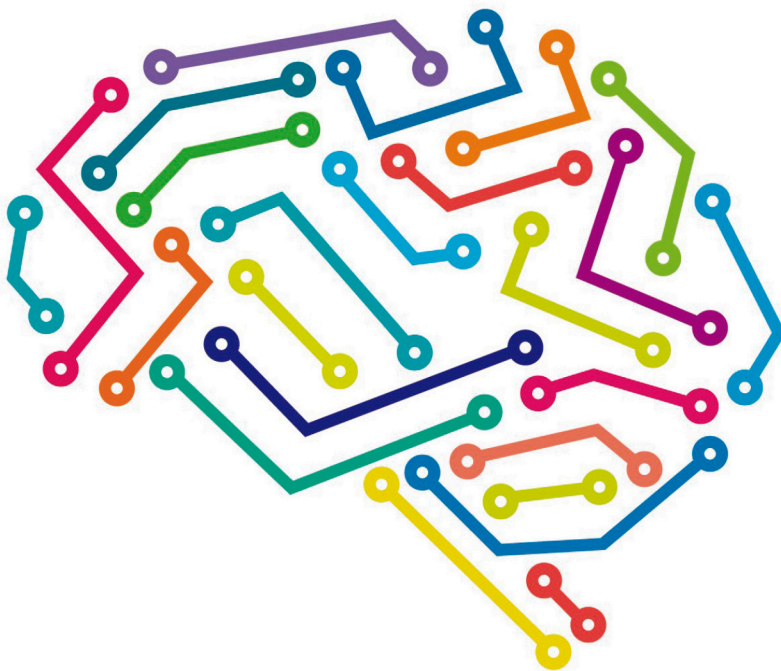


Approaches to Knowledge Representation and Language



Rocío Jiménez-Briones
Avelino Corral Esteban
(eds.)

EDITORIAL COMARES



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Avelino Corral Esteban
(eds.)

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Introduction

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As is well known, there is an immediate need to access different types of information in different languages in real time. The multicultural and multilingual village in which many of us live thanks to the Internet and the constant migration of peoples and communities around the world have reinforced the urgent need to be able to understand each other's message. However, this integration of peoples and communities with common access to information has not been fully achieved, leaving us with an information gap that could certainly be filled in by the strategic application of computational and functionally-cognitively oriented corpus linguistics, information technologies and artificial intelligence (Nolan & Periñán-Pascual, 2014).

Linguistics is concerned with the multiple dimensions of language (i.e. lexicon, phonetics, semantics, morphosyntax, pragmatics and discourse), including what constitutes language knowledge and the architecture of the language system. In addition, linguists are interested in the linguistic processes that underlie the production, perception, and interpretation of language in diverse circumstances and situations. Since language is a window into the cognitive abilities of people and, as such, is often studied to understand the nature of the mind that produces it, we linguists seek to identify the nature of human knowledge and language in all its richness and complexity. In other words, we approach the representation of meaning and knowledge, in general, as well as the whole process of language comprehension, in particular, whether from the viewpoint of theoretical and applied linguistics, sociology, computational linguistics, artificial intelligence (AI), knowledge engineering and natural language understanding and processing (NLU/NLP). Therefore, this volume sets out to explore the most current approaches to, and insights into, the field of knowledge and language representation in the context of NLU/NLP. Specifically, from the point of view of cognitive science, the chapters offer novel results on the construction and representation of meaning and knowledge, employing notions and concepts from functional, cognitive, computational and corpus linguistics, sociology, and AI. Many of the chapters present research conducted in competitive research projects and showcase the collaboration and mutual understanding between theoretical and com-

putational linguistics and NLP techniques, with specific applications in sociology (social sensing or social media crowdsensing), emotion detection or sentiment analysis, and dementia pre-diagnosis. In addition, evidence is included on the organizational power of cognitive mechanisms, such as metonymy and conceptual metaphor, in hyperbolic constructions in Spanish and in the names of fragrance brands in Morocco. Similarly, new ground is broken in the implicational constructions and attitudinal and denotational figures of speech in relation to irony and in the cognitive nature of attenuation and its related figures (i.e. meiosis and litotes). Moreover, this monograph includes the latest research in the English language within the Formalised Lexical-Constructional Grammar (FL_CxG), thus revealing its immense potential as a new model of unification grammar with a clear computational implementation.

