

An Analysis of Pseudopartitives and Measure Phrases that Say No to Extra Rules

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1 Introduction

In this paper, we present our HPSG analysis of English measure phrases (MP) in pseudopartitives. Our analysis is motivated by gaps we find in two proposals on how MPs can be handled in HPSG. The first is Flickinger and Bond [2003]. It does not cover pseudopartitives. The measure words it looks at are mostly restricted to units of measurement. The second proposal is Wright and Kathol [2003]. It deals with pseudopartitives but it says very little about units of measurement. Although these two papers complement each other in terms of coverage, the grammar rules given by them don't. It remains an academic challenge for us to offer better coverage of pseudopartitives, particularly since we try to avoid creating extra rules for handling MPs.

2 Coverage of Existing Proposals

Let us go into more details on the coverage of Flickinger and Bond [2003]. The following AVM is the SYNSEM of a MP generated by the measure phrase rule found in it:

$$\left[\begin{array}{l} \text{CAT|HEAD } \textit{noun} \\ \text{CONT} \left[\begin{array}{l} \text{INDX } [\text{PERNUM } \textit{3sing}] \\ \text{RELS } \left\{ \begin{array}{l} \text{DEGREE_RELS, CARD_RELS,} \\ \text{NOUN_RELS} \end{array} \right\} \end{array} \right] \end{array} \right]$$

The above representation admits MPs mainly formed by numerals and units of measurement and accounts for the use of such MPs as the modifying noun in noun-noun compounds (1) and as a NP by itself (2).

(1) I bought a **fourteen inch** candlestick.

(2) **Three gallons** was enough.

The representation would predict that a sentence like (3) whose main verb agrees with the plural form of the measure word is ungrammatical. The measure words used in such sentences are typically a collection of individuals.

(3) **Three herds** of deer are spotted.

Given that Flickinger and Bond [2003] makes no claim about pseudopartitives, we cannot say there is anything wrong with their analysis except for giving a name that sounds too powerful to the measure phrase rule. It generates only a subset of MPs for a subset of contexts that they can occur in.

Let us move on to Wright and Kathol [2003]. The following AVM is the rule that generates MPs found in their paper:

$$\left[\begin{array}{l} \text{SYNSEM} \left[\begin{array}{l} \text{CONT} \left[\begin{array}{l} \text{IND } [3] \vee [6] [\text{PERNUM } [7]] \\ \text{RESTR } [4] \cup \left\{ \begin{array}{l} [\text{MEASURE } [2]] \\ [\text{SUBSTANCE } [4]] \\ [\textit{equiv} \\ \text{ARG1 } [6] \\ \text{ARG2 } [3]] \end{array} \right\} \end{array} \right] \end{array} \right] \\ \text{BASE} \left[\begin{array}{l} \text{COMPS } \langle [5] \rangle \\ \text{CONT} \left[\begin{array}{l} \text{IND } [1] [\text{PERNUM } [7]] \\ \text{RESTR } [2] \end{array} \right] \end{array} \right] \\ \text{COMPL } [5] \left[\begin{array}{l} \text{HEAD } \textit{prep} \\ \text{CONT} \left[\begin{array}{l} \text{IND } [3] \\ \text{RESTR } [4] \end{array} \right] \end{array} \right] \end{array} \right]$$

The rule generates 2 representations of a MP, which is given a different definition from that given by Flickinger and Bond [2003]. In Wright and Kathol [2003], a MP is formed by a measure word and an of-phrase. The rule accounts for (3) and sentences like (4) whose main verbs agree with the objects of "of":

(4) One **herd of cows** cool themselves with mud.

When applied to pseudopartitives formed with units of measurement, the rule would generate unacceptable sentences like (5) whose main verbs agree with the plural forms of the measure words:

(5) *Fourteen **inches of cable** are used.

In addition, the rule does not explain why the main verb never agrees with the singular/mass object of "of" when plural measure words other than units of measurement are used, as shown in (6):

(6) *Two **strips of cloth** is wrapped around his feet.

