# Motion Verbs and Semantic Features in TAG*

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## 1 Introduction

We show how the domain of locality in a TAG elementary tree, (Frank 1992), can be extended through adjunction to include optional arguments for a class of motion verbs and how the adjunctions can be restricted appropriately through the use of semantic features. Some examples of motion verbs we consider are shown in Table **??**, which categorizes the verbs according to Levin classes (Levin 1993). Note that we are using a broader definition of "motion" verbs than Levin's class 51.

| VIDMs | Roll | Run | Force | Carry |
|---|---|---|---|---|
| arrive | float | jump | press | carry |
| enter | roll | run | pull | lug |
| escape | slide | slide | push | pull |
| exit | rotate | walk | | push |
| | turn | | | |

Table 1: Levin Classes of Verbs Involving Motion

These verbs are classified according to their syntactic behavior, which is taken to be a reflection of their underlying semantic properties. Motion verbs are able to occur with path phrases, where the term "path" is used as a cover term for *source*, *goal*, *via* and directional modifiers (PPs and adverbs), along the lines of Jackendoff (1976, 1990). Examples of these are given in (**??**-**??**).

## 2 Manner of motion verbs: (Run and Roll classes)

(1) I ran to the store. (goal)

(2) I ran from the room. (source)

(3) I slid the sleeve over the valve. (via)

(4) I slid the coupling nut forward. (direction)

We analyze manner of motion verbs as having the feature [eventType: motion:+]. Path phrases are constrained to only adjoin onto motion-compatible VPs.

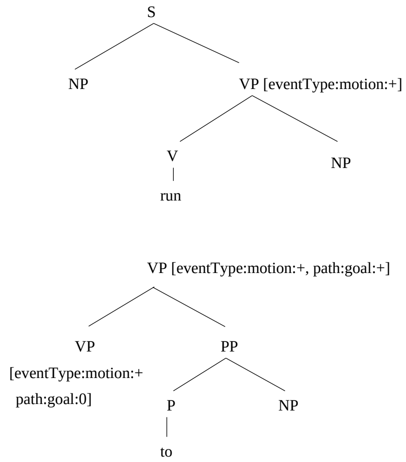


Figure 1: Elementary Tree for *run* and Auxiliary Tree for *to* PP

## 3 Explanation of Features

Within the feature structure that we propose there are several features whose values are not atomic, rather the feature contains another complex feature structure. For example, the feature [eventType] can be multi-valued. Possible features within [eventType] are [motion], [force], and [contact]. Similarly, path is composed of a complex feature structure which has the features [via], [direction], [source], and [goal]. The path features can take the values +,

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0, or NONE. [1] A "+" value means that the feature has been specified. A "0" value means that it has not yet been specified, but that it is appropriate for this feature to have a value. The feature [path: goal:0] or [path: source:0] occurs in the foot node of adjoining trees that represent source or goal, to ensure that an element with that value has not already been adjoined. An example is shown in Figure **??** above. The value "NONE", on the other hand, means that it is not appropriate to specify this value.

EventType features are also atomically valued, taking the values + or –. Having the feature [eventType: motion:–] means that the event is unable to be interpreted as a motion event and entails that path phrases cannot adjoin on. An example of a verb with this feature might be *eat*. On the other hand, non-specification of the [eventType: motion] feature entails that path phrases can adjoin. If a path phrase does adjoin, the event becomes a motion event. Sound emission verbs are of this sort.

## 4 Verbs of Inherently Directed Motion

The class of verbs of inherently directed motion (VIDMs) have a path component built into the meaning of the verb. Usually the verb specifies a source, as in *leave* and *exit*, or a goal, as in *enter*, *arrive*.

One interesting property of VIDMs is that they have a more limited ability to take path PPs even though they are motion verbs. For example, *arrive* does not take a prototypical goal PP (with the preposition *to*), but instead takes a locative PP which represents the goal of motion.

(5) a. Mary arrived at the station.
    b. * Mary arrived to the station.

(6) arrive = [GO [TO X]]
    (where X=location)

Following Jackendoff 1990, we analyze the goal function "TO" as being incorporated in the LCS of *arrive*, shown in (**??**). The PP slot in the subcategorization frame is coindexed with the location argument slot X. Therefore, the PP that represents the goal must be a location. In TAG terms, we assume that the part of the path inherently specified in the verb semantics constitutes an (optional) argument. In order to constrain what kind of preposition can instantiate the goal, we will need to define a class of locative prepositions and impose a constraint on the P node so that only this class is allowed to occur there. For now, we show the feature [locative:+] on the P node of the elementary tree for *arrive* in Figure **??**.

