Modeling Adnominal Possession in Multilingual Grammar Engineering

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Abstract

In this paper we describe insights gained from building an extension to the LinGO Grammar Matrix customization system to cover adnominal possessive phrases. We show how the wide range of such constructions attested in the world's languages can be handled with the typical major phrase types used in HPSG and discuss the value of feature bundling in the multilingual grammar engineering context.

1   Introduction

This paper presents observations drawn from an implemented, typologically grounded, cross-linguistic, HPSG analysis of adnominal possession. This particular phenomenon is an interesting target for such an analysis because it is likely to occur in most if not all languages, has an interesting range of typological parameters each of which has a tractable number of possible options. Our analysis is developed and implemented in the context of the LinGO Grammar Matrix (Bender et al., 2002, 2010) and we draw conclusions about the range of phrase structure rule types required for these expressions and the value of bundling information together within ancillary types.

The LinGO Grammar Matrix is an open-source project that allows user-linguists to jump-start the creation of implemented HPSG grammars. The Grammar Matrix consists of a core grammar and a customization system. The core grammar is a set of grammatical type definitions which can be used to model various realizations of typologically widespread phenomena; the customization system consists of a web interface that elicits typological information from the user-linguist via a questionnaire (Bender et al., 2010), and Python-based back-end code that draws from and adds to the core grammar in order to produce the implemented grammar for a given language. Since the Grammar Matrix project has always had the goal of being able to model the attested typological variation within the various linguistic phenomena that it covers, it functions not only as a tool for grammar engineers, but also as a set of typological generalizations and predictions, in a testable and internally consistent format (Bender et al., 2010; Bender, 2016).

We extended the current Grammar Matrix customization system by adding a library to model adnominal possession. This paper relates two of the typological and theoretical generalizations that were arrived at in the process of developing this extension to the Grammar Matrix. We begin by giving some background on the phenomenon — adnominal possession — that the library was intended to cover and the way in which we broke down this typological space. Second, we discuss one generalization we arrived at in the process of library creation, namely the suitability of major phrase types already in existence in the Grammar Matrix (head-specifier, head-complement, head-modifier) to model possessive phrases. We demonstrate that all marked possessive constructions can be modeled without requiring specific

additional binary phrasal constructions in any language. Lastly, we discuss another discovery, namely the implications of the decision made within the Matrix to bundle person, number, and gender features under a single feature called PNG. This bundling of features turns out to be very beneficial in the context of multilingual grammar engineering, since it allows a consistent way of dealing with these features in languages with disparate ways of dealing with person, number, and gender.

2 Describing the typological space

The goal in constructing this library was to be able to model all attested adnominal possessive constructions — that is, constructions involving two noun phrases whose referents participate in a possessive relation — based on a minimal amount of information from the user-linguist. To that end, in this section, we lay out the attested typological variation in terms of a few binary- or ternary-valued features that distinguish possible types of adnominal possessive phrases and define the boundaries of the typological space under discussion. The majority of typological variation in adnominal possessive phrases can be captured by the following features:

- Order: possessum–possessor, possessor–possessum

- Presence and type of marker: ϕ, affix, clitic, word

- Location of marker: possessum, possessor, both

- Syntactic relation: modifier-like, specifier-like

- Agreement: with possessum, with possessor, both

- Possessor type: full NP, pronoun

We briefly describe each of these in turn, bearing in mind that any given language can have multiple different possessive constructions.

