January 12, 2005

Prof. Pietro Torasso  
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Corso Svizzera 185  
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Dear Prof Pietro:

Re: Review letter for PhD thesis of A. Mazzei

I am writing to provide my review of A. Mazzei’s doctoral dissertation. I provide my comments below. They are organized into various sections which I hope are self-explanatory. If there is any additional information that is needed from me, please let me know.

General overview of the thesis

This thesis proposes a new formalism for the formal analysis of natural language syntax called DVTAG, which is a dynamic version of a well-studied grammar formalism called Tree Adjoining Grammar (TAG) which has been studied widely since it was proposed by Prof. Joshi and his collaborators in the early 1970s. A dynamic grammar processes the sentence or utterance one word at a time, from left to right. This kind of processing has been shown to be a plausible model for how humans process language, across multiple languages. Hence a computational model that also processes language from left to right, incrementally, is a contribution to cognitive science and also to some language processing applications.

The main contribution of this thesis is that it takes three crucial hypotheses about incremental processing, namely incrementality in competence (also called the strict competence hypothesis), the strong connectivity hypothesis and adjoining to factor recursive syntactic tree structure, and provides a formal grammar definition that instantiates them in a tractable computational setting. This thesis follows closely a particular definition of dynamic grammar proposed by David Milward in 1994 and also notions of incremental parsing proposed by Lombardo and Sturt in recent papers. The results presented here will be interesting to computational linguists, particularly those in the computational sentence processing community.

The basic notion of incremental parsing leads to the proposal of DVTAG in this thesis. The thesis is very comprehensive in the coverage of various aspects of the theory and empirical
testing of the DVTAG formalism. In terms of formal language theory: the thesis provides (in Chp 2) various lemmas that describe the generative power of the DVTAG formalism, some of which are non-trivial. The thesis also explores the conversion of a couple of real-world English TAG grammars into the DVTAG formalism (in Chp 4) and provides some empirical analysis of this conversion. In addition, the thesis also provides a conversion of an Italian grammar. However, the lack of an implementation of a parsing algorithm for DVTAG limits the empirical analysis. A large scale experiment that explores the various motivations behind DVTAG could potentially be useful in further testing the hypotheses under consideration.

The thesis (in Chp. 3) explores the linguistic validity of the proposed DVTAG formalism to various well-known linguistic cases in many different languages in order to justify some of the assumptions made in the definition of DVTAG and to show, using examples, the advantages of DVTAG in dealing with some well-known cases and to show that the predictions of the computational model of DVTAG matches human performance. This discussion lacks a more detailed comparison with existing models from the literature, but provides crucial examples that verify that DVTAG does address the initial motivating hypotheses.

In addition to all of this work, the thesis also defines a feature-structure (unification-based) DVTAG and explores the recently proposed wrapping variant of the adjunction operation in the TAG formalism.

The thesis as it stands is extremely comprehensive in the topics covered. All aspects related to the definition of DVTAG have been covered and in reasonable detail. The formal details and the empirical testing cover the basic issues of concern to those in the research community and in large part do not contain any errors to the best of my knowledge (minor typos or errors are listed below in a separate section).

The thesis was well-written and relatively easy to read and understand. I was pleased to review this work.

I include below some suggested revisions and general comments followed by a list of more minor and detailed comments.

**Suggested Revisions and General Comments**

In Section 1.1 you should mention the psycholinguistic eyetracking experiments done by Michael Tanenhaus (and his lab in Rochester) and subsequent experiments by John Trueswell (at UPenn) and related work on eyetracking that shows incremental semantic disambiguation in human sentence processing.

On page 19, Assumption 1, the **Strict Competence Hypothesis** assumes that partial syntactic structures at each step can be *interpreted*. However you are not explicit about what you mean by this interpretation process. For TAG linguistic grammars there are three main proposals for semantic interpretation and you should be explicit as to which alternative is most suited for your work. Option 1 is to do Montague-style lambda-calculus semantics.
on the derived tree produced by the DVTAG, Option 2 is the use of a synchronous grammar
to map the syntax tree to a semantics tree, and Option 3 is the use of minimal recursion
semantics style of interpretation on the derivation tree recently being studied by Prof. Joshi
and collaborators. Option 1 is not suitable for incremental processing and Option 2/3 will
need some exploration in order to be consistent with DVTAG assumptions.

On page 19, Is Assumption 2 necessarily monotonic?

In Section 1.3, can you compare the Dynamic Grammar approach to Earley parsing. The
same description you provide can be used for Earley as well, but these two notions are quite
different and the differences are not fully clear from the discussion.

On page 31, again is the notion of _predicted nodes_ the same as the notion of prediction in
Earley parsing or Left-corner parsing?

In Figure 1.7: is it possible to avoid the merger of John with the verb elementary tree by
performing an _inverse substitution_ as defined in the next chapter? If so, why introduce this
spurious ambiguity? Is it for cases of coordination using _and_? This needs to be explained
up front here to avoid questions in the reader’s mind later on.

In Section 1.4 you should cite Philip Miller’s work on strong generative capacity as well in
the discussion on p35.

In Section 2.6, I think it is interesting that in some cases the DVTAG derivation has to
proceed inside-out in the derivation tree while proceeding left-right in the input sentence.
For example, consider the following DVTAG (∗ marks a footnode and . marks the dot):

(S (X .d))
(X (Y .c) X∗)
(Y (Z .b) Y∗)
(Z .a Z∗)

On p63: your definition of partial derivation tree seems to be almost identical to the notion
of _m_-incomplete derivation tree defined in Vijay-Shankar’s thesis.

