Integrating Data from The Preposition Project into FrameNet

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Abstract

In the course of The Preposition Project, FrameNet sentences are used as instances to characteize preposition behavior. FrameNet sentences containing prepositional phrases beginning with a given preposition are presented to a lexicographer, whereupon the given preposition is tagged with a sense from a sense inventory derived from the Oxford Dictionary of English. For the 34 prepositions used in the SemEval-2007 task on preposition disambiguation, over 25,000 instances were so tagged. Since each instance, i.e., a prepositional phrase, had already been tagged by the FrameNet lexicographers with a frame element for a particular frame, each sense in The Preposition Project has an associated set of (Frame, FrameElement) pairs. For the 25,641 instances, 18,470 instances are FrameNet core frame elements, 4,518 are FrameNet peripheral frame elements, and 1,676 are FrameNet extra-thematic frame elements. Since, in general, prepositions are not targets for the FrameNet project, data from The Preposition Project provide an opportunity to make a systematic attempt to expand the treatment of prepositions in FrameNet. This paper describes various analyses upon data from The Preposition Project and FrameNet to explore and develop steps that can be taken.

1 Introduction

In the FrameNet project, developing frame semantic specifications to be associated with lexical units, prepositions are only rarely the target of detailed analysis. However, there are about 20 frames that have been developed. The Preposition Project (TPP), on the other hand, is designed to characterize preposition behavior. A principal source of data for TPP are instances drawn from the FrameNet database of sentences that have been analyzed for other parts of speech (open class words), in which prepositional phrases have been tagged as frame elements. The considerable work performed in TPP can potentially be used for a systematic extension of the FrameNet preposition senses.

2 The Preposition Project

The Preposition Project (TPP) is designed to provide a comprehensive characterization of the behavior of all single-word and phrasal prepositions in the English language (Litkowski & Hargraves (2005), Litkowski & Hargraves (2006)). The first phase of TPP was begun in late 2004 and will be completed in June or July of 2007. This phase consists of an initial characterization of each preposition sense, including the assignment of a (placekeeping) semantic relation or role name, characterization of the properties of the complement and attachment point, characterization of the definition as a core or subsense, identification of the syntactic position of a prepositional phrase (e.g., sentence beginning, or following a noun, a verb, or an adjective), and identification of other prepositions which have a similar sense.

The starting point for the analysis of a preposition is its sense inventory. The initial sense inventory is from *The New Oxford Dictionary of English* (NODE, 1998), as updated by *The Oxford*

Dictionary of English (ODE, 2003). Since prepositions are quite stable (as a closed class), the differences between NODE and ODE are relatively minor. For all practical purposes, ODE has been used as the initial sense inventory. During the course of analyzing a preposition's behavior, the TPP lexicographer may find it necessary to modify the sense inventory. As a result, the sense inventory for common prepositions has increased by approximately 10 percent.

FrameNet sentences are used as instances to characterize preposition behavior. FrameNet sentences containing prepositional phrases beginning with a given preposition are presented to a lexicographer, whereupon the given preposition is tagged with a sense from the ODE sense inventory. For the 34 prepositions used in the SemEval-2007 task on preposition disambiguation (Litkowski & Hargraves, 2007), over 25,000 instances were so tagged. Since each instance, i.e., a prepositional phrase, had already been tagged by the FrameNet lexicographers with a frame element for a particular frame, each sense in TPP has an associated set of (Frame, FrameElement) pairs. For the 25,641 instances, 18,470 instances are FrameNet core frame elements, 4,518 are FrameNet peripheral frame elements, and 1,676 are FrameNet extra-thematic frame elements.

3 Prepositions in FrameNet

In general, prepositions are not targets for the FrameNet project. There are 94 lexical unit senses identified as prepositions, of 22 have annotations and 17 are full prepositional phrases (which may better be construed as adverbs). Some of the other lexical units (as indicated by their definitions) may also better be construed as adverbs (e.g., some senses of *in*, *out*, and *off*). Forty-five of the lexical unit definition sources identify the *Concise Oxford Dictionary* (COD); these senses are almost all identical to senses in ODE. Another 16 lexical unit senses identify FN as the definition source.

