A constraint-based hypergraph partitioning approach to coreference resolution

Emili Sapena, Lluís Padró, Jordi Turmo

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TA-Graph 2014

Coreference Resolution



FC Barcelona president Joan Laporta has warned Chelsea off star striker Lionel Messi .

Aware of Chelsea owner Roman Abramovich 's interest in the young Argentine , Laporta said last night: " I will answer as always, Messi is not for sale and we do not want to let him go."

Coreference Resolution



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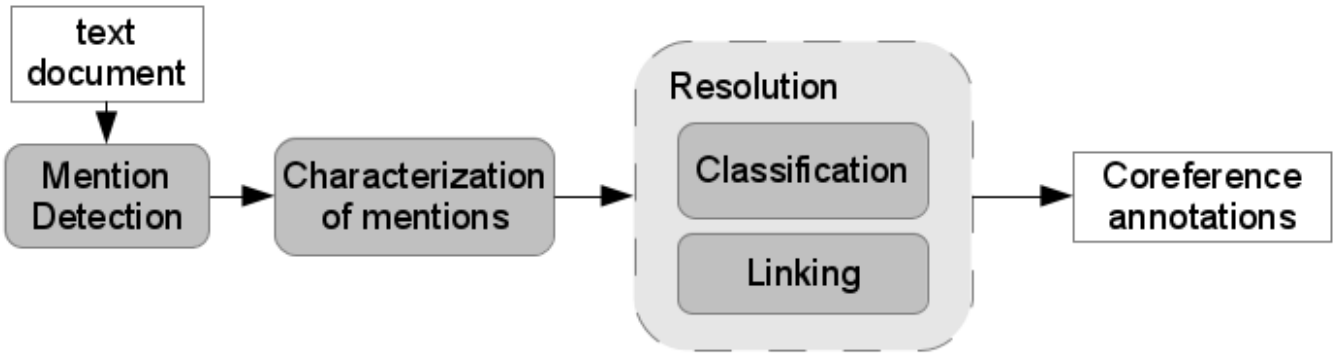
Architecture of coreference resolution systems



Preprocessing:

- **Mention detection**:
  - Detect the boundaries of the mentions in the input text.
  - $\mathbf{m} = (m_1, m_2, \ldots, m_n)$ ordered as found in the document.

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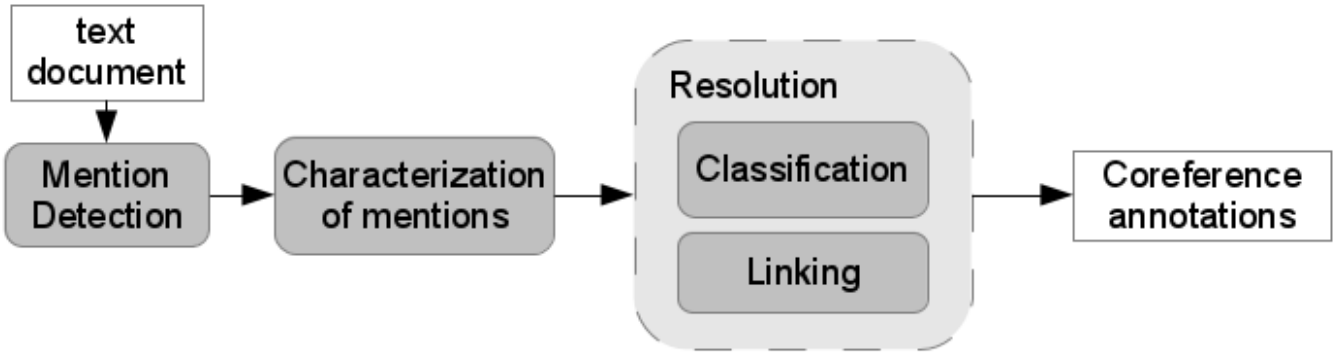

Preprocessing:

- **Characterization of mentions**.
  - Feature engineering: Part of speech, syntactic functions, semantic classes...

