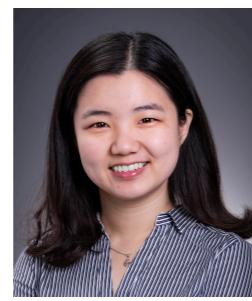


Applying Rhetorical Structure Theory to Student Essays to Provide Automated Writing Feedback

Shiyan Jiang, Kexin Yang, Chandrakumari Suvarna,
Pooja Casula, Mingtong Zhang, Carolyn Penstein Rosé



Language
Technologies
Institute

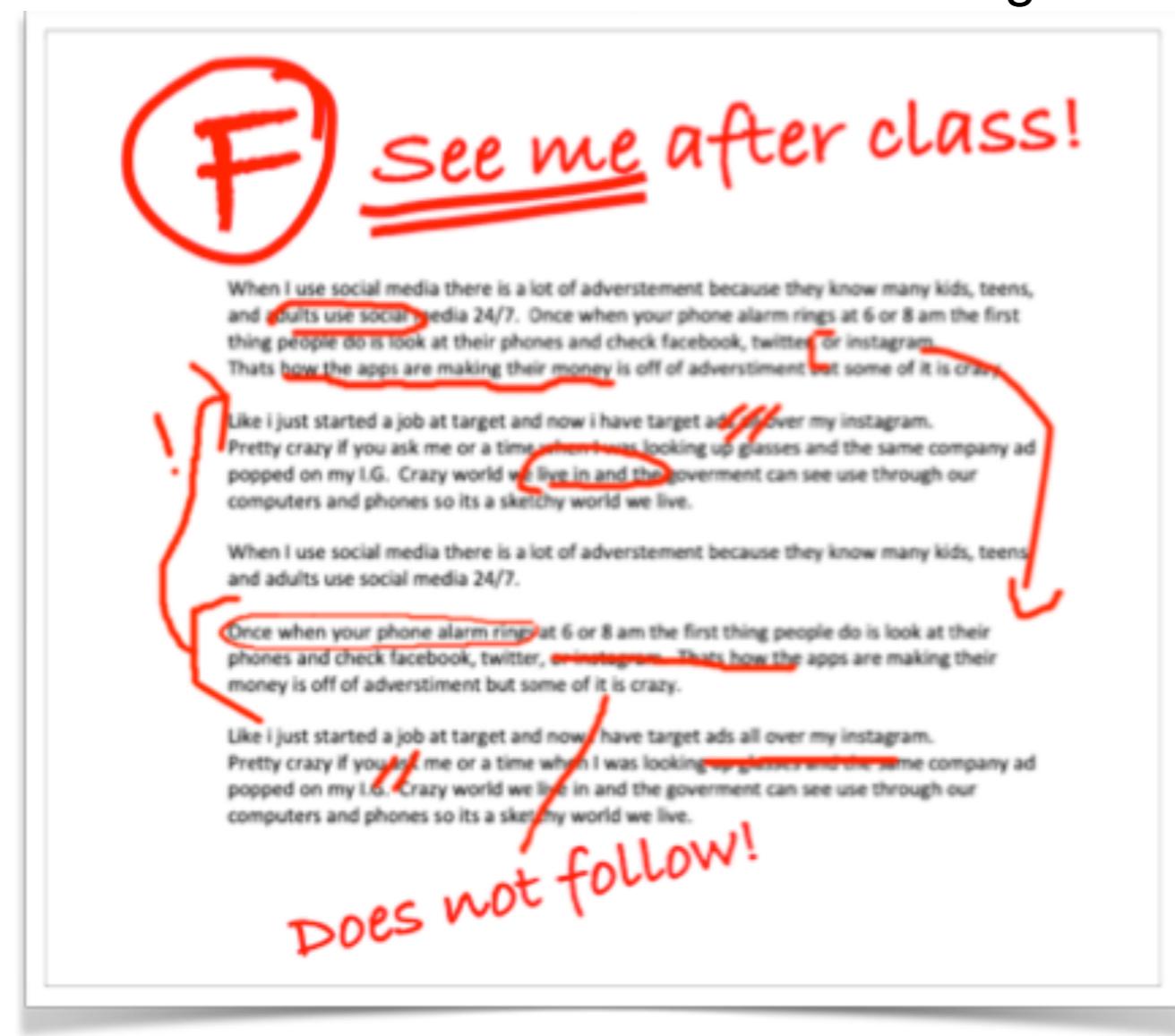
Carnegie
Mellon
University



Human-
Computer
Interaction
Institute

Introduction

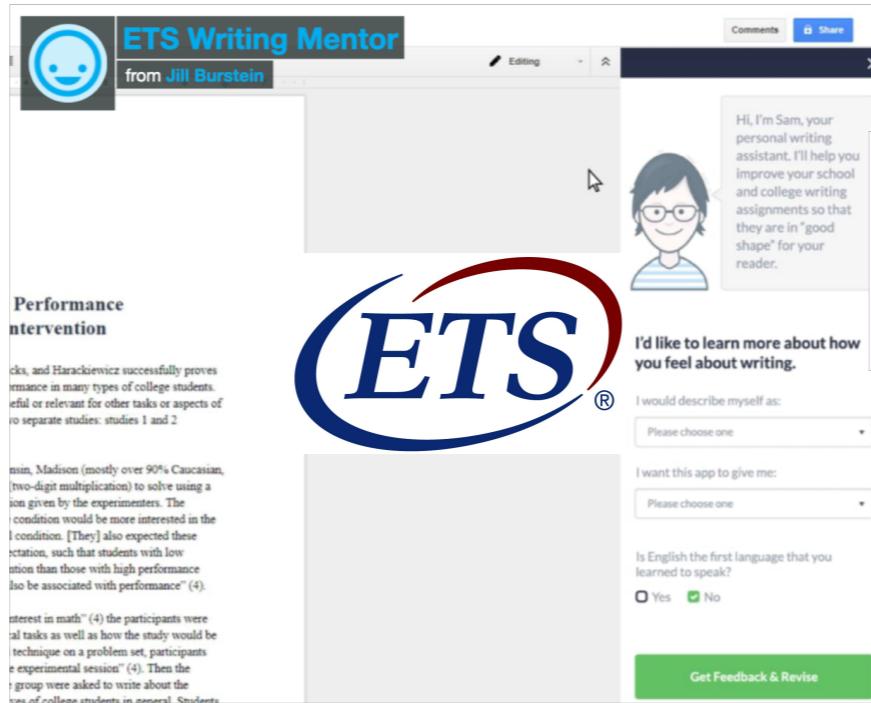
- **Structural Feedback:** Designed to help writer develop a clear structure in which sentences and paragraph are well-organized.
- **Problem:** Actionable structural feedbacks are hard to give automatically.



Technology-enabled Writing Feedback



grammarly.com



Limitation of state-of-the-art automated writing feedback:

- Locally situated in individual sentences.
- Not specific enough for students to take actions

Nitin Madnani, Jill Burstein, Norbert Elliot, Beata Beigman Klebanov, Diane Napolitano, Slava Andreyev, and Maxwell Schwartz. 2018. Writing mentor: Self-regulated writing feedback for struggling writers. In Proceedings of the 27th International Conference on Computational Linguistics: System Demonstrations, pages 113–117.
Bronwyn Woods, David Adamson, Shayne Miel, and Elijah Mayfield. 2017. Formative essay feedback using predictive scoring models. In Proceedings of the 23rd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, pages 2071–2080.



Language Technologies Institute

Carnegie Mellon University



Annotated RST Corpus of Student Writing

... .

Source Data:

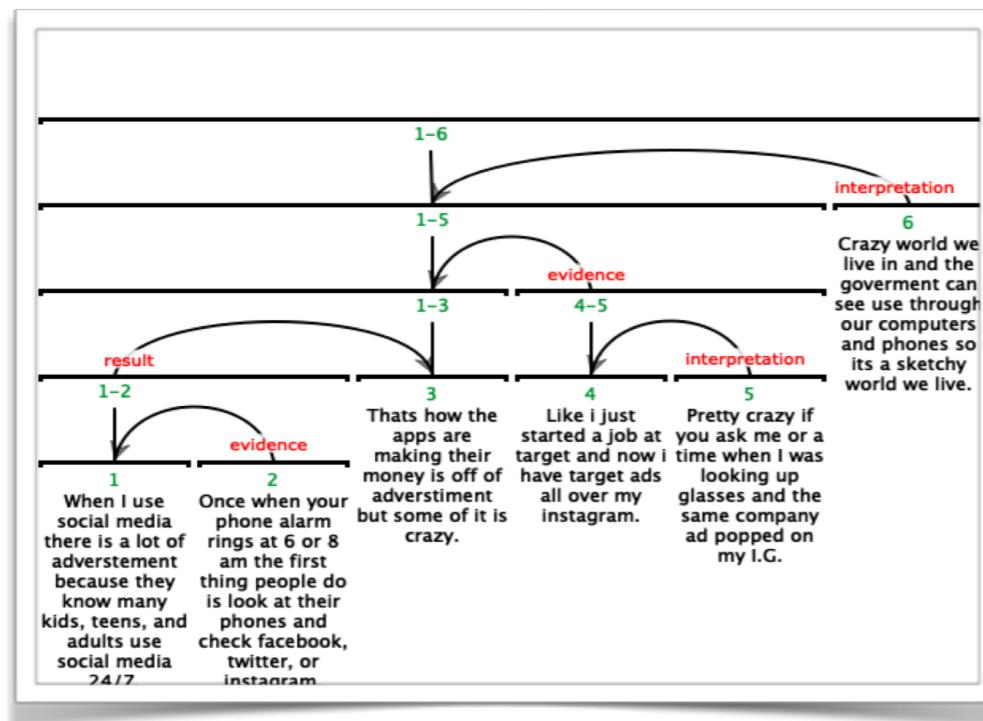
137 student essays from revision assistant built by our collaborator, Turnitin.

Genre:

Analysis, argumentative writing, historical analysis and informative writing

Goal of annotation:

To represent an essay in a rhetorical structure tree whose leaves are Elementary Discourse Units (EDUs)



A short student essay
annotated using RST

Amir Zeldes. 2016. rstWeb-a browser-based annotation interface for Rhetorical Structure Theory and discourse relations. In Proceedings of the 2016 Conference of the North American Chapter of the Association for Computational Linguistics: Demonstrations, pages 1–5.



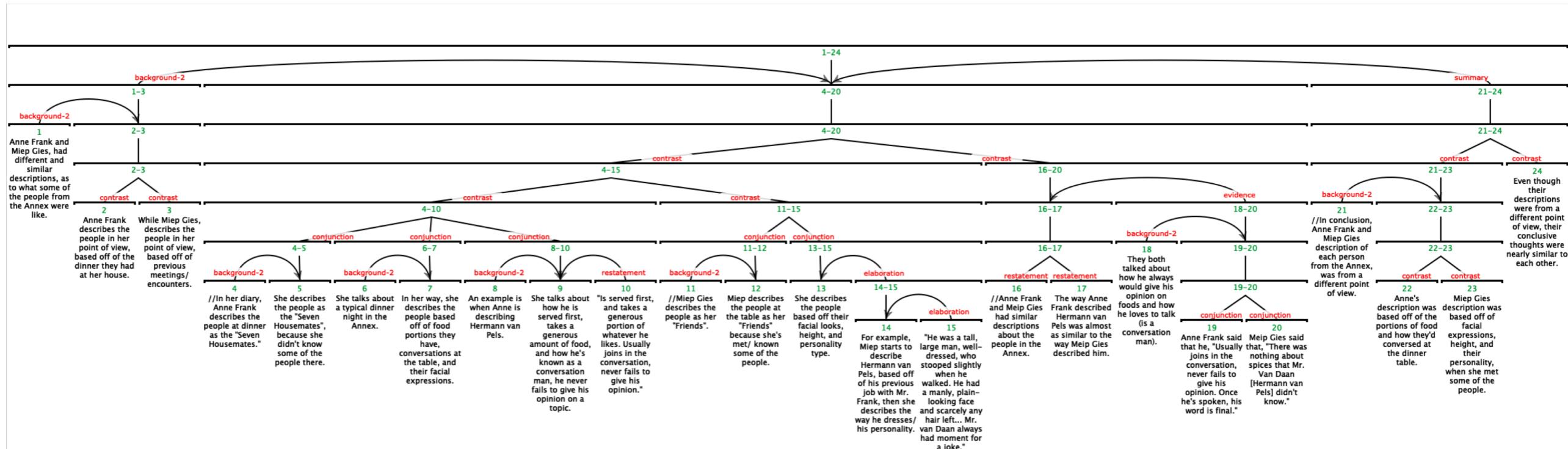
Language Technologies Institute

Carnegie Mellon University



Annotated RST Corpus of Student Writing

...