Order   We observe constructions in which the possessor always precedes the possessum, and the reverse:

(1)   Komi, possessum-final:

kyf   kor-jas
birch leaf-PL
birch's leaves [kom] (Grashchenkov 2005:29)

(2)   Maltese, possessum-first:

bin is-sultn
son DEF-king
the king's son [mlt] (Grashchenkov 2005:29)

Presence and type of marker   In a given possessive construction, overt markers of possession may or may not appear. If no such markers exist, a possessive phrase may simply consist of a pair of juxtaposed nouns, as in the following example from Yoruba:

(3)   Yoruba, no marking:

íwè   baba
book father
'father's book' [yor] (Grashchenkov, 2005, 28)

In cases where these markers appear, they may take the form of an affix, a clitic, or an independent word:

(4)   Imbabura Quechua, affix:

José-paj   wasi
José-POSS house
'José's house' [qvi] (Grashchenkov, 2005, 34-35)

(5)   Basque, clitic:

neska gazte-a=ren   edertasuna
girl   young-DEF=POSS beauty
'the beauty of the young girl' [baq] (Grashchenkov, 2005, 33)

(6)   Bulgarian, independent word:

lah   na   proletta
breath POSS spring
'the breath of spring' [bul] (Grashchenkov, 2005, 31)

Location of markers   In possessive constructions which are marked by an overt morpheme, those morphemes can also be described in terms of where they occur: markers of possession may appear on the possessor, on the possessum, or in both locations. For example, in Yucatec Maya, possession is marked by inflection on the possessum,[1] while in Malagasy, it is marked by inflection on the possessor:

(7)   Yucatec Maya, possessum-marking:

u=k'àaba'   le   x-ch'up-pàal-a'
POSS.3=name DEF FEM-woman-child-D1
'the name of that girl' [yua] (Grashchenkov, 2005, 36-37)

(8)   Malagasy, possessor-marking:

zana d-rabe
child POSS-Rabe
'the child of Rabe' [mlg] (Grashchenkov, 2005, 34-35)

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[1]In this example, the possessum-marking inflection also carries agreement information, indicating that it agrees with a third-person possessor; examples of possessum-marking inflection without agreement are rare (Grashchenkov, 2005).

Syntactic relation   In the typological literature on possessive phrases, a distinction is often drawn between specifier-like possessors and modifier-like possessors. The English *'s*-genitive is a classic example of a construction with a specifier-like possessor, since the possessor fills the same slot as a specifier, blocking the possessum from taking a determiner:

(9)   English, specifier-like possessor:
      the father's house
      * the the father's house [eng]

By contrast, Ancient Greek possessive pronouns are more like modifiers, in that they occur alongside the posessum's determiner:

(10)   Ancient Greek, modifier-like possessor:

he: to   patròs   oikía
the.F.SG.NOM the.M.SG.GEN father(M).SG.GEN house(F)SG.NOM
'the father's house' [gre] (Goodwin, 1894)

Agreement   There are languages in which the possessor agrees in person, number, and/or gender with the possessum, such as Romani, shown below. There are also languages, such as Yucatec Maya, as shown in (7) above, or Finnish, illustrated in (12), where the possessum agrees with the possessor.

(11)   Romani, possessor agreement:

e   manús-es-quiri   buzni
the:OBL.M.SG man-OBL.SG.M-GEN:F.SG.NOM goat(F)
'the man's goat' [rom] (Koptjevskaja-Tamm, 2001, 962)

(12)   Finnish, possessum agreement:

heidän ystävä-nsä
their   friend-3POSS
'their friend' [fin] (Toivonen, 2000, 585)

Noun type   All languages allow the expression of possessives with both full NP and pronominal possessors. In some languages, the same possessive constructions are used for both. In others, pronominal possessors are treated differently. A special case of this is when the pronominal possessives are just the affixes that would attach to the possessum to indicate agreement with the possessor, in the absence of any overt possessor.

This brief summary of the typological space under consideration provides the background for our crosslinguistic analysis of possessives. In the next section, we will give a brief overview of the analysis we put forward in this library for possessive phrases.

3   Phrase types used to model possession

In this section, we give an overview of the semantic and syntactic structures that we posit to model adnominal possessive phrases. For a more detailed presentation of this analysis, see Nielsen 2018. We will focus in particular on one important subset of possessive phrases — namely marked possessive phrases — and show that they can be modelled in terms of phrase types that already exist in the Grammar Matrix.

