

Integrating Coordination and Functor-Argument

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Abstract

The most basic semantic relations of structure in natural language are (i) functor-argument and (ii) coordination. Functor-argument connects different kinds of contents, namely subject/predicate, object\predicate, and modifier|modified, while coordination connects the same kinds of content, namely modifier–modifier, nominal–nominal, and predicate–predicate, at the elementary, phrasal, and clausal level of grammatical complexity. Depending on the conjuncts, coordinations use different kinds of semantic relation to combine with functor-arguments.

1 Coordination of Elementary Adnominals

In DBS, the distinction between functor-argument and coordination is integrated into the data structure of proplets, defined as non-recursive feature structures with ordered attributes. Core attributes of functor-argument are **noun**, **verb**, and **adj**. Attributes of coordination are **nc** (next conjunct) and **pc** (previous conjunct).

An example of a modifier–modifier coordination at the elementary level of grammatical complexity is *tall, cool, black, new* in the following content:

1.1 Content of The tall, cool, black, new building collapsed.

sur: noun: building cat: snp sem: def sg fnc: collapse mdr: tall nc: pc: prn: 23	sur: adj: tall cat: adn sem: pad mdd: building mdr: nc: cool pc: prn: 23	sur: adj: cool cat: adn sem: pad mdd: mdr: nc: black pc: tall prn: 23	sur: adj: black cat: adn sem: pad mdd: mdr: nc: new pc: cool prn: 23	sur: adj: new cat: adn sem: pad mdd: mdr: nc: pc: black prn: 23	sur: verb: collapsed cat: #n' decl sem: ind past arg: building mdr: nc: pc: prn: 23
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This content is a set (order-free) of proplets connected by (i) a shared **prn** value, here **23**, and (ii) continuation values. The proplets of the **adn** coordination are connected and ordered by the intrapropositional addresses of their **nc** and **pc** attributes, whereby the **pc** value of the first and the **nc** of the last conjunct are empty.

The connection between the **adn** coordination *tall cool black new* and the modified *building* is the functor-argument relation **tall|building**.¹ It is coded by the feature [**mdr: tall**] of *building* and the feature [**mdd: building**] of the initial conjunct

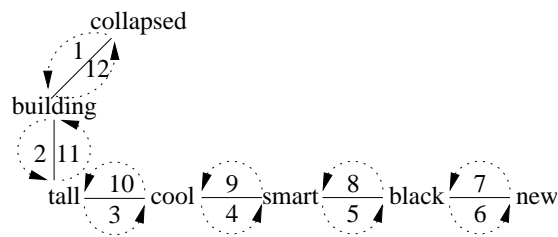
¹The hear mode operations $\text{DET} \times \text{ADN}$ (cross-copying) and $\text{DET} \cup \text{CN}$ (absorption) are defined in TExer, Sect. 2.2.

tall. In the noninitial conjuncts, in contrast, the *mdd* attributes of the conjuncts have no value; if needed, it can be retrieved from the initial conjunct via the *pc* connections.

The semantic relations coded in 1.1 may be shown as the following graph, whereby the different slashes /, |, and – represent the subject/predicate, modifier|modified and conjunct–conjunct relations:

1.2 Graph analysis of hear mode interpretation

numbered arcs graph (NAG)



surface realization

1	2	3	4	5	6	7	8	9	10	11	12
the	tall	cool	smart	black	new					building	collapsed_.
N A	N A	A–A	A–A	A–A	A–A	A–A	A–A	A–A	A–A	A N	A N

The modifier|modified relation between the *adn* coordination and the modified noun is traversed in arcs 2 (downward) and 11 (upward).

2 Phrasal adverbial Modifier Coordination

Phrasal modifiers consist of a preposition and a noun, for example, *in the water* (noun concept), *in Paris* (noun name), or *in here* (noun indexical). In contrast to elementary modifiers, which may distinguish morphologically between adnominal and adverbial use, as in *beautiful car* vs. *sang beautifully*, no such distinction exist in English phrasal modifiers. Also, while elementary modifiers in adnominal use precede the noun, phrasal modifiers must follow. *thmust* follow the modified, as in the following example:

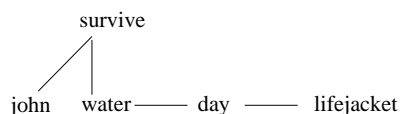
2.1 John survived in the water for days without a lifejacket.

