CKY

- So let's build a table so that an A spanning from i to j in the input is placed in cell [i,j] in the table.
- So a non-terminal spanning an entire string will sit in cell [0, n]
  - Hopefully an *S*
- If we build the table bottom-up, we'll know that the parts of the A must go from i to k and from k to j, for some k.

CKY

- Meaning that for a rule like A → B C we should look for a B in [i,k] and a C in [k,j].
- In other words, if we think there might be an A spanning i,j in the input… AND

  A → B C is a rule in the grammar THEN
- There must be a B in [i,k] and a C in [k,j] for some i<k<j

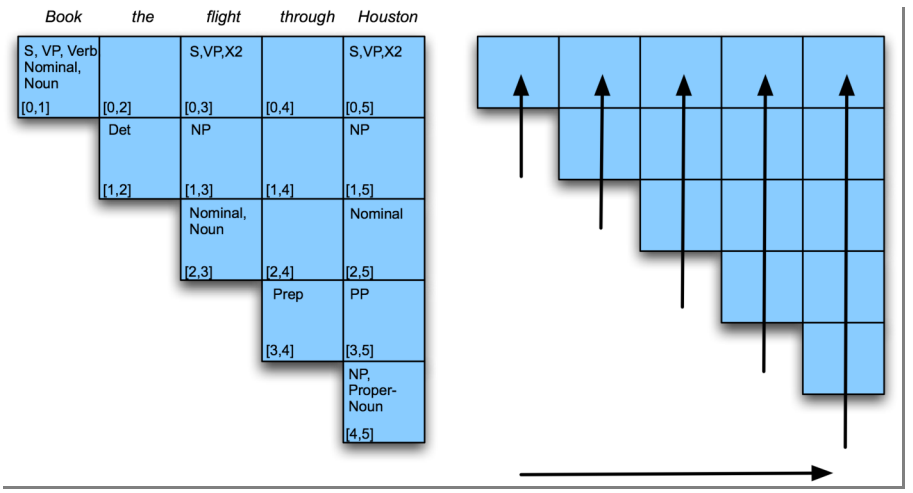
CKY

- So to fill the table loop over the cell[i,j] values in some systematic way
  - What constraint should we put on that systematic search?
  - For each cell, loop over the appropriate k values to search for things to add.

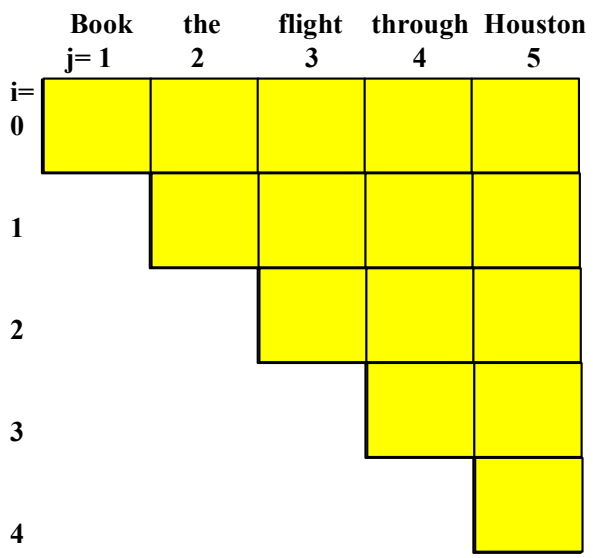
Note

- We arranged the loops to fill the table a column at a time, from left to right, bottom to top.
  - This assures us that whenever we're filling a cell, the parts needed to fill it are already in the table (to the left and below)
  - It's somewhat natural in that it processes the input a left to right a word at a time
    - Known as online

