

Sentence syntax trees should be made from morphemes. Semantically ordered trees.

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Abstract

Some critique of usage of sentence parse trees in modern linguistics. Two propositions on constructing trees, as mentioned in the title. Introduction of an English-to-Tatar translator program that is being developed by the author. Precedence by specificity.

Preface

I, the author, do not know English well. Also, I do not know well how to write in scientific paper format. And, I think, there are no new ideas for science, but, this paper is for popularisation of known ideas.

1. First proposition: Sentence syntax trees should be made from morphemes

Currently, people make English language sentence dependency trees with words as tree nodes.

I think, morphemes should be used as tree nodes of dependency trees of sentences, in canonical form of trees, in grammar books, etc.

1.1 Demonstration of modern situation. How people draw trees.

1.1.a English language dependency tree usage examples:

1) **Wikipedia:** See fig. 1.

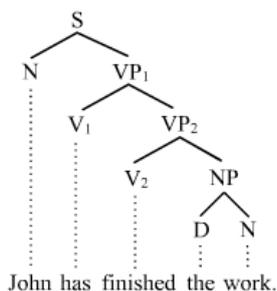


Figure 1. A tree from Verb phrase, Wikipedia.

2) **Stanford Parser sample:** Parse tree of “*The strongest rain ever recorded in India shut down the financial hub of Mumbai, snapped communication lines, closed airports and forced thousands of people to sleep in their offices or walk home during the night, officials said today.*” is:

```
(ROOT
(S
(S
(NP
(NP (DT The) (JJS strongest) (NN rain))
(VP
(ADVP (RB ever))
(VBN recorded)
(PP (IN in)
(NP (NNP India))))))
(VP
(VP (VBD shut)
(PRT (RP down))
(NP
(NP (DT the) (JJ financial) (NN hub))
(PP (IN of)
(NP (NNP Mumbai))))))
```

```
(, .)
(VP (VBD snapped)
(NP (NN communication) (NNS lines)))
(, .)
(VP (VBD closed)
(NP (NNS airports)))
(CC and)
(VP (VBD forced)
(NP
(NP (NNS thousands))
(PP (IN of)
(NP (NNS people))))))
(S
(VP (TO to)
(VP
(VP (VB sleep)
(PP (IN in)
(NP (PRPS their) (NNS offices))))))
(CC or)
(VP (VB walk)
(NP (NN home))
(PP (IN during)
(NP (DT the) (NN night)))))))))
(, .)
(NP (NNS officials))
(VP (VBD said)
(NP-TMP (NN today)))
(, .))
```

(2)

3) **Others:** Same way is used in lots of other works, for example, in Carnie, 2000, p.39; in the “Parse tree”, “Constituent (linguistics)”, “Dependency grammar” Wikipedia articles.

4) But, usage of morphemes separately is also known in science, see section 1.5.

There are not many word forms in English language, and such trees are not very bad. If they used morphemes, their trees would be harder to read.

1.1.b Parse trees in other language linguistics:

1) Modern Tatar philology dependency scheme example, see fig. 3.

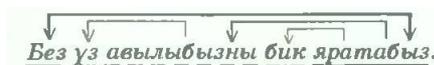


Figure 3. A tree from a Tatar language schoolbook (Miftakhov & Sungatov, 2002).