Several questions arise in considering the interaction between the FrameNet project and TPP:

- How to interpret the frame elements arising from the TPP instances with the FrameNet preposition frames and its elements?
- What to do with preposition senses that have TPP instances but that have no FrameNet frames?
- What to do with FrameNet prepositions that have FrameNet definitions?
- What to do with preposition senses that have no TPP instances and have no FrameNet frames?

These questions and possible strategies for dealing with the full range of English preposition senses are explored in the following sections.

4 Strategies for Incorporating TPP Data into FrameNet Prepositions

4.1 FrameNet Preposition Frames with TPP Instances

The most direct confluence of data between FrameNet and TPP occurs when (1) the FrameNet definition is taken from COD and is the same as that given in ODE, (2) FrameNet has annotated sentences with these preposition senses as targets, and (2) TPP has tagged instances with that sense. There are 4 such cases, as shown in Table 1, which presents the preposition, the definition, the FrameNet frame, and the TPP (frame, frame element) pairs in the instances that have been tagged

with this sense. The prepositions and the FrameNet frames are *beyond* (Locative_relation), *off* (Locative_relation), *from* (Time_vector), and *like* (Similarity).[1]

When FrameNet has annotated sentences containing the target preposition and assigned sentence components to the frame, it is possible to make a direct comparison with the frame elements assigned in sentences when the target is from another part of speech. In particular, the immediate question is what is the relationship between the frame element of the preposition frame and frame element that has been assigned in the TPP instances. For example, the object of the preposition *beyond* or *off* is assigned to the *Ground* frame element in the preposition frame, but has a diversity of frame elements among the TPP instances (including *Ground*, *Path*, *Area*, *Goal*, and *Place*). In this example, it is perhaps possible to posit that the TPP instances are specializations of the preposition frame element. For *from*, where the frame element is *Landmark_event*, the TPP instances have frame elements that are less directly comparable (including *Source*, *Path*, *Depictive*, and *Path_start*). For *like*, where the frame element is *Entity_2*, the TPP instances are mostly labelled as *Manner*.

The next most comparable sets of FrameNet and TPP data occur when there is a FrameNet frame, but no annotations, but with many instances available from TPP. These 22 cases are shown in Table 2. (In most cases, this table shows only a partial list of the all the instances.) Although there are no annotations for the preposition frames, the range of TPP instance frame element names can be directly compared with the preposition frame element that corresponds to the object of the preposition.

It should be pointed out that in Tables 1 and 2, there may be slight differences between the FrameNet COD definition and the one from ODE. These differences are italicized and are essentially minor, arising from the fact that COD was developed earlier than ODE and that ODE is a larger dictionary and contains a fuller expression of a preposition sense. This is clearly the case in the differences that are italicized.

4.2 TPP Instances without FrameNet Preposition Frames

As noted above, TPP has tagged a large number of instances for the most common prepositions, covering 332 senses for the prepositions included in SemEval-2007. Although a large number of these senses had no instances found in the FrameNet sentences that were used as the instance set (perhaps 50 senses), the remaining instances provide a rich set of data that can be used as the basis for developing specific FrameNet frames.

To mine this data, it would perhaps be a useful first step to develop a theory of the relation between the core preposition frame element and the frame elements of the TPP instances. A working hypothesis could be that the core frame elements are in some sense inherited by the various TPP instances. In any event, the range of TPP instance frame elements can be examined in an attempt to arrive at an appropriate frame specification for a FrameNet preposition frame.

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[1] An additional subsense of *off* is shown. This subsense appears thusly in ODE and has more instances in TPP.

4.3 FrameNet Preposition Frames with FrameNet Definitions

As indicated above, 16 lexical unit senses identify FN lexicographers as the source of the definition. The wording of these definitions is not intended to constitute a well-developed definition that might be found in a standard dictionary. Instead, these are intended merely to serve as placeholders. Notwithstanding their lack of precision, it is generally quite straightforward to link these definitions to a corresponding sense in ODE. Once this is done, it would be possible to make use of the available set of TPP instances as described in the previous section.

