Formal Modeling of Literary Interpretations: Limitations and Possibilities

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22 October 2025

MITE Workshop: From critical analysis to formal representation: literary characters, interpretations, and ontologies

Introduction

Core objective of our group in MITE, proof-of-concept ontology:

- To support the *documentation* and *analysis* of texts' interpretations
- Focus on interpretations of literary characters (cf. Univ. Sapienza's case studies)

  $\Rightarrow$ As provided by *real-world interpreters* such as literary scholars

Application perspective (beyond MITE):

- *Digital Research Environment*

  $\Rightarrow$ To preserve, compare, and explore multiple interpretations – their commonalities, recurrent patterns, points of departure, open conflicts, etc[1]

[1] Example in musicology: **CRIM project**: `https://crimproject.org/`

Result

Ontology of observations:

$\Rightarrow$ To represent – in a *uniform manner* – what scholars claim;

$\Rightarrow$ To automatically reason over claims.

Some requirements taken into account:

- *What* is claimed (at different levels of detail);
- *Chains* of observations (x observes that y observers that z observers that...);
- Presence of *incompatible* claims.

Observations

Classification of domain entities through properties (or relations).

Examples:

- **Empirical** observation: an artefact classified to the 3rd cent. b.C. through carbon-14 measurement;
- **Computational** observation: a specific pattern of notes found in multiple music scores through algorithmic analysis;
- **Scholarly** observation: the similarity between two literary characters through scholarly discourse.

$\Rightarrow$ Crucial information for multiple domains: from engineering[2] and natural sciences to musicology, literary studies, art criticism, etc.

[2] Janowicz et al. (2019). *SOSA: A lightweight ontology for sensors, observations, samples, and actuators*. Journal of Web Semantics, 56, 1-10.

Observations /2

Observations are expressed in terms of:

- **Observational vocabulary(-ies)**, shared by all agents (involved in a task)

Using first-order logic, observations are treated as domain entities.

This allows us to:

1. Quantify over observations;
2. Organize observations into formal structures (e.g, taxonomies);
3. Build chains of observations;
4. Manage incompatible observations while keeping formal consistency;
5. Provide *explicit and precisely defined* criteria for the analysis of observations;
6. etc

Observation types

The ontology covers three main types of observations:

1. **Basic** observations: domain specific, i.e., *what* is claimed by observers;
2. **Source** observations: make explicit the source of an observation (*accept*, *reject*):
   - 2.1 Illocutionary observations
   - 2.2 *Interpretative* illocutionary observations
3. **Argumentative** observations: observations providing positive/negative arguments for other observations (*support*, *defeat*).

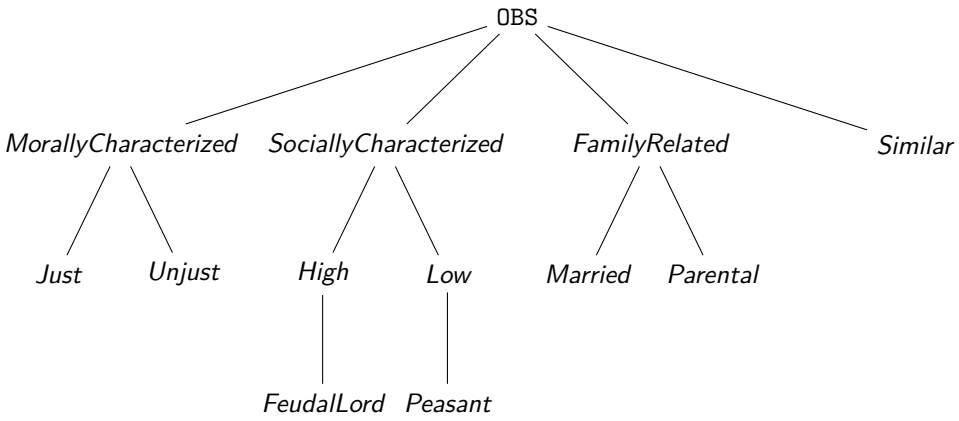
Basic Observation

Establish the basic *observational vocabulary* to represent more complex observations.

Development in **three steps**:

- Step 1 Identify and taxonomically structure a *finite* set $\mathcal{P}$ of (first-order) *unary* predicates, representing specific kinds of observations according to the level of generality of such kinds;
- Step 2 For each observation-kind $P \in \mathcal{P}$, determine the number and type of the entities involved in P's instances, i.e., the *arguments* of P;
- Step 3 Introduce general *incoherence* relations, as well as *correlations* between the instances of different kinds in $\mathcal{P}$.

