

Are Iterating Slot-Filler Structures Universal?

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Abstract

An example of an iterating slot-filler¹ structure is repeating infinitives as in John decided to try to persuade Bob to run (Sect. 3). Each infinitive serves as a phrasal object with a slot, e.g. to try *slot*. The slot is filled by another infinitive with a slot, i.e. to persuade Bob *slot*, and so on, except for the last one, which terminates the iteration with an intransitive verb. Similar slot-filler repetitions are iterating object clauses (Sect. 4) and iterating adnominal clauses (Sect. 5).

Another kind of iterating slot-filler or filler-slot structure is known as gapping. For example, Bill bought an apple, peeled a pear, ..., and ate a peach. is called subject gapping. Here the open-ended sequence *slot* peeled a pear, *slot* ate a peach, and so on, takes Bill as the shared subject. The end of the iteration is announced by the function word and in penultimate position. Systematic variants are predicate gapping, and object gapping (Sect. 6).

Iterating slot-filler structures may interact with other grammatical constructions. A prime example is a *long distance dependency*, such as Whom did John say that Bill claims that Suzy believes that ... Mary loves?, i.e. the single filler-slot pair Whom and Mary loves? is separated by a slot-filler iteration of object clauses (Sect. 7).

Remarkably, all of these highly conspicuous constructions occur in natural languages which are completely unrelated to English and other European languages, namely in Korean, Tagalog, and Georgian. They are therefore candidates for being universal² thought structures.

keywords: hear mode, content, speak mode, iteration, marked vs. unmarked slots, infinitive, object clause, adnominal clause, gapping, long distance dependency, intra- vs. extrapositional relations

1 Language and Thought

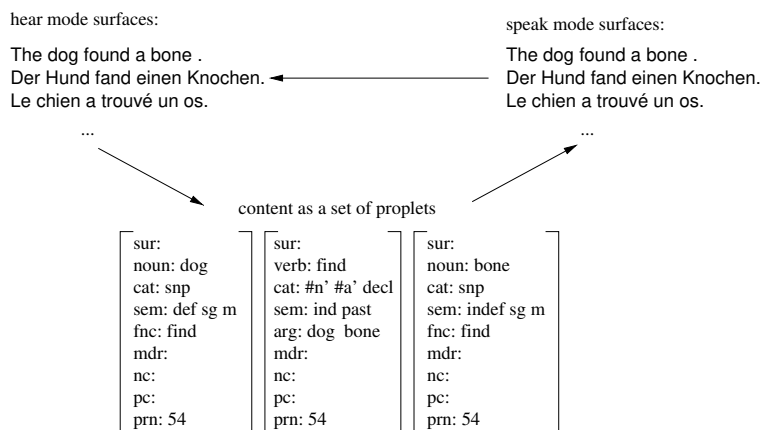
The agent-based data-driven ontology of DBS treats cognitive contents as sets (order-free) of proplets, defined as nonrecursive feature structures with ordered attributes. Proplets are connected into content by the classical semantic relations of structure coded by address. Language content and thought content are treated alike except that the proplets of a language content have language-dependent sur(face) values which are absent in the proplets of a thought content.

¹McCord (1980) used the slot-filler principle for *Slot Grammar*.

²What exactly constitutes a universal is a difficult question (Harbsmeier 2001).

A content may use different surfaces from typologically similar languages. For example, The dog found a bone, Der Hund fand einen Knochen, and Le chien a trouvé un os are surfaces in different languages for the same content:

1.1 FROM CONTENT TO SPEAK MODE TO HEAR MODE TO CONTENT

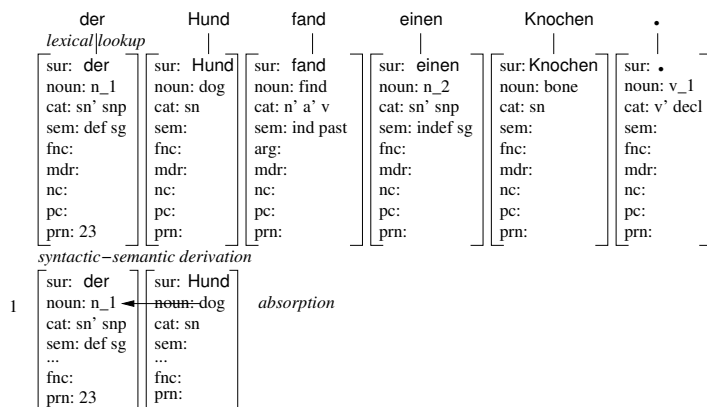


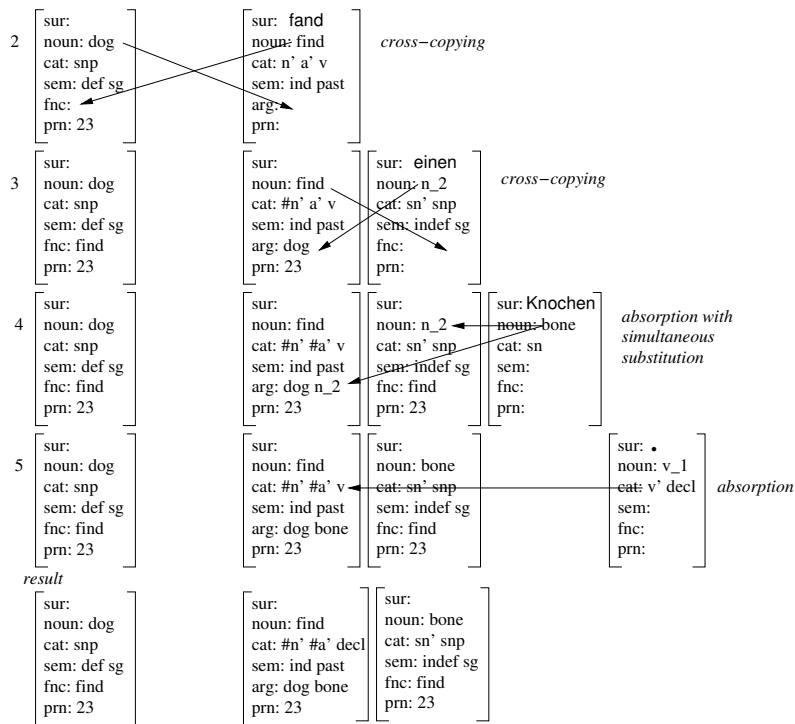
In language communication, the hear mode is provided with a sequence of lexical proplets by automatic word form recognition. They are connected into a content, which may be used as input to the speak mode for surface production as output.

