

BOOK REVIEW

Diego Gabriel Krivochen, *Syntax on the edge: A graph-theoretic analysis of sentence structure*. Leiden & Boston, MA: Brill, 2023. Pp. XXI + 518.

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This monograph proposes a novel way to deal with grammatical concepts and to develop a theory of syntax with an observation in McCawley (1982) as its starting point. It is an uncontroversial fact that certain rules of the grammar only alter word order, but not constituency: This amounts to the preservation of structural relations, but not of linear order. ‘What if *nearly all* transformations required to provide an empirically adequate analysis of English in fact only changed *linear order*, leaving syntactic relations unaffected?’ (xi) is Diego Gabriel Krivochen’s research question.

In general, the book focuses on English sentence structures, with comparisons to Spanish that are aimed at clarifying analytical choices. The most remarkable feature of this book is that – in contrast to derivationalist approaches – it argues for a formal theory of syntax that uses graph-theoretic concepts within a derivation-less, constraint-based system. Graph theory focuses on the analysis of mathematical structures designed to model relationships between objects. A graph consists of vertices (also known as *NODES*) that represent the objects, and edges (also referred to as *arcs*) that depict the connections between them. Notably, graphs are recognized as fundamental objects of study in discrete mathematics. However, this book demonstrates that they also play an important role in formal linguistics.

The contribution that this book offers is both theoretical and practical. From a theoretical perspective, the graph-based approach breaks from traditional frameworks like (classic) transformational generative grammar and its later developments based on set-theoretic assumptions. Using graphs in syntax is not new, as they can be found in arc pair grammar (Johnson & Postal 1980) and dependency grammars, for example, but this book expands on these ideas, capitalizing on the expressive power of graphs as formal objects. The research builds on descriptive insights from various yet compatible methods (like tree adjoining grammars, phrase structure grammars and categorial grammars). By combining these, the book provides a unified explanation for a wide range of phenomena. To get at the core of this book, it must be emphasized that Krivochen’s assumptions strongly differ from phrase structural ones in not using ‘intermediate’ or ‘nonterminal’ symbols like VP, CP, NP, V’, etc., (common in tree diagrams) to make sense of structural relationships. Rather, the theory recognizes (like categorial grammars) a lexicon defined as a set of basic expressions indexed by a set of uniquely identifying ‘addresses’ (like direct

access icons in a PC), not obtained by any operation (concatenation, infixation, etc.): Nodes in a graph are only basic expressions, with arcs delivering derived expressions and defining relations between these. As in any graph-theoretic framework, binarity and multidominance are delivered by formalism: Arcs connect two expressions by definition, and special stipulations are required to enforce the single mother condition. Basic expressions are atomic units syntactically and semantically. Because the aim is to provide structural descriptions for strings, the theory refrains (for the most part, but cf. 424) from using phonologically empty nodes or abstract categories.

At any rate, any review of such a lengthy volume necessitates selectivity. Due to space limitations, I will refrain from individually evaluating each of the chapters and focus on the fundamental issues raised by Krivochen's proposal.

Abiding by two strong methodological choices, namely (i) that structural descriptions should only contain overt expressions and specify their relations and (ii) that grammatical functions should be taken to be primitives, Krivochen assumes that all syntactic descriptions can be formulated in terms of directed graphs, identified by an edge e and two ordered vertices, say a and b ; edges are said to be directed, as they go *from* predicates *to* their arguments. This, in turn, defines the binary relation 'immediately dominates', which is not mediated by any intermediate node. This approach explores an option that is radically different from standard generative assumptions on the binary-branching nature of trees: syntactic structure is assumed to grow by maximally connecting subgraphs in local lexicalized domains. The idea is to formulate a system that formalizes connections between nodes and exploits the smallest possible number of nodes by allowing a single node to establish multiple relations with other nodes. This formalization is carried out within a *declarative* (or model-theoretic) approach as opposed to a procedural one: This implies that the 'derivations' assumed in the book amount to complying with the satisfaction of constraints applied to local structures. In fact, grammar 'is a finite set of admissibility conditions over relations between nodes in graphs' (30).

An important disclaimer for the reader is provided at the very beginning of the book (and throughout): in various approaches, tree diagrams conceived as formal objects have ended up being confused with 'drawings' that only display typographical properties instead of formal ones as trees have been used to showcase properties of extremely different formal objects. The author emphasizes that a grammatical theory should focus on the properties of the mathematical objects that formalize grammatical relations, diagrams 'serving a marginal purpose' (5). Commonly assumed 'trees' are not graph-theoretic objects but simply diagrams for sequences of mappings from strings to strings. Moreover, the graphs presented in the book should not be confused with diagrams of graphs, as the author himself strongly emphasizes throughout.

Notice that a consequence of assuming a graph-theoretic approach also allows one to capture the so-called mixed computation (Krivochen 2021), in which the structural descriptions of linguistic strings are not computationally uniform. This

means that language computation amounts to being an oscillatory process moving up and down the Chomsky Hierarchy: In fact, it is reasonable to assume that certain subparts of the structure are assigned a finite-state domain inside of a broader context-free domain as in the discussion on the iteration of adjectives, such as *fake fake news* meaning either truthful news or very fake news (see Chapter 1 ‘Introduction: Setting the Scene’). This assumption crucially affects key concepts such as binary branching: Local finite-state structures are assumed to be flat n-ary branching structures, which is the easiest way to capture the meaning of the reiterated adjectives without resorting to monotonic binary branching that would necessarily imply scopal issues. At the same time, a model using n-ary branching does not discard ‘run-of-the-mill’ binary branching that might be involved locally in the structure when context-free computation is required (this issue is further developed in Chapter 11).

