

## CLiC-it 2019 Italian Conference on Computational Linguistics

Proceedings of the Sixth Italian Conference on Computational Linguistics

Bari, Italy, November 13-15, 2019.

Edited by

Raffaella Bernardi \*  
Roberto Navigli \*\*  
Giovanni Semeraro\*\*\*

\* CIMEC and DISI, University of Trento, Trento, Italy

\*\* Department of Computer Science, Sapienza University of Rome, Rome, Italy

\*\*\* Department of Computer Science, University of Bari Aldo Moro, Bari, Italy

### Table of Contents

- ▀ Preface

### Keynote Talks and Tutorial

- ▀ Visually-Grounded Dialogue Models: Past, Present, and Future, Raquel Fernández, University of Amsterdam, The Netherlands
- ▀ Impossible Languages and the Architecture of Human Grammars, Andrea Moro, University School for Advanced Studies Pavia, Italy
- ▀ Recognizing and Reducing Bias in NLP Applications, Dirk Hovy, Bocconi University, Italy

### Contributed Papers: Long Papers

- ▀ Prerequisite or Not Prerequisite? That's the Problem! An NLP-based Approach for Concept Prerequisite Learning  
*Chiara Alzetta, Alessio Miaschi, Giovanni Adorni, Felice Dell'Orletta, Frosina Koceva, Samuele Passalacqua, Ilaria Torre*
- ▀ An Empirical Analysis of Linguistic, Typographic, and Structural Features in Simplified German Texts  
*Alessia Battisti, Sarah Ebling, Martin Volk*
- ▀ Almwave-SLU: A New Dataset for SLU in Italian  
*Valentina Bellomaria, Giuseppe Castellucci, Andrea Favalli, Raniero Romagnoli*
- ▀ Nove Anni di jTEI: What's New?  
(Nine Years of jTEI: What's New?)  
*Federico Boschetti, Gabriella Pardelli, Giulia Venturi*
- ▀ BullyFrame: Cyberbullying Meets FrameNet  
*Silvia Brambilla, Alessio Palmero Aprosio, Stefano Menini*
- ▀ Lost in Text. A Cross-Genre Analysis of Linguistic Phenomena within Text  
*Chiara Buongiovanni, Francesco Gracci, Dominique Brunato, Felice Dell'Orletta*
- ▀ Annotating Shakespeare's Sonnets with Appraisal Theory to Detect Irony  
*Nicolò Busetto, Rodolfo Delmonte*
- ▀ Embeddings Shifts as Proxies for Different Word Use in Italian Newspapers  
*Michele Cafagna, Lorenzo De Mattei, Malvina Nissim*
- ▀ Suitable Doesn't Mean Attractive. Human-Based Evaluation of Automatically Generated Headlines  
*Michele Cafagna, Lorenzo De Mattei, Davide Bacciu, Malvina Nissim*
- ▀ There and Back Again: Cross-Lingual Transfer Learning for Event Detection  
*Tommaso Caselli, Ahmet Üstün*
- ▀ PESInet: Automatic Recognition of Italian Statements, Questions, and Exclamations With Neural Networks  
*Sonia Cenceschi, Roberto Tedesco, Licia Sbattella, Davide Losio, Mauro Luchetti*
- ▀ What Makes a Review helpful? Predicting the Helpfulness of Italian TripAdvisor Reviews  
*Giulia Chiriatti, Dominique Brunato, Felice Dell'Orletta, Giulia Venturi*
- ▀ Is This an Effective Way to Annotate Irony Activators?  
*Alessandra Teresa Cignarella, Manuela Sanguinetti, Cristina Bosco, Paolo Rosso*
- ▀ Robospierre: an Artificial Intelligence to Solve "La Ghigliottina"  
*Nicola Cirillo, Chiara Pericolo, Pasquale Tufano*
- ▀ From Sartre to Frege in Three Steps: A\* Search for Enriching Semantic Text Similarity Measures  
*Davide Colla, Marco Leontino, Enrico Mensa, Daniele P. Radicioni*
- ▀ Is "manovra" Really "del popolo"? Linguistic Insights into Twitter Reactions to the Annual Italian Budget Law  
*Claudia Roberta Combei*
- ▀ Cross-Platform Evaluation for Italian Hate Speech Detection  
*Michele Corazza, Stefano Menini, Elena Cabrio, Sara Tonelli, Serena Villata*
- ▀ An Open Science System for Text Mining  
*Gianpaolo Coro, Giancarlo Panichi, Pasquale Pagano*
- ▀ Detecting Irony in Shakespeare's Sonnets with SPARSAR  
*Rodolfo Delmonte, Nicolò Busetto*
- ▀ Towards an Italian Learner Treebank in Universal Dependencies  
*Elisa Di Nuovo, Cristina Bosco, Alessandro Mazzei, Manuela Sanguinetti*
- ▀ Building an Italian Written-Spoken Parallel Corpus: a Pilot Study  
*Elisa Dominutti, Lucia Pifferi, Felice Dell'Orletta, Simonetta Montemagni, Valeria Quochi*
- ▀ Italian and English Sentence Simplification: How Many Differences?  
*Martina Fieromonte, Dominique Brunato, Felice Dell'Orletta, Giulia Venturi*
- ▀ Error Analysis in a Hate Speech Detection Task: The Case of HaSpeeDe-TW at EVALITA 2018  
*Chiara Francesconi, Cristina Bosco, Fabio Poletto, Manuela Sanguinetti*
- ▀ Nunc Est Aestimandum: Towards an Evaluation of the Latin WordNet  
*Greta Franzini, Andrea Peverelli, Paolo Ruffolo, Marco Passarotti, Helena Sanna, Edoardo Signoroni, Viviana Ventura, Federica Zampedi*
- ▀ Iride: an Industrial Perspective on Production Grade End to End Dialog System  
*Cristina Giannone, Valentina Bellomaria, Andrea Favalli, Raniero Romagnoli*
