Syntactic Cartography
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Syntactic cartography emerged in the 1990s as a result of the growing consensus in the field about the central role played by functional elements and by morphosyntactic features in Syntax. The declared aim of this research direction is to draw maps of the structures of syntactic constituents, characterize their functional structure and study the array and hierarchy of syntactically-relevant features. Syntactic Cartography has made significant empirical discoveries and its methodology has been very influential in research in comparative syntax and morphosyntax. A central theme in current cartographic research concerns the source of the emerging featural/structural hierarchies The idea that the functional hierarchy is not a primitive of Universal Grammar but derives from other principles does not undermine the scientific relevance of the study of the cartographic structures. On the contrary, the cartographic research aims at providing empirical evidence that may help answer these questions about the source of the hierarchy and shed light on how the computational principles and requirements of the interface with sound and meaning interact.

1. The research program of Cartography

Syntactic structures are complex objects. Since the earliest days of generative grammar, it has been clear that sentences are not linear concatenations of elements. Syntactic expressions are hierarchically structured and their study has revolved around two fundamental questions. The first concerns the principles that assemble these objects into constituents or expressions. Much current research attributes structure building to the (perhaps single) operation Merge, which "takes any two syntactic elements and combines them into a new, larger, hierarchically structured expression." (Berwick and Chomsky 2016, 10).

A second fundamental question concerns properties of the syntactic objects themselves, their label, their interpretation and the hierarchical order in which they are arrayed. Syntactic cartography has evolved from attempts to answer this second question. The basic aim of cartographic research is to draw maps, as detailed as possible, of the hierarchies that characterize syntactic structures, with particular attention to the functional, as opposed to the lexical configuration of expressions. These explicit maps have proven to be a valuable tool in comparative syntax.

Syntactic Cartography is, first and foremost, a research program and not a formal theory. While it is true that much of the research which can be labelled 'cartographic' shares some theoretical assumptions and hypotheses on the nature of syntactic computation and representation – see Section 6 – the unifying feature of this approach lies in its descriptive aim, namely, to characterize the hierarchical sequence of functional categories. In doing so, it employs the tools of comparative syntax, as developed in the Principles and Parameters work of the 1980s and 1990s; see Chomsky (1981; 1982; 1986a; 1986b; 1995a) and related work.

If we characterize Cartography as a research program, it makes little sense to ask whether it is right or wrong, whether it is a valid approach to the study of, say, word order or the hierarchy of positions. Since any phrase marker is, by definition, a statement of hierarchically-ordered

labeled nodes, namely a cartographic statement, the relevant question is whether a specific cartographic proposal is the correct one.

In this contribution, we highlight some of the landmarks in the evolution of Syntactic Cartography, clarify and exemplify its characteristic methodological guidelines and some of the shared theoretical assumptions, point to some of its achievements and briefly discuss the place of this research program in the landscape of contemporary syntactic theory. Section 2 presents the historical and conceptual background to Cartography. Section 3 describes the decomposition of the Complementizer Phrase (CP) and the resultant elaboration of the left-periphery. The cartography of the IP is the topic of Section 4 and the noun phrase is the subject matter of Section 5. Following the discussion of the cartography of the different structural layers, we take up the underlying theoretical assumption of Cartography in Section 6. Section 7 discusses the assumptions of cartographic research in relation to the minimalist program. Section 8 summarizes and concludes this article.

2.   Background

The formal foundation for cartographic representation is probably to be found in Chomsky's (1986b) extension and generalization of the X-bar schema from lexical to functional categories. The replacement of Chomsky's (1965) S(entence) by I(nflection)P and Bresnan's (1972) S' by CP enriched the structure of the clause by two heads, namely I° and C°, and by specifier positions for these projections, Spec,IP and Spec,CP. Coming at the heels of Chomsky (1986b), Abney (1987) argued that the determiner is a head (D^0), projecting a D(eterminer)P phrase and taking the lexical N(oun)P(hrase) as its complement. Soon after, Abney's DP was enriched by Num(ber)P (Ritter 1991), giving rise to a rudimentary map of the nominal constituent in which DP dominates NumP which in turn dominates NP.

The detailed study of crosslinguistic differences in the position of the verb in IP led to an important expansion of the functional structure of the clause. Pollock (1989) exploited the insight that the X-bar schema accommodates tense, agreement and negation, arrayed in a hierarchical functional sequence, to account for the different positions of the verb in English and French. Head movement, he argued, can place the verb in different positions relative to the assumed functional sequence, constituted by T(ense)P, Neg(ation)P and Agr(eement)P. Pollock expressed the differences between lexical verbs and auxiliaries, finite and nonfinite verbs internally to French and English and modelled the locus of difference between the two languages in terms of movement steps across layers of a fixed functional hierarchy. See also Belletti (1990) and Chomsky (1991).

The extension of X-bar structure to the functional lexicon led to a precise conceptualization of syntactic representations: Phrases are not only recursive but also display a uniform internal structure. Since the functional phrases are projected from elements of the functional lexicon, the number of functional projections depends on the size of the functional lexicon. At this point, research began to accumulate in favor of a richer and richer representation, both of the clausal and of the nominal domain. Probably the most influential work of that period is Rizzi's (1997) paper on the left periphery and Cinque's (1999) book on the order of adverbs and functional projections in IP.

3.   The C(omplentizer) P(hrase)

Rizzi's *The fine structure of the left periphery* (1997) constitutes one of the first detailed explorations of a clausal layer. The paper also makes use of some methodological devices that would become common practice in subsequent research. Rather than summarizing Rizzi's findings, we dedicate the following paragraphs to an illustration of his methodology and reasoning and sketch some possible extensions.

In Italian, we observe two distinct complementizers. *Che* introduces finite clauses and *di* introduces nonfinite ones.

