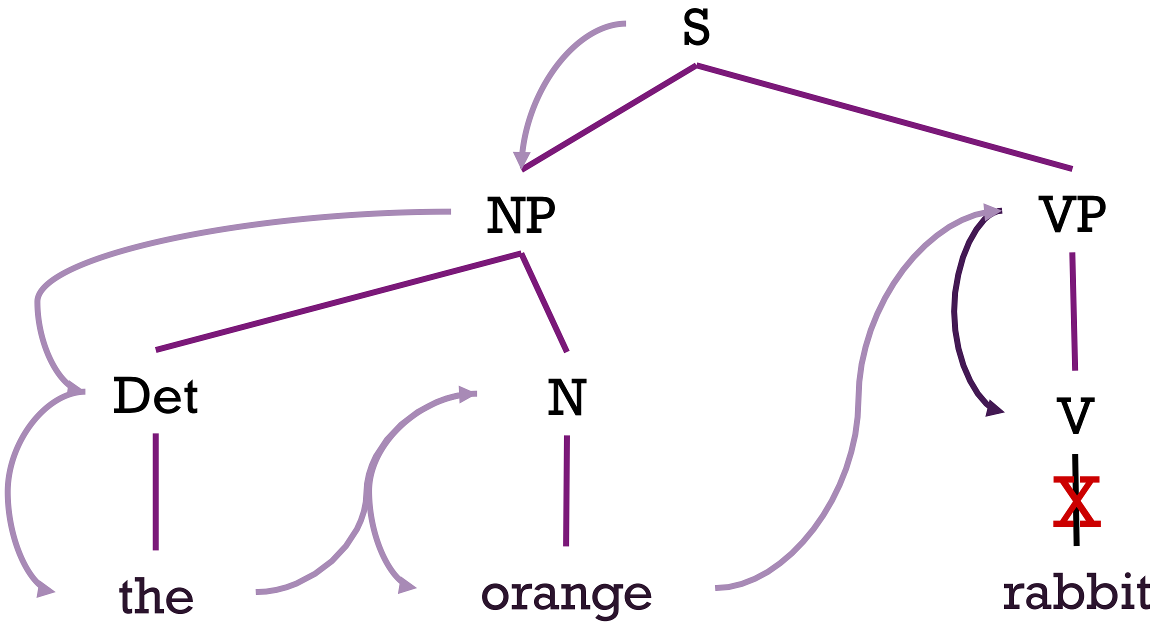
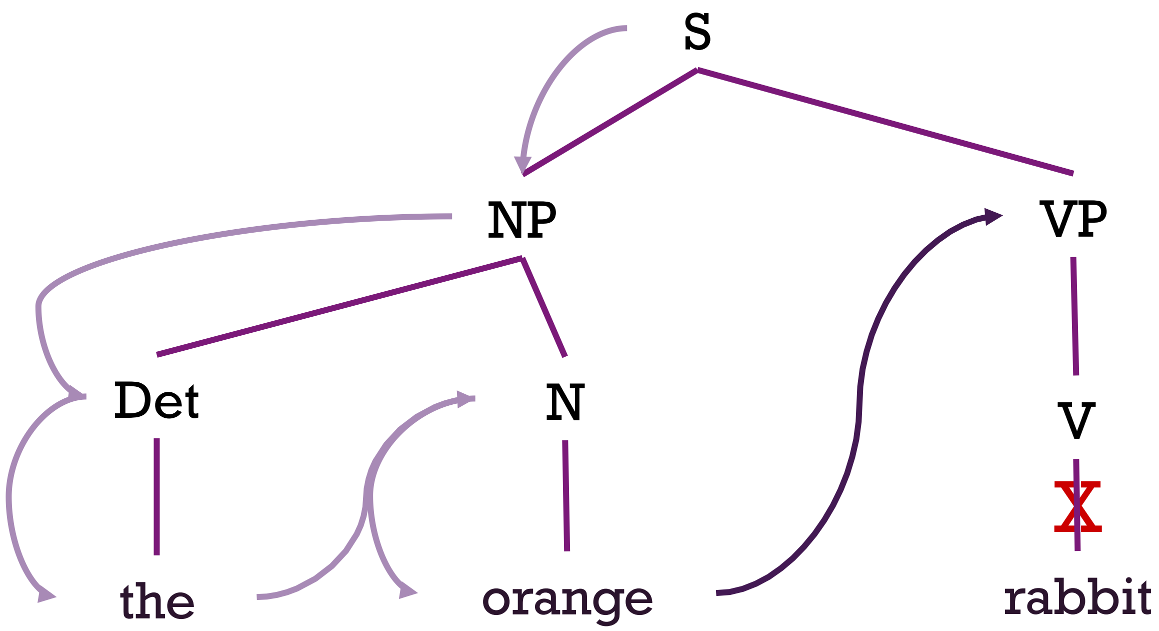
+ Top-Down Parsing

- *the orange rabbit* chased the cat



Top-Down Parsing

- *the orange rabbit* chased the cat



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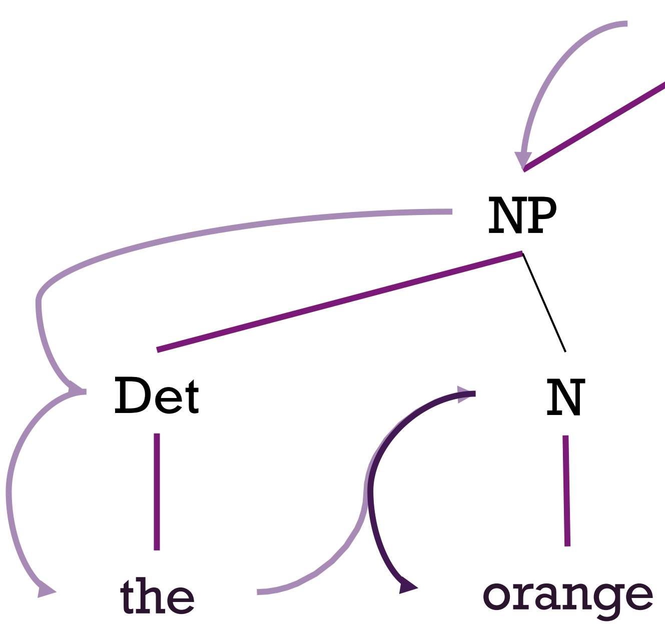

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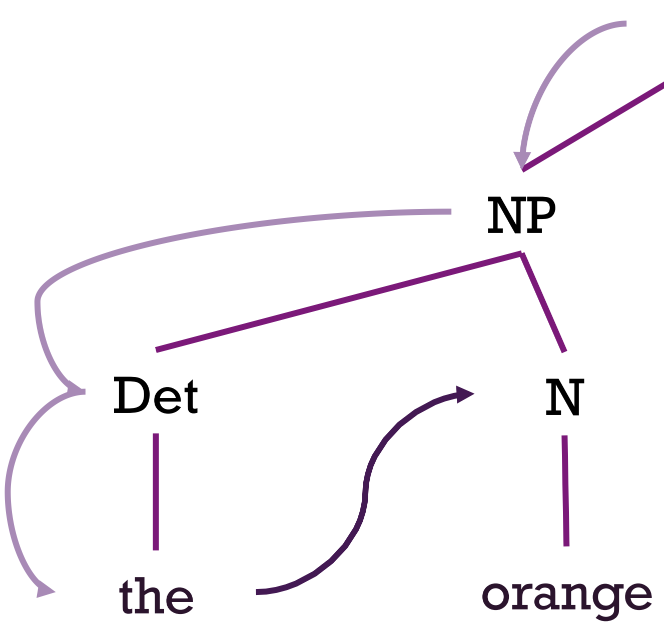