- ▀ When Lexicon-Grammar Meets Open Information Extraction: a Computational Experiment for Italian Sentences  
*Raffaele Guarasci, Emanuele Damiano, Aniello Minutolo, Massimo Esposito*
- ▀ Are Subtitling Corpora really Subtitle-like?  
*Alina Karakanta, Matteo Negri, Marco Turchi*
- ▀ Asymmetries in Extraction From Nominal Copular Sentences: a Challenging Case Study for NLP Tools  
*Paolo Lorusso, Matteo Greco, Cristiano Chesi, Andrea Moro*
- ▀ Objective Frequency Values of Canonical and Syntactically Modified Idioms: Preliminary Normative Data  
*Azzurra Mancuso, Alessandro Laudanna*
- ▀ Gender Detection and Stylistic Differences and Similarities between Males and Females in a Dream Tales Blog  
*Raffaele Manna, Antonio Pascucci, Johanna Monti*
- ▀ CROATPAS: A Resource of Corpus-derived Typed Predicate Argument Structures for Croatian  
*Costanza Marini, Elisabetta Jezek*
- ▀ Enhancing a Text Summarization System with ELMo  
*Claudio Mastronardo, Fabio Tamburini*
- ▀ KIParla Corpus: A New Resource for Spoken Italian  
*Caterina Mauri, Silvia Ballarè, Eugenio Gorla, Massimo Cerruti, Francesco Suriano*
- ▀ Evaluating Speech Synthesis on Mathematical Sentences  
*Alessandro Mazzei, Michele Monticone, Cristian Bernareggi*
- ▀ Automated Short Answer Grading: A Simple Solution for a Difficult Task  
*Stefano Menini, Sara Tonelli, Giovanni De Gasperis, Pierpaolo Vittorini*
- ▀ Games for Learning Old and Special Alphabets – The Case Study of Gamifying Mrežnik  
*Josip Mihaljević*
- ▀ Text Frame Detector: Slot Filling Based On Domain Knowledge Bases  
*Martina Miliani, Lucia C. Passaro, Alessandro Lenzi*
- ▀ Defining Action Types: on the roles of Thematic Structures and Argument Alternations  
*Massimo Moneglia, Alessandro Panunzi, Rossella Varvara*
- ▀ HateChecker: a Tool to Automatically Detect Hater Users in Online Social Networks  
*Cataldo Musto, Angelo Sansonetti, Marco Polignano, Giovanni Semeraro, Marco Stranisci*
- ▀ The Contribution of Embeddings to Sentiment Analysis on YouTube  
*Moniek Nieuwenhuis, Malvina Nissim*
- ▀ A Novel Integrated Industrial Approach with Cobots in the Age of Industry 4.0 through Conversational Interaction and Computer Vision  
*Andrea Pazienza, Nicola Macchiarulo, Felice Vitulano, Antonio Fiorentini, Marco Cammisa, Leonardo Rigutini, Ernesto Di Iorio, Achille Globo, Antonio Trevisi*
- ▀ Annotating Hate Speech: Three Schemes at Comparison  
*Fabio Poletto, Valerio Basile, Cristina Bosco, Viviana Patti, Marco Stranisci*
- ▀ AIBERTo: Italian BERT Language Understanding Model for NLP Challenging Tasks Based on Tweets  
*Marco Polignano, Pierpaolo Basile, Marco de Gemmis, Giovanni Semeraro, Valerio Basile*
- ▀ Evaluating the MuMe Dialogue System with the IDIAL protocol  
*Aureliano Porporato, Alessandro Mazzei, Daniele P. Radicioni, Rosa Meo*
- ▀ To be Fair: a Case for Cognitively-Inspired Models of Meaning  
*Simon Preissner, Aurélie Herbelot*
- ▀ The Impact of Self-Interaction Attention on the Extraction of Drug-Drug Interactions  
*Luca Putelli, Alfonso Emilio Gerevini, Alberto Lavelli, Ivan Serina*
- ▀ Enriching Open Multilingual Wordnets with Morphological Features  
*Stefania Racioppa, Thierry Declerck*
- ▀ A Comparison of Representation Models in a Non-Conventional Semantic Similarity Scenario  
*Andrea Amelio Ravelli, Oier Lopez de Lacalle, Eneko Agirre*
- ▀ How Much Competence Is There in Performance? Assessing the Distributional Hypothesis in Word Bigrams  
*Johann Seltmann, Luca Ducceschi, Aurélie Herbelot*
- ▀ Jointly Learning to See, Ask, Decide when to Stop, and then GuessWhat  
*Ravi Shekhar, Alberto Testoni, Raquel Fernández, Raffaella Bernardi*
- ▀ Creating a Multilingual Terminological Resource using Linked Data: the case of Archaeological Domain in the Italian language  
*Giulia Speranza, Carola Carlino, Sina Ahmadi*
- ▀ Vir is to Moderatus as Mulier is to Intemperans - Lemma Embeddings for Latin  
*Rachele Sprugnoli, Marco Passarotti, Giovanni Moretti*
- ▀ Valutazione umana di Google Traduttore e DeepL per le traduzioni di testi giornalistici dall'inglese verso l'italiano (Human evaluation of Google Translator and DeepL for translations of journalistic texts from English into Italian)  
*Mirko Tavosanis*
- ▀ Prendo la Parola in Questo Consesso Mondiale: A Multi-Genre 20th Century Corpus in the Political Domain  
*Sara Tonelli, Rachele Sprugnoli, Giovanni Moretti*
- ▀ Reflexives, Impersonals and Their Kin: a Classification Problem  
*Kledia Topciu, Cristiano Chesi*
- ▀ Annotation and Analysis of the PoliModal Corpus of Political Interviews  
*Daniela Trotta, Sara Tonelli, Alessio Palmero Aprosio, Annibale Elia*
- ▀ Analyses of Literary Texts by Using Statistical Inference Methods  
*Mehmet Can Yavuz*