In the vein of other successful publications such as Periñán-Pascual & Mestre-Mestre (2016), Rodríguez-Juárez (2017), Nolan & Diedrichsen (2019), and Felices-Lago & Ureña Gómez-Moreno (2020), this volume aims to serve as a catalyst for the publication of high impact papers on topics of importance for today's society. In this way, our book brings together the most recent research proposals on the representation of knowledge and language from different theoretical perspectives, which, however, far from being in conflict, aim to provide several complementary solutions to, among others:

- i) The detection, as well as the explanation, of problems arising in a given community (e.g. beach quality, economic income, educational policies or violence against women), evidencing the key role of social network users as social sensors (Sakaki *et al.*, 2013; Musto *et al.*, 2015; Arthur *et al.*, 2018).
- ii) The identification of negative communicative functions and the automatic processing of contextual operators affecting opinions expressed in tweets, with myriad implications for NLP tasks such as emotion detection and speech act classification (Cambria, 2016; Jurafsky & Martin, 2020; Mujahid *et al.*, 2021).
- iii) The analysis of speech expression and linguistic understanding of speech for cognitive assessment as a pre-diagnosis of dementia (AlzheimersOrgUk, 2018, 2020, 2021). This will provide a range of indicators of any potential problems with language production and cognition, as well as recommendations for the patient, caregiver, and the provision of appropriate health measures.
- iv) The value of metonymy and metaphor (Ruiz de Mendoza Ibáñez, 2014; Ruiz de Mendoza Ibáñez & Galera-Masegosa, 2014; Peña-Cervel & Ruiz de Mendoza Ibáñez, 2017) as cognitive tools that help us structure our knowledge through hyperbolic constructions and successful brand names of fragrances in Morocco.
- v) The role of axiology in facilitating the ironic interpretation of expressions like *As useful as buying one shoe*, which will also depend on the specification of the constructional variables, the speaker's world knowledge, and the context in which it is uttered (Lozano & Ruiz de Mendoza Ibáñez, 2022).
- vi) The attitudinal communicative impact of figurative constructions such as *I'm done in a second*, where 'a second' is a manifestly mitigated expression meaning

“in only a very short time” (Ruiz de Mendoza Ibáñez, 2020; Peña-Cervel & Ruiz de Mendoza Ibáñez, 2022). To this end, evidence supporting the cognitive nature of attenuation and related figures such as meiosis and litotes is presented for the explanation of such an impact.

- vii) The computational treatment, within FL_CxG (Cortés-Rodríguez, 2021), of reference phrases and constructions of the English language like interrogative sentences and the combinatory locative construction and the non-combinatory ‘applicative with-construction’ of the verb ‘spread’.

The book chapters to follow make true progress in research in the aforementioned fields thanks to the following strengths: i) the use of functional-cognitive linguistic theories; ii) the scholarly analysis and computational treatment of complex linguistic constructions; iii) the proof that the collaboration between linguistics and AI has successful applications in social sensing or social media crowdsensing, sentiment analysis, and the pre-diagnosis of dementia; iv) the variety of data used; and v) the authors’ extensive expertise in their respective fields.

The collection of papers is organized into three thematic blocks: Knowledge representation for social sensing and language (Part I), Knowledge representation for cognition and language (Part II), and Knowledge representation for syntax and language (Part III).

Part I (*Knowledge representation for social sensing and language*) comprises seven chapters that deal with a series of specific applications in social media crowdsensing, emotion detection, and dementia pre-diagnosis, as a result of the close cooperation between sociology, theoretical and computational linguistics, and NLP techniques. Six of the papers that make up this first block showcase the work developed within the R&D&I project grant PID2020-112827GB-I00 *ALLEGRO: Smart multi-modal crowdsensing-based system as a service oriented to the prediction of social problems*, funded by MICIU/AEI/10.13039/501100011033 and whose principal investigator is Carlos Periñán-Pascual. The project’s main objective is the development of ALLEGRO (**A**daptive **m**u**L**ti-domain **s**ocial**L**-media **s**EnsInG **f**Ramew**Or**k), an intelligent multi-modal system (i.e. text, audio and image) for the analysis and fusion of information published in social networks.¹ Specifically, the first chapter, by Periñán-Pascual, details the ontological foundations of one of the ALLEGRO’s modules, DIAPASON (unified **D** hybrid **A**p**P**roach to microtext **A**nalysis in **S**ocial-media **c**r**O**wdse**N**sing), which analyzes user-generated digital textual content in English and Spanish. The author exemplifies the operation of this module with the acquisition, specification and conceptualization of the knowledge required for the processing of texts linked to the topic of beach quality (Ariza *et al.*, 2010; Sardá *et al.*, 2014). Along the same lines, chapters 2, 3, and 4 delve into the construction of DIAPASON and, eventually, of ALLEGRO. On the one hand, Felices-Lago, in the second chapter, applies the ontological model designed by Periñán-Pascual (2023) to the iden-

