First Steps in Multimodal Grammar Development in LKB & PET

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July 6, 2010

Objectives

- analyse synchronous speech and co-verbal gesture
- ... so as to derive a single multimodal derivation tree
- use the Grammar Matrix as a basic grammar framework
- ... whereby extending it with types, features and construction rules
- use PET's token feature structures
- ... for parsing XML-based annotation data (ANVIL)
- ... containing gesture feature structures and prosodic information
- ... and for defining temporal constraints between speech and gesture

Outline

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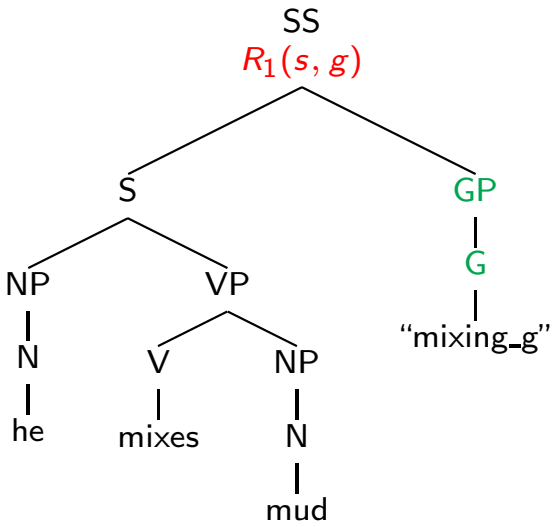
Speech-Gesture Synchrony

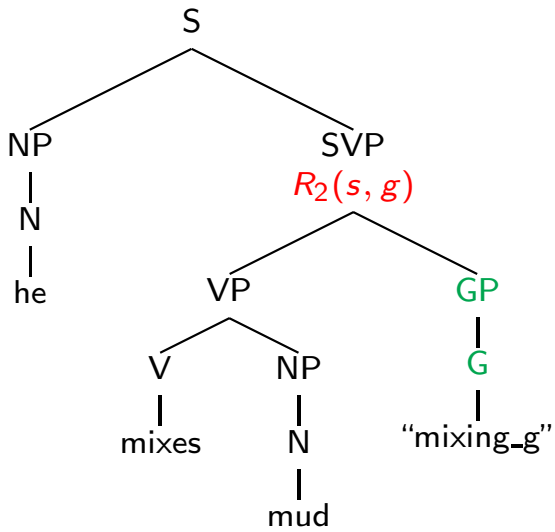
- Synchrony is prosodic, semantic and pragmatic [McNeill, 1992]
- But is it also syntactic?

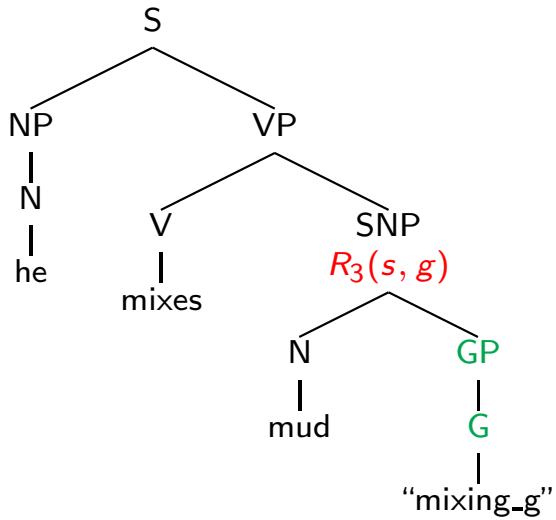
Example (Loehr, 2004)

So he MIXes MUD ...

