ANALYSIS INTO A FORMAL TASK-ORIENTED PIVOT WITHOUT CLEAR ABSTRACT
SEMANTICS IS BEST HANDLED AS "USUAL" TRANSLATION

Christian BOITET
GETA, CLIPS, IMAG
385, av. de la bibliothèque, BP 53
F-38041 Grenoble cedex 9, France
Christian.Boitet@imag.fr

Jean-Philippe GUILBAUD
GETA, CLIPS, IMAG
385, av. de la bibliothèque, BP 53
F-38041 Grenoble cedex 9, France
Jean-Philippe.Guilbaud@imag.fr

ABSTRACT
During the development of a multilingual international demonstration implemented by the CSTAR consortium, five of the six partners have adopted a task-oriented (task and domain specific) pivot architecture. To add French to the system, we have developed, among other components, an analyzer which converts written utterances, coming from a speech recognition system, into the pivot language known as IF (Interface Format). Perhaps paradoxically, the natural character of the relevant utterances and the lack of formal semantics in the resulting IF structures has led us to construct this analyzer as if we were translating between two poorly defined natural languages. We will describe how we have used the Ariane-G5 environment while adopting a technique inspired both by the example-based machine translation paradigm and by older, "semantic" machine translation approaches.

INTRODUCTION
Ariane-G5 (Boitet 1997) is a development environment for machine translation systems, originally intended for the creation of high-quality translators for written texts. It is based upon five rule-based languages, or LSPL (specialized languages for linguistic programming) well adapted for heuristic programming, where the heuristics are derived from the observation of a particular typology (lexicon & grammatical style).

The numerous applications already implemented in this spirit have made use of the "multi-level transfer" linguistic architecture of B. Vauquois (Vauquois et al, 1985), and, at the programming level, a grammatical and heuristic approach: through successive approximations, we seek a "static" formal description of utterances and their descriptors; and then implement this description using a heuristically controlled rule system.

The same environment (replacing the heuristic programming with combinatorial programming), was employed in the creation of a dialogue-based machine translation prototype (Blanchon 1994), in which the analyzer furnishes several multilevel structures, which are then disambiguated via a dialogue with the user. (This dialogue itself is constructed dynamically using a system of rules.)

From September 1997, until the end of 1999, we participated, within the CLIPS++\(^1\) group of the CSTAR II consortium, in a project involving speech translation in the domain of hotel reservations and tourism (Blanchon et al, 1997, Boitet et al, 1998). Our task was to transform the results of speech recognition into an IF (interface format) structure representing the meaning of the utterance to be translated.

For this purpose, we used Ariane-G5 in a new way: rather than use formal grammars and heuristics as in the past, we employed a linguistic architecture based upon a "task-oriented semantic pivot", and a computational approach using "semantic schemas".

The interest of this work is threefold. First, it has once again demonstrated the power of this environment, first created in 1978, whose underlying concept has allowed it to evolve and grow considerably in power and flexibility using minimal human-resources. Secondly, we were able to reuse without modification the morphological components initially intended for the treatment of written text. Finally, the current structural analysis is of a completely new type: rather than produce an abstract linguistic tree as in all of our previous projects, we produce directly the semantic structure, which is in fact an abstract tree of the IF expression ultimately produced by the transfer and generation stages.

After discussing the problem of translation from French into the IF format, we will briefly present our development methodology, and will then describe in detail the various modules now in operation.

1. THE PROBLEM
The IF format is a pivot language specialized for the representation of intended utterances in the intended domain. Certain limitations naturally arise from this specialization. It is incapable, for example, of representing modal nuances: I would like to reserve. I could reserve. I don't want to reserve, etc. would all be represented by the same expression. Of course, some inverse meanings are possible, but they are very rare in real dialogues.

1.1 General Definition of the IF Format

Intuitive Syntax and Semantics:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF utterance</td>
<td>:= ({\text{speech act} + \text{concept}}^*)</td>
</tr>
<tr>
<td>val</td>
<td>:= (\text{idf} + (\text{attr} + \text{val})^*)</td>
</tr>
</tbody>
</table>

Examples

\(c:\text{request-information}+\text{price}+\text{room} (\text{room-type}=\text{single} & \text{double})\)
a:give-information+price+room ((room-type=single, price=(currency=franc, quantity=200)) & (room-
type=double, price=(currency=franc, quantity=(300))))
c:accept
c:request-action+reservation+features+room (room-
type=(single, quantity=2), duration=(time-unit=night, quantity=10))

1.2 The Lack of True Coherence

Unfortunately, the IF formalism has not been supplied with a clear formal semantics. No precise rules are available for interpreting correctly the meanings or the nuances of most of the IF structures found in the reference data base of legal IF structures. For example, it was not possible to guess which fact in the reservations domain would be described using the following IF fragment: accept + confirmation + location + air or transport + restaurant. We were often uncertain about the influence of a given concept on other concepts, and about the exact nature of this influence (e.g. determiner vs. determined, thematic vs. rhematic, phematic negation vs. functional negation, and so on).

