Exploiting Linguistic Iconism for Article Selection in Machine Translation

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1 Introduction

This paper is meant to give a cognitive–linguistic explanation of the process of reference. This means that we are concerned with meaning arising from the speaker's conceptualization of reality. Different ways of referring to the same real situation are reflected differently on the expression side of language. We will exemplify this with the use of articles. We deal with two contrasting processes which are reflected in NP syntax: on the one hand, this is the selection of a specific part of a MASS, which normally has an indefinite extension. This process results in identification and hence in *token reference* (cf. Declerck 1986:163; Croft 1985; Langacker 1987a). On the other hand we are concerned with type reference to COUNT entities (cf. ibd.), more specifically with how we can talk about the whole kind of an entity which in reality is represented by individual instances.

Our ultimate aim is to exploit the cognitive principles by which reference is determined and to import them into Machine Translation (MT). Traditional MT systems so far have not been concerned with a semantic interpretation and translation of articles. The translational relevance of interpreting NP readings has been stressed in different places (cf. Meya 1990; Grabski 1990; Zelinsky-Wibbelt 1988, 1991): Bounding by individuation of a MASS results in definiteness in Germanic languages (*Das Wasser in der Tasse ist schmutzig.* 'The water in the cup is dirty.'). In English type reference to masses is usually expressed by the bare construction as in *Water is indispensable*, which in German can be expressed both by the definite NP and by the bare construction as in *(Das) Wasser ist unverzichtbar* (see e.g. ter Meulen 1988:390). In Spanish a DEFINITE NP is usually used for type reference *(El español me gusta más que el ruso.* 'I like Spanish better than Russian.').

Type reference to a COUNT entity by the subject NP may surface in two contrasting structures in French: *Un spectateur veut voir quelque chose.* 'A spectator wants to see something.' *Le spectateur est un être humain.* 'The spectator is a human being.'

In this paper we will explain the conceptual conditions for type and token reference, which in turn establish the conditions for generating the correct surface structures in the respective target language. We interpret genericity vs. identification by default rules (cf. McDermott & Doyle 1980; Reiter 1980), which should mirror cognitive processing (cf. e.g. Morreau 1988, Schubert & Pelletier 1988). There seems to exist a preference order among the contextual conditions on the restriction or preservation of the unbounded extension of a MASS. This order is based on the degree of prototypicality of the respective reference function: the typicality of the NP's reference function is rendered by the strength which the modifiers have with respect to bounding or unbounding the entity's normal extension denoted by the noun. The component of default rules has been implemented in the CAT2 system and results in successful article translation. We relate our conceptual conditions to the CAT2 rules given in the annex.

Dealing with different ways of reference, the conceptualization of entities will be in the foreground. Entities are denoted by nouns. We assume that words have a basic prototypical sense, which is represented in the lexicon. Senses of decreasing prototypicality are related to this prototypical sense by systematic metonymy rules.

2 Reference and prototype semantics

It is our aim to explain how universal and language–specific iconic principles result in different ways of referring to the same real situation by using differing syntactic structures. Speakers of different language communities, constrained by their different cultures, arrive at different measures of conventionality, salience, relevance and typicality for specific parts of their environment and thus categorize and refer to these in different ways. Our theoretical framework will be prototype semantics (cf. Rosch 1978), because this theory explains how categorization is in line with human judgement. Categorization is the recognition or judgement of some instance as being the same as a previously occurring one, where the differences which may well exist in reality are then irrelevant for the human conceptualizer. We want to adapt these human strategies of categorization to a computational interpretation of reference.

2.1 Cognitive constraints on conceptualization

Nouns denote something by virtue of their basic, lexical meaning. Reference is only achieved when a noun is used in a grammatical construction. The interpretation of a word's meaning in different ways relies on the speaker's capacity to construe alternate cognitive representations of the same real situation and to express this by different grammatical constructions. This is the result of selecting certain substructures from several cognitive dimensions (cf. Langacker 1987c:189ff.):

