Chapter

Introductory Chapter: Introduction to Computational Semantics

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"Some say that this is a sign of the soul, as it is buried in the present moment, and because through this, the soul signifies whatever it signifies, and this sign is rightly called a symbol."

Plato, Cratylus, 400 BCE

"Sema some say semaphores the psyche's burial into the soma during the present life. Because the psyche in the current soma semaphores polysemy, the semantic semantics are being semaphored"

Agaiarch Diocles, 2023 CE

1. Introduction

Computational semantics refer to the advanced scientific tools used for processing natural languages and extract interesting conclusions regarding the different meanings included. The models of the different languages should be well-understood and adequately put into the simulation and programming context. A language can be classified into three broad areas, including: syntax/structure, semantics/meanings and, finally, pragmatics. Seriatim, the principle of meaning can further be analysed. The main tool for reaching valid results is the efficient implementation of the logic principles involved in the modelling and computation processes [1].

2. Natural language characteristics

It took thousands of years for the different languages to evolve. It is this one skill of developing symbols, languages and communicating with each other that separates us from the animals. We have reached a great state of mind where a main Hellenic alphabet and subsequent ones have been created [2]. This allows us to form words, sentences and compile complete texts for specific subjects. Humans can efficiently express their thoughts and communicate with each other.

A great set of new scientific fields have been created, such as linguistics, in order to encapsulate the evolution of any language. In this field of science, it is always important to determine the qualities of the subject under investigation. Chomsky suggested various parameters and methods that can be used for correctly classifying a language [3]. A strong limitation in the modelling [4] and programming [5] stages has always been the level of understanding of the people involved in the different phases. Especially in the recent years where our computational capability [6] has

reached previously unseen levels of processing power [7], human limitation is still the restricting factor. For the purpose of further discussion, we will assume that a specific language can be defined through a textbook, archives or a series of representative sentences.

Grammar is probably the first thing we should seek in the skills of the various speakers. Grammar is a set of rules that stipulate and span throughout the language. The correct usage of the grammatic rules determines the efficiency of the implemented algorithms. Grammar demonstrates the following characteristics: Phonology, Morphology, Syntax and Semantics. Phonology distinguishes between tiny sounds and their combination into langer phonetic complexes. Morphology is responsible for the creation of words. Syntax is concerned with how words produce sentences. Semantics correspond to the meanings of the words that form sentences according to the syntactic rules.

In the current publication, we are focusing more on the top-level of language processing. The different chapters start from the discussion on phonology or morphology and elevate to semantics. Phonology is not further discussed in the current chapter. Based on the lingual rules that each of the authors has implemented the overall accuracy of the implemented algorithms is seriatim evaluated.

3. Morphology

In general, alphabetic languages can be analysed into their three counterparts: syntactic rules, the meanings of things and pragmatics. Syntax is more concerned with the art of combining morphemes and words into larger entities, as in phrases and sentences. To understand the purpose of semantics an excellent grasp of the corresponding language is needed and its grammar and syntax. In many languages, although we have a great knowledge of its constituents, we know little about their pragmatics usage. Pragmatics refer to the thoughts of the language users and the sentences that are being formed and exchanged between them to achieve communication. In this book, we are taking into consideration both pieces of speech and text of the English and Portuguese languages. Thus, we are considering samples of both natural and formal languages.

4. Semantics

In ethical teaching and philosophy, the aim is to communicate with each other, to describe and determine the truth and to acquire all the necessary virtues for a successful life. However, every language has historically being used to also deceive people, for the private benefit of the few. It is noticeable that no matter the education level of the participants it is frequent that the participants do not converge to a single truth. Logic and reasoning are techniques that every user should be trained to use [8]. This minimises the deviation between natural and formal languages when it comes to correctly defining a meaning. Semantics is what both states of a language share between them.

The implementation of state-of-the-art digital logic systems for various applications is the expertise of the author [9]. Logic has been used to create Hellenic, the first alphabetic language in the world [2]. Logic has been used to derive all the Hellenic dialects. Based on Hellenic, the other European languages have been logically derived, such as Spanish, Latin, French, English etc. Logic has been used extensively by the wise scholars to minimise the deviation between formal and natural morphemes [10]. Throughout human history, elements from the principles found in the field of discrete

mathematics have been found in the language formation phases down to the last detail of formally defining a language [11]. It is the usage of logical tools, such as predicate or propositional, that has permitted this. These are techniques being used by the authors of this book. A great analysis of the English language in terms of its natural and formal aspects is presented in [12]. It is well-known by ancient Hellenic that all the logical methods can be used into producing an extraordinary formal language. This is evident in the works of Homer, Hesiod, Socrates, Plato, Aristoteles, Proclus, the great Latin authors and many others. All these tools are also being used today to assist the convergence of natural and formal languages. Computational semantics is expedited by these techniques.