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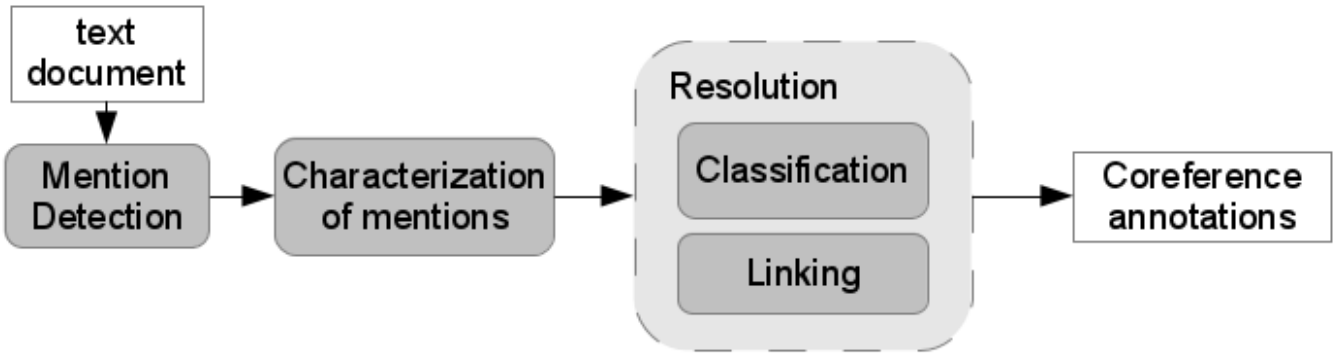

Resolution:

- **Classification**.
  - Evaluates the compatibility of elements in order to corefer.
  - Elements can be mentions or partial entities.
  - Commonly, binary classifier. Classes: CO (coreferential), NC (not coreferential)
  - Confidence values or probabilities associated with the class.
  - Classifiers can also use rankers and constraints.

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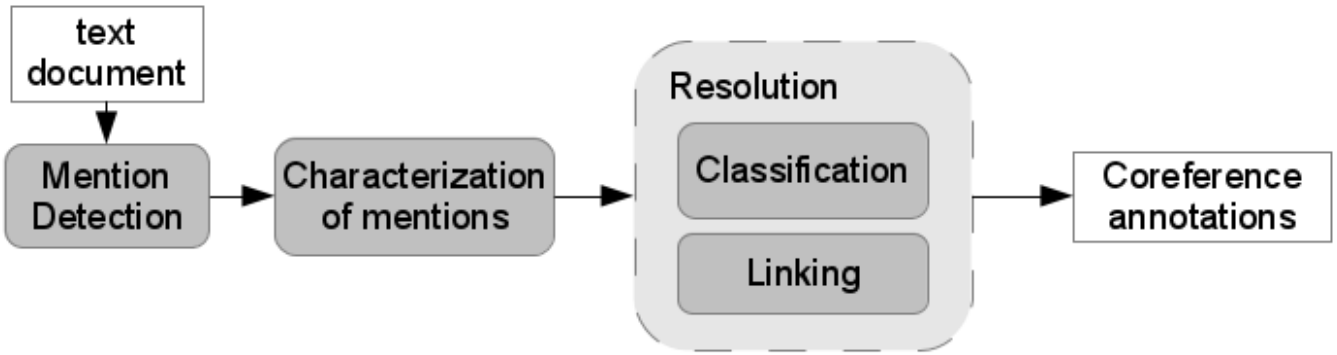

Resolution:

- **Linking**.
  - Links mentions and partial entities to form the final entities.
  - Input: the output of the classification process (classes and probabilities).
  - Diversity of algorithms: clustering, graph partitioning, heuristics, single-link, ILP...

Approaches

Mention pairs

- Binary classification of all possible mention pairs.
- Drawbacks:
  - Lack of information (e.g. uderspecified gender or number)
  - Transitivity contradictions (A$\Leftrightarrow$B, B$\Leftrightarrow$C, C$\not\Leftrightarrow$A)

Entity-mention

- Binary classification of each mention paired with partial entities built so far.

Rankers

- Classification is not binary: Candidates (either mentions or partial entities) are ranked and the best one is chosen.
- Drawbacks:
  - Forced to pick one (or to use anaphoricity filter, or a confidence threshold).

