Reduction of Lexical Redundancy via Semantically-driven Syntactic Generalisations

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Abstract

Syntax cannot be handled effectively in isolation from semantic factors. In this paper, a system is presented which models the syntactic phenomenon of dative alternation via its semantic basis. The system depends on a semantic representation that incorporates psycholinguistic insights about grammatically-relevant semantic criteria, and is implemented in an HPSG grammar in ALE. The semantic basis of the system is shown not only to lead to a more accurate and linguistically elegant model but also to aid in reducing redundancy in the base lexicon. This is accomplished through specification of lexical rules responsible for determining whether particular verbs alternate using both their syntactic and semantic properties. Furthermore, the consultation of verbal semantic features is shown to aid in prediction of the syntactic environments in which the verbs can appear.

1 Introduction

Syntax cannot adequately be treated as autonomous from semantics in any reasonable NLP system. Interaction between the two occurs at the level of the lexicon and must be taken into account in the design of NLP systems. Semantic features of words play a definite role in the determination of syntactic argument structure and cannot be ignored.

A particular grammatical phenomenon which clearly evidences this position is that of dative alternation, e.g. alternation between the dative form as in (1a), and the double object form as in (1b).

(1a) *John gave the book to Mary.*

(1b) *John gave Mary the book.*

This alternation can be captured in terms of a syntactic lexical rule licensing alternation between two verbal subcategorisation frames: [NP_1 NP_2 to NP_3] $\leftrightarrow$ [NP_1 NP_3 NP_2]. However, while many verbs display this alternating behaviour, not all do. Consider the contrast in (2). The application of such a rule to all verbs in the lexicon would incorrectly produce double object forms for non-alternating verbs, thus overgenerating. The sentence in (2b) would be allowed despite its ungrammaticality.

(2a) *John pulled the box to Mary.*

(2b) **John pulled Mary the box.*

The alternative to such a lexical rule is an ad hoc listing in the lexicon of every possible subcategorisation frame which should be allowed for each individual verb. This is clearly inadequate for identifying generalisations about the phenomenon. Thus any purely syntactic approach to modelling this phenomenon must fail in either predictive capacity or linguistic elegance.

The basis for the differences in syntactic argument structure among these verbs lies in differences in verbal semantic structure. These semantic differences can be used in the definition of lexical rules controlling the alternation to prevent application of the rule to verbs which should not participate in the alternation. The rules therefore depend on specification of verb semantics in the lexicon in terms of grammatically relevant semantic criteria and on identification of the semantic criteria which differentiate alternating verbs from non-alternating verbs.

Identification of semantic features critical for syntax has been undertaken via linguistic analysis [Jackendoff, 1990] and studies of child language acquisition [Pinker, 1989]. Both Jackendoff and Pinker develop representations for lexical semantic structure, aimed particularly at verb semantics, which capture elements of semantics with direct relevance to syntax. In the work being introduced, their representations were integrated and formalised for implementation, while maintaining the psychological grounding of the representational elements. Such a psychological basis is important in any attempt to develop computational systems which reflect human language processing.

Verbal semantic structures as introduced in this paper have been integrated into the framework of Head-driven Phrase Structure Grammar (HPSG) [Pollard and Sag, 1994]. HPSG utilises lexical entries to provide a direct interface between syntax and semantics. The mechanisms of the theory supply the mapping from semantic structure to syntactic form, enabling a focus on the development of an appropriate semantic structure for modelling syntactic regularities. For a full description of the HPSG implementation, the reader is referred to [Verspoor, 1994].

2 Semantic Representation

Neglect by computational linguists of the representational insights provided by Jackendoff and Pinker, despite their significance for the development of a cognitively motivated lexical semantic representation system, has stemmed from their apparent informal nature. It is, however, possible to shape their representations into a formalism which maintains psychological insights while rendering them implementable. In the work presented here, Jackendoff and Pinker's theories were integrated to create a formalised representation which was incorporated into an Attribute Logic Engine [ALE] [Carpenter, 1993] implementation of an HPSG grammar for English [Penn and Carpenter, 1993].