Example

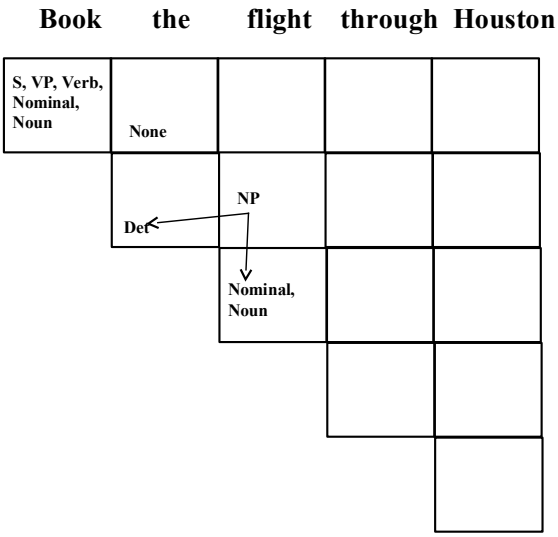


CKY Parser

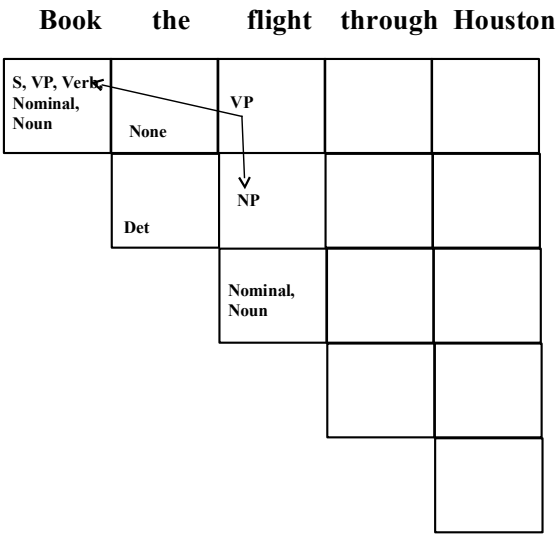


Cell[*i*,*j*] contains all constituents (non-terminals) covering words *i* +1 through *j*

CKY Parser



CKY Parser



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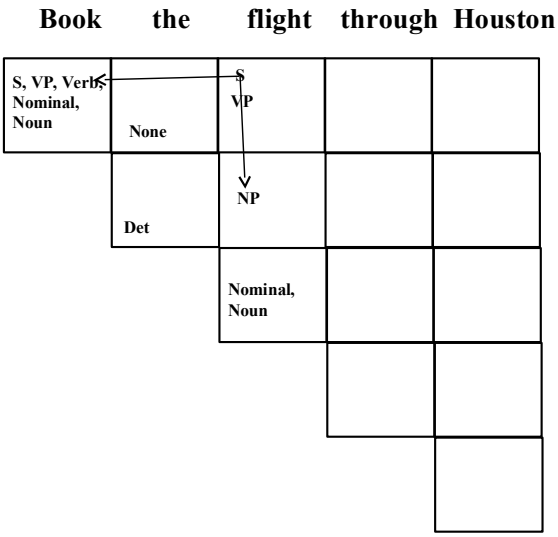

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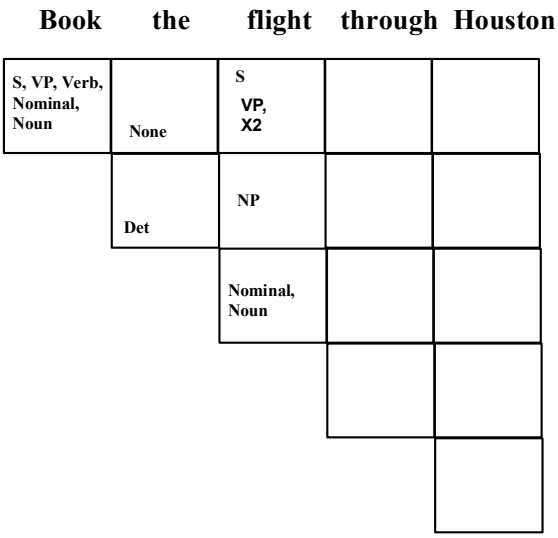