3 Solution for Increasing Coverage

The first part of our solution to the problem described above is made up by the lexical entry of a numeral and the lexical entries of two types of measure words given after this paragraph. Measure words are treated as a subclass of nouns that carry a *qty* (for quantify) value for the QQP feature. The QQP feature determines whether a noun is a measure word that quantifies its sister (*qty*), an attributive noun that qualifies its sister (*qly*) or a predicative noun (*prd*). Both measure words and attributive nouns carry non-empty SPEC values. By the SPEC values they carry, measure words are divided into two types. A measure word of the first type would specify the number of its sister to be singular in disregard of the number of the measure word itself. A measure word of the second type would specify the number of its sister to be equivalent to its own number. Units of measurement belong to the first type. The singular number of the index of its sister captures the idea that a unit of measurement quantifies the denotatum of its sister but it does not divide it into countable portions/parts. The second type of measure words includes collections of individuals, containers and shape classifiers like "pieces". The plural number of the indices of their sisters captures the idea that they individuate the denotata of their sisters by dividing them into countable portions/parts.

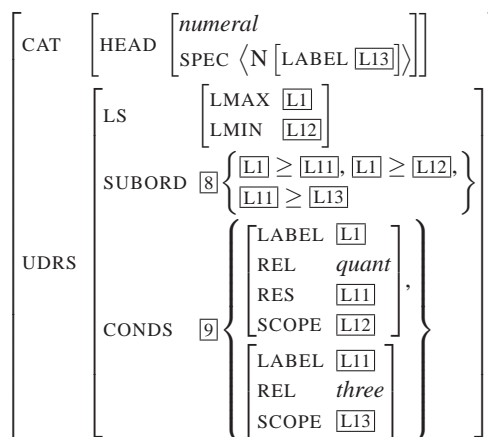


Figure 1: three

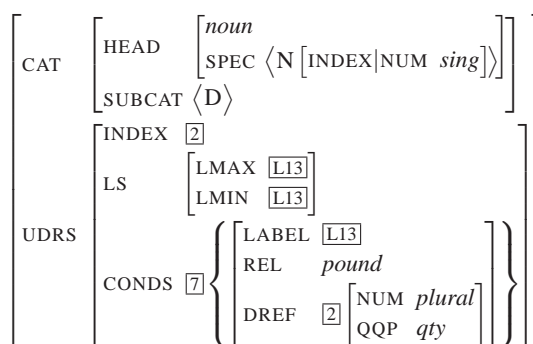


Figure 2: pound

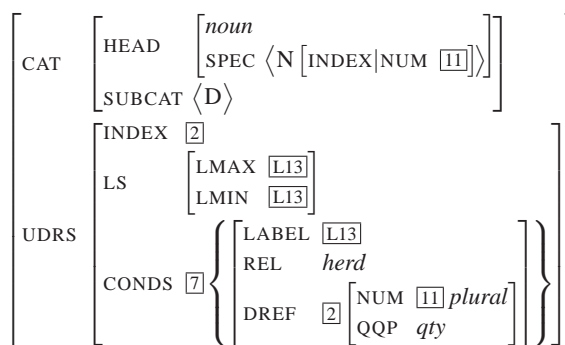


Figure 3: herd

Before we move on to explain what we will do with these lexical entries, let us give some explanation for the use of indices (boxed numbers) in figures that illustrate how our proposal works. From this section onwards, indices represented by the same boxed number are shared across figures, excluding figure 3 and figure 2. An index used in each of these two AVMs is shared with indices represented by the same boxed number in other figures. But between these two representations of measure words, indices represented by the same boxed number are not shared.

Now let us start parsing a pseudopartitive by applying schema 4 of Pollard and Sag [1994] and a revised version of the semantic principle of Reyle [1995] that works with an NP analysis of DET-N combinations to the lexical entry of "three" and the lexical entry of one of the measure words given above. Our first step yields the following representation of a MP:

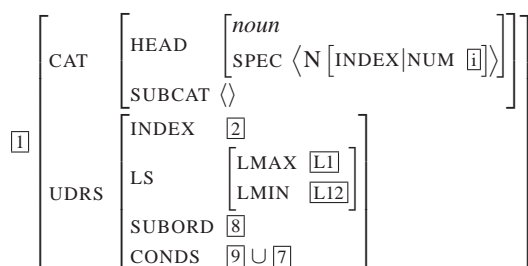


Figure 4: a MP

We only give one representation for "three herds" and "three pounds". Boxed "i" would stand for *sing* in "three pounds". In "three herds", boxed "i" would stand for *plural*.