2.1 Cognitive Grounding

Semantic primitives are not a new idea, but have been seriously criticised due to their representational limitations. What differentiates the Jackendoff/Pinker approach from previous proposals is that the aim is not to provide a set of primitives capable of representing all concepts, but rather to identify elements of semantics which consistently have relevance to syntax. This is done through analysis of linguistic data. In particular, sets of syntactically related sentences are investigated for the relations which obtain among them. Relations which obtain in many sets are postulated as general principles. For example, a distinction between verbs expressing states and those expressing events is evident from the contrast in (3a,b) [Jackendoff, 1983].

$$\text{(3a)} \quad \textit{What happened was that} \left\{ \begin{array}{l} \textit{the rock fell off the table.} \\ \textit{the mouse ran up the clock.} \end{array} \right\}$$

$$\text{(3b)} \quad ?\ \textit{What happened was that} \left\{ \begin{array}{l} \textit{the rug lay on the floor.} \\ \textit{the statue stood in the park.} \end{array} \right\}$$

Proposals made on the basis of such linguistic analysis are tested via studies of children's use of invented verbs assigned meanings incorporating the proposed critical semantic elements. Pinker (1989) provides a thorough overview of such research.

The importance of the identification of the representational elements via such psycholinguistic investigation is that the elements are based on linguistically recurring semantic relations, in contrast to the seemingly ad hoc nature of previous attempts at semantic decomposition. Furthermore, since this approach does not assume that the semantic elements are sufficient for capturing meaning, the issue of representational limitations does not arise. The representational elements can provide the basis for models of grammatical phenomena more accurate than purely syntactic models. Such models take advantage of insights about the influence of semantics on the syntactic phenomena through evaluation of the represented semantic features.

2.2 The Representation

The essential components of the representation are outlined below. It reflects the integration of elements relevant to dative alternation, from [Pinker, 1989] and [Jackendoff, 1990]. The specific source for each component and the resolution of differences between the two sources will not be addressed. See Table 1 for explicit specification of the elements.

- **Conceptual Constituents** A set of conceptual primitives corresponding to ontological categories which aim to characterise most grammatically relevant semantic distinctions.

Conceptual Constituents	
EVENT, STATE, THING, PLACE, PATH, PROPERTY, MANNER	
Predicate Definitions	
GO	an Event-function which denotes a Thing traversing a Path.
STAY	an Event-function which denotes stasis over a period of time; two arguments: the Thing standing still and its location (Place).
MOVE	an Event-function which specifies that a Thing moves.
ORIENT	a State-function specifying the orientation of a Thing with respect to a Path.
BE	a State-function for specifying the location (Place) of a Thing.
HAVE	a State-function which specifies a Thing which has (possesses) a Thing.
AFF	a State-function which specifies that an actor "affects" a patient.
Place Functions	
at, on, in, under...	functions expressing location.
Path Functions	
to, from, via away-from, toward	functions expressing direction.
Subordinating Relations	
effect, cause, despite, but, let, prevent, means, for/to, obligates, fulfills	
Semantic Field Features	
`epistemic, perceptual, physical, possessional, psychological, spatial, existential`	

Table 1: Representational Elements

- **Predicates** Functions which denote particular relations between conceptual constituents.

- **Subordinating Relations** A set of predicates used to express complex verb semantics by relating subevents within verb semantic structure in particular ways. Adopted from [Pinker, 1989], they differ from other predicates in that they are one-ary predicates which may take only an EVENT or STATE as an argument.

- **Semantic Field Features** There are a host of parallelisms between spatial expressions and expressions for more abstract states. For example, (4a) and (4b) have parallel syntax, but the former expresses spatial motion while the latter expresses a change of possession.

  (4a) *John went to the park.*

  (4b) *The inheritance went to the children.*

  The underlying semantics of these distinct uses of *go* differ only in the interpretation of the types of entities which may appear as arguments to the predicate

$$[\text{EVENT}] \rightarrow \left\{ \begin{array}{l} \left[_{\text{EVENT}}\ \text{GO}\ \left(\text{THING},\ \text{PATH},\ \textit{time},\ \textit{manner} \right) \right] \\ \left[_{\text{EVENT}}\ \text{STAY}\ \left(\text{THING},\ \text{PLACE},\ \textit{time} \right) \right] \\ \left[_{\text{EVENT}}\ \text{MOVE}\ \left(\text{THING},\ \textit{time},\ \textit{manner} \right) \right] \end{array} \right\}$$