4.4 Prepositions with Frames and no TPP Instances

About 15 preposition lexical unit senses have no TPP instances. These include single-word prepositions (*astride*, *athwart*, *atop*, *concerning*, *excluding*, *including*, and *regarding*) and phrasal prepositions (*along with*, *in favor of*, *next to*, *together with*, and *up to*). A few of these have annotations, but since they do not appear to have been annotated in sentences with other targets, no independent set of frame elements exist for comparison with the preposition core frame element. Notwithstanding the absence of TPP instances, these senses can still be mapped to ODE. No suggestion is made to modify or reconsider the current FrameNet characterization of these preposition frames. However, they can be examined along with other senses in TPP, as described in the next section.

4.5 Preposition Senses with no Frames and no TPP Instances

In TPP, approximately 300 (mostly phrasal) prepositions, along with about 550 senses, have been analyzed without FrameNet instances. Considerable descriptive information has been developed for these senses. TPP is nonetheless attempting to characterize the behavior of these senses without corpus data. (See particularly Litkowki & Hargraves (2006) and Litkowski (2002).)

The major underlying principle for extending the characterization of these preposition senses lies in the fact that the entire preposition sense inventory forms a hierarchy that can be discerned through a graph-theoretic analysis. A simple example of this phenomenon is provided by entries for the prepositions *concerning*, *with reference to*, *as regards*, and several others. The senses for these entries are frequently defined in terms of one another, and through graph-theoretic analysis, are rooted in a sense of *about* (the topic sense). When this type of analysis is extended to the full preposition dictionary, the various interconnections among the senses are specifically enumerated and eventually, a comprehensive set of primitive definitions can be identified.

The analysis of a preposition digraph is still ongoing, but is presently at a very mature stage, allowing for its use in developing preposition frames. As a first step, the preposition senses mentioned in the previous section can be immediately placed into the developing structure. This would simplify the identification of other lexical units that express a similar sense to those already identifying as instantiating the frames that have been developed. (This can be done as well with preposition senses that already have TPP instances.)

The preposition digraph can be used specifically to ensure that the full gamut of preposition meaning is covered in any attempt to provide complete coverage within FrameNet. Other data developed in TPP can be used to facilitate the necessary characterizations of FrameNet preposition frames. In addition, as further developments occur within TPP (such as the exploitation of results from SemEval, in which methods for disambiguating prepositions have been developed), they can be used to assist in the development of FrameNet preposition frames.

5 Summary and Conclusions

A careful examination has been made of data on prepositions in FrameNet and The Preposition Project, with the objective of identifying possible strategies for extending the reach of FrameNet preposition frames. A number of steps have been developed to take advantage of TPP data. These steps have been developed with the full expectation that further discussions among interested parties will lead to their modification and refinement.

References

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Table 1. FrameNet Frames and TPP Instance Frame Elements (Prepositions with FrameNet Annotations)			
Preposition	**Definition**	**FrameNet Frame**	**TPP Instance Frame Elements**
beyond	at or to the further side of	Locative_relation	Birth:Place; Cotheme:Path; Departing:Goal; Departing:Path; Location_of_light:Ground; Natural_features:Relative_location; Path_shape:Path; Perception_active:Direction; Perception_active:Ground; Perception_experience:Ground; Roadways:Area; Self_motion:Area; Self_motion:Goal; Self_motion:Path
off	situated or leading in a direction away from	Locative_relation	Roadways:Area
off	(*subsense*) out at sea from (a place on the coast)		Being_attached:Goal; Hostile_encounter:Location; Impact:Place; Natural_features:Relative_location; Self_motion:Area; Separation:Place; Setting_fire:Place

Table 1. FrameNet Frames and TPP Instance Frame Elements (Prepositions with FrameNet Annotations)			
Preposition	**Definition**	**FrameNet Frame**	**TPP Instance Frame Elements**
from	indicating the point in space at which a journey, motion, or action starts	Time_vector	Arriving:Source; Body_movement:Path; Body_movement:Source; Carrying:Path; Carrying:Path_start; Cause_motion:Path; Cotheme:Path; Cotheme:Source; Departing:Source; Evading:Pursuer; Fluidic_motion:Source; Kidnapping:Source; Mass_motion:Source; Motion:Source; Motion_noise:Path; Motion_noise:Source; Operate_vehicle:Source; Path_shape:Path; Path_shape:Source; Perception_active:Direction; Perception_active:Phenomenon; Piracy:Place; Placing:Goal; Placing:Source; Ride_Vehicle:Path; Ride_Vehicle:Source; Self_motion:Area; Self_motion:Path; Self_motion:Source; Sending:Source; Statement:Place; Use_firearm:Depictive; Use_firearm:Source