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  - Can be both automatically learned and manually written.
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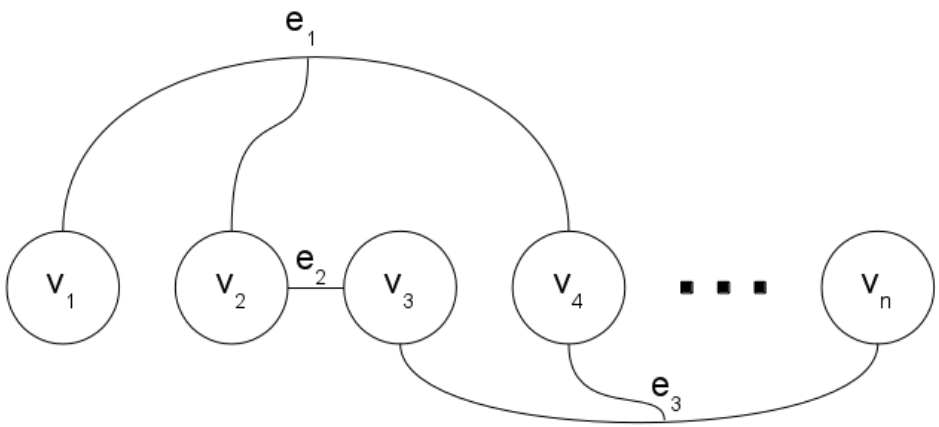
- **Relaxation labeling**: resolution algorithm
  - Performs function optimization based on local information.
  - Iterative resolution.
  - Use mention-pair and entity-mention models.
  - More confidence links are solved first.
  - Avoids errors caused by lack of information or context.

Problem representation

- **Mentions $\Rightarrow$ Vertices**
  - Each mention m_i is represented as a vertex $v_i \in V$.



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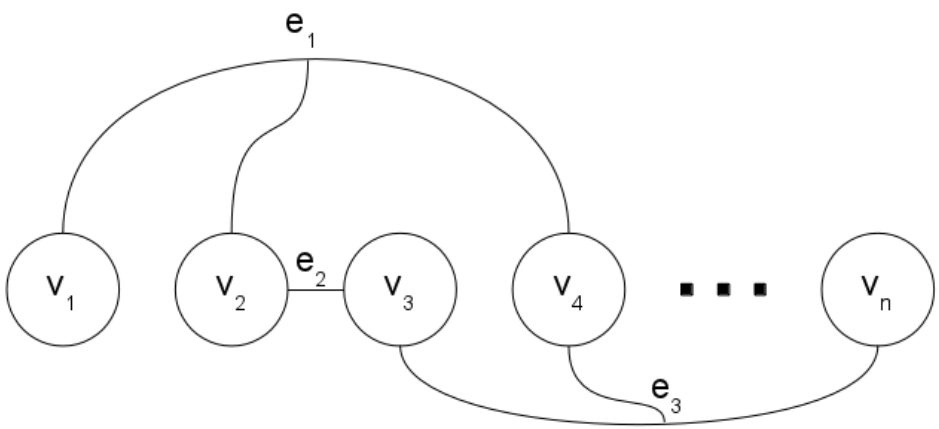
  - A hyperedge $e_g \in E$ for every group (g) of mentions satisfying a constraint.



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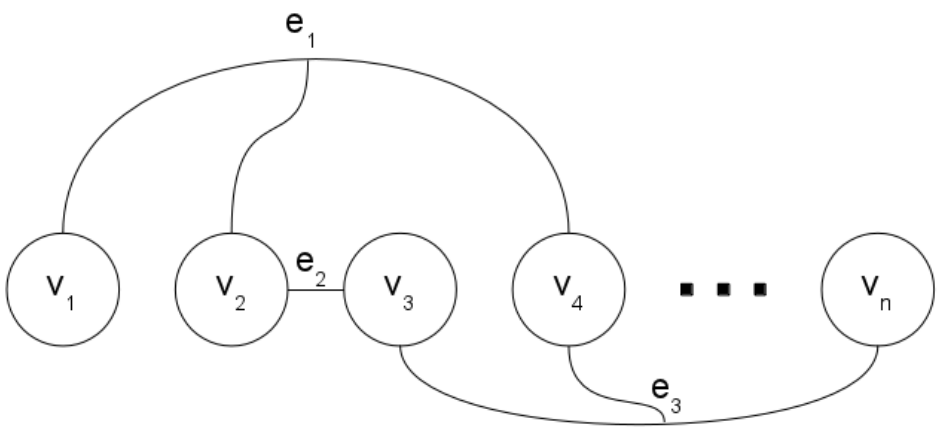
- **Constraint weights $\Rightarrow$ Edge weights**
  - Positive weight: mentions should corefer
  - Negative weight: mentions should not corefer
  - The higher the (absolute) weight, the more reliable.