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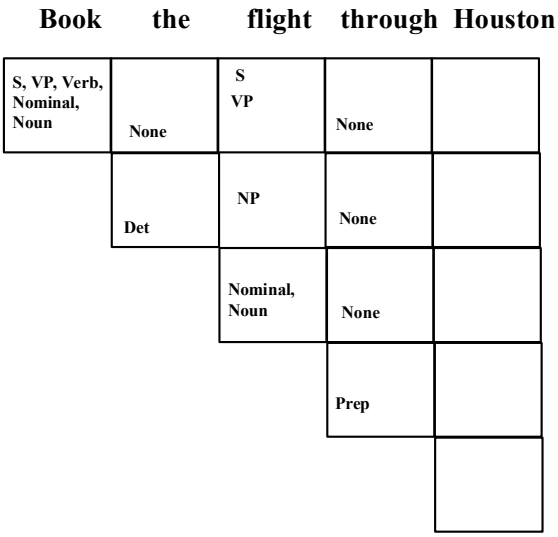

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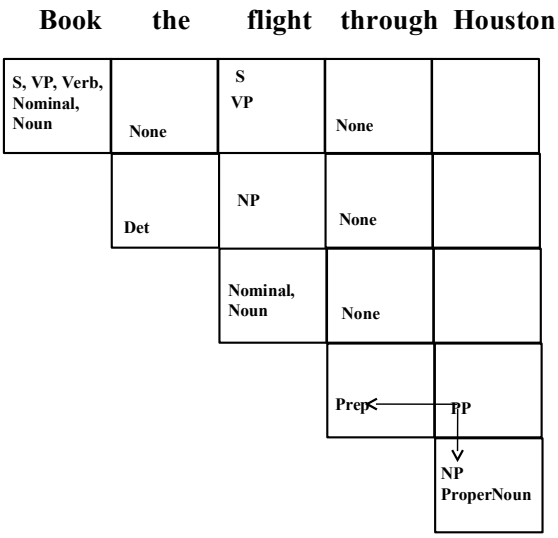

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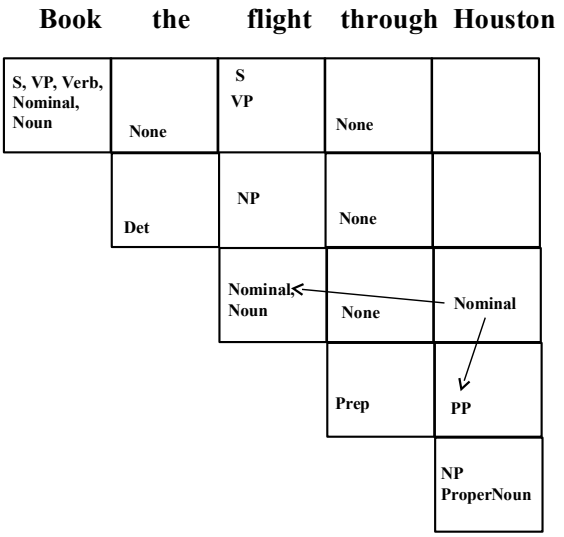

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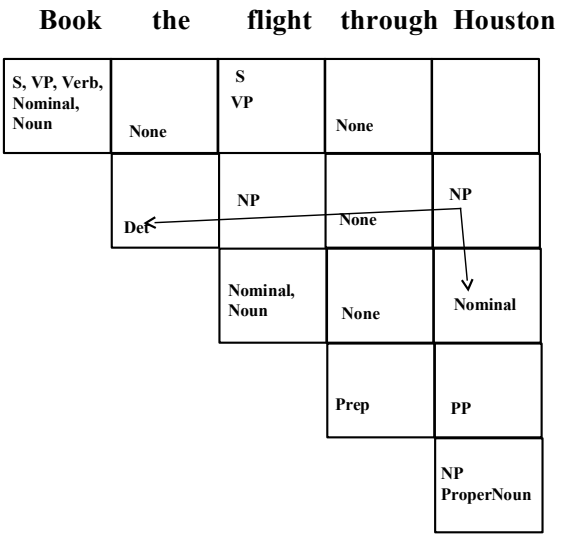