- Along the most significant dimension a speaker divides a scene into profile and base. The base is the necessary background knowledge out of which the profile is singled out as the prominent part. For instance the English words *lamb, ewe, mutton* and *sheep* profile different aspects of the common base which consists in the knowledge that we have about a certain animal, namely the aspects of AGE, GENDER, NUTRITION, COLLECTION respectively. The English nouns all translate into the German noun *Schaf*, which generalizes over all aspects profiled in English. This shows that both the selection of alternate substructures and of different degrees of granularity result in different mental profilings and hence different expressions.
- Along the figure/ground dimension the mental foregrounding and backgrounding of the parts which constitute a scene is achieved. For linguistic purposes the foregrounded part constitutes the trajector (cf. Langacker 1987c), which corresponds to the grammatical subject or verb, and the background constitutes the landmark, which corresponds to the grammatical object.
- Speakers may mentally image reality from different perspectives. To take Bolinger's example (1975:181):

  (1) *The airlines charge too much.*

  (2) *Airlines charge too much.*

  In the first case the speaker's perspective coincides with the time of speech and the scope of his predication includes all airlines currently existing. In the second case the speaker is farther away from the real situation, so that the scope of his predication includes all airlines of past, present and future (cf. rule (16) in the annex). The conditions for this difference in perspective are not provided within this sentence.
- Finally, prototypicality is a dimension along which the speaker construes his cognitive representation of reality. The core of a semantic category relating to a word is represented by the "optimal" prototypical instance to which instances of decreasing typicality are related (cf. Rosch 1978). A speaker can use an expression in a more or less typical meaning. We have to relate entities to their typicality space, as reference to entities by the predication of a typical property may differ in surface strucure from reference by predicating a contingent property (*Un spectateur veut voir quelque chose.* 'A spectator wants to see something.' *Le spectateur est un etre humain.* 'The spectator is a living being'.)

2.2 Conceptualizing external and internal bounding of entities

The following characteristics determine whether an entity is conceptualized as COUNT or MASS, and whether a MASS is conceptualized as HOMOGENEOUS or as HETEROGENEOUS (cf. Wierzbicka 1985:335):

- unboundedness vs. boundedness
- arbitrary vs. non–arbitrary divisibility
- pragmatically relevant vs. non–relevant countability

Langacker (1987a:63) defines COUNT nouns to denote a bounded region. This implies that COUNT nouns are individuated on the lexical level. It is for this reason that we can conceptualize several instances of a COUNT entity and express this fact by the plural form (*cups, rooms, figures*). A MASS noun denotes an unbounded region in physical or mental space (*butter, water*). A MASS is cumulative, that is, different amounts of the same MASS are arbitrarily unifiable without changing the MASS meaning (cf. Quine 1960:91; Bunt 1985; Link 1983). The unbounded extension of a MASS implies that we cannot conceptualize one or several bounded partitions of a MASS per se, a MASS may not be individuated without additional linguistic means.
HOMOGENEOUS entities, such as those denoted by *butter* are arbitrarily divisible without losing their constitution and function. The form and function of HETEROGENEOUS MASS entities, such as those denoted by *furniture*, are violated if they are divided.
Langacker's definitions apply to lexical units; they do not exclude a bounding or unbounding at the level of the NP.
If we determine the countability of MASS entities in semantic terms, three classes emerge dependent on their inner constitution (cf. Wierzbicka1985:321):

1. For MASS entities conceptualized exclusively as HOMOGENEOUS there exists no possibility of counting them without additional linguistic means. They have no 'built–in modes of distinguishing their reference' (Quine 1960:91). These MASS nouns can, however, adopt the criteria of distinctness, identity and particularity under a specific pragmatic purpose; then a classifier expresses some conventionalized form or function (cf. Lehrer 1986, Allan 1977) as in *a piece of butter, a glass of water.*
2. For COLLECTIVE MASS entities comprising different individuals, such as *furniture*, there exists no relevant perspective from which they may be counted.
3. Some MASSES are normally conceptualized as HOMOGENEOUS, but under a pragmatically unusual perspective may also be conceptualized as a HETEROGENEOUS COLLECTIVE entity comprising identical individuals, such as *grain, hair*; for instance one may count hair in order to have a measure for the density of a person's hair. In this situation the individual members are referred to by the plural form (cf. Zelinsky–Wibbelt 1992).

