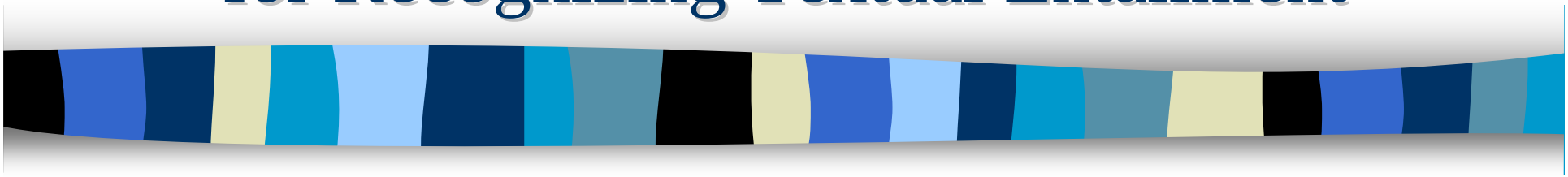
An Accuracy-Oriented Divide-and-Conquer Strategy for Recognizing Textual Entailment



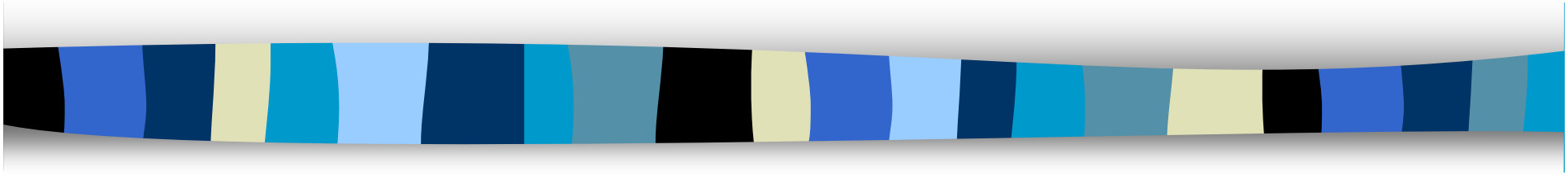
Rui Wang
Saarland University
rwang@coli.uni-sb.de

Guenter Neumann
DFKI GmbH
neumann@dfki.de

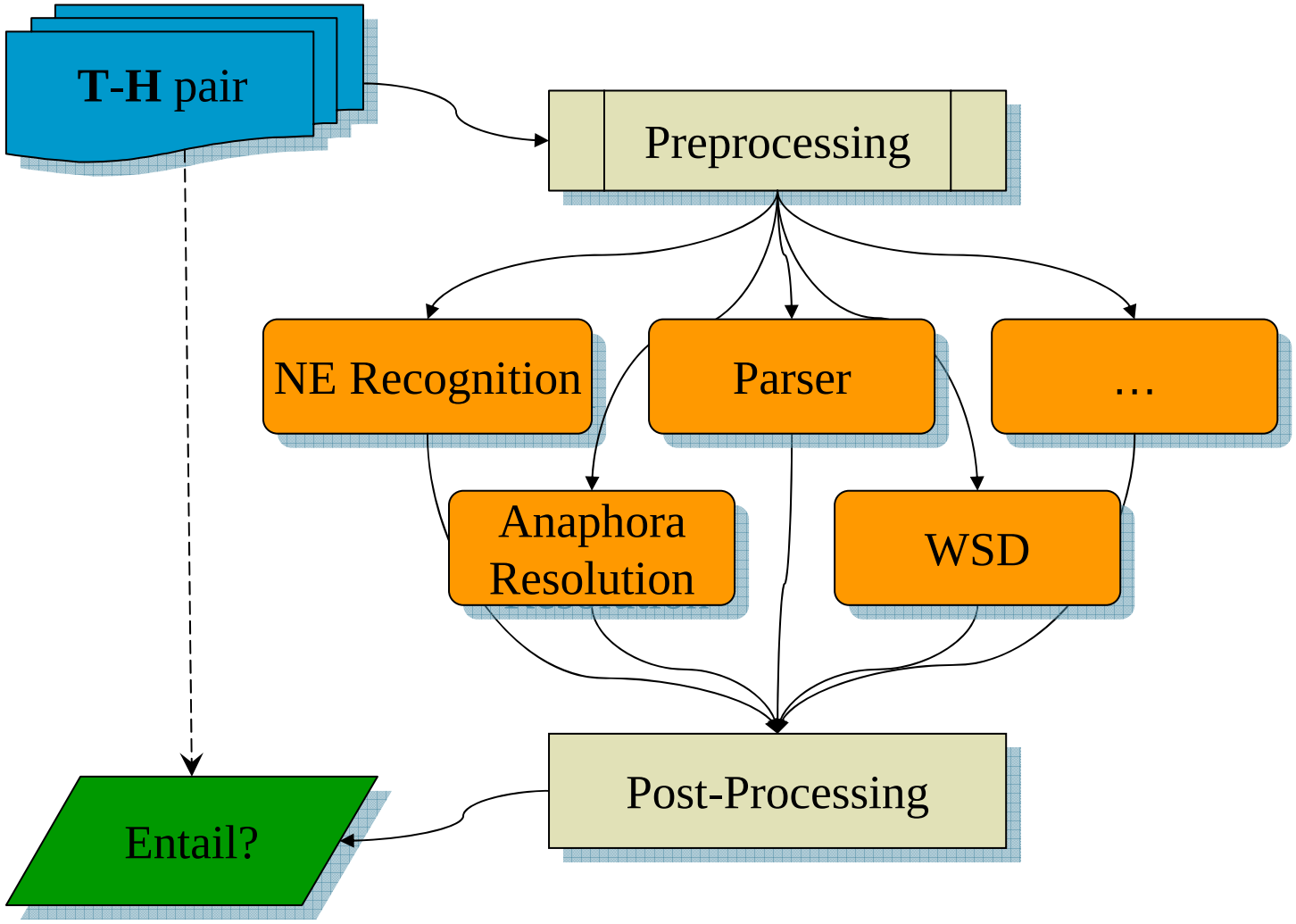
Outline

- The Architecture(s)
- Precision-Oriented Modules
  - The TACTE module
  - The NE-Oriented module
  - The Tree Skeleton module
- Results & Conclusion