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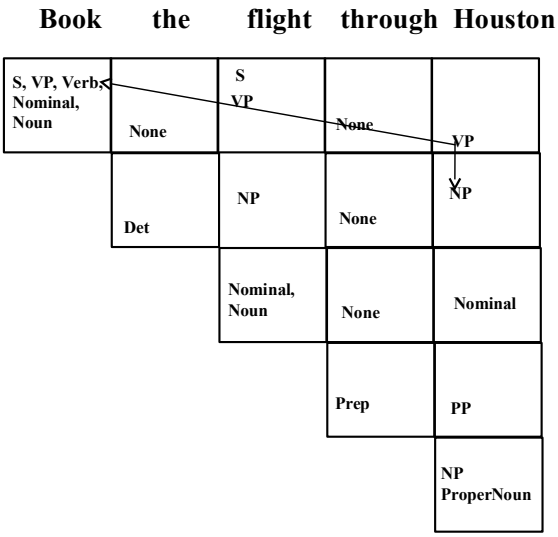

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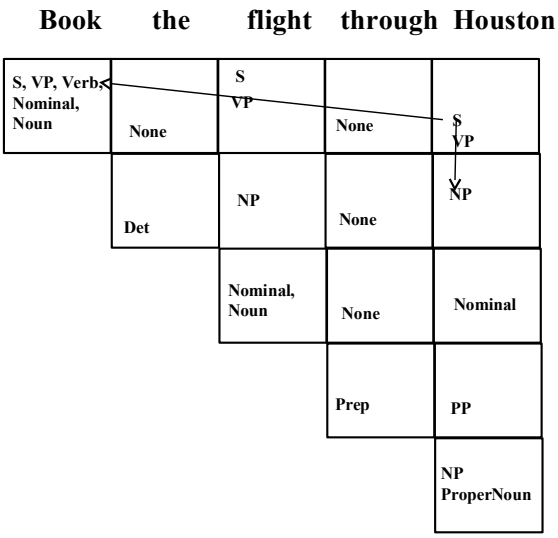

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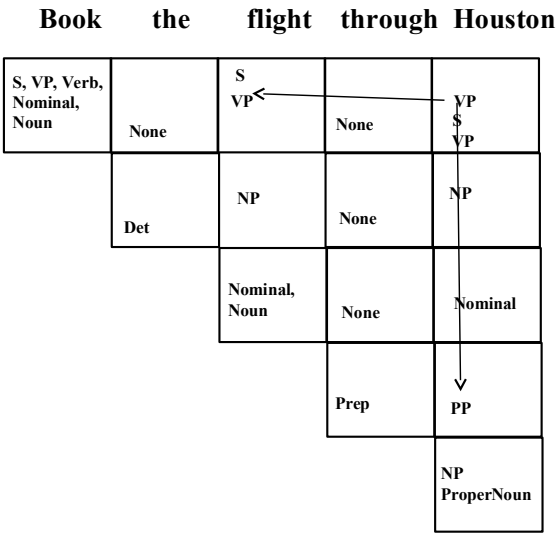
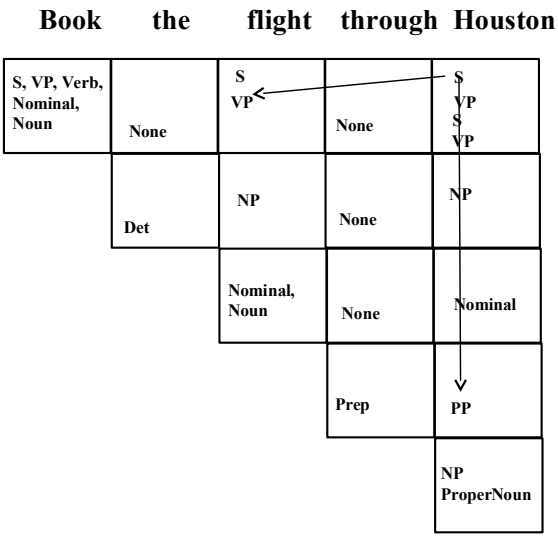