A long student essay
annotated using RST

Amir Zeldes. 2016. rstWeb-a browser-based annotation interface for Rhetorical Structure Theory and discourse relations. In Proceedings of the 2016 Conference of the North American Chapter of the Association for Computational Linguistics: Demonstrations, pages 1–5.



Language Technologies Institute

Carnegie Mellon University



Human-
Computer
Interaction
Institute

Essay Annotation Process

First step:

Segment an essay into EDUs.

Second step:

Identify central claims in each paragraph.

Third Step:

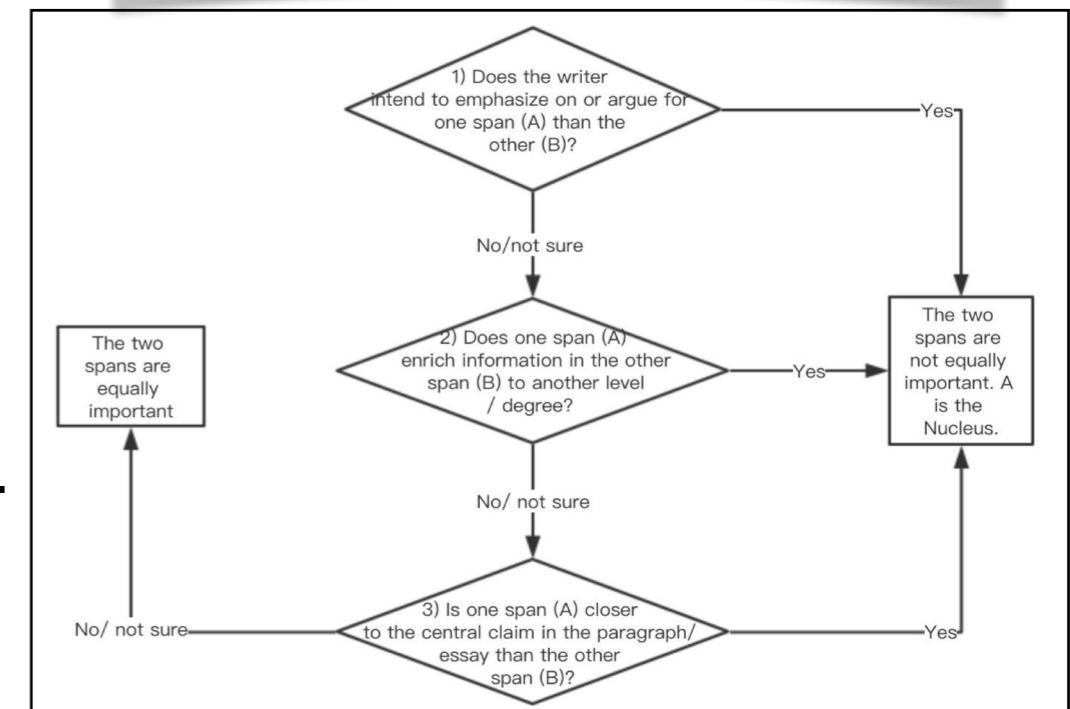
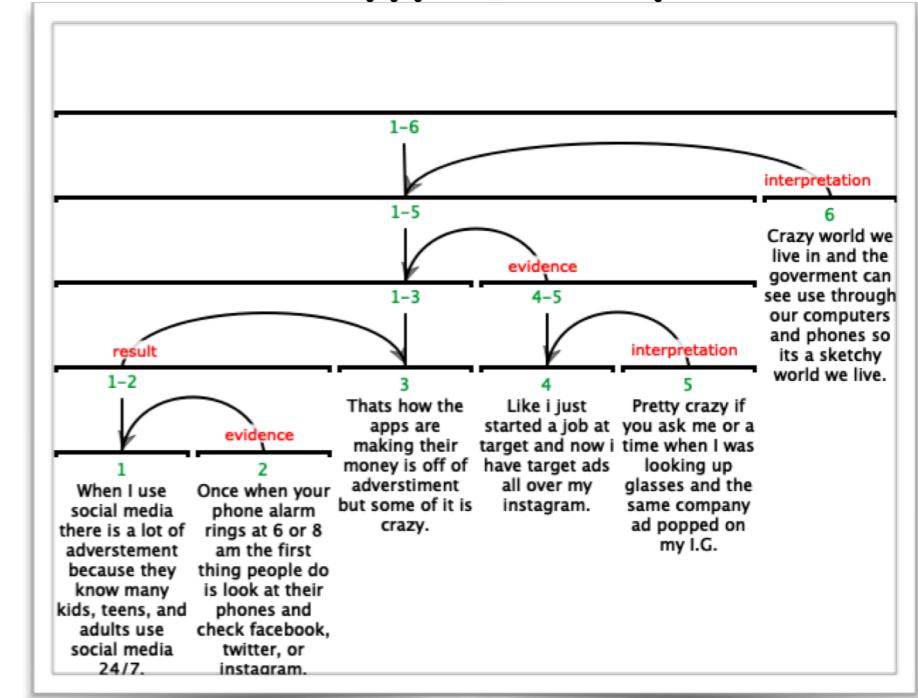
Identify rhetorical relations between EDUs.