Top-Down Parsing

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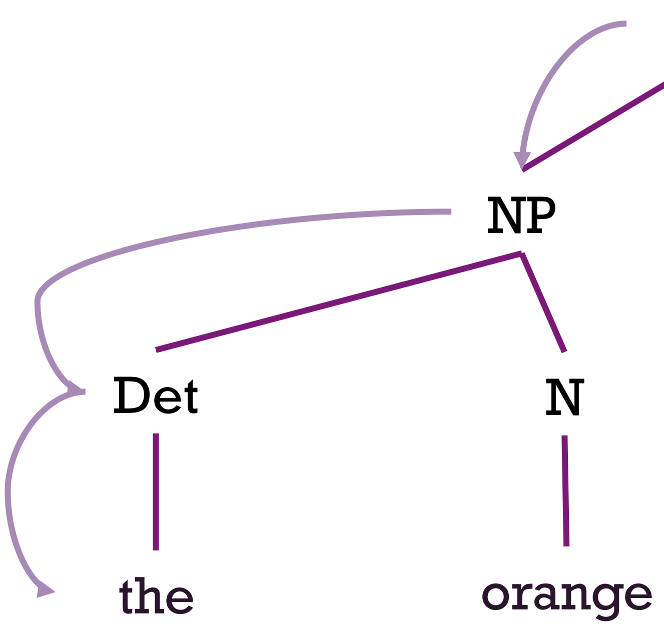

Top-Down Parsing

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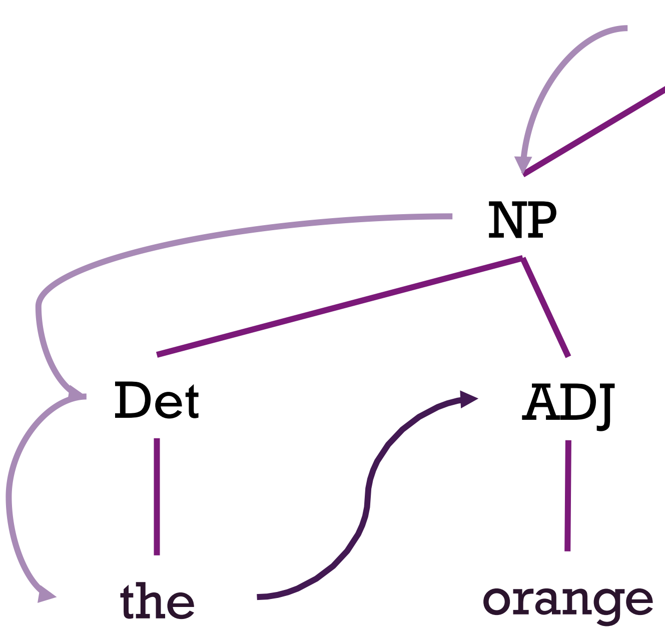

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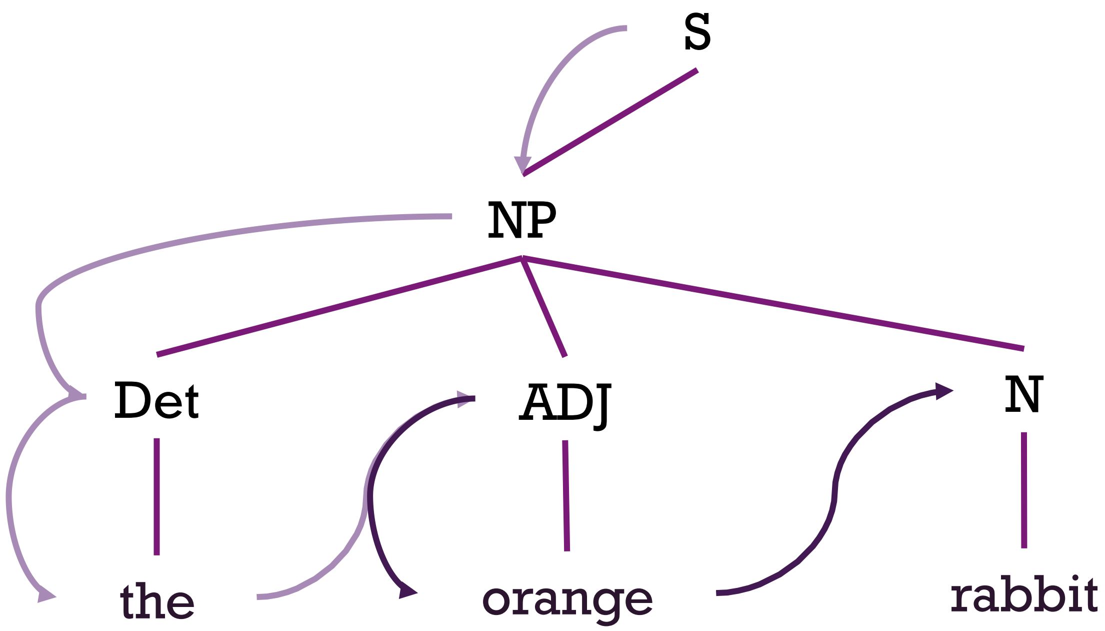

Top-Down Parsing

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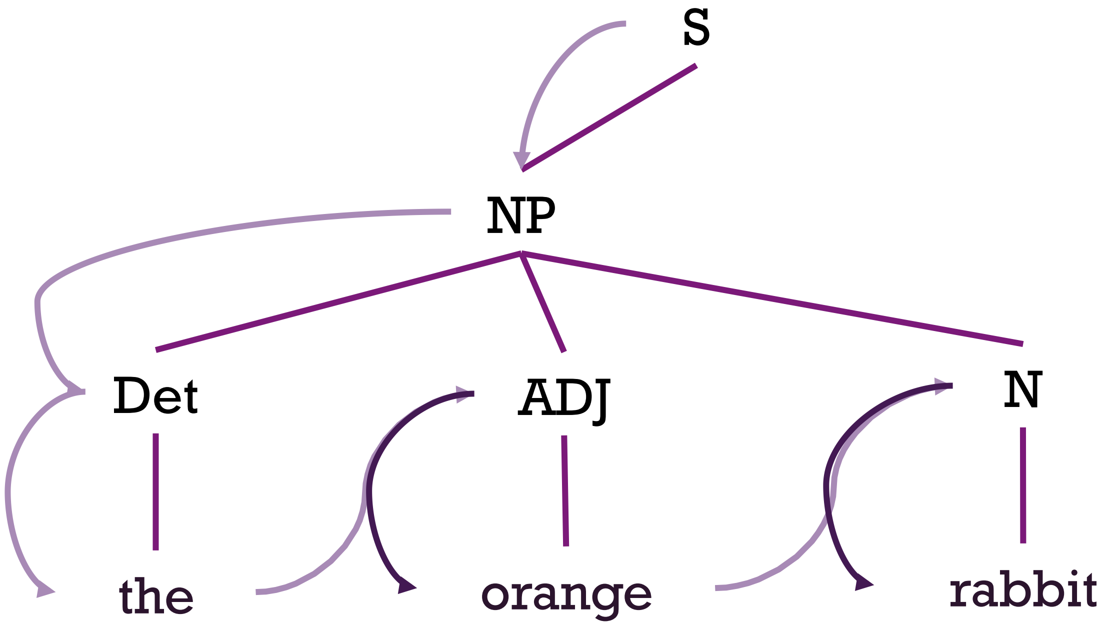

→ backtracking

Top-Down Parsing

Advantages:

- Never wastes time exploring trees that cannot result in an S
- Never explores trees which cannot find a place in some S-rooted tree

But:

- Spends considerable time on S trees which are not consistent with the input
- Has problems with coordination ambiguity
  - John talked to the novelist and the politician last week
  - John talked to the novelist and the politician wasn’t happy

+ Top-Down Parsing

Problems:

- ***recursive*** rules e.g. NP → NP CONJ NP
  - Options:
    - rewrite the rules
    - change the strategy to one which is not troubled by them (→ bottom-up)
- processor commits itself to a particular analysis before attempting to connect up words of the input string
  - Option
    - change the strategy (→ left-corner)