Examples of constraints

- Example of a **pair** constraint:

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Example: **He**$_0$ comes early. **He**$_1$ leaves late.

- Example of a **group** constraint:

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- Example of an **entity-mention** constraint:

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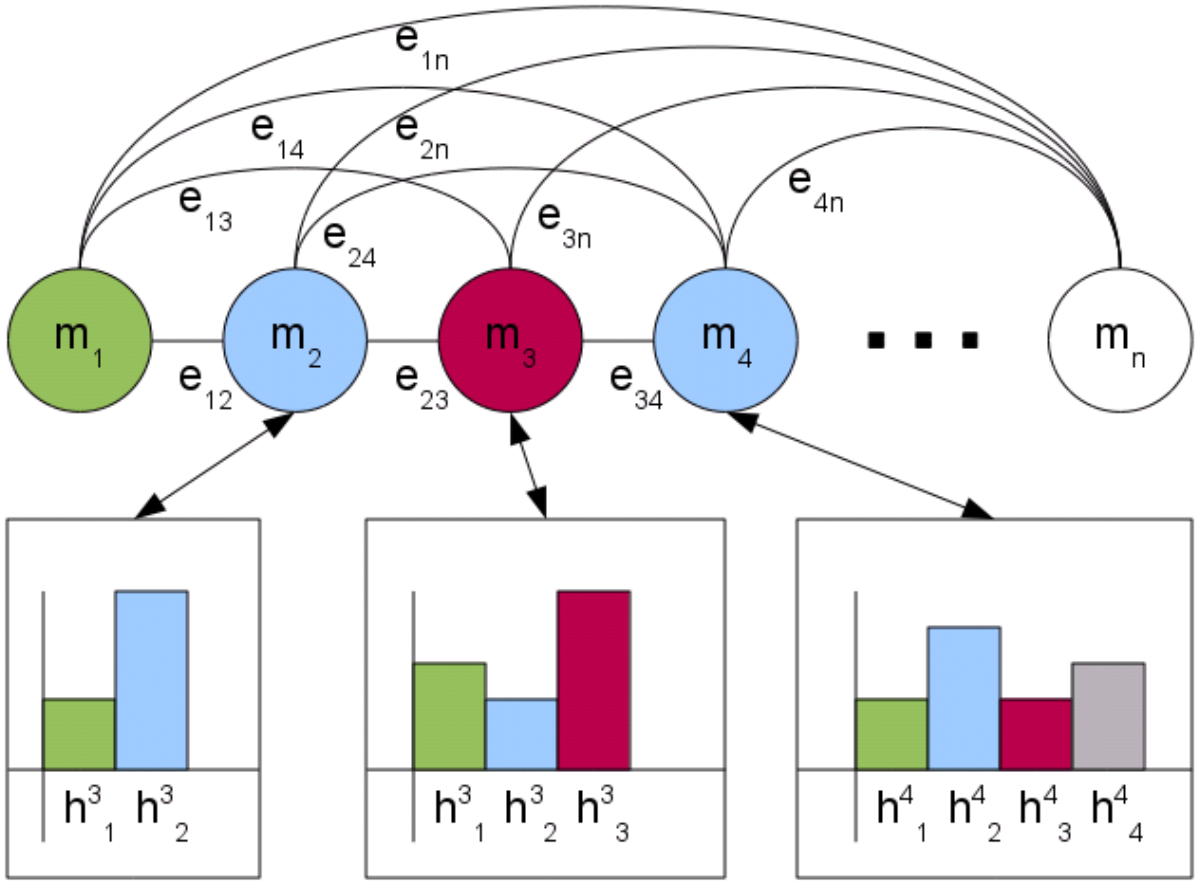
Relaxation Labeling



Evaluation

CoNLL-2011 shared task:

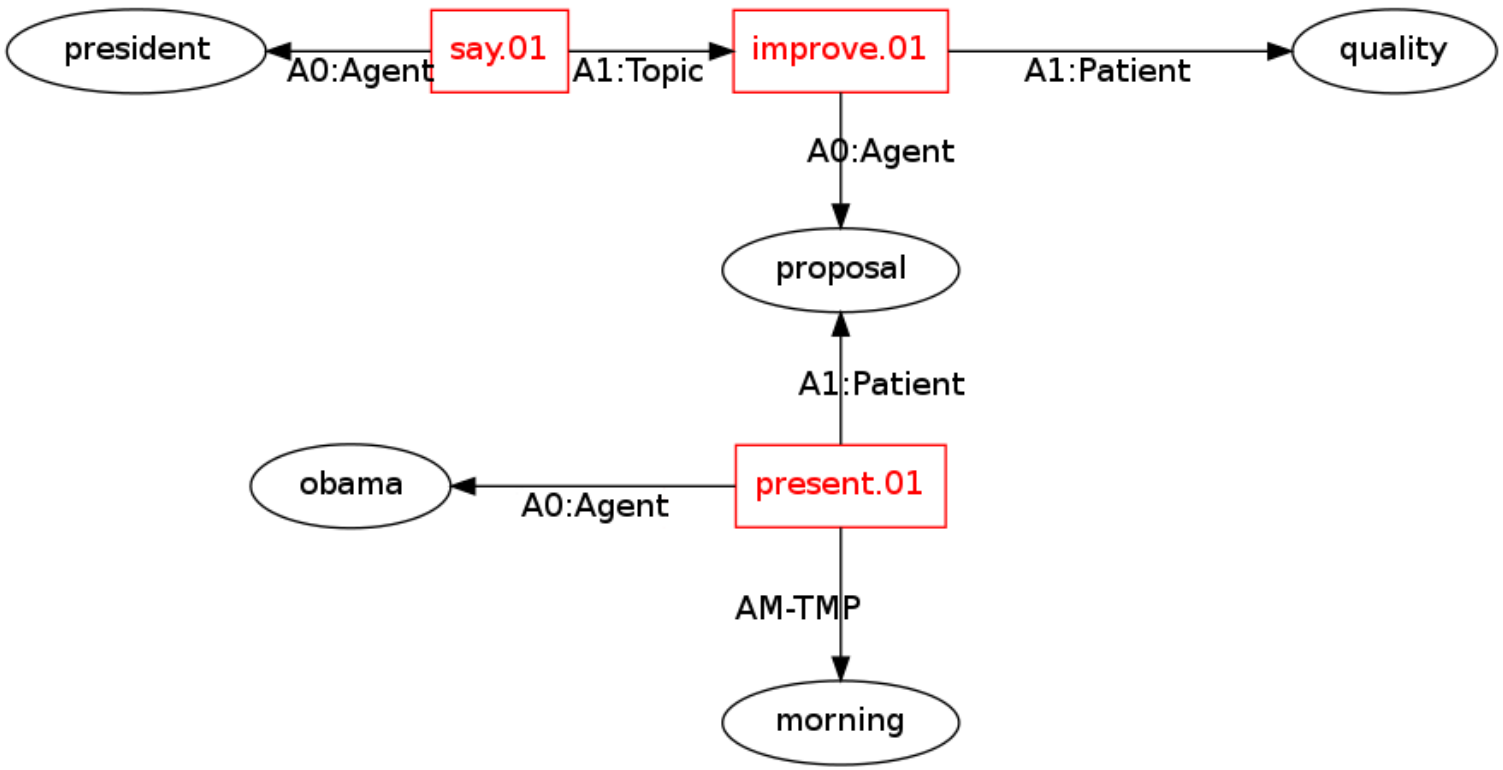
Modeling unrestricted coreference in OntoNotes

- RelaxCor (sapena) achieved 2nd position (out of 18 participants) in the official competition.

