Basic issues on Parsing 1

- Introduction
- Parsing issues
- Parsing CFG
- TN, RTN, ATN
- Charts

Basic issues on Parsing 2

- Parsing goals
  - Syntactic structure
  - Logic and basic semantic structure
- Syntax/semantics interaction
  - Only syntax
  - Only semantics
  - Performing in sequence
  - Performing in parallel.

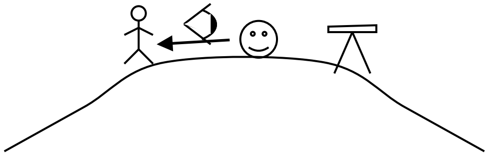
Basic issues on Parsing 3

- Parsing as searching in a search space
  - Characterizing the states
    - (if possible) enumerate them
  - Define the initial state (s)
  - Define (if possible) final states or the condition to reach one of them

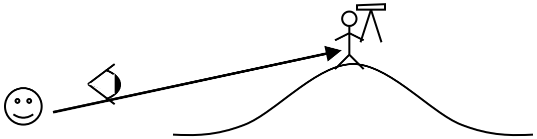
Basic issues on Parsing 4

- Factors in parsing
  - Grammar expressivity
  - Coverage
  - Involved Knowledge Sources
  - Parsing strategy
  - Parsing direction
  - Production application order
  - Ambiguity management
  - (in)determinism
  - Parsing engineering

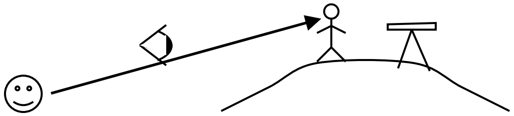
Basic issues on Parsing 5



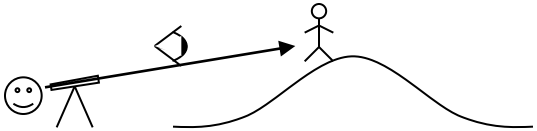
“I was on the hill that has a telescope when I saw a man.”



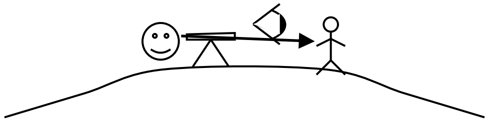
“I saw a man who was on a hill and who had a telescope.”



“I saw a man who was on the hill that has a telescope on it.”



“Using a telescope, I saw a man who was on a hill.”



“I was on the hill when I used the telescope to see a man.”

. . .

I saw the man on the hill with the telescope

☺Me → See A man The telescope The hill

Taken from Loper

Basic issues on Parsing 6

A bit of history of Parsing

- pattern matching
- TN => RTN => ATN
- WFST, Charts (M. Kay)
- Dynamic programming methods: CKY, Earley
- Phrase structure grammars: LSP (Sager), Diagram (Robinson)
- Deterministic parsers: LL, LR
- Parsifal (Marcus)
- Unification-based systems: DCG (Pereira,Warren) , Patr II (Shieber)

Woods, 1970

Kay, 1980

Younger, 1967
Earley, 1970

Sager, 1981
Robinson, 1982

Aho et al,1990
Chapman, 1987
Tomita, 1986, 1987

Marcus, 1980

Pereira, Warren, 1980
Shieber, 1986

Basic issues on Parsing 7

- Parsers today
  - CFG (extendided or not)
    - Tabular
    - Charts
    - LR
  - Unification-based
  - Statistical
  - Dependency parsing
  - Robust parsing (shallow, fragmental, chunkers, spotters)

Basic issues on Parsing 8

Parsing strategy

- Top Down
  - Guided by goals
  - Starts with a goal (or set of goals) to be built.
  - Tries to solve one of the pending goals
  - If more than one production can be applied:
    - serach problem
  - Pending goals can be reordered
  - Several search criteria (including heuristics) can be applied
  - The process ends when all the goals have been reached

Basic issues on Parsing 9

Parsing strategy

- Bottom up
  - Data driven
  - Starts from the sequence of words to be parsed (facts)
  - Proceeds bottom up
  - Several search criteria (including heuristics) can be applied
  - The process ends when the list of facts contains the initial symbol of the grammar.