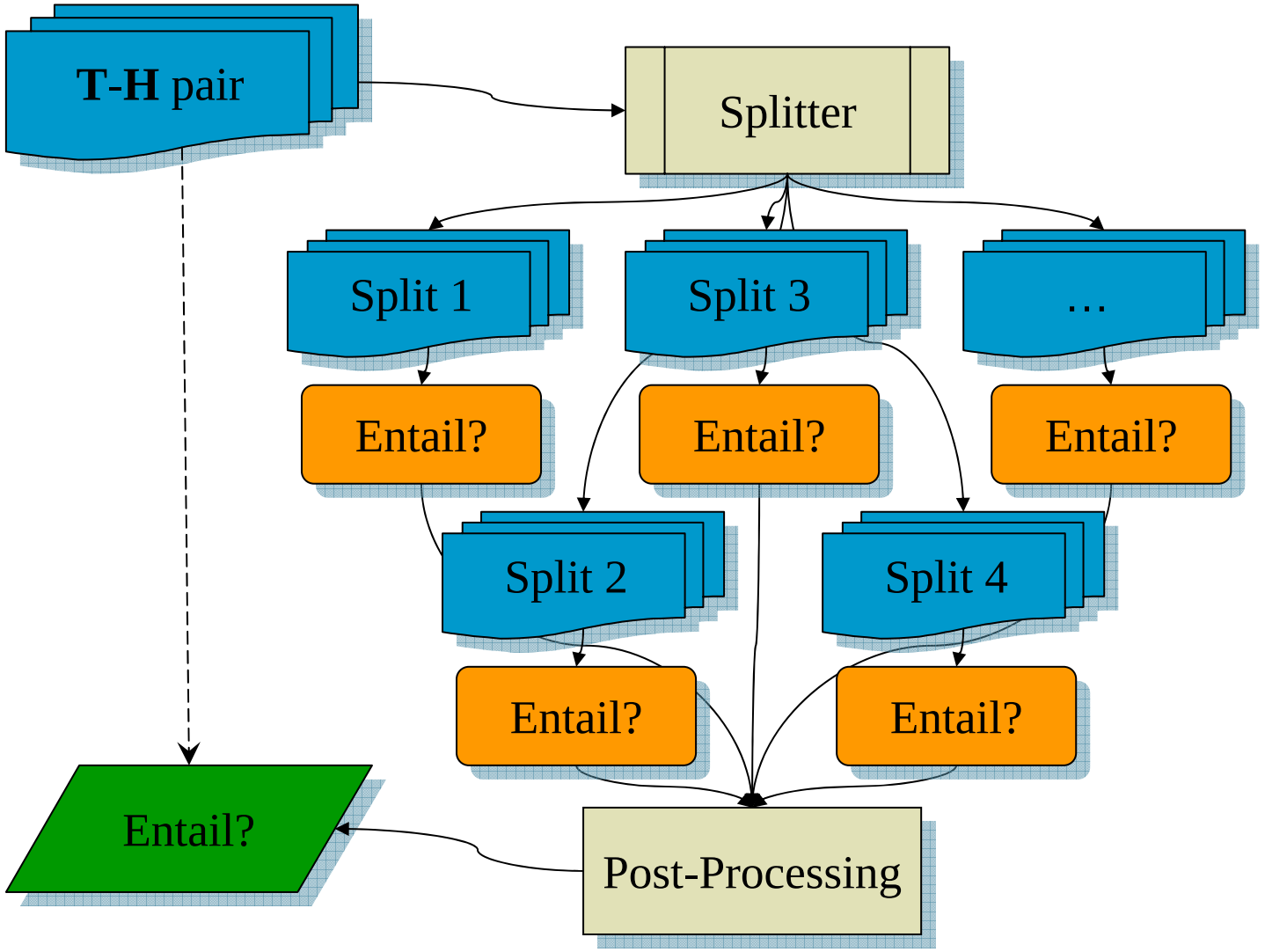
The Architecture(s)