Pos	System	MUC F_1	B^3 F_1	CEAFe F_1	(MUC+B^3+CEAFe)/3
1	Lee	59.57	68.31	45.48	57.79
2	**Sapena**	59.55	67.09	41.32	**55.99**
3	Chang	57.15	68.79	41.94	55.96
4	Nugues	58.61	65.46	39.52	54.53
5	Santos	56.65	65.66	37.91	53.41
6	Song	59.95	63.23	35.96	53.05
7	Stoyanov	58.43	61.44	35.28	51.92
...	...	...	...	...	...
16	Kummerfeld	42.70	60.29	38.32	47.10
17	Zhekova	24.08	61.46	35.75	40.43
18	Irwin	19.98	50.46	25.21	31.28

What is this useful for?

This morning Obama presented a new law proposal. The president said that the proposal improves citizens life quality.



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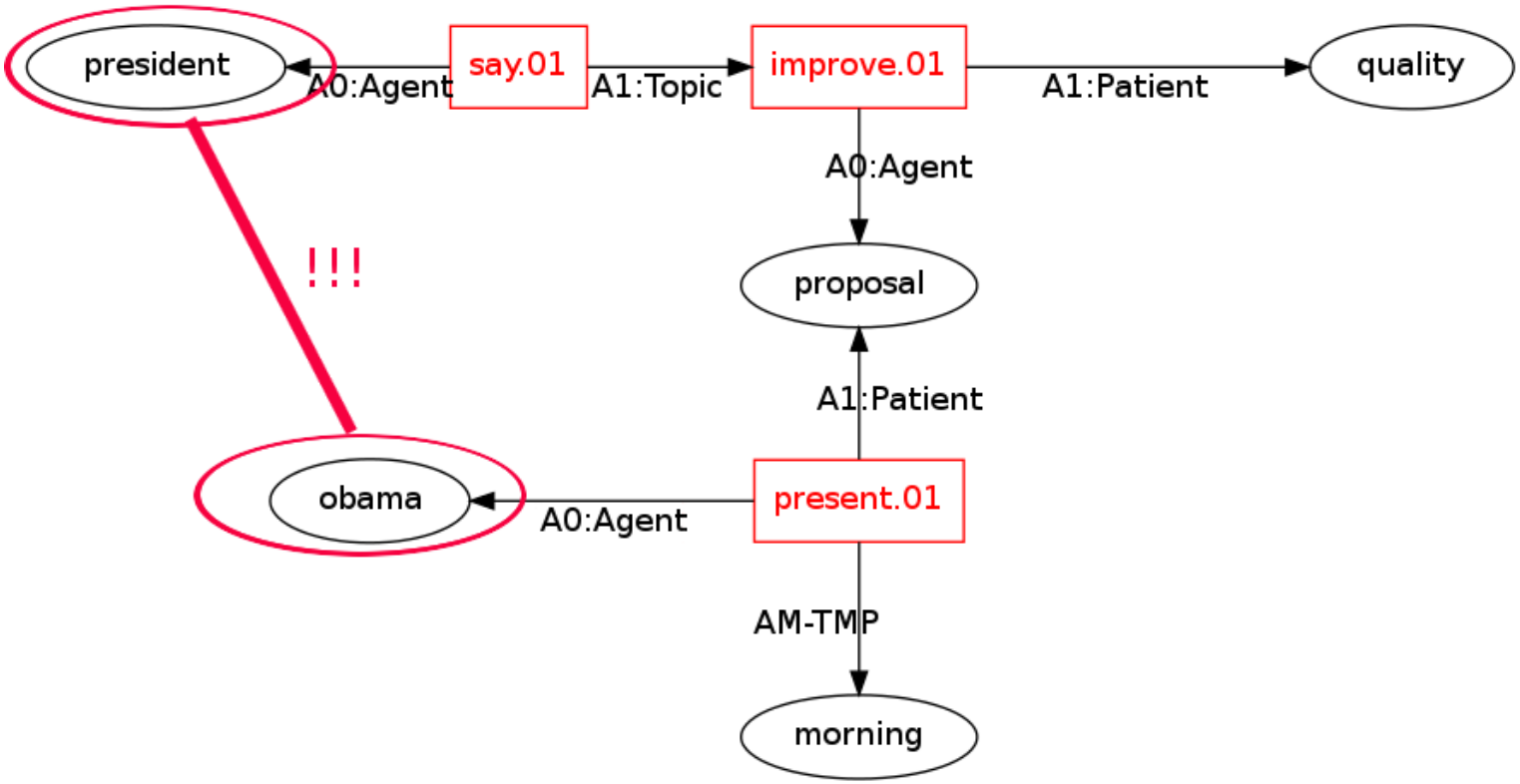

