# TEXTUAL REPRESENTATION OF MEANING

A survey presented to the Utilika Foundation
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***Task: Discover and document text-based systems for the representation of illocutionary forces, predicate argument structures, and semantic relations and evaluations of such systems, with an emphasis on systems designed for use by lay users as well as domain experts, and designed for application to typologically diverse languages.***

## Contents

## 1 Disclaimer

There may be systems that enable authors, writing in a variety of languages, to indicate the illocutionary force of their utterances or to otherwise enhance the meaning of what they write. If such systems exist, they are well-kept secrets (at least from someone unversed in the applicable lingo); they did not make it into this survey. Instead there are basically two types of systems described here: those designed for labeling existing corpora, and those that help authors to create or clarify semantic relationships. Besides being largely irrelevant, the systems reviewed here are presented with a bare minimum of detail, reflecting an inadequate understanding of what they purport to do and how they do it.

## 2 Systems for representing illocutionary force

### 2.1 Introduction

In written communication, illocutionary force must generally be inferred from the surface structure of an utterance. Whether monolingual or translingual, dialogue would become tedious if each utterance needed to be tagged as suggestion, advice, skepticism, gratitude, humor, etc. Sometimes, however, an utterance will offer one or more clues to its illocutionary force, without any conscious effort on the speaker's part. Searle (1969) called these clues "illocutionary force indicating devices". Levinson (1983) changed "indicating" to "identifying" and gave the term a catchy acronym: IFID. Some IFIDs are sentence openers that identify the utterance as an indirect speech act, thus giving the sentence a different illocutionary force from its surface meaning. Examples include "why not" and "let me".

IFIDs and other language-specific devices are helpful when people share a language, but they may be of little use to someone who is seeing an utterance in translation. The sentence "Is that right?", meaning basically "That's interesting" in colloquial English, may not have the intended illocutionary force when translated into another language. The average author or speaker, however, would not recognize this utterance as "Backchannel in question form" and tag it accordingly (as in the SWBD-DAMSL system described below). Instead the user would probably tag the utterance as a a simple question.

Any system that allows (or requires) users to specify illocutionary or semantic aspects of utterances needs to be easy to learn, language-independent (or easily translatable), and intuitive to use. The following subsections will describe a few existing, defunct, or proposed systems that could potentially meet those requirements.

### 2.2 System descriptions

#### 2.2.1 Searle and Clark

Many people have developed systems for categorizing utterances, and most have taken as their starting point the taxonomy of illocutionary acts suggested by Searle (1979), who in turn was influenced by Austin (1962). Each utterance type in Searle's taxonomy has an "illocutionary point". Clark (1996) called the scheme problematic, and he replaced the fifth category (Declarations) with two of his own, but he found it useful "as a gross classification and for its widely accepted nomenclature" (p. 135). His explanations and examples are summarized in the table below:

| *Type* | *Illocutionary point* | *Example* |
|---|---|---|
| **Assertives** | To convince the hearer that the speaker is committed to a certain belief | "It's raining out." |
| **Directives** | To get the hearer to do something | "Please pass the horseradish." "What are you doing?" |
| **Commissives** | To commit the speaker to a future action | "I'll get some coffee." |
| **Expressives** | To express certain feelings toward the hearer (e.g., thanking, apologizing, congratulating) | "Sorry I'm late." |
| **Effectives** | To change an institutional state of affairs | "You're fired." |
| **Verdictives** | To determine what is to be the case within the institution | "We find her innocent." "Strike!" |

### 2.2.2 DAMSL

Dialog Act Markup in Several Layers was developed "to provide a top-level structure for annotating a range of dialogs for many different purposes" (Allen & Core, 1997). The authors stated their expectation that the annotation scheme would be refined as necessary for specific applications. The following descriptions of the DAMSL "aspects" are excerpted from the DAMSL coding manual:

> **Statement** - The primary purpose of statements (utterances having a tag in the statement aspect) is to make claims about the world . . . As a rule, the content of statements can be evaluated as being true or false. -
>
> **Info-Request** - Info-request includes all questions, including yes/no questions such as ``Is there an engine at Bath?", ``The train arrives at 3 pm right?", and even ``The train is late" said with the right intonation. The category also includes wh-questions such as ``When does the next flight to Paris leave?" as well as actions that are not questions but request information all the same such as ``Tell me the time".
>
> **Influencing-addressee-future-action** (Influence-on-listener) - The primary purpose of this aspect is to directly influence the hearer's future non-communicative actions, as in the case of requests (``Move the train to Dansville" and ``Please speak more slowly") and suggestions (``how about going through Corning"). There are many verbs in English that describe variations of these acts that differ in strength, including acts like command, request, invite, suggest and plead.
>
> **Committing-speaker-future-action** (Influence-on-speaker) - The defining property of utterances with this aspect is that they potentially commit the speaker (in varying degrees of strength) to some future course of action. The only distinction made within this aspect is whether the utterance's commitment is conditional on the listener's agreement or not. Commits that are conditional on the Addressee's agreement include what are called offers in English . . .
>
> **Agreement** - In general, the agent may explicitly accept or reject all or part of the proposal, or may simply be noncommittal on the proposal, or may leave the proposal open by requesting additional information or exploring the consequences.
>
> **Understanding** - This aspect concerns the actions that speakers take in order to make sure that they are understanding each other as the conversation proceeds. There are many levels of

"understanding", ranging from merely hearing the words to fully identifying the speaker's intention. Here we group most of these levels together so that if the hearer is said to have understood the speaker, then the hearer knows what the speaker meant by the utterance.

**Answer** - Most questions are answered with one or more declarative sentences although it is possible to answer a question with an imperative . . .

Khoo, Marom, and Albrecht (2006) labeled utterances in an email corpus with a tag set based on DAMSL and enhanced with domain-specific tags: **Statement, Thanking, Request, Salutation, Instruction, Instruction-Item, URL, Response-Ack, Suggestion, Specification, Signature, Question, Apology, Others.**

### 2.2.3 SWBD-DAMSL

A influential study in dialog act analysis involved the Switchboard corpus of 5-minute telephone conversations. The SWBD-DAMSL corpus consists of 1,115 annotated conversations (40 were left unannotated, to be used in testing). The tag set was based on DAMSL, although some of the DAMSL tags are subdivided. (Stolcke et al., 2000; see also Jurafsky, Shriberg, & Biasca, 1997.) The 18 tags in the table below, listed in descending order of frequency, account for 94% of the dialog acts in the corpus. Another 25 tags account for the rest, with each of those 25 being assigned to fewer than 1 percent of the dialog acts.

| ***Tag*** | ***Example*** |
|---|---|
| **Statement-non-opinion** | *Me, I'm in the legal department.* |
| **Acknowledge (Backchannel)** | *Uh-huh.* |
| **Statement-opinion** | *I think it's great* |
| **Agree/Accept** | *That's exactly it.* |
| **Abandoned or Turn-Exit** | *So, -* |
| **Appreciation** | *I can imagine.* |
| **Yes-No-Question** | *Do you have to have any special training?* |
| **Non-verbal** | *[Laughter], [Throat_clearing]* |
| **Yes answers** | *Yes.* |
| **Conventional-closing** | *Well, it's been nice talking to you.* |
| **Uninterpretable** | *But, uh, yeah* |
| **Wh-Question** | *Well, how old are you?* |
| **No answers** | *No.* |
| **Response Acknowledgement** | *Oh, okay.* |
| **Hedge** | *I don't know if I'm making any sense or not.* |
| **Declarative Yes-No-Question** | *So you can afford to get a house?* |
| **Other** | *Well give me a break, you know.* |
| **Backchannel in question form** | *Is that right?* |