### Contributed Papers: Short Papers

- ▀ Neural Semantic Role Labeling using Verb Sense Disambiguation  
*Domenico Alfano, Roberto Abbruzzese, Donato Cappetta*
- ▀ Kronos-it: a Dataset for the Italian Semantic Change Detection Task  
*Pierpaolo Basile, Giovanni Semeraro, Annalina Caputo*
- ▀ How do Physiotherapists and Patients talk? Developing and annotating RiMotivAzione dialogue corpus.  
*Andrea Bolioli, Francesca Alloatti, Mariafrancesca Guadalupi, Roberta Iolanda Lanzi, Giorgia Pregnolato, Andrea Turolla*
- ▀ Standardizing Language with Word Embeddings and Language Modeling in Reports of Near Misses in Sevens Industries  
*Simone Bruno, Silvia Maria Ansaldi, Patrizia Agnello, Fabio Massimo Zanzotto*
- ▀ Computational Linguistics Against Hate: Hate Speech Detection and Visualization on Social Media in the "Contro L'Odio" Project  
*Arthur T. E. Capozzi, Mirko Lai, Valerio Basile, Cataldo Musto, Marco Polignano, Fabio Poletto, Manuela Sanguinetti, Cristina Bosco, Viviana Patti, Giancarlo Ruffo, Giovanni Semeraro, Marco Stranisci*
- ▀ Supporting Journalism by Combining Neural Language Generation and Knowledge Graphs  
*Marco Cremaschi, Federico Bianchi, Andrea Maurino, Andrea Primo Pierotti*
- ▀ Deep Bidirectional Transformers for Italian Question Answering  
*Daniilo Croce, Giorgio Brandi, Roberto Basili*
- ▀ Applying Psychology of Persuasion to Conversational Agents through Reinforcement Learning: an Exploratory Study  
*Francesca Di Massimo, Valentina Carfora, Patrizia Catellani, Marco Piastra*
- ▀ WeblsAGraph: A Very Large Hypemymy Graph from a Web Corpus  
*Stefano Faralli, Irene Finocchi, Simone Paolo Ponzetto, Paola Velardi*
- ▀ CULTURE as a "Liquid" Modern Word. Evidence from Synchronic and Diachronic Language Resources  
*Maristella Gatto*
- ▀ A Dataset of Real Dialogues for Conversational Recommender Systems  
*Andrea Iovine, Fedelucio Narducci, Marco de Gemmis*
- ▀ Quanti anni hai? Age Identification for Italian  
*Aleksandra Maslennikova, Paolo Labruna, Andrea Cimino, Felice Dell'Orletta*
- ▀ Multi-task Learning Applied to Biomedical Named Entity Recognition Task  
*Tahir Mehmood, Alfonso Gerevini, Alberto Lavelli, Ivan Serina*
- ▀ Mining Italian Short Argumentative Texts  
*Ivan Namor, Pietro Totis, Samuele Garda, Manfred Stede*
- ▀ Fixing Comma Splices in Italian with BERT  
*Daniele Puccinelli, Silvia Demartini, Renée E. D'Aoust*
- ▀ A Comparative Study of Models for Answer Sentence Selection  
*Federico Rossetto, Alessio Gravina, Silvia Severini, Giuseppe Attardi*
- ▀ An Italian Question Answering System for Structured Data based on Controlled Natural Languages  
*Lucia Siciliani, Pierpaolo Basile, Giovanni Semeraro, Matteo Mennitti*
- ▀ The Tenuousness of Lemmatization in Lexicon-based Sentiment Analysis  
*Marco Vassallo, Giuliano Gabrieli, Valerio Basile, Cristina Bosco*



# Asymmetries in extraction from nominal copular sentences: a challenging case study for NLP tools

Paolo Lorusso, Matteo Greco, Cristiano Chesi, Andrea Moro

NEtS at Scuola Universitaria Superiore IUSS.

P.zza Vittoria 15, I-27100 Pavia (Italy)

{paolo.lorusso, matteo.greco,

andrea.moro, cristiano.chesi}@iusspavia.it

## Abstract

In this paper we discuss two types of nominal copular sentences (Canonical and Inverse, Moro 1997) and we demonstrate how the peculiarities of these two configurations are hardly considered by standard NLP tools that are currently publicly available. Here we show that example-based MT tools (e.g. Google Translate) as well as other NLP tools (UDpipe, LinguA, Stanford Parser, and Google Cloud AI API) fail in capturing the critical distinctions between the two structures in the end producing both wrong analyses and, possibly as a consequence of a non-coherent (or missing) structural analysis, incorrect translations in the case of MT tools. To support the proposed analysis, we present also an empirical study showing that native speakers are indeed sensitive to the critical distinctions. This poses a sharp challenge for NLP tools that aim at being cognitively plausible or at least descriptively adequate (Chowdhury & Zamparelli 2018).

## 1. Introduction

The main hypothesis of this paper is that sentence comprehension cannot be achieved independently from a coherent structural analysis. To support this claim, we first present a precise structural analysis that is critical for recovering the relevant dependencies within specific constructions, then we will show that the crucial structural properties captured by the theoretical framework are in fact correctly perceived by native speakers, but not revealed by some widely used Natural Language Processing (NLP) tools. This leads to poor performance in tasks like Machine Translation (MT).

