Comments on Left-Corner

- Mixed data-driven and hypothesis driven approaches
  - Eager corresponds to composition of partial structures

- Arc Standard: less ambiguity
  - attach when constituents are complete: safer
  - delayed attachment means more is kept on the stack

- Arc Eager: less memory
  - early composition reduces stack growth
  - eager attachments are less bottom-up
Ambiguity in Parsing

• Rule selection: *what if more than one rule can be selected?*
• Local ambiguity: a parse derivation may fail later
• Global ambiguity: multiple parses can succeed

• How can we handle local and global ambiguities during parsing:
  • Backtracking
  • Parallelism
  • Determinism
  • Underspecification
Backtracking Parsers

• Parsing is a sequence of rule selections

• If at one point, more than one rule can be applied, this is called a choice point

  • Make a decision, based on some selection rule

  • If subsequently parsing ‘blocks’, return to a choice point and re-parse from there

• Which choice point to return to?

  • usually the last, why?

  • what other choice point selection rules could be used

Backtracking: an example

Bill reads

Bill reads
Parallel Parsers

- Build parse trees through successive rule selections
- If more than one rule may be applied, create a new parse derivation for each possibility
- Pursue all parses in parallel
- If any of the parses ‘blocks’, discard it
- Because of multiple local ambiguities, the number of parallel derivation grows exponentially
- Bounded parallelism: pursue a fixed number
- How do we choose which ones to keep?

Parallel: an example

Bill reads

Parse 1

Parse 2

Discard

Pursue
Theories of Sentence Processing

• Explanatory and descriptive goals

• Theories of parsing typically determine …

  • what architecture is assumed: modular? symbolic? …

  • what mechanism is used to construct interpretations?

  • which information sources are used by the mechanism?

  • which representation is preferred/constructed when ambiguity arises?

• Linking Hypothesis: Relate theory/model to observed measures

  • Preferred sentence structures should have faster reading times in the disambiguating region than dispreferred

Garden-Path Theory: Frazier

• What architecture is assumed?

  • Modular syntactic processor, with restricted lexical (category) and semantic knowledge

• What mechanisms is used to construct interpretations?

  • Incremental, serial parsing, with reanalysis

• What information is used to determine preferred structure?

  • General syntactic principles based on the current phrase structure

• Linking Hypothesis:

  • Parse complexity and reanalysis cause increased RTs
The Garden Path Theory (Frazier)

Which attachment do people initially prefer?

First Strategy: Minimal Attachment

**Minimal Attachment:** Adopt the analysis which requires postulating the fewest nodes
NP/S Complement Ambiguity

**Minimal Attachment:** Adopt the analysis which requires postulating the fewest nodes

Second Strategy: Late Closure

**Late Closure:** Attach material into the most recently constructed phrase marker
Well-known local ambiguities

NP/VP Attachment Ambiguity:
“The cop [saw [the burglar] [with the binoculars]]”
“The cop saw [the burglar [with the gun]]”

NP/S Complement Attachment Ambiguity:
“The athlete [realised [his goals]] last week”
“The athlete realised [[his goals] were unattainable]”

Clause-boundary Ambiguity:
“Since Jay always [jogs [a mile]] [the race doesn’t seem very long]”
“Since Jay always jogs [[a mile] doesn’t seem very long]”

Reduced Relative-Main Clause Ambiguity:
“[[The woman [delivered the junkmail on Thursdays]]”
“[[The woman [delivered the junkmail]] threw it away]”

Relative/Complement Clause Ambiguity:
“The doctor [told [the woman] [that he was in love with her]]”
“The doctor [told [the woman [that he was in love with]] [to leave]]”

Summary of Frazier

• Parsing preferences are guided by general principles:

  • Serial structure building

  • Reanalyze based on syntactic conflict

  • Reanalyze based on low plausibility (“thematic fit”)

• Psychological assumptions:

  • Modularity: only syntactic (not lexical, not semantic) information used for initial structure building

  • Resources: emphasizes importance of memory limitations

  • Processing strategies are universal, innate
Grammar-Based Strategies

• Not concerned with representation or ‘form’, but defined in terms of syntactic ‘content’

• Strategies are modular, but ‘knowledge-based’

• Motivation: strategies are derived from the purpose of the task, not e.g. computational efficiency

• Closer competence-performance relationship

• Defined w.r.t. to deeper syntactic notions: less sensitive to minor structural details (cf. Minimal Attachment)


Pritchett (1992)

• Incrementally establish primary syntactic dependencies

• Theta-Criterion: (GB theory, also in LFG + HPSG)
  • Each argument must receive exactly one theta-role, and each theta role must be assigned to exactly one argument

• Consider:

  The boy put the candy on the table in his mouth
Pritchett (1992)

- **Theta-Attachment:**
  - Maximally satisfy the theta-criterion at every point during processing, given the maximal theta-grid of the verb

- **Theta Reanalysis Constraint:**
  - Reanalysis of a constituent out of its theta-domain results in a conscious garden-path effect

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**Theta-Reanalysis: Easy**

**Reanalysis** to a position **within** the original theta-domain is easy.
Theta-Reanalysis: Difficult

**Reanalysis** to a position *outside* the original theta-domain is difficult.

![Syntax Tree]

Pritchett: Another example

- “Without her contributions the orphanage closed”

- ‘Without’: a Prep with a single thematic role

- ‘her’: an determiner of an unseen NP head, or a Full NP (Pronoun) [Theta-attach]

- ‘contributions’: head of a new NP, with no role, or combine with ‘her’ for a Full NP [Theta-attach]

- “Without her contributions failed to come in”

- ‘contributions’ becomes subject of ‘failed’, violating [Theta-reanalysis Constraint]
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Grammar-Based (cont’d)

• Theta-Attachment: reliance on theta-grids means it’s head driven

• O.k. for English, but not incremental for head-final languages

• Same problem for Abney (1989), and other head-driven models

• Argument-Attachment: Attach constituent into potentially role-receiving positions (Crocker, 1992)

... dat het meisje van Holland glimlachte/houdt
... that the girl from Holland smiled/likes

That study used phrase-by-phrase self-paced reading.
Eye-tracking studies suggest the modifier attachment is actually preferred.
Problematic for A-Attachment, unclear what Theta-Attachment would predict, why?
Pritchett’s Theory (1992)

• What **architecture** is assumed?
  • Modular lexico-syntactic processor with syntactic and thematic role features

• What **mechanisms** is used to construct interpretations?
  • Incremental, serial parsing, with reanalysis

• What **information** is used to determine preferred structure?
  • Grammar principles and thematic role information

• **Linking Hypothesis:**
  • TRC violation causes garden-path, reanalysis without TRC is relatively easy