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MINING ASSUMPTION-BASED ARGUMENTS FROM HOTEL REVIEWS

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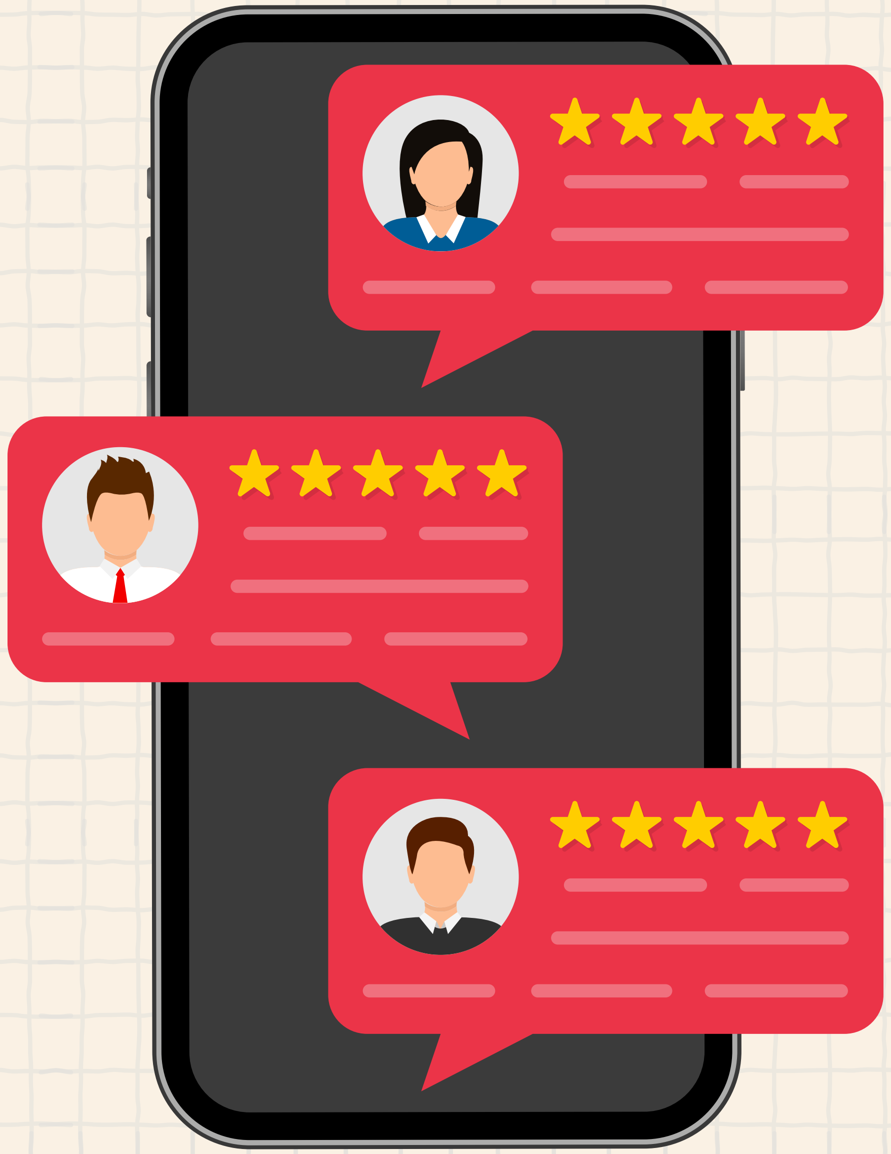
TOWARDS ASSUMPTION-BASED ARGUMENTATION MINING IN HOTEL REVIEWS



Project Goal: To automatically extract structured assumption-based arguments (ABA) from unstructured hotel review text.

Why This Matters:

- Argumentation mining aims to detect human opinions and their reasoning from natural language.
- Most current approaches ignore formal logic models like ABA used in knowledge representation (KRR).
- This limits the ability to build structured, explainable knowledge bases from text.

Bridging Two Worlds: KRR + Machine Learning by using Assumption-Based Argumentation Mining (ABA Mining)
→ To raise awareness of how NLP can be enhanced using structured reasoning.

WHAT IS ABA?

Assumption-Based Argumentation (ABA) is a specific instance of Abstract Argumentation (AA). While AA focuses on abstract relationships between arguments, ABA provides concrete logical foundations through assumptions and inference rules.