Fourth Step:

Identify rhetorical relations between spans.

Fifth Step:

Identify rhetorical relations between paragraphs.



Flowchart for identifying relative importance

Amir Zeldes. 2016. rstWeb-a browser-based annotation interface for Rhetorical Structure Theory and discourse relations. In Proceedings of the 2016 Conference of the North American Chapter of the Association for Computational Linguistics: Demonstrations, pages 1–5.



Language Technologies Institute

Carnegie Mellon University



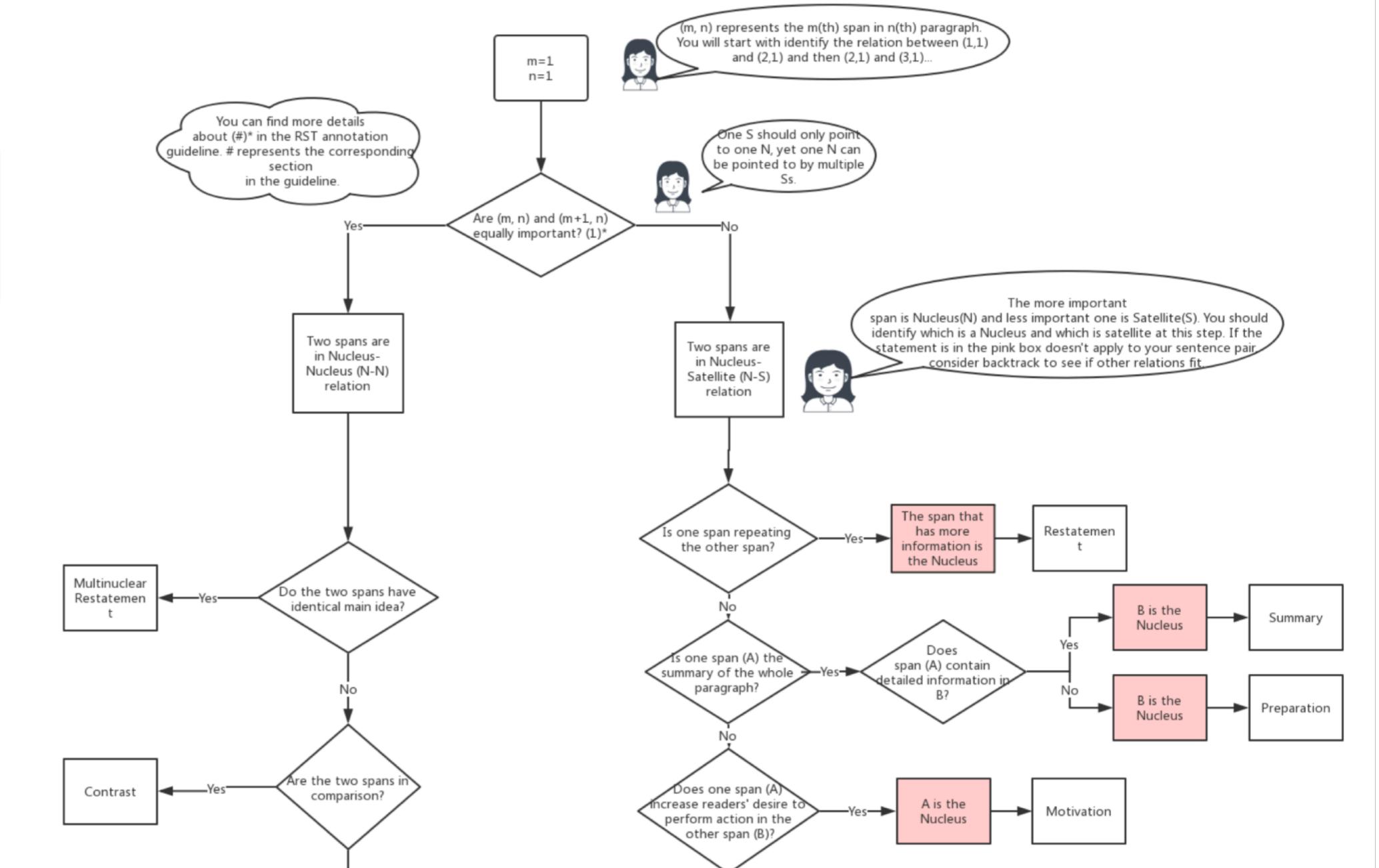
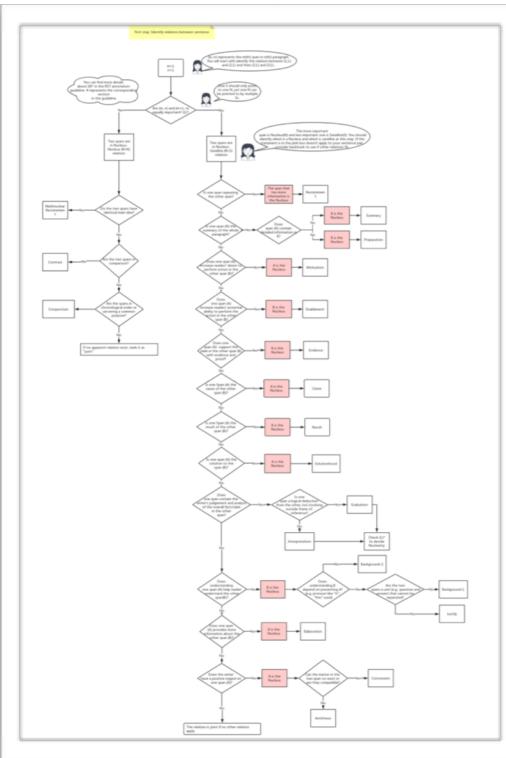
Human-Computer Interaction Institute