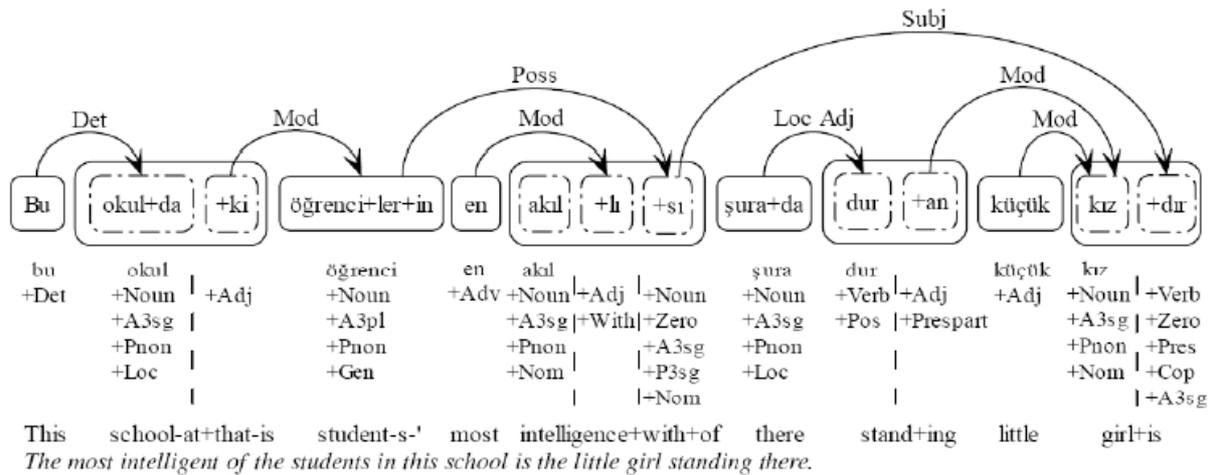


Figure 4. A tree from Oflazer, 2007.

```
<?xml version="1.0" encoding="windows-1254" ?>
<Set sentences="1">
<S No="1">
<W IX="1" LEM="" MORPH="" IG="[(1,"Brecht+Noun+Prop+A3sg+Pnon+Abl)]" REL="[2,1,(ABLATIVE.ADJUNCT)]"> Brecht'ten
</W>
<W IX="2" LEM="" MORPH="" IG="[(1,"yap+Verb+Pos")(2,"Adj+PastPart+P1sg)]" REL="[5,1,(MODIFIER)]"> yaptığım
<W IX="3" LEM="" MORPH="" IG="[(1,"bu+Det)]" REL="[5,1,(DETERMINER)]"> bu
<W IX="4" LEM="" MORPH="" IG="[(1,"uzun+Adj)]" REL="[5,1,(MODIFIER)]"> uzun
<W IX="5" LEM="" MORPH="" IG="[(1,"alinti+Noun+A3sg+Pnon+Abl)]" REL="[6,1,(OBJECT)]"> alintidan
<W IX="6" LEM="" MORPH="" IG="[(1,"sonra+Postp+PCAb)]" REL="[12,2,(MODIFIER)]"> sonra
<W IX="7" LEM="" MORPH="" IG="[(1,"+Punc)]" REL="[1,1,(PUNCT)]"> .
<W IX="8" LEM="" MORPH="" IG="[(1,"ev+Noun+A3sg+Pnon+Dat)]" REL="[9,1,(OBJECT)]"> eve
<W IX="9" LEM="" MORPH="" IG="[(1,"ilişkin+Postp+PCDat)]" REL="[11,1,(MODIFIER)]"> ilişkin
<W IX="10" LEM="" MORPH="" IG="[(1,"ben+Pron+PersP+A1sg+Pnon+Gen)]" REL="[11,1,(POSSESSOR)]"> benim
<W IX="11" LEM="" MORPH="" IG="[(1,"ütopya+Noun+A3sg+P1sg+Dat)]" REL="[12,1,(DATIVE.ADJUNCT)]"> ütopyama
<W IX="12" LEM="" MORPH="" IG="[(1,"gel+Verb+Pos")(2,"Verb+Able+Aor+A1pl)]" REL="[13,1,(SENTENCE)]"> gelebiliriz
<W IX="13" LEM="" MORPH="" IG="[(1,"+Punc)]" REL="[1,1,(PUNCT)]"> .
</S>
</Set>
```

Figure 5. A tree from Oflazer, 2007.