CKY Parser



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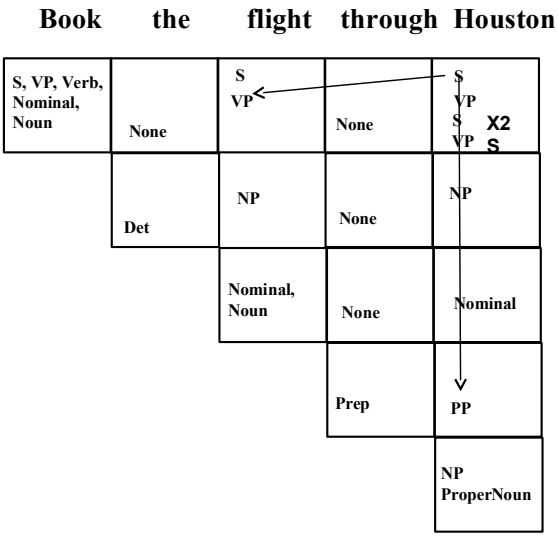
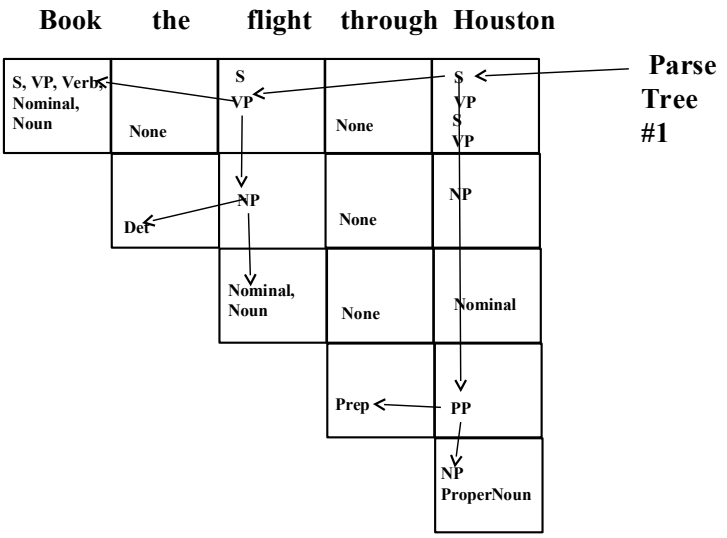
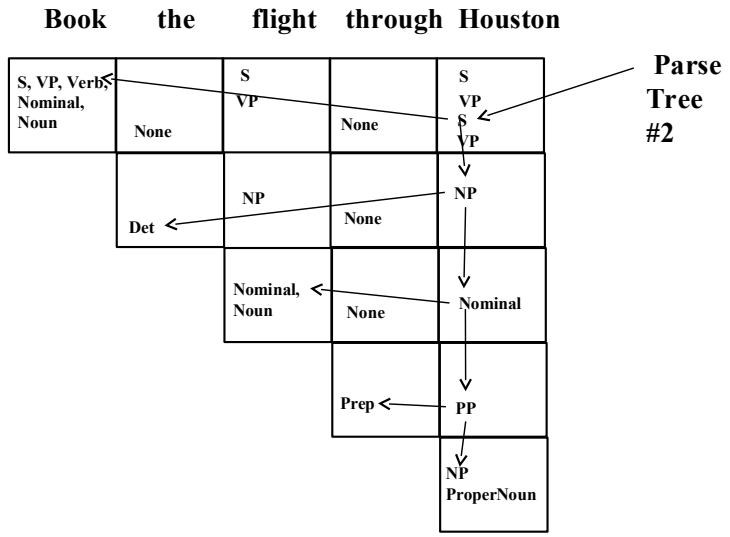