Basic issues on Parsing 10

- Problems of TD strategy
  - Left recursivity
  - Many productions expanding the same non terminal
  - useless work
  - Search basically guided by the grammar
  - Repeated work
  - In general problems of backtracking algorithms

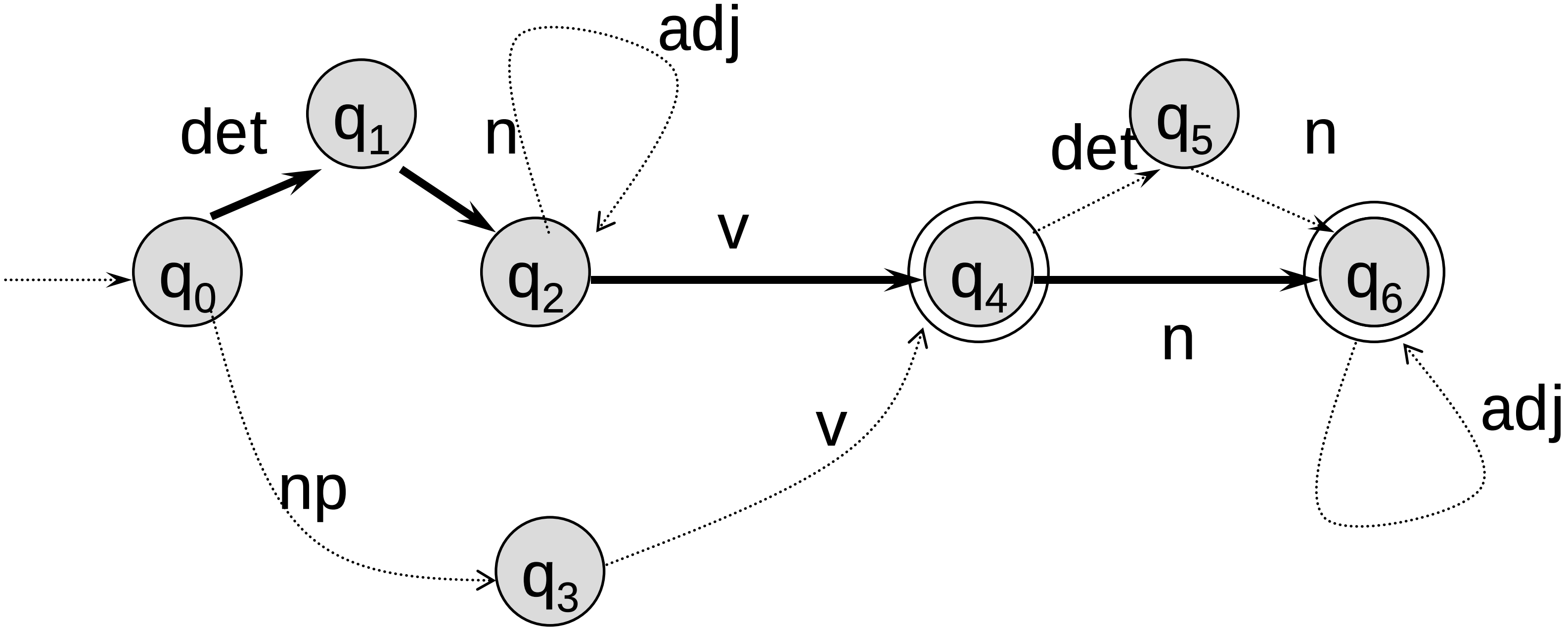
Basic issues on Parsing 11

- Problems of BU parsing
  - empty (optional) categories
  - Useless work (locally possible but globally impossible)
  - Inefficient when there is a high lexical ambiguity
  - Repeated work

ATN 1

- FSA -> Transition Network TN
  - States associated to the positions in the sentence
  - Arcs (transitions)
    - Labeled with POS
      - An arc can be traversed if the current word has the same POS as the arc.
  - Non determinism
    - More than one initial state
    - Current word with more than 1 POS
    - More than one arc for the same POS