+ Bottom-Up Parsing

- Bottom-up

Syntactic Rules

S → NP VP
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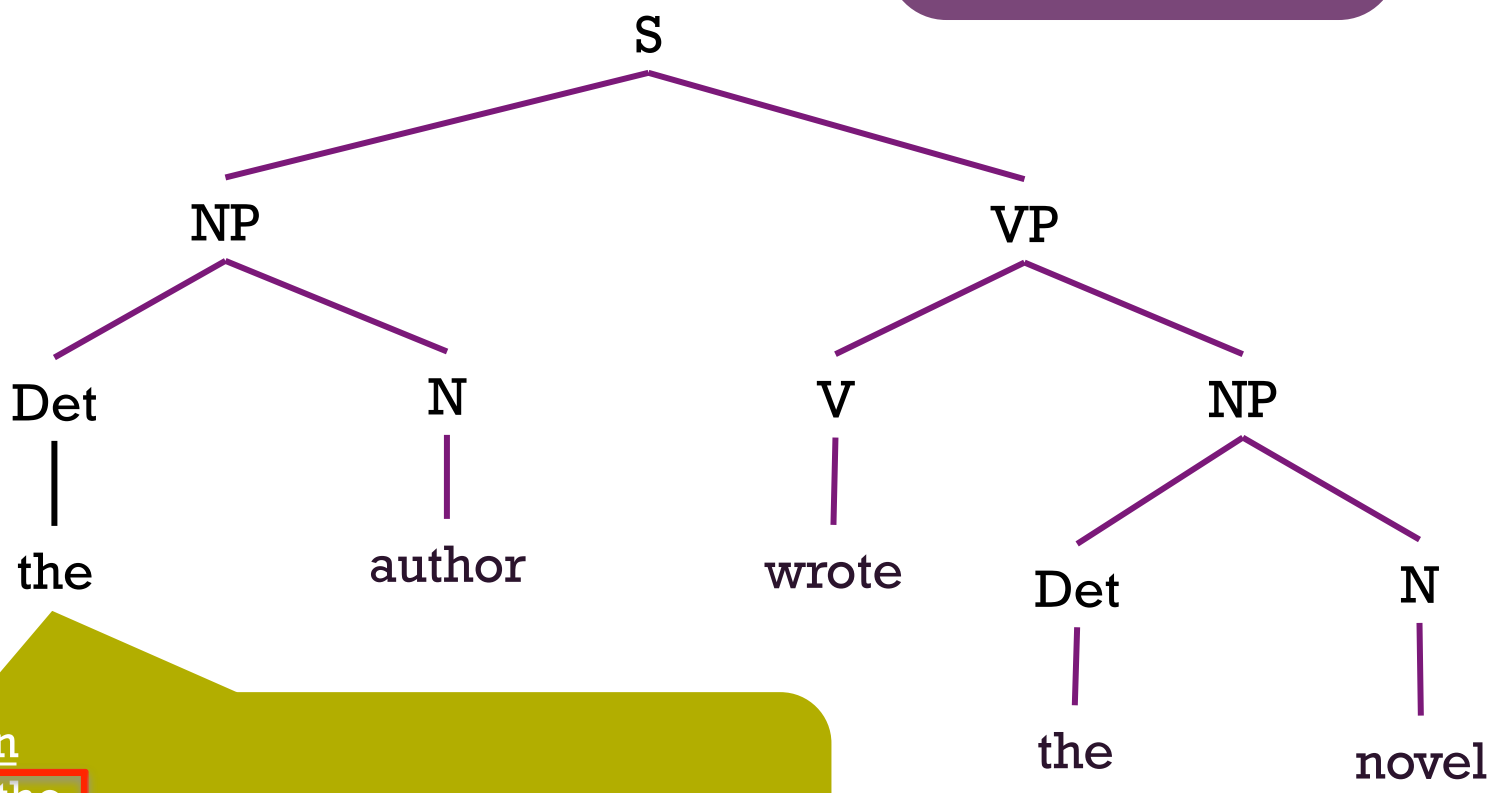
NP → Det Adj N
VP → V NP



Lexicon

Det → the
N → author | novel | orange | rabbit | cat
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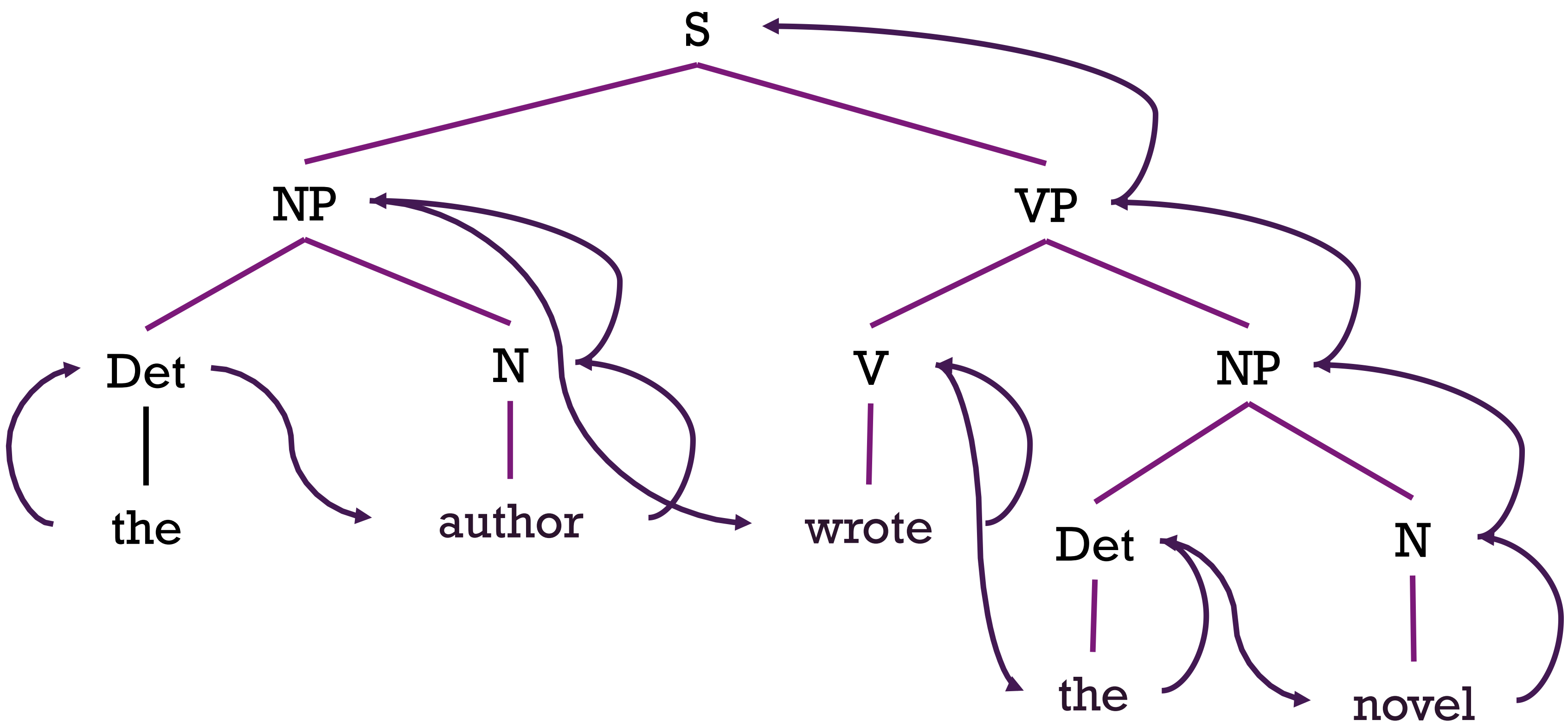
+ Bottom-Up Parsing

- Bottom-up



- Starting with the words

+ Top-Down vs. Bottom-Up

- One problem with top-down parsing strategy was that the parser commits to a particular analysis before connecting up the words of the input string.

- Incorrect guesses can be recovered through backtracking but this process can involve a great deal of futile computation as structures are pursued that could never be supported by the input.