Annotation Guideline & Flowchart

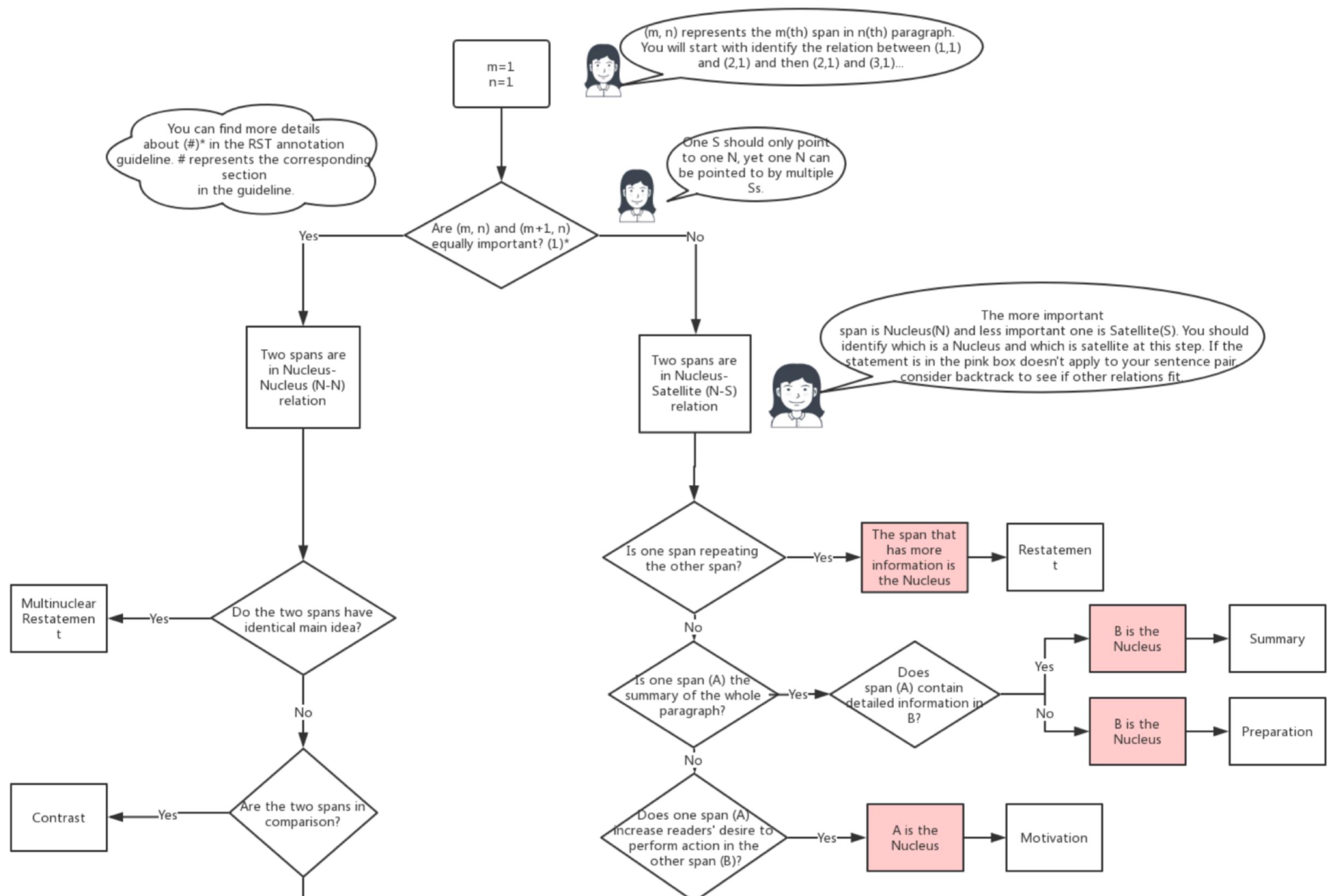
Openly accessible
for research use,
see reference.

RST Annotation Guideline

In this guideline, we provide a flowchart to identify which span is more important in a sentence pair. We also illustrate in details the RST relations we encounter frequently in students' essay, and explain them with examples extracted from the context of students' writing.



Shiyan Jiang, Kexin Yang, Chandrakumari Suvarna, and Carolyn Rose. 2019. Guideline and Flowchart for Rhetorical Structure Theory Annotation. Technical report, Carnegie Mellon University, School of Computer Science.



Adaptation of RST relations

...

Purpose of Adaptation:

1. Identify relations that can reveal the structure of student essays and trigger meaningful writing feedback
2. Reduce confusion and increase inter-rater reliability

One example of relation change

Background -1 : closely connected by pronoun, e.g. “it”, “they”

Background -2 : loose connection

Combine	Eliminate	Change
Conjunction Sequence List	Condition Unless Purpose Disjunction	Background Justify Preparation Summary



Intelligent Tutoring System for RST Annotation

...

...

Practical Rst Ex: 1 2 3 4 5 6 7 8 9 ▶

Practical RST Tutor

Relation 1

Evaluation

Defintion:

S assesses N based on what is presented in N or logical deduction from N.

Example:

S: They are going to be very warm in winter.

N: These sweaters have supreme wool inside.

Conjunction Phrases:

"People have reason to say...", "It is logical to say..."

Group:

Supplementary

Relation 2

Conjunction

Defintion:

The two sentences are joined to form a unit that serve a common purpose

Example:

N: This did not make me like the story any less

N: nor did I find it hard to follow.

Conjunction Phrases:

"Another thing about this is..."

Group:

Conjunct

Relation 3

Evidence

Defintion:

S provides N with additional details.

Example:

S: According to statistics, the average time that Chinese kids doing housework is only 0.2 hr/ week, while American kids spend 0.8 hr/week on housework.

N: Chinese students may be more spoiled with doing less housework in the childhood.

Conjunction Phrases:

"One evidence for this is..." , "What can effectively support this is..." , "This is backed up by the fact that..."

Group:

Supplementary

Open for public use, accounts upon request.