This argument seems to us especially relevant in those structural configurations in which a non-local dependency must be established: in parsing, for instance, interpreting correctly a *wh*-dependency requires that the *dependent* (the *wh*-phrase) and the *dependee* (the head selecting the *wh*-phrase as its argument/modifier) are identified, and the nature of the dependence disambiguated (e.g. argument vs. modifier). In (1) we exemplify the special case of a non-local dependency between a *wh*-PP and a DP it depends on (a co-indexed underscore signals the possible extraction sites, hence the dependent constituent; the diacritic “\*” prefixes, as usual, illegal sites):

- (1) [Di quale segnale]<sub>i</sub> [i telescopi \* \_i] hanno  
Of which signal the telescopes have  
scoperto \* \_i [un’interferenza \_i]?  
discovered an interference?  
‘[which signal]<sub>i</sub> did the telescopes discover  
an interference of \_i?’

The second DP *un’interferenza* (an interference) (the internal argument) is the dependee of the *wh*-phrase and neither the subject DP nor the predicate can host this *wh*-dependency instead.

According to Google Translate (as of 12<sup>th</sup> July 2019), this second option seems indeed a viable one:

- (2) What signal did the telescopes find an interference?

The translation is ill formed being the internal argument of *find* filled both by the *wh*-phrase and the DP *an interference* (which cannot take a *wh*-DP as its own argument).

In this work we focus on a similar non-local dependency involving two kinds of copular sentences: Inverse (3.a) and Canonical (3.b). Using these constructions, we will test the

availability of *wh*- PP sub-extraction from both the first and the second DP as exemplified in (4).

- (3) a. le foto del muro **sono** la causa della rivolta  
 the pictures of the wall **are** the cause of the riot  
 b. la causa della rivolta **sono** le foto del muro  
 the cause of the riot **are** the pictures of-the wall  
 ‘the cause of the riot **is** the pictures of the wall’
- (4) a. [Di quale rivolta]<sub>i</sub> le foto del muro **sono**  
*of which riot the pictures of the wall are*  
 la causa   <sub>i</sub> ?  
*the cause*  
 b. [Di quale muro]<sub>i</sub> le foto   <sub>i</sub> **sono**  
*of which riot the pictures of the wall are*  
 la causa della rivolta?  
*the cause of the riot*

In the first part of this paper (§2), we will briefly present an analysis for these constructions, then we will demonstrate that native speakers are selectively sensitive both to the copular structural configuration (Canonical vs. Inverse) and to the extraction site (subject vs. predicate) (§3). In §4 we will test the insensibility of some freely available NLP tools (Google Translate, the Natural Language service of Google Cloud AI API, UDpipe, Stanford Parser and LinguA) to the syntactic oppositions previously discussed.

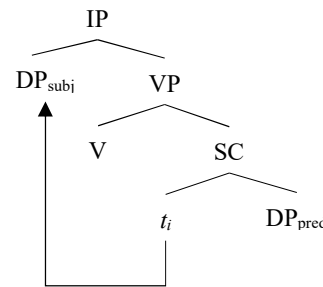
## 2. The structure of nominal copular sentences

Copular sentences are those sentences whose main verb is *to be* (the copula) and its equivalents across languages. A subset of copular sentences is the one involving two DPs, linearly ordered as DP V DP. Those are dubbed *nominal copular sentences*. In this configuration, a nominal phrase realizes the predicate of the sentence (“the cause...” in (3)) while the other is the subject of the predicate (“the pictures...” in (3)). According to Moro (1997), nominal copular sentences can be distinguished in two subtypes: *Canonical copular sentences* (3.a) – in which the order is subject-copula-predicative expression – and *Inverse copular sentences* (3b) – in which the order is inverted, i.e. predicative expression-copula-subject.

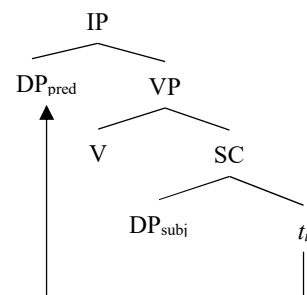
Moro (1991, 1997, 2006) showed that these two types of copular constructions can be distinguished on the basis of different diagnostics like agreement on the verb, grammaticality for the extraction of DPs (*Wh*- or clitic) and pronominal binding.

Traditionally, copular sentences are analyzed as involving the raising of a DP from the same base generated structure (Stowell 1978). Moro (1997, 2018) showed that the predicate DPs (including *there* and its equivalents across languages) can be raised along with the subject DPs to the preverbal position from the so-called *Small Clause* (SC) – a structure resulting from merging two DPs (Moro 2000, 2009 Chomsky 2013, Rizzi 2016). In other words, while in Canonical copular sentences the subject DP raises to the preverbal position and the predicative DP stays *in situ* inside the small clause in the postverbal position (4), in the Inverse copular sentences the predicative DP raises to the preverbal position and the subject DP stays *in situ* inside the small clause in the postverbal position (5).

- (5) Canonical copular sentence structure



- (6) Inverse copular sentence structure



### 2.1 Asymmetries in copular sentences

These two different representations offer a principled explanation for many asymmetries across languages. Distinguishing between Canonical and Inverse copular sentences is not always easy or possible (see Jespersen 1924 as cited in Moro 1997). However, agreement and PP/*ne* sub-extraction offer robust diagnostics. For example, verbs invariably agree with the subject DP in Italian (7), regardless of the pre-verbal or post-verbal position, while they invariably agree with the preverbal DP in English (8):

- (7) a. le foto **sono**/\*è la causa  
the pictures are/\*is the cause  
b. la causa **sono**/\*è le foto  
the cause are/\*is the pictures

Italian

- (8) a. the pictures **are**/\*is the cause.  
b. the cause **\*are/is** the pictures

English

Extraction is only allowed from the post-verbal DP – the predicate – in Canonical sentences (9), whereas it is not allowed from the post-verbal DP – the subject – in Inverse copular sentences (10).