Components of ABA

An ABA framework is defined as a tuple $\langle L, R, A, \bar{\ } \rangle$, where:

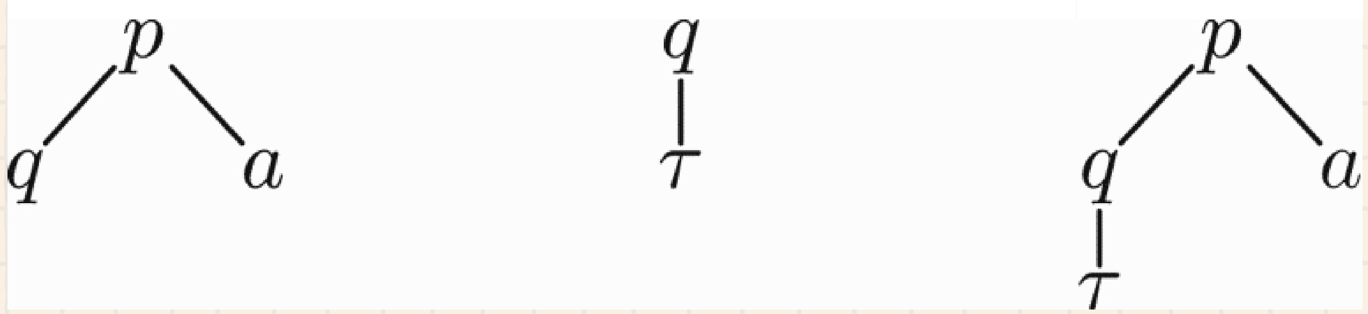
- $\langle L, R \rangle$ is a deductive system, with L the language and R a set of rules, that we assume of the form $\sigma_0 \leftarrow \sigma_1, \ldots, \sigma_m$ ($m \geq 0$) with $\sigma_i \in L$ ($i = 0, \ldots, m$); σ_0 is referred to as the head and $\sigma_1, \ldots, \sigma_m$ as the body of rule $\sigma_0 \leftarrow \sigma_1, \ldots, \sigma_m$;
- $A \subseteq L$ is a non-empty set of assumptions
- $\bar{\ }$ is a function mapping each assumption to its contrary where $\bar{\alpha}$ is the contrary of α.

An argument in ABA is a deduction tree:

- Root: Conclusion (claim) of the argument
- Leaves: Assumptions (or empty premises, denoted as τ)
- Branches: Inference rules,
- Denoted $S \vdash c$ a set of assumptions deduces claim c .

$$\mathcal{L} = \{a, b, c, p, q, r, s, t\}$$
$$\mathcal{R} = \{p \leftarrow q, a,\ \ q \leftarrow,\ \ r \leftarrow b, c\}$$
$$\mathcal{A} = \{a, b, c\}$$
$$\bar{a} = r, \quad \bar{b} = s, \quad \bar{c} = t.$$

$$\{q, a\} \vdash^{R_1} p \quad \text{for } R_1 = \{p \leftarrow q, a\},$$
$$\{\} \vdash^{R_2} q \quad \text{for } R_2 = \{q \leftarrow\},$$
$$\{a\} \vdash^{R_3} p \quad \text{for } R_3 = R_1 \cup R_2,$$



HOW ARGUMENTS ATTACK EACH OTHER IN ABA

- Argument A = S1 ⊢ c1 attacks Argument B = S2 ⊢ c2 if and only if c1 is the contrary of some assumption in S2.

Example from hotel reviews:

- Argument A:
  {theo(jo)} ⊢ ¬prog(jo)
- Argument B:
  {nor(jo)} ⊢ prog(jo)
- If we define: **¬prog(jo)** is the **contrary** of **nor(jo)**, then Argument A attacks Argument B

HOW ARGUMENTS ATTACK EACH OTHER IN ABA

- A set of arguments Arg1 attacks a set of arguments Arg2 if an argument in Arg1 attacks an argument in Arg2.