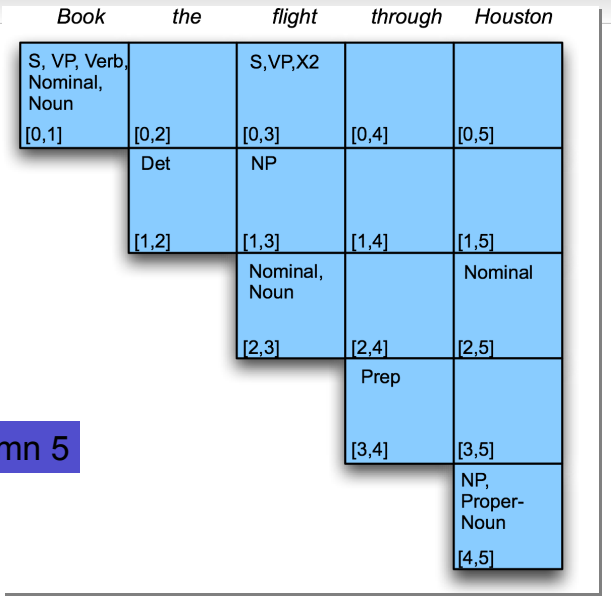
CKY Parser



CKY Parser

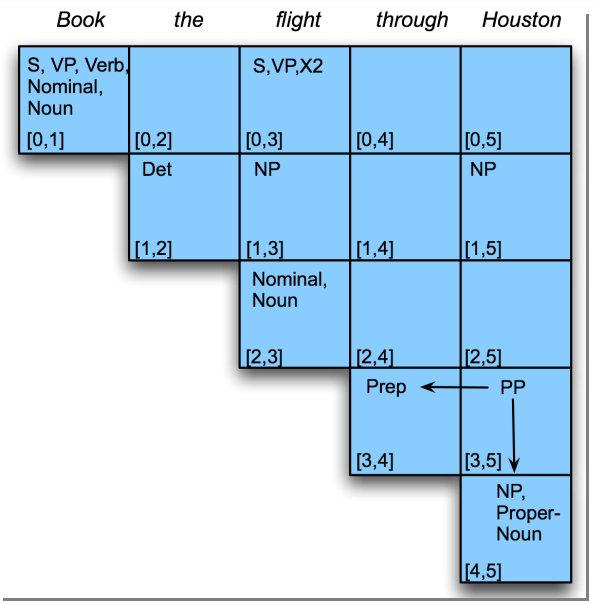


Example

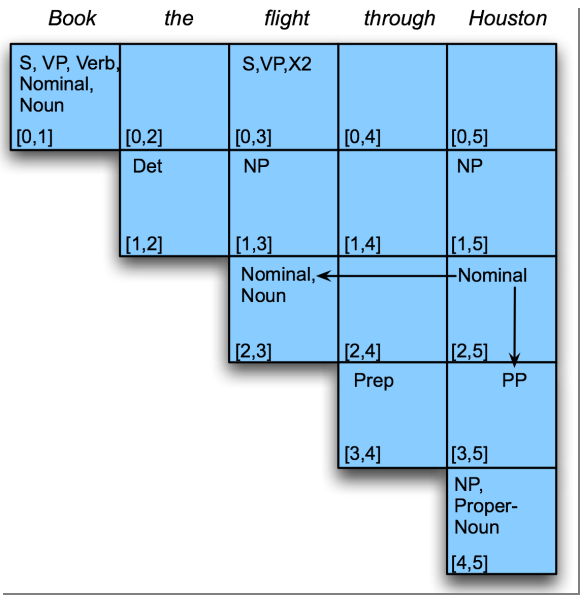


Filling column 5

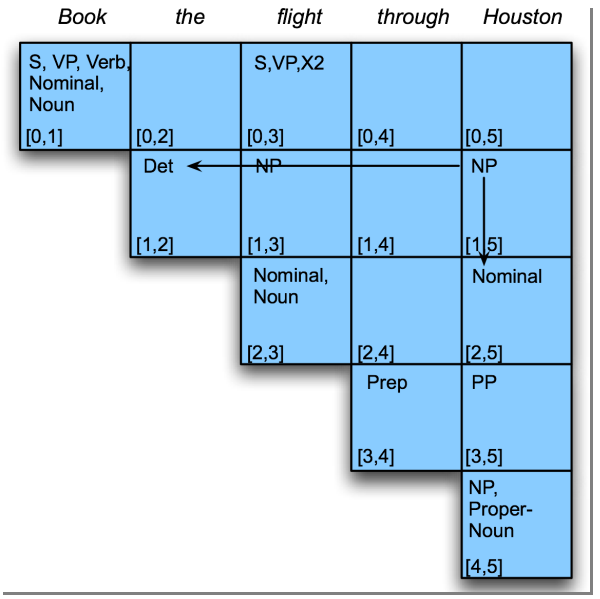
Example



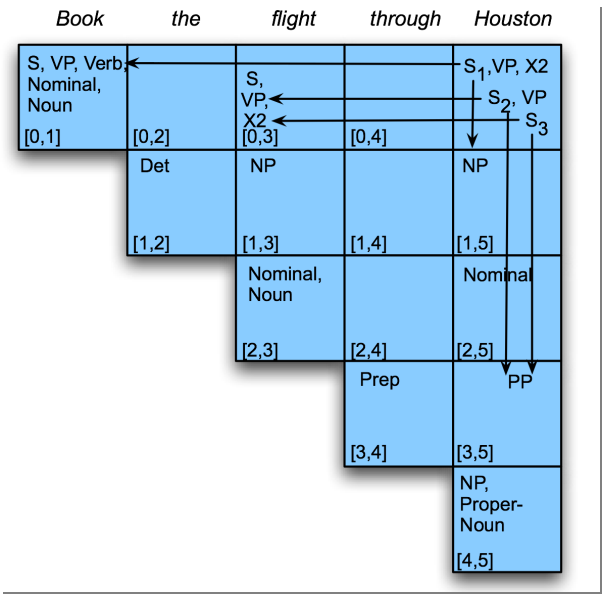
Example



Example



Example



CKY Notes

- Since it's bottom up, CKY populates the table with a lot of phantom constituents.
  - Segments that by themselves are constituents but cannot really occur in the context in which they are being suggested.
  - To avoid this we can switch to a top-down control strategy
  - Or we can add some kind of filtering that blocks constituents where they can not happen in a final analysis.

Earley Parsing

- Allows arbitrary CFGs
- Top-down control
- Fills a table in a single sweep over the input
  - Table is length N+1; N is number of words
  - Table entries represent
    - Completed constituents and their locations
    - In-progress constituents
    - Predicted constituents

Back to Ambiguity

- Did we solve it?

Ambiguity

- No…
  - Both CKY and Earley will result in multiple S structures for the [0,N] table entry.
  - They both efficiently store the sub-parts that are shared between multiple parses.
  - And they obviously avoid re-deriving those sub-parts.
  - But neither can tell us which one is right.

Ambiguity

- In most cases, humans don't notice incidental ambiguity (lexical or syntactic). It is resolved on the fly and never noticed.
  - I ate the spaghetti with chopsticks
  - I ate the spaghetti with meatballs
- We'll try to model that with probabilities.

Shallow or Partial Parsing

- Sometimes we don't need a complete parse tree
  - Information extraction