- (9) a. **which** riot<sub>i</sub> do you think a picture of the wall was **the cause of** <sub>i</sub>?  
b. **di quale rivolta**<sub>i</sub> pensi che una foto del of which riot<sub>i</sub> do you think that a picture of the muro sia la causa <sub>i</sub>?  
wall is the cause <sub>i</sub>?  
(10) a. **\*which** wall<sub>i</sub> do you think a cause of the riot was a **picture of** <sub>i</sub>?  
b. **\*di quale muro**<sub>i</sub> pensi che la causa della of which wall<sub>i</sub> you think that the cause of the rivolta sia **una foto** <sub>i</sub>?  
riot is a picture <sub>i</sub>?

### 3. Experimental evidence supporting the analysis of copular sentences

Before considering the computational side or the proposed structural analysis we investigated whether the human parser is sensitive to the critical distinctions illustrated here. Two experiments are discussed, testing the processing of Canonical vs Inverse copular sentences (first condition) involving the extraction of a wh-element from a DP embedded either under the subject or the predicate (second condition).

Our prediction was that the sensitivity to agreement and to the *argumental* vs. *predicative* role distinction for the two DPs involved would have influenced both the online and the offline performance of native speakers: participants should show an advantage in parsing Canonical copular sentences (vs. Inverse ones), since only the Canonical configuration allow the extraction from the predicate DP, whereas all the other kinds of extraction – from the subject in Canonical and from both the subject and the predicate in Inverse – should be disallowed (§2.1).

In order to test these hypotheses, we performed (i) a Self-Paced Reading (SPR) experiment with a Sentence Comprehension Task at the end, and (ii) an Acceptability Judgement Task (AJT).

#### 3.1 Material and methods

In both the SPR and AJT the set of stimuli was the same: 128 items (divided in 4 conditions) and 40 fillers, in SPR, and 60 fillers, in AJT per condition (72 items per experiment in SPR, 92 in AJT). The 2x2 design produced four experimental conditions, exemplified in (11):

(11) *Condition 1:*

##### Canonical + Extraction from the Subject

\*[<sub>PP</sub> Di quale muro]<sub>i</sub> ... [<sub>DP</sub> le **foto** <sub>t<sub>i</sub></sub>]<sub>a</sub> sono [<sub>SC</sub> [<sub>t<sub>a</sub></sub>]  
Of which wall the pictures are  
[<sub>DP</sub> la **causa** [<sub>PP</sub> della rivolta]]?  
the cause of the riot?

*Condition 2:*

##### Canonical + Extraction from the Predicate

[<sub>PP</sub> Di quale rivolta]<sub>j</sub> ... [<sub>DP</sub> le **foto** [<sub>PP</sub> del muro]]<sub>a</sub>  
Of which riot the pictures of the wall  
sono [<sub>SC</sub> [<sub>a</sub>]] [<sub>DP</sub> la **causa** [<sub>i</sub>]]  
are the cause?

*Condition 3:*

##### Inverse + Extraction from the Subject

\*[<sub>PP</sub> Di quale muro]<sub>k</sub> ... [la **causa** [<sub>PP</sub> della rivolta]]<sub>b</sub>  
Of which wall the cause of the riot  
sono [<sub>SC</sub> [le **foto** <sub>k</sub>] [<sub>b</sub>]]?  
are (=is) the pictures?

*Condition 4:*

##### Inverse + Extraction from the Predicate

\*[<sub>PP</sub> Di quale rivolta]<sub>l</sub> ... [la **causa** <sub>l</sub>]<sub>b</sub> sono [<sub>SC</sub>  
Of which riot ... the cause are (=is)  
[<sub>DP</sub> le **foto** [<sub>PP</sub> del muro]] [<sub>b</sub>]]?  
the pictures of the wall

#### 3.2 Self-Paced Reading

40 native Italian speakers participated to the experiment. Stimuli were composed by questions and by their answers; participants had to read the question word by word and, then, the answer. Finally, they had to judge the appropriateness of the answer.

#### 3.3 Results

Participants showed higher accuracy in answering to comprehension questions when the extraction takes place from the post-verbal DP in Canonical copular sentences – DP *predicate* in Condition 2 – than in Inverse copular sentences – DP *subject*

in Condition 3 – while extraction from the Inverse copular constructions induced lower accuracy (-0.41,  $z=-2.054$ ,  $p=0.04$ ; Fig. 1). This confirms that the structural asymmetry between referential subjects and predicative DPs has a central role in both the processing and the comprehension of nominal copular sentences, as well as the fact that none of the site in the Inverse copular constructions are legal extraction sites (as predicted by Moro 1997, 2006).

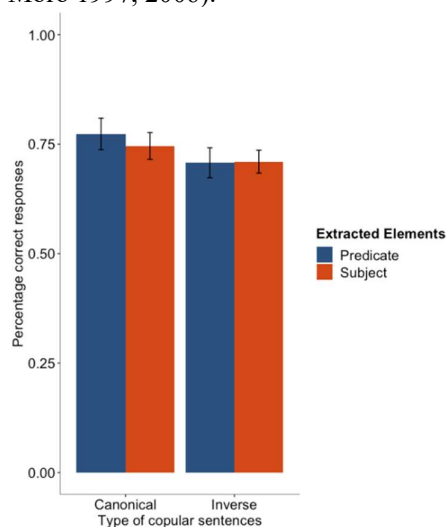


Fig.1 Percentage of correct answers across conditions.

