Linguistic Affordances: Making sense of Word Senses

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Abstract. In this position paper we want to focus the attention on the roles of word senses in standard Natural Language Understanding tasks. We first identify the main problems of having such a rigourous and inflexible way of discriminating among different meanings at word-level. In fact, in human cognition, we know the process of language understanding refers to a more shaded procedure. For this reason, we propose the concept of *linguistic affordances*, i.e., combinations of objects properties that are involved in specific actions and that help the comprehension of the whole scene being described. The idea is that similar verbs involving similar properties of the arguments may refer to comparable mental scenes. This architecture produces a converging framework where meaning becomes a distributed property between actions and objects, without having to differentiate among terms and relative word senses. We hope that this contribution will stimulate the debate about the actual effectiveness of current Word Sense Disambiguation systems towards more cognitive approaches able to go beyond word-level automatic understanding of natural language.

1 Background

In linguistics, a *word sense* is the meaning ascribed to a word in a given context. A single word can have multiple senses. For instance, within the well-known lexical database WordNet [1], the word "play" has 35 verb senses and 17 senses as noun. This phenomenon is called polysemy. However, this must be distincted from the concept of homonymy, where words share the same spelling and the same pronunciation, having different and unrelated meanings. According to the human process of disambiguating meanings, the man reads a word at a time through a process called "word sense disambiguation". In the Natural Language Processing field, there exist numerous systems to automate this task, relying on existing ontologies [2, 3] rather than through statistical approaches [4, 5].

From another perspective, an *affordance* is linked to the meaning of an action that is dynamically created by the interaction of the involved agents [6–8]. Dropping this principle in natural language, an action (for example indicated by the use of a verbal phrase) will have a certain meaning that is given by the interaction between the agent and the receiver, and more particularly by the

their properties. The idea is that *different* combinations of subjects and objects with their properties are likely to lead to *different* actions in terms of execution, or final outcome.

2 Linguistic Affordances

In this work, we want to focus on the application of the concept of *affordance* to the natural language understanding made by machines. If a computer could comprehend language meanings at a more cognitive level, it would allow more complex and fine-grained automatic operations, leading to highly-powerful systems for Information Extraction [9] and Question Answering [10].

The meaning of a word is a concept that is very easy to understand by humans. A word sense is directly tied to a single entry in a dictionary. It applies to nouns and verbs in the same way. Given a word with more than one meaning, humans must proceed with the process of disambiguation using all the available information coming from the context of use.

The affordance of a word is a more complex thing. First of all, the word in question must refer to an action. For this reason, it is particularly oriented towards verbs (although other language constructions can refer to actions or events). In addition, the affordances related to an action (we will now use the more precise term "action" instead of "word") is suggested by the properties (also called qualities, attributes, or characteristics) of those who act and those who receive the action, together. The affordance is more tied with the cognitive aspect of an action rather than its encyclopedic meaning. More precisely, it refers to *how the action can be mentally imagined*. This is also in line with [11, 12], i.e., meanings are relativized to scenes.

For these reasons, the affordance is not directly linked to an entry in a dictionary. It has no direct link with a descriptive meaning. Nevertheless, it can coincide with it. In general, affordances and meanings are two distinct concepts that travel on separate tracks, but which can also converge on identical units. On the contrary, it may be the case that two distinct senses for a verb accurately reflect two different subject-object contexts. In this case, word senses and affordances coincide.

Still, a single sense can include multiple affordances. It is the case where a word with a single meaning can be applied to multiple subject-object combinations, creating different mental images of the same action.

Finally, two distinct word senses could not theoretically lead to a single linguistic mental image of an action, since two different meanings are likely to identify two different mental images. We think that it would be interesting to see how much of such theoretical concept can be considered valid. Potentially, two word senses can be very close semantically, inducing to a single mental image (and therefore a single combination of properties). This, undoubtedly, also depends on the level of granularity that has been chosen during the creation of the possible senses related to a word. In any case, we want to stress the actual independence between the two perspectives.

Word senses are completely separated. This means that they refer to meanings that have the same degree of semantic distance between them. However, this results to be quite approximate, since human cognition does not work this way. A sense "x" can be very similar to another sense "y", while very distant from a third one "z". More in detail, there exist the concept of "similarity between senses" thought as the similarity of the mental models that they generate [13]. These abstractions are plausibly created by combining the properties of the agents that are involved in the action, thus through the affordances that they exhibit.

Let us think at the WordNet entry for the verb "to play". Among all 35 word senses, there exist groups that share some semantics. For instance, the word sense #3 and the word senses #6 and #7 are defined by the following descriptions:

- To play #3: play on an instrument ("the band played all night long")
- To play #6: replay as a melody ("play it again, Sam", "she played the third movement very beautifully")
- To play #7: perform music on a musical instrument ("he plays the flute", "can you play on this old recorder?")

It is noticeable that the three word senses refer to similar meanings. Within the WordNet knowledge base, the lexicographers have manually grouped word senses according to this idea. However, coverage of verb groups is incomplete. Moreover, having groups of senses only solves the semantic similarity problem to a limited extent, since the concept of similarity usually deals with more fine-grained analyses. In literature, there are several computational models to classify words of a text into relative word senses. On the contrary, there are no computational models to identify "scenes" or "mental images" in texts.

The Word Sense Disambiguation task is one of the most studied in computational linguistics for several reasons:

- there are a lot of available resources (often manually produced) presenting dictionaries and corpus annotated with word senses (such as WordNet and the SemEval competition series [1, 14]).
- it has a significant impact in the understanding of language from the computational point of view. Through the disambiguation of terms in texts it is possible to increase the level of accuracy of different systems for Information Retrieval, Information Extraction, Text Classification, Question Answering, and so on.

The extraction of linguistic affordances in texts is an issue rather untouched, for different (but correlated) reasons:

- there are no resources and manual annotation of this type of information
- affordances have a more cognitive aspect than word senses, thus they seem less applicable

Nevertheless, we think that this type of analysis can represent a significant step forward on the current state of the art.

3 Conclusions

In this paper we presented the limits of having fixed and word-level semantic representations, i.e., word senses, for automatic tasks like Information Extraction and Semantic Search. Instead, we proposed an orthogonal approach where meaning becomes a distributed property between verbs and arguments. In future work we aim at studying how arguments properties distribute over actions indicated by specific verbs in order to test the idea, making first comparisons with standard word sense-based approaches for automatic natural language understanding.

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