[*Proceedings of the Evaluators' Forum*, April 21st – 24th, 1991, Les Rasses, Vaud, Switzerland; ed. Kirsten Falkedal (Geneva: ISSCO).]

Measuring Compositionality of Transfer

Björn Gämback & Manny Rayner
Swedish Institute of Computer Science

Hiyan Alshawi & David Carter
SRI International Cambridge Research Centre

Reading the literature on machine translation, one can find a number of criteria mentioned as significant when evaluating the worth of a transfer formalism; among these are *expressiveness, simplicity, generality, reversibility, language-independence, monotonicity* and *compositionality*. Unfortunately, one soon learns, when trying to convince others of the worth of one's own approach, that most of these are not easy to measure objectively, if they are not absolute properties of the formalism. (In particular, a pure unification-based formalism is guaranteed to be monotonic). To say, for example, that a formalism is "good" from the point of view of expressiveness, and then back this up with five carefully-chosen examples, is not really to say very much.

However, compositionality is an important exception. Here, we will describe a simple method for evaluating the compositionality of a transfer-based MT system, and give an example of its use in the context of the BCI (Bidirectional Conversation Interpreter), an interactive transfer-based bidirectional system currently being developed in a co-operation between SICS and SRI Cambridge. The main components of the BCI are English and Swedish versions of the SRI Core Language Engine, transfer taking place at the level of Quasi Logical Form (QLF); the transfer formalism is unification-based and bidirectional.

For compositionality to be a meaningful notion in the first place, it must be possible for transfer rules to apply to partial structures. These structures can consequently occur in different contexts; other transfer rules will apply to the contexts. The question is the extent to which particular combinations of rules and contexts give rise to special problems. In a perfectly compositional system, this will never happen; however, it seems a safe bet to guess that no such system exists today. What we want is a method which measures how closely we approach the compositional ideal.

Our first step in this direction has been the construction of *compositionality tables,* in which a set of rules and a set of contexts are systematically

combined in all possible meaningful combinations. In the following three diagrams, we give an example of such a table for the current version of the BCI. Table 1 gives a set of rules, which exemplify six common types of complex transfer. Table 2 gives a set of twelve common types of context in which the constructions referred to by the rules can occur. Finally, Table 3 summarizes the results of testing the various possible combinations. Each square in the table consists of two entries, the first for the Swedish-English, and the second for the English-Swedish direction. The entries are to be interpreted as follows:

- NA means that the combination was not applicable, i.e. that the contraction referred to by the rule cannot occur in this context.
- OK means that analysis, transfer and generation all functioned correctly, without any extra rule being necessary to deal with the particular context.
- **Swe/Eng grammar** means that processing (either analysis or generation) failed due to a shortcoming in that language's grammar and/or lexicon.
- **transfer fails** means that the transfer component was unable to make a correct transfer.
- All other entries are names of rules needed to deal with special combinations of rule and context. For this table, only three extra rules were needed: **pres-not,** which adjusts the relative scope of the operators for negation and the present tense; **past-not,** which performs a similar function for the past tense; and **pres-mod,** which rescopes VP modifiers with respect to the present tense operator. No more than one rule is needed to deal with any single example.

At the workshop, we would discuss in more detail the use of this technique, and our experiences in using it to debug and develop the BCI.

Complex transfer type	English-Swedish example	
Different particles	John likes Mary	John tycker om Mary
Passive to active	Insurance is included	Försäkring ingår
Verb to adjective	John owes Mary $20	John är skyldig Mary $20
Support verb to normal verb	John had an accident	John råkade ut för en olycka
Single verb to phrase	John wants a car	John vill ha en bil (lit.: "wants to have")
Idiomatic use of PP	John is in a hurry	John har bråttom (lit.: "has hurry")

Table 1: EXAMPLES OF COMPLEX TRANSFER TYPES

Transfer context	English-Swedish example	
Perfect tense	John has liked Mary	John har tyckt om Mary
Negated	John doesn't like Mary	John tycker inte om Mary
YN-question	Does John like Mary?	Tycker John om Mary?
WH-question	Who does John like?	Vem tycker John om?
Passive	Mary was liked by John	Mary blev omtyckt av John
Relative clause	The woman that John likes	Kvinnan som John tycker om
Sentential complement	I know that John likes Mary	Jag vet att John tycker om Mary
Embedded question	I know who John likes	Jag vet vem John tycker om
VP modifier	John likes Mary today	John tycker om Mary idag
Object raising	I want John to like Mary	Jag vill att John ska tycka om Mary (lit.: "I want that John shall like Mary")
Change of aspect	John stopped liking Mary	John slutade tycka om Mary (lit.: "John stopped like-INF Mary")

Table 2: EXAMPLES OF TRANSFER CONTEXTS

Compositionality Table (Swedish-English over English-Swedish)						
Transfer context	Different particles	Passive to active	Verb to adjective	Support verb to normal verb	Single verb to phrase	Idiomatic use of PP
Present tense	OK OK	OK OK	OK OK	OK OK	OK OK	OK OK
Perfect tense	OK OK	Eng grammar Eng grammar	OK OK	Eng grammar Eng grammar	OK OK	OK OK
Negated	pres-not pres-not	pres-not pres-not	pres-not pres-not	past-not past-not	pres-not pres-not	transfer fails transfer fails
YN-question	OK OK	OK OK	OK OK	OK OK	OK OK	OK OK
WH-question	OK OK	OK OK	OK OK	OK OK	OK OK	OK OK
Passive	Swe grammar OK	NA NA	NA OK	NA NA	NA OK	NA NA
Relative clause	OK OK	OK OK	OK OK	OK OK	OK OK	OK OK
Sentential complement	OK OK	OK OK	OK OK	OK OK	OK OK	OK OK
Embedded question	OK OK	OK OK	OK OK	OK OK	OK OK	OK OK
VP modifier	pres-mod pres-mod	transfer fails transfer fails	pres-mod pres-mod	OK OK	pres-mod pres-mod	pres-mod pres-mod
Change of aspect	OK OK	Eng grammar Eng grammar	OK OK	Eng grammar Eng grammar	OK OK	OK OK
Object raising	transfer fails OK	transfer fails Eng grammar	transfer fails OK	transfer fails OK	transfer fails OK	transfer fails OK

Table 3: A COMPOSITIONALITY TABLE