3 Multiple ways of reference

Type reference to a COUNT entity by default is achieved by attributing a typical property to it:

(3) *Airlines fly airplanes.*

If, in contrast to this, we attribute a contingent property to *airlines*, token reference to some bounded part occurs and a definite NP expresses the restriction in English:

(4) *The airlines fly airplanes again.*

Type reference to a count entity may be expressed by a singular definite NP in most European languages:

(5) *The computer is an indispensable tool nowadays.*

In this case the totality is referred to by metonymy: one instance is taken to represent the whole kind of computers (cf. Bolinger 1975:182). This generalisation is achieved by the predication of an EVALUATION: *indispensable* is an EVALUATIVE adjective, and if the speaker utters an evaluation this results in a habitual meaning which implies TEMPORAL UNBOUNDEDNESS in the absence of conflicting conditions (cf. rule (14) in the annex).
The prototypical type reference occurs to entities designated by NPs in subject position, i.e. to entities which are mentally foregrounded as the trajector and located with respect to some property space designated by the landmark NP in object position. The latter is usually restricted by the verbal scope of predication, especially if the verb expresses some temporally extended action as in (4). This does not hold for verbs expressing an ATTITUDE or a SEMIOTIC or COGNITIVE action or state as in (22). These verbs imply habituality, i.e. TEMPORAL UNBOUNDEDNESS which the process has in relation to the speech event, if not restricted by conflicting conditions:

(22) *They regard computers as important.*

4 Contextual bounding a MASS concept

Whereas in German individuated as well as non-individuated entities may be designated by definite NPs, in English only individuated entities may be so designated; non-individuated entities are designated by the bare construction:

(6) *Das Wasser in der Tasse ist schmutzig.*
⟶
The water in the cup is dirty.

(7) *(Das) Wasser ist unverzichtbar für die Menschheit.*
⟶
Water is indispensable for humanity.

In (6) the definite article expresses that out of the basically unbounded MASS *water* the PP-modifier picks out the quantity which is in the cup as being dirty (cf. Platteau 1980:114; cf. rule (7) in the annex). In (7) the adjective expresses an evaluation about the subject NP, from which a habitual sentence meaning is inferred and the subject NP thereby refers to a totality, hence the bare construction in English (cf. rule (14) in the annex).

In order to individuate a specific part of a MASS, this specific part has to be identified by restrictive modification, as *the water in the cup* in (6) (cf. C. Lyons 1980; Hawkins 1980), whereas the unbounded extension of the MASS is preserved, if the MASS entity has no modifier, as in (7), or if the modifier is not successful in scope narrowing, which holds for non-restrictive modifiers which are themselves conceptualized as unbounded, as in (15) below. We assume that a hearer – following a conversational principle (cf. Declerck 1986:87) – tends to interpret German definite NPs dominating MASS nouns as GENERIC by default, unless semantically restrictive modifiers yield a contrasting interpretation (cf. rule (15) in the annex). In this section we will give the conditions for interpreting German definite NPs and translating them into English.

4.1 Relative clause modification

Relative clauses modifying MASS nouns have greatest strength with respect to modifying the reference function. A relative clause inherits the temporal boundedness from its verbal predicate. According to Vendler's classification (cf. Vendler 1967, Dowty 1979) TEMPORALLY BOUNDED verbs are those which express an ACHIEVEMENT or an ACCOMPLISHMENT of some state of affairs (cf. also Langacker 1987a). In (8) the relative clause – by virtue of its predicate *liefern*, which denotes an ACHIEVEMENT – narrows down the unboundedness which *Information* expresses in its basic meaning to that amount which holds for a specific period of time (cf. rule (2) in the annex):

(8) *Die Information, die geliefert wird ...*
⟶
The information which is given ...

(9) *Die Industrie, die entwickelt wird, braucht finanzielle Unterstützung.*
⟶
Industry, which is being developed, needs financial support.

In (9) the Aktionsart of the modifying relative clause is ACTIVITY, which is unbounded, and hence does not restrict the unbounded extension which *industry* denotes in its basic meaning (cf. rule (4) in the annex).