(1) a. Gianni ha   deciso   che presenteremo   Marta a Luca.
        Gianni AUX.3SG decided   COMP introduce.FUT.1PL Marta to Luca
        'Gianni decided that we would introduce Marta to Luca.'

     b. Gianni ha   deciso   di   presentare   Marta a Luca.
        Gianni AUX.3SG decided   COMP introduce.INF Marta to Luca
        'Gianni decided to present Marta to Luca.'

Rizzi (1997) notes that a clitic left dislocated topic, the direct object *Marta* in the following examples, must appear after the finite complementizer *che* but must precede the nonfinite complementizer *di*.

(2) a. Gianni ha   deciso Marta di   presentarla   a Luca.
        Gianni AUX.3SG decided Marta COMP introduce.INF.CL to Luca

     b. *Gianni ha   deciso di   Marta presentarla   a Luca.
        Gianni AUX.3SG decided COMP Marta introduce.INF.CL to Luca

     c. Gianni ha   deciso che Marta la presenteremo   a Luca.
        Gianni AUX.3SG decided COMP Marta CL introduce.FUT.1PL to Luca

     d. *Gianni ha   deciso Marta che la presenteremo   a Luca.
        Gianni AUX.3SG decided Marta COMP CL introduce.FUT.1PL to Luca

Rizzi interprets this observation to mean that the two complementizers occupy different positions in what he labels the left periphery of the clause. *Che* lexicalizes the head of a functional projection labeled ForceP that is hierarchically higher than the projection labeled Fin(ite)P, the head of which is lexicalized by *di*. Topics are specifiers of phonologically-null Topic heads and TopicPs are consistently located in the complementizer area, delimited by ForceP and FinP, as schematized in (3).

(3)   [ForceP [Force0 *che*] [TopicP DP-topic [Topic0 $\varnothing$] [FinP [Fin0 *di*]…]]]

In order to better understand the contribution of Rizzi's approach to the left periphery, consider a non-cartographic alternative analysis of the data in (2). One could postulate that optional material such as left-dislocated topics, (as well as, possibly, adverbials and other modifiers) occupy (non X-bar-compliant) adjunction positions.[1] A possible implementation of such a view is the assumption that there is a single CP with a single head C^0, marked as either +finite or –finite. Assuming, further, that adjunction targets maximal projections, topics could, in principle, be adjoined to either TP or CP. The Italian paradigm in (2) could then be expressed by the following set of rules:

(4) a. If C is [+finite], then: (i) * adjoin Topic to CP
                                 (ii) ok adjoin Topic to IP

     b. If C is [-finite], then: (i) ok adjoin Topic to CP
                                 (ii) * adjoin Topic to IP

According to the map in (3), clitic left-dislocated topics consistently appear in the CP area, conceptualized as a zone delimited by Fin and Force. According to (4), topics appear in two different positions – adjoined to two different maximal projections – the choice determined by the finiteness of C^0.

The two approaches make different empirical predictions, which emerge clearly when one considers the position of topics in clauses with an interrogative complementizer. Indirect polar questions in Italian – both finite and nonfinite - are introduced by the complementizer *se*. If (4) is correct, then the topic in (5a) is predicted to only appear to the left of *se*, as the embedded clause is finite. The fact that it can also appear to the right of *se* invalidates (4a(i)). (4b(ii)) is, in turn, invalidated by the possible placement of the topic after *se* in the nonfinite (5b).[2]

(5) a. Mi   chiedo (mio figlio) se (mio figlio) lo   devo
        1.CL-REFLEX   ask.1SG (my son)   if (my son)   3MS.CL   must.1SG
        mandare al   mare   o in montagna.
        send   to.the sea   or to mountain
        'I'm wondering (my son) whether (my son) I should send him to the seaside or
        to the mountains.'

     b. Mi   chiedo (mio figlio) se (mio figlio) mandarlo
        1.CL-REFLEX   ask.1SG (my son)   if (my son)   send.INF.him.3MS.CL
        al   mare   o in montagna.
        to.the sea   or to mountain
        'I'm wondering (my son) whether (my son) to send him to the seaside or to the
        mountains.'

Let us now consider the data (5) from a cartographic perspective. Given the map in (3), one could imagine that *se* can be merged either in $Force^0$ or in Fin^0. When it is in Fin^0, topics are predicted to precede *se* and when it is in $Force^0$, they are expected to follow *se*. Rizzi (2001a), however, makes a different move, one which would become a hallmark of the research strategy of Cartography: He hypothesizes that *se* lexicalizes yet a distinct head in the left periphery. Based on distributional evidence - the positional options of *se* with respect to other material in the left periphery – Rizzi argues that that *se* lexicalizes an Int(errogative) head, occupying a position in-between $Force^0$ and Fin^0, as in (6).

(6) $Force^0...Int^0...Fin^0$

There are, thus, three "complementizer" positions: $Force^0$ and Fin^0 define the inner and outer boundaries of the zone, IntP occurs in-between them and topics appear both above and below IntP as in (7), a refinement of (3).

(7)   ForceP…TopicP…IntP…TopicP…FinP

(7) is only a partial map of the Italian left periphery. The articulated structure of CP proposed by Rizzi (1997) also hosts a functional projection dedicated to the expression of fronted wh elements and fronted foci. In related work, Rizzi (2004a) further extends (7), to include a position for non clitic left dislocated modifiers and a distinct position for wh elements in indirect questions (Rizzi 2001a, see also Rizzi & Bocci 2017).

One should keep in mind that the cartographic project shares with the earliest work in generative grammar the hypothesis that languages are structurally uniform. The null hypothesis is that the hierarchy of functional projections identified for Italian is valid crosslinguistically. It should be revised, parametrized or rejected only on the basis of syntactic evidence for a different hierarchy. Crosslinguistic variation that can be shown to be confined to the phonological and morphological expression of the functional elements cannot, in and of itself, lead to a departure from structural uniformity.

