TFLEX: Speeding up Deep Parsing with Strategic Pruning

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1 Introduction

This paper presents a method for speeding up a deep parser through backbone extraction and pruning based on CFG ambiguity packing. The TRIPS grammar is a wide-coverage grammar for deep natural language understanding in dialogue, utilized in 6 different application domains, and with high coverage and sentence-level accuracy on human-human task-oriented dialogue corpora (Dzikovska, 2004). The TRIPS parser uses a best-first beam search algorithm and a chart size limit, both of which are a form of pruning focused on finding an n-best list of interpretations. However, for longer sentences limiting the chart size results in failed parses, while increasing the chart size limits significantly impacts the parsing speed.

It is possible to speed up parsing by implementing faster unification algorithms, but this requires considerable implementation effort. Instead, we developed a new parser, TFLEX, which uses a simpler technique to address efficiency issues. TFLEX combines the TRIPS grammar with the fast parsing technologies implemented in the LCFLEX parser (Rosé and Lavie, 2001). LCFLEX is an all-paths parser which uses left-corner prediction and ambiguity packing, and which was shown to be efficient on other unification augmented context-free grammars. We describe a way to transfer the TRIPS grammar to LCFLEX, and a pruning method which achieves significant improvements in both speed and coverage compared to the original TRIPS parser.

2 TFLEX

To use the TRIPS grammar in LCFLEX we first extracted a CFG backbone from the TRIPS grammar, with CFG non-terminals corresponding directly to TRIPS constituent categories. To each CFG rule we attach a corresponding TRIPS rule. Whenever a CFG rule completes, a TRIPS unification function is called to do all the unification operations associated with the TRIPS rule. If the unification fails, the constituent built by the CFG is cancelled.

The TFLEX pruning algorithm uses ambiguity packing to provide good pruning points. For example, in the sentence “we have a heart attack victim at marketplace mall” the phrase “a heart attack victim” has two interpretations depending on whether “heart” modifies “attack” or “attack victim”. These interpretations will be ambiguity packed in the CFG structure, which offers an opportunity to make pruning more strategic by focusing specifically on competing interpretations for the same utterance span. For any constituent where ambiguity-packed non-head daughters differ only in local features, we prune alternative interpretations coming from them to a specified prune beam width based on their TRIPS scores. In the example above, pruning will happen at the point of making a VP “have a heart attack victim”. The NP will be ambiguity packed, and we will prune alternative VP interpretations resulting from combining the same sense of the verb “have” and different interpretations of the NP.

This approach works better than the original TRIPS best-first algorithm, because for long sentence the TRIPS chart contains a large number

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of similar constituents, and the parser frequently
reaches the chart size limit before finding the correct
constituent to use. Ambiguity packing in TFLEX
helps choose the best constituents to prune by prun-
ing competing interpretations which cover the same
span and have the same non-local features, thus
making it less likely that a constituent essential for
building a parse will be pruned.

3 Evaluation

Our evaluation data is an excerpt from the Monroe
corpus that has been used in previous TRIPS re-
search on parsing speed and accuracy (Swift et al.,
2004). The test contained 1042 utterances, from 1
to 45 words in length (mean 5.38 words/utt, st. dev.
5.7 words/utt). Using a hold-out set, we determined
that a beam width of 3 was an optimal setting for
TFLEX. We then compared TFLEX at beam width
3 to the TRIPS parser with chart size limits of 1500,
5000, and 10000. As our evaluation metrics we re-
port are average parse time per sentence and proba-
bility of finding at least one parse, the latter being a
measure approximating parsing accuracy.

The results are presented in Figure 1. We grouped
sentences into equivalence classes based on length
with a 5-word increment. On sentences greater
than 10 words long, TFLEX is significantly more
likely to produce a parse than any of the TRIPS
parsers (evaluated using a binary logistic regression,
\( p < .001 \)). Moreover, for sentences greater than
20 words long, no form of TRIPS parser returned
a complete parse. TFLEX is significantly faster
than TRIPS-10000, statistically indistinguishable in
terms of parse time from TRIPS-5000, and signifi-
cantly slower than TRIPS-15000 (\( p < .001 \)).

Thus, TFLEX presents a superior balance of cov-
erage and efficiency especially for long sentences
(10 words or more) since for these sentences it is
significantly more likely to find a parse than any ver-

tion of TRIPS, even a version where the chart size is
expanded to an extent that it becomes significantly
slower (i.e., TRIPS-10000).

4 Conclusions

In this paper, we described a combination of effi-
cient parsing techniques to improve parsing speed
and coverage with the TRIPS deep parsing grammar.

The TFLEX system uses an all-paths left-corner
parsing from the LCFLEX parser, made tractable
by a pruning algorithm based on ambiguity packing
and local features, generalizable to other unification
grammars. Our pruning algorithm provides a bet-
ter efficiency-coverage balance than best-first pars-
ing with chart limits as utilised by the TRIPS parser.

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