A Linear-Time Bottom-Up Discourse Parser with Constraints and Post-Editing

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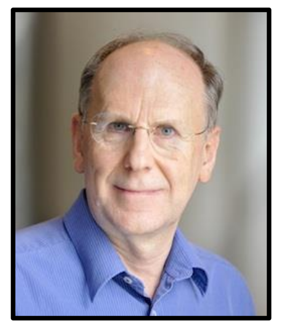
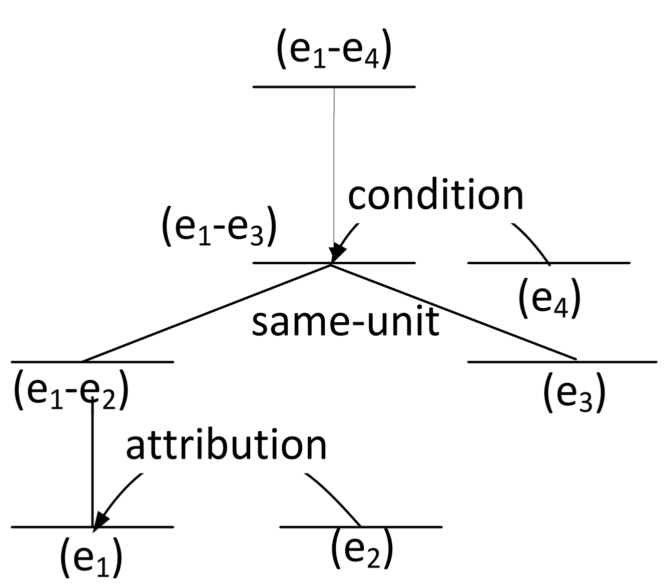


1. Rhetorical Structure Theory[1]

- A discourse tree representation of the full text.
  - Leaves: elementary discourse units (EDUs).
  - Internal nodes: concatenation of continuous EDUs, with discourse relations among them labeled.
- Example

[Catching up with commercial competitors in retail banking and financial services,]e_1 [they argue,]e_2 [will be difficult,]e_3 [particularly if market conditions turn sour.]e_4



2. Two-stage Discourse Parsing

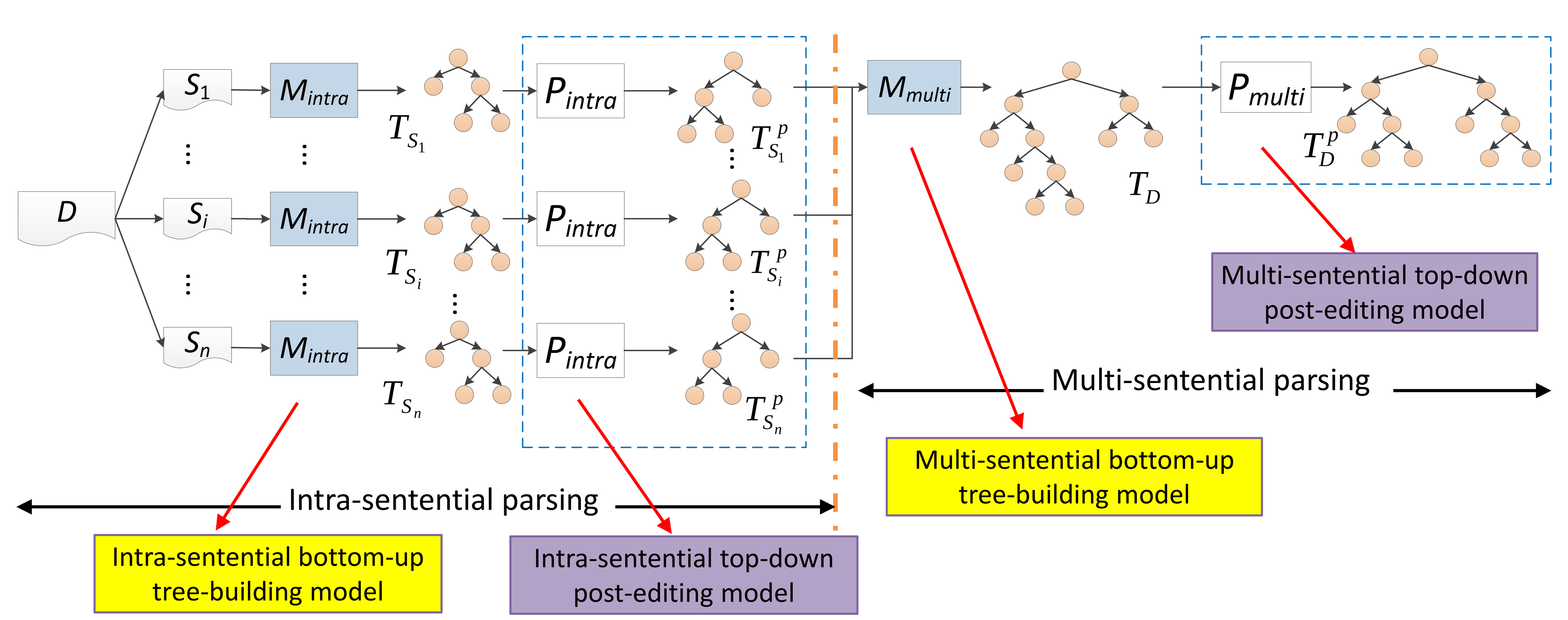
- Joty et al., 2013[2]. Decompose text-level discourse parsing into intra- and multi-sentential parsing.
- Joint modeling of the structure and the relation of adjacent text units.
- CKY-like parsing algorithm to build the discourse tree from bottom up.