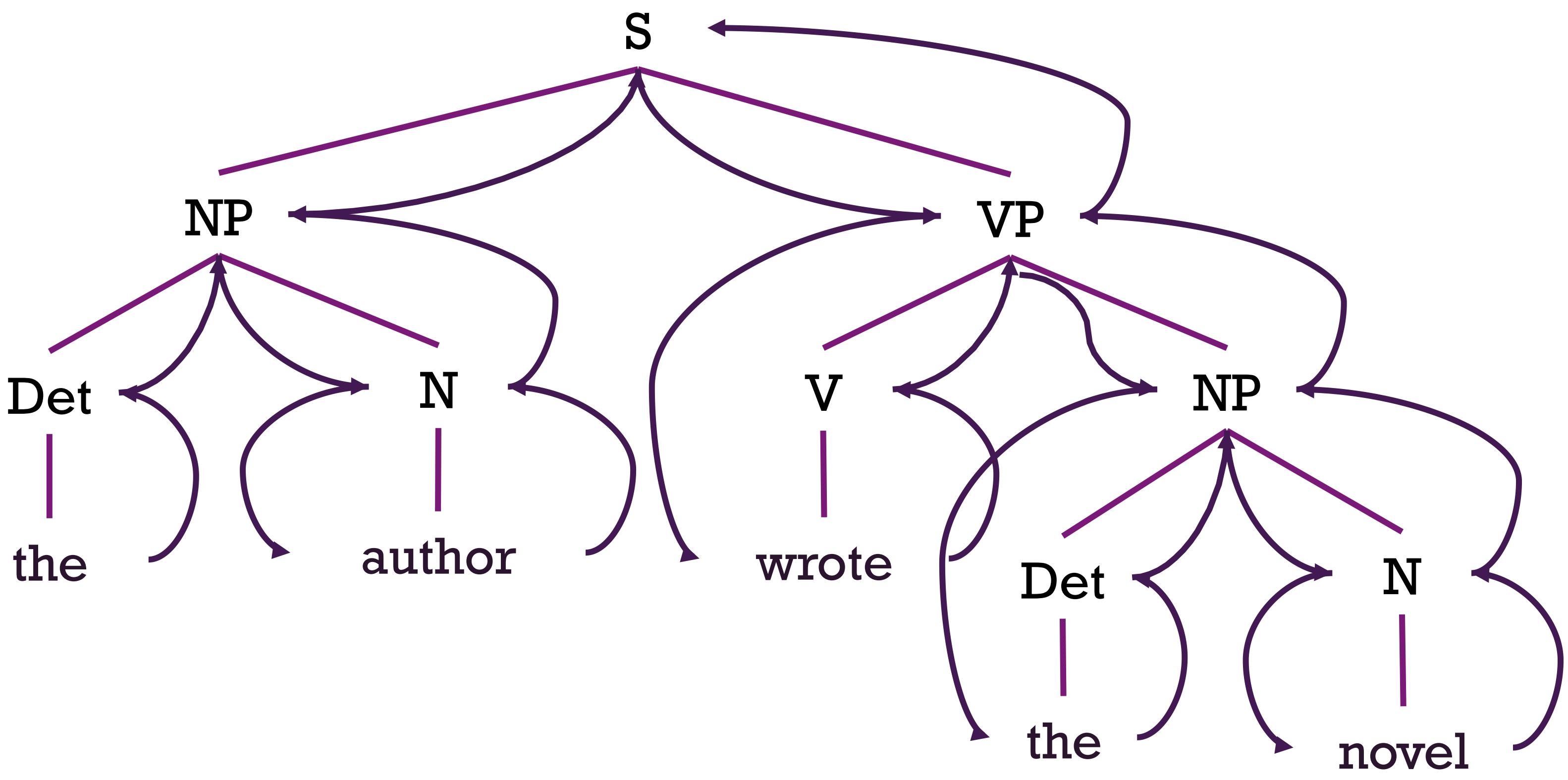
Top-Down vs. Bottom-Up

- **Bottom-up** parsing does not get misled this way as it is input-driven.

- But a bottom-up strategy can also result in much fruitless processing if analyses are attempted which could never be true **in that particular context.** (→ ambiguous words: can, play, orange)

- It is possible to temper a blind bottom-up strategy with a **degree of top-down control** (bottom-up parsing with top-down lookahead → left-corner)

+ Left-Corner Parser



Left-Corner Parsing

- Behaves sensibly on left- and right branching structures

But

- still has problems with centre-embedding (as do humans!)
  - E.g. a man that a woman that a child that a bird that I heard saw knows loves…
- unlike the top-down parser, the structure it builds is not always completely connected.
- unlike the bottom-up parser, it predicts phrases just on the basis of the left corner which can be wrong.

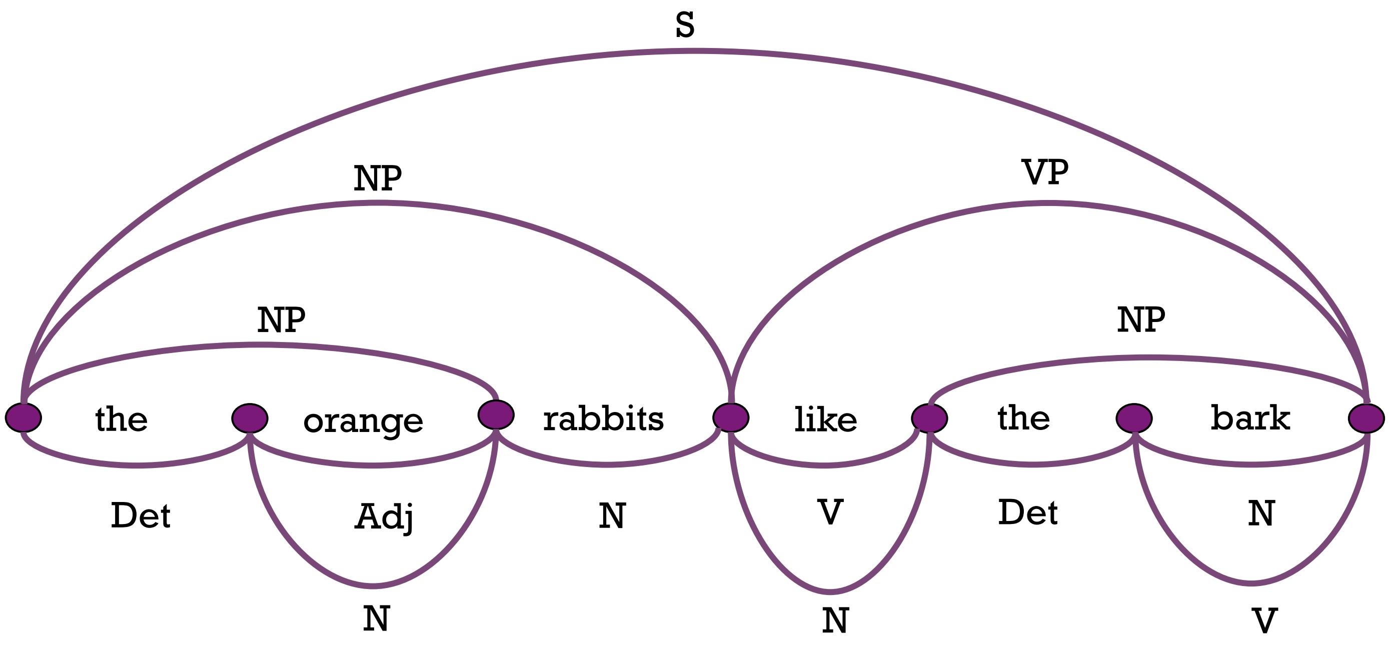
Chart Parsing

- One of the problems of relying on backtracking to recover from errors parsing is that the parser forgets everything it has found between the backtracking points

→ rediscovering previously recognised lexical items or phrases

Chart Parsing

- A solution is to keep track of whatever has already been processed in a **chart**.



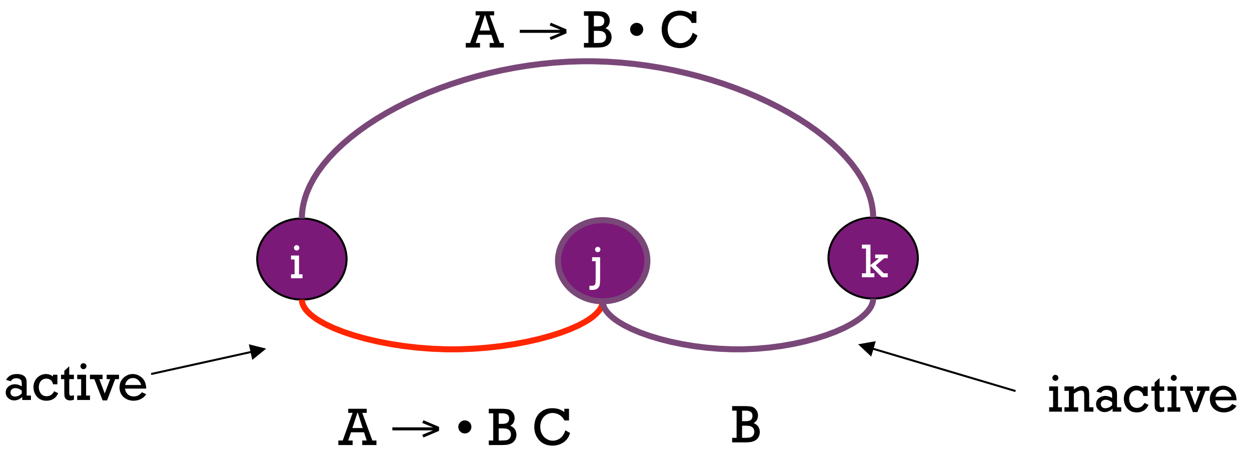
- The nodes (vertices) represent the gaps between the words

- The edges (arcs) represent the lexical or phrasal categories.