ATN 2



the   *cat* *eats*   *fish*

det   n   v   n

ATN 3

TN limitations

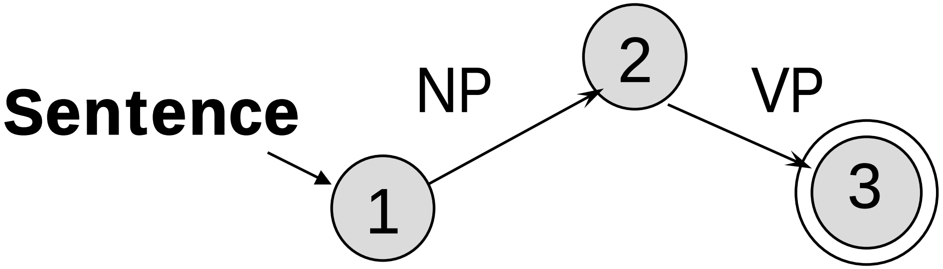
- Only RG
- Only recognition
- Non-determinism ⇒ backtracking
- No separation between grammar and parser
  - grammar ⇒ syntactic model description
  - parser ⇒ control

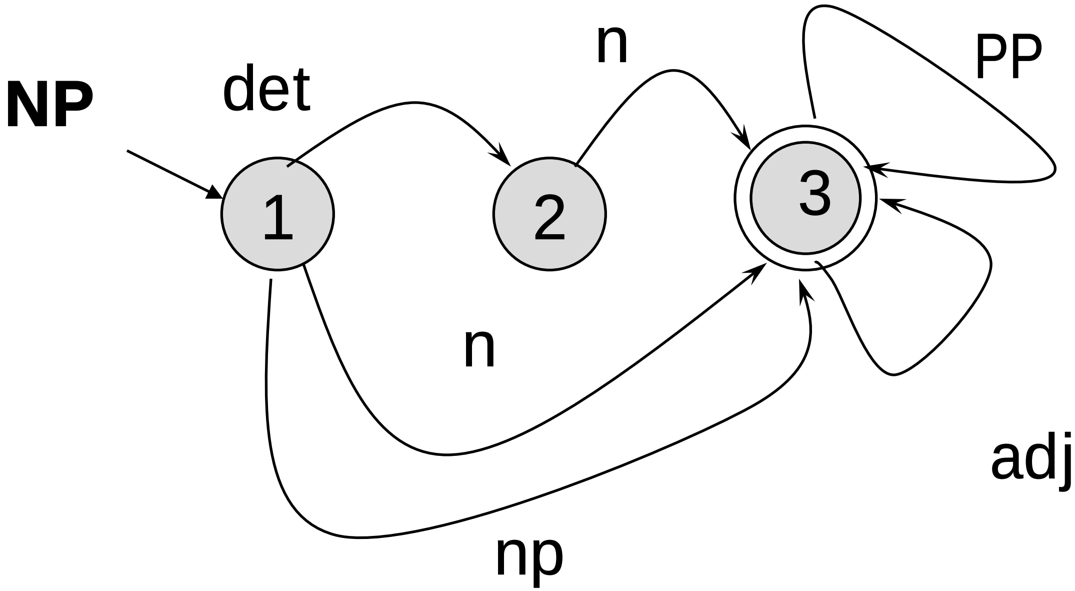
ATN 4

RTN

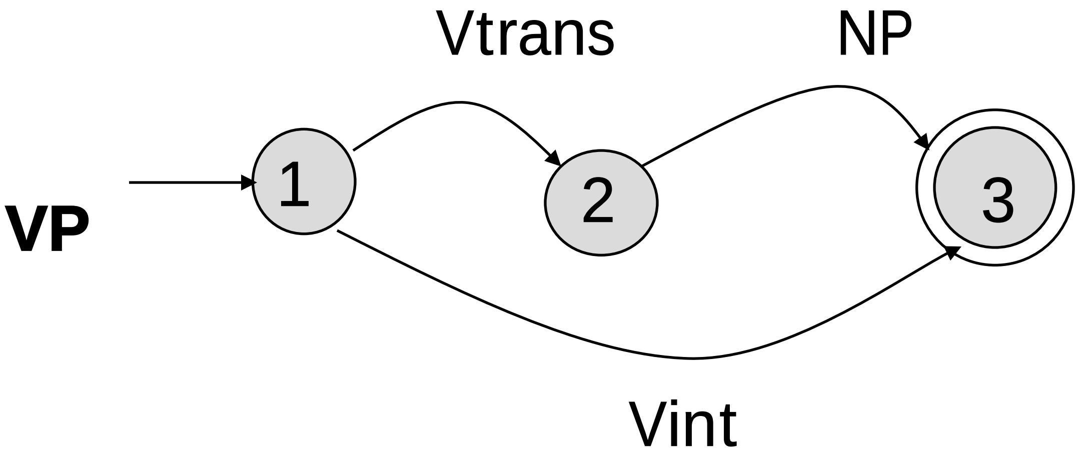
- Colection of TNs labeled with a name
  - Arcs
    - Labeled as in TN with POS
      - Terminal labels
    - Labeled with RTN identifiers
      - Non terminal labels
      - Final states in RTN produce coming back to the target state of the arc producing the call
- RTN are weakly equivalent to CFG