Example:

- Arg_1 =
  A_1: {c_eng(jo,cs)} $\vdash$ reqs(sw)
  A_2: {nor(jo)} $\vdash$ prog(jo)
- Arg_2 =
  B_1: {theo(jo)} $\vdash$ ¬prog(jo)
  B_2: {c_prof(jo,cs)} $\vdash$ reqs(sw)
- Assume:
  - **¬prog(jo)** is the **contrary** of **nor(jo)**
  - Then set of Arg_2 attacks set Arg_1 as $B_1 \in Arg_2$ attacks $A_2 \in Arg_1$

ACCEPTABILITY OF ARGUMENTS IN ABA

1

Admissible Set

- It does not attack itself
- It defends against all attacks.

2

Complete Set

A set is complete if:

- It is admissible
- It includes all the arguments it defends

Example:

arg1 = {c_eng(jo,cs)} ⊢ reqs(sw)
arg2 = {nor(jo)} ⊢ prog(jo)
arg3 = {theo(jo)} ⊢ ¬prog(jo)
arg4 = {c_prof(jo,cs)} ⊢ reqs(sw)

¬prog(jo) is the **contrary** of **nor(jo)**
prog(jo) is the **contrary** of **theo(jo)**

- **{arg1, arg2}** forms an admissible set (no internal attacks and they defend each other)
- **{arg4}** is grounded because it’s small, unchallenged, and not conflicting with any admissible argument (sceptical).