$$[\text{STATE}] \rightarrow \left\{ \begin{array}{l} \left[_{\text{STATE}}\ \text{BE}\ \left(\text{THING},\ \text{PLACE},\ \textit{time} \right) \right] \\ \left[_{\text{STATE}}\ \text{HAVE}\ \left(\text{THING},\ \text{THING},\ \textit{time} \right) \right] \\ \left[_{\text{STATE}}\ \text{ORIENT}\ \left(\text{THING},\ \text{PATH},\ \textit{time} \right) \right] \\ \left[_{\text{STATE}}\ \text{AFF}\ \left(\text{THING},\ \text{THING},\ \textit{time},\ \textit{manner} \right) \right] \end{array} \right\}$$

$$[\text{PLACE}] \rightarrow \left[_{\text{PLACE}}\ \textit{place function} \left(\text{THING} \right) \right]$$

$$[\text{PATH}] \rightarrow \left[_{\text{PATH}}\ \left\{ \begin{array}{c} \text{to} \\ \text{from} \\ \text{toward} \\ \text{away} - \text{from} \\ \text{via} \end{array} \right\} \left(\left\{ \begin{array}{c} \text{THING} \\ \text{PLACE} \end{array} \right\} \right) \right]$$

Table 2: Formation Rules

GO and the role played by location. These differences are annotated by a label indicating the abstract semantic field in which the predicate is to be interpreted. For (4b), the predicate is notated as $\text{GO}_{\texttt{possessional}}$, and is interpreted as denoting that a Thing becomes possessed by something else (Thing_2). The Path argument is represented as [*to (at (Thing*$_2$*))*]. Table 1 lists those semantic fields relevant to dative alternation.

- **Time** Temporal relations among subevents in the verbal semantic structure are represented through the association of specific "time points" – time_0, time_1, time_2 – with each occurrence (EVENT or STATE). Occurrences with no clear endpoint are indicated by a *continuous* marker rather than a time point[1].

- **Manner** An element associated with certain occurrences which indicates how an actor acts or a theme changes.

- **Formation Rules** Rules which specify valid predicate–argument structure. They are outlined in Table 2.

- **Action and Thematic Tiers** Actor/patient relations are captured in an *action tier*, while relations pertaining to motion and location and their extensions

[1]Note that this treatment avoids issues of tense and aspect, focusing solely on rough temporal relations among subevents expressed in the verbal semantics.

$$[\text{DESCRIPTION}] \rightarrow \left\{ \begin{array}{c} [\text{STATE}] \\ [\text{EVENT}] \\ [\text{COMPLEX\_DESCRIPTION}] \end{array} \right\}$$

$$[\text{COMPLEX\_DESCRIPTION}] \rightarrow \left[\begin{array}{c} \text{ACTION\_TIER} \\ \text{THEMATIC\_TIER} \end{array} \right]$$

$$[\text{ACTION\_TIER}] \rightarrow \left[{}_{\text{STATE}}\ \text{AFF} \left(\text{THING},\ \text{THING},\ \mathit{time},\ \mathit{manner} \right) \right]$$

$$[\text{THEMATIC\_TIER}] \rightarrow \left[\left\{ \begin{array}{l} \mathit{SubordFunc}_1 \left(\left\{ \begin{array}{c} \text{EVENT} \\ \text{STATE} \end{array} \right\} \right), \\ \mathit{SubordFunc}_2 \left(\left\{ \begin{array}{c} \text{EVENT} \\ \text{STATE} \end{array} \right\} \right), \\ \vdots \end{array} \right\} \right]$$

Table 3: Semantic Description Grammar

into other semantic fields are captured in a *thematic tier*. The thematic tier expresses the causal relationships between the relation in the action tier and other occurrences encompassed by a verb's semantics.

The grammar for valid semantic descriptions relevant to the modelling of dative alternation is found in Table 3, where *SubordFunc* refers to an element of the set of subordinating relations.

The lexical entry in (5a) below provides an example of the use of the introduced representation for the semantics of a particular verb, *pay*. The first line of the entry shows the word to which the entry corresponds, and the second line shows its syntactic category. The third line shows the word's subcategorisation list, including the subject, with the arguments appearing in surface order[2]. The remaining lines contain a substructure representing the word's grammatically relevant semantics[3]. The semantic structure shown in (5a) can be interpreted as expressing, "NP_1 acts on NP_2, which has the property of being *money*, such that NP_2 goes into NP_3's possession." (5b) provides an example of a relevant use of *pay*.

[2] Although the HPSG theory dictates that elements on the subcat list appear in order of obliqueness, the ALE implementation requires this to correspond to surface order.