  - Question answering
- But we would like more than simple POS sequences

Chunking

- Find major but unembedded constituents like NPs, VPs, AdjPs, PPs
  - Most common task: NP chunking of base NPs
  - [NP I] saw [NP the man] on [NP the hill] with [NP a telescope]
  - No attempt to identify full NPs – no recursion, no post-head words
  - No overlapping constituents
  - E.g., if we add PPs or VPs, they may consist only of their heads, e.g. [PP on]

Approaches: RE Chunking

- Use regexps to identify constituents, e.g.
  - NP → (DT) NN* NN
  - Find longest matching chunk
  - Hand-built rules
  - No recursion but can cascade to approximate true CF parser, aggregating larger and larger constituents

Approaches: Tagging for Chunking

- Require annotated corpus
- Train classifier to classify each element of input in sequence (e.g. IOB Tagging)
  - B (beginning of sequence)
  - I (internal to sequence)
  - O (outside of any sequence)
  - No end-of-chunk coding – it's implicit
  - Easier to detect the beginning than the end

  Book/B_VP that/B_NP flight/I_NP quickly/O

Summary and Limitations

- Sometimes shallow parsing is enough for task
- Performance quite accurate

Distribution of Chunks in CONLL Shared Task

Label	Category	Proportion (%)	Example
NP	Noun Phrase	51	*The most frequently cancelled flight*
VP	Verb Phrase	20	*may not arrive*
PP	Prepositional Phrase	20	*to Houston*
ADVP	Adverbial Phrase	4	*earlier*
SBAR	Subordinate Clause	2	*that*
ADJP	Adjective Phrase	2	*late*

Summing Up

- Parsing as search: what search strategies to use?
  - Top down
  - Bottom up
  - How to combine?
- How to parse as little as possible
  - Dynamic Programming
- Shallow Parsing