5. Computational semantics

Natural and formal language calculation of semantics has been based on [13] for many decades. Advanced programming techniques have been built around logical reasoning. Functional modelling and implementation have been built primarily around Montague reasoning. We are calling this field of mathematical thinking Λ (lamda) calculus. Functional modelling is a great expertise for linguists, since it allows them to parameterize all language aspects. Experimenting with the syntax, semantics and pragmatics is a means of evaluating all the classical theories. Through modelling the linguist gets immediate results and provides feedback to the theories under test.

The algorithms we are working on for computing semantics manipulate two categories of data representations. The first is the realisation of the various semantics. We are also post-processing the results acquired. The initial models are being put into extensive testing and the parameters of the initial models are accordingly adjusted. It is through extensive feedback that we have managed to build the various data retrieval software for searching through archives, computer databases and building impressive internet searching software. The combination of advanced computer science and artificial intelligence tools greatly assists in designing the next generation of natural and formal language processing tools. For instance, Haskell has historically been used for achieving functional modelling. Prologue was one the first programming languages used to implement predicate reasoning and perform engineering modelling [14]. Prologue does not meet today's needs for computing semantics. Haskell incorporated Prologue and a lot of programmers used it in computational semantics [15]. All modern high-level programming languages and dedicated hardware, preferably reconfigurable, are recommended for implementing computational semantics [16].

6. Conclusion

Natural language processing has always been intriguing linguists. However, high-performance programming has only been viable over the recent 20 years. In this publication, new state-of-the-art results are presented in the areas of natural and formal language speech processing, linguistics, classical studies and computational semantics. We anticipate this book to be an asset to researchers and the younger generations will be motivated to pursue studies in the areas of computer science, artificial intelligence, logic, linguistics and classical studies.

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References

[1] Dekoulis G. Field Programmable Gate Array. London, UK: INTECH; 2017. ISBN 978-953-51-3208-0

[2] Babiniotis G. The Hellenic Alphabet. Athens, Hellas: Kentro Lexicologias; 2018. ISBN 978-960-95-8213-1

[3] Chomsky N. Syntactic Structures. The Hague/Paris: Mouton; 1957

[4] Dekoulis G. Field Programmable Gate Array (FPGAs) II. London, UK: INTECH; 2020. ISBN 978-1-83881-057-3

[5] Dekoulis G. Novel space exploration technique for analysing planetary atmospheres. In: Air Pollution Vanda Villanyi. London, UK: IntechOpen; 2010. DOI: 10.5772/10053

[6] Dekoulis G. Novel digital magnetometer for atmospheric and space studies (DIMAGORAS). In: Aeronautics and Astronautics Max Mulder. London, UK: IntechOpen; 2011. DOI: 10.5772/17326

[7] Dekoulis G, Honary F. Novel Low-Power Fluxgate Sensor Using a Macroscale Optimisation Technique for Space Physics Instrumentation. SPIE, Smart Sensors, Actuators, and MEMS III. 2007;**6589**:65890G-1-65890G-8

[8] Dekoulis G, Honary F. Novel sensor design methodology for measurements of the complex solar wind – Magnetospheric, ionospheric system. Journal of Microsystem Technologies. 2008;**14**(4-5):475-482

[9] Dekoulis G. Robotics. London, UK: INTECH; 2018. ISBN 978-953-51-3636-1

[10] Dekoulis G. Drones – applications. London, UK: INTECH; 2018. ISBN 978-953-51-5948-3

[11] Lukasiewicz J. Aristotle's Syllogistic from the Standpoint of Modern Formal Logic. Oxford: Clarendon Press; 1951

[12] Montague R. English as a Formal Language: Formal Philosophy. New Haven and London: Yale University Press; 1974. pp. 188-221

[13] Montague R. The proper treatment of quantification in ordinary English. Approaches to Natural Language. 1973;**1973**:220-243

[14] Allison L. An executable Prolog semantics. Algol Bulletin. 1983;(50):10-18

[15] Spivey JM, Seres S. Embedding Prolog in Haskell. Utrecht: Department of Computer Science, University of Utrecht; 1999

[16] Allison L. A prolog semantics. In: A Practical Introduction to Denotational Semantics: Cambridge Computer Science Text. Cambridge; 1987. pp. 102-116