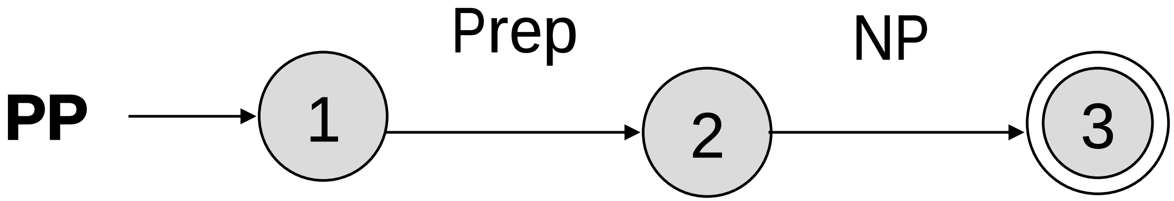
ATN 5





ATN 6





ATN 7

RTN limitations

- Transitions depend only on the categories
  - CFG
- Only recognizing
- In fact fixed TD strategy

ATN 8

- Woods (1970)
- ATN = RTN with *operations* attached to arcs and use of *registers*.

Operations

Conditions

Filter transitions between states

Actions

Building intermediate and output structures.

Initializations

- Allow expressing contextual constraints

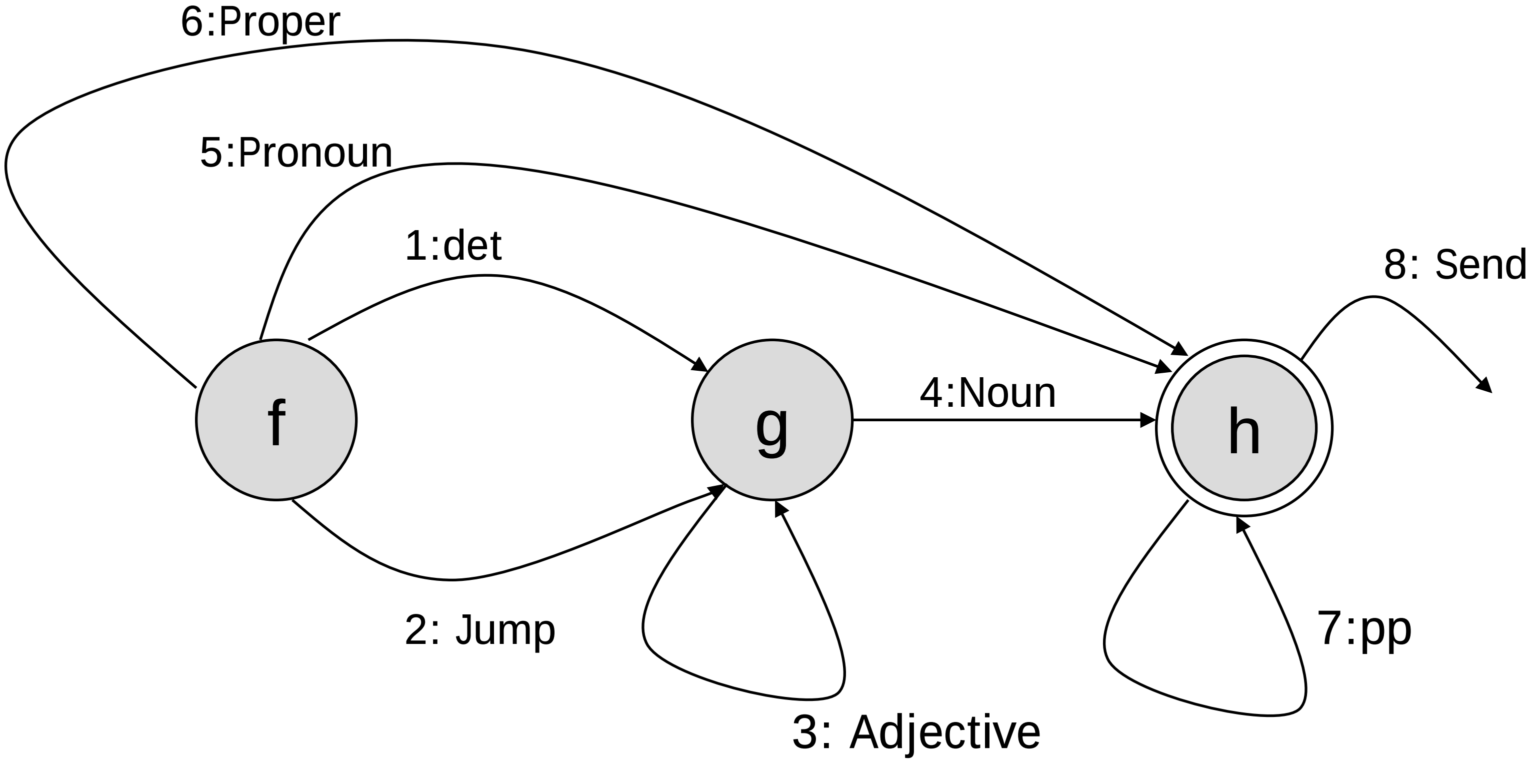
ATN 9

Features

Number: Singular, Plural   Default: empty

Person: 1st, 2nd, 3rd   Default: 3rd

Rols: Subject



Taken from Winograd, 1983

ATN 10

Inicializations, Conditions and Actions

NP-1: $_f$Determiner$_g$

A: Set Number to the number of *

NP-4: $_g$Noun$_h$

C: Number is empty or number is the number of *

A: Set Number to the number of *

Set Subject to *

NP-5: $_f$Pronoun$_h$

A: Set Number to the number of *

Set Person to the Person of *