Example


OBS
MorallyCharacterized
SociallyCharacterized
FamilyRelated
Similar
Just
Unjust
High
Low
Married
Parental
FeudalLord
Peasant

Example (cont'd)

Some axioms for the previous example:

1. $\texttt{JustObs}(x) \vee \texttt{UnjustObs}(x) \rightarrow \texttt{MorallyCharacterizedObs}(x)$
2. $\texttt{JustObs}(x) \rightarrow \neg\texttt{UnjustObs}(x)$
3. $\texttt{MorallyCharacterizedObs}(x) \rightarrow \exists y(\texttt{ARG}(y, x)) \wedge \forall y(\texttt{ARG}(y, x) \rightarrow \texttt{AGN}(y))$
4. $\texttt{JustObs}(x) \wedge \texttt{UnjustObs}(y) \wedge \texttt{ARG}(z, x) \wedge \texttt{ARG}(z, y) \rightarrow \texttt{INC}(x, y)$

Then, e.g.:

5. $\texttt{JustObs}(\texttt{o}_1) \wedge \texttt{ARG}(\texttt{gualtieri}, \texttt{o}_1)$
6. $\texttt{UnjustObs}(\texttt{o}_2) \wedge \texttt{ARG}(\texttt{gualtieri}, \texttt{o}_2)$
7. $\texttt{INC}(\texttt{o}_1, \texttt{o}_2)$, follows from 4,5,6

Source Observations

Recall the distinction between:

- **Illocutionary Observations**: make explicit what an interpreters beliefs with respect to a text (even without access to the text);
- ***Interpretative* Illocutionary Observations**: make explicit how an interpreter *interprets* a text (access to texts is necessary).

Note (1): Texts and Reports

Two important notions are:

- **Text**: a sequence of words in one or more languages produced by some agent;
- **Report**: a text collecting the observations that an agent expresses through an observational vocabulary.

Hence, they are both relevant because:

- Texts: *what is interpreted* (e.g., the *Divine Comedy*, an essay on the *Comedy*, etc);
- Reports: *what make explicit the interpretations* of texts (e.g., my interpretation of the *Comedy* in an obs. vocabulary).

$\Rightarrow$ In our ontology, all observations are documented in reports, i.e., reports are always the ultimate sources of observations.

Note (2): Interpretation

"The formulation of hypotheses about aspects of meaning in literary texts. These hypotheses regarding meaning are generated by **reasoning processes** that apply **inference rules** based on **consistency**, **coherence**, and other aspects in order to give the best explanation for the (portion of) text in question" (emphasis is ours).[3]

"If explicit meanings are assigned to a literary text on the basis of textual evidence and a **process of inference** based on **criteria of rationality**, then they are not in any way 'given', but **created** in the interplay between 'textual data' and inferential relations, and that means *constructed*. As a result, there is no ultimately valid, 'true' interpretation, because both the data and the inferential processes can be challenged" (emphasis is ours).[4]

[3] Gius and Jacke (2017). *The hermeneutic profit of annotation: On preventing and fostering disagreement in literary analysis*. International Journal of Humanities and Arts Computing, 11(2).

[4] Hempfer (2024). *Fundamentals of Literary Theory*. Palgrave Macmillan, pp. 22-23.

Illocutionary Observations

Source observations of **assertion** and **denial**:

- $\mathbf{asr}(\mathtt{t}, \mathtt{o})$, $\mathbf{dny}(\mathtt{t}, \mathtt{o})$ (compacted form)

Examples:

1. $\mathbf{asr}(\mathtt{r}_1, \mathbf{unjust}(\mathtt{gualtieri}))$, r_1 asserts that ...
2. $\mathbf{asr}(\mathtt{r}_1, \mathbf{asr}(\mathtt{tx10}, \mathbf{unjust}(\mathtt{gualtieri})))$, r_1 asserts that $tx10$ asserts that ...

$\Rightarrow$ All illocutionary observations must be ultimately included in reports

Intended meaning (with report):

- if $\mathbf{asr}(r, o)$, then the set of beliefs of the author of r, i.e., $\beta(a(r))$, allows to prove o.

Interpretative Illocutionary Observations

Source observations (**assertion** and **denial**) to express observers' *interpretation* of texts:

- $\mathbf{iasr}(\mathtt{t}, \mathtt{t}', \mathtt{o})$ / $\mathbf{idny}(\mathtt{t}, \mathtt{t}', \mathtt{o})$ (compacted form)

Example:

- $\mathbf{iasr}(\mathtt{r}_1, \mathtt{bmd}, \mathbf{unjust}(\mathtt{gualtieri}))$, according to r_1's interpretation of bmd, bmd asserts that ...

