Practical Grammar Engineering using HPSG
Exercises day3: MRS

Goals:

1. Learn about MRS.
2. Introduce MRS into the grammar.
3. See how semantic composition works.

Background

The type *mrs* in the matrix.tdl file has these features:

```
mrs := mrs-min &
  [ HOOK hook,
    RELS diff-list,
    HCONS diff-list,
    MSG basic_message ].
```

The RELS list contains all the relations in the sign. A lexeme typically has one element on this list. The value of RELS in a phrase is the concatenation of all the relations introduced by the lexical entries and rules that make up the phrase. We will come back to how a rule introduces relations. The HCONS feature has as value a difference list which concatenates all handle constraints of the sign. A handle constraint is a way to express equality between handles without using unification. The MSG feature has as value a message. The HOOK feature bundles together three features, namely LTOP, INDEX and XARG:

```
hook := avm &
  [ LTOP handle,
    INDEX individual,
    XARG individual ].
```

The value of LTOP is the top handle of the sign and typically shares structure with the handle of one relation on the RELS list. The INDEX value points to the ARG0 of the main relation on the RELS list. The XARG feature is a pointer to the index of an external argument, and can be used in case of VP complements and relative clauses.

Exercises:

1. Extend your grammar to have MRS semantics in lexemes.
   (a) Let *det-word* inherit from *norm-lex-item* in addition to *word*.
   (b) Constrain nouns to have a *noun-relation*, verbs to have an *event-relation* and determiners to have a *quant-relation*. If your language doesn't have determiners, we will come to another way to introduce quantifier relations.
   (c) Introduce PRED values on all lexical entries. If you for example have a noun 'dog' in your lexicon, you can give it the PRED value *"_dog_n_rel"*. You can reach the PRED value via the path SYNSEM.LKEYS.KEYREL.PRED. Introduce *def-relation* and *indef-relation* as subtypes of *quant-relation*, and give them corresponding PRED values. Update your determiner (if you have one) with regard to determiner relation.
   (d) Introduce a type *arg1-subj-lex-item* as a subtype of *lex-item* and link its ARG1 with the index of its subject. (The feature SYNSEM.LKEYS.KEYREL points to the main relation on the RELS list.) Remember that the elements on the valence lists are of type *synsem*.
   (e) Let your intrans-verb-lxm type inherit from *arg1-subj-lex-item* in addition to *verb-lxm*. Inspect the expanded type of your intransitive verb and check that the linking is correct. It should have these constraints:

$$
\begin{bmatrix}
\text{SYNSEM} & \begin{bmatrix}
\text{LOCAL} & \begin{bmatrix}
\text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{SUBJ} & \left\langle \begin{bmatrix}\text{LOCAL}\,|\,\text{CONT}\,|\,\text{HOOK}\,|\,\text{INDEX}\ \boxed{1}\end{bmatrix} \right\rangle \\ \text{SPR} & \langle\rangle \\ \text{COMPS} & \langle\rangle \end{bmatrix} \end{bmatrix} \\
\text{CONT} & \begin{bmatrix} \text{HOOK}\,|\,\text{INDEX}\ \boxed{2} \\ \text{RELS} \left\langle !\ \boxed{3} \begin{bmatrix} \textit{arg1-ev-relation} \\ \text{PRED ``\_bark\_v\_rel''} \\ \text{ARG0}\ \boxed{2} \\ \text{ARG1}\ \boxed{1} \end{bmatrix} ! \right\rangle \end{bmatrix}
\end{bmatrix} \\
\text{LKEYS}\,|\,\text{KEYREL}\ \boxed{3} &
\end{bmatrix}
\end{bmatrix}
$$

2. Introduce determiner relations.

   (a) If you have a determiner in your grammar, constrain its index to share structure with the index of its SPEC element.

   (b) If your language reflects the definite/indefinite distinction by using affixes instead of determiners (or nothing at all), you will first need a lexeme-to-lexeme rule which introduces the determiner relation. Then you need a lexeme-to-word rule which forms a word.

      i. For languages with definite suffixes on singular nouns: Introduce a type *sg-def-noun-lexeme* which inherits from *infl-ltol-rule*. Enter a definite determiner relation into the C-CONT.RELS difference list and unify the HOOK of the daughter with the HOOK of the mother. Also unify the C-CONT.HCONS with the HCONS in the mother. Link the ARG0 of the determiner relation to the INDEX of the mother. Then introduce an inflectional rule *sg-def-noun-irule1* which inherits from *sg-def-noun-lexeme* and which adds the inflection. You also need a *sg-def-noun-word* type which doesn't add any inflection. This type inherits from *const-ltow-rule* and *noun-word*. It will be the supertype of the non-inflecting *sg-def-noun-irule2*

      ii. For languages with neither determiners nor morphology, it is the same procedure, except that the lexeme-to-lexeme rule should be *const-ltol-rule* instead of *infl-ltol-rule*.

   If you use a lexeme-to-lexeme rule, you should be aware that almost no information is automatically copied from the daughter to the mother. This holds for features like HEAD, VAL, HOOK and HCONS.

   (c) You can now parse your short sentence and inspect the MRS. If the composition works as it should, the ARG0 of the determiner relation and the noun relation should be coindexed with the ARG1 of the verb relation.

3. Add message and handle constraints.

   (a) Add a handle constraint (*qeq*) in the HCONS list of the determiners. Link the HARG to the RSTR of the determiner relation and the LARG to the LTOP of the element in SPEC. In case of determiner relations introduced by C-CONT, the *qeq* is introduced in the C-CONT.HCONS difference list. Make sure that all noun lexemes and verb lexemes have empty HCONS lists.

   (b) Unify the value of MSG in *head-subj-phrase* with one element of type *message* and PRED value *proposition_m_rel* on the C-CONT.RELS difference list. Introduce a handle constraint in C-CONT.HCONS of *head-subj-phrase*. Link the HARG of the handle constraint to the MARG of the message and the LARG to the LTOP of the head daughter. Unify the LTOP of *head-subj-phrase* with the handle of the message, and unify the INDEX of the phrase with the INDEX of the head daughter.

   (c) Now you can ask the LKB for a scoped MRS.