Set Subject to *

NP-6: $_f$Proper$_h$

A: Set Number to the number of *

Set Subject to *

ATN 11

ATN limitations

- Fixed TD strategy
- Redundancy in backtracking operations
- Problems of notational expressivity:
  - Very difficult to transport

Basic issues on Parsing 12

- Unified mechanism of parser description
  - Sikkel, 1997
- Parser (schema):
  - Given a sentence, an inicial set of items is build
  - Given a grammar, a set of rules can be used for getting additional items
- Parser (algorithm):

  Parsing schema

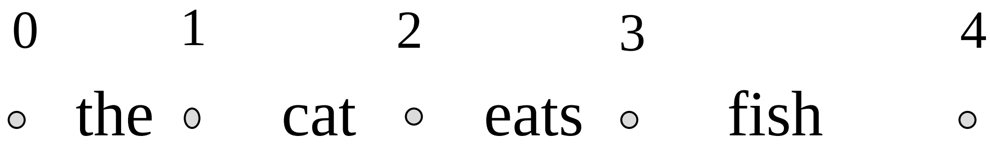
  + data structures

  + control structures

  (+ communication structures)

Charts 1

- A *Chart* is a directed graph built dynamically along parsing
- Extension of WFST
- Nodes correspond to the start and end of the sentence and to the positions between words.
- Active arcs (goals or hypothesis) and inactive arcs (facts)
  - Notation active arcs: dotted rules
  - inactive arcs : category