A Common Architecture



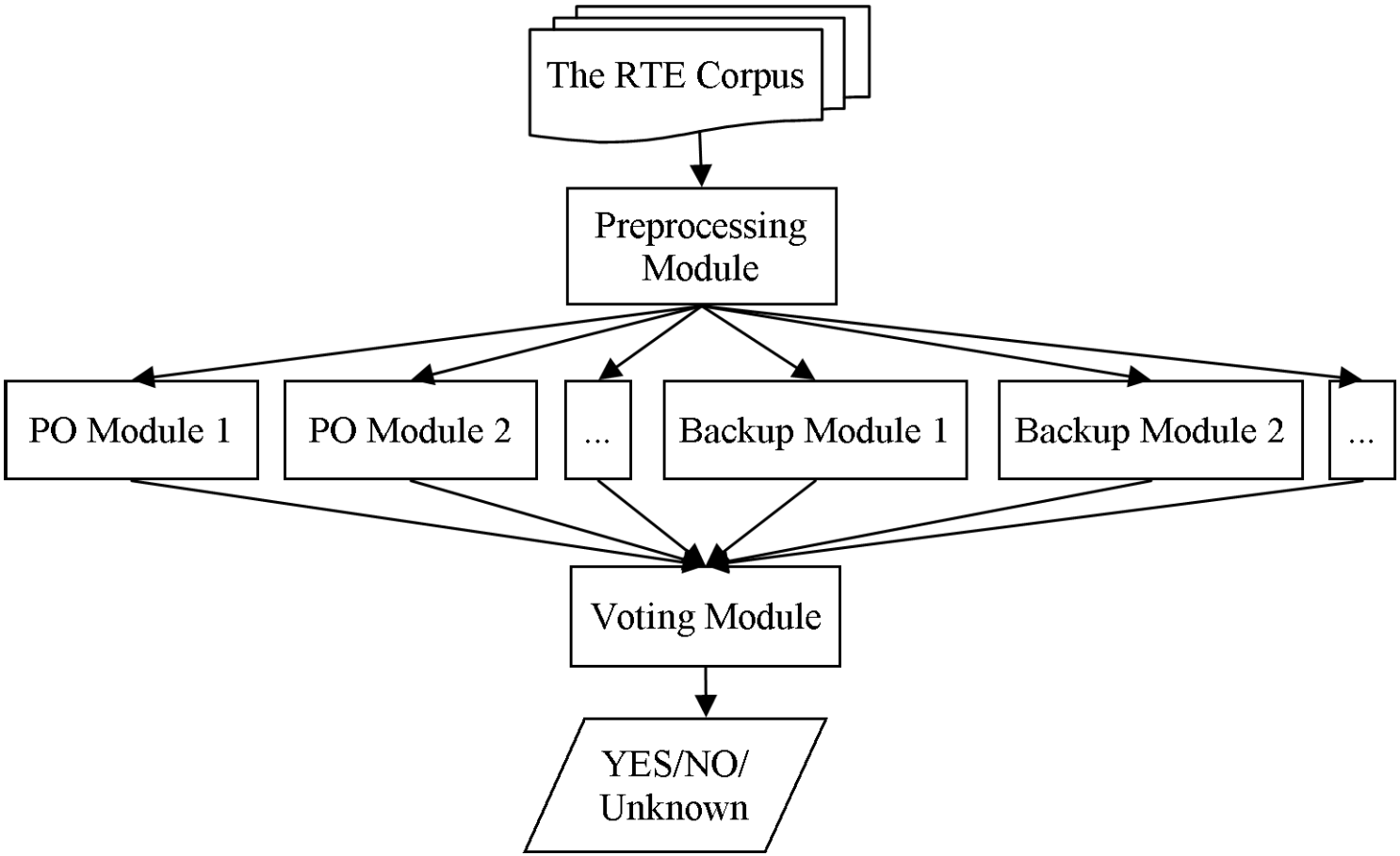
An Alternative Architecture



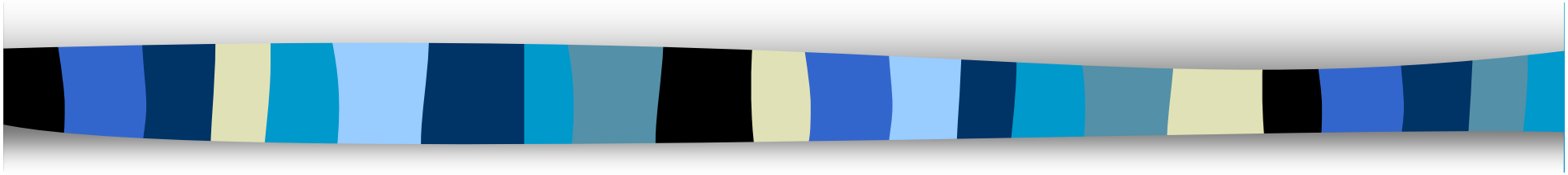
Requirements

- Divide
  - A good split
- Conquer
  - Precision-oriented / Highly confident

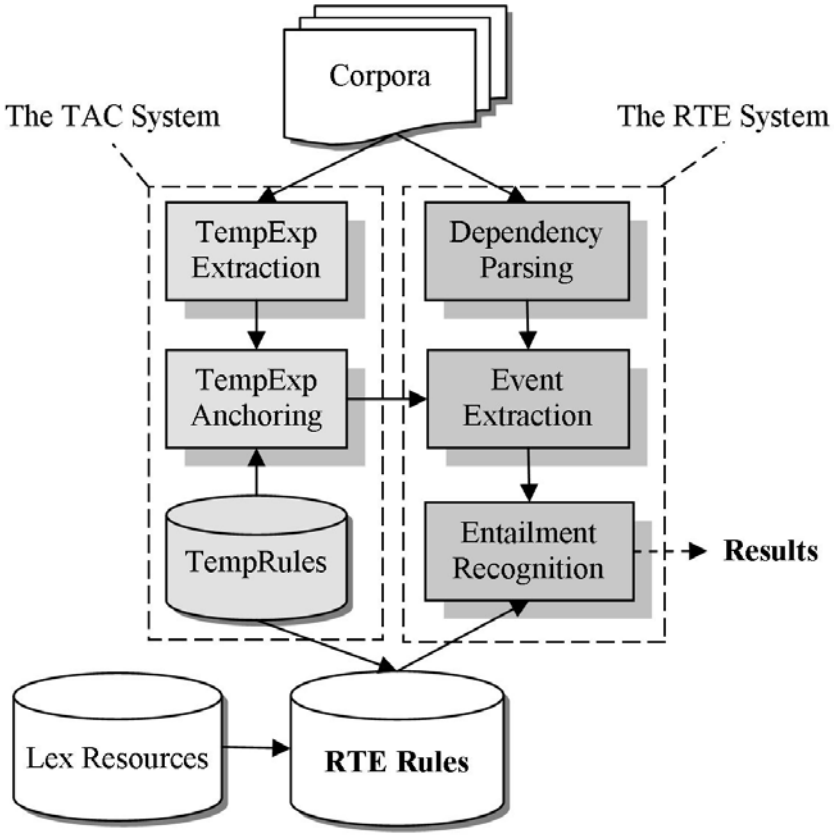
The Workflow



The Precision-Oriented Modules



The TACTE Module



- Input: <T> & <H>
- Result: Yes or No
- NER: SProUT
- Parser: Stanford Parser
- Lexical Resources:
  - WordNet
  - VerbOcean

Temporal Expression Anchoring (TAC)

- Temporal Expression Extraction
  - SProUT
- Temporal Expression Anchoring
  - Default reference date for both <T> and <H>
  - Explicit vs. relative temporal expressions

    e.g. *July 5th* vs. *last Friday*
  - Granularity

    [second < minute < hour < pofd < dofw < day < weeknumber < pofm < month < pofy < year]