Chart Parsing

- Processing using a chart involves interaction between active (incomplete) and inactive (complete) edges which leads to the introduction of a new edge into the chart

→ Fundamental Rule



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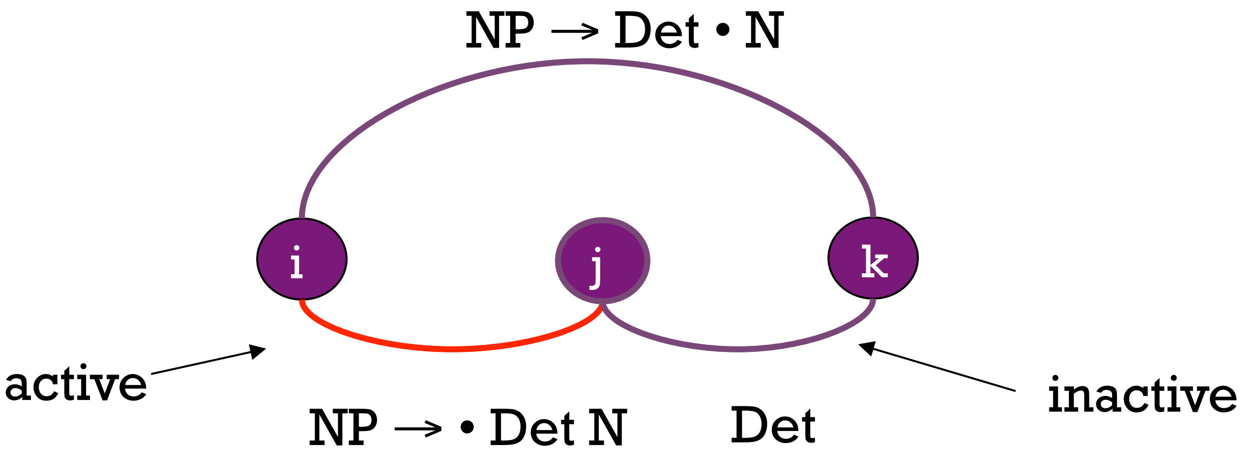


+ Chart Parsing

- Assuming the following grammar and lexicon:

Syntactic Rules

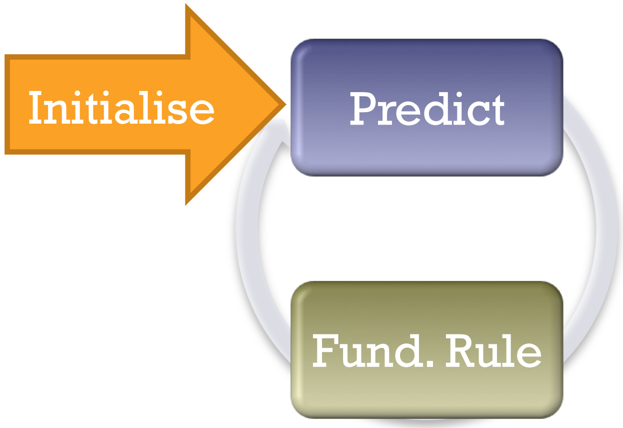
S → NP VP
NP → Det N
NP → Det Adj N
VP → V NP

Lexicon

Det → the
N → orange | rabbits | bark | like
Adj → orange
V → like | bark

+ Chart Parsing

- Bottom-Up
  - Initialisation rule
  - Predict rule
  - Fundamental rule



- Top-Down
  - Initialisation rule
  - Expand rule
  - Match rule
  - Fundamental rule

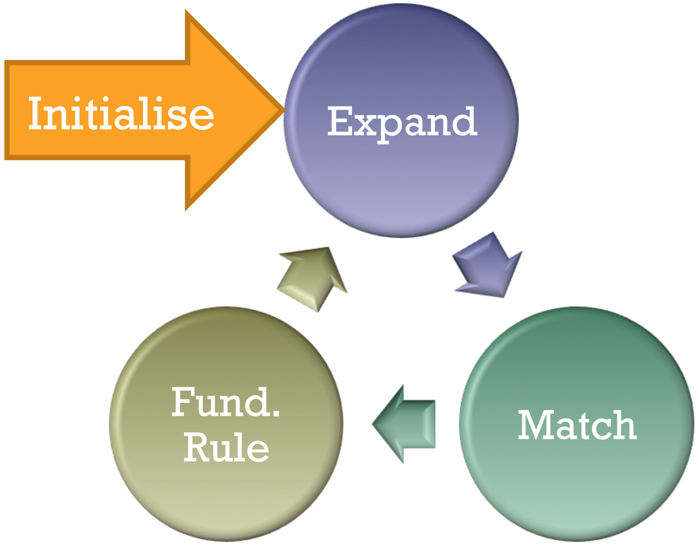


Chart Parsing

- Bottom-Up Initialisation:
  - add an inactive (completed) edge for each of the lexical items

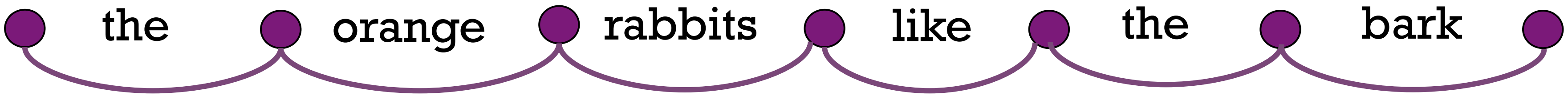


Chart Parsing

- Bottom-Up Prediction:
  - For each complete edge, add an active (incomplete) edge based on the lexicon and grammar

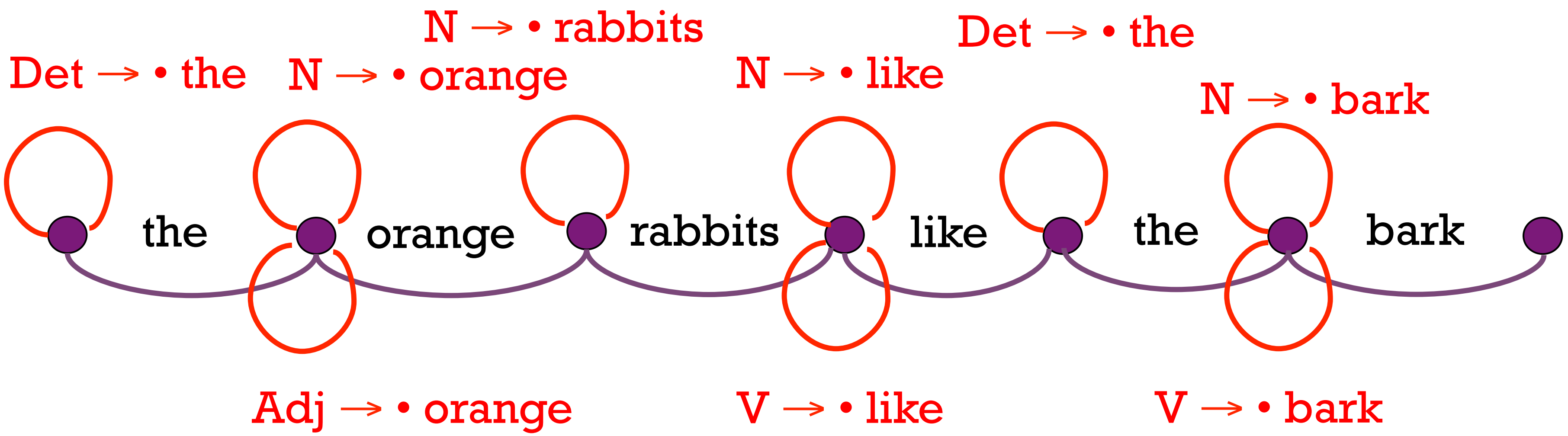
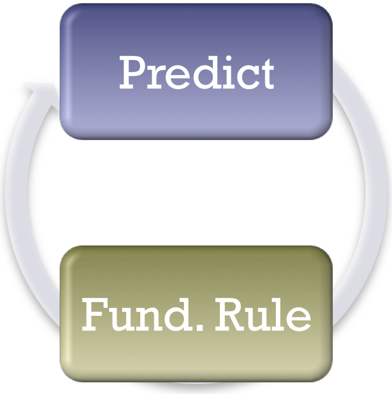