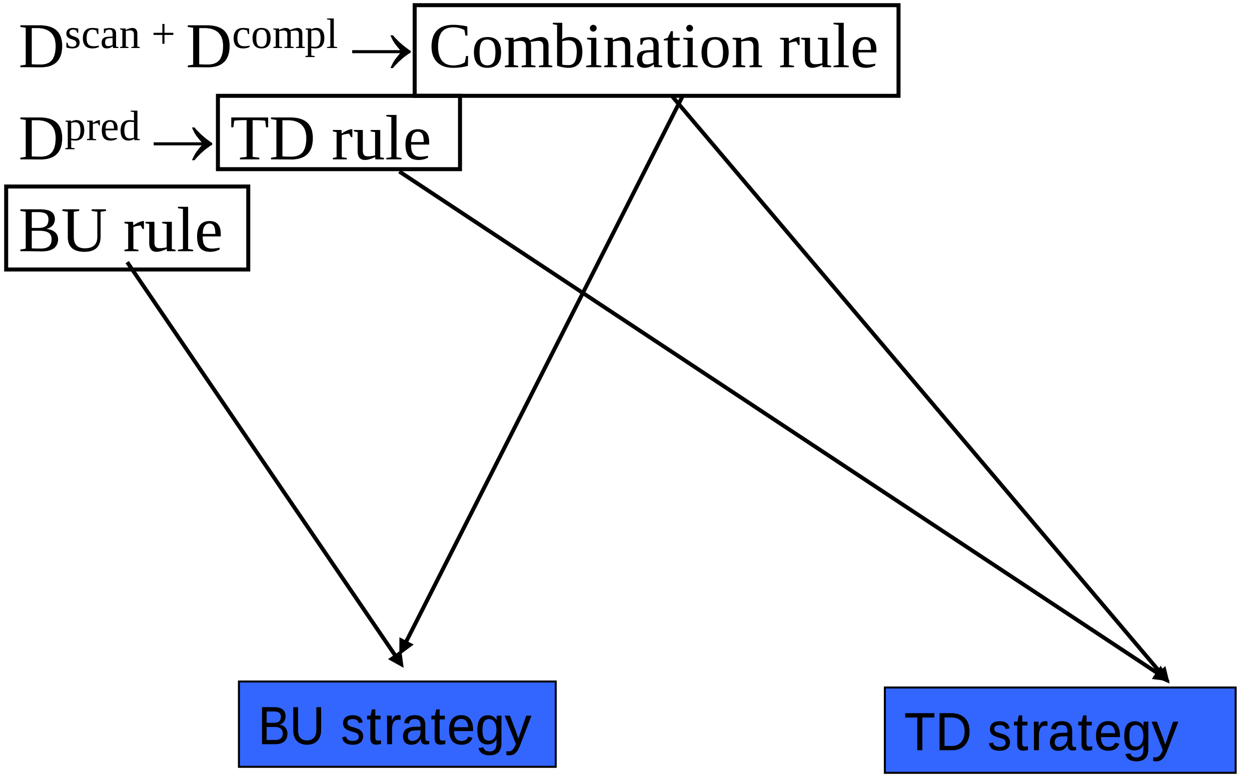


Charts 2

```
program chart
{ inicialize the chart with H;
  inicialize the agenda with items which can be deduced without antecedents;
  while not empty (agenda)
  {extract current_item from agenda and put it on the chart;
    foreach item which could be deduced with one step including  current_item
     {if item not in  agenda and not in chart
      then add item to agenda
     }
  }
}
```

Charts 3

- A concrete Chart algorithm should:
  - define the structure of *agenda* and its scheduling criteria
  - define order of performing deductive steps



- $D^{scan} + D^{compl} \rightarrow$ Combination rule
- $D^{pred} \rightarrow$ TD rule
- BU rule

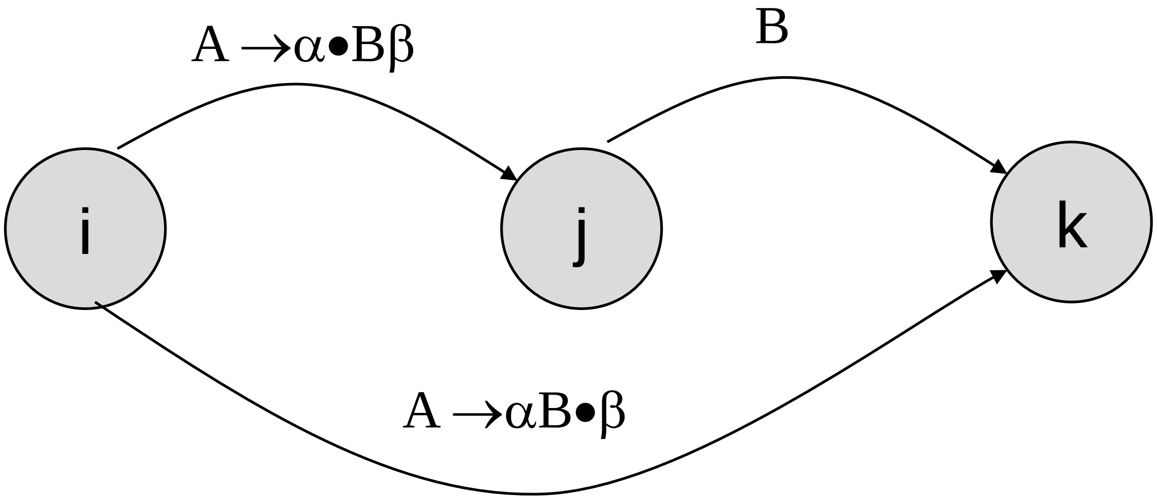
BU strategy

TD strategy

Charts 4

Combination rule

When an active arc of the Chart reaches a node ***j*** and from this node starts an inactive arc labeled with the category the active arc was waiting for, both arcs are combined for building a new arc (active or not) starting in the start node of the active arc and ending in the ending node of the inactive arc.