The Grammar Matrix produces grammars which map from strings to Minimal Recursion Semantics (MRS; Copestake et al. 2005) representations. A full description of the elements of MRS is beyond the scope of the present work. For the purposes of this discussion, it is sufficient to note that the various entities in a possessive phrase such as *the dog's cat* each correspond to a predication element in the MRS representation (see (13)). For example, the predication *_dog_n_rel* corresponds to the noun *dog*, and so forth. The possessive relation itself is likewise encoded by means of a predication, namely a possessive relation (called *poss_rel*). This relation takes two arguments, which correspond to possessor (*x3*) and possessum (*x2*):

$$
(13) \quad
\begin{array}{|l}
\langle\, h_{13}, \\
h_4\!:\!\_\text{cat\_n\_rel}(\text{ARG0}\ x_2), \\
h_6\!:\!\_\text{dog\_n\_rel}(\text{ARG0}\ x_3), \\
h_{11}\!:\!\text{exist\_q\_rel}(\text{ARG0}\ x_3,\ \text{RSTR}\ h_7,\ \text{BODY}\ h_{12}), \\
h_8\!:\!\text{exist\_q\_rel}(\text{ARG0}\ x_2,\ \text{RSTR}\ h_5,\ \text{BODY}\ h_9), \\
h_4\!:\!\text{poss\_rel}(\text{ARG0}\ e_{10},\ \text{ARG1}\ x_2,\ \text{ARG2}\ x_3\ ) \\
\{\, h_5 =_q h_6,\ h_7 =_q h_4 \,\}\,\rangle
\end{array}
$$

Any given possessive construction must include some element that introduces this *poss_rel*, in order to ensure that the final phrase has the correct possessive semantics. In this section, we outline briefly the approach taken to solving this problem in two cases: unmarked and marked possessive constructions. In unmarked possessive phrases, we introduce a unique binary phrase structure rule to model possessive phrases; in the case of marked possessive phrases, we have demonstrated that all possessive phrases can be modeled in terms of existing phrase structure types in the Grammar Matrix.

3.1   Unmarked possessive phrases

In marked possessive constructions (see §3.2), the *poss_rel* is introduced on our analysis by the overt marker of possession. Unmarked possessives represent the same meaning, but there is no such marker to pin the semantics on. Accordingly, we introduce a new binary phrase type, called *poss-phrase*, to license the juxtaposition of possessum and possessor and introduce the possessive semantics (*poss_rel*). One variant of this phrase rule is shown as an AVM in (14) below.[2] It inherits from one of two supertype phrase structure rules which are defined in the matrix

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[2]Some constraints not relevant to this discussion are omitted due to space constraints.

core grammar: *head-initial* or *head-final*, which introduce the appropriate ordering constraints. The rule also varies depending on other properties of the possessive construction. The version shown in (14) is appropriate for the case where the possessor is in a modifier-like relationship to the possessum. Accordingly, the SPR value is shared between mother and daughter. If the possessor fills the specifier role for the possessum, the SPR value on the mother will be the empty list and the *poss-phrase* will also contribute a quantifier for the possessum through its C-CONT. For further details on variants of this rule, see Nielsen 2018.

(14)