Reading times, on the other hand, revealed a clear difference at the copular region for the two conditions ( $t=3.37$   $p=0.002$ ) suggesting a penalty for the Inverse copular constructions compared to the Canonical one. Also at the first DP region the Predicate vs Subject distinction is productively differentiated ( $t>2$   $p=0.008$ ) indicating the *la causa* (“the cause”) and “*le foto*” (“the pictures”) conditions, respectively predicate and subject condition, are perceived as different.

### 3.4 Acceptability Judgement Task

40 native Italian speakers participated to the experiment. Stimuli were the same than in SPR. Participants had to rate the acceptability of questions on a scale from 1 to 7.

### 3.5 Results

The results (fig.2) confirm the previous on-line findings and show that (i) Canonical constructions were more acceptable than Inverse ones and that (ii) among the different types of copular sentences, the ones with an extraction from predicates have higher rates than the ones with extraction from subjects.

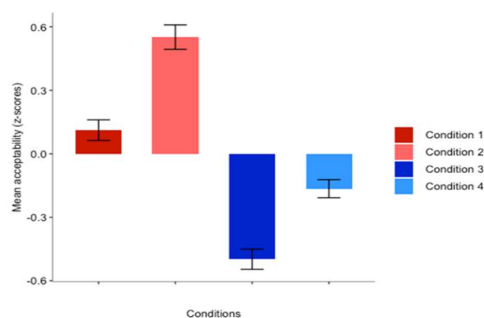


Fig.2 Acceptance rates across conditions.

## 4. Parsing copular sentences

To evaluate the state-of-the-art of NLP with respect to the contrasts we discussed (Canonical vs Inverse copular sentences) in a configuration where overt agreement disambiguates the critical roles (predicate vs subject), we ran few tests using the following tools:

1. UDPipe (Straka et al 2016)
2. Stanford Parser - English (Chen & Manning 2014)
3. LinguA parser (Attardi, Dell’Orletta 2009)
4. Google Translate (translate.google.com)
5. Google Cloud AI Solutions (cloud.google.com)

We first tested standard Canonical (3.a) and Inverse (3.b) copular constructions, then we tried to assess qualitatively the output analyses provided by these tools with respect to sub-extraction from the predicate in Canonical sentences (9.a-b), here repeated for convenience:

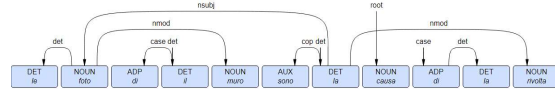
- (3) a. le foto del muro **sono** la causa della rivolta  
the pictures of the wall **are** the cause of the riot  
b. la causa della rivolta **sono** le foto del muro  
the cause of the riot **are** the pictures of the wall  
the cause of the riot **is** the pictures of the wall
- (9) a. **which riot<sub>i</sub>** do you think a picture of the wall was **the cause of**   <sub>i</sub>?  
b. **di quale rivolta<sub>i</sub>** pensi che una foto del muro sia la causa   <sub>i</sub>?  
of which riot<sub>i</sub> do you think that a picture of the wall is the cause   <sub>i</sub>?

### 4.1 UDPipe

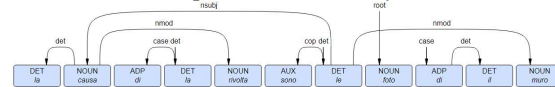
UDPipe Natural Language Processing - Text Annotation interface (Wijffels 2018, Straka et al 2016) provides a handy tool easily integrated in the R environment. Various pre-trained models

are available for many languages. We run our analyses using the pre-trained model `italian-isdt-ud-2.4-190531`. The results of the analysis for both Canonical (10.a) and Inverse (10.b) are simply the same. In fact, not even the basic local dependencies are fully recovered (e.g. `det-noun`). The analysis of the sub-extraction from predicate in Canonical structures (13.a) is paradoxically less disastrous than the other analyses, but if we try to analyze sub-extraction from the subject of a Canonical construction, we obtain wrong analyses (13.b) (the *wh*- items is considered an extra argument of *cause*):

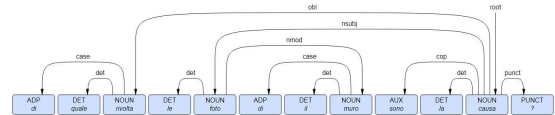
(12) a. Canonical copular sentence analysis



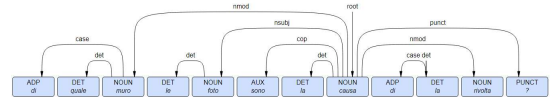
b. Inverse copular sentence analysis



(13) a. sub-extraction from predicate in Canonical configuration



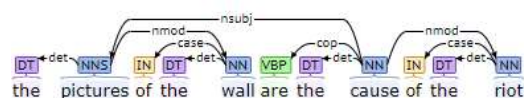
b. sub-extraction from subject in Canonical configuration



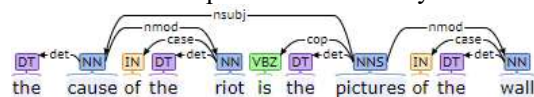
## 4.2 Stanford Parser

Stanford parser (Chen & Manning 2014) can be considered the state-of-the-art parser for English. Canonical constructions, in fact, gave the opportunity to live up to expectations: the analysis of the canonical copular sentence (14.a) is perfectly in line with the analysis presented in §2-§2.1 (*cause* is identified as predicate and *pictures* as its subject). Unfortunately, the same analysis is proposed for inverse copular constructions (14.a).