2) Modern Turkish linguistics example, see fig. 4, 5. Words are in some of tree nodes (*öğrencilerin*), parts of word in some (*okulda*), “inflectional groups” in some (*biliriz*, I think, it is just an archaic word). But morphemes are separated and set in some tree nodes, examples are in the following “Previous works” section.

(1:1:4) I-rahîmî. the Most Merciful.
 (1:1:3) I-rahmâni. the Most Gracious.
 (1:1:2) I-hahî. (of) Allah.
 (1:1:1) bis'mî. In (the) name

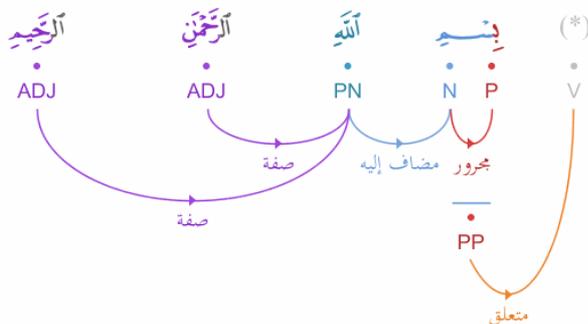


Figure 6. A tree from Dukes, 2010.

3) Modern Arabic linguistics example, see fig. 6. Some morphemes, like “bi”, are shown with different colour and regarded as separate element, but case

endings are not separated, though they are even easier. And complex modifications of root are not shown as abstract morphemes. But, I think, what the author, Kais Dukes, has chosen, is appropriate for his purpose; if all morphemes were separated, the trees would not be beautiful and easy.

4) Japanese and English trees, that are made from words, can be seen in the papers referenced by this paper.

1.2 Demonstration of my first proposition. How do I suggest drawing parse trees.

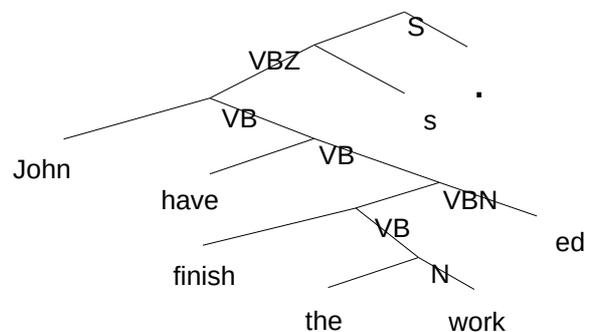


Figure 7. My proposition. Morphemes are at nodes. Example tree for my proposition: see fig. 7. I have

marked here phrases, which are made from morphemes (and from inner phrases), (subtrees) with Penn Treebank part-of-speech tags. (Originally, in Penn Treebank, and in other works, that tags, *VB*, *N*, etc, are used to mark words, and other tags like *VP*, *PP*, *S* are used to mark phrases (groups of words), which are made from words (and from inner phrases). For examples, see section 1.1.a of this article.)

1.3 Reasons

Though there are not many word forms in English language, there are reasons to use morphemes at sentence tree nodes:

1) In speech, words may be, sometimes, like joined or, sometimes, like split; written spaces and words are just a writing tradition, and, so, should not be blindly followed.

2) The "traditional" tree nodes anyway would have to be transformed into this structure, for example: There are several phrases like these 3, made from a phrase from Tree 2:

(VP (VBD snapped)
(NP (NN communication) (NNS lines)))

(VP (VB snap)
(NP (NN communication) (NNS lines)))

(VP (VBN snapped)
(NP (NN communication) (NNS lines)))

But they all would be translated into another language by translating

(VP (VB snap)
(NP (NN communication) (NNS lines)))

with addition of something corresponding to past simple or past participle or other (*s*, *ing*) suffixes.

3) It is easier to translate to other languages.

1.5 Previous works that use morphemes as tree nodes

This proposition is not result of a formal scientific research; I had seen this inaccuracy when I saw how we drew word dependency connections in our Tatar (see fig. 3) and Russian language lessons, and later I saw that same way is used also in English linguistics. But, for I am writing in format of scientific paper, I should make some bibliography research.