In analogy to the *Aktionsart* of the verb, the aspect of the relative clause can affect the unboundedness of MASS entities. In (9) above, the DURATIVE aspect of the relative clause, which implies that the beginning and end of the action is unbounded in relation to the reference time (cf. Comrie 1976), is an additional condition for the preservation of the unbounded extension of the MASS. In contrast to this, the RETROSPECTIVE aspect of a relative clause, by the completion which the action has with respect to the reference time, results in delimitation of some part of a MASS (cf. rule (3) in the annex):

(10) *Die Industrie, die entwickelt worden ist, braucht weiterhin finanzielle Unterstützung.*
⟶
The industry, which has been developed, needs further financial support.

Note again that these conditions only apply in the absence of conflicting conditions which may be provided by a broader context.

4.2 Adjective phrase modification

Among the conditions provided by adjective modification the comparison expressed by the superlative has greatest strength in bounding a MASS entity. It fixes the conception of the MASS entity from all its possible realizations exactly to the degree of the property specified by the adjective, as in sentence (11) (cf. Bierwisch 1989). The result is identification, which is

expressed by a definite NP in English (cf. rule (1) in the annex):

(11) *Die interessanteste Industrie entwickelt sich.*
⟶
The most interesting industry is developing.

NON–GRADABLE adjectives (e.g. *adequate, sufficient, genuine*) have a similar effect when modifying MASS nouns. They are also called 'absolute' because they either do or do not apply to an entity as there exists only one realization of them; they are conceptualized as sharply bounded and hence in German definite NPs result in a restriction of the unbounded extension of a MASS as the adjective *system–bezogen* ('system–related') (cf. rule (8) in the annex). Note that we are concerned here with the translation of German definite NPs into English:

(12) *Die system–bezogene Information fehlt.*
⟶
The system–related information is lacking.

This is the unmarked, typical modification of MASS nouns by NON–GRADABLE adjectives. There are, however, NON–GRADABLE adjectives which stand out as non–typical when modifying a MASS noun. By choosing a LOCATIONAL or PROVENANCE adjective as modifyer, as in (13) and (14), the speaker merely makes an additional commentary to the inherently unbounded entity by locating it in a conventionalized property space and thus creates a new unbounded MASS (cf. rule (6) in the annex).

(13) *Die europäische Industrie entwickelt sich.*
⟶
European industry is developing.

(14) *Die Kognitive Linguistik löst das Problem.*
⟶
Cognitive Linguistics solves the problem.

GRADABLE adjectives preserve the unboundedness of a MASS entity in the unmarked case, because GRADABLE properties, without being contextually fixed by a conventional standard of comparison, are vague with respect to their degree of realization on a contextually graded scale (cf. Dowty 1979:88; Kamp 1975). Genericity and hence indefiniteness results in English (cf. rule (9) in the annex):

(15) *Die interessante Forschung wird nicht gefördert.*
⟶
Interesting research is not being supported.

Again, this is the default case of modification by GRADABLE adjectives. An exception are MODAL adjectives which are DEONTIC. They restrict the MASS to exactly that partition about which the speaker expresses an obligation (cf. rule (8) in the annex):

(16) *Die notwendige Forschung wird nicht gefördert.*
⟶
The necessary research is not being supported.

COMPARISON adjectives such as *similar* behave in the same way by identifying the specific part of the unbounded MASS which is compared, as we can only compare what we can identify (cf. rule (8) in the annex):

(17) *Die vergleichbare Information fehlt.*
⟶
The comparable information is lacking.

5 Type reference to COUNT entities

If the speaker refers to the type of a COUNT entity, the indefinite article expresses that the entity's description satisfies its prototypical or "ideal" concept (cf. Croft 1985:7–5), or it expresses a certain regularity (cf. Krifka 1988:287). This results from attributing a typical property to the whole kind of the entity (cf. Declerck 1986:168f.):

(18) *Ein Zuschauer will etwas sehen.*
⟶
Un spectateur veut voir quelque chose.
'A spectator wants to see something.'