Speech-Gesture Synchrony, Cont'd



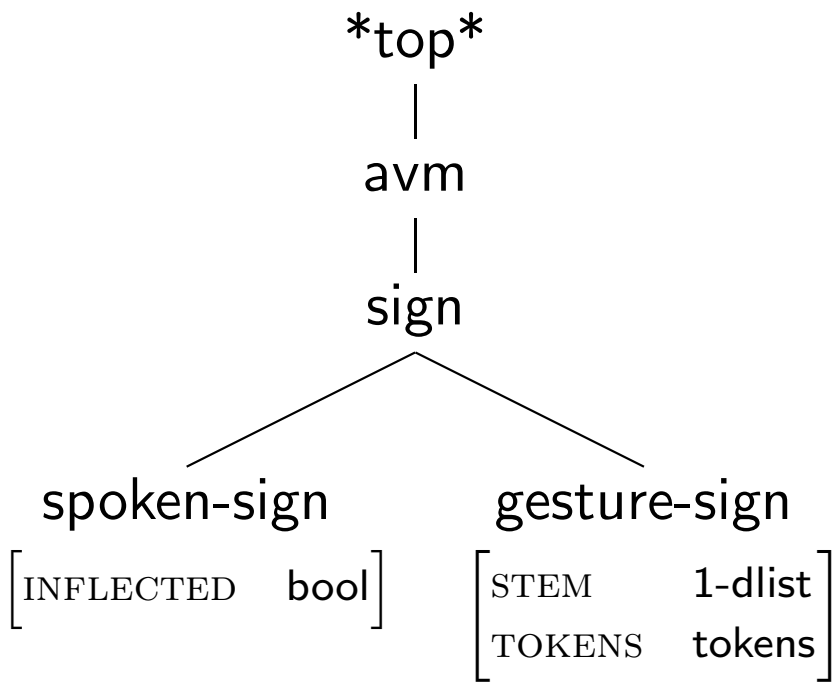




Outline

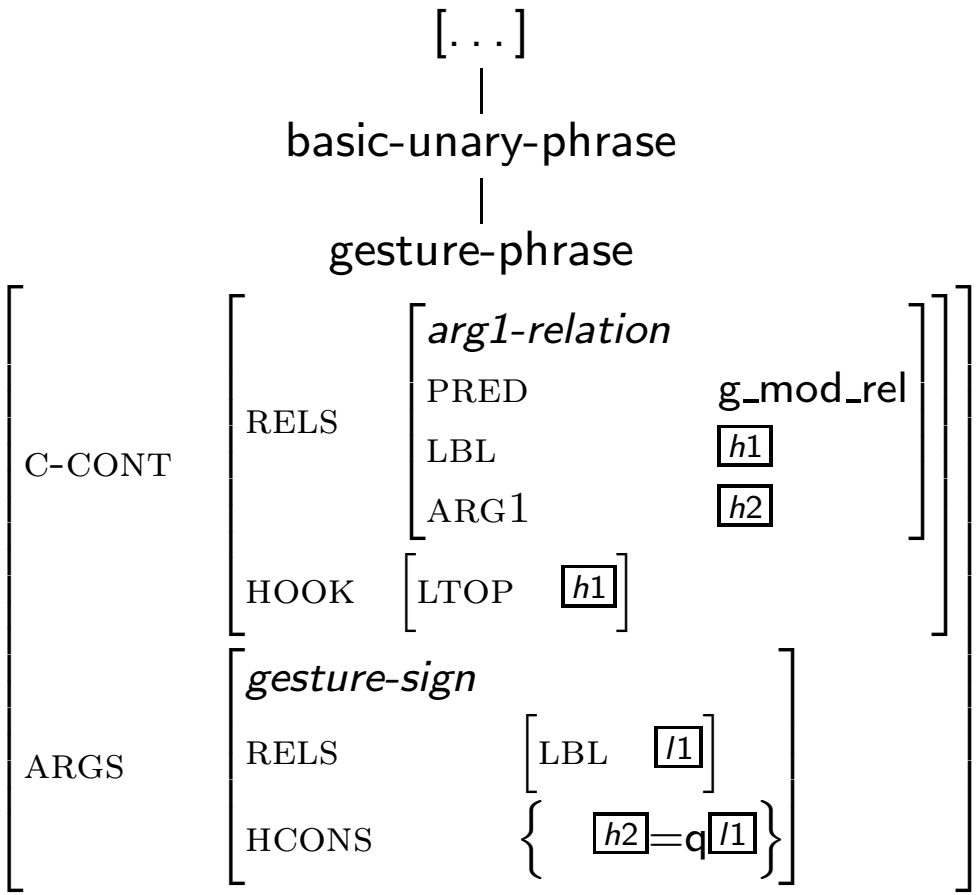
Type Hierarchy

Signs



Type Hierarchy, Cont'd

Phrases



... we'll review this rule later...