Table 1. FrameNet Frames and TPP Instance Frame Elements (Prepositions with FrameNet Annotations)			
Preposition	**Definition**	**FrameNet Frame**	**TPP Instance Frame Elements**
like	in the manner of	Similarity	(*Partial list*) Abundance:Degree; Appearance:Characterization; Arriving:Manner; Body_movement:Manner; Cause_to_fragment:Manner; Change_posture:Manner; Chatting:Manner; Make_Noise:Sound_source; Making_faces:Manner; Motion:Manner; Motion_directional:Manner; Operate_vehicle:Manner; Path_shape:Manner; Perception_body:Degree; Performers_and_roles:Manner; Posture:Manner; Request:Manner; Self_motion:Manner; Separation:Manner; Sound_movement:Manner

Table 2. FrameNet Frames and TPP Instance Frame Elements (Prepositions with COD definitions without FrameNet Annotations)			
Preposition	**Definition**	**FrameNet Frame**	**TPP Instance Frame Elements**
after	in the time following (an event or another period of time)	Relative_time	(*Partial list*) Amalgamation:Time; Arrest:Time; Arriving:Time; Avoiding:Time; Becoming_aware:Time; Behind_the_scenes:Time; Cause_change_of_phase:Time; Cause_change_of_scalar_position: Time; Cause_harm:Time; Processing_materials:Time; Quitting:Time; Reshaping:Time; Rotting:Time; Self_motion:Time; Sleep:Time; Subject_stimulus:Circumstances; Surpassing:Time; Travel:Time

Table 2. FrameNet Frames and TPP Instance Frame Elements (Prepositions with COD definitions without FrameNet Annotations)			
Preposition	**Definition**	**FrameNet Frame**	**TPP Instance Frame Elements**
at	expressing location or arrival in a particular place or position	Locative_relation	(*Partial list*) Arrest:Place; Arriving:Goal; Arriving:Path; Arson:Place; Avoiding:Place; Becoming_aware:Ground; Behind_the_scenes:Place; Being_attached:Goal; Being_attached:Handle; Being_employed:Employer; Commerce_sell:Place; Congregating:Place; Impact:Place; Ingest_substance:Place; Ingestion:Place; Kidnapping:Place; Roadways:Area; Robbery:Place; Sleep:Place; Smuggling:Place; Social_event:Place; Speak_on_topic:Place; Statement:Place; Topic:Text; Verdict:Place
on	physically in contact with and supported by (a surface)	Locative_relation	(*Partial list*) Accoutrements:Body_location; Apply_heat:Heating_Instrument; Arranging:Location; Arriving:Path; Being_attached:Connector; Being_attached:Goal; Body_decoration:Body_location; Body_movement:Area; Body_movement:Goal; Cause_harm:Place; Change_posture:Goal;

Table 2. FrameNet Frames and TPP Instance Frame Elements (Prepositions with COD definitions without FrameNet Annotations)			
Preposition	**Definition**	**FrameNet Frame**	**TPP Instance Frame Elements**
around	on every side of	Locative_relation	Abundance:Location; Accoutrements:Body_location; Biological_area:Relative_location; Birth:Place; Body_mark:Attachment; Cause_harm:Body_part; Change_of_consistency:Place; Change_position_on_a_scale:Path; Fluidic_motion:Area; Mass_motion:Area; Observable_bodyparts:Attachment; Path_shape:Area; Perception_experience:Ground; Posture:Location; Ride_Vehicle:Path
above	at a higher level *or layer* than	Locative_relation	Becoming_aware:Ground; Biological_area:Relative_location; Body_movement:Path; Cause_motion:Path; Location_of_light:Ground; Make_Noise:Place; Natural_features:Relative_location; Path_shape:Goal; Perception_active:Direction; Perception_experience:Direction; Placing:Goal; Posture:Location; Residence:Location; Roadways:Area; Self_motion:Area; Self_motion:Path
over	at a higher level *or layer* than	Locative_relation	Body_movement:Goal; Change_posture:Path; Perception_experience:Body_part; Posture:Path; Roadways:Path