The second part of our solution is made up by the lexical entry of "of", which is treated as a copula for nouns in pseudopartitives. The differences in syntactic behaviour between pseudopartitives and partitives pointed out by Stickney [2004] convince us that we need a different analysis from that typically offered for partitives (treating the of-phrase as a PP) and adopted for pseudopartitives by Wright and Kathol [2003]. We are further convinced by a closer correspondence between the syntax and semantics that the copular analysis of "of" supported by Stickney [2004] and credited to den Dikken [1998] is what we need. The equivalence relation between the denotatum of the of-object and the denotatum of the preceding NP given in Wright and Kathol [2003] as the semantic representation of "of" is the same equivalence relation between the subject and the object of a copula. A copular analysis is also useful for avoiding the agreement problem caused by the plural forms of units of measurement in grammar engineering. The copular head can prevent the verb that takes the pseudopartitives in question as subject from directly interacting with either the measure word or the object of "of". Below is the representation of "of":

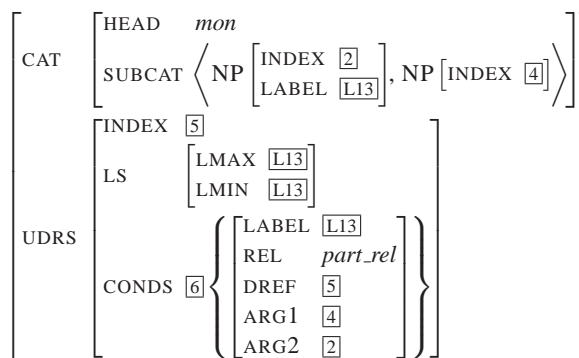


Figure 5: of

The HEAD value *mon* is taken from Schwarzschild [2006]. It stands for "monotonic constructions". A monotonic construction is a noun phrase construction whose interpretation uses a dimension that is monotonic relative to the part-whole relation in the domain given by the noun regarded as the semantic core of the noun phrase. Let us go into more details on how this part-whole relation works. The *part_rel* in the CONDS list of "of" creates a discourse referent corresponding to the sum of some part(s) whose material makeup is specified by its ARG2 value and whose size (the size of each part) is specified by its ARG1 value. Whether the sum of these parts (the DREF value of the *part_rel* and the INDEX of "of") is a singular individual (*sing*), a mass *sing* or a plural individual *plural* is determined by the SPEC value of the MP to be combined with the projection of "of". The projection of "of" is formed by applying schema 2 and the semantic principle of Reyle [1995] to the lexical entry of a noun and the lexical entry of "of". This yields the following representation of an of-phrase:

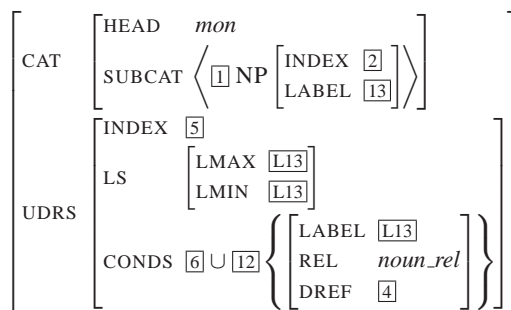


Figure 6: an of-phrase

Now we can construct a pseudo partitive by applying schema 4 and our modified version of the semantic principle of Reyle [1995] to the of-phrase and the MP represented by figure 4. The

representation of the resulting pseudopartitive is given below:

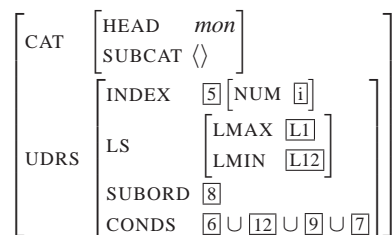


Figure 7: a pseudopartitive

For "three pounds of beef", the INDEX value boxed "i" would be singular. For "three herds of deer", the INDEX value boxed "i" would be plural. We can rule out (5) by specifying the SPEC|UDRS|INDEX value of "inches" to be *sing*. We can also rule out (6) by specifying the SPEC|UDRS|INDEX value of "strips" to be *plural*.

4 Handling Coercion by Salient Plural Individuals

We still have (4) left. Wright and Kathol [2003] points out that the agreement pattern exhibited by this sentence cannot be generalized to all combinations of measure words and of-objects, as illustrated by the following unacceptable example from their paper:

(7) *A pile of logs were burning

Even for (4), replacing the plural verb "cool" with its singular form is found to be equally, if not more acceptable among native speakers. Wright and Kathol [2003] sees the agreement pattern exhibited by (4) as a result of coercion by some salient plural individuals. Although dealing with saliency falls outside the scope of a grammar, we are aware that being animate appears to be a prerequisite for a plural individual to be salient in all the acceptable examples given by Wright and Kathol [2003]. So we create a rule that allows the not-so-acceptable agreement pattern only when the of-object is animate. The rule would convert the lexical entry of "of" to the representation given in figure 7. Note the *animate* value assigned to ARG1|ANI of the *part_rel*.