[sur: john noun: [person x] cat: snp sem: def sg fnc: survive mdr: nc: pc: prn: 25	[sur: verb: survive cat: n' v sem: ind past arg: [person x] mdr: water nc: pc: prn: 25	[sur: noun: water cat: snp sem: in def sg fnc: survive mdr: nc: days pc: prn: 25	[sur: noun: days cat: snp sem: for def sg mdd: mdr: nc: lifejacket pc: water prn: 25	[sur: noun: lifejacket cat: snp sem: without indef sg mdd: mdr: nc: pc: day prn: 25
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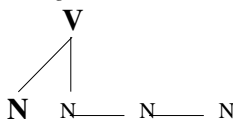
The noun *bone* is modified by the first prepositional phrase *table*,² connected by cross-copying the core values into the respective mdr and mdd slots. *Table*, in turn, is modified by the second prepositional phrase *tree*, etc. The repeating relation is modification because the location *table* is modified by the location under the tree which is modified by the location in the garden.

2.2 Graph analysis underlying production of 2.1

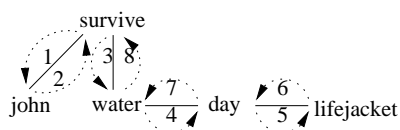
(i) SRG (semantic relations graph)



(ii) signature



(iii) NAG (numbered arcs graph)



(iv) surface realization

1	2	3	4	5	6	7	8	9
john	survived	in_the_water	for_days	without_a_lifejacket				•
V/N	N/V	V}N	N-N	N-N	N-N	N-N	N-N	N V

The unbounded repetition of prepositional phrases, here two, is based on the local, binary N–N relation between two conjuncts, coded by address. Comparison with TExer 5.1.12 shows the semantic difference between the intrapositional repetition of modification vs. coordination.

²DBS distinguishes elementary, phrasal, and clausal modifiers in terms of their respective core attributes *adv*, *noun*, and *verb*.

3 Coordination Phrasal Adnominal Modifiers

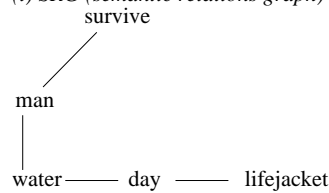
Phrasal adnominal modifiers consist of a preposition and a noun, as in in the water (noun concept), in Paris (noun name), in here (noun indexical). In contrast to elementary adnominal modifiers, which precede the noun, phrasal adnominals must follow.

3.1 The man in the water for days without a lifejacket survived.

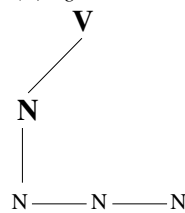
sur: noun: man cat: snp sem: def sg fnc: survive mdr: water nc: pc: prn: 26	sur: noun: water cat: adv sem: <i>in</i> fnc: survive mdd: man nc: day pc: prn: 26	sur: noun: day cat: adv sem: <i>for</i> indef pl fnc: mdr: nc: lifejacket pc: water prn: 26	sur: noun: lifejacket cat: adv sem: <i>without</i> indef sg mdd: mdr: nc: pc: day prn: 26	sur: verb: survive cat: #n' decl sem: ind past arg: man mdr: nc: pc: prn: 26
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3.2 Graph analysis underlying production of 3.2

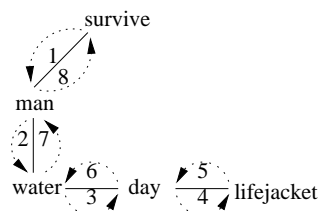
(i) SRG (semantic relations graph)



(ii) signature



(iii) NAG (numbered arcs graph)



(iv) surface realization

1	2	3	4	5	6	7	8
the_man	in_the_water	for_days	without_a_lifejacket				survived_.
V/N	N}N	N-N	N-N	N-N	N-N	N-N	N/V

4 Noun coordination

The following coordination of elementary nouns (names) serves as the grammatical subject. It is also coded via the *nc* and *pc* values:

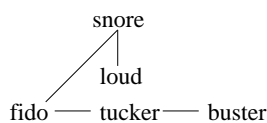
4.1 Content of Fido, Tucker, and Buster snored loudly.