Table 2. FrameNet Frames and TPP Instance Frame Elements (Prepositions with COD definitions without FrameNet Annotations)			
Preposition	**Definition**	**FrameNet Frame**	**TPP Instance Frame Elements**
below	at a lower level *or layer* than	Locative_relation	Cause_motion:Goal; Change_of_phase:Place; Containers:Relative_location; Departing:Goal; Duplication:Goal; Make_Noise:Place; Motion_noise:Area; Natural_features:Relative_location; Observable_bodyparts:Subregion; Path_shape:Goal; Perception_active:Direction; Perception_experience:Ground; Placing:Goal; Posture:Location; Residence:Location; Self_motion:Area
beside	at the side of; next to	Locative_relation	Biological_area:Relative_location; Body_mark:Attachment; Body_movement:Goal; Building:Place; Change_posture:Goal; Change_posture:Location; Containers:Relative_location; Fluidic_motion:Area; Gesture:Message; Natural_features:Relative_location; Placing:Goal; Posture:Location; Roadways:Area; Self_motion:Area; Self_motion:Cotheme; Self_motion:Goal; Self_motion:Path

Table 2. FrameNet Frames and TPP Instance Frame Elements (Prepositions with COD definitions without FrameNet Annotations)			
Preposition	**Definition**	**FrameNet Frame**	**TPP Instance Frame Elements**
beneath	extending or directly underneath	Locative_relation	Being_attached:Goal; Body_mark:Attachment; Change_of_consistency:Reason; Change_posture:Goal; Congregating:Place; Cotheme:Goal; Dispersal:Goal_area; Grinding:Grinding_cause; Grinding:Locus; Location_of_light:Cause_of_shine; Location_of_light:Ground; Make_Noise:Reason; Path_shape:Area; Path_shape:Goal; Perception_body:Subregion; Perception_experience:Body_part; Perception_experience:Ground; Placing:Goal; Posture:Location; Scrutiny:Ground; Seeking:Ground; Self_motion:Area; Self_motion:Cotheme
along	extending in a more or less horizontal line on	Locative_relation	Accoutrements:Body_location; Amalgamation:Place; Biological_area:Relative_location; Body_movement:Goal; Hostile_encounter:Location; Ingestion:Place; Natural_features:Relative_location; Observable_bodyparts:Attachment; Perception_body:Body_part; Perception_experience:Body_part; Placing:Goal; Reshaping:Place; Residence:Location; Roadways:Path; Social_event:Place
among	situated more or less centrally in relation to (several other things)	Locative_relation	Cause_motion:Area; Cause_motion:Goal; Cotheme:Area; Departing:Goal; Eclipse:Obstruction; Escaping:Goal; Motion_noise:Area; Path_shape:Area; Path_shape:Path; Perception_active:Direction; Placing:Goal; Posture:Location; Self_motion:Area

Table 2. FrameNet Frames and TPP Instance Frame Elements (Prepositions with COD definitions without FrameNet Annotations)			
Preposition	**Definition**	**FrameNet Frame**	**TPP Instance Frame Elements**
against	in or into *physical* contact with *(something), so as to be supported by or collide with it*	Locative_relation	Body_movement:Goal; Cause_impact:Impactee; Impact:Impactee; Change_posture:Goal; Posture:Location; Reshaping:Resistant_surface; Cause_motion:Goal; Placing:Goal; Manipulation:Locus; Cause_to_fragment:Resistant_surface; Cause_fluidic_motion:Goal
about	on the subject of; concerning	Topic	(*Partial list*) Awareness:Content; Awareness:Topic; Becoming_aware:Topic; Candidness:Topic; Certainty:Content; Certainty:Topic; Chatting:Topic; Cogitation:Topic; Coming_to_believe:Content; Coming_to_believe:Topic; Commitment:Topic; Communication_manner:Topic; Communication_noise:Topic; Communication_response:Topic; Contacting:Topic; Contrition:Action; Discussion:Topic; Emotion_active:Topic; Emotion_directed:Stimulus; Emotion_directed:Topic;
on	*having (the thing mentioned) as a topic;* about	Topic	(*Partial list*) Awareness:Topic; Being_employed:Field; Candidness:Topic; Certainty:Topic; Choosing:Topic; Coming_to_believe:Topic; Communication_response:Topic; Discussion:Topic; Education_teaching:Subject; Expertise:Knowledge; Mental_property:Behavior;