Ivanovic (2005) derived a tag set from SWBD-DAMSL for classifying instant-messaging utterances: **Statement, Thanking, Yes-no, Response-ack, Request, Open-question, Yes-answer, Conventional-closing, No-answer, Conventional-opening, Expressive, Downplayer.**

To classify chat-room postings, Wu, Khan, Fisher, Shuler, and Pottenger (2002) used a tag set derived from SWBD-DAMSL and two other systems. The most frequently used tags were **Statement, Accept, System, Yes/no question, Other, Wh question, Greet, Bye.**

### 2.2.4 Verbal Response Modes

The Verbal Response Modes system, developed by William B. Stiles, has been influential in the field of speech-act modeling. (Stiles, n.d.) Initially intended for coding dialog between therapists and clients, the system has been generalized for coding speech acts of all types. Proponents of VRM claim that the system is exhaustive and that its categories are mutually exclusive, i.e., there is exactly one label for each speech act. The table below shows the eight possible modes in the VRM taxonomy.

| Source of experience[1] | Frame of reference[2] | Presumption[3] | |
|---|---|---|---|
| | | Other | Speaker |
| Other | Other | **REFLECTION (R)**<br>***Form***: Second person; verb implies internal experience or volitional action.<br>***Intent***: Puts other's experience into words; repetitions, restatements, clarifications. | **ACKNOWLEDGMENT (K)**<br>***Form***: Nonlexical or contentless utterances; terms of address or salutation.<br>***Intent***: Conveys receipt of or receptiveness to other's communication; simple acceptance, salutations. |
| Other | Speaker | **INTERPRETATION (I)**<br>***Form***: Second person ("you"); verb implies an attribute or ability of the other; terms of evaluation.<br>***Intent***: Explains or labels the other; judgments or evaluations of other's experience or behavior. | **QUESTION (Q)**<br>***Form***: Interrogative, with inverted subject-verb order or interrogative words.<br>***Intent***: Requests information or guidance. |
| Speaker | Other | **CONFIRMATION (C)**<br>***Form***: First person plural ("we") where referent includes other.<br>***Intent***: Compares speaker's experience with other's; agreement, disagreement, shared experience or belief. | **EDIFICATION (E)**<br>***Form***: Declarative; third person (e.g., "he," "she," "it").<br>***Intent***: States objective information. |
| Speaker | Speaker | **ADVISEMENT (A)**<br>***Form***: Imperative, or second person with verb of permission, prohibition, or obligation.<br>***Intent***: Attempts to guide behavior; suggestions, commands, permission, prohibition. | **DISCLOSURE (D)**<br>***Form***: Declarative; first person singular ("I") or first person plural ("we") where other is not a referent.<br>***Intent***: Reveals thoughts, feelings, wishes, perceptions, or intentions. |

[1]whether the utterance's topic is information held by the other or by the speaker

[2]whether the utterance is expressed from a point of view shared with the other or from the speaker's own point of view

[3]whether the speaker presumes knowledge of what the other's experience or frame of reference is, was, will be, or should be (other) or instead uses knowledge only of his or her own experience and frame of reference (speaker)

Each VRM utterance is coded twice, once for form and once for intent. An utterance of *pure mode* has the same code for both form and intent; an example would be the declarative, objective sentence "Cats eat fish.", which would be coded EE. An utterance is of *mixed mode* if the form and intent are in different categories, as with the sentence "Can you please pass the butter?" This indirect speech act would have the code QA, because it's in the form of a question but has advisement (the force of an imperative) as its intent.

In translingual communication, the form or intent of an utterance may change completely from one language to another. Cultural norms also play a role. Citing the 1993 edition of *Pragmatics* by Jacob L. Mey (the passage doesn't seem to exist in the 2001 edition), Grenoble (2000) gives this example of how two people from different cultures might respond to being misunderstood):

> A: I'm afraid I didn't express myself too clearly.
> F: Mais vous ne comprenez pas!

