Towards a Computational Semantic Analyzer for Urdu

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Motivation

1. Advances in the computational processing of Urdu
2. Increasing amount of lexical resources for Urdu available
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Task

Gathering information from various resources and putting them together to form one coherent resource for Urdu.
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Gathering information from various resources and putting them together to form one coherent resource for Urdu.

Challenge
What formalism can we employ that puts this information together? And what are the particular challenges with respect to Urdu?
Taking stock

- Urdu is still a language with comparably few linguistic resources

Syntactic parsers:
- Treebank-based PCFG parser (Abbas, 2002)
- Urdu dependency parser trained with MaltParser (Ali and Hussain, 2010)
- Urdu ParGram grammar based on LFG (Butt and King 2004, Bögel et al. 2009)

Lexical resources:
- Emille corpus (Baker et al., 2004)
- “Experiences in Building Urdu Wordnet” (Adeeba and Hussain, 2011)
- Urdu WordNet based on Hindi WordNet (Ahmed and Hautli, 2009)
- Automatic collection of Urdu multiwords (Hautli and Sulger, 2011)
- Development of a lexical resource for Urdu verbs
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The Urdu ParGram grammar

- Parser based on the formalism of Lexical Functional Grammar (Bresnan and Kaplan 1981) run on the development platform XLE (Crouch et al. 2011)

- The Urdu ParGram grammar as part of an international effort to create parallel grammars for different languages
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transliteration (FST) ↓
tokenizer & morphology (FST)
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\[
\text{transliteration (FST)}
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\downarrow
\text{semantics (XFR ORDERED REWRITING)}
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The Urdu ParGram grammar

us nE t3ul AbEb mEN sEb kHAyA
he Erg Tel Aviv in apple eat.Perf.F.Sg
‘He/She ate an apple in Tel Aviv.’

"us nE t3ul AbEb mEN sEb kHAyA"

\[
\begin{align*}
\text{PRED} & : \text{'kHA<[1:vuh], [26:sEb]>'} \\
\text{SUBJ} & : \text{NTYPE [NSYN pronoun]} \\
\text{OBJ} & : \text{NTYPE [NSEM [COMMON count]]} \\
\text{ADJUNCT} & : \text{NTYPE [NSEM [PROPER [PROPER-TYPE location]]]} \\
\text{LEX-SEM} & : \text{AGENTIVE +]}
\end{align*}
\]
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```
transliteration (FST) ↓
tokenizer & morphology (FST) ↓
syntax (XLE LFG) ↓
semantics (XFR ORDERED REWRITING)
```
The xfr rewrite system

- Rewriting and flattening of f-structure facts by rewrite rules (Crouch and King, 2003)
  - \text{SUBJ}(%1,%2) \Rightarrow \text{subj}(%1,%2).
- Each clause is embedded in a context where predications are true or false
- Allows for the incorporation of lexical resources such as WordNet and VerbNet using a database interface
The xFR rewrite system

What information would we like to get from a semantic representation?

‘He/She ate an apple in Tel Aviv.’
The XFR rewrite system

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The XFR rewrite system

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2. What are the thematic roles of the grammatical functions?

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‘He/She ate an apple in Tel Aviv.’
The XFR rewrite system

What information would we like to get from a semantic representation?

‘He/She ate an apple in Tel Aviv.’

1. What predications hold in the context of the sentence?
2. What are the thematic roles of the grammatical functions?
3. What is the lexical information contained in the sentence?
1. What predications hold in the context of the sentence?

‘He/She ate an apple in Tel Aviv.’

context_head(t,kHA:25),
in_context(t,role(subj,kHA:25,vuh:1)),
in_context(t,role(obj,kHA:25,sEb:21)),
in_context(t,role(mod,kHA:25,’t3ul AbEb’:7)).
The \textit{xfr} semantics

2. What are the thematic roles of this sentence?

- Development of a lexical resource for Urdu verbs in the style of VerbNet
  - Assignment of thematic roles to the grammatical functions
  - \textit{kHA} ‘to eat’: \texttt{SUBJ} $\rightarrow$ Agent
    \texttt{OBJ} $\rightarrow$ Patient
  - VerbNet information is stored in a database which can be accessed by the \textit{xfr} system
  - The \textit{xfr} rules replace the grammatical functions with the thematic roles from the database

- Locational information is available from the f-structure representation and directly put into the semantic representation
The **XFR** semantics

us nE t3ul AbEb mEN sEb kHAyA
he Erg Tel Aviv in apple eat.Perf.F.Sg
‘He/She ate an apple in Tel Aviv.’

code:

```latex
context\_head(t,kHA:25),
in\_context(t,role('Agent',kHA:25),vuh:1),
in\_context(t,role('Patient',kHA:25),sEb:21),
in\_context(t,role('Location',kHA:25),'t3ul AbEb':7),
```
3. What is the lexical information contained in the sentence?

He/she ate an apple in Tel Aviv.

- *kHA* ‘to eat’: ingestive verb where the agent consumes an eatable object
- *us* ‘he/she’: living thing that performs the eating event
- *sEb* ‘apple’: fruit that is the object of consumption
- *t3ul AbEb* ‘Tel Aviv’: location
- *mEN* ‘in’: indicates that the event takes place in Tel Aviv
The \textbf{xfr} semantics

- The lexical information in our system comes from Urdu WordNet, which is build on the basis of Hindi WordNet (Ahmed and Hautli 2010)

\begin{itemize}
  \item transliterate Urdu input to Hindi
  \item lookup and extract all information from Hindi WordNet
  \item remove the gloss (synset description and example sentence)
  \item store the lexical information in an \textbf{xfr}-accessible database
\end{itemize}
The XFR semantics

Inclusion of all resources:

Location

\[ t3ul \ AbEb \text{ ‘Tel Aviv’} \]

Ingestion: \( kHA \text{ ‘to eat’} \)

Animate Thing:
\( vuh \text{ ‘he/she’} \)

Agent

Fruit/Tree:
\( sEb \text{ ‘apple’} \)

Patient
The XFR semantics

Treatment of spatial expressions (Ahmed, 2010):
The XFR semantics

Treatment of spatial expressions (Ahmed, 2010):

‘He/She ate an apple in Tel Aviv.’

case

context_head(t,kHA:25),
in_context(t,role('Agent',kHA:25),vuh:1),
in_context(t,role('Patient',kHA:25),sEb:21),
in_context(t,role('Location',kHA:25),location:100),
The XFR semantics

Treatment of spatial expressions (Ahmed, 2010):

`us nE t3ul AbEb mEN sEb kHAyA`  
he Erg Tel Aviv in apple eat.Perf.F.Sg  
‘He/She ate an apple in Tel Aviv.’

```prolog
context_head(t,kHA:25),
in_context(t,role('Agent',kHA:25),vuh:1),
in_context(t,role('Patient',kHA:25),sEb:21),
in_context(t,role('Location',kHA:25),location:100),
in_context(t,role(figure,location:100,vuh:1)),
in_context(t,role(ground,location:100,'t3ul AbEb':7)),
in_context(t,role(configuration,'t3ul AbEb':7,in)).
```
The \textbf{XFR} semantics

Treatment of modality:
The XFR semantics

Treatment of modality:

- Expression of modality mostly constructionally (Bhatt et al. 2011)

us t3ul AbEb mEN sEb kHA pA-yA

he Tel Aviv in apple eat find-Perf

‘He/She was able to eat an apple in Tel Aviv.’

"vuh t3ul AbEb mEN sEb kHA pAyA"
The XFR semantics

Treatment of modality:

- Expression of modality in Urdu mostly constructionally

us t3ul AbEb mEN sEb kHA pA-yA
he Tel Aviv in apple eat find-Perf
‘He/She was able to eat an apple in Tel Aviv.’

context_head(t,pA:6),
context_head(ctx(kHA:25),kHA:25),
in_context(t,ABIL(pA,ctx(kHA:25))),
in_context(t,role(Holder_Of_Obligation,pA:6),vuh:1),
in_context(ctx,role(’Agent’,kHA:25,vuh:1)),
in_context(ctx,role(’Patient’,kHA:25,sEb:21)),
in_context(ctx,role(’Location’,kHA:25,’t3ul AbEb’:7)).
Challenges

An extreme case - *EAT* expressions in Hindi/Urdu (Hook and Pardeshi, 2009):

- Employment of ‘eat’ in idiomatic expressions
- About 160 *EAT* expressions for Hindi/Urdu
- Variety of uses due to loan translations from Persian
Challenges

h2asan=nE kEk=kO kHAyA
h2asan cake eat.Perf.Sg.Masc
‘Hasan ate the cake.’
\textbf{eat} = \langle \text{Agent, Patient} \rangle

inqilAbI fikar zang kHA jAEgl
revolutionary thought rust eat go.Fut.Fem.Sg
‘Revolutionary thinking will gather rust.’
\textbf{eat (gather rust)} = \langle \text{Patient, Theme} \rangle

is sAl=kl mandI sheyar-bAzAr kHA gAyI
this year slowdown stockmarket eat go.Perf.Fem.Sg
‘This year’s slowdown wrecked (lit. devoured) the stock market.’
\textbf{eat (wreck)} = \langle \text{Agent, Theme} \rangle
Tasks ahead

- Further develop the lexical resources for Urdu
- Define concrete application areas for the semantic representation and adjust it accordingly
- Develop evaluation standards for semantic representations and run large-scale experiments
  - Hindi TreeBank could provide some semantic information
- Work on the theoretical semantic analysis of the language
The `xfr` rewrite system is an adequate way of combining various resources in one tool

- Lexical information from WordNet
- Verb frames from a verb resource

Based on a detailed syntactic analysis, the semantic representation can go deeper, e.g.

- spatial expressions
- modality constructions
Thank you!