

KU Leuven - NLP 2024-2025
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Exercise Session 4 - Solutions
ILP for coreference and temporal inference

For questions contact:
Toledo Forum for Questions or
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1 Coreference resolution¹

Co-reference Resolution with Back-pointers

Question 1.A

Let $u_{ij} \in U$ be binary decision variables indicating $a_i = j$ ($u_{ii} \sim new$) Then the objective function to be maximized is:

$$O = \sum_{i=1}^N \sum_{j=1}^i u_{ij} P(a_i = j|x)$$

, subject to

$$\forall i : \sum_{j=1}^i u_{ij} = 1$$

Question 1.B

- If the back pointer of m_i refers to m_j then the two mentions are in the same chain:

$$\forall j < i : u_{ij} - v_{ij} \leq 0 \quad (1)$$

- If $u_{ij} = 1$, then $\forall i > j > k, v_{jk} = v_{ik}$:

$$\forall k < j < i : u_{ij} + v_{jk} - v_{ik} \leq 1$$

$$\forall k < j < i : u_{ij} - v_{jk} + v_{ik} \leq 1$$

If $u_{ij} = 1$, then $\forall i > k > j, v_{ik} = v_{kj}$:

$$\forall j < k < i : u_{ij} + v_{kj} - v_{ik} \leq 1$$

$$\forall j < k < i : u_{ij} - v_{kj} + v_{ik} \leq 1$$

Question 1.C

C is the set of K binary constraint indicator variables indicating if linguistic constraints are violated. Specifically, $c_{k,i,j} = 1$ iff the linguistic constraint C_k is violated for the back pointer u_{ij} . Each C_k is associated with a penalty score ρ_k .

We aim to maximize the objective function:

$$\sum_{i=1}^N \sum_{j=1}^i u_{ij} P(a_i = j|x) - \sum_{k=1}^K \rho_k c_{k,i,j}$$

Subject to:

$$\forall i : \sum_{j=1}^i u_{ij} = 1 \quad \forall j < i : u_{ii} + v_{ij} \leq 1 \quad \forall j < i : u_{ij} - v_{ij} \leq 0$$

$$\forall k < j < i : u_{ij} + v_{jk} - v_{ik} \leq 1$$

$$\forall k < j < i : u_{ij} - v_{jk} + v_{ik} \leq 1$$

¹This exercise is based on the paper [Adapting Coreference Resolution for Narrative Processing, Do et al.](#)

$$\forall j < k < i : u_{ij} + v_{kj} - v_{ik} \leq 1$$
$$\forall j < k < i : u_{ij} - v_{kj} + v_{ik} \leq 1$$