(14) a. Canonical copular sentence analysis

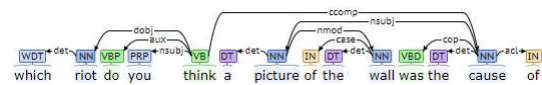


b. Inverse copular sentence analysis



The quality of the analysis for the sub-extraction case confirms every suspicion: the sub-extracted *wh*-item (*which riot*) is wrongly associated to the matrix predicate (*think*) (15).

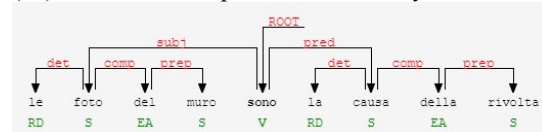
(15) sub-extraction from predicate in Canonical configuration



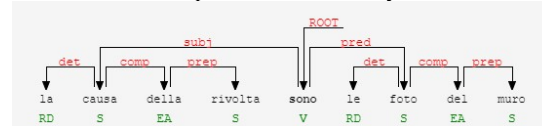
## 4.3 LinguA

LinguA annotation pipeline (service provided online by ItaliaNLP Lab at Istituto di Linguistica Computazionale "Antonio Zampolli" ILC in Pisa) has been used for our tests on Italian, implementing a version of Attardi & Dell'Orletta (2009) parser (currently the state-of-the-art parser for Italian). The analyses of this parser are definitely more precise than the ones proposed by the UDpipe tool, but the symmetric results returned for both Canonical and Inverse copular sentences did not identify either the dependency between the predicate and the subject or their actual role in the structure (16.a-b). The analysis of the extraction, interestingly attempts an interpretation of the *wh*- item as an (extra) argument of the first DP (*le foto [di quale rivolta] (del muro)*). This is a wrong analysis, but it is coherent with the slow-down observed in self-paced reading experiment (§3.3) at the first DP region, though the parser does not make the relevant distinction between subject (17.a) and predicate (17.b) (in this second case, sub-extraction is interpreted as a copula argument).

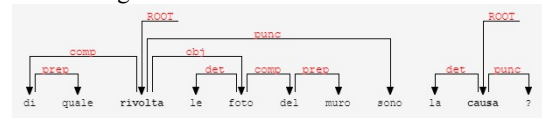
(16) a. Canonical copular sentence analysis



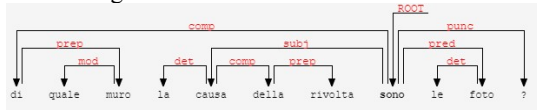
b. Inverse copular sentence analysis



(17) a. sub-extraction from predicate in Canonical configuration



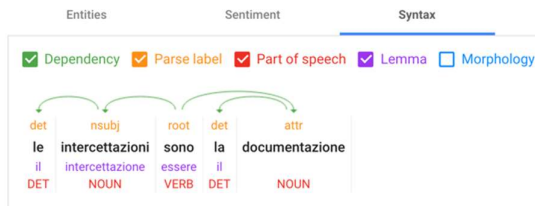
b. sub-extraction from subject in Inverse configuration



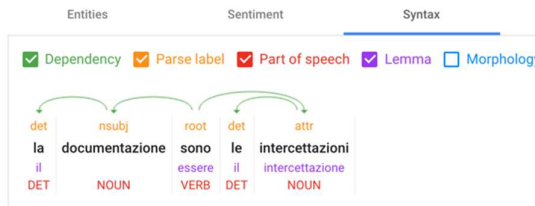
#### 4.4 Google AI

We finally investigated the Natural Language service – one of the tools provided by Google Cloud AI Solutions – which returns syntactic representations of sentences (<https://cloud.google.com/natural-language/>).

While both canonical and inverse copular analyses are equivalent in English to the ones provided by the Stanford Parser (hence marginally consistent with our analyses), in Italian, using the Canonical copular sentence ‘*le intercettazioni sono la documentazione*’ (‘the interceptions are the documentation’), it incorrectly analyses the predicate DP *the documentation* as an attribute (fig. 4). Moreover, when it is provided with the Inverse form of the sentence ‘*la documentazione sono le intercettazioni*’ (lett. the documentation are the interceptions; ‘The documentation is the interceptions’), it incorrectly analyzes the raised predicative DP *the documentation* – singular noun – as the subject, putting it in a wrong agreement relation with the verb (plural form) (Fig. 5). Crucially, this parser fails in recognizing the difference between Canonical and Inverse copular sentences giving exactly the same analysis for both the cases shown in (3) and (4).



**Fig.4** The structural analysis of the Canonical sentence ‘*le intercettazioni sono la documentazione*’ (‘The interceptions are the documentation’) given by Google Natural Language.



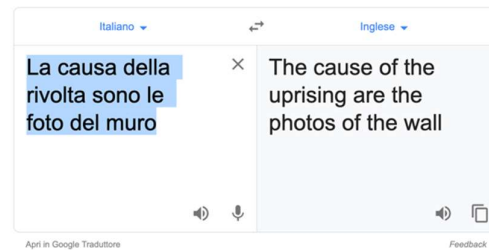
**Fig.5** Structural analysis of the Inverse copular sentence ‘*la documentazione sono le intercettazioni*’

(lett. the documentation are the interceptions; ‘The documentation is the interceptions’) given by Google Natural Language.

#### 4.4 Google Translate

In order to evaluate the impact of these wrong analyses on a practical NLP task, we finally carried out our conclusive experiments on one of the most famous and largely exploited machine translation software: *Google Translate*.