Here the predicated property defines a stereotype of the species of *Zuschauer* in the sense of Putnam (1975), hence this sentence is GENERIC by default, i.e. it is true even if the predicated typical property does not hold 'inclusively' (cf. Declerck 1986:157f.) of all members of the species of *Zuschauer*. If no typical property is attributed to the entity, but the entity is classified by a basic domain supercategory, comparable to Heyer's essential property (cf. Heyer 1988:180ff.), a law–like GENERIC reading results, which holds 'inclusively' – without exception – for the whole kind (also referred to as 'nomic' sentences or 'gnomic' by Carlson 1982). Three different NPs may then be used in German, but only definite NPs in French (cf. also Winkelmann 1980:97), as shown by the following examples, where *Zuschauer* is classified by NATURAL and NOMINAL (SOCIAL) kinds:

(19) *Zuschauer sind Menschen.*
⟶
Le(s) spectateur(s) est (sont) un (des) être(s) humain(s).
'Spectators are human beings.'

(20) *Der Zuschauer ist ein soziales Wesen.*
⟶
Le(s) spectateur(s) est (sont) un (des) être(s) social (sociaux).
'The spectator is a social being.'

(21) *Ein Zuschauer ist ein Mensch.*
⟶
Le(s) spectateur(s) est (sont) un (des) être(s) humain(s).
'A spectator is a human being.'

6 Marked type reference by NPs in object position

The prototypical type reference occurs with entities in subject position. Generally the scope of the verbal predication restricts the unbounded extension of an entity to which an object NP refers to that quantity for which the verbal predication holds as in (22) (cf. rule (10) in the annex):

(22) *They sell water.*

An exception to this rule are verbal predicates which express a MENTAL ACTIVITY or a MENTAL STATE.

They do not restrict the unbounded extension referred to by the object NP (cf. rule (11) in the annex), hence the bare construction is used in English and a definite NP in Spanish:

(23) *They regard computers as important.*
⟶
Consideran importantes los ordenadores.

(24) *I like Spanish more than Russian.*
⟶
El español me gusta más que el ruso.

Here GENERIC reference is achieved by the verbal scope of predication, whose EVALUATIVE meaning applies to the total extension of the entity refered to by the object NP.

In the following sentence the trajector is an individual token which is located with respect to a landmark which is basically conceptualised as a MASS. The contingent process of writing a text is located with respect to a specific use of a language; the noun *Spanish* does not refer to the language as such, but part of it is used at the particular occasion of writing a text. Hence the bare construction in Spanish.

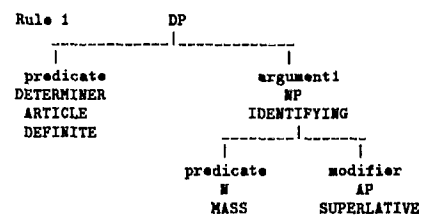
(25) *This text is written in Spanish.*
⟶
Este texto está escrito en español.

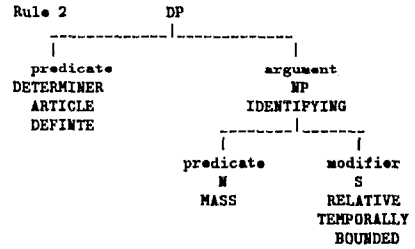
7 Conclusion

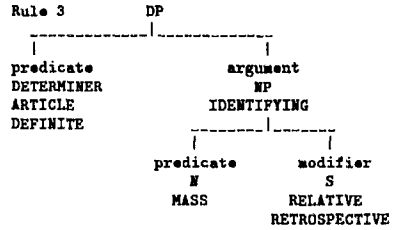
We have shown how conceptual bounding and unbounding of entities result in different ways of reference. The translational relevance of the process of bounding and unbounding arises from the fact that different languages are sensitive to the process by surface distinctions in different ways. Our non–monotonic approach to the problem guarantees extensibility of the rule fragment, that is, we can add rules with conflicting conditions provided by a larger context in the future, when the interpretation is made from a broader perspective, for instance by including discourse phenomena and by using a knowledge base.