[3] This example requires a COMPLEX_DESCRIPTION to capture the verb's semantics. The top line of the substructure contains the action tier and subsequent lines contain the thematic tier. Each subordinating relation in the notation appears in italics (e.g. *effect*), with the subordinated occurrence appearing indented underneath it. Properties are notated as superscripts on THINGs (e.g. $\text{THING}_2{}^{money}$), semantic fields are notated as subscripts on the function to be interpreted in a different field (e.g. $\text{GO}_{\texttt{possession}}$), and numerical subscripts denote structure sharing. In particular, the coindexing between NPs and THINGs indicates that they share an HPSG INDEX value.

(5a)

$$\left[\begin{array}{l} \text{pay} \\ \text{V} \\ \text{NP}_1,\ \text{NP}_2,\ \text{to NP}_3 \\ \left[\begin{array}{l} \textsc{aff}\ (\textsc{thing}_1,\ \textsc{thing}_2{}^{money},\ \text{time}_0,\ \text{no\_manner}) \\ \left\{\begin{array}{l} \textit{effect} \\ \quad (\textsc{go}_{\textsf{possession}}\ (\textsc{thing}_2,\ \text{to (at }(\textsc{thing}_3)),\ \text{time}_0,\ \text{no\_manner})) \end{array}\right\} \end{array}\right] \end{array}\right]$$

(5b) *John pays £25 to Bill.*

3 Handling Dative Alternation

As argued in the introduction, the dative alternation is an example of a grammatical phenomenon for which, in any adequate model, syntactic factors cannot be isolated from semantic factors. Semantic features of words play a clear role in the determination of allowed syntactic argument structure of dative verbs and simply cannot be ignored.

Pinker (1989) convincingly argues for the semantic basis of this syntactic phenomenon, showing that subclasses of verbs which share syntactic alternation properties can be delineated on the basis of semantic similarity. He uses the identification of semantic structure common to all verbs in a subclass as the basis for definition of lexical rules which control alternation: one lexical rule is tailored to the semantics of each alternation semantic subclass (e.g. verbs of giving [*give*], illocutionary verbs of communication [*tell*], verbs of future having [*bequeath*]). That is, the common semantic structure of each alternating subclass serves as an input constraint of a lexical rule. Verbs in non-alternating subclasses (e.g. verbs of manner of speaking [*shout*], verbs of fulfilling/deserving [*present*]), will be prevented from doing so because no lexical rule will exist specifying the semantics of that subclass as its required input structure. The core semantic structure for nonalternating subclasses differs substantially enough from the semantics of alternating subclasses to prevent the lexical rules for the alternating subclasses from being applicable.

By requiring a distinct lexical rule for each alternating subclass, Pinker's treatment misses generalisations about which semantic criteria typically interact to distinguish alternating from nonalternating verb subclasses. Upon analysis of his semantic subclasses, however, these criteria have been identified as [i] the type of properties associated with a direct object, [ii] the semantic field of subordinated occurrences, and [iii] the temporal nature of the occurrences in the action and thematic tiers. Furthermore, his proposals for the lexical rules are inadequately defined and demand formalisation.

The subclasses identified by Pinker, along with his theoretical insights into the general nature of lexical rules and the specific nature of each verb subclass, were adopted in the current implementation. The lexical rules, however, were explicitly defined in terms of semantic criteria represented in the formalism introduced above. ALE provides a built-in mechanism for lexical rules, generating new lexical entries from existing entries fitting a specified format. Six lexical rules were defined to handle the alternation properties of forty-five "to"-dative and "for"-dative verbs belonging to twelve

(6) Basic "to"-dative Lexical Rule

$$\begin{bmatrix} \text{V} \\ \text{NP}_1,\ \text{NP}_2,\ \text{to NP}_3 \\ \begin{bmatrix} \textsc{aff}\ (\textsc{thing}_1,\ \textsc{thing}_2^{\{\textit{no property, simple property}\}},\ \textsc{pt\_in\_time}_0,\ \textsc{manner}_4) \\ \left\{ \begin{array}{l} \textit{effect} \\ \quad (\textsc{go}_{\{\texttt{possession, spatial}\}}\ (\textsc{thing}_2,\ \text{to (at}\ (\textsc{thing}_3)),\ \textsc{pt\_in\_time}_5,\ \textsc{manner}_6)), \\ \textit{Remaining\_Set\_Thematic}_7 \end{array} \right\} \end{bmatrix} \end{bmatrix}$$