Starting with simple examples, we observed that when the tool is provided with the Italian Inverse copular sentence ‘*La causa della rivolta sono le foto del muro*’ (lett. the cause of the riot are the pictures of the wall; ‘The cause of the riot is the pictures of the wall’), it gives the wrong English translation ‘*\*The cause of the uprising are the photos of the wall*’ (Fig.6), in which the verb does not agree with the pre-verbal DP “*the cause of the uprising*”, contrary to what it does in English (as we saw in 7).



**Fig.6** Example from Google translate: <https://translate.google.it/?hl=it#view=home&op=translate&sl=auto&tl=en&text=La%20causa%20della%20rivolta%20sono%20le%20foto%20del%20muro>

Interestingly, reversing the translation from English to Italian *the cause of the riot is the pictures of the wall* the system correctly produces *la causa della rivolta sono le immagini del muro* where proper agreement (with the post-verbal subject) is in place. Since the analysis provided by any tool we tested is theoretically inconsistent with this result, we hypothesized that this translation could have been obtained adopting an example-based approach; it was worth then to test if the correct agreement with the post-verbal subject is just an accident (this is a well know prototypical sentence, widely discussed in literature and it might have been included in the Google Translate training set) or if the analysis is generalized of any possible subject/predicate pair.

A sentence like *la documentazione sono le intercettazioni* (lett. the documentation are the interceptions, that means ‘The documentation is the interceptions’) would suit our purpose nicely.



In the English > Italian direction the correct singular copular agreement is produced (“the documentation is the interceptions”) but from Italian to English this time the wrong agreement is obtained, totally ignoring the number of the real post-verbal subject (*the documentation is the interceptions > la documentazione è le intercettazioni*). We concluded then that no deep analysis is attempted so as to distinguish between subject and predicate roles and this turns out to be fatal.

## 5. Conclusion

In this paper we demonstrated that nominal copular sentences constitute a clear challenge for the computational analysis since the same string of elements [DP V DP] can have in principle two different syntactic representations (hence two different meanings), depending on which kind of copular sentence is realized (Canonical or Inverse). In this paper, we spotted various glitches in the automatic analyses which in the end led either to significant failures (Google Translate) or to rough structural hypotheses that bluntly ignore the relevant contrasts here discussed. Our empirical study, testing both online and offline the *wh*- PP sub-extraction possibilities from both subject and predicate DPs, shows the native speakers’ sensitivity with respect to the different structural roles, as well as their perception of the underlying structural representation of Canonical vs. Inverse copular construction. None of the NLP tools we tested succeeded in providing a full set of coherent analyses, with the exception of the Stanford Parser for English that at least succeeded in analyzing correctly the canonical copular sentences. This analysis was however insufficient in the case of inverse constructions and in case of sub-extraction, confirming that non-local dependencies are critical configurations native speakers are able to parse but machine do not, yet.

## Reference

- Attardi G., Dell’Orletta F. (2009). Reverse Revision and Linear Tree Combination for Dependency Parsing“. In: *NAACL-HLT 2009 – North American Chapter of the Association for Computational Linguistics – Human Language Technologies (Boulder, Colorado, June 2009)*. *Proceedings*, Association for Computational Linguistics, 2009. pp. 261 – 264.
- Chen D., C. D. Manning. (2014). A Fast and Accurate Dependency Parser using Neural Networks. *Proceedings of EMNLP 2014*. pp. 740-750
- Chomsky, N., (2013). ‘Problems of projection.’ *Lingua* 130:33–49
- Chowdhury, S. A., & Zamparelli, R. (2018, August). ‘RNN simulations of grammaticality judgments on long-distance dependencies.’ In *Proceedings of the 27th International Conference on Computational Linguistics* (pp. 133-144).
- Jespersen, O., (1924) *The Philosophy of Grammar*, Allen & Unwin, London.
- Moro, A., (1991). The raising of predicates: copula, expletives and existence. *MIT Working Papers in Linguistics* 15: 119-181.
- Moro, A., (1997). *The Raising of Predicates*. Cambridge: Cambridge UP
- Moro, A., (2000). *Dynamic Antisymmetry*. *Linguistic Inquiry Monograph, Series*, MIT Press
- Moro, A., (2006). ‘Copular sentences.’ In Everaert, M. & H. van Riemsdijk (eds.), *MA. Blackwell Companion to Syntax II*, Blackwell, Oxford, 1-23.
- Moro, A., (2009). ‘Rethinking Symmetry: A Note on Labelling and the EPP.’ In *La grammatica tra storia e teoria: Scritti in onore di Giorgio Graffi*, edited by P. Cotticelli Kurras and A. Tomaselli, 129–31. *Alessandria: Edizioni dell’Orso*; also at <http://www.ledonline.it/snippets/allegati/snippets19007.pdf>.
- Moro, A., (2018). ‘Copular sentences.’ In Everaert, M. & H. van Riemsdijk (eds.), *MA. Blackwell Companion to Syntax, Revised edition vol. II*, Blackwell, Oxford, 1-23.
- Rizzi, L., (2016). ‘Labeling, maximality, and the head-phrase distinction.’ *The Linguistic Review* 33, 103–127.
- Straka, M., Hajic, J., & Straková, J. (2016). UDPipe: trainable pipeline for processing CoNLL-U files performing tokenization, morphological analysis, pos tagging and parsing. In *Proceedings of the tenth international conference on language resources and evaluation (LREC 2016)* (pp. 4290-4297).
- Stowell, T., (1978). ‘What was there before there was there.’ In D. Farkas et al., eds., *Papers from the Fourteenth Regional Meeting, Chicago Linguistic Society*. Chicago Linguistic Society, University of Chicago.
- Wijffels, J. (2018). *udpipe: Tokenization, Parts of Speech Tagging, Lemmatization and Dependency Parsing with the UDPipe ‘NLP ‘Toolkit*. R package version 0.5.