1) Cite from Embick & Noyer, 2005:
In its essence the Distributed Morphology approach to morphology is syntactic. As a consequence of the architecture of the grammar, in the simplest case,

morphological structure and syntactic structure are the same. Because there is no Lexicon in which complex objects are assembled according to rules distinct from the rules of syntax, the generation of all complex forms must be performed in the syntax. ... Words and phrases are assembled by the same generative system, and there is thus no sense in which words must 'interface' with the syntax; rather, they are derived by the rules of syntax (with PF understood as operating on the output of the syntax).

2) Oflazer, 2007: See fig. 4 and 5. Morphemes inconsistently are separated and set at tree nodes, examples: *li*, *dur*, *ki* in fig. 4.

3) Dukes, 2010: See fig. 6. Some morphemes, like "*bi*", are shown with different colour and regarded as separate element.

4) Hangstom, 2001; Carnie, 2000, p. 155: *-ed* suffix is used separately.

5) Previous publications by me: 1) Handwritten notes on linguistics in a notebook, I have written that nearly in 2000. I used morphemes at sentence tree nodes. 2) English-Tatar translator program, written in PHP, 2013-2015, it's not production software for now. 3) A blog post, 2013.

2. Second proposition: Semantically ordered trees

There is an idea of semantically ordered binary tree of syntax of sentence, consisting of morphemes with head-final order in each pair of branches. Also similar tree with head-initial order exists. I think, usage of these forms of tree is better, I explain that in the Reasons section below. Example of such tree:

```
(
  0:(
    0:(
      0:John
      1:(
        0:(
          0:(
            0:the
            1:work
          )
          1:finish
        )
        1:ed
      )
      1:have
    )
  )
  1:s
)
1:.
```

(8) By saying "semantically ordered", I mean the

consistent ordering of main part (branch) and dependent part (branch) in every node of tree.

2.1 Demonstration in form of tree

See fig. 9.

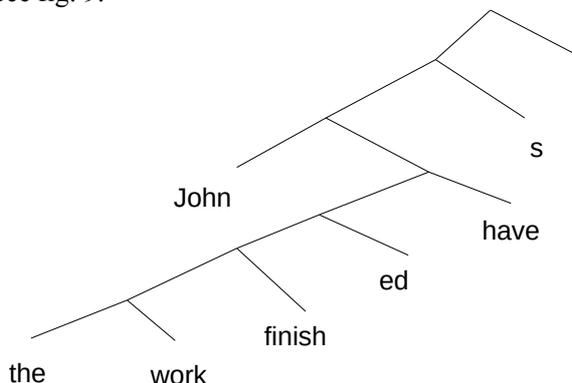
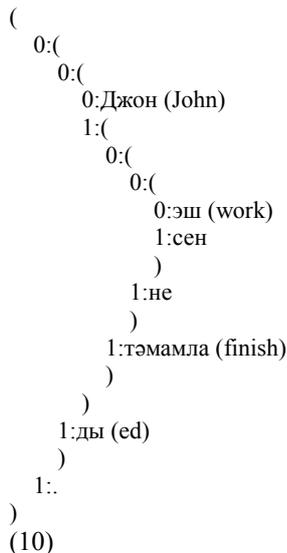


Figure 9. My proposition. Dependents are at left branches, heads (main parts) are at right branches. (and morphemes are at nodes).

2.2 Reasons

1) Trees are intended to show semantic structure of sentence, at least, as I regard them, and, the phonetic phenomenon (phenomenon of level of 1-dimensional speech) of word order should not be mixed into/with the semantic order (precedence, hierarchy, priority) representation.

2) Tatar and English languages become very similar in this form and easy to translate from one to another, and I believe, also all other natural languages mostly use semantically similar morphemes and similar trees of this form and they are easily translatable to each another. For example, how much semantic tree of the English sentence (8) is similar to corresponding semantic tree of Tatar language sentence (10):



3) This approach is already used in science of computer programming languages and known as reverse Polish notation and postfix notation, (and

reversed version as forward Polish notation and prefix notation).