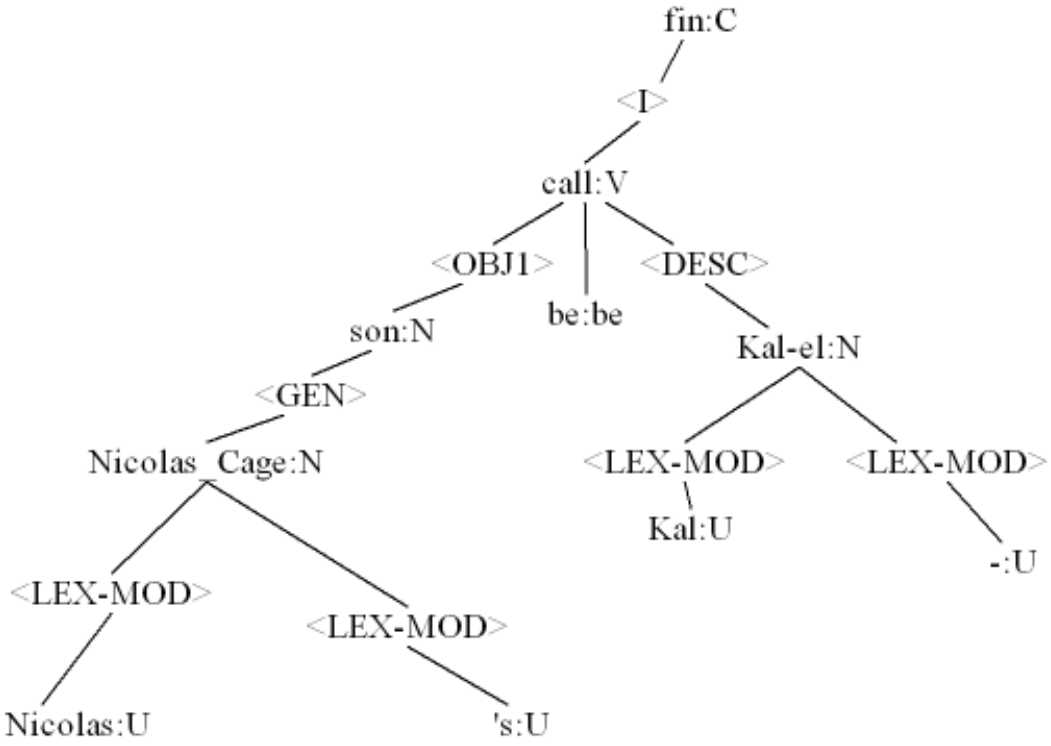
(Reference date: *Friday, Oct 24th, 1997*)

(1) The defense secretary William Cohen announced plans on *last Thursday*. → *Thursday, Oct 16th, 1997*

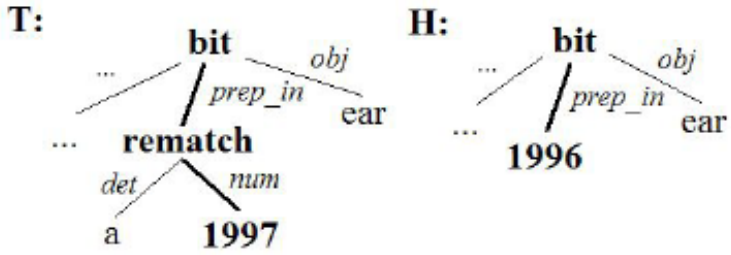
(2) The earthquake shook the province of Mindanao at *3:08 p.m this afternoon*. → *15:08, Friday, Oct 24th, 1997*

Event Extraction - Preprocessing

- Preprocessing: dependency parsing (Stanford parser)



An Example



(Entailment = No)

- <T> Released in 1995, Tyson returned to boxing, winning the World Boxing Council title in 1996. The same year, however, he lost to Evander Holyfield, and in a 1997 rematch bit Holyfield's ear, for which he was temporarily banned from boxing.
- <H> In 1996 Mike Tyson bit Holyfield's ear.