Chart Parsing

- Apply Fundamental Rule



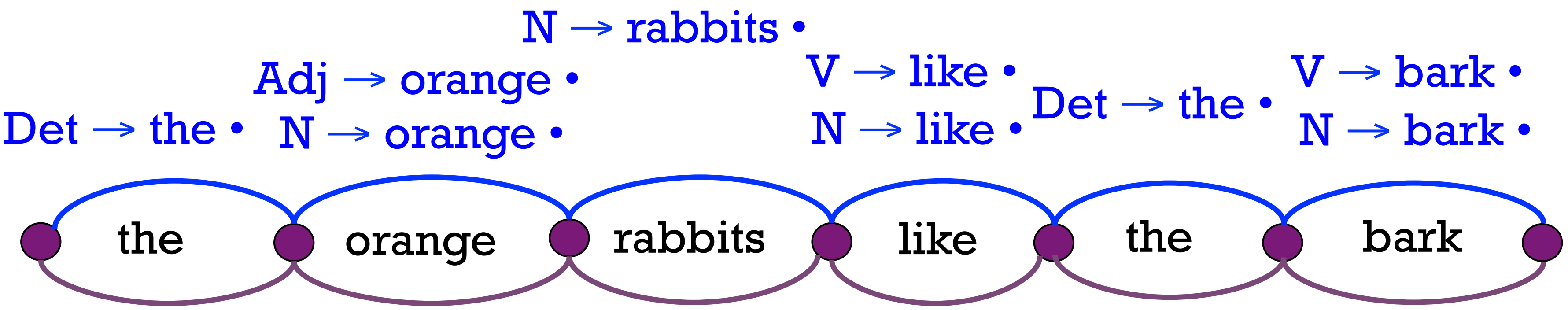
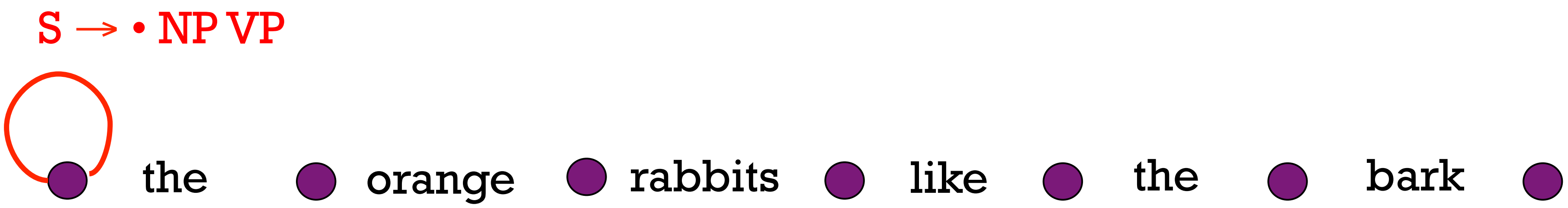


Chart Parsing

- Top-Down Initialisation:
  - add an **active (incomplete) edge for the S category**



S → • NP VP

the orange rabbits like the bark

Chart Parsing

- Top-Down Expand Rule:
  - expand by adding an **active (incomplete) edge for all left corners (i.e. top-down predict)**

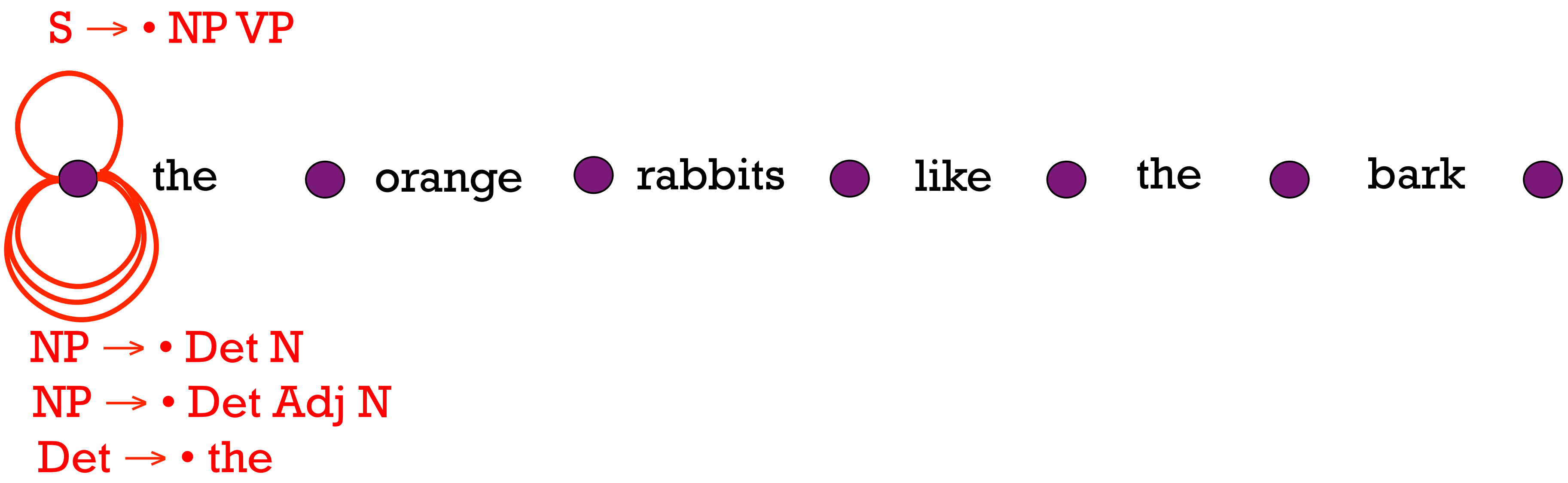


Chart Parsing

- Top-Down Match Rule:
  - Allows the grammar predictions to be matched against the input by adding a complete edge for the lexical items