$$
\begin{bmatrix}
\textit{poss-phrase} \\[2pt]
\text{SYNSEM|LOCAL|CAT} \begin{bmatrix} \text{HEAD } \boxed{1} \\ \text{VAL} \begin{bmatrix} \text{COMPS} & \langle\,\rangle \\ \text{SUBJ} & \langle\,\rangle \\ \text{SPEC} & \langle\,\rangle \\ \text{SPR} & \boxed{7} \end{bmatrix} \end{bmatrix} \\[2pt]
\text{HEAD-DTR|SYNSEM|LOCAL} \begin{bmatrix} \text{CAT} \begin{bmatrix} \text{HEAD } \boxed{1} \begin{bmatrix} \textit{noun} \\ \text{PRON } - \end{bmatrix} \\ \text{VAL.SPR } \boxed{7} \langle\, \text{X} \,\rangle \end{bmatrix} \\ \text{CONT|HOOK } \boxed{2} \begin{bmatrix} \text{LTOP } \boxed{5} \\ \text{INDEX } \boxed{3} \end{bmatrix} \end{bmatrix} \\[2pt]
\text{NON-HEAD-DTR|SYNSEM|LOCAL} \begin{bmatrix} \text{CONT|HOOK|INDEX } \boxed{4} \\ \text{CAT} \begin{bmatrix} \text{VAL|SPR } \langle\,\rangle \\ \text{HEAD } \textit{noun} \end{bmatrix} \end{bmatrix} \\[2pt]
\text{C-CONT} \begin{bmatrix} \text{HOOK } \boxed{2} \\ \text{RELS} \left\langle \begin{bmatrix} \text{PRED} & \textit{poss\_rel} \\ \text{LBL} & \boxed{5} \\ \text{ARG1} & \boxed{3} \\ \text{ARG2} & \boxed{4} \end{bmatrix} \right\rangle \\ \text{HCONS } \langle\,\rangle \end{bmatrix}
\end{bmatrix}
$$

This phrase structure rule allows the correct possessive relationship to be modeled between possessor and possessum in the absence of any overt markers of possession. In the next section, we discuss how we model possessive phrases which do include an overt marker of possession.

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3.2 Marked possessive phrases

In the literature on adnominal possession, both within the HPSG framework and beyond, it is common to discuss possessive phrases as being one manifestation of highly general phrase types. In one classic example, Lyons (1986) draws a distinction between 'adjective-genitives' and 'determiner-genitives', suggesting that, modulo some inflectional morphology, possessors are essentially just another kind of specifier or modifier, no different from any other. Within the HPSG literature, there are examples of analyses of possessive phrases being described as instances of head-modifier phrases (e.g. Beerman and Ephrem, 2007) or head-specifier phrases (e.g. Kolliakou, 1995).

Though there are challenges in modeling possessive phrases in terms of these major phrase types, we demonstrate that the head-specifier, head-modifier, and head-complement[3] phrase structure rules can adequately model all attested possessive phrase types. This serves to validate the practice of referring to possessive phrases as subtypes of these major phrase types.

Using major phrase types to model possessive phrases does present several challenges. Most pronounced of these are the challenges involved in using the head-specifier construction to model possessive phrases with specifier-like possessors. As constituted in the Grammar Matrix with its implementation of Minimal Recursion Semantics (MRS; Copestake et al., 2005), the head-specifier rule is non-head-compositional — that is, semantic information used for further composition (the information in HOOK) from the non-head daughter is 'passed up' to the mother (as shown in (15)). Given the nature and goals of the Grammar Matrix, this formulation of the head-specifier rule is not merely a convenient implementation choice, but a cross-linguistic analytical claim (Bender et al., 2002).

(15)
$$\begin{bmatrix} \textit{basic-head-spec-phrase} \\ \text{NON-HEAD-DTR|SYNSEM|LOCAL|CONT|HOOK } \boxed{1} \\ \text{C-CONT|HOOK } \boxed{1} \end{bmatrix}$$

In a typical head-specifier construction, such as a noun phrase consisting of a determiner and a noun, the determiner identifies its own INDEX with the INDEX of

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[3]The head-complement phrase structure rule is used to model some modifier-like possessive phrases. This is because the head-modifier rule only includes one-way selection — the modifier selects for its head, but not vice versa. In order for the possessive semantics to work out correctly, the element that carries the *poss_rel* must have access to the semantic information of both possessum and possessor, since this relation takes both possessor and possessum as arguments. This circumstance only obtains for the selecting element. This could always be modeled by simply having the possessive semantics appear on the selecting element, regardless of whether or not it is the marked element. This is a perfectly acceptable solution. However, we chose to keep the possessive semantics on the element that carries overt marking of possession. This means that in some cases, such as in Hungarian, it will be the case that the selecting element in a head-modifier construction will not be the marked element. In these cases, we use the head-complement rule in order to make the marked element the selecting element, allowing us to construct the same semantic representation. For further detail, see Nielsen 2018.

the noun (through its SPEC value), so the INDEX of the head-specifier phrase is still
identified with the INDEX of the noun.