¹ <http://allegro.ucam.edu/#introduction>

tification and categorization of the social problems belonging to the *INCOME* domain. Each problem is defined using a schema that includes essential aspects for its computational detection, such as the typology (category, dimension, domain, problem type and problem schema), the definition, the WordNet label (Felbaum, 1998), and the syntactic validation. On the other hand, by compiling a corpus of Twitter (now X) microtexts, in chapters 3 and 4, Pedro Ureña Gómez-Moreno & Ángela Alameda Hernández present a crowd-sensing proposal for detecting two of the most pressing social problems for the population: educational policies (i.e. public education organization, school management, and student-teacher conflicts) and violence against women. However, while Ureña Gómez-Moreno foregrounds the general challenges of collecting a corpus of tweets to serve as a ‘gold standard’ for subsequent problem detection by the ALLEGRO learning model, Alameda Hernández emphasizes the relevance of the formal schemas that codify the social problem of violence against women and the criteria needed for the collection of such a specific corpus of user-generated content units from Twitter/X.

Chapters 5 and 6 are framed within emotion detection or sentiment analysis. In chapter 5, Nicolás José Fernández-Martínez introduces a new NLP task called ‘communicative function identification’ to capture the whole range of intentions related to the citizens’ emotional states or judgements. Drawing on the notion of communicative function from the communicative approach in the English as a Foreign Language (EFL) literature, Fernández-Martínez develops a taxonomy of negative communicative functions (e.g. worry, anger, threat, etc.) in the context of smart cities. Based on such a taxonomy, he compiles two corpora (one manually built, the other using ChatGPT as a synthetic data generator) to design NLP models for the automatic identification of these communicative functions in social media microtexts. Yolanda Blázquez-López’s chapter proposes a novel model, based on the construction of a modular architecture using linguistic rules, formulas, and matrices, to detect and computationally process the types of contextual polarity-shifting operators included in negation (i.e. ‘never’, ‘nobody’, ‘nothing’, etc.). Employing a symbolic approach, Blázquez-López also aims to advance in the automatic processing of the polarity shifters that affect the opinions expressed on social media platforms in English.

The last chapter of this thematic block is a multidisciplinary and transversal work aimed at the pre-diagnosis of people with mild cognitive impairment or early dementia. Combining approaches from computer science, AI, linguistics, and cognitive psychology, as well as technology-inspired social health needs, Kulvinder Panesar & María Beatriz Pérez Cabello de Alba present a language and cognition assessment model supported by the DementiaBank multimedia database. This model provides indicators of any potential problems with language production and cognition, which can be used as a precursor to other clinical tests for the diagnosis of dementia. The authors, then, create a hybrid solution that contributes to research related to NLU, AI healthcare applications, and cognitive impairment assessment.

Part II of the edited volume (*Knowledge representation for cognition and language*) gathers four papers that unpack new studies of the Spanish and English languages from the perspective of cognitive linguistics and with possible implications for computational language processing. In addition, three of these chapters present the work carried out within the R&D&i project grant PID2020-118349GB-I00, *Interpretative and descriptive non-denotational dimensions in the construction of meaning: integration of linguistic, cross-linguistic and experimental data*, funded by MICIU/AEI and whose principal investigator is Francisco José Ruiz de Mendoza Ibáñez. Chapter 8 provides empirical evidence, by means of 200 corpus examples, of how metonymy structures the hyperbolic Spanish construction ‘X is todo/a Y’ (“X is all Y”), where X is a person and Y is a body part (e.g. *John es todo oído/s* “John is all ears”). To characterize the construction, María Sandra Peña-Cervel and Carla Ovejas-Ramírez set out to i) classify the examples into well-established categories, ii) analyze them, drawing on Ruiz de Mendoza Ibáñez (2014), by making explicit the magnified scenario and the factual situation, the way they clash, and the meaning implications that result from this clash, iii) uncover the correlation between the counterfactual scenario, the observable scenario and the degree of emotional impact on the hearer, and iv) explore the complexity of the source and target domains of the hyperbolic mapping. Chapter 9, by María Enriqueta Cortés de los Ríos & Fatima Azzahraa El Yamlaoui, examines the role of conceptual metaphor and metonymy in a sample of anglicized Moroccan fragrance brand names, from the Office Marocain de la Propriété Industrielle et Commerciale (OMPIC), and the specific modes (verbal or pictorial) involved in the semantic makeup of these names. Their findings reveal that there is a systematic tendency in comparison and correlation metaphors and the predominance of expansion metonymy. While in comparison metaphors, the verbo-pictorial mode is dominant, in correlation metaphors and metonymies, the most recurrent one is the verbal mode.