Type Hierarchy, Cont'd

Construction Rules

[. . .]

basic-binary-headed-phrase

situated-phrase

$$\begin{bmatrix}
\text{SS} \mid \text{LOC} & \begin{bmatrix} \text{CAT} & \boxed{1} \\ \text{CONT} \mid \text{HOOK} & \begin{bmatrix} \text{IND} & \boxed{2} \\ \text{LTOP} & \boxed{3} \end{bmatrix} \end{bmatrix} \\
\text{S-DTR} & \begin{bmatrix} \text{SS} \mid \text{LOC} & \begin{bmatrix} \text{CAT} & \boxed{1} \\ \text{CONT} \mid \text{HOOK} \mid \text{LTOP} & \boxed{h1} \end{bmatrix} \end{bmatrix} \\
\text{G-DTR} & \begin{bmatrix} \text{SS} \mid \text{LOC} \mid \text{CONT} \mid \text{HOOK} \mid \text{LTOP} & \boxed{h2} \end{bmatrix} \\
\text{C-CONT} \mid \text{RELS} & \begin{bmatrix} \textit{vis-relation} & \\ \text{PRED} & \text{vis_rel} \\ \text{LBL} & \boxed{3} \\ \text{M-ARG} & \boxed{2} \\ \text{S-HNDL} & \boxed{h1} \\ \text{G-HNDL} & \boxed{h2} \end{bmatrix}
\end{bmatrix}$$

Outline

Multimodal Input

[Loehr, 2004]

- text annotated with timing

```
<el index="117" start="33.155910491" end="33.261188507">
  <attribute name="text">he</attribute>
</el>
<el index="118" start="33.261188507" end="33.667694091">
  <attribute name="text">mixes</attribute>
</el>
<el index="119" start="33.667694091" end="34.289043426">
  <attribute name="text">mud</attribute>
</el>
```

- .. and prosody

```
<el index="35" start="33.19949" end="33.32139">
   <attribute name="text"> H* </attribute>
</el>
<el index="36" start="33.71449" end="33.84776">
   <attribute name="text"> X* </attribute>
</el>
```

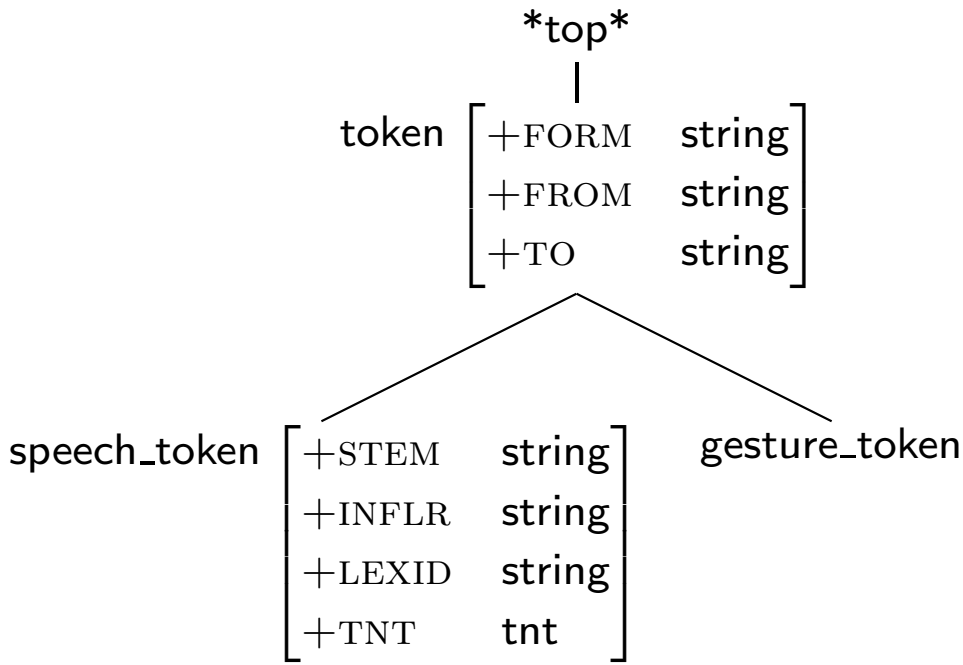
- ... and gestural performance

```
<el index="24" start="59" end="59">
  <attribute name="Hand Shape"> Open-Flat </attribute>
  <attribute name="Palm Orientation"> TC (Towards Centre) </attribute>
  <attribute name="Finger Orientation"> Towards Down </attribute>
  <attribute name="Location"> Centre-Low </attribute>
  <attribute name="Move"> Circular </attribute>
  <attribute name="Gloss"> mixing drywall mud </attribute>
</el>
```