In the VRM system, A's disclosure and F's interpretation, which have two different forms, might both be categorized as having the intent of edification (E).

To complicate matters a bit, VRM also has three "role dimensions": Attentiveness-Informativeness; Acquiescence-Directiveness; and Unassumingness- Presumptuousness. The position of each utterance on these binary dimensions supposedly indicates "how the utterance contributes to the interpersonal relationship." These psychological dimensions could probably be ignored in the coding of general-purpose communication.

The VRM coder training application and its data files are available to download from http://www.users.muohio.edu/stileswb/archive.htmlx "The program is old, written for DOS," warns the site, "but it will run on any version of Windows."

### 2.2.5 Simplified VRM

The goal of Lampert, Dale, and Paris (2006) was "to assist users to identify outstanding tasks easily (both for themselves and their correspondents) through automatically flagging incomplete conversations, such as requests or commitments that remain unfulfilled" (p. 2). Toward that end, they used a set of annotated dialogs from the VRM training materials to train a statistical classifier.

There are two particularly interesting aspects of the tagging activity described in this paper. First, the researchers provided a mapping of the VRM categories to Searle's taxonomy:

| ***Searle*** | ***VRM*** |
|---|---|
| **Commissive** | **Disclosure** |
| **Expressive** | **Disclosure** |
| **Representative** | **Edification** |
| **Directive** | **Advisement; Question** |
| **Declaration** | **Interpretation; Disclosure; Edification** |

Second, because the VRM system is allegedly exhaustive, the Lampert tag set is the only one reviewed in this paper that does not include an "other" tag. However, the researchers ignored half of the VRM system – the coded intent of speech acts – and used only the form, or literal meaning, of each utterance for their training experiment.

### 2.2.6 Ontology-derived tags

In a study of machine learning aimed at classifying entire email messages, Cohen, Carvalho, and Mitchell (2004) derived the categories of speech act from an ontology of verbs (e.g., propose, commit, deliver) and nouns (e.g., information, meeting, task). A message could have more than one speech act, as in "(commit (deliver information))". The results of this study include a table that lists the most

common “verbs” encountered in the email corpus: **Request, Proposal, Delivery, Commitment, Directive, Commissive, Meet.**

## 3 Systems for showing semantic relations

### 3.1 What are “semantic relations”?

In WordNet, semantic relations are the relationships that exist between word forms. These include synonymy, antonymy, hyponymy, and meronymy. (Miller, 1995)

In the Unified Medical Language System, *Semantic Relations* are the set of relationships that exist between *Semantic Type*s (UMLS, 2007). Examples of Semantic Relations include *part_of, location_of, performs, causes, manifestation_of.* (UMLS, 2006)

In natural language processing, the term *semantic relations* can refer to the thematic roles filled by the arguments of a verb. See, for example, Ruus & Spang-Hanssen (1986) and Gildea & Jurafsky (2003).

A fairly strong connection exists between the first and second uses of the term. If two words have the semantic relation of hyponymy, then the concept expressed by one could be called a *manifestation of* the concept expressed by the other. If two words have the relation of meronymy, then the concept expressed by one is a *part of* the concept expressed by the other.

A similarly strong connection exists between the second and third uses of the term. A semantic role is the relationship that a participant has with the main verb in a clause. Many traditional thematic roles (agent, causer, location, etc.) could be expressed using one of the semantic relations from the UMLS list (performs, causes, location_of, etc.).

The third connection, between the lexicographic and NLP uses of the term, seems less obvious. Fortunately we do not need to ponder this connection (or lack thereof), because for the purposes of indicating meaning in translingual communication, only the second and third uses of the term seem applicable.