Japanese distinguishes three (clause-final) complementizers, *to*, *ka* and *no*, arrayed hierarchically. On the basis of their s(emantic) selectional properties, Saito (2015) argues that the lowest head, *no*, selects embedded propositions (and c(ategory)-selects T). It thus lexicalizes Fin. *Ka* can be taken to realize Int, as it merges with propositions and turns them into questions. The highest head, *to*, embeds paraphrases of direct discourse and can be seen as the realization of a particular kind of force, namely 'reported speech'.[3]

Japanese and Italian differ in two ways. First, Italian cannot lexicalize more than one head in each left periphery, while in Japanese the three complementizers can co-occur in the same left periphery. This difference manifests a familiar dimension of crosslinguistic variation, namely, the phonological or morphological realization of functional material.

The second difference has to do with linear order. The surface order of the complementizers in Japanese is exactly the reverse of the order of heads in (7), proposed for Italian. However, this difference is only superficial. Both languages comply with the same underlying hierarchical order but differ in the linear order of heads and complements, since Japanese is head-final while Italian is head-initial.

The comparison of the left peripheries of Italian and Japanese illustrates the analytic power of the structural uniformity hypothesis. We now turn to the distribution of topics in the left periphery of Modern Hebrew which, at first sight, appear to warrant a departure from structural uniformity.

The complementizer that introduces indirect polar questions in Hebrew is *'im*, which Shlonsky (2014) takes to lexicalize Int^0. It differs from Italian *se* in that a topic cannot precede it, but only follow it, (compare (8) and (5b)).

(8)   a. *Ani lo   zoxer   et   ha   sefer ha   ze   **'im** kaniti.
           I   NEG remember.1SG   ACC the   book the this Q   bought.1SG
           'I don't remember this book if I bought.'

        b. Ani lo   zoxer   **'im** et   ha   sefer ha   ze   kaniti.
           I   NEG remember.1SG Q   ACC the book the this bought.1SG

'I don't remember if this book I bought.'

The facts in (8) might lead one to think that the map of the Hebrew left periphery is as in (9), with no topic position between $Force^0$ and Int^0. But if (9) is valid, then Hebrew deviates from structural uniformity

(9)   Possible Hebrew: ForceP > IntP > TopicP > FinP

There is an empirical reason to reject (9), however. In root polar questions, Hebrew optionally employs a bi-syllabic counterpart to *'im, ha'im*. The null hypothesis is that both *im* and *ha'im* are Int^0 elements. However, in root questions, unlike in embedded ones, topics can both precede and follow Int^0.

(10)   a. et   ha   sefer ha   ze   **ha'im**   kanita?
           ACC   the   book the   this   Q   bought.2SG
           'This book, did you buy?'

       b. **ha'im**   et   ha   sefer ha   ze   kanita?
           Q   ACC the   book the   this   bought.2SG
           'This book, did you buy?'

Rather than saying that (9) is valid only for embedded questions and that root questions follow (7), we can attempt to ascribe the observed difference in topic placement in root and indirect questions to a factor that is independent of the structural makeup of the left periphery.

Along these lines, assume that the configuration of the left periphery sketched in (7) on the basis of Italian is valid for Hebrew as well. The difference between root and embedded questions in Hebrew is that in the latter, $Force^0$ attracts Int^0, which moves to the Force head. As a result of this operation, *'im* will always precede topics.

(11) $[_{ForceP}$ $Force^0$ $[_{TopicP} \ldots][_{IntP}$ $Int^0][_{TopicP} \ldots]]]$

The movement operation schematized in (11) allows us to account for the difference in topic placement in Hebrew and Italian without tampering with the basic map of the left periphery. The difference in topic placement in Hebrew and Italian is not due to a different functional sequence but rather, follows from an independent operation involving movement of Int^0 to $Force^0$. Head movement is an area of substantial crosslinguistic variation. It is, therefore, a natural candidate for expressing the difference between *'im* and *se.*

Whether this analysis is valid or not is an empirical issue and obviously, gains in plausibility once an independent motivation is identified for movement of Int^0 to $Force^0$. While the scope of this contribution does not allow us to provide this motivation, what needs to be emphasized is that the mere formulation of this research question presupposes an articulated structure for the complementizer zone, coupled with the structural uniformity hypothesis.

So far, we have discussed positional evidence in favor of the idea that CP is a cover term for a series of independent projections delimited upwards by ForceP and downwards by FinP. Three additional assumptions underlie the cartographic approach to the left periphery. First, the projections proposed by Rizzi (1997) and related work are not merely shells, in the sense

e.g., of Emonds (2004), but encode specific properties. Second, at least some information structure properties (e.g., topic, focus) are syntactically encoded as features. Third, positional data are just one of the possible sources of evidence to determine the underlying hierarchical structure (see also the discussion of adverbial positions in §4).

With respect to the first assumption, consider again the boundary categories of the left peripheral field: ForceP and FinP. Force encodes the features responsible for the type of the clause (question, declarative, etc., see Cheng 1997) and illocutionary force. In this sense, $Force^0$ constitutes an interface between the propositional content of the clause and the superordinate structure, either a higher clause or the discourse (in a root clause). Fin^0 encodes a specification of finiteness in the complementizer. Although Rizzi (1997) argued that $Force^0$ and Fin^0 constitute a single syncretic syntactic head which only splits when material such as topics is merged, current cartography eschews syncretic heads, guided by the idea that every feature projects a distinct head (see §6). $Force^0$ and Fin^0 should therefore be considered as distinct heads (which may or may not be contiguous.)