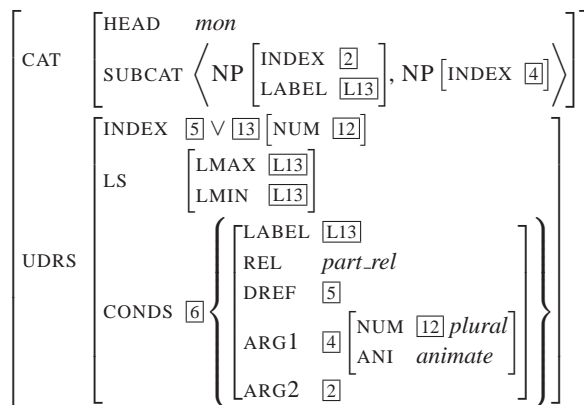


Figure 8: "of" as a result of coercion

The projection of this "of" has the options to unify its INDEX value with boxed 5, whose NUM value is determined by the SPEC|UDRS|INDEX|NUM value of the measure word, or unify its INDEX value with boxed 13, whose NUM value is determined by the UDRS|NUM value of the object of "of". The later option would admit (4) but reject (7).

5 Extension

The proposal that we have given above can be further extended to cover (2) in a more intuitive way. We call such construction "anaphoric" following Downing [1996]'s work on classifiers. We have confirmed with native speakers that the meaning of (2) is far more often "A quantity of some substance equivalent to three gallons is enough" than "A degree equivalent to three gallons is enough". To capture this, we propose a unary rule that empties the SPEC list of a MP and introduce into the background the *part_rel* and *noun_rel* supplied by the head of a pseudopartitive. This rule, whose representation is given in figure 9 is introduced as an instance of a class of rules for handling a variety of specifiers used anaphorically in the following monotonic constructions:

(8) Too much is wasted

(9) Two million are killed

Given that this paper is about pseudopartitives, we would skip the details about the generalization. When compared to Flickinger and Bond [2003]'s rule, our rule has an appeal from the perspective of the universality of languages. The backbone of the rule given below can be adapted (with all the

agreement features removed) to apply to anaphoric constructions of classifier languages like Japanese and Mandarin.

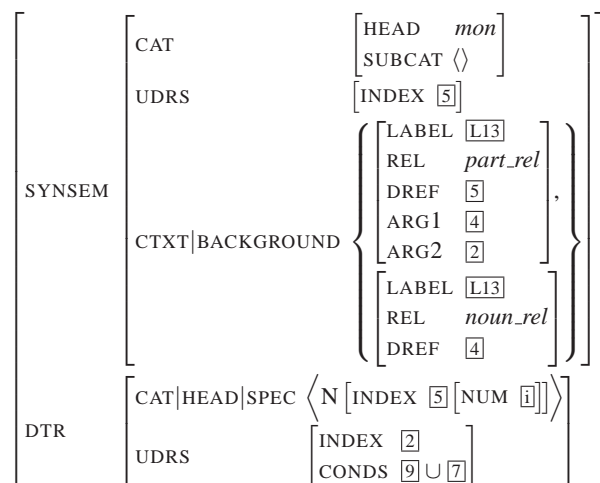


Figure 9: anaphoric construction rule

6 Conclusion

We have stuck to our claim that no extra rules would be created for our analysis of pseudopartitives. Our analysis of pseudopartitives that exhibit the more acceptable agreement pattern only draws on general principles proposed in Pollard and Sag [1994] and Reyle [1995]. Our revision of the semantic principle of Reyle [1995] is geared more towards a general approach to the analysis of DET-N combinations than a compositional semantics customized for pseudopartitives. The pursuit for this theoretical elegance has a practical motivation. Restricting the number of rules and introducing rule classes rather than specific rules when new rules are needed for increasing coverage go hand in hand with our attempt at restricting the number of features as presented in [author’s paper]. Placing these constraints on grammar engineering makes a wide-coverage grammar easy for grammar writers to maintain and developers of NLP systems to use. Our actual implementation of the work presented here in ENJU [Miyao et al., 2004] also comes with a simplified output format (an alternative to the standard AVM format) that captures the gist of our HPSG analysis in Penn Treebank bracketing style such that members of the NLP community can share the fruit of our research with members of the HPSG community.

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