2.3 Some ideas

1) The trees were semantically ordered almost in all previous works, because head and dependents are usually marked either by part-of-speech tags (like in fig. 1) or by arrows (like in fig. 6) or by higher position. So, this my proposition is just about better visual representation of such order, and, in computing, about detecting and direct indexing/marking of the main part (head) (branch) and dependent part (branch) of each branching point.

2) You can see that main words has similar position in both languages in this example: (John (work (finish))). I think, this precedence of verb specifiers is same phenomenon as with order of noun specifiers, when word for more close feature of noun takes more close position to it. Example: *big red book*, colour is usually more inseparable feature of thing than its size, and for that reason, its word (*red*) joins to head noun phrase with higher precedence (earlier) than the word of size (*big*). Same happens in Arabic, and corresponding words get reverse order in speech, because adjective should be located after the word it specifies (the word that is specified by it), in Arabic. By the “semantically ordered trees”, I suppose, all languages will have similar structures for corresponding sentences (unlike the dissimilarity of word order, in speech level, between Arabic and English). (Same explains the order (John (work (finish))): *work* is more close feature of *finish* compared to *John*, so *work* takes precedence over *John* in joining order.)

A cite from a previous work: Halliday & Matthiessen, 2004: *So there is a progression in the nominal group from the kind of element that has the greatest specifying potential to that which has the least.*

3) But, only after I have written this paper, I have come to an idea: if really semantic ordering with closeness is used, then tense morpheme should be dependent, not main (not head). I.e., it should be (s (John (... have))) , not ((John (... have)) s)

2.4 Previous works

I have found some previous works, also for the sake of writing in scientific paper format, but also I introduce my other work:

1) Similar way of head-final ordering of English was proposed by Taijiro Tsutsumi (1986), Katsuhito Sudoh et al, (2011), Isao Goto et al, (2012).

2) I have used this idea in my prototype English-to-Tatar translator. Example from its output:

```
Array
(
  [0] => Array
```

```

(
  [0] => i
  [1] => Array
  (
    [0] => Array
    (
      [0] => every
      [1] => day
    )
    [1] => Array
    (
      [0] => Array
      (
        [0] => school
        [1] => to
      )
      [1] => go
    )
  )
)
[1] => pr-si
)

```

(11)

I have come to it like the Japanese scientists, in process of planning translator program; Tatar language has word order similar to Japanese', it's almost fully head-final ordered, i.e. it has semantic order, and I just ordered English also in same way, in parsing stage, I even never thought about "surface structure" order of English sentence tree.

3) Binary trees was proposed previously by Richard S. Kayne (1984).

4) Usage of trees for semantic structure, also, is not a new thing, for example, more semantically ordered trees are named "deep structures" in Chomsky, 1965.

5) My new idea of putting tense suffix at specifier position (idea No. 3 in section 2.3), is also not a new idea in science: for example, in Hangstrom, 2001, *-ed* suffix is used separately and is put at specifier position i.e. to left branch.

3. General conclusion for the two propositions

Head-final or head-initial tree of morphemes, with usage of abstract morphemes for some languages, can be regarded as semantic layer of grammar of a language. Each morpheme, or phrase (subtree), which has the morpheme in its head branching's end, has its property of locating (taking its place) after head (main part) or before head, when it, the morpheme (or phrase), is dependent, and becomes part of speech (in speech layer), and its rules (properties) of phonological joining with morphemes which become its closest neighbours in speech. For example, any adjective in Arabic takes place after head, but any adjective takes place before head in English, Turkish, Russian, Japanese. Another example: specifier object of morpheme "to" takes place after head i.e. after "to", or corresponding morpheme of other language, in English, Arabic, Russian, (if cases are not counted; actually, there are a case morpheme, in tree, between

them, in these languages), but takes place before head in Turkish and Japanese. Words appear just as phonetically joined blocks of morphemes at surface layer (speech layer), and, semantically, that morphemes (which compose a word) do not have so much close relation to each other.