<T> 1995: released (verb)
1996: winning (verb)
1997: rematch (noun), bit (verb)
<H> 1996: bit (verb)

Another Example

(Entailment =Yes)

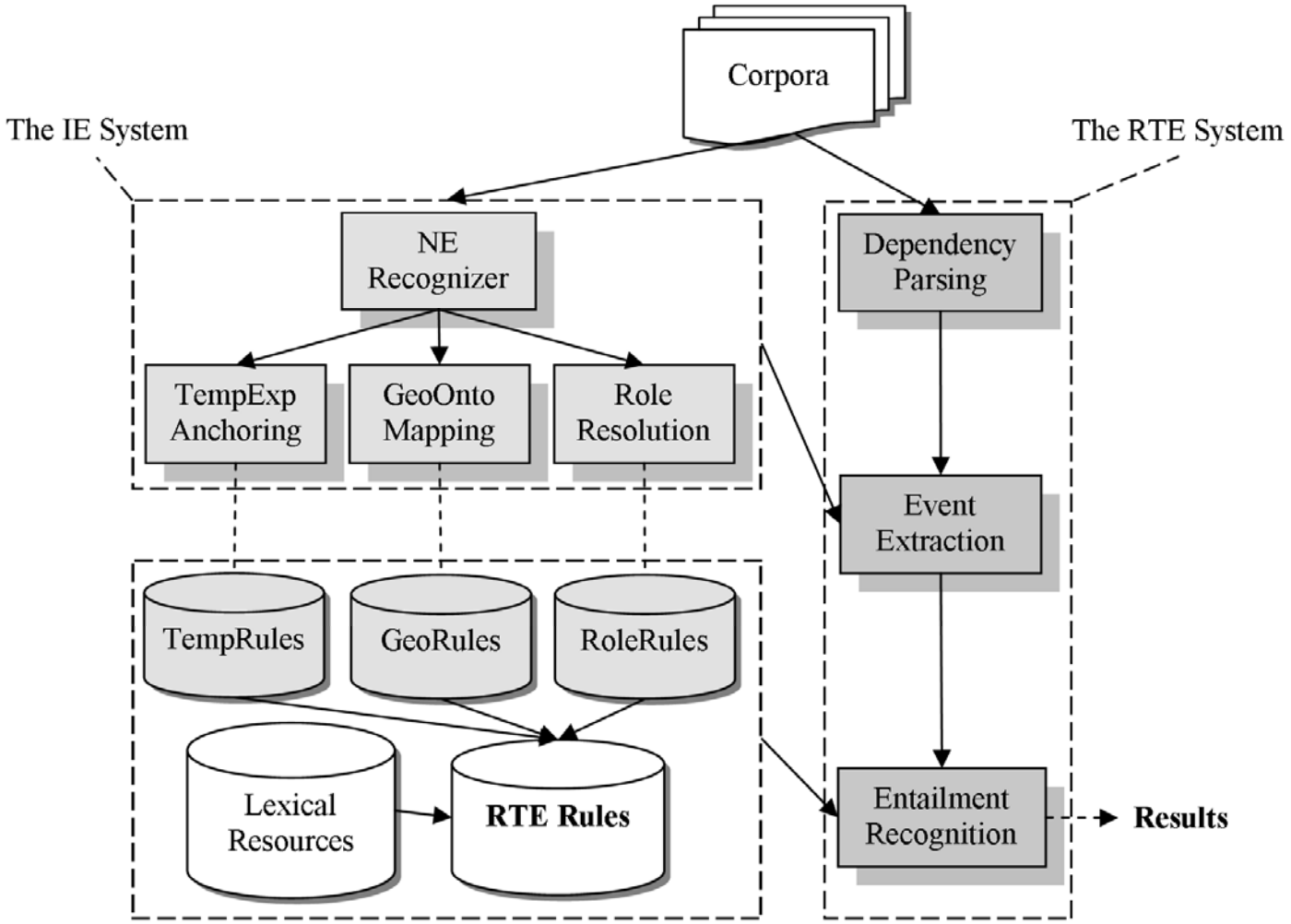
- <T> Lima, Jan. 10, '90, the national police reported that over 15,000 people have been arrested in Lima in a dragnet aimed at uncovering the assassins of former Defense Minister Enrique Lopez Albujar Trint, who was murdered in a terrorist attack, yesterday.
- <H> Enrique Lopez Albujar Trint was killed on Jan. 9 '90.

<T> 10-01-1990 (*Jan. 10, '90*): …

09-01-1990 (*yesterday*): murdered

<H> 09-01-1990 (*Jan. 9 '90*): killed

The NE-Oriented Module



The Event Structure

- <Event, Time, Location, List<Participants>>
  - Time: the TACTE system (Wang and Zhang, 2008)
  - Location: the GeoCLEF system (Wang and Neumann, 2008)
  - Participants: the Stanford NER system (Finkel et al., 2005)

An Example

- Pair: YES
  - T: *A controversial part of the agreement is the release of Lebanese prisoner Samir Kantar, a militant serving a 542-year sentence for killing two men and a four-year-old girl in a 1979* ***raid*** *on northern Israel. The brutality of that attack horrified Israelis.*
  - H: *In 1979 Israel was* ***attacked****.*
- Events
  - T: [Event:[**raid**], Time:[1979], Location:[Israel]]
  - H: [Event:[**attacked**], Time:[1979], Location:[Israel]]

An Example with Multiple Events

- Pair: YES
  - T: *Spain appeared hardest **hit** by the protests today. An estimated 100,000 farmers drove tractors through Madrid and dozens of other Spanish cities, warning of more aggressive action if there is no agreement to **compensate** them for higher fuel costs by October.*
  - H: *Spain **stages** fuel protests.*

- Events
  - T1: [Event:[**hit**], Time:[today]]
  - T2: [Event:[**appeared**], Location:[Spain]]
  - T3: [Event:[**compensate**], Time:[October]]