Outline

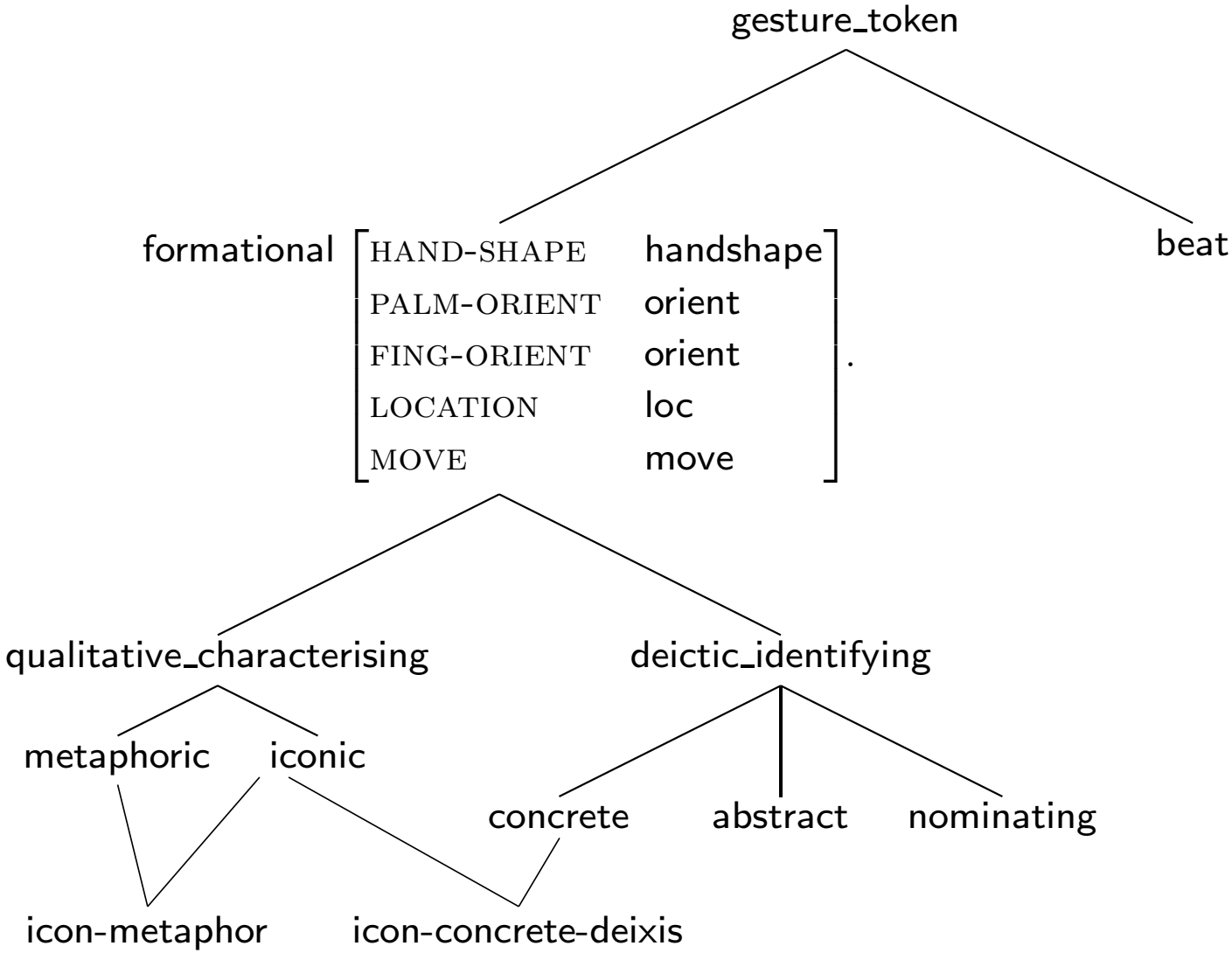
Extending Token Type Hierarchy

Token Types

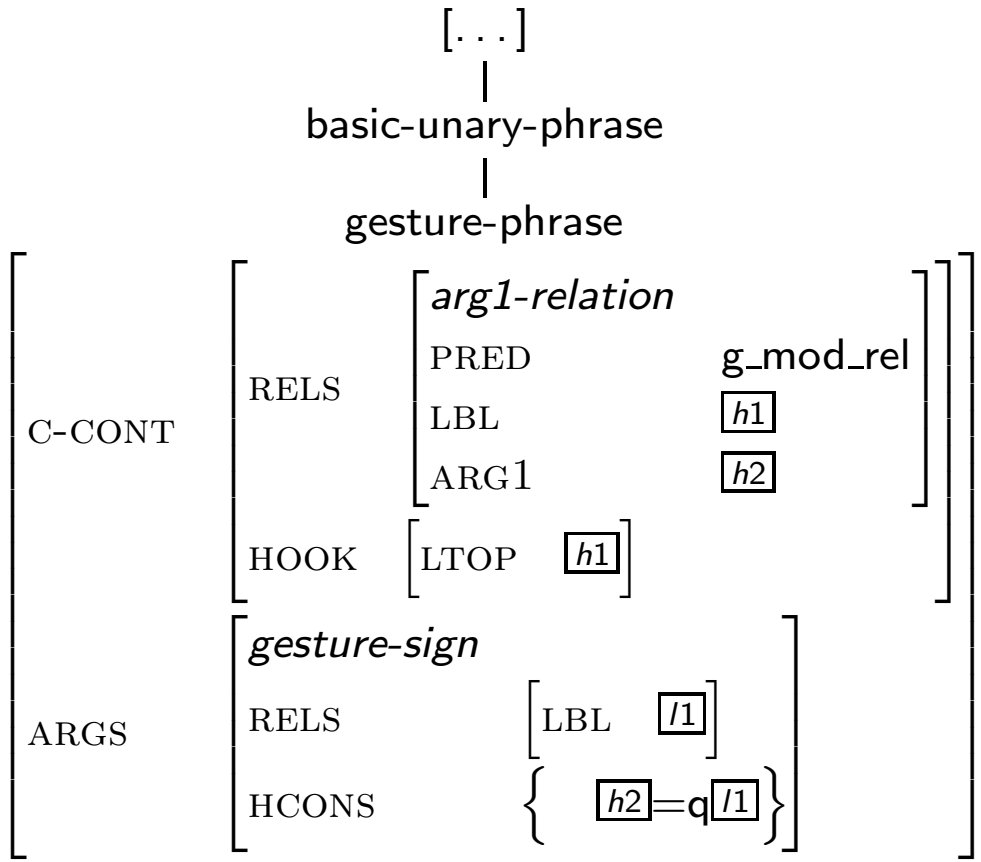


