Tense and Implict Role Reference

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Abstract

1. Introduction

This paper describes preliminary work relating tense to implicit role reference. Past work has shown that tense affects the resolution of other reference types such as pronouns as well as discourse structure (Webber, 1988; Hwang and Schubert, 1992). We extend this claim to the reference of implicit roles. We annotated a small corpus for NPs and VPs and tense information and show, in some cases, that one can improve resolution rates of implicit roles by using simple heuristics incorporating tense with focusing. To our knowledge, this is the first time that an automated corpus study has been done analyzing the effects of temporal information in reference.

2. Implicit Role Reference

We claim that in addition to canonical reference types such as pronominal reference, VP ellipsis, and discourse deixis, verb phrases have certain required roles that can be viewed as anaphoric. These required roles refer to discourse entities and are necessary for the interpreter to understand the verb phrase, and thus the complete utterance. For example, in order to use the verb "take" one needs to understand that an entity is being moved, that it is being moved to one place from some other place, and that there is some entity that is responsible for moving it.

Implicit role reference has been briefly studied as a side effect of bridging and discourse relations (Poesio (1994) and Asher and Lascarides (1998)) but no major empirical work has been done in the area.

Resolution of implicit roles occurs frequently in naturally occurring dialog. Consider the following, modified from Asher and Lascarides (p. 90):

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(1)  Take engine E1 from Avon to Dansville.
(2a) Pick up the box-
car and take it to Broxburn.
(2b) Also take the boxcar.
(3)  Leave it there and go to Clarksville.
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For the sake of simplicity, assume that the verb "take" has these roles: "Theme": the entity being moved; "To-Loc": the location we are taking the "theme"; and "From-Loc" the location we are leaving.

In utterance (2a) one needs to know the At-Loc of the boxcar, in order to send it to Broxburn. This role is implicit and is resolved to Dansville. In order to resolve "there" after utterance (2b) one must resolve the implicit "From-Loc" in "take" in the previous sentence. Asher and Lascarides point out that use of rhetorical roles can aid in the resolution, that is, if one knows if the relation between two utterances is narrative or parallel, an interpretation can be made. For example, the relationship between (1) and (2a) is a narrative while (1) and (2a) is parallel. While it is hard to annotate rhetorical relations we believe that one can approximate them by calculating the temporal relation between the two utterances and thus be able to resolve the implicit roles correctly. For instance, if we know that there is a narrative relation then we know that the entity that serves as the To-Loc role will probably serve as the From-Loc role in the next utterance, since entities move from the place they were just taken.

In our corpus we found the following distribution (see Figures 1 2) for From-Loc and To-Loc roles and their antecedents, the roles we focus on in this study. These figures show that for a given role, how many sentences back (depth) its antecedent is found and in what role focus list it is located in. The trend is that antecedents for a From-Loc or To-Loc are predominantly found in the current utterance or the previous two utterances.

We describe our work in implicit roles in more detail in (Tetreault,)

3. Annotation

We use a subset of the TRAINS-93 Corpus (Heeman and Allen, 1994) annotated with coreference information for pronouns (Byron and Allen, 1998). The dialogs typically consist of short sentences, usually under 10 words or less and are annotated using a sgml-style encoding. Our domain consists of an 86-utterance dialog in which two human participants are given a task involving moving commodities and trains around a fictional world. We manually annotated each NP with an unique ID and its class (engine, tanker, location, food). Each VP was annotated with an ID, a time ID, and what NP ID(s) each role refers to. If a role is not mentioned explicitly in the text such as the "at-loc" role in (2a), then it is marked as implicit. The roles from each verb are taken from the TRIPS natural language system lexicon (Allen et al., 2000). For all the roles that are marked in this study (instrument, theme, from-loc, to-loc) roughly 30% are implicit.

A time point is associated with each verb event and constraints with previously mentioned time points are included in the time tag. The first element of each time tag is the time point associated with that event and is a string of a character followed by a number such as "t0." There are two

Depth	From-Loc	To-Loc
1	11	9
2	4	1
3	0	0
4	1	0
5+	0	0
%	61.5%	38.5%

Figure 1: From-Loc

Depth	Theme	From-Loc	To-Loc
1	0	1	1
2	0	0	2
3	0	0	0
4	1	0	1
5+	0	1	0
%	14.3%	28.6%	57.1%

Figure 2: To-Loc

types of constraint relations: either time x precedes a time y: "$x < y$" or x follows y: "$x > y$". Multiple constraints for a time point are encoded by linking the individual constraints with an ampersand: "$t1 > t2 \& t1 < t0$" which says that t1 comes after t2 and t1 precedes t0. It should be noted that this is a very naive encoding scheme and that complex verb tenses are reduced to their root forms. Below is a sample annotation (modified for readability):

Annotation of time points were difficult because the goal of each dialogs was to create a plan not necessarily execute a plan in real-time. This means that the two speakers will often talk abstractly about parts of the plan and create hypothetical plans that may fail if the speakers feel that it would not meet the constraints outlined by the experiment. Often utterances such as "We will need to move the boxcar to Avon by midnight" would appear and be followed by statements on the way of getting that task done. For our purposes, these multiple stand-alone plans complicate annotation because all time points in the discourse are not necessarily related, or can be chained. To deal with this, we give each sub-plan or hypothetical plan it's own code, so one sub-plan may have its events labelled with "u": "$u0, u1, u2...$" while another distinct plan would have "v."