As the computational data structure of DBS, a proplet encodes all lexical and compositional properties of a content word as proplet-internal attribute-value pairs called features. For example, the noun proplets in 1.1 have the lexical features [sem: def sg] and [sem: indef sg] for definiteness and number, and the verb proplet has the lexical features [cat: #n' #a' decl] for valency and syntactic mood, and [sem: past ind] for tense and verbal mood. The syntactic-semantic distinction between subject and object is coded inside the verb proplet by the value order in the feature [arg: dog bone]. The subject proplet *dog* and the object proplet *bone* are connected to the *find* proplet by their respective [fnc: find] features.

Consider the explicit hear mode derivation of the German surface:

1.2 SURFACE COMPOSITIONAL TIME-LINEAR HEAR MODE DERIVATION

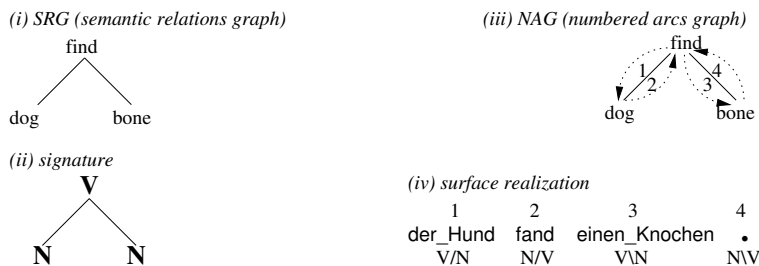




The derivation is *surface compositional* because each input surface has exactly one lexical proplet representation and there are no lexical proplet representations without a concrete surface. The derivation is *time-linear*, as shown by the stair-like addition of one new next word form in each line. The proplets of the function words *the* and *a* absorb their respective content words, as shown in lines (1,2) and (4,5), while the *.* proplet is absorbed into the top verb (5, result).

Contents resulting from hear mode derivations are possible inputs to the think mode operations of (a) selective activation by navigation and (b) inferencing. Either may be mirrored by language-dependent surfaces in the speak mode riding piggyback on sequences of think mode operations:

1.3 GRAPHICAL PRESENTATION OF THE SEMANTIC RELATIONS IN 1.1

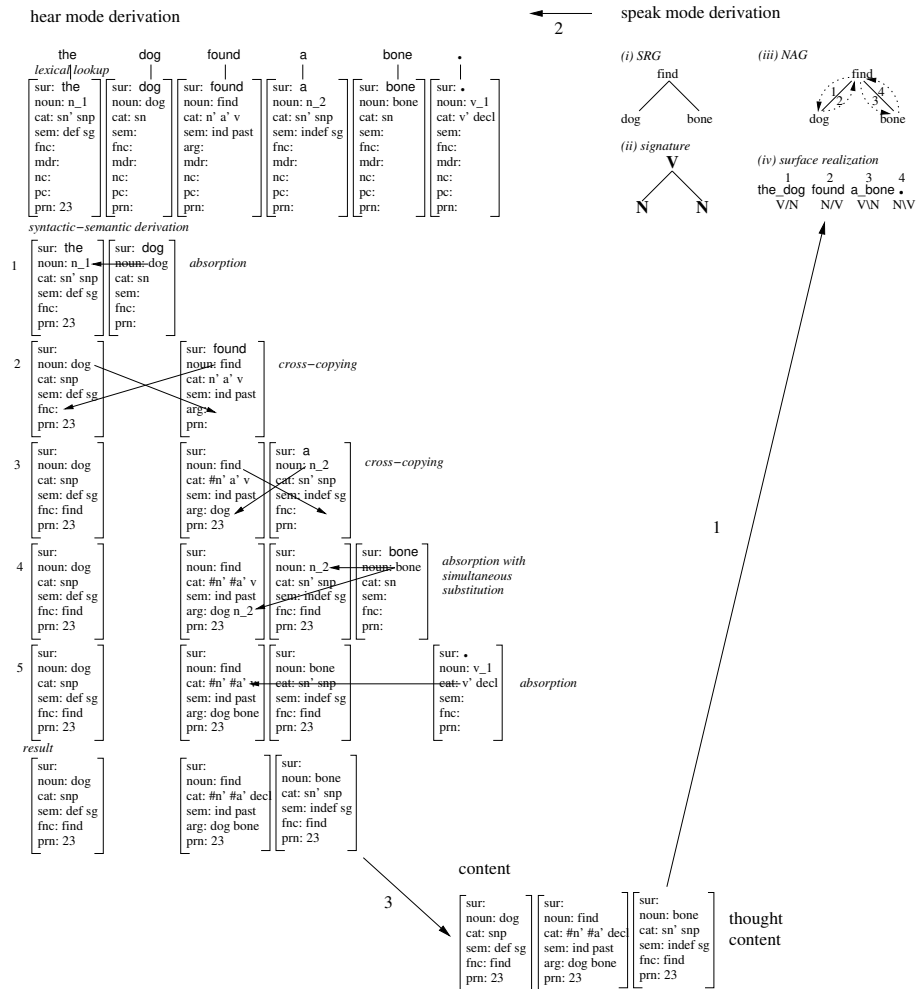


The (i) SRG and the (ii) signature show the static semantic structure, here subject/predicate and object/predicate, whereby the nodes in the SRG represent the core values and in the signature the core attributes of the proplets in the content. The (iii) NAG and the (iv) surface realization, in contrast, show the dynamic aspect of

the think mode which activates content by a navigation for inferencing and for the speak mode realization of language-dependent surfaces.