Extending Token Type Hierarchy, Cont'd

Gesture features, a fragment

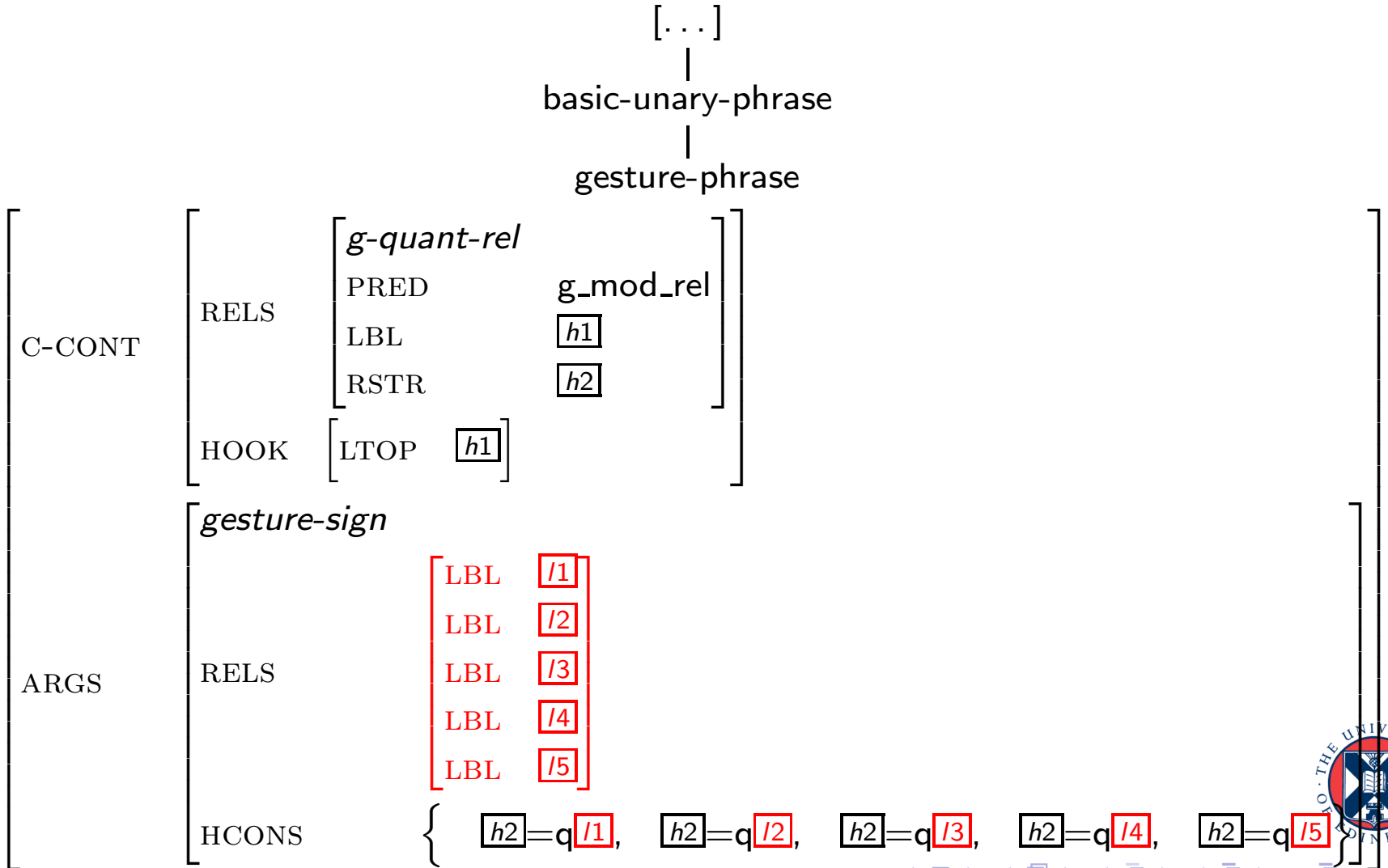


How do the gesture features reflect our gesture rule?



How do the gesture features reflect our gesture rule?