Both my propositions at least partially and inconsistently already presented in linguistics, and this my paper has at least intention of popularisation of these ideas.

References

- Dukes, Kais. 2010. The Quranic Arabic Corpus. Syntactic Treebank - Dependency Graphs. <http://corpus.quran.com/treebank.jsp> , 2015-02-11.
- Carnie, Andrew. 2000. Syntax: A generative introduction. Published by Blackwell Publishers in 2002, 2006, 2013.
- Chomsky, Noam. 1965. Aspects of the Theory of Syntax, p. 16. MIT Press.
- Embick, David; Noyer, Rolf. 2005. Distributed Morphology and the Syntax/Morphology Interface, p. 10. To appear in *The Oxford Handbook of Linguistic Interfaces (2007)*. http://babel.ucsc.edu/~hank/mrg.readings/E_N_DM_S_M_Interface.pdf , 2015-02-02.
- Hagstrom, Paul. 2001. CAS LX 522 Syntax I, Handouts, Week 3: X-bar Theory, p. 13. <http://www.bu.edu/linguistics/UG/course/lx522-f01/> , 2015-02-19.
- Halliday, M.A.K. & Matthiessen, C.M.I.M. 2004. An Introduction to Functional Grammar, p. 322. Hodder Arnold.
- Isao Goto, Masao Utiyama, Eiichiro Sumita. 2012. Post-ordering by Parsing for Japanese-English Statistical Machine Translation. *Proceedings of the 50th Annual Meeting of the Association for Computational Linguistics (Volume 2: Short Papers)*, Jeju Island, Korea. Association for Computational Linguistics. <http://www.aclweb.org/anthology/P12-2061> .
- Katsuhito Sudoh, Xianchao Wu, Kevin Duh, Hajime Tsukada, Masaaki Nagata. 2011. Post-ordering in Statistical Machine Translation. In *Proceedings of the 13th Machine Translation Summit*. <http://www.mt-archive.info/MTS-2011-Sudoh.pdf> .
- Kayne, Richard S. 1984. Connectedness and Binary Branching, pp. 133-5. Foris Publications.
- Мифтахов, Б. М., Сөнгатов, Г. М. 2002. Татар теле (Tatar language, for 7th grade of school), p. 28. Мәгариф.
- Oflazer, Kemal. 2007. The Turkish Treebank. *Treebank Workshop*. Hindi/Urdu Treebank Project at University of Washington. <http://faculty.washington.edu/fxia/treebank/workshop07/agenda.htm> , 2015-01-30.
- Qurbanov, Dinar. 2003. Notes on linguistics, pp. 57, 58, 60. <http://qdb.narod.ru/tattyazmaindex.htm> .
- Qurbanov, Dinar. 2013. Right (correct) analysis of phrase structure... <http://qdb.wp.kukmararayon.ru/2013/11/26/right-correct-analysis-of-phrase-structure/> .
- Qurbanov, Dinar. Tarjima, output of index2.php. <https://github.com/qdinar/tarjima/archive/812c17e3cf-d340001a8ae5aa445bde94b4eb6b29.zip> .
- Taijiro Tsutsumi. 1986. A Prototype English-Japanese Machine Translation System for Translating IBM Computer Manuals. *Coling 1986 Volume 1: The 11th International Conference on Computational Linguistics*, pp. 646—648. <http://www.aclweb.org/anthology/C86-1152> .
- The Stanford Parser: A statistical parser. The Stanford NLP (Natural Language Processing) Group. <http://nlp.stanford.edu/software/lex-parser.shtml#Sample> , 2015-02-02.
- Verb phrase - *Wikipedia, the free encyclopedia*. https://en.wikipedia.org/wiki/Verb_phrase , 2015-02-02.