The content 1.1, the speak mode derivation 1.3, the hear mode derivation 1.2 combine into the following cycle of natural language communication in DBS (shown for English surfaces):

1.4 CYCLE OF NATURAL LANGUAGE COMMUNICATION



This constellation supports two important functions of turn taking (Schegloff 2007): (i) transfer of a content from the speaker to the hearer (two agents, arrow sequence 1, 2) and (ii) repeated hearsay, i.e. interpreting content in the hear mode and reproducing it in the speak mode (one agent, arrow sequence 3, 1).

2 Slot-Filler Iteration

There is comparatively little argument that, roughly speaking, all natural languages distinguish between the word kinds noun, verb, and adj, the syntactic moods declar-

ative, interrogative, and imperative, the verbal moods indicative and subjunctive, the tenses present, past, and future, the semantic relations of functor-argument and coordination, the degrees of elementary, phrasal, and clausal grammatical complexity, and the intra- vs. extrapositional semantic relations of structure, whereby the latter may be intra- or extrasentential. The basic grammatical structures built on these notions may be considered likely to be universal contents.

In contrast, structures perhaps³ more promising for being non-universal is the conspicuous iteration of (i) slot-fillers or (ii) filler-slots such as the following:

2.1 EXAMPLES OF SLOT-FILLER AND FILLER-SLOT ITERATIONS

1. *Iterating infinitives* (phrasal)
John decided to try to persuade Bob to run.
2. *Iterating object clauses* (clausal)
Mary saw that Peter saw that Suzy saw Fido.
3. *Iterating adnominal clauses* (clausal)
Mary saw the man who loves the woman who feeds the child.
4. *Subject gapping* (phrasal)
Bob bought an apple, peeled a pear, and ate a peach.
5. *Predicate gapping* (phrasal)
Bob bought an apple, Jim a pear, and Bill a peach.
6. *Object gapping* (phrasal)
Bob bought, Jim peeled, and Bill ate the peach.
7. *Object clause iteration with long distance dependency* (clausal)
Whom did John say that Bill believes that Mary claims that Suzy loves?

In this list, three construction kinds may be distinguished: (i) marked slot-filler repetition using different fillers (1-3), (ii) unmarked filler-slot or slot-filler repetition using the same filler (4-6), and (iii) a single filler-slot relation with an intervening object clause iteration, resulting in a long-distance dependency (7).

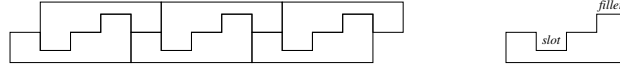
3 Marked Slot-Filler Repetition in Infinitives

In English, marked slot-filler repetition occurs at the phrasal level as (a) repeating infinitives,⁴ and at the clausal level as (b) repeating object clauses and (c) repeating adnominal clauses. The cognitive structure common to all three may be shown abstractly as follows:

³Because they are of low frequency in daily use or not in every tree bank?

⁴In HPSG, infinitives are treated as a kind of clause (Sag 1997). It seems, however, that the adnominal use of infinitives, as in *The decision to try...*, is restricted to nominalized transitive verbs.

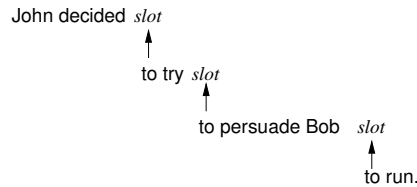
3.1 SLOT-FILLER REPETITION AS ABSTRACT COGNITIVE STRUCTURE



For example, the slot-fillers in an infinitive iteration consist of a sequence of transitive predicates taking another transitive predicate as their second argument, except for the last one. The lower predicate's subject is absent in the surface (slot) but equals implicitly the next higher subject (subject control, e.g. *try*, *promise*) or the next higher object (object control, e.g. *persuade*).

The function word marking the slots in English is *to*. The characteristic semantic connections in iterating infinitives may be illustrated as follows:

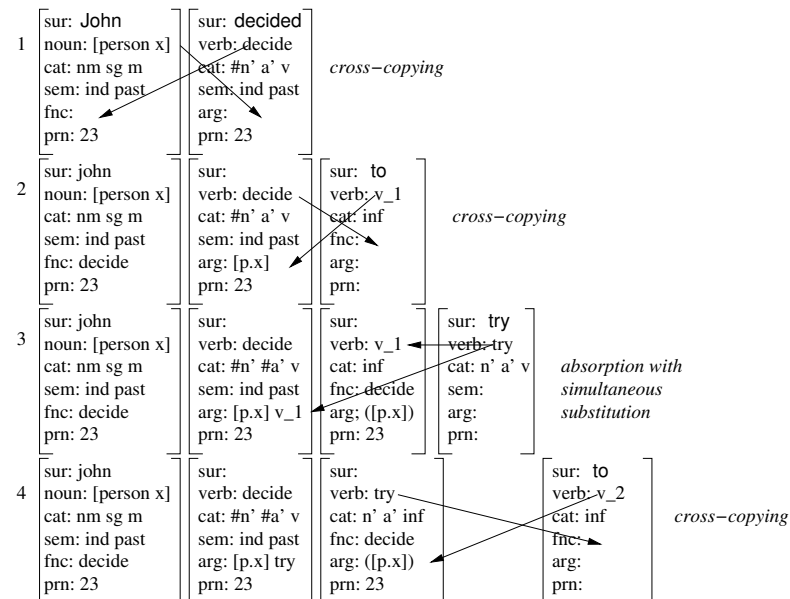
3.2 MARKED SLOTS IN ITERATING INFINITIVES

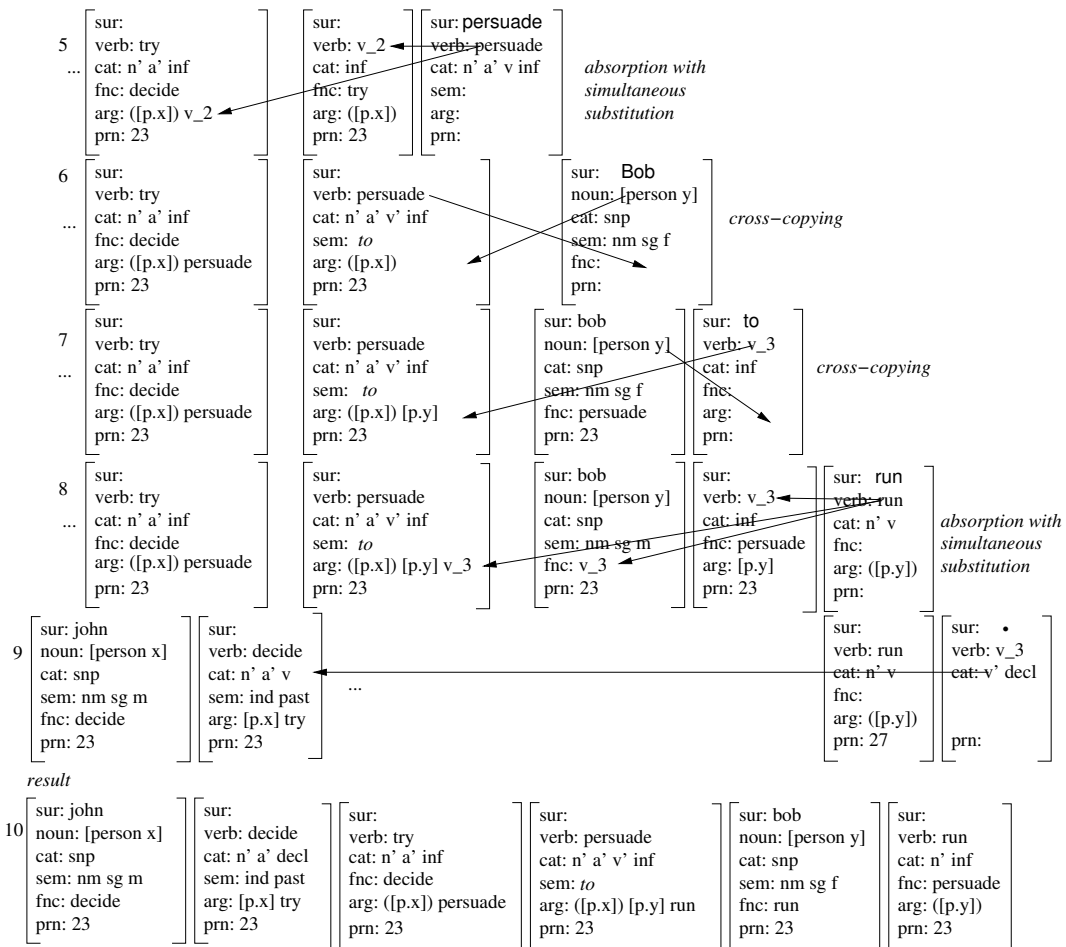


The initial predicate *decide_slot* is filled by *to try_slot* which is filled by *to persuade Bob_slot* which is filled by *to run*. The last filler terminates the iteration because it does not introduce another slot. Whether an infinitive has subject or object control (CLaTR Sects. 15.4–15.6) depends on the verb.

The hear mode derivation of *John decided to try to persuade Bob to run*. shows the ‘controlled’ subjects and objects in round brackets, e.g. [arg: ([p.x]) try]:

3.3 HEAR MODE DERIVATION OF REPEATING INFINITIVES





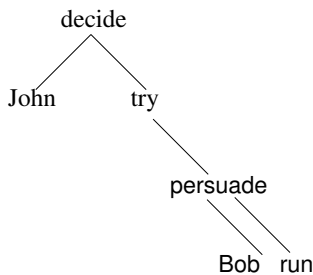
As a surface compositional approach, DBS connects **decide** directly with **to_try**, **try** directly with **to_persuade**, and **persuade** directly with **to_run**, using the $V \setminus V$ relation intrasententially. The implicit subject and object control of the infinitives is shown explicitly as the abbreviated values $([p. x])$ and $([p. y])$, in round brackets.

For the corresponding speak mode, consider the following graph analysis:

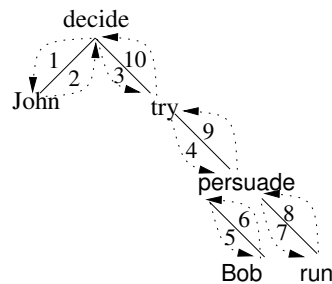
3.4 GRAPHICAL PRESENTATION OF THE SEMANTIC RELATIONS IN 3.3

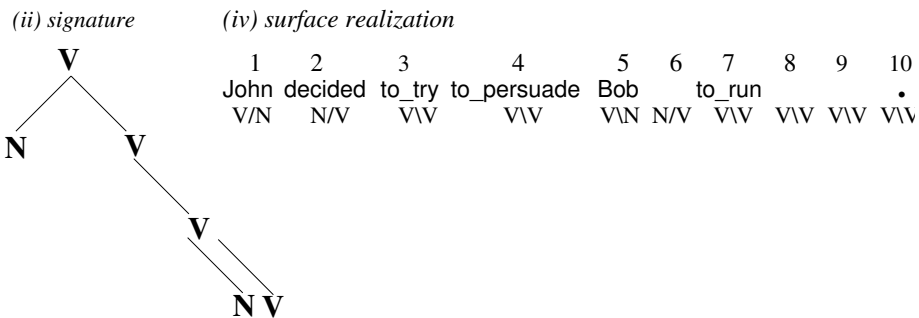
John decided to try to persuade Bob to run.