The second underlying assumption is that between the two boundary positions, the left periphery hosts an optional system of functional projections dedicated to the expression of specific discourse-related properties such as focus and topic. Fronted foci and topics occupy the specifiers of functional projections whose heads encode specific discourse-related properties that are visible to the interface with sound and meaning.

The insight underlying the "syntactization of scope-discourse semantics" (Cinque and Rizzi 2009) is that syntactic configurations provide a simple and homogeneous format (specifier-head-complement) that is exploited by interpretative routines and that gives rise to transparent interfaces of syntax with semantic and pragmatics. In (12), *questa bolletta* 'this bill' must express two interpretative properties: argumental properties qua thematic argument of the verb *pagare* 'pay*', and discourse-related properties such as topic. Just as the thematic properties are assigned under a local configuration established between a head and the argument *questa bolletta* 'this bill', the discourse-related properties are assigned via a local configuration with the relevant functional head, in this case a topic head.

(12)   Questa   bolletta   la   devi   pagare ___ entro   lunedì.
       This   bill   3FSCL   must.2SG   pay   by   Monday
       'You must pay this bill by Monday.'

In Italian, the dedicated heads $Topic^0$ and $Focus^0$ are not phonologically-overt. In other languages, topics and fronted foci are marked by special particles that can be identified as the lexicalization of the functional heads. Comparative evidence is once more illuminating in this respect. In Gunbge, for instance topic phrase in the left periphery is followed by the particle *yà* while a focus phrase is followed by the particle wέ, Aboh (2004). See (13) from Aboh (2010: Ex. 23).

(13)   Ùn   sè   ɖò   xwé   lɔ   yà   Kòfi wέ   Àsíbá   gbá-ὲ   ná
       1.SG hear that   house DET TOP Kofi FOC Asiba   built.3SG   for
       'I heard that, as for the house, Asiba built it for KOFI.'

In this section, we have shown that treating left-peripheral topics as adjuncts to TP or CP has difficulty in explaining the position of topics in both embedded declarative and interrogative clauses. An alternative view is that the Complementizer zone consists of several distinct

projections and that topics appear in-between them. This analysis, originally proposed by Rizzi (1997), applies the cartographic method and shows that the development of a more detailed map of the left periphery is not only a useful tool to describe constituent structure in a given language, but also provides an analytic tool for crosslinguistic comparison and typology. In other words, it allows the researcher to pinpoint, with greater precision, the loci of variation. It is not surprising, from this standpoint, that the cartographic approach has shown great heuristic power in comparative syntax and typological research.

The first analysis of the left periphery was developed on the basis of evidence from Italian, with extensions to other Romance and Germanic languages, but the cartographic analysis of the left periphery was rapidly extended to other language families. On Romance see Rizzi (1997, 2000, 2004a-b), Belletti (2001; 2004; 2009), Poletto (2000), Benincà & Poletto (2004), Laenzlinger (1998), Benincà and Munaro (2011), and on Germanic see Grewendorf (2002), Haegeman (2004; 2006; 2012), among many other references. See also Roberts (2004) on Celtic; Krapova & Cinque (2008)on Slavic; Puskas (2000) on Finno-Ugric; Shlonsky (2000; 2014) on Semitic, Frascarelli & Puglielli (2007) on Cushitic; Aboh (2004), Torrence (2013), Biloa (2013), on African languages; Durrleman (2008) on Creole; Tsai (2015), Endo (2007), Saito (2015) on East Asian; Pearce (1999) on Austronesian; Speas & Tenny (2003) on American Indian; Legate (2002) on Australian aboriginal. Romance dialectology has been extensively investigated: see Ledgeway (2000), Paoli (2007), Cruschina (2012). On classical languages and diachrony, see Benincà (2006), Franco (2009), and Danckaert (2017), among others. The volumes 1, 2, 3, 5, 7, 8, 9 and 10 in the series "The Cartography of Syntactic Structures" of the Oxford Studies in Comparative Syntax are devoted in part, or entirely, to the cartography of the left periphery. For general overviews, see Cinque & Rizzi (2009), Rizzi & Bocci (2017), Rizzi & Cinque (2016a) and Shlonsky (2010).

4.   The IP field

Roughly contemporaneous with Rizzi's paper on the left periphery is Cinque's *Adverbs and functional heads*. In this monograph, Cinque shows that the IP "field" is composed of an extremely rich and crosslinguistically stable hierarchical sequence of functional projections (see also Giorgi and Pianesi (1997).) He characterizes and labels several dozens of functional projections, each one encoding specific features of Mood, Tense, Modality, Aspect, and Voice.

Cinque's heuristic procedure is based on a systematic crosslinguistic comparison that integrates morphological, syntactic, and interpretative evidence. He observes that adverbs, elements that are clearly phrasal and hence mapped onto specifier positions, are ordered in a rigid structure across languages and that the very same sequence arises for the semantically-corresponding functional particles (morphemes), typically heads. Linking the two, Cinque unifies the sequence of adverbs and of functional morphemes in the same underlying hierarchical structure of functional projections. Consider the hierarchy in (14), adapted from Rizzi & Cinque (2016: Figure 3): (14a) illustrates the hierarchy identified for adverbs (specifiers) and (14b) for grammatical morphemes, (heads). Cinque's discovery is that the two are isomorphic.

(14) a.   b.