  - H: [Event:[**stages**], Location:[Spain]]

The Tree Skeleton Module

- Pair: id=*“61"* entailment=*“**YES**"* task=*“**IE**“* source=*“RTE”*
  - Text:

    *Although they were born on different planets, Oscar-winning actor **Nicolas Cage**'s new **son** and Superman have something in common, both were named **Kal-el**.*

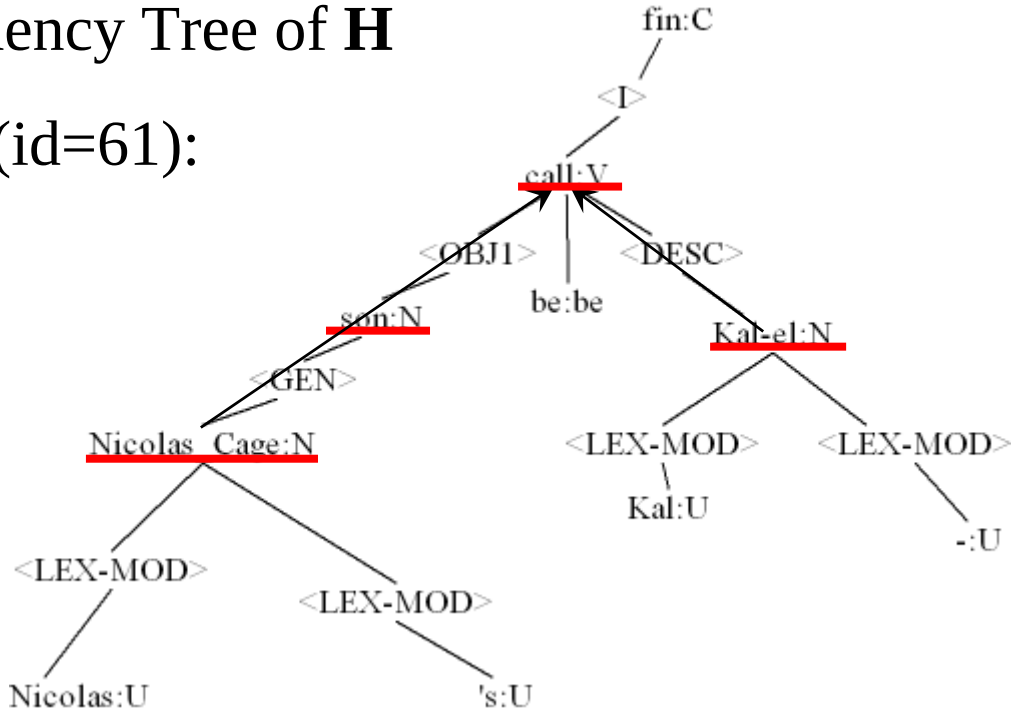
  - Hypothesis:

    ***Nicolas Cage**'s **son** is called **Kal-el**.*

Tree Skeleton

Dependency Tree of **H**

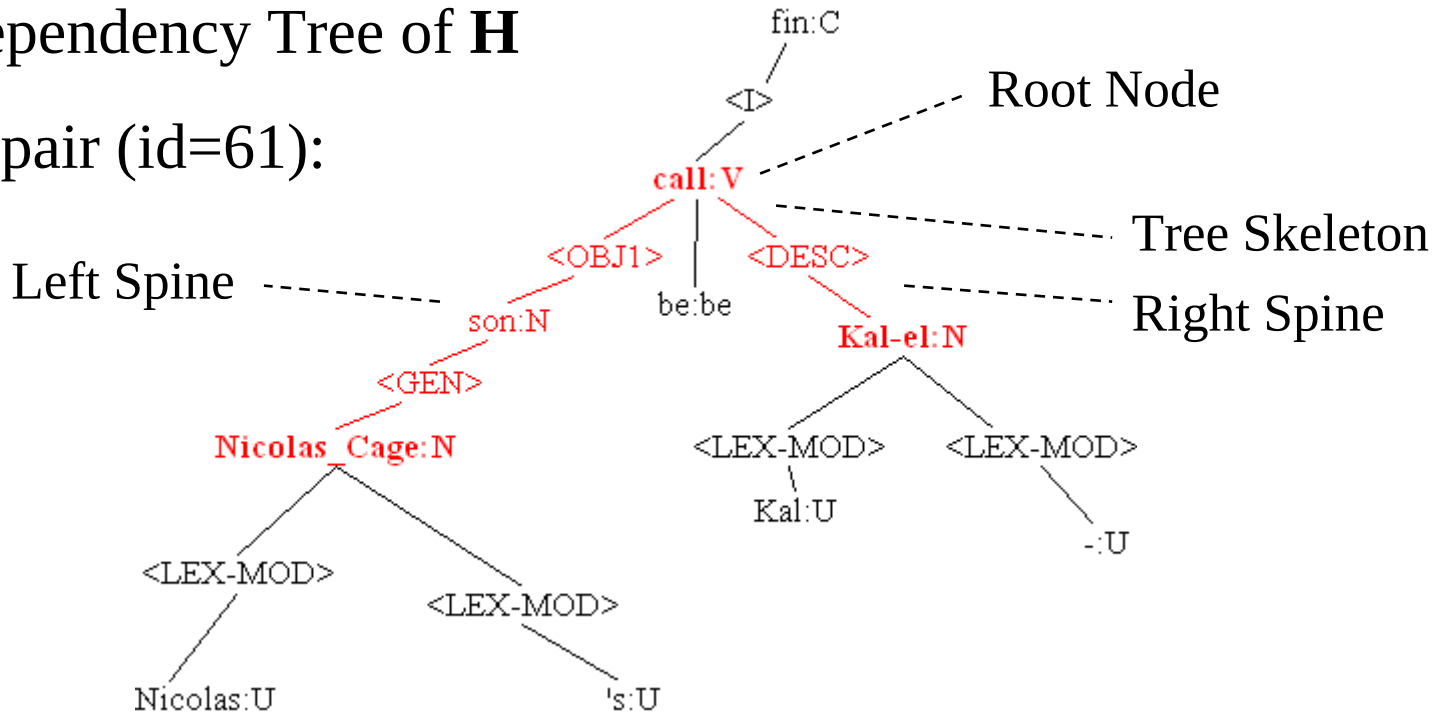
of pair (id=61):