$\Rightarrow$ All interpretative illocutionary observations must be ultimately included in reports

Intended meaning (with report):

- if $\mathbf{iasr}(r, t, o)$ then either (i) $\mu(a(r), t)$ allows to prove o; or (ii) $\beta_\mu(a(r), t)$ allows to prove o but $\beta(a(r))$ alone does not allow to prove o

Interpretative Illocutionary vs. Illocutionary Observations

Note the differences:

1. $\mathbf{asr}(\mathtt{r}_1, \mathbf{asr}(\mathtt{bmd}, \mathbf{unjust}(\mathtt{gualtieri})))$
   $\Rightarrow$ it follows from $a(r_1)$'s beliefs that bmd asserts Gualtieri being unjust;
   $\Rightarrow$ $a(r_1)$ doesn't have access to bmd; they report on their beliefs.
2. $\mathbf{iasr}(\mathtt{r}_1, \mathtt{bmd}, \mathbf{unjust}(\mathtt{gualtieri}))$
   $\Rightarrow$ it follows from both $a(r_1)$'s beliefs and $a(r_1)$'s interpretation of bmd.
   $\Rightarrow$ hence, $a(r_1)$ has access and interprets bmd.

Argumentative Observations

Observations that (partially) represent the argument put forward by an agent to support or defeat another observation.

- **Support**: increases the plausibility of an observation ($\mathbf{sup}(o_1, o_2)$);
- **Defeat**: decreases the plausibility of an observation ($\mathbf{def}(o_1, o_2)$).

Examples:

– $\mathbf{asr}(r_1, \mathbf{def}(\texttt{similar}(\texttt{griselda}, \texttt{fresne}), \texttt{similar}(\texttt{griselda}, \texttt{mary})))$

– $\mathbf{asr}(r_1, \mathbf{sup}(\texttt{patient}(\texttt{griselda}) + \texttt{patient}(\texttt{mary}), \texttt{similar}(\texttt{griselda}, \texttt{mary})))$

Criteria for Analysis

Disagreement between reports:

- $\texttt{rDIS}(r_1, r_2) := \exists o_1 o_2 (\texttt{A}(r_1, o_1) \wedge ((\texttt{A}(r_2, o_2) \wedge \texttt{INC}(o_1, o_2)) \vee (\texttt{D}(r_2, o_2) \wedge \texttt{IMP}(o_1, o_2))))$

Disputability of observations:

- $\texttt{DSP}(o) := \exists r_1 r_2 \bar{o}((\texttt{A}(r_1, o) \wedge \texttt{A}(r_2, \bar{o}) \wedge \texttt{INC}(o, \bar{o})) \vee (\texttt{A}(r_1, o) \wedge \texttt{D}(r_2, \bar{o}) \wedge \texttt{IMP}(o, \bar{o})) \vee (\texttt{D}(r_1, o) \wedge \texttt{A}(r_2, \bar{o}) \wedge \texttt{IMP}(\bar{o}, o)))$

$\Rightarrow$ Criteria on these lines can be used to analyze reports, texts, observations (see next slides for example)

Semantic Web Ontology

Formal representation in the Web Ontology Language (OWL) for data management, automated reasoning, etc.

Two modules:

- **Core** (domain-independent) module ($\Rightarrow$ reusable in multiple contexts);
- **Literary** (domain dependent) module.

Ontology (**currently work in progress**) available through:
`https://www.loa.istc.cnr.it/mite/index.php/dissemination/`

Example

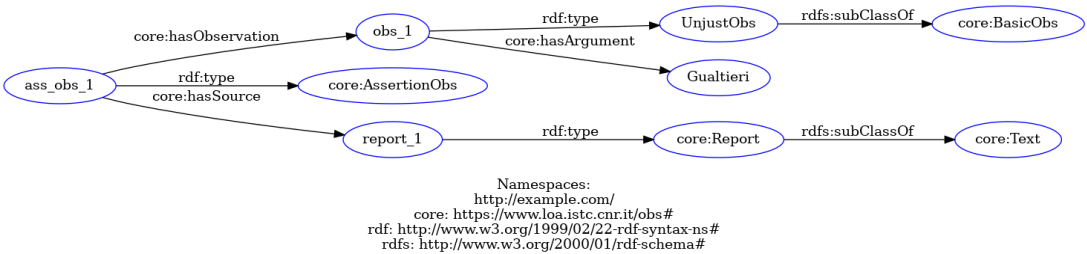


Figure: RDF graph for the illocutionary **assertion** (ass_obs_1) of Gualtieri being unjust (obs_1) by report_1