In section 2.7.3, Defn 2.19: does the definition have to consider nodes in the derivation tree
that are not immediate daughters (or parents)? Consider for example the following LTAG:

(S a (X e))
(X (Y b X∗))
(Y (Z Y∗) d)
(Z .c Z∗)

For the input string _abcd_ it looks like it is considered to be a dynamic LTAG, but it seems
to cause problems if _parent_ in Def 2.19 is not some kind of transitive closure on dominance?
As I understand it, in DVTAG, the only way to derive the string \textit{abcd} is to perform successive operations of inverse adjoining from the left which creates the derivation tree inside-out. Perhaps you can compare this with the performance of Nederhof’s correct-prefix algorithm that also goes left to right in the input.

Section 2.9: there is some discussion that states that a mildly-context sensitive grammar formalism can be represented with the Linear Context-Free Rewriting System (LCFRS) formalism. Have you explored this possibility for DVTAG?

Proof of Lemma 2.22 skips some important steps. In particular, the statement \textit{a new grammar that generates the same tree language without operations on the left side} requires some further argument or proof.

p90: You state that the prediction step in Earley does not take into account the anchor in the predicted tree. For LTIG, the SW95 paper does provide such a method inside Earley for LTIG, and there are variants of Earley that do the prediction step based on \textit{k} symbols of lookahead.

p115: you should also consider another famous problem case: \textit{Does i John j t i seem t j to like Mary?}. The problem for DVTAG and some analyses under LTAG is that \textit{does} modifies \textit{seems}.

Section 3.4: please expand the discussion on p143. It is currently too short to cover some important issues about your \textit{type-raising} inspired operations in DVTAG.

Some fonts have not been included into the document and as a result some of the figures and even some of the text has the incorrect font and is not legible as a result. This was a problem mostly in Chp 3 and 4.

**Minor Comments and Typos**

Legend: a \rightarrow b (change from a to b in text), [command] and ((free-form comments))

- p7: such incremental nature \rightarrow incremental nature
- p7: generative \rightarrow generative
- p7: DVTAG is strongly adequate to generate context-free languages \rightarrow [rephrase to be more accurate]
- p9: in the competence \rightarrow as part of competence
- p9: The chapter counts four sections \rightarrow [delete]
- p9: TAG family \rightarrow the family of TAG formalisms
- p9: describe the \rightarrow describe their
- p9: of this formalism \rightarrow [delete]
• p10: open →[delete]
• p10: how the natural →exactly how natural
• p10: must incremental is →incremental
• p14: Kamide et al. →((here and in many other places, the citation is not done to a bib entry. This should be fixed throughout the thesis for this and other refs)))
• p15: ((sentence 1.7 is still ambiguous even in the dynamic grammar paradigm and so locally the strong connectivity hypothesis cannot be maintained here without always garden-pathing on this kind of sentence. Is this to be expected under the assumed hypotheses?))
• p19: this schema →((what does this refer to?))
• Kamide et al. and Sturt-Lombardo →[cite correctly]
• p21: Grammars →Grammar
• p22: generate context-sensitive →generate some context-sensitive
• p25: footnote 4 →[rephrase]
• p27: footnote 5: od →of ((please explain the Gel98 reference in more detail in the main text. At least define the 2 terms used in the footnote currently))
• p28: a sort of →[delete] ((in fact, delete every instance of this phrase since it does not add any information about the modifee))
• p32: a sort of →[delete]
• p36: ((you can use indices to make footnote 7 much shorter and easier to understand))
• p37: some kinds →[delete]
• p37: belongs →belong
• p41: Definition 2.1: im →im ((and what is m here?))
• p41: a set of nodes →[explain more here why it is a set]
• p42: ((⟨γ, i⟩ does not match with YIELDj(γ) in last sentence on p42))
• p43-p45: ((the discussion of left fringe and right fringe is done in the figures 2.2-2.4, which are cited in the discussion for the definition of fringe – the defn of left/right fringe only appears later at the end of p44. You need to reorganize the figures and examples to appear after all the defns have appeared))
• p59: ⟨Γ, n⟩ →⟨Γn, n⟩
• p63: trough →through
• p77: derivation in a derivation chain →derivation into a derivation chain
• p77: a LTAG →some LTAG
• p77: elementary trees of a partial →nodes of a partial
• p77: has not a child → does not have a child
• p85: Section 2.8: title has a missing character (font problem?)
• p87: viz → with
• p87: Fig 2.33: descript → described
• p87: an on → and on
• p89: LTIG dynamic → dynamic LTIG
• p89: the context-free → context-free
• p89: the parsing → parsing
• p93: footnote 11: ((font problem))
• p118: ((figure overflow problem))
• p131: Joshi and Rambow → ((cite publication))
• p145: in an applicative scenario → for NLP (natural-language processing) applications as well
• p147: nit → not
• p151: ((please explain, perhaps with a simple example, the empirical mismatch between LTAG and DVTAG as empirically seen in the conversion))
• p154: redux → reduce
• p160: Penn → Penn TreeBank
• p161: ((please compare the two converted grammars and explain the difference in underspecified items in the two grammars here))
• p163: Fig 4.7, 4.9: ((severe font problems))
• p169: hardly → ((??))
• p171: very different → ((explain how they are different))
• p175: [Jos85] → [typo in title]
• p177: [LS97] → [missing page numbers]
These are all my comments. Please do not hesitate to contact me if you have any further questions or comments on this review.

Yours truly,

Anoop Sarkar
Assistant Professor
Simon Fraser University