AdvP$_{\text{speech act}}$ (frankly,..)   Mood$_{\text{speech act}}$
 AdvP$_{\text{evaluative}}$ (oddly,..)   Mood$_{\text{evaluative}}$
  AdvP$_{\text{evidential}}$ (allegedly,..)   Mood$_{\text{evidential}}$
   AdvP$_{\text{epistemic}}$ (probably,..)   Mod$_{\text{epistemic}}$
   AdvP$_{\text{past/future}}$ (then,..)   Tense$_{\text{past/future}}$
    AdvP$_{\text{necessity}}$ (necessarily,..)   Mod$_{\text{necessity}}$
    AdvP$_{\text{possibility}}$ (possibly,..)   Mod$_{\text{possibility}}$
    AdvP$_{\text{habitual}}$ (usually,..)   Aspect$_{\text{habitual}}$
    AdvP$_{\text{delayed}}$ (finally,..)   Aspect$_{\text{delayed}}$
     AspectP$_{\text{predispositional}}$ (tendentially,..)   Aspect$_{\text{predispositional}}$
     AdvP$_{\text{repetitive}}$ (again,..)   Aspect$_{\text{repetitive}}$
     AdvP$_{\text{frequentative}}$ (frequently,..)   Aspect$_{\text{frequentative}}$
     AdvP$_{\text{volition}}$ (willingly,..)   Mod$_{\text{volition}}$
     AdvP$_{\text{celerative}}$ (quickly,..)   Aspect$_{\text{celerative}}$
     AdvP$_{\text{anterior}}$ (already)   Tense$_{\text{anterior}}$
     AdvP$_{\text{terminative}}$ (no longer,..)   Aspect$_{\text{terminative}}$
     AdvP$_{\text{continuative}}$ (still,..)   Aspect$_{\text{continuative}}$
     AdvP$_{\text{continuous}}$ (always,..)   Aspect$_{\text{continuous}}$
     AdvP$_{\text{retrospective}}$ (just,..)   Aspect$_{\text{retrospective}}$
     AspectP$_{\text{proximative}}$ (soon,..)   Aspect$_{\text{proximative}}$
     AdvP$_{\text{durative/ progressive}}$ (briefly,..)   Aspect$_{\text{durative/progressive}}$
     AdvP$_{\text{prospective}}$ (imminently,..)   Aspect$_{\text{prospective}}$
     AdvP$_{\text{obligation}}$ (obligatorily,..)   Mod$_{\text{obligation}}$
     AdvP$_{\text{frustrative}}$ (in vain,..)   Aspect$_{\text{frustrative}}$
     AdvP$_{\text{completive}}$ (partially,..)   Aspect$_{\text{completive}}$
     AdvP$_{\text{manner}}$ (well,..)   Voice$_{\text{passive}}$
      Verb   Verb

It is extremely difficult to judge the grammaticality of sentences with more than 3 co-occurring adverbs. In his study of the extended hierarchy in (14), Cinque employs transitivity tests. If adverb A precedes adverb B and adverb B precedes adverb C, then adverb A precedes adverb C. As shown in (15)-(16), *fortunately* precedes *no longer*, while *no longer* precedes *always*. *Fortunately* then precedes *always*, as in (17). In this specific case, the three adverbs can actually co-occur, as in (18), but in many cases, they cannot.[4]

(15) a. John fortunately no longer sings under the shower.
    b. *John no longer fortunately sings under the shower.

(16) a. John no longer always sings under the shower.
    b. * John always no longer sings under the shower.

(17) a. John fortunately always sings under the shower.
    b. * John always fortunately sings under the shower.

(18) John fortunately no longer always sings under the shower.

Cinque applies the same type of reasoning to identify the order of morphemes and particles, (14b). Let us consider the example in (19) from Gungbe (Cinque 1999:(52), see Aboh (2004: §5.2.2.2)), in which (Future) Tense precedes Habitual Aspect. (Future) Tense precedes

Habitual Aspect, (19a), and Habitual Aspect precedes Progressive Aspect, (19b). We then observe (Future) Tense > Progressive Aspect in (19c). In (19d), the three functional morphemes appear together.

(19) a. Àsíbá   ná   nɔ̀   wá   hwégbe.
         A   FUT   HAB   come home
         'Asiba will frequently come home.'

      b. Àsíbá   nɔ̀   tò   zizé vi   lè
         Asiba   HAB   PROG take children the
         'A. will be eating the rice.'

      c. Sèna nà   tò   dudu lesi lɔ̀
         S.   FUT   PROG   eat rice the
         'S. will be eating the rice.'

      d Àsíbá   ná   nɔ̀   tò   kpikpon vi   lè   go.
         A.   FUT   HAB   PROG take.care children the   body
         'A. will frequently be taking care of the children.'

Gungbe is a head-initial language and the superficial order is thus Tense- Progressive Aspect. In head-final languages, this order is reversed - a mirror image of the head-initial order, as in (20), from the Sino-Tibetan language Tshangla (Cinque 1999:153).

(20) Got-chho-wa-uphe.
      look-PROG-ANT-FUT
      '(He) will have been looking.'

While the sequence of functional projections turns out to be uniform crosslinguistically, languages vary with respect to the actual morphological manifestation of the functional heads: as autonomous function words, as adverbs, as affixes, or lacking an overt exponent. For a given functional projection, some languages may lexicalize the head, while others may resort to the corresponding adverb, inserted in the relevant specifier. To take an example, Retrospective Aspect ("to have just V") can be expressed in French by the periphrastic construction *venir de*, while Italian employs the adverb *appena*. Or consider the fact that Gungbe marks future tense and progressive aspect by means of particles but Welsh expresses tense by means of suffixes. Regardless of this morpho-phonological difference, Future tense precedes Progressive Aspect in Welsh (21) just as it does in Gungbe (19).

(21) Bydda   I 'n   canu y fory
      be.FUT I PROG sing tomorrow
      'I will be singing.'