Language Technologies Institute

Carnegie Mellon University



Human-
Computer
Interaction
Institute

10

Intelligent Tutoring System for RST Annotation

Your Task

Identify the relation for the sentence pair:

A: It is snowing and 30 degree outside.
B: Pittsburgh is experiencing a really cold winter now.

Identify Evaluation
Nucleus-Satellite vs. Nucleus-Nucleus
Identifying Group
Identify Conjunction Phrase
Identify Conjunction
Identify Evidence

Additional Information

Group Definition

Progressive:
Sentence A builds on Sentence B, and moves the idea forward.

Supplementary:
The Satellite (one sentence) is supplementing information to the Nucleus(the other sentence).

Conjunct:
Two sentences are joined to form a unit and serve a common purpose.

Repeating:
The two sentences contain similar information.

Step by Step

Lets try to solve this problem step by step!

Step 1: Which class/group do you think the relation will likely fall into? (In other words, what best describe the nature of this relation?)
Please select from the drop down menu.

Step 2: What conjunction phrase can best connect the two parts?
Please select from the drop down menu.

Step 3: Is this a Nucleus-Nucleus relation (two parts equally important) or a Nucleus-Satellite one?
 Nucleus-Nucleus Nucleus-Satellite

Step 4: Now, what is the relation between these two sentences?

A: It is snowing and 30 degree outside.
B: Pittsburgh is experiencing a really cold winter now.

Done

Open for public use, accounts upon request.



Intelligent Tutoring System for RST Annotation- Development Process

Authoring tool: CTAT - Cognitive Tutor Authoring Tools

Two rounds of cognitive task analysis(CTA):

First Round: Five subjects, RST novices

Second Round: Three subjects with experience in RST

Findings from CTA:

Novices tend to:

- Refer back to definition
- Compare given task with examples sentences
- insert conjunction phrases to see if it make sense

Intelligent features:

- Bayesian Knowledge Tracing Algorithm
- Provide adaptive selection of next problem
- Mastery learning



Ryan S. Baker, Albert T. Corbett, and Vincent Aleven. 2008. More accurate student modeling through contextual estimation of slip and guess probabilities in Bayesian Knowledge Tracing. In International conference on intelligent tutoring systems, pages 406–415.

Current Status

.. .

Completed:

- 77 essays (62 training+15 evaluation), 1635 relations
- Prototype two-stage RST parser that can learn from our annotations and automatically parse novel essays, but with low accuracy

Future work:

- Increase scope of annotated data
- Iteratively improve RST parsing approach
- Classroom study to test whether structural feedback improves students' writing over existing feedback

Wang, Y., Li, S., & Wang, H. (2017, July). A two-stage parsing method for text-level discourse analysis. In Proceedings of the 55th Annual Meeting of the Association for Computational Linguistics (Volume 2: Short Papers) (pp. 184-188).



Language Technologies Institute

Carnegie Mellon University

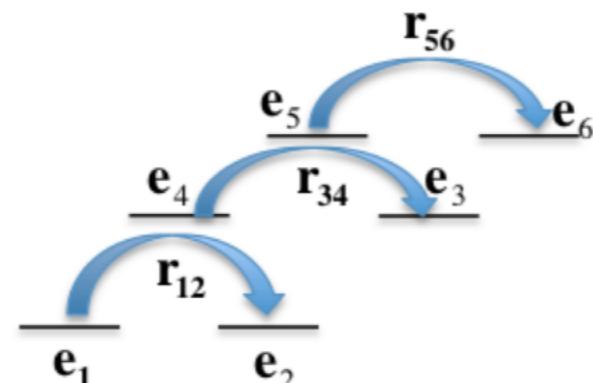


13

Tree-structure Construction

...

- Recursive Deep Models for Discourse Parsing (Binary (Structure) Classification)



$$\begin{aligned}t_{\text{binary}}(e_1, e_2) &= 1, & t_{\text{binary}}(e_3, e_4) &= 1, \\t_{\text{binary}}(e_2, e_3) &= 0, & t_{\text{binary}}(e_3, e_6) &= 0, \\t_{\text{binary}}(e_5, e_6) &= 1\end{aligned}$$

Acknowledgement

...

This work was funded in part by NSF grant and a Schmidt foundation postdoc fellowship.

We thank our collaborators at Turnitin for providing student essays.

We also thank Vincent Aleven and Jonathan Sewall for help in building the practical RST tutor.