- **{arg3}** is also admissible but credulous, because it is in conflict with {arg2}.

3

Grounded Set

- Smallest trustworthy group of arguments

COMPUTATION OF ACCEPTABILITY IN ABA

To determine which arguments are acceptable by simulating a dialogue between a proponent (who defends a claim) and an opponent (who challenges it).

Dispute Trees

Dispute Derivations

DISPUTE TREES

A structured way to show how a claim is defended against attacks using arguments.

- It looks like a debate between two sides:
  - **P** (**Proponent**) = tries to defend a claim.
  - **O** (**Opponent**) = tries to attack the claim.

Basic Rules:

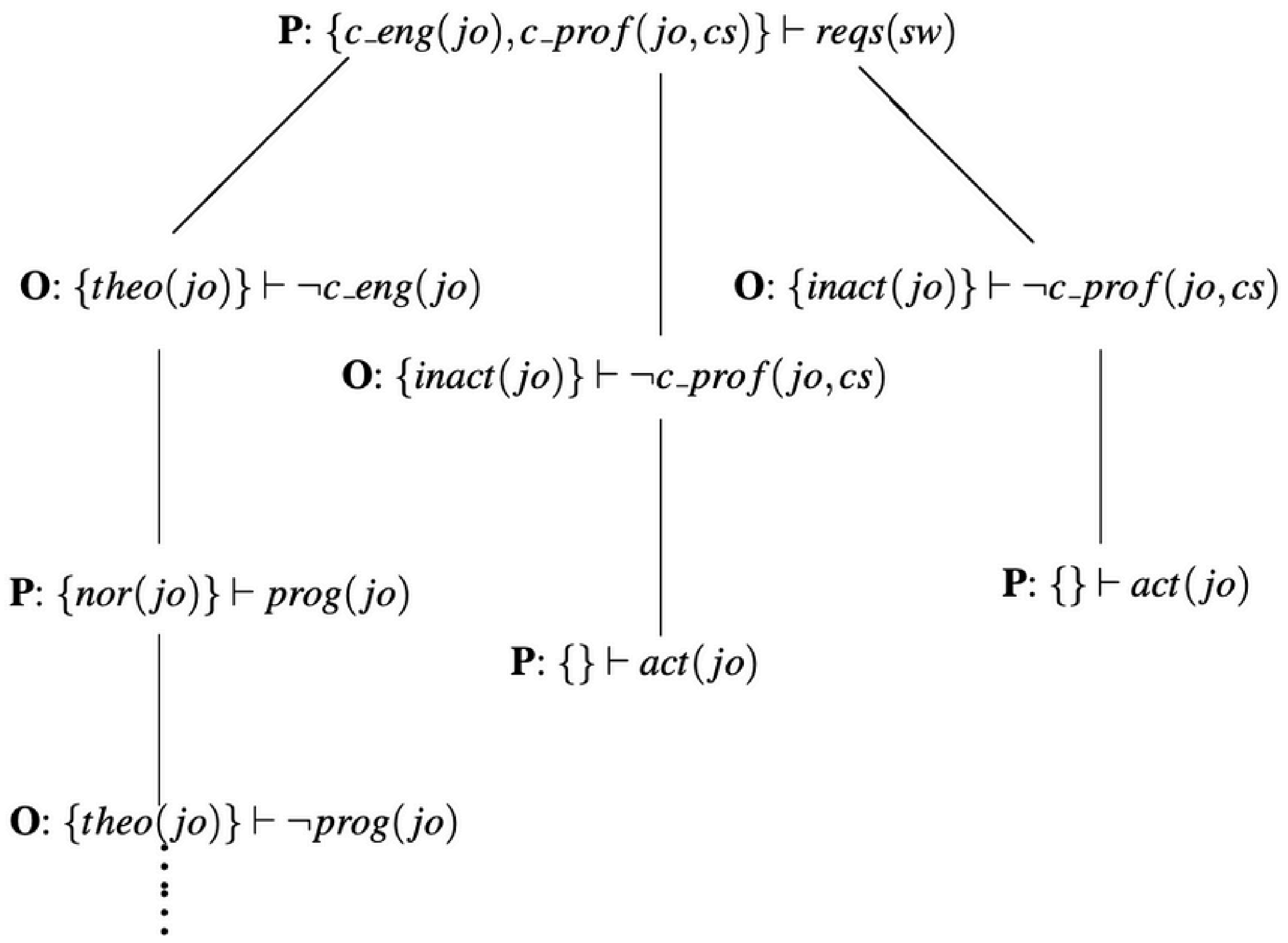
- Each node = one argument.
- Nodes are either Proponent (P) or Opponent (O).
- The root is a Proponent node
- Every opponent node must be attacked by one child proponent node.
- Every proponent node must include all possible attacks as children.