(16)
$$
\begin{bmatrix}
\textit{basic-determiner-lex} \\[4pt]
\text{SYNSEM|LOCAL|CAT|VAL|SPEC} \left\langle \begin{bmatrix} \text{LOCAL|CONT|HOOK|INDEX} \; \boxed{1} \end{bmatrix} \right\rangle \\[8pt]
\text{LKEYS|KEYREL} \begin{bmatrix} \text{ARG0} \; \boxed{1} \end{bmatrix}
\end{bmatrix}
$$

However, this approach does not work for modeling specifier-like possessive con-
structions. Take for example the scenario where the possessor is marked with a
possessive affix. If we were to attempt a similar approach, the lexical rule for the
possessive affix would look something like (17) (in abbreviated form), where the
overall index of the lexical rule ($\boxed{1}$) is identified with the index of the possessum
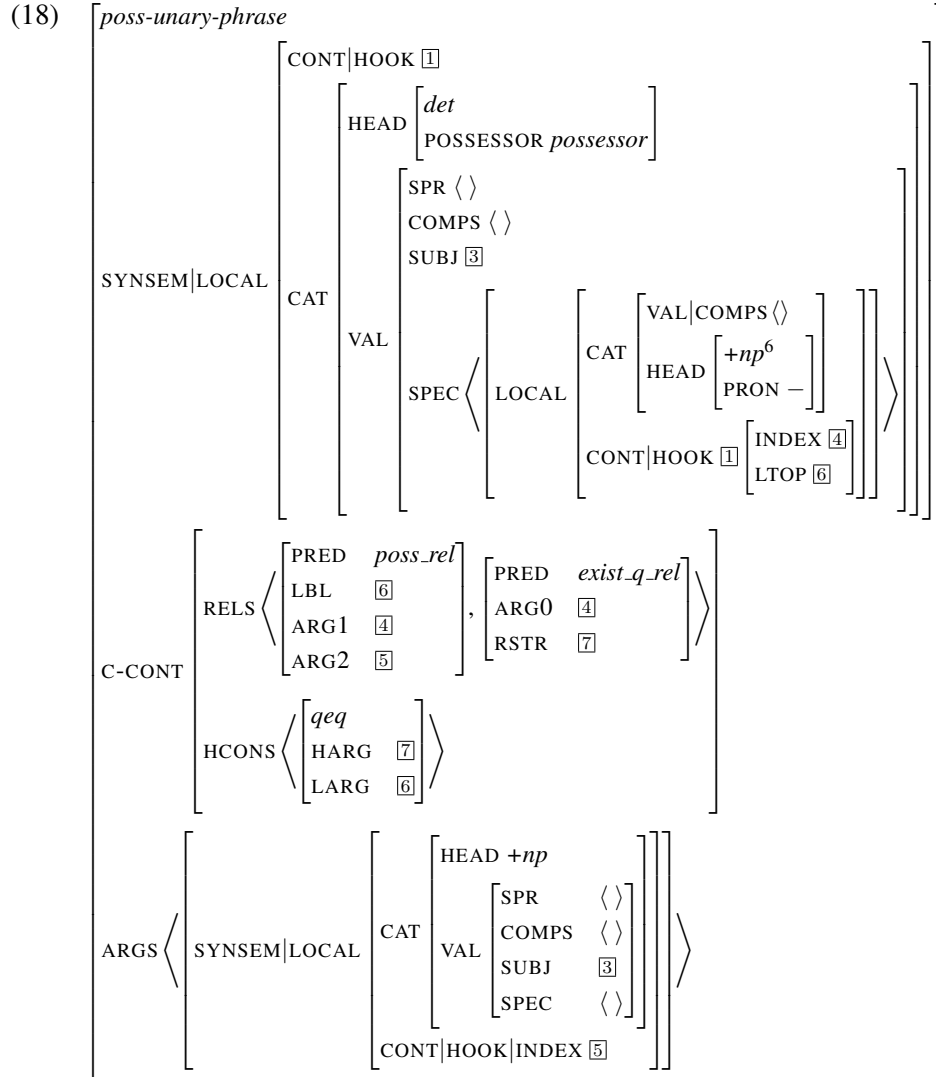noun, much like in the lexical type for determiners.