Example /2

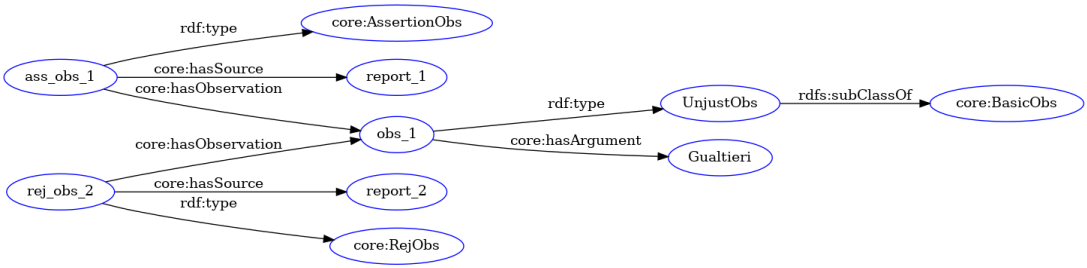


Figure: RDF graph for illocutionary **assertion** (ass_obs_1) and **rejection** (rej_obs_2) of Gualtieri being unjust (obs_1) by two different reports, i.e., report_1 and report_2

Automated Reasoning

Reasoning with **OWL** and **SWRL rules** over the previous example:

- obs_1 is classified as a **disputable observation**;
- report_1 and report_2 as **disagreeing** reports;

Example of SWRL rule:

'Assert Observation'(?a1), 'has source'(?a1, ?s1), 'has observation'(?a1, ?o1), 'Reject Observation'(?a2), 'has source'(?a2, ?s2), 'has observation'(?a2, ?o2), implies(?o1, ?o2) $\rightarrow$ 'Disputable Observation'(?o1)

$\Rightarrow$ Inferences on the data as transparent **criteria** to support their analyses

Main Publications

- C. Masolo, E. Sanfilippo, E. Bottazzi, R. Ferrario, A. Mosca, M.M.Vilardo, *An Observational Approach to Represent Interpretation*. (Journal of) « Applied Ontology» (forthcoming 2025)
- E. Sanfilippo, C. Masolo, A. Mosca, G. Tomazzoli, *Operationalizing Scholarly Observations in OWL*, in Proceedings of the 4th International Workshop on Semantic Web and Ontology Design for Cultural Heritage (SWODCH 2024), CEUR vol. 3809
- E. Sanfilippo, C. Masolo, E. Bottazzi, R. Ferrario, *Interpreting Texts and Their Characters, in Formal Ontology in Information Systems*. Proceedings of the 14th International Conference (FOIS 2024), IOS Press, 2024
- E. Sanfilippo, A. Sotgiu, G. Tomazzoli, C. Masolo, D. Porello, R. Ferrario, *Ontological Modeling of Scholarly Statements: A Case Study in Literary Criticism*. Formal Ontology in Information Systems. Proceedings of the 13th International Conference (FOIS 2023), Amsterdam-Berlin-Washington, IOS Press, 2023.

Conclusions

Formal approaches inevitably resolve into approximations of the intricacies and nuances of the literacy criticism discourse.

A formal approach provides a fundamental support for, e.g.,:

- Reducing ambiguities in the arguments of interpreters,
- Making explicit the argumentative assumptions of the various positions on a given subject,
- Qualifying the proximity or distance between the advocated theses,
- Comparing the contents of the various positions with each other
- Identifying the discursive elements that generate convergence or divergence between them.

Future work

Short term:

- Test and improve the ontology with further work on the case studies (obs. vocabulary, criteria for analysis, etc.);
- Interaction with fellows in KRR (e.g., standpoint logics).

Long term (beyond MITE):

- Exploitation of machine learning and NLP systems for extraction of observational data: (semi-)automatic population of the ontology through observational vocabularies;
- Creation of knowledge-base of observational data on literary criticism + toolkit for its consumption.

Grazie!

Acknowledgement: MITE – Make it explicit: Documenting interpretations of literary fictions with conceptual formal models (2023-2025) funded by the European Union – Next Generation EU, Mission 4, Component 1, CUP B53D23028830001