Pros
- Takes into account the interaction between structures and relations.
- Globally optimal tree.

Cons
- Inefficient for large documents. CKY-parsing: $O(n^3)$ time complexity.

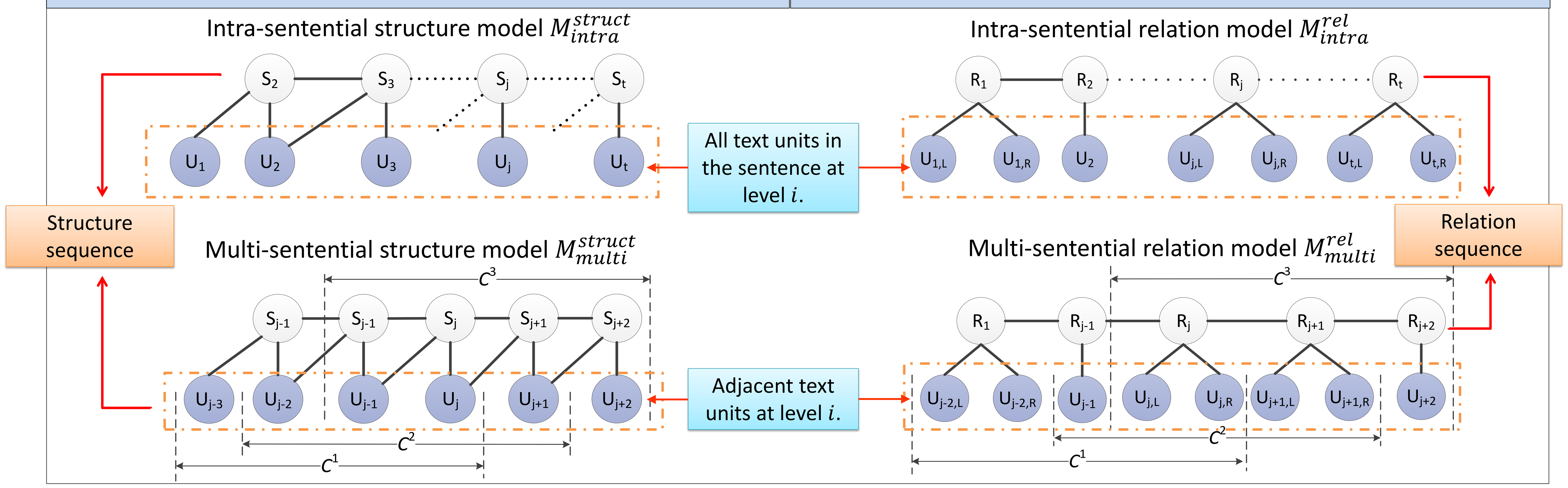
- **Our objective:** to develop a text-level discourse parser that is both accurate and efficient.
- **Our idea:** two-stage parsing with greedy tree-building and post-editing.
  - Post-editing: Incorporates additional features derived from the initial tree.

3. Overall Workflow



4. Linear-chain CRFs with Constraints as Local Models

- Two-stage pipeline in local models:
  - Decompose $P(structure, relation)$ into $P(structure) \times P(relation \mid structure)$.
  - First identify the pair of adjacent text units to be related, then assign the relation to the pair.
- Efficient in practice: $O(n)$ time complexity.



5. Experiments

- Features
  - Organization, textual, n-gram, dominance, contextual, substructure, entity transition, cue phrases, and post-editing features.
- Data
  - The RST Discourse Treebank: 347 for training and 38 for testing.
  - # of sentences: 2 to 187, average 26.
- Evaluation
  - Parsing accuracy using constituent precision and recall[3].
  - Parsing time.

Estimated time consumption of Joty et al. (2013) [2] on the largest document is over 16 hours.

Our previous work.

6. Results

- Parsing accuracy

Model	Span	Nuclearity	Relation
Joty et al., 2013[2]	82.5	68.4	55.7
Feng and Hirst, 2012[4]	82.8	67.1	52.0
Ours (no post-editing)	**84.9***	**69.9***	**57.2***
Ours	**85.7*†**	**71.0*†**	**58.2*†**
Human	*88.7*	*77.7*	*65.8*

* Significantly better than Joty et al., 2013 ($p < .01$).
† Significantly better than ours (no post-editing) ($p < .01$).

- Parsing time in seconds

Model	Min	Max	Average
Feng and Hirst, 2012[4]	0.42	124.86	11.19
Ours (no post-editing)	**0.05**	**40.57**	**5.52**
Ours	**0.12**	**84.72**	**10.71**

Parsing time excludes the time for necessary pre-processing.

References

[1] William Mann and Sandra Thompson. 1988. Rhetorical structure theory: Toward a functional theory of text organization. *Text*, 8(3):243–281.
[2] Shafiq Joty, Giuseppe Carenini, Raymond Ng, and Yashar Mehdad. 2013. Combining intra- and multi-sentential rhetorical parsing for document-level discourse analysis. *In Proceedings of the 51st Annual Meeting of the Association for Computational Linguistics (ACL 2013)*, pages 486–496, Sofia, Bulgaria.
[3] Daniel Marcu. 2000. *The Theory and Practice of Discourse Parsing and Summarization*. The MIT Press.
[4] Vanessa Wei Feng and Graeme Hirst. 2012. Text-level discourse parsing with rich linguistic features. *In Proceedings of the 50th Annual Meeting of the Association for Computational Linguistics: Human Language Technologies (ACL 2012)*, pages 60–68, Jeju, Korea.

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