4. Algorithm

We have developed a preliminary model of resolving implicit roles that uses a combination of focusing and temporal reasoning. Our algorithm for resolving implicit roles in a discourse is as follows: first, as one progresses through the discourse, each utterance maintains a focus list for each role, such that when a NP is encountered, its discourse entity representation is placed at the top of the appropriate focus stack(s). When a verb is encountered, we check all of its roles and place explicit ones (those found in surface form of the sentence) on the top of the appropriate focus stack. If a role is implicit then it is resolved as determined by its type:

- Instrument: search through current utterance first (either in sentence order or by recency) for an entity that meets the verb's constraints. If one is not found, then search through each past utterance's focus stacks: looking at the instrument and theme stacks in that order.
- Theme: same as above except that the search order of instrument and theme focus stacks is reversed
- From/To-Loc: use temporal reasoning to determine what order to search past To-Loc and From-Loc lists for each utterance.

Our temporal reasoning scheme amounts to determining whether the current sentence u_j is in a narrative or parallel relation with a preceding utterance u_i being searched through for an antecedent. We annotate each verb with a time ID that is related to other utterances' event times. If u_j's event time occurs after u_i's event time then we assume that a narrative relation holds between the two and that a From-Loc role in u_j should search through the To-Loc list in u_i. This is because in a narrative, there is a linear movement from place to place. If no such temporal relation is found, then we assume that a parallel relation holds between u_j and u_i and we search the From-Loc of u_i for antecedents first. The same method is used for To-Loc roles.

5. Results

We implemented the implicit role algorithm in a LISP system and and tested it on our dialog. Figure 1 shows how the percentage correct for each version of the algorithm on each implicit role. The first two versions of the algorithm do not use temporal reasoning, while the last two do. R-L indicates that each focus list is searched from right to left, or from most recent to least recent. L-R indicates that the focus list is searched in reverse order, meaning that the

subject of that utterance would be prominent. The last line is the number of times that role appears implicitly in the corpus.

6. Discussion

The conclusion of this study is that simple temporal reasoning has a mixed effect on the resolution rate of a verb's implicit roles. While there is a moderate improvement over the resolution of To-Loc's (55.6% to 44.5%), the naive method for resolving From-Loc's clearly outperforms its temporal reasoning counterpart (88.5% to 69.3%). Since our corpus is so small it is hard to draw concrete conclusions on whether not temporal reasoning works, especially since a most-recent strategy performs very well. This is not too surprising however since our statistics show that

It should be noted that this is a work in progress. Our annotation scheme is very basic and our error analysis shows that many of the From-Loc errors using temporal reasoning are due to deficiencies in the annotation (such as reducing complex verb phrases to their one root verb). We believe that a more detailed annotation of tense would make result in a finer temporal ordering which would improve performance. Another area of concern is our very small corpus. Many empirical studies ((Strube, 1998); (Tetreault, 2001)) have corpora of hundreds or even thousands of annotated sentences. The larger and more varied the corpus, the more reliable the results. We also acknowledge the fact that automating the annotation of temporal relations is complicated task all to itself and that it is an area of future research.

Recent work on this corpus has focused on seeing the effects of breaking up conjoined utterances on reference resolution as suggested by (Kameyama, 1998). and implemented by (Strube, 1998). We found that this simple metric improved scores for all implicit roles (without using temporal reasoning) as well as for pronouns in another corpus (Tetreault, 2001). We tested temporal reasoning with the utterances broken apart and found it did not improve the score any higher.

Currently, we are annotating a much larger corpus of a similar domain (emergency rescue planning for a city). We hope that this new domain will address the problems discussed above.

In short, preliminary results indicate that temporal reasoning can be useful in reference resolution, but a better annotation scheme and a larger corpus are needed to strengthen this claim.

7. References

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Algorithm	Instrument	Theme	From-Loc	To-Loc
R-L	78.9%	55.6%	65.4%	22.2%
L-R	78.9%	44.4%	88.5%	44.5%
Time, L-R	78.9%	55.6%	61.5%	55.6%
Time, R-L	78.9%	44.5%	69.3%	55.6%
Total	19	9	26	9

Figure 3: Implicit Role Reference Results

Take Engine E1 from Avon to Dansville. Pick up the boxcar.

<ve id=ve122 time=t0 theme=ne12 from-loc=ne5 to-loc=ne6> **Take** <ne id=ne12>**engine E1**</ne> **from** <ne id=ne5>**Avon**</ne> **to** <ne id=ne6>**Dansville**</ne></ve>. <ve id=ve123 time=$t1 > t0$ from-loc=ne6 theme=ne13 implicit=from-loc> **Pick up** <ne id=ne13>**the boxcar**</ne></ve>.