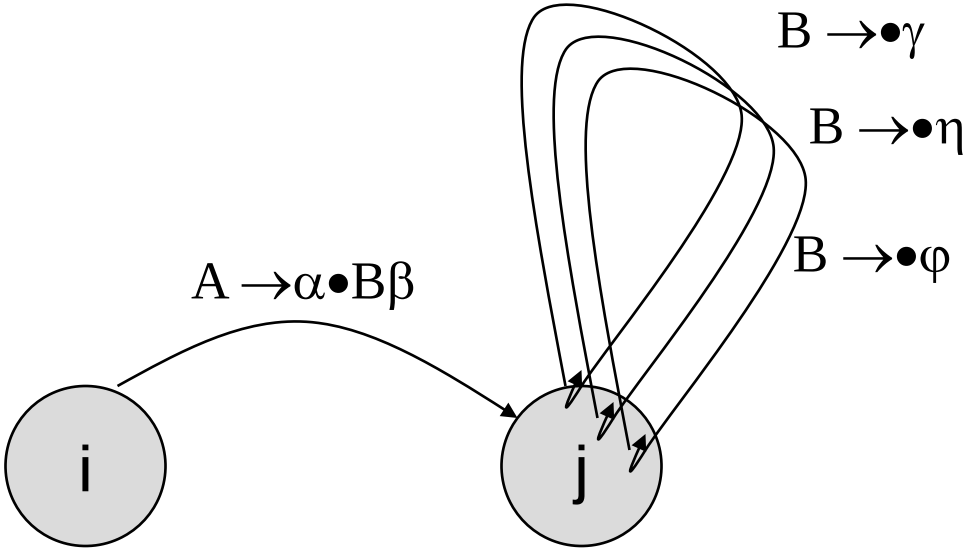


Charts 5

TD rule

When an active arc of the Chart reaches a node ***j***, for all the productions of the grammar expanding the category the active arc is waiting for a new active arc is built starting and ending in ***j*** corresponding to the dotted rule with dot in the initial position.

B →γ
B →η
B →φ
...