By highlighting the axiological element of potentially ironic constructions, chapter 10 addresses implicational constructions, and attitudinal and denotational figures of speech in relation to irony. Thus, Inés Lozano Palacio explores the constructional dimension of irony, providing insights into the constructional elements that constrain the production and interpretation of irony, the interaction of such constructional components, and the role of axiology in them. Chapter 11 closes part 2 by focusing on another figure of speech: understatement or figurative attenuation (an umbrella concept for meiosis and litotes). Herein, Francisco José Ruiz de Mendoza Ibáñez & María Sandra Peña-Cervel further look into the relationship of understatement with hyperbole and provide a fuller picture of the cognitive and communicative nature of understatement by elaborating on its role in irony and humor as well as depicting its relationship to meiosis and litotes. The findings of the chapters from this second thematic block, thus, not only help us to learn more about the human mind and language but may also be of interest for the development of practical applications in the field of AI and knowledge engineering, especially those that require the understanding and processing of real language use.

Finally, part III of the monograph (*Knowledge representation for syntax and language*) encompasses three proposals whose common theme revolves around a new grammatical model: the Formalised Lexical-Constructional Grammar (FL_CxG). Based on the functional and cognitive aspects present in Role and Reference Grammar (RRG, Van Valin, 2005) and the Lexical Constructional Model (Ruiz de Mendoza Ibáñez & Mairal-Usón, 2011; Ruiz de Mendoza Ibáñez & Galera-Masegosa, 2014), this new approach presents a unification grammar with a constructional and lexical basis through which the grammatical structures of a language are formally described with an eye to their computational implementation. In this line, chapter 12, by Emmanuel Hernández Hernández, presents the typed feature structures (Typed Fs) and attribute-value matrixes (AVMs) that FL_CxG uses to encode the linguistic expressions of a language, specifically, reference phrases (RPs) of English. After reviewing the components and operators of RPs within RRG, Hernández Hernández displays the different AVMs for the layered structure of English RPs, exemplifying his complex analysis with the RP ‘a chocolate cake’.

Chapters 13 and 14 address, respectively, the English polar interrogative sentences and the combinatory locative construction and the non-combinatory ‘applicative with-construction’. María Auxiliadora Martín-Díaz & Marta González-Orta, in chapter 13, offer a detailed study of the AVMs of English polar interrogative constructions (i.e. *Is she coming?*), as well as the set of attributes constraining the unification process that underlies the generation/decoding of these structures. In chapter 14, Carolina Rodríguez-Juárez illustrates the potential of FL_CxG and contributes to its catalogue of AVMs, by designing the Typed Fs for the representation of the lexical entry for ‘spread’ and for the core combinatory and non-combinatory locative constructions in which this predicate can be integrated, e.g. *Jack sprayed paint on the wall* and *Jack sprayed the wall with paint*. Therefore, the contributions of this third thematic block highlight the full potential of FL_CxG and its mathematically based formalism when creating a catalog of AVMs for any type of linguistic entity and its corresponding computational treatment.

We hope this edited volume provides useful reading and challenging ideas for (post) graduate students, researchers and scholars interested in functional-cognitive theoretical linguistics, corpus linguistics, sociology, AI, and NLP. There is a need and a niche for a book that builds a well-motivated connection between the work done in the fields of linguistics and computational models. The editors (and authors) believe that this work is a timely and necessary scholarly contribution to knowledge in these fields.

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Ana Belén Martínez López y Pedro San Ginés Aguilar

This monograph aims to serve as a catalyst for the publication of high-quality papers on topics of importance for today's society related to knowledge and language representation by delving into the latest approaches and methodologies within this field, particularly in the context of natural language understanding and processing. Throughout the lens of cognitive science, the chapters showcase fresh insights into the construction and representation of meaning and knowledge, drawing upon notions, concepts, and analytical tools from sociology, artificial intelligence (AI), and various branches of linguistics, including functional, cognitive, computational and corpus linguistics.

Many of the chapters feature studies carried out within competitive research projects to illustrate the synergy between theoretical and computational linguistics alongside NLP techniques, which has yielded applications in sociology, sentiment analysis, and dementia pre-diagnosis. Other chapters present innovative research on the organizational power of metonymy and conceptual metaphor, on the implicational constructions and attitudinal and denotational figures of speech in the context of irony, as well as on the cognitive nature of attenuation and related figures like meiosis and litotes. Likewise, this monograph includes the latest research in the Formalised Lexical-Constructional Grammar (FL_CxG), highlighting its potential as a robust model of unification grammar with computational implementations.

In sum, this edited volume offers valuable reading and challenging ideas for (post) graduate students, researchers and scholars with an interest in these fields. There exists a distinct demand and opportunity for a publication that establishes a compelling link between the advancements in linguistics and computational models. The editors and authors believe that this work is a timely and pertinent scholarly addition to the significant needs within the domains of functional-cognitive and corpus linguistics, sociology, AI, and NLP.