(i) SRG (semantic relations graph)



(iii) NAG (numbered arcs graph)





content

[sur: john noun: [person x] cat: nm sg f sem: fnc: decide ... prn: 32]	[sur: verb: decide cat: n' a' decl sem: ind past arg: [person x] try ... prn: 32]	[sur: verb: try cat: n' a' inf sem: to arg: ([person x]) persuade ... prn: 32]	[sur: verb: persuade cat: n' a' v' inf sem: to arg: ([person x])[person y] run ... prn: 32]
[sur: bob noun: [person y] cat: snp sem: nm sg m fnc: run ... prn: 32]	[sur: verb: run cat: n' a' inf sem: to arg: ([person y]) ... prn: 32]		

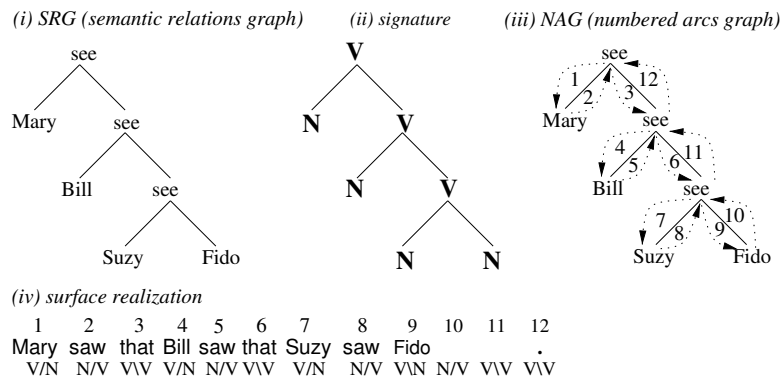
Decide, try, and persuade have subject control while run has object control. Run is 1-place, decide and try are 2-place, and persuade is 3-place. The valency positions in the cat slot are marked with ' and canceled with #.

4 Marked Slot-Filler Repetition in Object Clauses

The clausal counterpart to phrasal infinitive iteration is the extrapositional repetition of object sentences, as in the following example:

4.1 OBJECT CLAUSE REPETITION

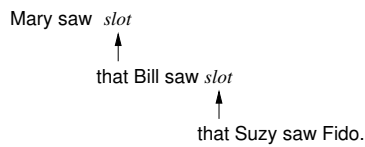
Mary saw that Bill saw that Suzy saw Fido.



<i>content</i>			
[sur: mary noun: [person x] cat: snp sem: nm sg f fnc: see ... prn: 33	[sur: verb: see cat: #n' #a' decl sem: ind past arg: [person x] (see 34) ... prn: 33	[sur: bill noun: [person y] cat: snp sem: nm sg m fnc: see ... prn: 34	[sur: verb: see cat: #ns3' #a' v sem: ind past arg: [person y] (see 35) ... prn: 34
[sur: suzy noun: [person z] cat: snp sem: nm sg m fnc: see ... prn: 35	[sur: verb: see cat: #ns3' #a' v sem: ind past arg: [person z] (see 35) ... prn: 35	[sur: fido noun: [dog w] cat: snp sem: nm sg m fnc: see ... prn: 35	

The extrapositional nature of the example is shown by the different prn values, from 33 to 35. The function word marking the slots is that:

4.2 MARKED SLOTS IN ITERATING OBJECT CLAUSES



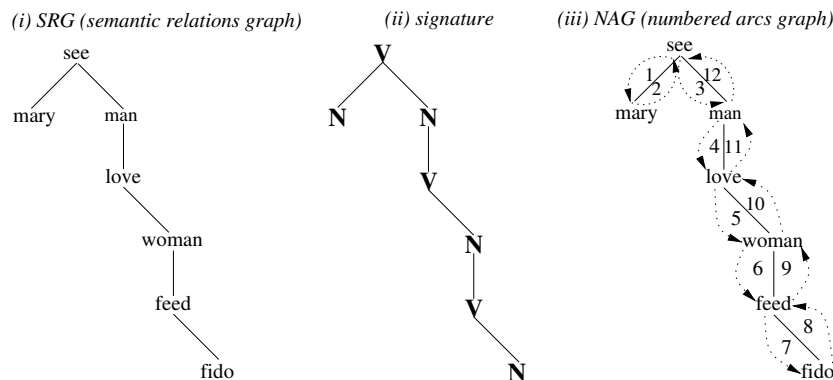
The last clause terminates the iteration because the filler does not introduce another slot. The analyses 3.3, 3.4, and 4.1 rely on the strictly time-linear derivation order of DBS.

5 Marked Slot-Filler Repetition in Adnominal Clauses

Like infinitives and object clauses, adnominal clauses may be iterated, as in *Mary saw the man who loves the woman who ... feeds Fido.*

5.1 GRAPH ANALYSIS UNDERLYING MULTIPLE ADNOMINAL CLAUSES

Mary saw the man who loves the woman who fed Fido.



⁴To keep track of a navigation, traversed proplets are incrementally #-marked.

(iv) *surface realization* (English, subject gap)

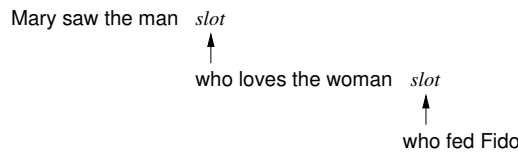
1 2 3 4 5 6 7 8 9 10 11 12
 Mary saw the man who loves the woman who fed Fido
 V/N N/V V/N N/V V/N N/V V/N N/V V/N N/V V/N N/V

content

[sur: mary noun: [person x] cat: snp sem: nm f fnc: see mdr: prn: 29]	[sur: verb: see cat: #n' #a' decl sem: past arg: [person x] man mdr: prn: 29]	[sur: noun: man cat: snp sem: def sg fnc: see mdr: (love 30) prn: 29]	[sur: verb: love cat: #ns3' #a' v sem: who pres arg: 0 woman mdd: [man 29] prn: 30]	[sur: noun: woman cat: snp sem: def sg fnc: love mdr: (feed 31) prn: 30]	[sur: verb: feed cat: #n' #a v sem: who past arg: 0 [dog x] mdd: [woman 30] prn: 31]	[sur: fido noun: [dog x] cat: snp sem: nm fnc: feed mdr: prn: 31]
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In this construction, the function word marking the slot is a “relative pronoun” (subordinating conjunction with argument role) such as *who*, *whom*, or *which*. As shown by the increasing *prn* values, the construction is extrapositional.