The hierarchical structure of the functional projections is not always surface apparent. Other phenomena like verb movement or pied-piping may alter the order in the surface form. In some languages, the same morphological exponent lexicalizes the specifiers of two distinct projections in the hierarchy. Such cases generally involve differences in the interpretative scope properties. Moreover, adverbs can be topicalized or focalized, altering their surface position. Yet, when these details are factored out, the hierarchical sequence emerges and the

existence of such a uniform hierarchy across languages is one the most important empirical discoveries in syntax in the last generation.

5.   Cartography and typology in the noun phrase

The structural uniformity hypothesis substantially reduces the space of hypotheses that can be entertained in the face of variation in the surface order of constituents. A particularly challenging domain, in this respect, are large scale typological studies of word order combinations.

There are 24 mathematically possible orders of the four elements demonstrative, numeral, adjective, and noun, (4! = 4 x 3 x 2 x 1 = 24). Reviewing the literature on this subject over the last 40 years, Cinque (2005) concludes that only 14 orders appear to be attested in the languages of the world (but see Dryer (2009) for a dissenting view.)

If the order of merge of these elements were free or unconstrained among natural languages, one would, ceteris paribus, expect a more or less equal proportion of the 24 orders across languages and not the kind of stilted distribution that is actually found. The mere fact that 10 of the 24 orders are unattested strongly suggests that there are principles that rule out some of the orders. What are those principles?

Cinque's (2005) argument is that this distribution of word orders can be accounted for *without tampering with the underlying structural hierarchy,* i.e. the order of external merge in the sense of Chomsky (2004), which he takes to be universal. The observed distribution is rather the product of the interplay of parameters governing the target of movement within the noun phrase (which constituent is moved?) and its goal (where does it land?).

His analysis starts out with an explicit cartographic proposal. Demonstratives, numerals and adjectives are categories merged in specifiers of dedicated functional projections (labeled XP, YP and ZP in (22)) in a precompiled, universal, hierarchical order (but see for Ouwayda & Shlonsky (2017) for a refinement of the proposed hierarchy). XP, YP and ZP are each sister to a head that projects a category (and hence is endowed with a single specifier position.) Cinque labels these interspersed categories AgrP (see also Shlonsky (2004).)

(22) $[AgrxP\ldots Agr^0\ [XP\ DemP\ X^0\ [AgryP\ldots Agr^0\ [YP\ NumP\ Y^0\ [AgrzP\ldots Agr^0\ [ZP\ AdjP\ Z^0\ [NP\ N^0]]]]]]]$

Movement can target any phrasal category containing the head noun (N).[5] The goal of movement is the specifier of any of the AgrPs. Crucially, only categories can move (i.e., NP, ZP, AgrP, etc.) but not heads.

If NP fails to move and no other movement takes place, the English-like order is manifested, e.g. *these three nervous dogs*: Demonstrative Numeral Adjective Noun.

The remaining 13 attested orders are all derivable by combinations of movement of NP alone, pied-piping of NP by a category containing it or pied piping by NP of the material below it. Moreover, movement can either be total (all the way up to Spec/AgrXP) or partial (stopping at either Spec/AgrYP or Spec/AgrZP).

The unattested orders involve either movement of a category not containing NP (for example, movement of NumP alone above DemP) or movement of a constituent which contains NP but not the material below it. (23) tabulates the unattested cases and the violation(s) their derivation incurs.

(23)	Unattested order	Nature of violation
a.	Num Dem Adj N	NumP moves alone above DemP.
b.	Num Dem N Adj	NumP moves alone above DemP.
c.	Num N Dem Adj	NP moves above AdjP and then the non-constituent [NumP NP] moves above DemP.
d.	N Num Dem Adj	NP moves above NumP and then the non-constituent [NP NumP] moves above DemP.
e.	Adj Dem Num N	AdjP moves alone above DemP.
f.	Adj Dem N Num	AdjP moves alone above DemP.
g.	Dem Adj Num N	AdjP moves alone above NumP.
h.	Num Adj Dem N	The non-constituent [NumP AdjP] moves above DemP.
i.	Adj Num Dem N	AdjP moves alone above NumP.
j.	Adj Num N Dem	AdjP moves alone above NumP.

The three structural regions that we briefly discussed in the previous sections yield feature-rich representations of hierarchically-ordered projections which are strikingly uniform across a wide variety of languages. When crosslinguistic variation is encountered, the cartographic approach encourages the formulation of very specific questions in syntax, phonology and morphology Its capacity to generate new research questions is, we believe, an important reason for why Cartography continues to be a major driving force in comparative research in linguistics.

## 6.	Shared theoretical assumptions in cartographic studies

A common thread in cartographic research is the use of a strict version of the X-bar schema, in which a single specifier is available for each head and adjunction to X^{max} is prohibited. (Adjunction to heads is allowed as the standard implementation of head movement and incorporation.) This constrained view of the basic structural molecule of syntactic representations is what underlies e.g., Cinque's (1999) view that adverbial phrases are neither adjoined to each other or to other categories, nor housed as multiple specifiers to a single head but that each adverbial phrase is projected as a single specifier of a distinctly labeled head.

Cinque explicitly argues for this view in showing that there is a potential verb position between every two adverbial phrases. In the Italian examples in (24), (based on Cinque 1999:46), the past participle *rimesso* 'put back in order' (in bold) can appear in-between any pair of adverbs below the auxiliary *hanno*. This is predicted if AdvPs are specifiers of heads that host a verb and cannot be straightforwardly explained if they are adjuncts or multiple specifiers.

(24) a. Da	allora,	non	hanno	**rimesso** di solito mica	più	sempre
since then	not	have	put	usually	not.any	longer	always

completamente	tutto	bene	in ordine.
completely	everything	well	in order

    b. Da allora, non hanno di solito **rimesso** mica più sempre completamente tutto bene in ordine.

    c. Da allora, non hanno di solito mica **rimesso** più sempre completamente tutto bene in ordine.

    d. Da allora, non hanno di solito mica più **rimesso** sempre completamente tutto bene in ordine.

    e Da allora, non hanno di solito mica più sempre **rimesso** completamente tutto bene in ordine.

    f. Da allora, non hanno di solito mica più sempre completamente **rimesso** tutto bene in ordine.