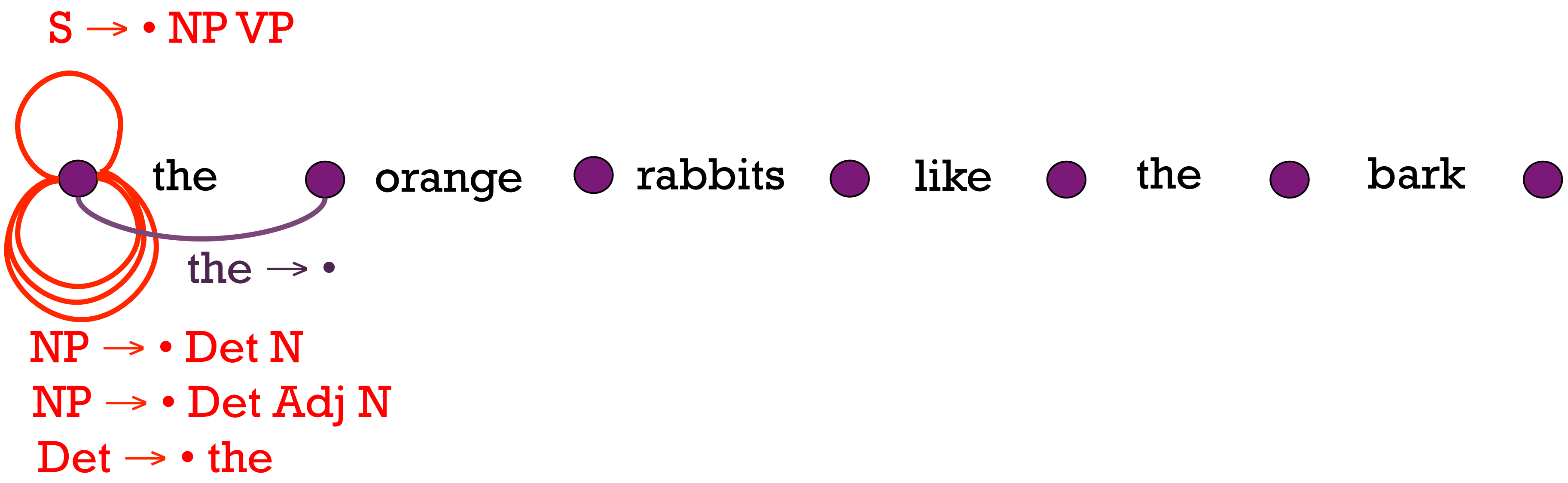
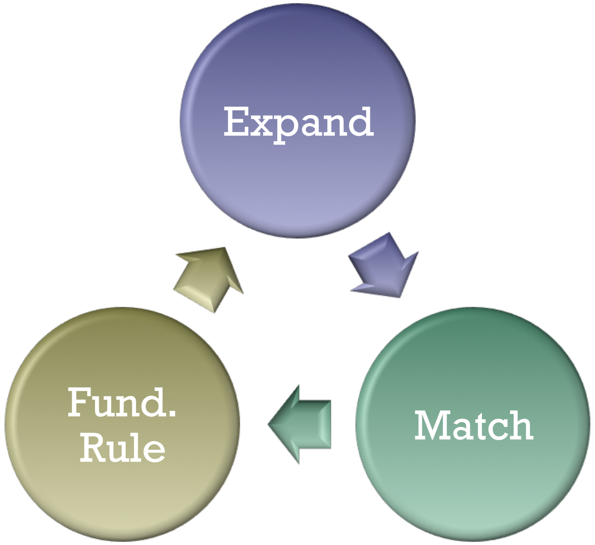
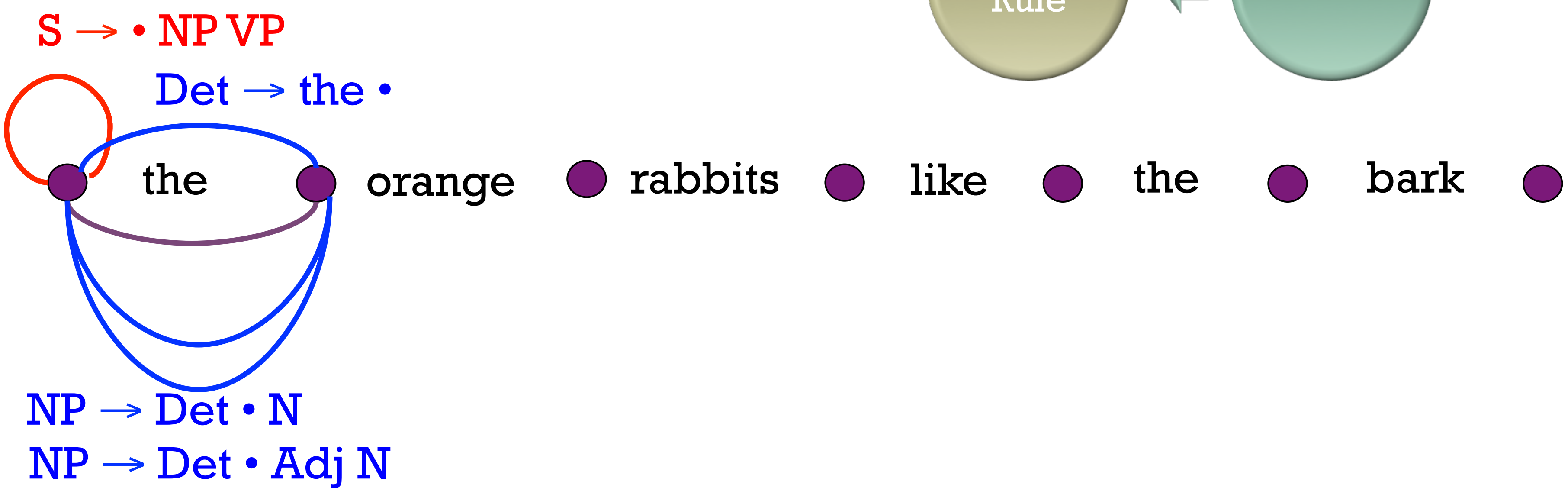


