Refining the Semantics of Lexical Rules in HPSG

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Meurers' Approach

Lexical Rules (LRs) are employed in HPSG to derive new words from existing ones. They are commonly specified in the shape

$$A \mapsto B$$

Where A and B are AVMs. A rule is supposed to **apply** to every word that is described by A and to return a word that is **as similar as possible** to A while also conforming to B.

Meurers (2001) specifies a semantics for LR specifications (LRSs; also see the glossary). Under this approach, LRs are descriptions of a certain sort of object to which the *word*-valued attributes IN and OUT are appropriate. They should ascertain that as much of IN as possible is transferred to OUT. This is to be achieved by ruling out (via an appropriate translation of the LRSs into the actual descriptions) all *proto-instances* (see the glossary) of the LRS which do not transfer the properties as desired. The remaining *instances* of the rule thus perform the desired transfers. The leading ideas are the following:

Sort Tranfer: The denotation of a rule may not contain a proto-instance x if another proto-instance exists that transfers the species of a path whose species x does not transfer.

Value Transfer: In any instance of a rule, the values of corresponding paths that are not mentioned should be token-identical whenever this is possible.

It turns out that Meurers' approach leads to counterintuitive results as it violates the criterion of **Universality** (see the glossary): rules may apply to far fewer words than one should expect because *not every word that can be the* IN *value of a proto-instance could also be that of an instance.* We start out from Meurers' approach and refine it so as to no more suffer from this problem.

Sort Transfers

$$\begin{bmatrix}\text{U} & g\end{bmatrix} \mapsto \begin{bmatrix}\text{U} & \begin{bmatrix} h & \\ \text{K} & bool \\ \text{L} & bool\end{bmatrix}\end{bmatrix}$$

Fig. 1: Illustration of problematic aspects of sort transfer.

$$\begin{bmatrix}\text{IN} & \begin{bmatrix}\text{U} & \begin{bmatrix} g & \\ \text{K} & + \\ \text{L} & + \end{bmatrix}\end{bmatrix} \\ \text{OUT} & \begin{bmatrix}\text{U} & \begin{bmatrix} i & \\ \text{K} & - \\ \text{L} & + \end{bmatrix}\end{bmatrix}\end{bmatrix}$$

Fig. 2: U has species i in the output; transfer of U L but not U K

$$\begin{bmatrix}\text{IN} & \begin{bmatrix}\text{U} & \begin{bmatrix} g & \\ \text{K} & + \\ \text{L} & + \end{bmatrix}\end{bmatrix} \\ \text{OUT} & \begin{bmatrix}\text{U} & \begin{bmatrix} j & \\ \text{K} & + \\ \text{L} & - \end{bmatrix}\end{bmatrix}\end{bmatrix}$$

Fig. 3: U has species i in the output; transfer of U L but not U K

- Fig. 2 describes objects with values of the same species on IN U L and OUT U L (green).
- According to Meurers' semantics, this rules out objects described by the AVM in Fig. 3.
- Analogously, objects described by Fig. 3 rules out those described by Fig. 2.

As a result, Fig. 1 does not license any objects (and thus not derive any words) at all.

Value Transfers

$$word \mapsto \begin{bmatrix}\text{X} & \boxed{1} \\ \text{Y} & \boxed{1}\end{bmatrix}$$

Fig. 4: Illustration of problematic aspects of value transfer.

Meurers' semantics enforces the following token-identities:

OUT U X K = IN U X K and OUT U Y K = IN U Y K

Since the rule specifies OUT U X = OUT U Y, it follows that

OUT U X K = OUT U Y K

and hence

IN U X K = IN U Y K

Thus the rule only accepts inputs in which U X K and U Y K have token-identical values.

The Alternative

The basic idea: A proto-instance x will only become an instance if no other proto-instance has a congruent IN-value and transfers a superset of the properties that x transfers.

DEF (Frames). *Given an LRS λ, for any proto-instance x of λ:*
$SFrame(x) = \{\pi \in Mentioned(\lambda) \,|\, \text{IN}\pi$ *and* $\text{OUT}\pi$ *have the same species on* $x\}$
$VFrame(x) = \{\pi \in Edge(\lambda) \,|\, \text{IN}\pi$ *and* $\text{OUT}\pi$ *have the same value on* $x\}$

A proto-instance x of a rule will become an instance only if no proto-instance y exists such that

- The IN-values of x and y are congruent and
- $SFrame(x) \subset SFrame(y)$ or $VFrame(x) \subset VFrame(y)$

This means that

- No additional transfer could be made by an instance without refraining from another.
- Since only proto-instances with congruent IN-values are compared, *Universality is guaranteed.*

Illustration

Sort Transfers

For Fig. 2, the $SFrame$ is $\{\text{U L}\}$, for Fig. 3 it is $\{\text{U K}\}$. Since neither $\{\text{U L}\} \subset \{\text{U K}\}$ nor *vice versa*, no proto-instances are dropped to transfer the species of any of these two paths.