(17)
$$
\begin{bmatrix}
\textit{possessor-lex-rule (hypothetical)} \\[4pt]
\text{SYNSEM|LOCAL|CAT|VAL|SPEC} \left\langle \begin{bmatrix} \text{LOCAL|CONT|HOOK|INDEX} \; \boxed{1} \end{bmatrix} \right\rangle \\[6pt]
\text{DTR|SYNSEM|LOCAL|CONT|HOOK|INDEX} \; \boxed{2} \\[6pt]
\text{C-CONT}
\begin{bmatrix}
\text{HOOK|INDEX} \; \boxed{1} \\[4pt]
\text{RELS} \left\langle
\begin{bmatrix} \text{PRED} & \textit{poss\_rel} \\ \text{ARG1} & \boxed{1} \\ \text{ARG2} & \boxed{2} \end{bmatrix},
\begin{bmatrix} \text{PRED} & \textit{exist\_q\_rel} \\ \text{ARG0} & \boxed{4} \\ \text{RSTR} & \boxed{7} \end{bmatrix}
\right\rangle \\[18pt]
\text{HCONS} \left\langle
\begin{bmatrix} \textit{qeq} \\ \text{HARG} & \boxed{7} \\ \text{LARG} & \boxed{6} \end{bmatrix}
\right\rangle
\end{bmatrix}
\end{bmatrix}
$$

Problems arise with this analysis because the possessor noun must still partic-
ipate in some constructions as a typical noun would, but it has partially adopted
the semantics of the possessum. For example, when a determiner attaches to this
possessor noun, it will serve as the quantifier for the possessum, rather than for the
possessor.

We solve this in our library in the following way: the *possessor-lex-rule* is
pared down to a rule that simply adds a HEAD feature [POSSESSOR *possessor*].[4]
A unary phrase rule (shown in (18) below) then takes the NP consisting of the pos-
sessor (and any determiner and/or modifiers it may take) as its daughter, introduces
the possessive predication (*poss_rel*), and produces a constituent whose INDEX is
identified with the possessum, as shown in (18). This allows the possessor to be a

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[4]The feature POSSESSOR has the values *possessor* and *nonpossessive*. Similarly, there exists a
POSSESSUM feature with values *possessum* and *nonpossessive*.

semantically typical noun within its own NP, and then to take on the necessary specialized semantic behavior when interacting with the rest of the possessive phrase. This analysis is used for all specifier-like possessive constructions.[5]

