Ambiguity
What is it that needs representing and what needs resolving?

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***Abstract*— Despite previous attempts to clarify what we understand as ambiguity and to analyse its nature, research on the field reveals a lack of uniformity on its theoretical treatment, accentuated by a tendency to not to specify which are the commitments embodied in the proposed representation and resolution techniques. This paper analyses the phenomenon of ambiguity from a multidisciplinary perspective and in contrast to other semantic issues, in particular vagueness and generality as discussed in philosophy and polysemy and homonymy as in linguistics. The theoretical considerations are then briefly matched to the current trends in representation and resolution, concluding that the field could benefit from richer semantic representations and, fundamentally, from considering an unrecognised step: that of deciding, in context, whether there is something that need to be disambiguated or not.**

I. INTRODUCTION

Most natural language terms do not have precise universally agreed definitions that fix their meaning. Rather, words used in human communication can be associated to a wide and ever changing variety of senses and are versatile enough to fit new and detached scenarios (such as metaphors). It is thus not surprising that the phenomenon of ambiguity, often referred as concerning a word or phrase displaying multiple possible meanings, is pervasive in human communication, occurring at all levels of linguistic analysis [1], [2]: Words have multiple senses and can belong to different syntactic categories, sentences may admit several Logical Forms (syntactic trees) and speech acts can be ambiguous in their type (e.g. a sentence may be an assertion or a warning).

Research on the field of Ambiguity is highly multidisciplinary; Philosophical interest dates well back to Ancient Greek philosophy [3], [4] and, although traditionally it has predominantly considered it a mere obstruction for good philosophy [5], different views on the nature of human language arising fundamentally in the 20th century (e.g. [6], [7]) have contributed to the philosophical efforts on clarifying the concept of ambiguity with respect to related phenomena (such as vagueness) and on understanding its role in natural language (e. g. [8], [9], [10], [11]). Meanwhile, work in the emergent fields of Linguistics and Cognitive Science have joined this quest, the former by analysing ambiguity with respect to other linguistic phenomena [12], [2], [13] and on elucidating tests for it's detection [14] and the latter shedding light on human strategies for resolution [15], [16], [17], [18], some of which suggest that ambiguity may be a feature that makes communication more efficient [15], [1], which has also been suggested in the case of vagueness. Finally, research on Artificial Intelligence (AI) has embraced the challenge of Word Sense Disambiguation (WSD), the computational identification of meaning for words in context [19] and has delivered substantial advances in representation and resolution (see [19] for a complete survey). Multidisciplinarity has enriched the research on ambiguity, enabling feedback between philosophical and linguistic theory, cognitive models and experiments and implementations. However, it has also lead to difficulties due to different domains using terminology in different ways and/or avoiding explicit commitments on the nature of the phenomenon at hand. Such scenario motivates the following part of this piece of research.

The rest of the paper is structured as follows: Section II clarifies the terminology of related phenomena, facilitating the subsequent analysis of the nature of ambiguity in section III. Following is a discussion of the implications for the representation and resolution in section IV and in Section V we close with some final remarks.

II. WHAT IS NOT AMBIGUITY.

In this section we first describe our take on some of the related concepts that get often entangled with that of ambiguity, with the aim of clearly differentiating them.

A. Vagueness and Generality

Vagueness is ubiquitous in language [20] and arises whenever a concept or linguistic expression admits of borderline cases of application [21]. Vagueness occurs both when the applicability of a predicate depends on parameters whose thresholds are undetermined, such as in "tall" (height), and when there is a lack of clarity on which attributes or conditions are essential to fix the meaning of a given term, so that it is controversial how it should be defined [22], [23].

While in some literature in cognitive linguistics no clear distinction is made between vagueness and generality (e.g. [24], [8], [11]), here we do differentiate them sharply, on the basis that generality doesn't display uncertainty. For example, if we compare the statements 'I am in my twenties' and 'I am 29' we find that, although the first sentence is more general, it is not at all vague: It is true for me being any age within the twenties and false otherwise [25].'I am approaching 30', however is vague, because it doesn't have a clear range of applicability.

B. Polysemy and homonymy

Both polysemy and homonymy are studied in linguistics and denote the capacity for a sign (such as a word, phrase, or symbol) to have multiple meanings or senses. While in the former those senses are related by contiguity of meaning, in the later they convey unrelated meanings, being often the result of mere linguistic coincidence. Thus, if they where to be represented in a semantic field, polysemous terms would be closely clustered senses while homonymous ones would be totally disconnected [8], [26].

The accounts of the notion of polysemy in cognitive science and linguistic (e.g. [9], [26], [17], [18]) literature and that of conceptual vagueness in [22], [23] can be considered somewhat parallel, given that the idea of a well defined number of precise senses in polysemy is often relaxed. Moreover, when it is viewed from a cognitive perspective, the phenomenon emerges as a natural, indeed necessary consequence of the human ability to think flexibility [27].