In Chapter 2, the author introduces all the technical details of graph theory, notably the mathematical properties of graphs, the set of all dominance relations within a graph (called the ρ set) and the crucial aspect that the nodes in a graph ‘do not correspond to terminal/nonterminal symbols from a typed alphabet or to lexical item tokens: rather, they correspond to basic expressions of the language, and are indexed by addresses which point to their semantic values [their intensions, AP]’ (82).

The first issue the author considers is discontinuity (in relation-preserving rules, see below; cf. Emonds, 1970) and how it can be tackled in this theoretical framework: Krivochen shows that an approach devoid of constituents (and hence of phrase structure rules) and where multidominance is allowed, better captures discontinuity by maximizing the connectivity of graphs (with no need of readjustment rules).

To show how this approach works let us consider a complex sentence like *The judge believed John to have committed the crime*: the elementary graphs involved have the following format, $\rho_1 = \langle (\text{believe, judge}), (\text{believe, John}) \rangle$, $\rho_2 = \langle (\text{commit, John}), (\text{commit, crime}) \rangle$ and the derived set $\langle (\text{believe, judge}), (\text{believe, John}), (\text{believe, commit}), (\text{commit, John}), (\text{commit, crime}) \rangle$ obtained via graph union, which delivers structure sharing. As the reader may observe, all relevant syntactic relations are obtained via the sharing of nodes contained in graphs (‘believe’ is connected to both ‘judge’ and ‘John’), no intermediate nodes being assumed, as would be commonplace in phrase structure representations.

Building on the foundational principles of lexicalized tree adjoining grammars (LTAGs), as detailed in Frank’s works (2002, 2013), Krivochen defines an elementary graph as (i) a predicative lexical basic expression p , (ii) the functional modifiers of p (e.g. temporal and some aspectual auxiliaries and (iii) the arguments of p (e.g. subject, object, oblique): Thus, an elementary graph is a unit of argument structure whose selectional properties are satisfied within the elementary graph itself. Although elementary graphs are reminiscent of the elementary trees assumed in LTAGs, these graphs are more restrictive as only lexical predicates define elementary graphs as opposed to elementary trees. At any rate, the grammatical

approach presented in the book converges with that of LTAGs, especially when it comes to dealing with (limited) crossing dependencies (i.e. the treatment of mild context-sensitivity) as in the now well-known examples of clause-final verb clusters in Germanic OV languages.

Krivochen goes on to analyze chains of auxiliaries in Spanish, that is, verbal periphrasis with at least two auxiliary verbs: in the treatment of auxiliaries, it becomes apparent that what is obtained via movement/external merge in transformational theories receives a straightforward explanation in terms of properties of graphs – in particular, the operation of graph union that allows structure sharing. Spanish auxiliaries are divided into two classes: (i) lexical auxiliaries, which can modify other auxiliaries and the lexical VP and be modified themselves by other auxiliaries in a chain, e.g. *empezar a* ‘to start’, *tener que* ‘to have to’, etc.); and (ii) functional auxiliaries, which can only modify lexical heads (auxiliaries or main verbs), but cannot themselves be modified (i.e. these can only be functors). Krivochen convincingly shows that an approach in terms of elementary graphs – instead of a monotonic sequence built via merge – captures the uncontroversial fact that the highest auxiliary does not take scope over the auxiliaries in its domain as is the case in *Juan va a poder empezar a trabajar allí* ‘John will be able to start working there’, where the future auxiliary temporally anchors the modal *poder* but not the inchoative *empezar a*. Functional auxiliaries are taken to be modifiers of lexical auxiliaries or of lexical verbs, that is, they belong in the elementary graph defined by the latter. Lexical auxiliaries anchor their own elementary graphs, whereas functional auxiliaries belong in the elementary graphs defined by either lexical auxiliaries or lexical verbs as functional modifiers of these.

From Chapter 10 onward, Krivochen focuses on applying graph theory to analyze issues that have been the subject of extensive research: among other things, an analysis of filler-gap dependencies is proposed in graph-theoretic terms analyzing the syntax/semantic interface from a Montagovian perspective. Afterward, the author moves on to discuss coordinated structures: a graph-theoretic approach to coordination is argued to be flexible enough to tackle the heterogeneity of coordinated structures, especially the divide between the ‘paratactic’ one – which requires finite-state computation – and a hypotactic one, which is context-free. In Chapter 13, Krivochen resumes the discussion between ‘relation changing’ and ‘relation preserving’ transformations that he introduced at the beginning: a critical tenet of this book’s core argument posits that the majority of syntactic processes do not, in fact, affect grammatical relations. Passivization and dative shift play a key role in possibly being the only relation-changing transformations in English. The book concludes with an appendix that explores the use of graphs in other theoretical frameworks.

This monograph represents a groundbreaking contribution to syntactic theorizing, as it radically departs from ‘run-of-the-mill’ phrase structure grammars, convincingly building on a set of long-neglected assumptions that deserve to be reconsidered in new terms.

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