5.2 MARKED SLOT STRUCTURE OF ITERATING ADNOMINAL CLAUSES



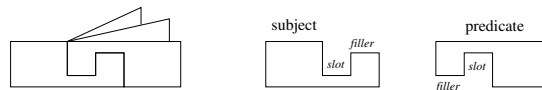
The function word marking the slots in this example is *who*.

6 Unmarked Slot-Filler Iteration in Gapping Constructions

In gapping constructions, a single unmarked slot is used several times, as in subject and predicate gapping (filler-slot), and object gapping (slot-filler). This is in contradistinction to slot-filler iterations which use several different marked slots (Sects. 3–5).

In subject gapping, a single subject slot takes multiple predicate fillers, which may be shown as follows:

6.1 SUBJECT GAPPING AS AN ABSTRACT COGNITIVE STRUCTURE



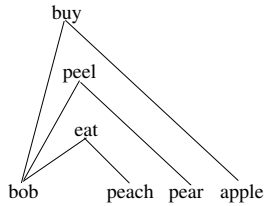
Without the multiple predicates, this three-dimensional graph would equal a simple subject-predicate combination, i.e. a subject with a single intransitive or transitive verb. Computationally, the slot-filler combination is implemented as a cross-copying between order-free proplets.

Instead of marking the slots with a function word, as in slot-filler iteration, gapping marks the slots with a pause in speech or a comma in writing. This kind of slot is called ‘unmarked,’ but indicated by \emptyset for analysis:

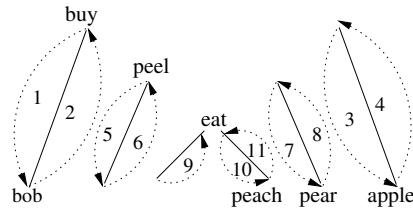
6.2 DBS ANALYSIS OF SUBJECT GAPPING (TExer Sect. 5.2)

Bob bought an apple, \emptyset peeled a pear, and \emptyset ate a peach.

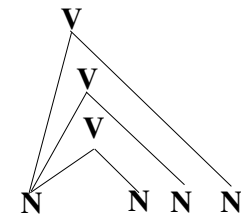
(i) SRG (semantic relations graph)



(iii) NAG (numbered arcs graph)



(ii) signature



(iv) surface realization

1 2 3 4 1 6 7 8 5 9 10 11
 Bob bought an apple peeled a pear and ate a peach .
 V/Nⁱ N²/V V\N N\N V/N^s N²/V V\N N\N V/N^s N²/V V\N N\N

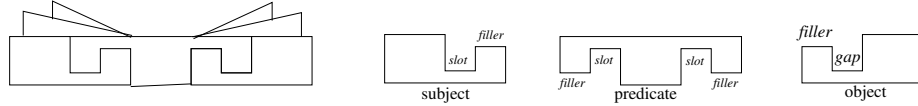
$\left[\begin{array}{l} \text{content} \\ \text{sur: bob} \\ \text{noun: [person x]} \\ \text{cat: snp} \\ \text{sem: nm m} \\ \text{fnc: buy} \\ \dots \\ \text{peel} \\ \text{eat} \\ \dots \\ \text{prn: 32} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{verb: buy} \\ \text{cat: \#n' \#a' decl} \\ \text{sem: past} \\ \text{arg: [person x] apple} \\ \dots \\ \text{prn: 32} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{noun: apple} \\ \text{cat: snp} \\ \text{sem: indef sg} \\ \text{fnc: buy} \\ \dots \\ \text{prn: 32} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{verb: peel} \\ \text{cat: \#n' \#a' v} \\ \text{sem: past} \\ \text{arg: [person x] pear} \\ \dots \\ \text{prn: 32} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{noun: pear} \\ \text{cat: snp} \\ \text{sem: indef sg} \\ \text{fnc: peel} \\ \dots \\ \text{prn: 32} \end{array} \right]$
$\left[\begin{array}{l} \text{sur:} \\ \text{verb: eat} \\ \text{cat: \#n' \#a' v} \\ \text{sem: and past} \\ \text{arg: [person x] peach} \\ \dots \\ \text{prn: 32} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{noun: peach} \\ \text{cat: snp} \\ \text{sem: indef sg} \\ \text{fnc: eat} \\ \dots \\ \text{prn: 32} \end{array} \right]$			

In contradistinction to the depth-first numbering of the NAGs in marked slot-filler constructions, the NAG numbering in gapping constructions is breadth-first (TExer Chap. 1). The final gapped item is announced by the function word *and*, coded in the *sem* slot of the *eat* proplet.

The proplet *bob* serves as the shared subject of the predicates *buy*, *peel*, and *eat* by specifying them in its *fnc* slot as the *gap list*. The inverse relation from the predicates to their shared subject is established by writing the core value [person x] of *bob* into the first (subject) *arg* slot of the verbs. The construction is intrapositional, as indicated by the shared *prn* value 32.

The next gapping construction is predicate gapping, in which a single predicate takes multiple subjects and objects as fillers (three-dimensional):

6.3 PREDICATE GAPPING AS AN ABSTRACT THOUGHT STRUCTURE

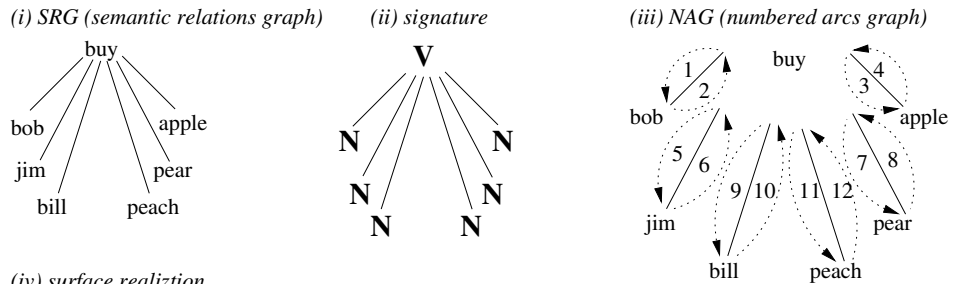


Without the multiple subjects and objects, the graph would equal a simple subject/predicate/object combination.