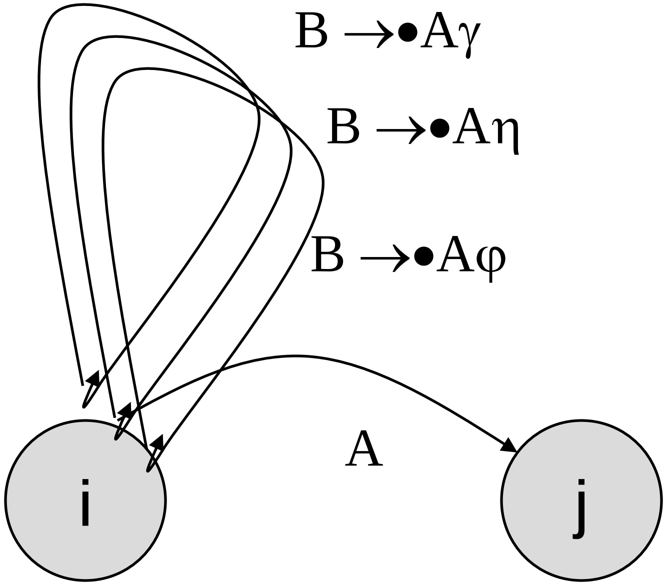


Charts 6

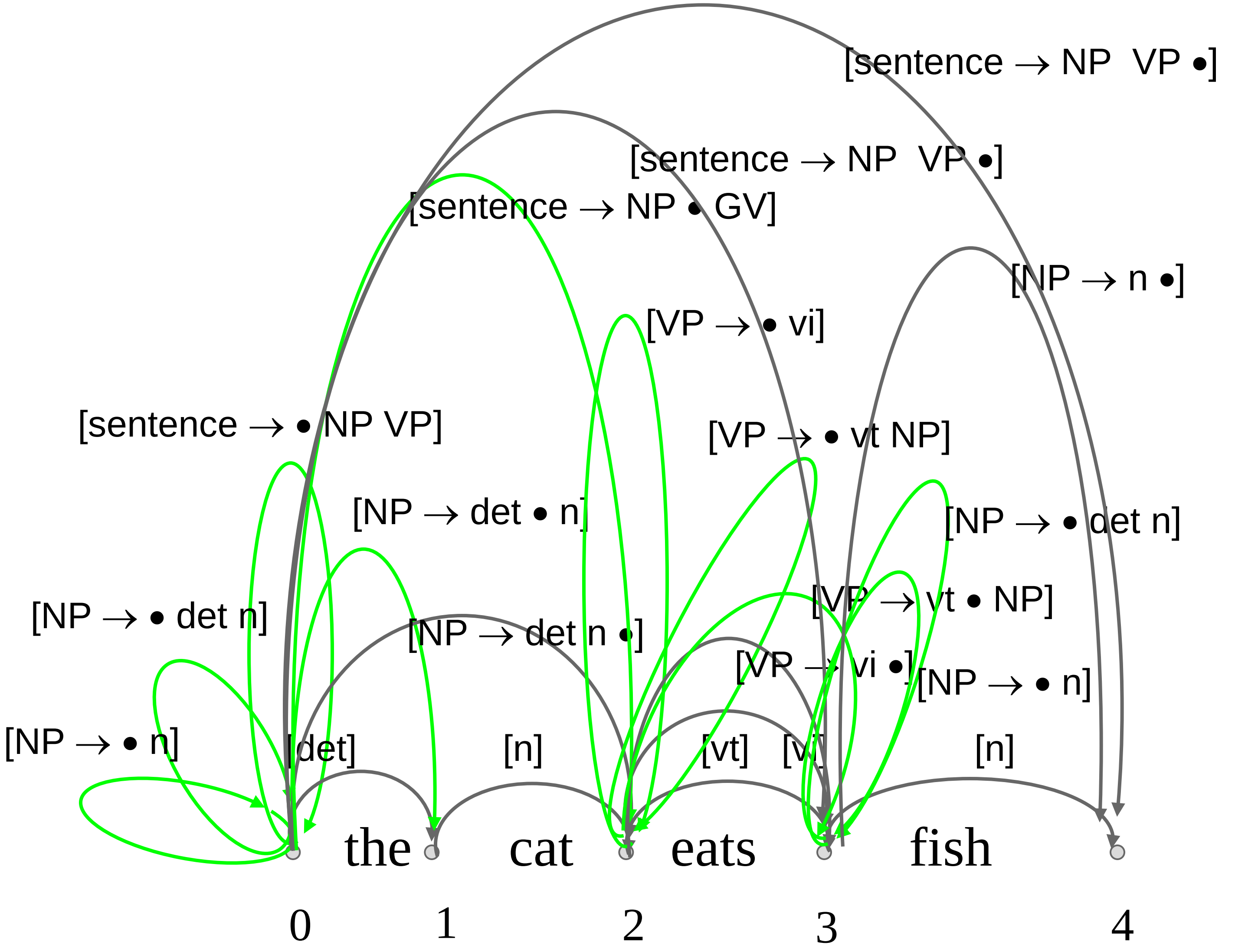
BU rule

When an inactive arc of the Chart starts in a node ***i***, for each producction of the grammar owning as first copnstituent of the right side the category of the inactive arc a new active arc is built starting and ending in ***i*** corresponding to the dotted rule with dot in the initial position.

B →Aγ
B →Aη
B →Aφ
...



Charts 7


[sentence → NP VP •]
[sentence → NP VP •]
[sentence → NP • GV]
[NP → n •]
[VP → • vi]
[sentence → • NP VP]
[VP → • vt NP]
[NP → det • n]
[NP → • det n]
[NP → • det n]
[VP → vt • NP]
[NP → det n •]
[VP → vi •]
[NP → • n]
[NP → • n]
[det]
[n]
[vt]
[vi]
[n]
the
cat
eats
fish
0
1
2
3
4

Charts 8

- Problems
  - The size of the Chart grows with the size of the grammar making the algorithm difficult to scale up.
  - A lot of useless active and inactive arcs are built.
  - In practice, lacking appropriate knowledge, a fixed BU strategy, eventually corrected with TD predictions, is used