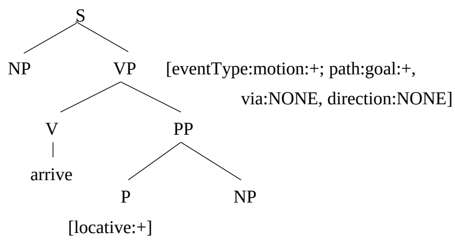


Figure 2: Elementary Tree for *arrive*

In addition, many VIDMs (like *arrive, enter, exit*) are achievement verbs; that is, they have no durative aspect. Because of this, they cannot take a path phrase that modifies durative motion.

(7) John arrived (*around the lake) at Mary's house.

The [via:NONE] and [direction:NONE] features in the VP node in Figure **??** represent a non-durative path. While via and direction PPs cannot occur with *arrive*, a source can be specified, as shown in (**??**), because this does not conflict with the lack of durativity of the event.

(8) John arrived in Chicago from Philadelphia.

## 5 Regular sense extensions

Path phrases can adjoin to a VP node which is unspecified for motion. Even verbs that are not inherently motion verbs can be modified by path phrases, augmenting their semantic representation to include explicit motion. For instance, verbs of sound emission such as *whistle* and *roar* can convey directed motion when they appear with path phrases, as in (**??**) and (**??**).

(9) The train whistled into the station.

[1] We use atomically valued features for source and goal rather than putting in the actual value of the goal (i.e. the referent of the goal) because the simple presence or absence of these features is what affects the derivation. That is, having a goal present means that another goal cannot adjoin on (but see footnote **??**). For this purpose, the referent of the goal does not need to be represented.

(10) The truck roared past the weigh station.

Additionally, we see other cases where the syntactic frame in which a verb occurs determines the senses that a verb can have. For example, *push* can have the senses shown in (**??**–**??**). (See Dang et al. 1998 for discussion).

(11) Mary pushed the chair. [force:+, contact:+]
(12) Mary pushed the cart to the store. [motion:+, path:+]
(13) Mary pushed the branches apart. [motion:+, separation:+]
(14) Mary pushed at the boulder. [motion:–]

The transitive sentences (**??**), (**??**), and (**??**) will all be generated from a transitive elementary tree where the VP node has the features [force:+] and [contact:+], but is unspecified for [motion]. Adjoining in the modifiers *to the store* and *apart* will introduce the additional features listed in (**??**) and (**??**), respectively.

The conative construction (illustrated in (**??**)) is represented by the elementary tree given in Figure **??**.

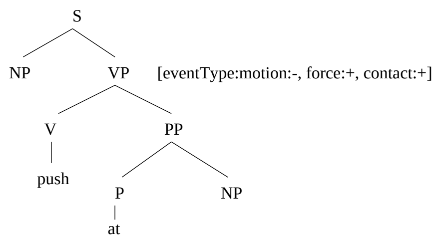


Figure 3: Elementary Tree for Conative Construction

## 6 Tree Families and Optional Arguments

Implicit in our discussion of VIDMs and regular sense extensions above is the assumption that some PPs are arguments of the verbs they occur with, and hence are present in the verb's elementary tree. The cases in question are (1) the PP which represents the inherently specified path of a VIDM; and (2) the *at* PP of the conative construction.

### 6.1 Optional arguments of Verbs of Inherently Directed Motion

The first case is represented by the following example, where *at the station* represents the goal that is implicit in the meaning of *arrive*.

(15) The train arrived at the station.

Note that the meaning of (**??**) is not compositional since *at the station* by itself or combined with a motion verb like *run* can only mean a location of the event.[2] It cannot represent the goal of motion in these cases.

(16) The athlete ran at the gym.
(17) I saw Mary at the station.

It is only with a verb whose meaning includes [goal:+], that an *at*-PP or any other locative PP can represent a goal. Thus, in this example, it is the head verb which determines the role that the PP phrase has in the clause. This kind of idiosyncracy is evidence that a constituent is an argument rather than an adjunct (see e.g., Pollard and Sag 1987; Marantz 1984). By this criterion, then, the PP representing an inherent role of a VIDM should be considered an argument, and thus, should be present in the elementary tree.

It has been noted that all source and goal PPs simultaneously show both argument and adjunct properties. Larson (1988) discusses the argument status of the source and goal phrases in sentences like (**??**) and (**??**).