    'Since then, they haven't usually not any longer always everything well put back in order.'

An important advantage of the constrained X-bar structure is that the global complexity and dimensions of the syntactic representation result from simple and strict recursion of identical structures. Hence, the syntactic trees generated by cartographic research are long but simple.

Complexity does arise, however, but it is due not to the richness of the structural representation, but to the fact that parametric choices can affect each functional head independently, giving rise to substantial cross-linguistic variation. It is commonly assumed that parametric variation effects functional projections along several dimensions, among which are the following (see (Rizzi and Cinque 2016b; Shlonsky 2010)):

(25) a. the phonological properties or label of the functional head, expressing whether and how it is pronounced,

    b. whether the specifier of a functional head needs to be filled or not (its EPP 'feature'),

    c. whether both the head and its specifier are realized or not,

    d. whether the functional head attracts a lower functional head which incorporates to it (but see note 5),

    e. whether the complement to a functional head merges to its left or to its right (head-initiality vs. head-finality).

The heads which populate the cartographic representation (see, e.g., (14)) are drawn from a rich functional lexicon. These heads are taken to represent features.

While the hypothesis that features are the atoms of the functional lexicon is not unique to Cartography – it has a long history in generative grammar, going back to Chomsky's early work, and plays a pivotal role in Minimalism and in Distributed Morphology (Halle & Marantz 1993; 1994, see Embick & Noyer 2007 for an overview) – the innovation of Cartography lies in associating each feature with a distinctly labeled syntactic head which enters into selection and subcategorization. In keeping with the X-bar schema, each head projects a category with a possible specifier. This view of the *syntactization* of features

reduces the question of the size of the syntactic tree (the number of heads) to the question of the dimensions of the functional lexicon.

The magnitude of the functional lexicon is a question about the aspects of the human conceptual system that are *grammaticalized*. This is, strictly speaking, not a *cartographic* question although research is guided by the observation that entire domains of concepts which enter into cognition in the broad sense are not grammaticalized in any known language. This observation argues against a wholesale reduction of grammatical features to conceptual structure and conversely, in favor of the idea that universal grammar considers as syntactically relevant only a subset of cognitive notions.

Finally, the *one feature one head* hypothesis leads to the claim that the bundling of features in a single head must be the product of a syntactic operation merging one head (and thus, one feature) with another head, e.g., v^0 to T^0 in French or Italian, Int^0 to $Force^0$ in Hebrew, etc.[6]

7.   The integration of Cartography and Minimalism

The interest of Cartography in features, their content, properties and order, illustrates one important sense in which Cartography has been nourished by mainstream research in minimalism. There are however, some important differences in the role that features play in Minimalism and in Cartography (see Ramchand & Svenonius (2014)). For Chomsky (1995b) and subsequent work, features can be interpretable or non-interpretable at the interface. The latter constitute the triggers for syntactic movement, designed to eliminate (or value) uninterpretable features. In cartography, the distinction between uninterpretable and interpretable features is sidelined – see Aboh (2010). This is partially due to the fact that cartographic maps are representations, while the feature-driven computational engine of minimalism is primarily concerned with derivation (Search and internal merge – Chomsky (2004)). The main thrust of cartography, to reiterate, has been to characterize the inventory of interpretable features and their hierarchical order.

Cartographic maps do not formally express the traditional view of the clause as built up of three domains or extended projections (Grimshaw (2000); see also Grohmann (2000)), the thematic domain (vP), the functional domain (TP) and the scope-discourse domain, (CP).

Such a delimitation of structure is necessary for good empirical reasons since one needs to explain not only the clustering of similar features in the structure: Aktionsart features close to the verb (see e.g. Ramchand 2008), aspectual and modal properties in the functional domain, discourse-related projections in CP and so forth, but also the delimitedness of verb-movement, of NP movement and of other operations which depend, in Minimalism, on uninterpretable features like Case or agreement. Such features seem to be restricted to the functional domain and typically fail to extend to the heads of left periphery. Cartographic works have, for the most part, implicitly or explicitly assumed delimited zones or spaces but have not provided a formal implementation of domains. Minimalism, in contrast, has been explicitly concerned with these questions and has sought formal explanations, for example, in terms of cyclic domains or phases.

Non-cartographically informed research often assumes a relatively simple structure constructed around the heads of phases, namely C^0-T^0-v^0-V^0 (often, with multiple specifiers to each head). For some, such a bare format is taken to be an abbreviation for a richer structure, an "expository convenience" (Rizzi 2004:7). However, there is some tension between

Minimalism's impoverished structures and the richness of cartographic representations. Strong phases (CP and vP) and their edges (i.e., their heads and specifiers) play a key role in the computation of locality in minimalist syntax. It is not clear how to integrate these notions into the structural maps of cartography, in which the clause is typically seen as a homogenous hierarchy of projections. In Cinque's system, for example, T^0 dissolves into three distinct, non-contiguous heads ($Past^0$, $Future^0$ and $Anterior^0$) but which one corresponds to the traditional T(ense)^0? Similarly, what does "little v" correspond to in a cartographic articulation of lower aspect and event-type (Borer 2005a; 2005b; Folli and Harley 2005, Ramchand 2008, a.o.)? Which one of these lower heads should be taken to constitute the edge of vP? The problem is just as acute in the CP domain, where the edge of CP is C^0 and its (outer) specifier, but in a cartographic perspective, should it be equated with Fin and Spec/Fin or Force and Spec/Force?