### 3.2 System descriptions

#### 3.2.1 Annotation of predicate-argument structure

The Proposition Bank (Palmer, Gildea, & Kingsbury, 2005) added a layer of predicate-argument information to the syntactic structures of the Penn Treebank. Proposition Bank II (Babko-Malaya, Palmer, Xue , Joshi, & Kulick, 2005) enhanced the data by adding eventuality variables, nominal references, sense tagging, and connections to the Penn Discourse Treebank. A parallel project added PropBank features to the first 100,000 words of the Penn Chinese Treebank and its English translation (Palmer, Xue, Babko-Malaya, Chen, & Snyder, 2005).

The specific role labels used in PropBank annotation, such as *Arg0 causer of motion* and *Arg3 end point,* are unlikely to be useful in the design of a system for general translingual communication. However, the prototypical thematic roles of *agent*, *patient*, etc., could very well be useful as conceptual tags for lexemic/lemmatic communication.

Many research projects in linguistics require that at least part of a corpus be annotated by hand. Since annotation is an ancillary (though fundamental) task, research reports often include little or no information

about the people and process involved in performing the annotation. The creators of the Proposition Bank provide a refreshing level of detail:

> The annotators themselves are drawn from a variety of backgrounds, from undergraduates to PhDs; linguists, computer scientists, and others. Undergraduates have the advantage of being inexpensive but tend to work for only a few months each, so require frequent training. Linguists have the best overall judgements although several of our non-linguist annotators also have excellent skills. The learning curve for the annotation task tended to be very steep, with most annotators becoming comfortable with the process within three days of work. This contrasts favorably with syntactic annotation, which has a much longer learning curve . . . [p. 13]

The PropBank annotation task, which consisted of selecting nodes in a parse tree for labeling as arguments of the given predicate, required at least a rudimentary understanding of syntactic structure and semantic roles. The success of the nonspecialist PropBank annotators is therefore encouraging. This information could help with predicting whether lay users can learn to annotate.

### 3.2.2 Semantic MediaWiki

Text on a standard wiki page contains hyperlinks to other pages on the site or to external pages. The word "Germany" in a Wikipedia article about Berlin might have a link to the Wikipedia article about Germany. With Semantic MediaWiki, an extension to the MediaWiki software, authors can annotate such links with text that describes the relationship between the linked concepts. (Semantic MediaWiki, 2007) The "Germany" link could have a property called "capital of" with the value Germany; the resulting link would look like this:

```
[[capital of::Germany]]
```

These annotations do not appear in the text of the page, but they help software agents to locate relevant information. One service that takes advantage of the annotations is *semantic search*, an "easy-to-use" query language that mirrors the syntax of annotations. Here is a simple search that would retrieve only pages about actors who were born in Boston and were 180 cm tall:

```
<ask>[[Category:Actor]] [[born in::Boston]] [[height:=180cm]]</ask>
```

Semantic MediaWiki and its semantic search are intended for use by anyone who wants to create or retrieve wiki pages with enhanced information content. As of September 2007, the English-language Wikipedia had 3.4 million registered users (Wikimedia Foundation, 2007). This figure includes all those who merely want to make corrections or discuss the articles with other users. Even if each of the 2 million articles had one distinct author, the number of contributors would be quite small compared to the general population who may wish to engage in computer-mediated communication.

Demonstrating the Wikimedia Foundation's professed commitment to multilinguality, the MediaWiki user interface has been translated, at least partially, into more than 70 languages. ("MediaWiki", 2007) This makes MediaWiki, if not the Semantic add-on, a possible platform for collaborative multilingual publishing.

### 3.2.3 Cyc

To make it possible for users with minimal technical and linguistic knowledge to add information to the Cyc knowledge base, researchers developed the User Interaction Agenda (Witbrock et al., 2003). The UIA hides the underlying CycL language from the user, who is typically a subject-matter expert.

The user begins by logging in and selecting a topic (this tells Cyc where in the ontology to be looking for concepts). A choice of languages is presented, based on user preferences known to the system; the user chooses one (only English has significant support) and enters an utterance in the "Say This" box. The system interprets the utterance as one of three possibilities: question, command, or assertion. If the possible interpretation is ambiguous, the system asks for clarification.