Chart Parsing

- Apply Fundamental Rule





+ Chart Parsing

- Finished

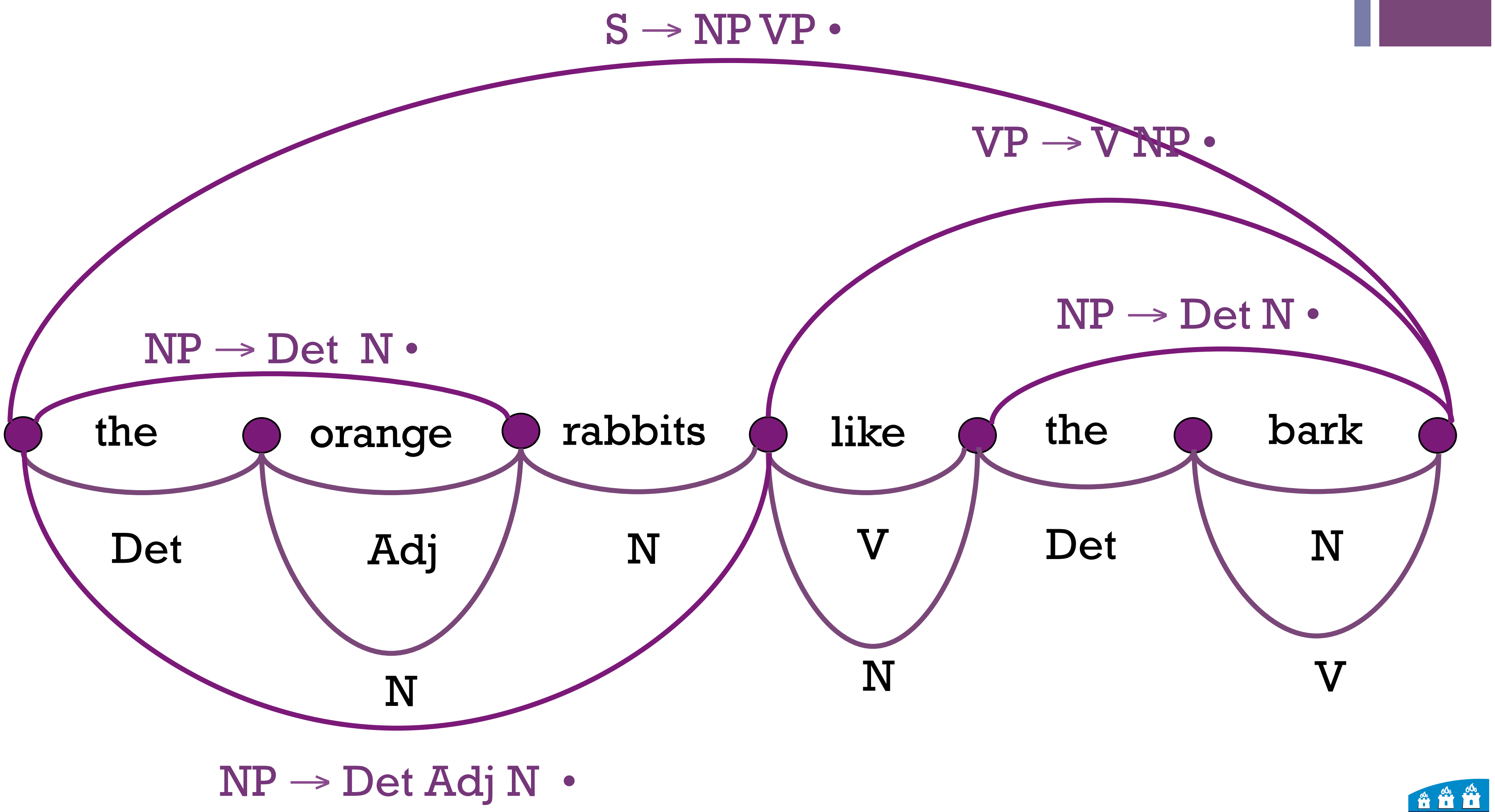


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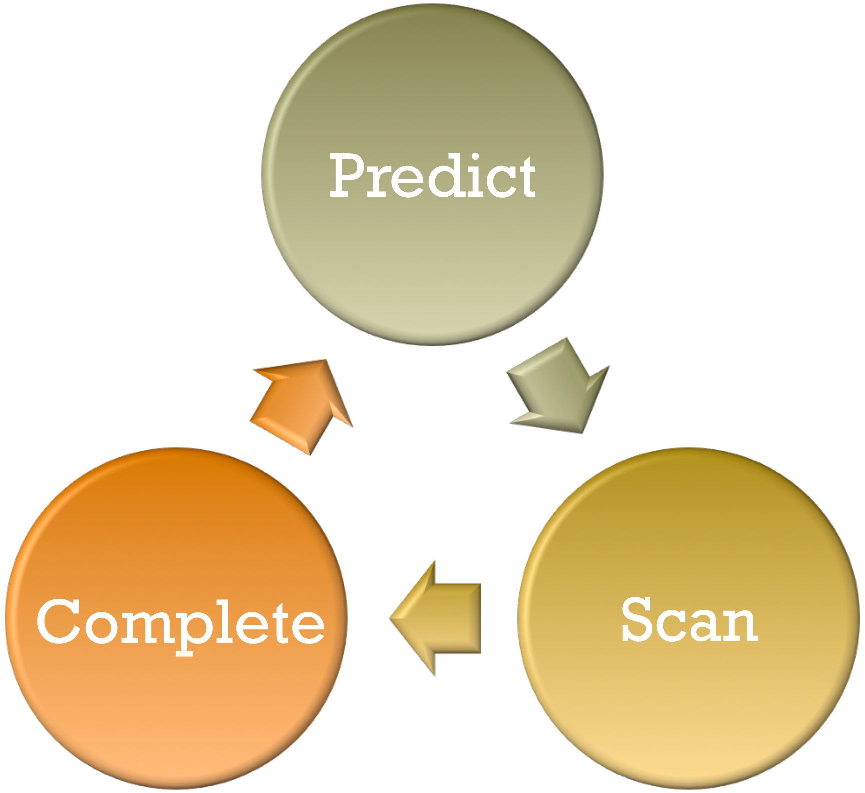
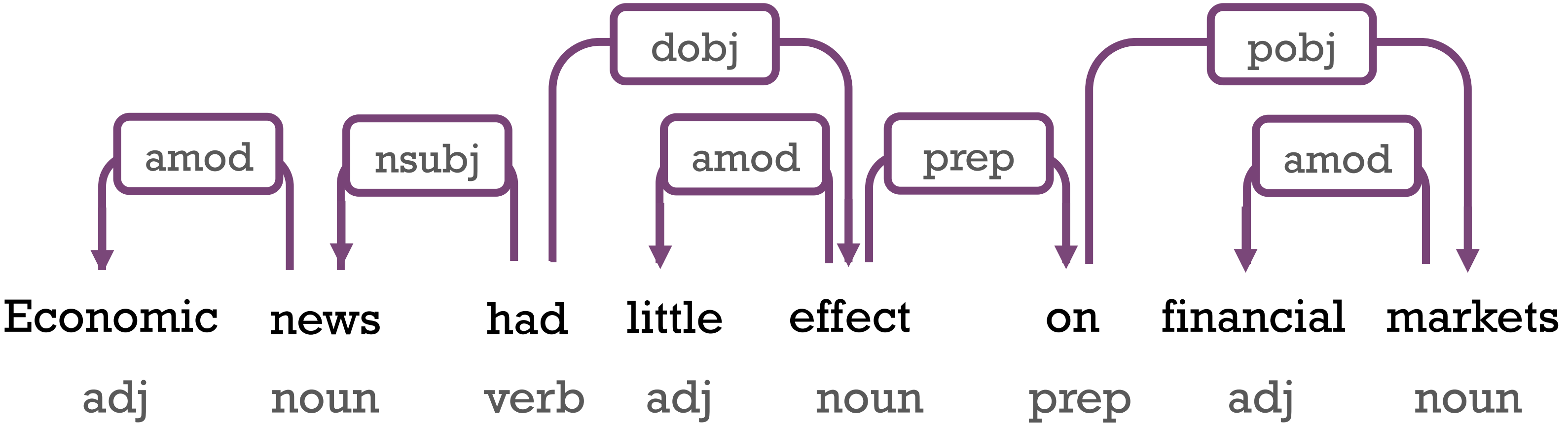
Chart Parsing

- Earley Algorithm
  - Predict
  - Scan
  - Complete

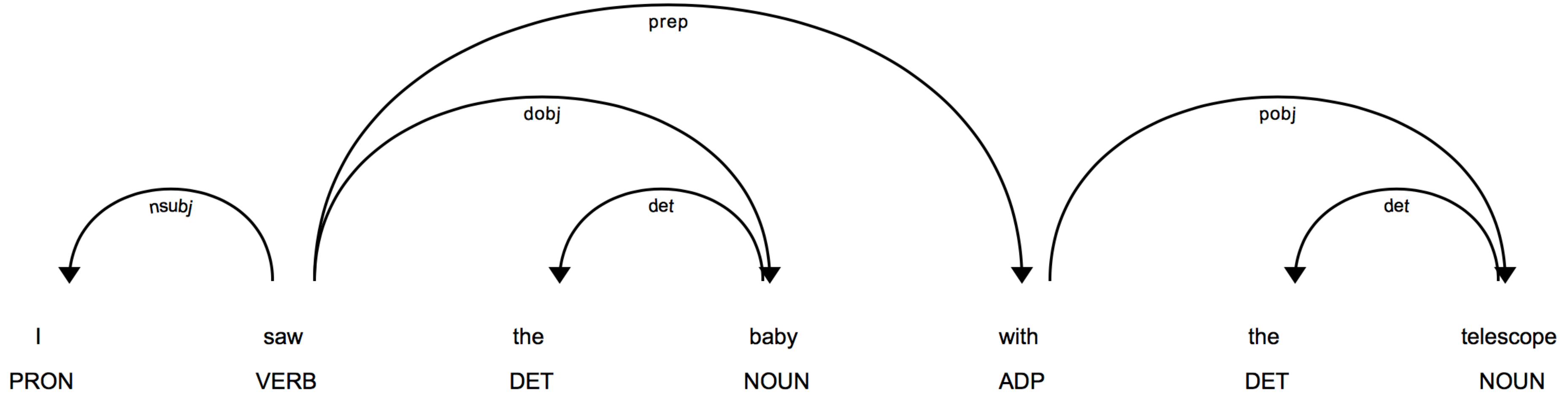


Dependency Parsing



From: http://stp.lingfil.uu.se/~nivre/docs/05133.pdf

+ Dependency Parsing


prep
dobj
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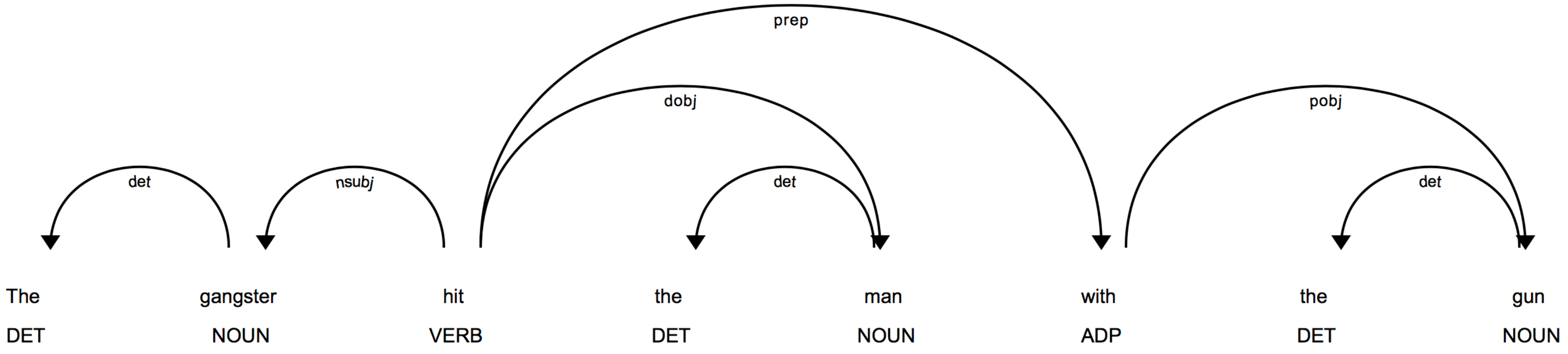
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