Consider also the related problem of selection. Minimalism inherits from previous approaches the view that selection is carried out under sisterhood. Thus, V^0 selects C^0 and C^0 selects T^0. How is selection satisfied in e.g., an indirect question, if the head bearing the interrogative feature is Foc^0 or Int^0 (or some other projection, see Rizzi 2001) and, given the intervention of Force, not a sister to V^0? Or take the problem of how subjunctive mood features on an inflectional head, ultimately realized in verbal morphology, are selected by a higher predicate, given the intervening structure.

Rather than viewing the richness of cartographic representations as a hindrance to the formulation of local relations or to the characterization of phase edges, one should consider the fine detail of cartographic maps as advancing research by imposing a set of new problems, which could otherwise not be stated. If a matrix V like *ask* or *wonder* semantically-selects a question, it c(ategory)-selects an 'interrogative' force, $Force^0$+Q. But since Int^0, the specialized interrogative head in the left periphery is configured lower than $Force^0$, then the syntax must devise some way for Int^0 and $Force^0$ to be related. One possibility is through movement, as we argued for Hebrew. Another option would be through agreement (Rizzi 2017). If this is now generalized to all cases of 'nonlocal' selection, we see that cartographic hypotheses actually contribute to a deeper understanding of the mechanisms of selection. It is thus not the case that the agendas of Minimalism and Cartography are at odds with one another. It is rather the contrary, Minimalism and Cartography complement each other on different levels and their integration serves to pose new research questions (see also Shlonsky 2010).

The cartographic study of the syntactic structures points to the existence of a universal fine-grained hierarchy of functional projections. This empirical result immediately gives rise to at least two fundamental questions. Why does this universal hierarchy exist at all? Why does the hierarchy have that specific structure? These are not easy questions to answer. Standard poverty-of-stimulus considerations strongly argue against the idea that the hierarchy is somehow learned by children through experience. If the structure is not learned, it must emerge 'automatically' in a uniform way across the human species. This suggests that it emerges from the architecture of UG and develops in children rather than acquired by them. While this must be right at some level, it cannot constitute the whole answer, because there are aspects of the hierarchy that can be fairly straightforwardly ascribed to other principles. In the present debate, we can identify two possible sources for the hierarchy that, perhaps, interact in shaping the sequence, namely, interpretative requirements at the conceptual interface and conditions that govern the syntactic computation.

To illustrate an aspect of the cartographic structure that is, in all likelihood, due to interface requirements, let us consider once again the relative positions of IntP and FocusP. In Italian, as we have seen, Int^0 is lexicalized by *se* in indirect questions, but it is covert in root questions. In Sicilian, the head of IntP can be lexicalized by *chi* in root yes/no questions. When focus fronting takes place in this type of sentences, *chi* must precede the focus element. In other terms, IntP>FocusP. Bianchi, Bocci & Cruschina (2016) and Bianchi & Cruschina (2016) argue that this order is imposed by compositionality at the interpretative level, because the focal alternatives are exploited at the propositional level to generate specific presuppositions or conventional implicatures; consequently, the focus operator must take scope below the interrogative operator (see also the discussion in Stepanov and Tsai 2008 for a different argument and Bianchi, Bocci & Cruschina (2017)).

For Abels (2012), some aspects of the cartographic structure can be ascribed to formal principles that govern the syntactic computation. He argues that some of the ordering restrictions in the left periphery derive from the theory of locality (Relativized Minimality - Rizzi 1990 and subsequent work). In the same vein, Haegeman (2012) argues that some of the differences between the left periphery of root and non-root clauses are due to conditions imposed by feature-relativized minimality (Starke 2001; Rizzi 2001b; Rizzi 2004a).

The idea that the hierarchy has a deeper explanation does not undermine the scientific relevance of the study of the cartographic structures. On the contrary, the cartographic research of syntactic structures aims at providing empirical evidence that may help answer these questions about the source of the hierarchy and shed light on how the computational principles and requirements of the interface with sound and meaning interact.

8.   Cartography: Recursive syntactization of the functional lexicon

The research program of syntactic Cartography has been mostly concerned with the refinement of the description of the syntactic representation of the functional lexicon, its *syntactization*. By using simple, recursive structures, it allows us to characterize the hierarchical representation of complex, feature-rich syntactic objects. One of Cartography's major achievements has been to substantially expand the scope and coverage of comparative syntax. In so doing, it has brought to light evidence bearing on the characterization of core principles of Universal Grammar and has advanced our understanding of the parameters that ultimately underlie cross-linguistic differences in syntax.

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[1] Although the move away from rewrite rules to the more constrained X-bar schema (see ahead, §6), eliminates rules such as S'' → Topic S' (Chomsky (1977, 62), their arbitrary quality has been preserved in much current work, but in the form of adjunction (to e.g., TP or CP)

[2] Various patches and modifications can be formulated to rescue a non-cartographic representation of topics, though not without a cost. See Abels (2012) and Rizzi (2017) for discussion.

[3] Saito's characterization of these functional heads is slightly different; we reinterpret his description along the lines of Rizzi 2013; Rizzi & Bocci Riz.

[4] Apparent transitivity failures have been extensively discussed in the literature. See Bobaljik (1999), Nilsen (2004), Craenenbroek (2006), Abels (2016), among others. See also Cinque (2006:fn. 43, p. 143), Mao & Meng (2016:14), Rizzi & Bocci (2017:fn.7), and the references cited therein.

[5] Although Cinque (2005) and related work is guided by the assumption that head movement is not a legitimate operation, the status of this operation remains open in Cartography as in other research areas in contemporary syntax.

[6] For extensions and developments of this idea, see the work in Nanosyntax (Starke 2009), Svenonius et al. (2009).