III. ON THE NATURE OF AMBIGUITY

So far, we've attempted to depict a general picture of some of the main aspects of semantic heterogeneity in natural language that are normally conflated and/or confused with that of ambiguity. We now address our understanding of the nature of ambiguity, which, despite the generalised lack of consensus, a surprisingly small amount of papers from the reviewed literature, particularly in the WSD domain (e.g. [28], [29], [30], [31], [32], [17], [33]) explicitly define. Most definitions of the phenomenon at hand go along these lines:

"Ambiguity is a semantic property. [...] An expression is ambiguous if it has two or more distinct denotations — that is, if it is associated with more than one region of the meaning space"[9]

"Semantic lexical ambiguity is of two types. Polysemy refers to words whose several meanings are related [...]. Homonymy refers to words whose various definitions are unrelated"[16]

Most of the accounts of ambiguity are limited at pointing at the existence of more than one denotation or meaning, in line with the etymological origin of the term, like the first definition above. However, one of the hard problems in giving an account of ambiguity is to figure out what are the objects that are said to be ambiguous[34], which remains unspecified. Another very common position is to narrow down the scope to Lexical Ambiguity and describe it as a property of terms, comprising both Polysemy and Homonymy [8], [9] and, in other cases, only Homonymy [35], [11], [26]. Almost the totality of the experimental and computational research reviewed fits this approach, explicitly or implicitly.

This account seems, however, unsatisfactory, as it leaves some open questions such as:

- If lexical ambiguity is a property of natural language terms, how do we explain the existence of ambiguity in other linguistic levels such as structural or syntactic, homophone and pragmatic? [36]
- If polysemy is not to be included under the umbrella of ambiguity as suggested in [35], how do we explain the need for disambiguation in many scenarios involving polysemous words? [14] And conversely, if polysenmia is to be systematically included, how do we justify constant unnecessary disambiguation?
- If ambiguity is a property of words of natural language, how do we justify the impact of context, not only on the result of the disambiguation, but on the need or not for disambiguation (i.e. on the presence of ambiguity).

In order to provide tentative answers to these questions, we suggest characterising ambiguity not as a property of terms but as a phenomenon *arising in communication*, as a consequence of different manifestations of the underdetermination of natural language, in which different choices in the sense of a term, the LF of a sentence or the pragmatics of a speech act, lead to fundamentally different semantics of the whole, which can only be elucidated individually. E.g. In the sentence 'I went to the bank', the semantics given to bank drastically change the meaning of the utterance, unlike in "my cousin is tall", wherever we place the threshold for tallness. Moreover, the disambiguation will normally require knowledge of the semantic variability of the terms into play, the syntactic rules of the language and the context of the communication act.

Moreover and unsurprisingly, ambiguity occurs almost invariably in the presence of homonyms, given that scenarios where two unrelated senses of a term don't have different implications in the meaning of the whole are at least infrequent. However, in the otherwise more frequent case of polysemy, it is expected and desirable that communication can carry on within a reasonable degree of vagueness and without the need of fully disambiguating the involved terms, thus following Grice [37] methodological principle: "Senses are not to be multiplied beyond necessity".

IV. REPRESENTATION, DETECTION AND RESOLUTION

A. Representation

Following the considerations of sections II and III, computational frameworks able to handle ambiguity should involve a representation of natural language, if possible featuring its semantic heterogeneity, as well as a representation of the context in which the ambiguity occurs. In the reviewed works the latter is almost invariably represented by a vector model and the former by WordNet [28], [31], [32] or, less frequently, clustered vector models. This piece of research suggests, however, that better characterisations of the semantic heterogeneity of language could lead to improved results in the disambiguation.

B. Detection and Resolution

The main insight that we derive from section III is that, given that semantic heterogeneity doesn't necessarily imply ambiguity, particularly in the case of polysemous terms with closely related senses, then:

- Current approaches disambiguating polysemy may be overprecisifying the semantics of those terms, which would contradict Grice's principle.
- Strategies to assess whether words need to be disambiguated must be developed.

Additionally, it is expected to obtain benefits from resolving with subsets of senses instead of a complete disambiguation when possible, for example along the lines proposed in [38]

V. FINAL REMARKS AND FUTURE DIRECTIONS

The term Ambiguity is ironically widely used in substantially different senses in different fields and, especially in the computational literature, the tendency is rather to avoid theoretical commitments. We believe, however, that theoretical analyses of the problems in hand often help with identifying challenges and can shed light on possible ways to overcome them.

In this paper we take a very specific (and potentially controversial) standpoint on the concept of ambiguity and we explore both the theoretical and practical implications with respect to techniques for representation and resolution. We conclude that our perspective draws from multidisciplinary research and could easily accommodate not only the phenomenon of lexical but also syntactic or structural and pragmatic ambiguity. Moreover, it highlights some aspects that may be currently overlooked in WSD, in particular the contextualised decision on whether disambiguation is necessary, and places interest on holistic approaches for the representation of language as an evolving heterogeneous semantic field

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