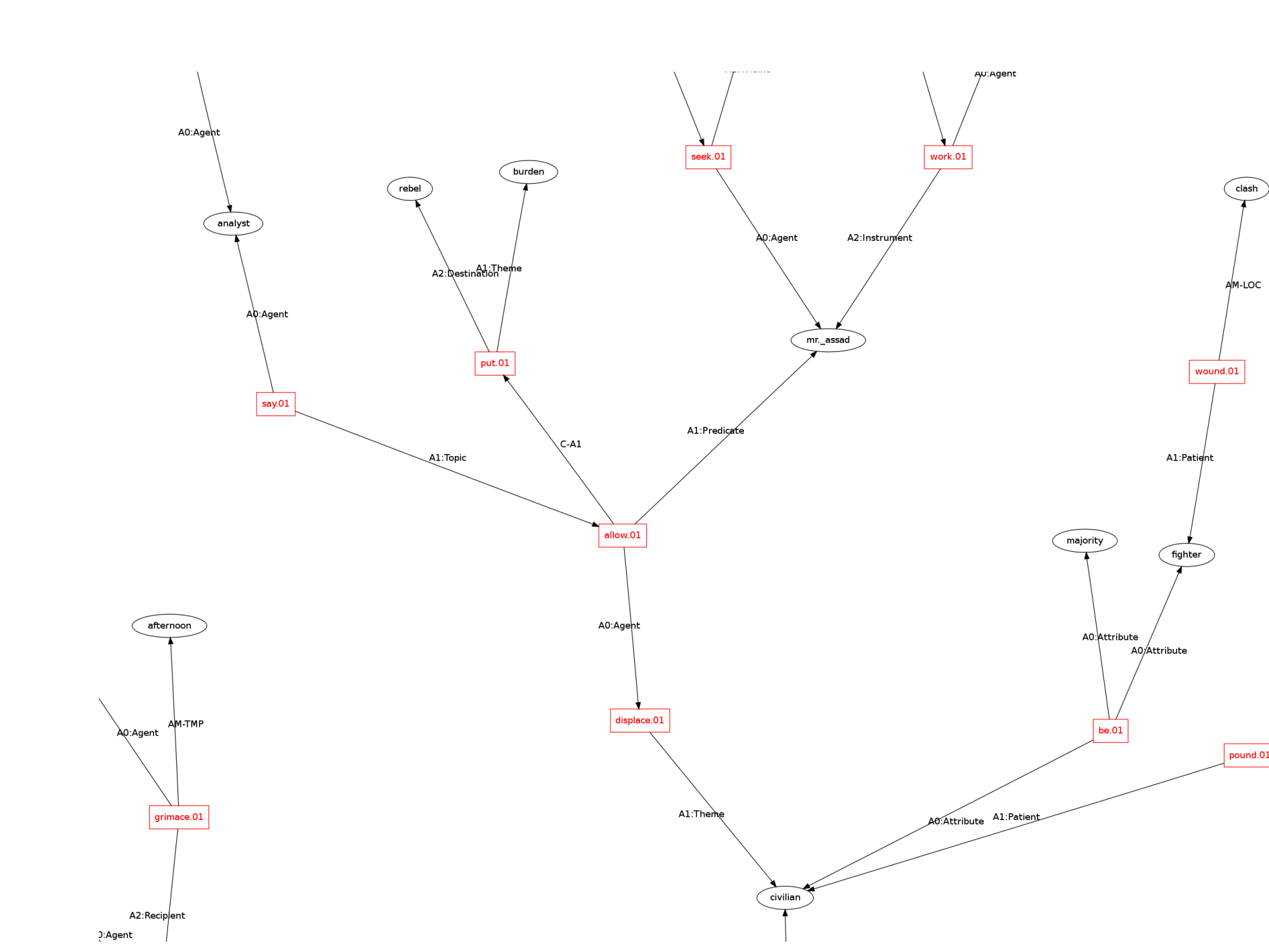
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