The canonical DBS graph analysis of predicate gapping may be shown as follows:

6.4 DBS ANALYSIS OF PREDICATE GAPPING (TEXer Sect. 5.3)

Bob **bought** an apple, Jim \emptyset a pear, and Bill \emptyset a peach.



(iv) surface realization

1 2 3 4 5 6 7 8 9 10 11 12
 Bob bought an apple Jim a pear and Bill a peach .
 V^p/N N/Vⁱ V\N N\V V^p/N N/V^p V\N N\V V^p/N N/V^p V\N N\V

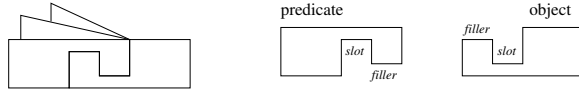
content

$\left[\begin{array}{l} \text{sur: Bob} \\ \text{noun: [person x]} \\ \text{cat: snp} \\ \text{sem: nm m} \\ \text{fnc: buy} \\ \dots \\ \text{prn: 33} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{verb: buy} \\ \text{cat: \#n' \#a' decl} \\ \text{sem: past} \\ \text{arg: [person x] apple} \\ \quad \text{[person y] pear} \\ \quad \text{[person z] peach} \\ \dots \\ \text{prn: 33} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{noun: apple} \\ \text{cat: snp} \\ \text{sem: indef sg} \\ \text{fnc: buy} \\ \dots \\ \text{prn: 33} \end{array} \right]$	$\left[\begin{array}{l} \text{sur: Jim} \\ \text{noun: [person y]} \\ \text{cat: snp} \\ \text{sem: nm m} \\ \text{fnc: buy} \\ \dots \\ \text{prn: 33} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{noun: pear} \\ \text{cat: snp} \\ \text{sem: indef sg} \\ \text{fnc: buy} \\ \dots \\ \text{prn: 33} \end{array} \right]$
$\left[\begin{array}{l} \text{sur: Bill} \\ \text{noun: [person z]} \\ \text{cat: snp} \\ \text{sem: and nm m} \\ \text{fnc: buy} \\ \dots \\ \text{prn: 33} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{noun: peach} \\ \text{cat: snp} \\ \text{sem: indef sg} \\ \text{fnc: buy} \\ \dots \\ \text{prn: 33} \end{array} \right]$			

The shared item is the predicate *buy*. Its *arg* slot contains the gap list, here the subject-object pairs *bob apple*, *jim pear*, and *bill peach*. The conjunction *and* is coded into the initial *sem* slot of *bill*. The subject and object proplets take *buy* as their shared *fnc* value.

In object gapping, a single object is taken by multiple predicates. Its graph is the mirror image of the three-dimensional graph for subject gapping (6.1):

6.5 OBJECT GAPPING AS AN ABSTRACT THOUGHT STRUCTURE

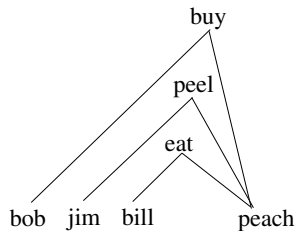


Without the multiple predicates, the graph would equal a simple object \ predicate combination (including a predicate without a subject, as in imperatives).

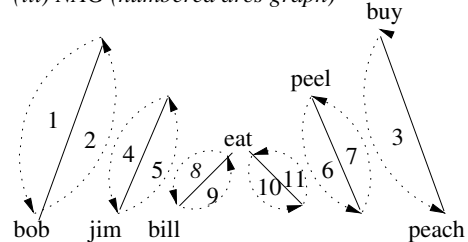
6.6 DBS ANALYSIS OF OBJECT GAPPING (TExer Sect. 5.4)

Bob bought \emptyset , Jim peeled \emptyset , and Bill ate a peach

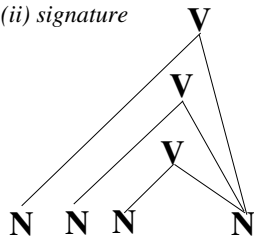
(i) SRG (semantic relations graph)



(iii) NAG (numbered arcs graph)



(ii) signature



(iv) surface realization

1 2 3 7 4 5 6 11 8 9 10 11
 Bob bought Jim peeled and_Bill ate a_peach •
 V/N N/V V\N° N°V V/N N/V V\N° N°V V/N N/V V\N° N°V

content

$\left[\begin{array}{l} \text{sur: Bob} \\ \text{noun: [person x]} \\ \text{cat: snp} \\ \text{sem: nm m} \\ \text{fnc: buy} \\ \dots \\ \text{prn: 34} \end{array} \right]$	$\left[\begin{array}{l} \text{sur: buy} \\ \text{verb: buy} \\ \text{cat: \#n' \#a' v} \\ \text{sem: past} \\ \text{arg: [person x] peach} \\ \dots \\ \text{prn: 34} \end{array} \right]$	$\left[\begin{array}{l} \text{sur: Jim} \\ \text{noun: [person y]} \\ \text{cat: snp} \\ \text{sem: nm m} \\ \text{fnc: peel} \\ \dots \\ \text{prn: 34} \end{array} \right]$	$\left[\begin{array}{l} \text{sur: peel} \\ \text{verb: peel} \\ \text{cat: \#n' \#a' v} \\ \text{sem: past} \\ \text{arg: [person y] peach} \\ \dots \\ \text{prn: 34} \end{array} \right]$	$\left[\begin{array}{l} \text{sur: Bill} \\ \text{noun: [person z]} \\ \text{cat: snp} \\ \text{sem: and nm m} \\ \text{fnc: eat} \\ \dots \\ \text{prn: 34} \end{array} \right]$
$\left[\begin{array}{l} \text{sur:} \\ \text{verb: eat} \\ \text{cat: \#n' \#a' decl} \\ \text{sem: past} \\ \text{arg: [person z] peach} \\ \dots \\ \text{prn: 34} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{noun: peach} \\ \text{cat: snp} \\ \text{sem: indef sg} \\ \text{fnc: buy} \\ \text{peel} \\ \text{eat} \\ \dots \\ \text{prn: 34} \end{array} \right]$			

Gapping constructions are intrapositional, like iterated infinitives.