$$\Updownarrow$$

$$\begin{bmatrix} \text{V} \\ \text{NP}_1,\ \text{NP}_3,\ \text{NP}_2 \\ \begin{bmatrix} \textsc{aff}\ (\textsc{thing}_1,\ \textsc{thing}_3,\ \textsc{pt\_in\_time}_0,\ \text{no\_manner}) \\ \left\{ \begin{array}{l} \textit{effect} \\ \quad (\textsc{have}\ (\textsc{thing}_3,\ \textsc{thing}_2,\ \textsc{pt\_in\_time}_5)), \\ \textit{Remaining\_Set\_Thematic}_7 \end{array} \right\} \end{bmatrix} \end{bmatrix}$$

verb subclasses, reflecting significant generalisation of semantic criteria common to alternating verbs. The input requirements of the lexical rules for the "to"-dative forms vary only in the three critical semantic elements identified in the previous paragraph. Verbs either do or do not match the input structures of a lexical rule due to the values of these elements.

The definition of lexical rules in this way has an additional benefit in that it enables capturing of differences in semantic interpretation which are associated with the alternate syntactic forms. Any purely syntactic approach to the alternation clearly cannot directly account for these differences. The changes in semantic structure which accompany syntactic alternation are identified by Pinker (1989) through analysis of the differing psychological and pragmatic consequences of the alternating syntactic forms. The differences are accommodated within the lexical rule definitions by outputting lexical entries which not only contain a modified subcategorisation list, but also a semantic structure which is a manipulated version of the semantic structure of the input entry. The essential semantic difference between the dative and the double object forms according to Pinker is that the dative form *X gimbles Y to Z*[4] incorporates "X causes Y to go to Z" into the semantic representation for the verb *gimble* with this argument structure, while the double object form *X gimbles Z Y* incorporates "X causes Z to have Y"[5]. This is the broad semantic alternation reflected in each "to"-dative lexical rule.

The most general of the lexical rules handles the alternation of several subclasses of "to"-datives, and is shown in (6). The other lexical rules will not be introduced here, but are designed to handle more specific requirements of the alternating subclasses. Each incorporates the core semantic shift associated with dative alternation

[4] *gimble* is a marker for any verb which appears in this syntactic configuration.

[5] Each of these structural glosses is highly generic. GOing and HAVE-ing can be interpreted in other semantic fields. For example, in ***John told a story to Mary***, John causes a story to be communicated to Mary, incorporating a $\textsc{go}_{\texttt{communication}}$ predicate.

as identified by Pinker, and varies only in the values of the three critical semantic elements.

The rule in (6) will generate a new lexical entry from all lexical entries which match the input structure. In particular, matching lexical entries will be verbs in the dative form, whose semantics involve an agent AFFecting a patient at some particular point in time, such that the patient GOes (in either the spatial or possessional senses) to the argument of the preposition. The generated entries will be verbs in the double object form, specifying that an agent AFFects the first object at a particular point in time such that the first object HAS the second object. Any manner specified for the AFF relation in the input is tolerated, and any additional occurrences specified in the thematic tier will be carried over to the generated lexical entry.

The application of this lexical rule to the subclass of *verbs of instantaneous imparting of force in some manner causing ballistic motion* [*throw*] compared with its application to the related subclass of *verbs of continuous imparting of force in some manner causing accompanied motion* [*pull*] clarifies how lexical rules control alternation and shows how certain semantic properties not critical for dative alternation are ignored in the application of the rule. Verbs in the *throw*-subclass alternate as in (7a,b) while verbs in the *pull*-subclass, do not, as was shown in (2a,b). The lexical entries for these verbs are shown in (7c) and (8).

(7a) *John threw the ball to Mary.*

(7b) *John threw Mary the ball.*

$$(7c)\quad \left[\begin{array}{l} \text{throw} \\ \text{V} \\ \text{NP}_1,\ \text{NP}_2,\ \text{to NP}_3 \\ \left[\begin{array}{l} \textsc{aff}_{\texttt{physical}}\,(\textsc{thing}_1,\ \textsc{thing}_2,\ \text{time}_0,\ \text{throwing\_manner}) \\ \left\{\begin{array}{l} \textit{effect} \\ \quad (\textsc{go}_{\texttt{spatial}}\,(\textsc{thing}_2,\ \text{to (at }(\textsc{thing}_3)),\ \text{time}_1,\ \text{no\_manner})) \end{array}\right\} \end{array}\right] \end{array}\right]$$

$$(8)\quad \left[\begin{array}{l} \text{pull} \\ \text{V} \\ \text{NP}_1,\ \text{NP}_2,\ \text{to NP}_3 \\ \left[\begin{array}{l} \textsc{aff}_{\texttt{physical}}\,(\textsc{thing}_1,\ \textsc{thing}_2,\ \text{continuous},\ \text{pulling\_manner}) \\ \left\{\begin{array}{l} \textit{effect} \\ \quad (\textsc{go}_{\texttt{spatial}}\,(\textsc{thing}_2,\ \text{to (at }(\textsc{thing}_3)),\ \text{continuous},\ \text{no\_manner})) \end{array}\right\} \end{array}\right] \end{array}\right]$$