(18)
$$
\begin{bmatrix}
\textit{poss-unary-phrase} \\[2pt]
\text{SYNSEM}|\text{LOCAL}
\begin{bmatrix}
\text{CONT}|\text{HOOK } \boxed{1} \\[2pt]
\text{CAT}
\begin{bmatrix}
\text{HEAD}
\begin{bmatrix}
\textit{det} \\
\text{POSSESSOR } \textit{possessor}
\end{bmatrix} \\[6pt]
\text{VAL}
\begin{bmatrix}
\text{SPR } \langle\,\rangle \\
\text{COMPS } \langle\,\rangle \\
\text{SUBJ } \boxed{3} \\[4pt]
\text{SPEC}
\left\langle
\begin{bmatrix}
\text{LOCAL}
\begin{bmatrix}
\text{CAT}
\begin{bmatrix}
\text{VAL}|\text{COMPS } \langle\rangle \\
\text{HEAD}
\begin{bmatrix}
+np^6 \\
\text{PRON } -
\end{bmatrix}
\end{bmatrix} \\[10pt]
\text{CONT}|\text{HOOK } \boxed{1}
\begin{bmatrix}
\text{INDEX } \boxed{4} \\
\text{LTOP } \boxed{6}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
\right\rangle
\end{bmatrix}
\end{bmatrix}
\end{bmatrix} \\[40pt]
\text{C-CONT}
\begin{bmatrix}
\text{RELS}
\left\langle
\begin{bmatrix}
\text{PRED } & \textit{poss\_rel} \\
\text{LBL} & \boxed{6} \\
\text{ARG1} & \boxed{4} \\
\text{ARG2} & \boxed{5}
\end{bmatrix},
\begin{bmatrix}
\text{PRED } & \textit{exist\_q\_rel} \\
\text{ARG0} & \boxed{4} \\
\text{RSTR} & \boxed{7}
\end{bmatrix}
\right\rangle \\[20pt]
\text{HCONS}
\left\langle
\begin{bmatrix}
\textit{qeq} \\
\text{HARG} & \boxed{7} \\
\text{LARG} & \boxed{6}
\end{bmatrix}
\right\rangle
\end{bmatrix} \\[30pt]
\text{ARGS}
\left\langle
\begin{bmatrix}
\text{SYNSEM}|\text{LOCAL}
\begin{bmatrix}
\text{CAT}
\begin{bmatrix}
\text{HEAD } +np \\
\text{VAL}
\begin{bmatrix}
\text{SPR} & \langle\,\rangle \\
\text{COMPS} & \langle\,\rangle \\
\text{SUBJ} & \boxed{3} \\
\text{SPEC} & \langle\,\rangle
\end{bmatrix}
\end{bmatrix} \\[14pt]
\text{CONT}|\text{HOOK}|\text{INDEX } \boxed{5}
\end{bmatrix}
\end{bmatrix}
\right\rangle
\end{bmatrix}
$$

Though possessive phrases are challenging for the established major phrase types in the Grammar Matrix, it is ultimately still possible to assimilate them to

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[5]This analysis differs from the analysis put forth for the English *'s*-possessive in Sag et al. (2003) and Flickinger (2002). Since this construction features a specifier-like possessor, these previous accounts have analyzed *'s* as a determiner. The semantics of determiners make the unary rule discussed here unnecessary. However, this analysis is only possible for specifier-like possessives where the possessive marker is an independent word. Since this is only one of many construction types that must be covered by the adnominal possession library, we chose the more general solution put forward here.

[6]This is an abbreviation used in the Grammar Matrix for a supertype that includes the HEAD values *adp(osition)* and *noun*.

these types (though at the cost of adding minor phrase types that are specific to possessives). This analysis supports the widespread claim that possessive phrases are instances of head-specifier, head-modifier, and head-complement phrases.

4 Feature bundling

In this section, we discuss the analysis developed for agreement between possessor and possessum, focusing on how bundling together certain features is particularly useful in multilingual grammar engineering. The phenomenon of either the possessum or the possessor agreeing with the other element of the possesive phrase is observed in many languages, as shown in (11) and (12) and above, reproduced as (19) and (20) below:

(19) Romani:

   e   manús-es-quiri   buzni
   the:OBL.M.SG man-OBL.SG.M-GEN.:F.SG.NOM goat(F)
   'the man's goat' [rom] (Koptjevskaja-Tamm, 2001, 962)

(20) Finnish:

   heidän ystävä-nsä
   their   friend-3POSS
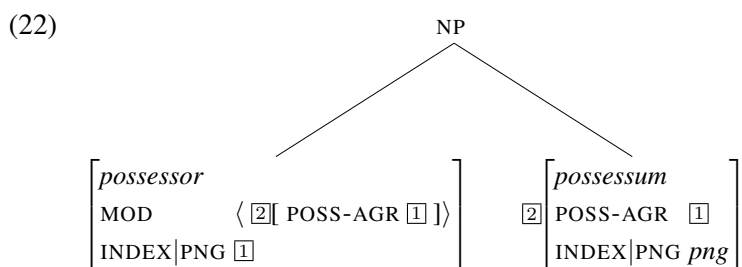   'their friend' [fin] (Toivonen, 2000, 585)