A Dispute Tree is winning for the proponent if:

- The proponent can counter every opponent's attack.

Types of Dispute Trees:

- **Admissible:** No argument appears on both sides (proponent and opponent).
- **Grounded:** Finite (no infinite branches) and admissible.



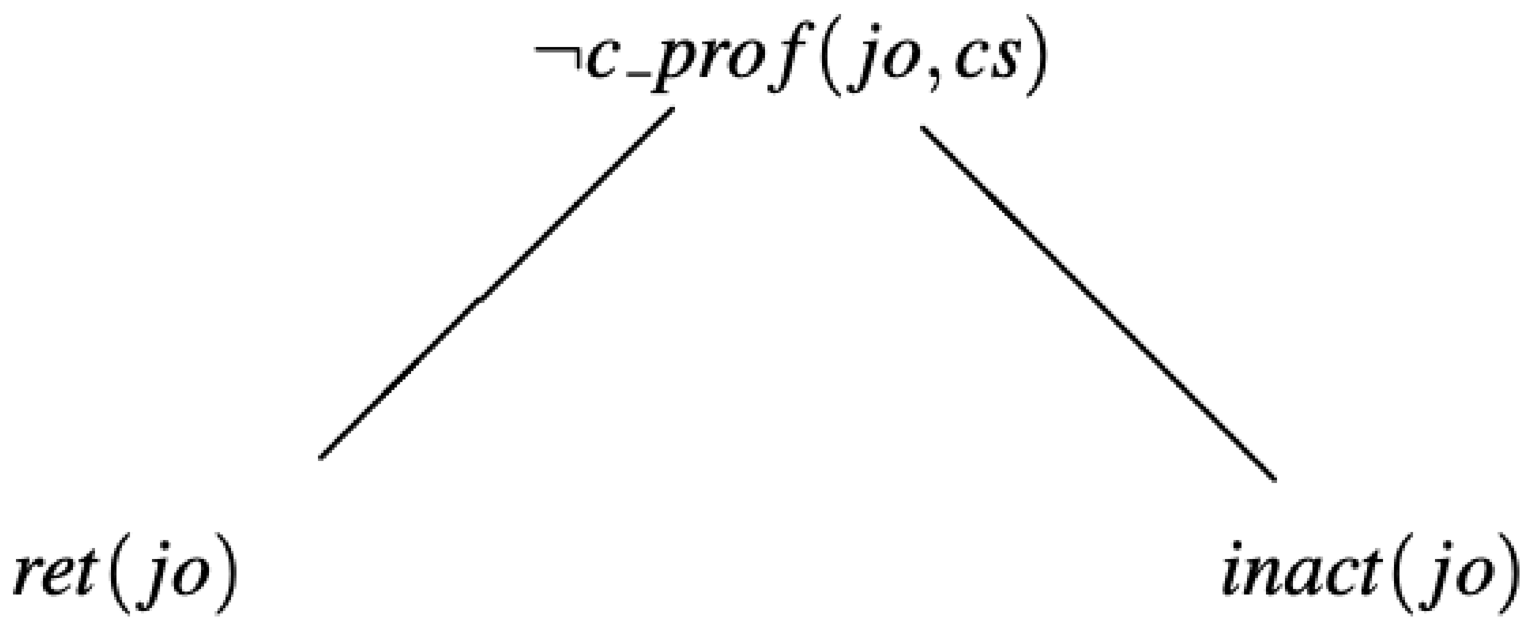
DISPUTE DERIVATIONS

A step-by-step top-down method for simulating a debate between:

- **Proponent** (wants to prove the claim)
- **Opponent** (tries to attack the claim)
- **Potential Argument**: argument not fully built yet
- **Actual Argument:** Fully constructed and acceptable
- **Defence Assumptions (D):** Assumptions used by Proponent
- **Culprits (C):** Assumptions used by the Opponent

3 Key Filtering Strategies:

1. Defence filtered by defence (D by D)
2. Culprits filtered by defence (C by D) and vice versa
3. Culprits filtered by culprits (C by C)



TOWARDS ABA MINING IN HOTEL REVIEWS

Raw Text

Title	Highly recommend these apartments.
Positive	Very helpful staff, super clean room with modern furniture all together make your stay max comfortable. Sure worth it to come back again. Option to have a good breakfast within the hotel save your time. Highly recommend these apartments.
Negative	Little bit noisy during evening time from the street side. I believe it doesn't disturb you in case you choose the garden view apartments or just close the windows and start the air conditioning)

Classify based on 8 topics and label positive/negative

Topic	Topic-relevent Text	Positive/ Negative
Staff	Very helpful staff	Positive
Room	super clean room with modern furniture all together make your stay max comfortable	Positive
Food	Option to have a good breakfast within the hotel save your time.	Positive
Room	Little bit noisy during evening time from the street side.	Negative

Transform original text from each topic into inference rule of ABA structure

Head	Body
good_staff	helpful_staff, no_evident_not_helpful_staff
good_room	clean_room, modern_furniture, comfortable_stay, no_evident_not_clean_room, no_evident_not_modern_furniture, no_evident_not_comfortable_stay
good_food	good_breakfast, no_evident_not_good_breakfast
bad_room	noisy, have_evident_noisy

ABA MINING TASKS

Task 1: Multi-label Topic Modelling

Input

```
Very helpful staff,
super clean room with
modern furniture all
together make your stay
max comfortable.
```

```
there was hair on the floor
from previous visitors,
```

Output

Topic	Topic-relevant Text	Positive/ Negative
Staff	Very helpful staff	Positive
Room	super clean room with modern furniture all together make your stay max comfortable	Positive
Room	there was hair on the floor from previous visitors,	Negative