- Text: ***Nicolas Cage's son*** *is called* ***Kal-el.***

Tree Skeleton

Dependency Tree of **H** of pair (id=61):

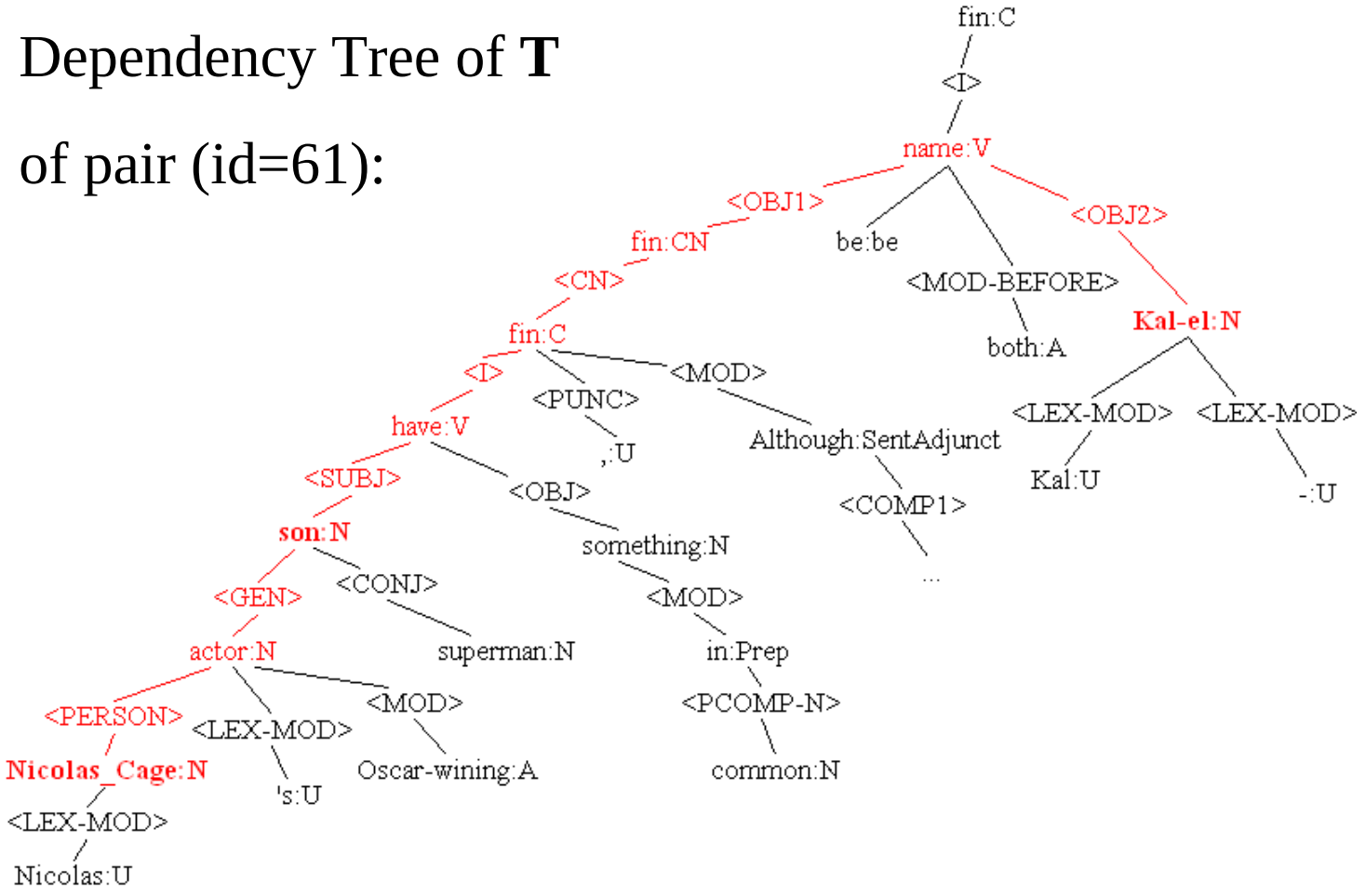


- Text: ***Nicolas Cage**'s **son** is called **Kal-el**.*

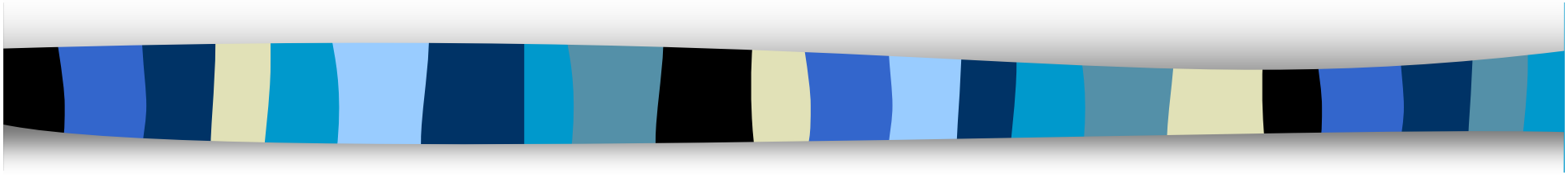
Tree Skeleton (cont.)