Each CycL sentence has a predicate that relates the other terms in the sentence to one another, and each predicate has a set of argument constraints. For example, CycL translates the assertion "Jerry Allison is a member of The Crickets" as "(hasMembers TheCrickets JerryAllison)". If the user enters a sentence that Cyc cannot process according to these constraints, it will suggest another possible formulation of the sentence.

Another component of Cyc is the Dictionary Assistant, which allows the user to add new terms to the ontology. Through an interactive dialog, the user specifies semantic and syntactic information about the new term. An example would be the addition of the word *whelp* to Cyc's concept *Dog*; Cyc would thereafter be able to associate any use of the new word with the established concept. (Cycorp, 2002)

### 3.2.4 AURA (Project Halo)

The Vulcan-sponsored Project Halo has the ultimate aim of building a knowledge repository and question-answering system called the Digital Aristotle. In a 6-month pilot project, three teams of researchers built knowledge bases of scientific information extracted from textbooks. The goal was to construct a system capable of answering questions on Advanced Placement tests. The efforts were moderately successful, costing about $10,000 per page of information entered.

The initial studies all relied on knowledge engineers using a formal language to enter information. In Phase II of the project, the researchers are developing tools to enable domain experts to build knowledge bases. One such tool is the AURA system developed by Chaudrhi et al. (2007).

In the *document-rooted* interface to AURA, the user selects which parts of the book to encode and underlines the words of interest. AURA then maps the selected words to concepts that are already in the knowledge base. If a concept isn't there, AURA suggests to the user that it be added as new. The figure below shows the AURA interface.


Development of AURA continues. Future work may include interfacing AURA with a Semantic Wiki "to test if some of the knowledge needed for answering questions . . . could be acquired from contributors given little or no training." (Chaudrhi et al., 2007, p. 166)

### 3.2.5 WYSIWYM

The WYSIWYM system (What You See Is What You Meant) was designed to allow domain experts to add information directly to a knowledge base without the need to learn a formal encoding language. The user interacts with an ordinary natural language document, responding to feedback text generated by the system. Assertions are created by filling in the slots for a given entity (e.g., the arguments of a verb). For example, the following sentence presents the author with a phrase made up of two fillable slots:

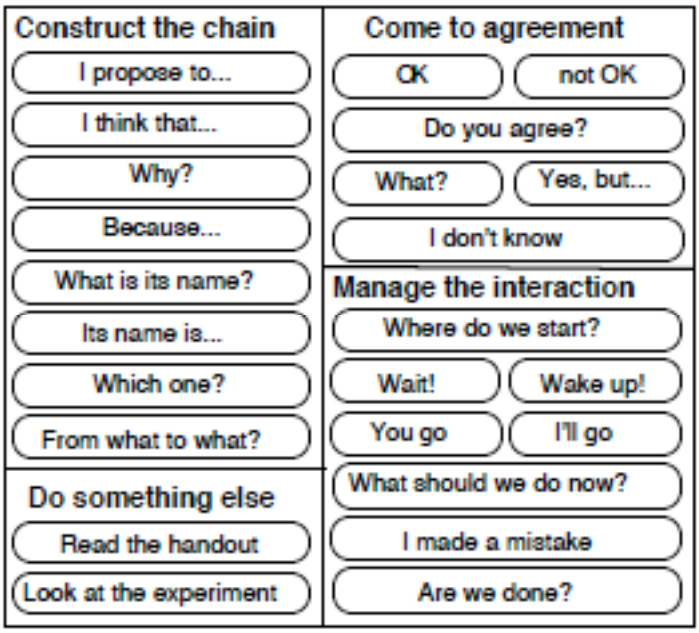
Your medicine is a coloured substance

The abstract, boxed terms are called *anchors*. In the actual system they would be color-coded, red for required and green for optional. In the sentence above, *substance* is a required slot, and *coloured* is optional. Clicking on one of the terms will bring up a list of possible filler phrases. After choosing one, the author sees a feedback text with the new information and any additional options that result from choosing that particular word or phrase. (Natural Language Generation Group, 2007) Power and Evans (2004) created an extension to WYSIWYM that allowed for more expressivity by enabling the user to specify illocutionary force, time, polarity, modality, and modifiers for an entity.