[sur: fido noun: [dog x] cat: snp sem: nm m fnc: snore mdr: nc: [dog y] pc: prn: 18	[sur: tucker noun: [dog y] cat: snp sem: nm m fnc: mdr: nc: [dog z] pc: [dog x] prn: 18	[sur: buster noun: [dog z] cat: snp sem: <i>and</i> nm m fnc: mdr: nc: pc: [dog y] prn: 18	[sur: verb: snore cat: #n' decl sem: ind past arg: [dog y] mdr: loud nc: pc: prn: 18	[sur: adj: loud cat: adv sem: pad mdd: snore mdr: nc: pc: prn: 18
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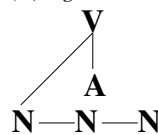
In contrast to an adn coordination, the prefinal conjunction *and* is obligatory.³

4.2 Graph analysis of the semantic relations of structure

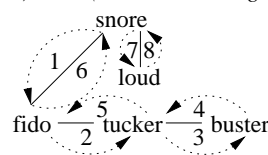
(i) SRG (semantic relations graph)



(ii) signature



(iii) NAG (numbered arcs graph)



(iv) surface realization

1	2	3	4	5	6	7	8
Fido	Tucker	and_Buster			snored	loudly	.
V/N	N-N	N-N	N-N	N-N	N/V	V A	A V

In a noun coordination, the connection to the functor-argument structure is based on the subject/predicate or the object/predicate relation, here arcs 1 and 6. In 5.1, this relation is coded by [fnc: snore] feature of the initial conjunct *fido* and [arg: [dog y] feature of the verb *snore*. In the noninitial conjuncts, the *fnc* attributes have no value; if needed, it can be retrieved from the initial conjunct via the *pc* connections.

5 Intra- and extrapositional verb coordination

While adn and noun coordination are always intrapositional, verb coordination can be both, intra- and extrapositional. In extrapositional use, a proposition is represented by its top verb proplet. The concatenation of propositions, as in a text, is a coordination of their top verbs. A top verb proplet is sufficient to represent

³For the graph analysis and the complete sequence of explicit hear mode operations see TExer3, Sect. 3.6.

a possibly complex proposition because its continuation values allow a complete reconstruction of the whole.⁴

Intra- and extrapositional verb coordinations may be combined, as in the following example:

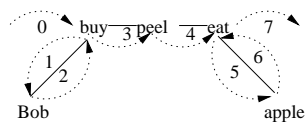
5.1 Combining intra- and extrapositional verb coordination

Julia slept. Bob bought, peeled, and ate an apple. Fido snored
 [prn: n] [prn: n+1] [prn: n+2]

The critical transition is from the intrapropositional coordination of proposition [prn: n+1] to [prn: n+2] by means of an extrapropositional coordination. The following solutions have been proposed:

5.2 Alternative NAG proposals for verb coordination

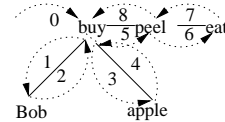
TECER3 proposal
 (iii) numbered arc graph (NAG)



(iv) surface realization

1 2 3 4 5 6
 Bob bought peeled and ate an apple .
 V/Nⁱ N/V V-V V-V V\N N/V

NLC2 proposal
 (iii) numbered arc graph (NAG)



(iv) surface realization

1 2 5 6 7 8 3 4
 Bob bought peeled and ate an apple .
 V/N N/V V-V V-V V-V V-V V\N N/V

The NLC2 analysis on the right takes an intrapropositional perspective by treating subject (Sect. 5), predicate (NLC2 8.3.4), object (NLC2 8.2.7), and modifier (Sect. 1) coordinations alike. Also, the initial conjunct *buy* is treated as (a) as the representative of the proposition, (b) the point of extrapropositional entrance, and (c) the point of extrapropositional exit.

If there is only a single top verb, which is usually the case, this is easily fulfilled. However, if there are several verbs of equal rank, as in an intrapropositional verb coordination (5.1), there is a problem. A first symptom is the absent exit arc in the NLC2 NAG in 5.2. At the proplet level, the reason may be located in the *nc* slot of the initial verb proplet *buy*. Consider the following schematic instantiation:

5.3 Intrapropositional verb-verb coordination

verb: buy	verb: peel	verb: eat
...
nc: peel	nc: eat	nc:
pc:	pc: buy	pc: peel
prn: n	prn: n	prn: n

The intrapropositional nature is shown by the shared *prn* value and the intrapropositional address values of the *nc* and *pc* attributes. The *nc* slot of the first conjunct

⁴Computational Cognition, Sect. 3.3, Resonating Content: Selective Activation.

is filled by the address of the next verbal conjunct *peel*, which makes it unavailable for any relation to an extrapositional next verbal conjunct (as would be needed for the NLC analysis in 5.1). The *nc* slot of the last conjunct, however, is available for an extrapositional coordination with a next proposition.