Dependency Tree of **T**

of pair (id=61):



Results & Conclusion



Settings of the Whole System

- Main modules
  - The TACTE system (TAC-M)
  - The Event system (NE-M)
  - The Tree Skeleton system (TS-M) (Wang and Neumann, 2007)
- Backup modules (Wang and Neumann, 2007)
  - The triple similarity (Tri-BM)
  - The bag-of-words similarity (BoW-BM)
- Two issues
  - When to apply the module (Coverage)
  - How good is the module (Precision)

Results (2-way)

Tasks	TAC-M	TS-M	NE-M	BoW-BM	Tri-BM	Run1	Run2	Run3
IR(300)	75.0%/4	**76.5%/85**	61.0%/164	63.3%	54.3%	66.0%	**72.3%**	71.7%
QA(200)	**90.0%/10**	73.2%/82	54.8%/93	49.0%	53.5%	73.0%	72.0%	**74.0%**
SUM(200)	**83.3%/6**	74.5%/51	55.2%/67	63.5%	54.0%	64.0%	69.5%	**71.5%**
IE(300)	72.7%/11	**74.2%/128**	46.7%/152	50.0%	50.0%	**66.7%**	66.3%	**66.7%**
All(1000)	**80.6%/31**	74.6%/346	54.3%/477	56.5%	52.8%	67.2%	69.9%	**70.6%**

- **Run1**: TAC-M, TS-M, and Tri-BM
- **Run2**: TAC-M, TS-M, and BoW-BM
- **Run3**: TAC-M, TS-M, NE-M, and Tri-BM, BoW-BM

Results (3-way)

Answers	**Run1(2)**	**Run2(2)**	**Run3(2)**	Answers	**Run1(3)**	**Run2(3)**	**Run3(3)**
Yes(500)	66.6%	**81.4%**	74.8%	**Yes(500)**	68.2%	66.6%	**72.8%**
No(500)	**67.8%**	58.4%	66.4%	**No(150)**	38.7%	**41.3%**	33.3%
/	/	/	/	**Unknown(350)**	**61.4%**	47.1%	54.9%
All(1000)	67.2%	69.9%	**70.6%**	**All(1000)**	**61.4%**	56.0%	60.6%

- **Run1**: TAC-M, TS-M, and Tri-BM, BoW-BM
- **Run2**: TAC-M, TS-M, NE-M (partial), and Tri-BM, BoW-BM
- **Run3**: TAC-M, TS-M, NE-M, and Tri-BM, BoW-BM

- If BoW-BM=*YES* & Tri-BM=*NO* then *CONTRADICTION*
- If BoW-BM=*YES* & Tri-BM=*YES* then *ENTAILMENT*
- Others *UNKNOWN*

**de Marneffe, M., Rafferty A., and Manning, C. 2008. Finding contradictions in text. In Proceedings of ACL-HLT 2008.*

An Example

- Pair: YES
  - T: *A French court on Wednesday* ***sentenced*** *serial killer Michel Fourniret and his wife to life in prison for the murder of seven girls and young women.*
  - H: *Michel Fourniret was* ***sentenced*** *to life imprisonment.*

- Events
  - T: [Event:[**sentenced**], Time:[on Wednesday], Roles:[Michel Fourniret]]
  - H: [Event:[**sentenced**], Roles:[Michel Fourniret]]

An Error

- Pair: YES
  - T: Two Britons have **died** in a light aircraft plane **crash** in north west Italy, the Foreign Office has said.
  - H: A plane **crashes** in Italy.
- Events
  - T1: [Event:[**died**], Location:[Italy]]
  - T2: [Event:[**crash**], Location:[Italy]]
  - H: [Event:[**crashes**], Location:[Italy]
- How to know the corresponding events
  - Similarity vs. Relatedness

Others' Work

- NE features
  - Vanderwende, L., Menezes, A., and Snow, R. 2006. Microsoft Research at RTE-2: Syntactic Contributions in the Entailment Task: an implementation. In Proceedings of the RTE-2 Challenge.
- Precision-based RTE
  - Bobrow, D., Crouch, D., King, T., Condoravdi, C., Karttunen, L., Nairn, R., de Paiva, V., and Zaenen, A. 2007. Precision-focused Textual Inference. In Proceedings of the RTE-3 Challenge.
- Natural Logic
  - MacCartney, B. and Manning, C. 2007. Natural Logic for Textual Inference. In Proceedings of the RTE-3 Challenge.

Conclusion & Future Work

- Divide
  - Basic linguistic processing
    → Simple cases of entailment
- Conquer
  - Precision-oriented modules
    → More accurate and more modules
- Integration
  - The voting model
    → A uniform representation/theory

Acknowledgements

- The work was partially supported by a research grant from BMBF to the DFKI project HyLaP (FKZ: 01 IW F02) and the EC-funded project QALL-ME.

- Special thanks to Yajing Zhang for the TAC system.

- Thank you!

Publications

- Rui Wang and Günter Neumann. 2007. Recognizing Textual Entailment Using a Subsequence Kernel Method.
- Rui Wang and Yajing Zhang. 2008. Recognizing Textual Entailment with Temporal Expressions in Natural Language Texts.
- Rui Wang and Günter Neumann. 2008. Ontology-based Query Construction for GeoCLEF