Table 2. FrameNet Frames and TPP Instance Frame Elements (Prepositions with COD definitions without FrameNet Annotations)			
Preposition	**Definition**	**FrameNet Frame**	**TPP Instance Frame Elements**
after	in the time following *(an event or another period of time)*	Time_vector	(*Partial list*) Amalgamation:Time; Arrest:Time; Arriving:Time; Avoiding:Time; Becoming_aware:Time; Behind_the_scenes:Time; Cause_change_of_phase:Time; Cause_change_of_scalar_position: Time; Cause_harm:Time; Cause_temperature_change:Time; Change_of_consistency:Time; Change_posture:Time; Contacting:Time; Cooking_creation:Time; Criminal_investigation:Incident;
before	during the period of time preceding *(a particular event or time)*	Time_vector	(*Partial list*) Amalgamation:Time; Apply_heat:Time; Arrest:Time; Avoiding:Time; Calendric_unit:Relative_time; Cause_change_of_phase:Time; Cause_temperature_change:Time; Cause_to_move_in_place:Time; Cause_to_wake:Time; Change_of_consistency:Time; Chatting:Time; Contacting:Time; Discussion:Time; Escaping:Time; Event:Time; Giving:Time;
through	from beginning to end of (an experience or activity, *typically a tedious or stressful one*)	Time_vector	No instances

Table 2. FrameNet Frames and TPP Instance Frame Elements (Prepositions with COD definitions without FrameNet Annotations)			
Preposition	**Definition**	**FrameNet Frame**	**TPP Instance Frame Elements**
from	indicating the source or provenance *of someone or something*	Origin	(*Partial list*) Accoutrements:Descriptor; Being_employed:Employer; Breathing:Source; Building:Components; Change_of_leadership:Conditions; Chemical-sense_description:Source; Collaboration:Place; Coming_to_be:Components; Coming_to_believe:Content; Commerce:Seller; Commerce_buy:Seller; Commerce_sell:Seller; Contacting:Communicator; Contacting:Location_of_communicator; Duplication:Creator; Duplication:Source; Education_teaching:Institution;
among	being a member or members of (a larger set)	Inclusion	(*Partial list*) Becoming_aware:Ground; Change_position_on_a_scale:Group; Custom:Society; Desirability:Comparison_set; Differentiation:Phenomena; Discussion:Topic; Evaluative_comparison:Comparison_set; Expertise:Protagonist; First_rank:Contrast_set; Health_response:Protagonist; Inclination:Entity;
for	*in support of or* in favour of *(a person or policy)*	Taking_sides	Desiring:Event; Desiring:Focal_participant; Evidence:Proposition; Finish_competition:Competitor; Judgment_communication:Evaluee; Reasoning:Content; Statement:Message; Verdict:Finding

Table 2. FrameNet Frames and TPP Instance Frame Elements (Prepositions with COD definitions without FrameNet Annotations)			
Preposition	**Definition**	**FrameNet Frame**	**TPP Instance Frame Elements**
against	in opposition to	Taking_sides	(*Partial list*) Emotion_directed:Stimulus; Reasoning:Content; Evidence:Proposition; Hostile_encounter:Side_2; Statement:Topic; Collaboration:Undertaking; Statement:Message; Judgment_communication:Evaluee; Coming_to_be:Entity; Emotion_active:Topic; Talking_into:Content;
in	indicating someone's occupation or profession	Fields	Being_employed:Field; Businesses:Product; Education_teaching:Institution; Education_teaching:Subject