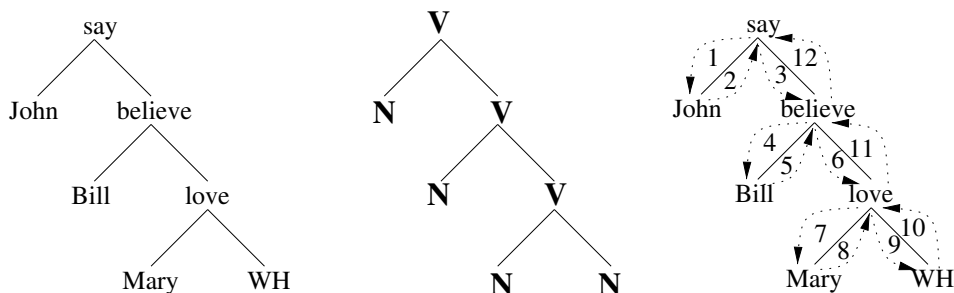
7 Long-Distance Dependency

The slot-filler iteration of object clauses (Sect. 4) may be combined with a single filler-slot relation, taking the filler in first and the slot in last position. This results in the following long-distance dependency (TE_{EXER} Sect. 5.5):

7.1 OBJECT-CLAUSE ITERATION WITH LONG-DISTANCE DEPENDENCY

Whom did John say that Bill believes that Mary loves?

(i) SRG (semantic relations graph) (ii) signature (iii) NAG (numbered arcs graph)



(iv) surface realization

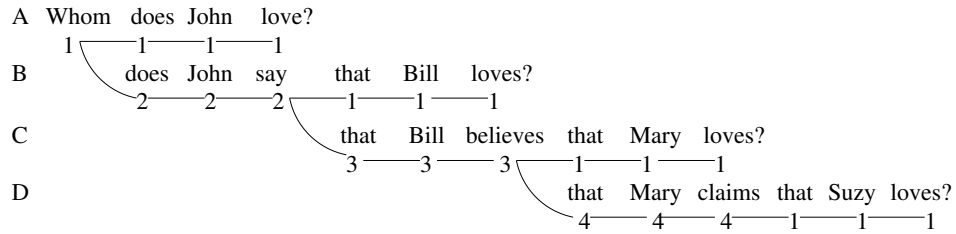
3 6 9 10 11 12 1 2 3 4 5 6 7 8 11 12
 Whom does John say that Bill believes that Mary loves ?
 V\V V\V V\N N\V V\V V\V V\N N\V V\V V\N N\V V\V V\N N\V V\V V\V

$\left[\begin{array}{l} \text{sur:} \\ \text{noun: wh_1} \\ \text{cat: obq} \\ \text{sem: whom} \\ \text{fnc: love} \\ \dots \\ \text{prn: 26\&} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{verb: say} \\ \text{cat: \#ns3' \#a' interrog} \\ \text{sem: do pres} \\ \text{arg: [person x] (believe 28)} \\ \dots \\ \text{prn: 27} \end{array} \right]$	$\left[\begin{array}{l} \text{sur: john} \\ \text{noun: [person x]} \\ \text{cat: snp} \\ \text{sem: nm m} \\ \text{fnc: say} \\ \dots \\ \text{prn: 27} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{verb: believe} \\ \text{cat: \#ns3' \#a' v} \\ \text{sem: that pres} \\ \text{arg: [person y] (love 26\&)} \\ \text{fnc: (say 27)} \\ \dots \\ \text{prn: 28} \end{array} \right]$
$\left[\begin{array}{l} \text{sur: bill} \\ \text{noun: [person y]} \\ \text{cat: snp} \\ \text{sem: nm m} \\ \text{fnc: believe} \\ \dots \\ \text{prn: 28} \end{array} \right]$	$\left[\begin{array}{l} \text{sur:} \\ \text{verb: love} \\ \text{cat: \#ns3' \#a' v} \\ \text{sem: that pres} \\ \text{arg: [person z] wh_1} \\ \text{fnc: (believe 28)} \\ \dots \\ \text{prn: 26\&} \end{array} \right]$	$\left[\begin{array}{l} \text{sur: mary} \\ \text{noun: [person z]} \\ \text{cat: snp} \\ \text{sem: nm f} \\ \text{fnc: love} \\ \dots \\ \text{prn: 26\&} \end{array} \right]$	

As in the object clause iteration 4.1, the slots are marked with the function word that.

In DBS, an unbounded dependency has the form of an unbounded suspension, here between initial *whom* and the final transitive verb form *loves*. Because the length of the suspension is only determined at the end of the input sentence, the time-linear surface compositional hear mode derivation has the following syntactic ambiguity structure (NLC 7.6.5):

7.2 AMBIGUITY STRUCTURE OF AN UNBOUNDED SUSPENSION



This systematic ambiguity does not affect the linear time complexity of DBS because the time-linear derivation replaces each previous reading with the new input. Accordingly, 7.2 has only a single reading, namely D.

Conclusion

This paper investigates grammatical structures which are conspicuous in that they are based on repeated sharing. The question is whether these constructions are (i) limited to a certain language type or (ii) universal in that they may be found in numerous typologically unrelated natural languages. The latter hypothesis is supported by the fact that the iterations discussed have direct structural counterparts in several languages completely unrelated to the European languages, namely Korean⁵, Tagalog⁶, and Georgian⁷. This is remarkable, and analyzed data from additional languages supporting or opposing the conjecture would be interesting.

⁵Thanks to Professor Kiyong Lee, native speaker of Korean.

⁶Thanks to Mrs. Guerly Söllch, M.A., native speaker of Tagalog.

⁷Thanks to Mrs. Sofia Tekmalaze-Fornwald, M.A., native speaker of Georgian.

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