Task 2: Topic-relevant Inference Rule Extraction

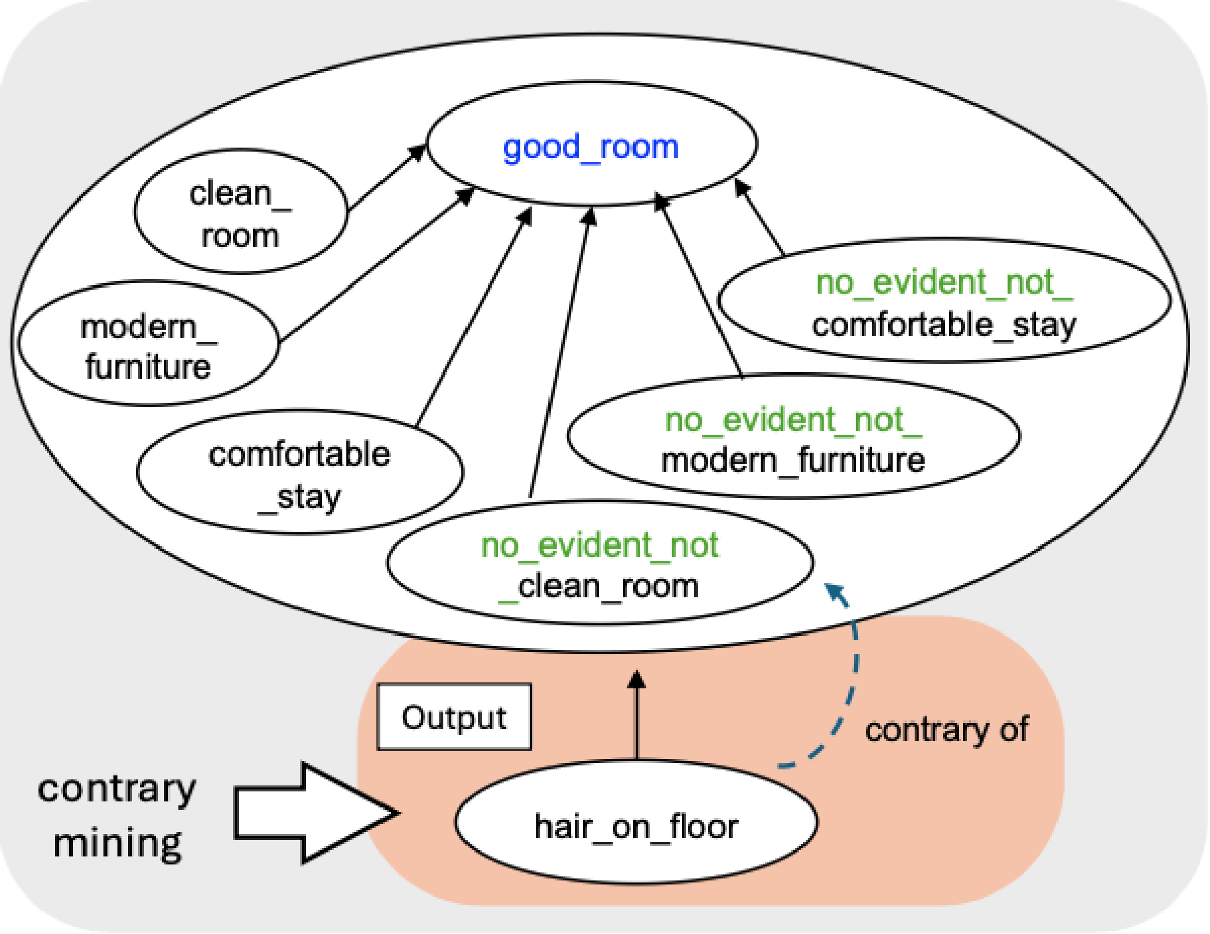
Mining Rule's Head:
- **Mining "claim"** for their corresponding topic and sentiment

Mining Rule's Body:
- **Mining "supports"** (premises and assumptions) of the claim from Topic-relevant Text.
- **Mining "contraries"** for each assumption

Output

Head	Body
good_staff	helpful_staff, **no_evident_not**_helpful_staff
good_room	clean_room, modern_furniture, comfortable_stay, no_evident_not_clean_room, no_evident_not_modern_furniture, no_evident_not_comfortable_stay
bad_room	hair_on_floor, **have_evident**_hair_on_floor

Task 3: Contrary Mining



MODEL EVALUATION

- Used GPT-4o to generate ABA structures.
- Controlled outputs (low randomness).
- Evaluated using precision and recall to check
- Micro-precision, Micro-recall, Average Precision, Average Recall

“

REFERENCE

Racharak, T., Jearanaiwongkul, W., Pooksook, J., & Takashima, K. (n.d.). Towards assumption-based argumentation mining in hotel reviews. Advanced Institute of So-Go-Chi Informatics, Tohoku University; Japan Advanced Institute of Science and Technology; Naresuan University.

Dung, P. M., Kowalski, R. A., & Toni, F. (2009). Assumption-Based Argumentation. In I. Rahwan & G. R. Simari (Eds.), Argumentation in Artificial Intelligence (pp. 199–218).

Toni, F. (2014). A tutorial on assumption-based argumentation. Argument and Computation, 5(1), 89–117.

THANK YOU!