Value Transfers

$$\begin{bmatrix}\text{IN} & \begin{bmatrix}\text{X K} & \boxed{2} \\ \text{Y K} & \boxed{3}\end{bmatrix} \\ \text{OUT} & \begin{bmatrix}\text{X } \boxed{1}\text{K} & \boxed{2} \\ \text{Y } \boxed{1}\text{K} & \boxed{2}\end{bmatrix}\end{bmatrix}$$

Fig. 5: The value of X K is transferred.

$$\begin{bmatrix}\text{IN} & \begin{bmatrix}\text{X K} & \boxed{2} \\ \text{Y K} & \boxed{3}\end{bmatrix} \\ \text{OUT} & \begin{bmatrix}\text{X } \boxed{1}\text{K} & \boxed{3} \\ \text{Y } \boxed{1}\text{K} & \boxed{3}\end{bmatrix}\end{bmatrix}$$

Fig. 6: The value of Y K is transferred.

$$\begin{bmatrix}\text{IN} & \begin{bmatrix}\text{X K} & \boxed{2} \\ \text{Y K} & \boxed{3}\end{bmatrix} \\ \text{OUT} & \begin{bmatrix}\text{X } \boxed{1}\text{K} & \boxed{4} \\ \text{Y } \boxed{1}\text{K} & \boxed{4}\end{bmatrix}\end{bmatrix}$$

Fig. 7: Neither is transferred.

Figures 5 and 6 show possible constellations regarding (4): Either X K is transferred or Y K is because $\{\text{X K}, \text{U}\} \not\subset \{\text{Y K}, \text{U}\}$ and $\{\text{Y K}, \text{U}\} \not\subset \{\text{X K}, \text{U}\}$ (U, not mentioned in the AVMs, always is transferred); leaving both untransferred is ruled out because $\{\text{U}\} \subset \{\text{X K}, \text{U}\}$.

Glossary

A **Lexical Rule Specification (LRS)** $A \mapsto B$ is an abbreviation for

$$\begin{bmatrix} lex\_rule & \\ \text{IN} & A \\ \text{OUT} & B\end{bmatrix}$$

Objects denoted by LRSs are called **proto-instances** (PIs) of the specified rules. **Instances** (objects denoted by the actual rule) are singled out from these by the semantics to be defined.

Criterion (Universality). *For every PI of an LR, there is an instance of this LR such that the values of the* IN *attribute on the PI and the instance are congruent.*

Hence the LRS alone determines whether a given object is a possible input to a given rule.

DEF (**Mentioned Paths**).
$Mentioned(\lambda)$ = The set of paths π such that $\text{OUT}\pi$ *is explicitly mentioned in the LRS λ.*

DEF (**Edge** of an LRS).
$Edge(\lambda) =$
$\{\pi\alpha \,|\, \pi \in Mentioned(\lambda)\ \&\ \pi\alpha \notin Mentioned(\lambda)\}$

Sort Hierarchy

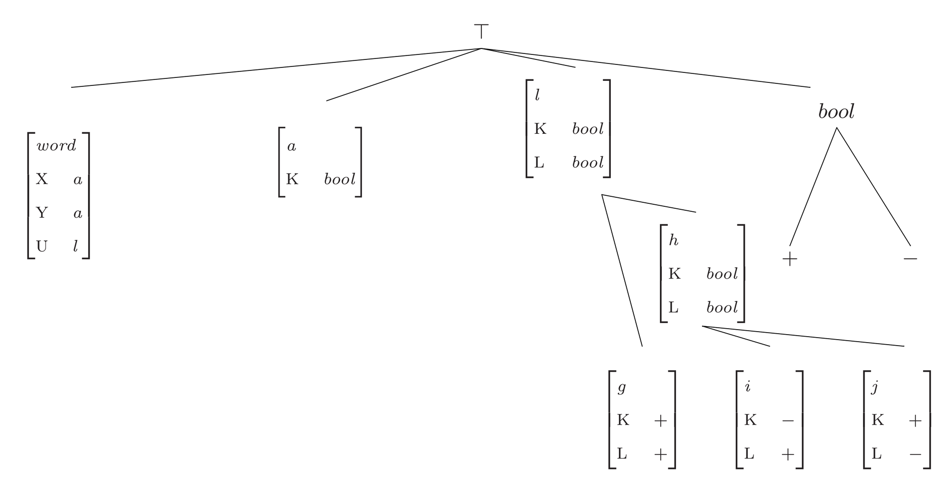

Fig. 8: The toy sort hierarchy presupposed in the examples.

References

Meurers, Walt Detmar. 2001. On Expressing Lexical Generalizations in HPSG. *Nordic Journal of Linguistics* 24:161–217.

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