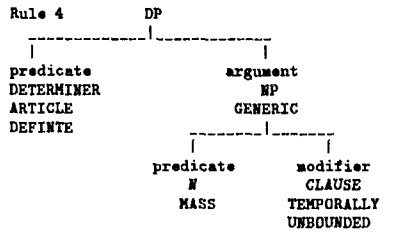
8 Annex of Default Rules

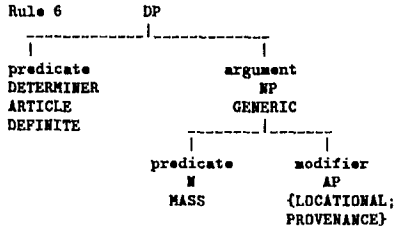
This annex contains our fragment of default rules, which interpret German NPs in a compositional way, i.e. by unifying the semantic and syntactic features of different lexical and non–lexical nodes of the sentence. The result of this interpretation process is an interlingually constant NP reading out of which the syntactic NP structure is generated. The rule order represents the degree of markedness; the less marked, more typical interpretation only applies after the exceptional marked conditions have failed.
In order to facilitate reading we have translated the CAT2 rules into trees and simplified the feature structures to mere labels (The only relations are those enclosed in curly brackets: ";" indicates disjunction, "," conjunction). For a more detailed explanation of CAT2 cf. Sharp 1991. CAT2 consists in stepwise translation between two linguistically motivated levels, both in source language analysis and in target language synthesis. These levels represent configurational structure and semantic functional structure. The semantic level should contain all information needed for transfer, analysis and synthesis. Our rule fragment is implemented on this level. The structure of the rules is based on the DP analysis (cf. Abney 1987, Haider 1988, Olson 1988).

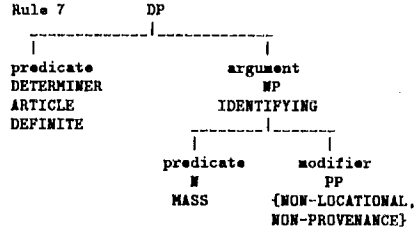


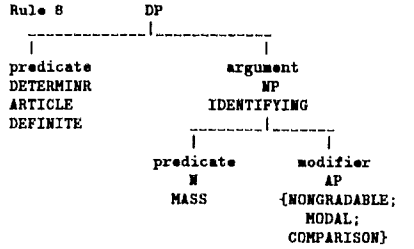


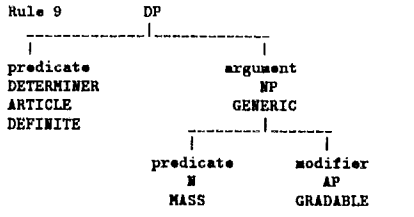


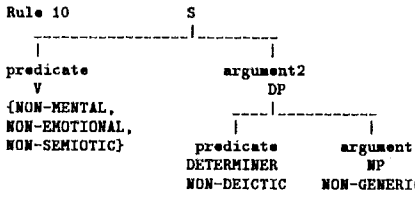


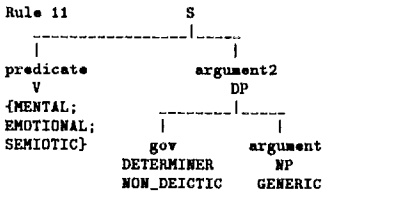


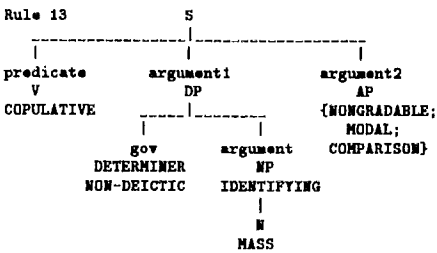


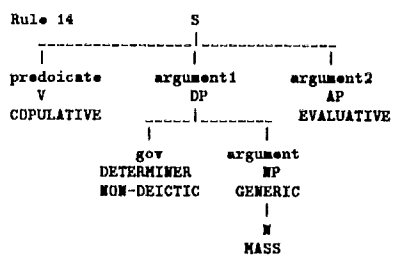


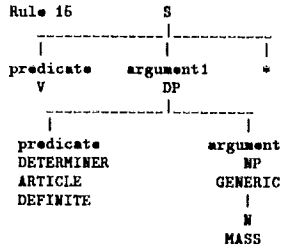


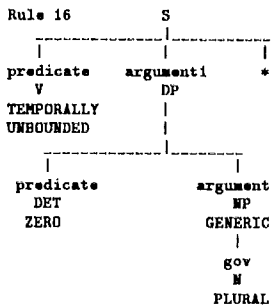












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