An early implementation of the WYSIWYM concept, DRAFTER, was an interactive system for producing software manuals in English and French (Paris & Vander Linden, 1996). The tool that was used for construction of the language-independent knowledge base, the Knowledge Editor, presents pre-defined concepts and instances for the author to select; when a term is selected for expansion, suggested additions are presented in a controlled natural language.

## 4 Structured interaction

Lund & Baker (1997) compared two communication interfaces for collaborative learning. One interface allowed the use of free text, and the other provided a restricted set of communicative acts. The buttons in the restrictive interface (see the illustration below) were derived from an analysis of dialog-box interactions and existing interaction models. In this study, the students' collaborative task was to produce an "energy chain" – a model for energy storage, transfer and transformation.




Analyzing the interactions produced with the two interfaces, the researchers observed that the more restrictive interface was associated with slightly more reflection (i.e., giving explanations and evaluations). Students also spent less time off-task when they had a restricted set of interaction choices.

Other research has suggested that over-scripting the collaborative learning process can be harmful. Disadvantages of scripting include interference with natural communication and problem-solving processes, an increase in the cognitive load from having to learn to work with the script, and interference with natural goal-setting and the development of shared goals (Dillenbourg, 2002).

## 5 Techniques used in multilingual communication systems

Some of the systems designed for multilingual interaction employ devices for indicating semantic relations or other aspects of meaning. In the AnnoChat system (Shigenobu1, Fujii, & Yoshino, 2007), users can create annotations of three types: dictionary (defining a term), conversation supplementation (explaining a part of the conversation), and translation confirmation (asking for explanation of a term that is not understood).

Other features of such systems include escape sequences for indicating that items should not be translated (proper names, for example) and a WYSIWYM-based ability to specify coreferences. These systems are discussed at greater length in "Systems for multilingual interaction", coming soon to an inbox near you.

## 6 Summary and recommendations

As noted in section 1, none of the systems reviewed here was designed as an annotation method for use by people trying to communicate across language boundaries. However, some of the tags developed for analyzing dialogs could possibly be borrowed for annotating translingual utterances. Such tags would need to be kept to a minimum, as they would require translation into every interface language available.

The various tag sets adapted from DAMSL provide a few candidate terms for indicating common utterance types. In particular, there are three types that Wu et al. (2002) found among those most often used in chat-rooms: **Statement, Yes/no question,** and **Wh question** (more universally translatable as **Open Question**). Utterances of the type **Greet** and **Bye** are unlikely to require annotation, as their meanings should be clear from the words chosen, but even these tags may prove useful.

Given the vagaries of translation into hundreds of languages, it's probably best to avoid a system like VRM that uses relatively uncommon terms to indicate the precise intent of a dialog act. For example, the term **Edification** is translated by PanImages into fewer than 20 languages; one of the two senses has the gloss "construction" (e.g., Esperanto *konstruo*). Human translation of such terms would be a bit more reliable, but there may still be more room for error with these words than with less esoteric terms.

Similarly, semantic-role indicators like *causer* and *instrument* might suffer in translation. Perhaps some more generic – and less ambiguous – terms would be useful, e.g., those that identify objects, subjects, and verbs. Even those, however, could be problematic if not carefully translated.

User testing will reveal which terms, if any, produce more clarification than confusion. Generally speaking, though, textual indicators of meaning are probably best avoided in multilingual communication.

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