(18) John walked to the store.
(19) Mary ran from the house.

They act like adjuncts in being optional, but like arguments in being non-iterable. (The following examples are Larson's.)[3]

(20) * John flew to New York to Kennedy Int'l Airport.
(21) * Max got a letter from Felix from his friend.

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[2] It can also have the meaning of *towards*.

[3] Note that (**??**) isn't that bad if the second PP is interpreted as a further specification of the goal location.

(1) ? I ran to Philadelphia to IRCS.

We do not yet have an account of this phenomenon, but we do not take it as counterevidence to the generalization that only one goal may be given per event. This is unlike true modifiers like PPs of location, of which more than one can be given without any restriction:

(2) I hid in the building on the third floor in a classroom under a desk.

Jackendoff (1976) takes motion verbs to contain the abstract predicate GO which is a three-place relation, taking the arguments (x,y,z), where x is an element that moves from y (source) to z (goal).

For current purposes, however, we do not take all sources and goals to be present in the elementary tree. Only PPs whose meaning is implicit in the meaning of the verb itself are present in the elementary tree, whereas all other PPs are adjoined. This is in contrast with the analysis provided by Levin and Rappaport Hovav (1995) in which all sources and goals are treated as arguments as a result of a lexical rule that applies to verbs of motion.

### 6.2 The Conative Construction and Elementary Trees

The other case to consider is the conative *at* construction, shown in (**??**).

(22) The child hit at the ball.

We assume that the conative *at* PP is present in the elementary tree. If we took the *at* PP to be adjoined in, then an intranstive elementary tree for *hit* is required. However, *hit* can only occur transitively, and so we would need additional mechanisms for blocking the intransitive tree from ever occurring outside of the conative construction.

On the other hand, we could take the position that the noun phrase (*the ball* in (**??**)) is an argument of the verb, and *at* adjoins in. However, it is not possible for a PP to adjoin at this point.[4]

The conative is properly analyzed as a lexical process of object demotion – an operation that applies to the lexical representation of the verb, affecting its argument-structure. It demotes a direct object to be an oblique element with the effect that the object is interpreted as not affected by the action of the verb. However, in TAG, there is no level of representation independent of the elementary trees in which demotion operations of this sort could take place. Therefore, the best TAG analysis of the conative treats the PP as an argument, and hence, present in the elementary tree.

[4]It would only be possible for an NP to adjoin, requiring an analysis of the *at* PP as an NP, which is linguistically unmotivated.

## 7 Conclusion

The goal of our work is to capture lexical semantic properties that we hope will be helpful in reducing the search space in parsing, as well as aid in generation (SPUD; see Stone and Doran 1997; Stone and Webber 1998) and machine translation (in the transfer of lexical semantic properties) (see Palmer, et al. (to appear)).

We have examined several subclasses of motion verbs, and posited features to capture their semantic properties. These features not only allow us to place restrictions on the verbs to constrain possible derivations, but also allow us to account for regular sense extensions through the underspecification of certain features and by having modifiers introduce these features in the course of the derivation.

## References


Dang, H. Trang, K. Kipper, M. Palmer, J. Rosenzweig. (1998). Investigating regular sense extensions based on intersective Levin classes. ACL

Frank, R., (1992). *Syntactic locality and Tree Adjoining Grammar: grammatical, acquisition and processing perspectives.* PhD Thesis, University of Pennsylvania, Technical Report IRCS-92-47.

Jackendoff, R. (1976). Toward an Explanatory Semantic Representation. *Linguistic Inquiry* 7, 89-150.

Jackendoff, R. (1990). *Semantic Structures.* MIT Press.

Larson, R. (1988). Implicit Arguments in Situation Semantics. *Linguistics and Philosophy* 11:169-201.

Levin, B. (1993). *English Verb Classes and Alternations.* University of Chicago Press.

Levin, B., and M. Rappaport Hovav. (1995). *Unaccusativity: At the Syntax-Lexical Semantics Interface.* MIT Press.

Palmer, M., J. Rosenzweig, W. Schuler. (to appear, 1998). Capturing Motion Verb Generalizations with Synchronous TAGs. in St. Dizier, Patrick, *Predicative Forms in NLP*, Kluwer Press.

Stone, M. and C. Doran. (1997). Sentence planning as description using tree-adjoining grammar. *Proceedings of ACL*, 198–205.

Stone, M. and B. Webber. (1998). Textual economy through close coupling of syntax and semantics. *International Natural Language Generation Workshop*