When the possessor is specifier-like, this is easy enough to account for: an agreeing possessum constrains the relevant person, number, and gender features of the possessor, which appears on its SPR list. Since the head and non-head daughters both select for each other in the head-specifier schema (Pollard and Sag, 1994, Ch. 9), this analysis works equally well in the case where the possessor agrees with the possessum. However, when the possessor is modifier-like, possessor and possessum are joined by a head-modifier rule which has no such mutual selection. The possessor can constrain the features of the possessum, which appears on its MOD list, but the possessum has no access to its possessor's features. In order to fully cover the possible typological space, agreement in both directions should be possible whether the possessor is modifier-like or specifier-like.

Indeed, that full typological space is attested in the world's languages. Hungarian provides an example of the scenario where the possessor is the modifier of the possessum, but we still see agreement markers on the possessum, as illustrated in (21).

(21) Hungarian:

   az én kalap-ja-i-m
   the I hat-POSS-PL-1SG

   'my hats' [hun] (Laczko, 2007)

Since the possessum cannot select its modifier, instead the possessum must somehow 'publish' the person, number or gender features it agrees with, so that the possessor can select for a possessum with the correct agreement features. This means it is necessary for the possessum to carry two sets of agreement features: the inherent person, number, and gender features it has as a noun; and the person, number, and gender features that it agrees with. The former are found (as usual) at INDEX.PNG, while the latter are in the new head feature we posit, called POSS-AGR. The possessum can then do the work of identifying the possessor's agreement features with its own features, as sketched in the tree in (22):

(22)

$$
\begin{array}{c}
\text{NP} \\
\\
\begin{bmatrix}
\textit{possessor} \\
\text{MOD} \quad \langle\; \boxed{2}[\; \text{POSS-AGR}\; \boxed{1}\;]\rangle \\
\text{INDEX}|\text{PNG}\; \boxed{1}
\end{bmatrix}
\qquad
\boxed{2}\begin{bmatrix}
\textit{possessum} \\
\text{POSS-AGR}\quad \boxed{1} \\
\text{INDEX}|\text{PNG}\; \textit{png}
\end{bmatrix}
\end{array}
$$

Adding this second set of agreement features has the potential to be difficult in the multilingual grammar engineering context. While some languages have separate person, number, and gender features, others lack one of these three, or are better analyzed as having a combined PERNUM feature (Drellishak, 2009). Our library needs to be interoperable with all of these options. Given just three possible features, which may or may not appear, or which may be combined, there are a dozen possible features sets available. Creating different variants of the possessor-possessum agreement constraints in each of these cases would amount to redundantly reproducing the work of Drellishak's PNG library.

Fortunately, and for independent reasons, Drellishak bundled all person, number, and gender features as features of the type *png*. This turns out to be very beneficial for us: We simply reuse the type *png* as the value of our new feature POSS-AGR. This allows our library to abstract away from the specifics of how person, number, and gender work. Thus we see that in addition to providing efficiency as a monolingual level (Flickinger, 2000), types also add efficiency to cross-linguistic grammar engineering.

5   Conclusion

The process of implementing an analysis for any phenomenon frequently leads to theoretical insights or analytical refinements. In the context of multilingual grammar engineering, the added constraint of harmonizing analyses for hundreds of possible variations on the phenomenon crosslinguistically provides all the more

opportunity for finding such insights and refinements. In this paper, we have detailed two ways in which the crosslinguistic perspective on modeling adnominal possession is beneficial, namely the confirmation of the applicability of major phrase types to modeling possessive phrases and the insight into the advantages of bundling person, number, and gender features under a single type. This analysis has been tested by constructing testsuites for ten typologically and genetically diverse languages, half of which weren't considered during library development and then creating grammars using the augmented customization system to evaluate against those testsuites. The results of these tests can be found in Nielsen 2018. Possible directions for future work include extending the library to fully cover inalienable possession (which is currently only partially covered by the library) and handling agreement in features such as case, where currently only person, number, and gender are handled.

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