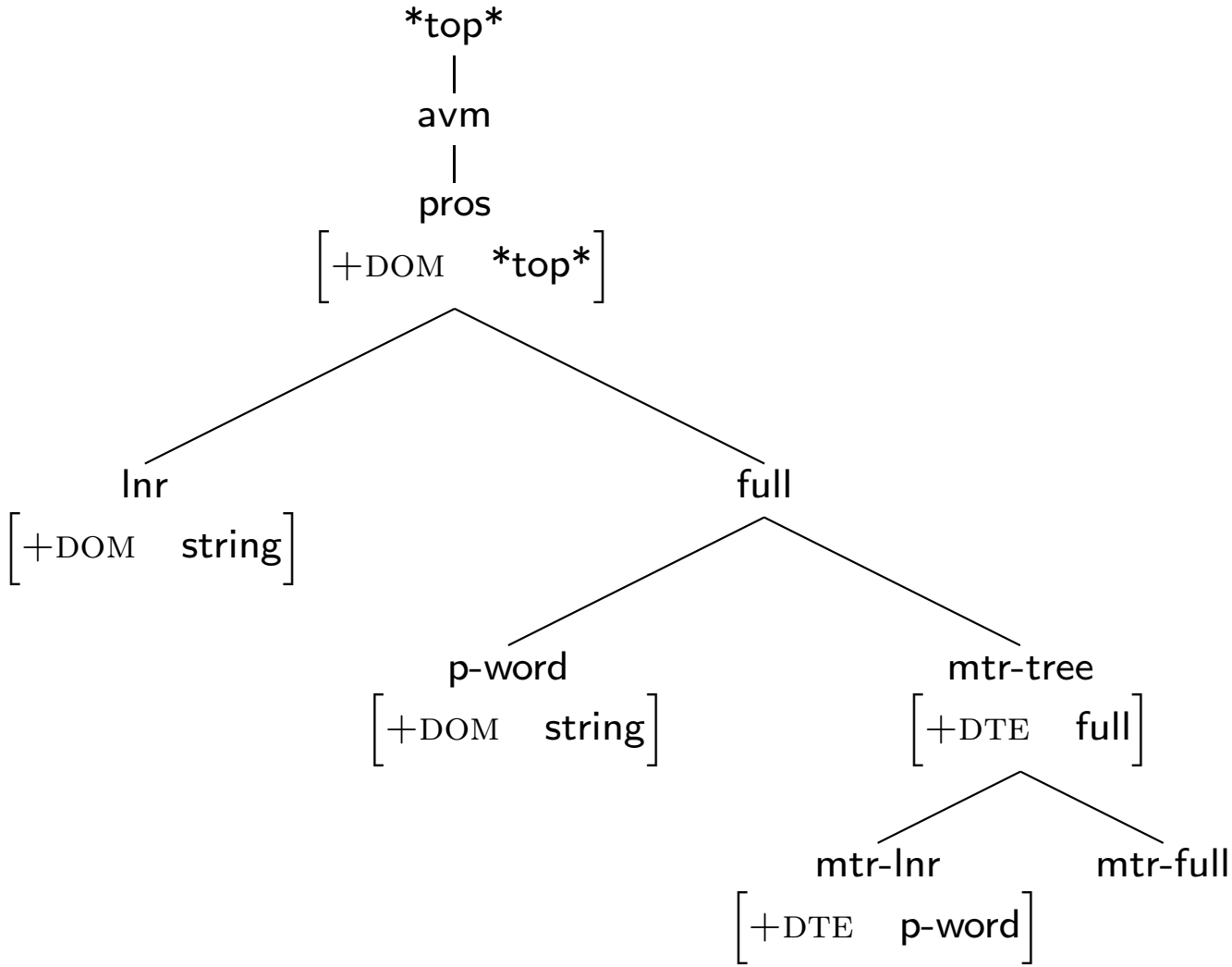
- every feature-value maps to an underspecified predicate, [Lascarides & Stone, 2009]:



Outline

Extending Type Hierarchy with Prosody

Prosodic types and features, [Klein 2000]



Outline

Future Work and Discussion

- derive structured phonology

$$\begin{bmatrix} \text{PHON} & \langle \text{HE, MIXES, MUD} \rangle \\ \text{SYNSEM} & \text{synsem} \end{bmatrix}$$

Figure: Unstructured Phonology

vs.

$$\begin{bmatrix} \textit{mtr(full)} & & \\ & \begin{bmatrix} \textit{mtr(lnr)} & & \\ & & \\ \text{PHON} & \text{DOM} & \left\langle \begin{bmatrix} \textit{mtr(lnr)} & \\ \text{DOM} & \langle \textit{he}, \boxed{1}\ \textit{mixes} \rangle \\ \text{DTE} & \boxed{1} \end{bmatrix}, \boxed{2}\textit{mud} \right\rangle \\ & & \\ & \text{DTE} & \boxed{2} \end{bmatrix} \\ \text{SYNSEM} & \text{synsem} & \end{bmatrix}$$

Figure: Structured Phonology

Future Work, Cont'd

- integrate a gesture and a prosodic structure (which is not a syntactic constituent)
- add semantics to a prosodic structure (which is not a syntactic constituent)
- add temporal constraints

References I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