Verbs like *throw* alternate via the lexical rule (6). The entry in (7) matches the input required by the lexical rule, and thus the rule generates the entry in (9). Both the general structure and the details of its semantics – the semantic field features associated with the predicates, the instantaneous nature of the time points, the specific manner in which the agent AFFects the patient – are compatible with the input requirements.

Verbs like *pull*, however, are prevented from alternating because they do not match the input required by any lexical rule. In particular, these verbs do not match the form

$$
(9)\quad \begin{bmatrix} \text{throw} \\ \text{V} \\ \text{NP}_1,\ \text{NP}_3,\ \text{NP}_2 \\ \begin{bmatrix} \textsc{aff}\ (\textsc{thing}_1,\ \textsc{thing}_3,\ \text{time}_0,\ \text{no\_manner}) \\ \left\{ \begin{array}{l} \textit{effect} \\ \quad (\textsc{have}\ (\textsc{thing}_3,\ \textsc{thing}_2,\ \text{time}_1)) \end{array} \right\} \end{bmatrix} \end{bmatrix}
$$

required by (6) because they specify continuous rather than instantaneous events, as reflected in the *time* fields associated with each predicate.

Each of the verbs in this implementation required only one lexical entry in the base lexicon, reflecting its syntactic and semantic argument structure in the dative form. When the program was loaded into ALE, each lexical entry was evaluated by each lexical rule. Any entry which matched the input requirements of a lexical rule resulted in the generation of a related entry reflecting the alternate possible syntactic and semantic structure for the verb. Thus lexical entries for verbs in the double object form would only be generated for those verbs with semantic structures appropriate to the alternation. The introduction of the lexical rules significantly reduced the size of the lexicon by requiring a single entry for verbs participating in dative alternation.

The system neither over- nor under- generated. A maximum of one lexical entry in the double object form was generated for each verb. An appropriate lexical entry was generated for each verb belonging to an alternating subclass. Crucially, no lexical entries were mistakenly generated for verbs belonging to nonalternating subclasses. The six lexical rules were therefore precisely adequate for modelling dative alternation.

In addition, the approach accommodates generalisation of argument structure to newly learned verbs. That is, given a representation of a dative verb's semantics in the lexicon, the system is capable of determining whether the verb will alternate. This is done via attempted application of the dative alternation lexical rules to the lexical entry: if the newly acquired verb has a semantic structure compatible with the input requirements of a lexical rule, a second lexical entry in the double object form will be generated. Otherwise, only the dative form of the verb will be allowed by the system. This generalisation property mimicks children's use of newly learned verbs – they use dative verbs only in syntactic forms predictable from their semantics, rather than indiscriminately using both dative and double object forms for these verbs. The lexical rules thus seem to reflect a natural cognitive process.

4 Conclusions

This paper has described a system which utilises formalised psychological insights about the semantics underlying dative alternation to constrain the size of the base lexicon. Each verb in the lexicon requires only one entry for the dative form; the related double object form will be generated automatically if its semantics satisfy specific semantic criteria as defined by lexical rules. Furthermore, the approach provides a direct mechanism for capturing correspondences between syntactic form and semantic interpretation. The existence of a working system shows that it is computationally realistic to incorporate semantic features into the lexicon, and to use these features in the treatment of syntactic phenomena. The representation and general method of modelling alternations presented can be extended to alternations other than the dative, such as the causative, the locative, and the passive. The semantic components incorporated into the representation have relevance for many more syntactic phenomena.

The specific analysis of the semantic basis for the alternation presented here is not critical, but the conclusion that reference to semantic factors can lead to more accurate and linguistically motivated models has implications for future development of NLP systems. Specifically, semantic factors play a critical role in grammatical phenomenon. Semantic features must therefore be incorporated into NLP lexicons and utilised if adequate treatments of syntactic phenomena are to be achieved.

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