Next consider an extrapositional coordination in a similar format as 5.3:

5.4 Extrapositional verb-verb coordination

$\begin{bmatrix} \text{verb: sleep} \\ \text{arg: julia} \\ \text{nc: (sing n+1)} \\ \text{pc:} \\ \text{prn: n} \end{bmatrix}$	$\begin{bmatrix} \text{verb: buy} \\ \text{arg: bob apple} \\ \text{nc: (snore n+2)} \\ \text{pc: (sleep n)} \\ \text{prn: n+1} \end{bmatrix}$	$\begin{bmatrix} \text{verb: snore} \\ \text{arg: fido} \\ \text{nc:} \\ \text{pc: (buy n+1)} \\ \text{prn: n+2} \end{bmatrix}$
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The extrapositional nature of the coordination is shown by the extrapositional address values of the *nc* and *pc* attributes, and the incremented *prn* values of the clausal conjuncts. Here the empty *pc* value in the *sleep* proplet indicates initial position, just as an empty *nc* value indicates the end of a text.

It is the empty *nc* value of the intrapositional coordination 5.3 which opens the possibility of the TExer3 analysis on the left of 5.2. The first verb of the intrapositional coordination is the entrance proplet with (1) the subject value *bob*, (2) the object value *apple* and (3) the syntactic mood value *decl*, while the last verb *eat* of the coordination is the exit proplet. The non-initial conjuncts, here *peel* and *eat*, implicitly share the *arg* values and explicitly the *prn* value of the initial verbal conjunct *buy*. The only function *buy* had to relinquish is the role as the exit proplet, which is taken here by the last verbal conjunct *eat* and expressed by the feature [*nc: n+2*] of *snore*.⁵

The intrapositional verb coordination in the TExer3 proposal on the left of 5.2 and the extrapositional coordination in 5.1 have in common that they are uni-directional, in the direction of time. They may, however, be traversed in the anti-temporal direction by means of the following inference:

5.5 Inference navigating backward through a coordination

$$\begin{bmatrix} \text{verb: } \beta \\ \text{pc: } \alpha \\ \text{prn: n+1} \end{bmatrix} \Rightarrow \begin{bmatrix} \text{verb: } \alpha \\ \text{nc: } \beta \\ \text{prn: n} \end{bmatrix}$$

The considerations for a simple coordination (5.3) apply also to another kind of intrapositional repetition, namely subject and object gapping:

⁵That, e.g., *buy* has this function in single predicate constructions is because there it is the entrance and the exit proplet at the same time.

6 Extrapositional Coordination

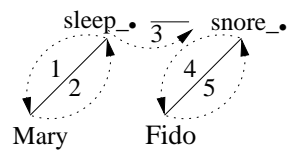
6.1 Content of Mary slept. Fido snored.

[sur: mary noun: [person x] cat: snp sem: nm f fnc: sleep mdr: nc: pc: prn: 17]	[sur: verb: sleep cat: #ns3 decl sem: ind past arg: [person x] mdr: nc: (snore 18) pc: prn: 17]	[sur: verb: snore cat: #ns3 decl sem: ind past arg: [dog y] mdr: nc: pc: (sleep 17) prn: 18]	[sur: fido noun: [dog y] cat: snp sem: nm m fnc: snore mdr: nc: pc: prn: 18]
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The two propositions are distinguished by their prn values 17 and 18. The proplets have nc (next conjunct) and pc (previous conjunct) attributes which may be empty or take intra- or extrapositional address values. The nc attribute of *sleep* has the extrapositional address value (snore 18) while pc attribute of *snore* has the extrapositional address value (sleep 17).

6.2 Graph analysis of the semantic relations of structure

(iii) numbered arc graph (NAG)



(iv) surface realization

1	2	3	4	5
Mary	slept_.	Fido	snored_.	
V/N ⁱ	N/V	V-V	V/N	N/V