Because of this difficulty, we used the generator of our partner CMU to verify the validity of the IF structures produced by our system from French utterances.

1.3 Methodology

Thus we were led to consider IF structures almost as if they had been those of a natural language whose syntax and semantics were necessarily unknown at the outset: we attempted to gradually approach the structures, starting from examples.

However, the spontaneous character of French spoken examples prevents their description in classical grammatical terms, because of hesitations, repetitions, false starts, various noises, breaks, fragments, and so on. These effects could be modeled as transformations T of more “correct” utterances describable by a normative grammar GN, even if we are unable to construct an operational grammar GO such that GO = T o GN.

On the other hand, the syntax of IF structures is very simple and perfectly defined: it is only the semantics which is not clear. An additional obstacle does arise from obvious limitations in the expressiveness of this formalism: many natural utterances seen in the dialogues in question cannot be faithfully represented by IF structures. This is the case wherever modality is at issue, or where circumstances bear upon the speech act itself. For example, it would not be possible to represent "Perhaps I'll reserve a room for you tomorrow" (without specifying the date of the reservation itself).

However, in their example lists, the creators of IF structures have associated these structures with very distant or even totally distinct meanings. For the example above, the most natural IF structure -- the structure produced by an analyzer seeking the most usual schemas -- would have the meaning "I'd like a room for tomorrow".

2. RESOURCES, TOOLS, METHOD

2.1 Resources

The following resources for handling IF structures have been made available by CMU:

- the general definition shown above
- very general comments concerning usage restrictions
- a file of examples (English to IF)
- nearly instantaneous access to the English-IF generator developed since 1995.

In addition, we had at our disposal from the beginning of the project a list of French utterances drawn from (a) dialogues concerning tourist reservations compiled by an AUPELF-funded project, and (b) imaginary dialogues by some 40 people. By the end of the project, we also had transcriptions of the actual dialogues produced during experiments carried out in preparation for demonstrations.

Finally, the list of proper nouns associated with the tasks in question (names of cities, hotels, monuments, people, shows, etc.) was gradually built up and regularly incorporated into the component dictionaries.

Unfortunately, we did not have access to the French speech recognizer or the French generator during the project, since they were also under development.

2.2 Ariane-G5

During most of the project, it was possible to use the complete Ariane-G5 environment on a local machine without much power, and to use the subset for executing translation chains on a more powerful remote machine of Université Saint-Jérôme in Marseille.

We will not describe this environment in detail here (see Boitet 1997) for more details). Below, however, is a diagram showing the possible phases of a translation lingware and the specialized languages in which they are written.

The entire French-to-IF analyzer was written in this environment, which made possible the reuse of several modules developed for other projects. Thus we used almost all of the possible phases -- the obligatory phases AM, AS, TL, GS, and GM, and the optional lexical expansion phases AX, AY, TX, TY, and GY.

2.3 Development Cycle

In order to develop our specific application for the translation of French utterances into IF structures, we principally used
three exterior resources. In the first place, an English-to-IF
eample base, sufficiently large, allowed us to infer a certain
umber of French-to-IF correspondences so as to stock our
dictionaries and thus to bootstrap the application. Secondly,
the database containing, in extension, the legal combinations
of speech acts with concepts helped us to figure out cases
missing from the example base. Finally, the CMU IF-to-
English generator allowed us to judge the validity of the results that we obtained.

3. IMPLEMENTATION

3.1 AM

The French morphological analysis module was developed in
the framework of the LIDIA project. We simplified it and
adapted it to the terminology of our new application domain.
The role of this AM module is to lemmatise, to handle the
very numerous idiomatic expressions, to produce a mor-
phological analysis, and to transform the text into a decorated
tree for use in subsequent processing.

(a) Input text:
<agent> je vous propose l'hôtel de l'institut à cent
cinquante dollars la nuit

Output tree:
1: [ul('ultxt')]
(2: [ul('ulfra')]
(3: [ul('ulsol')]
(4: [ul('<agent>')], cat(p, pref)),
5: [ul('je_pron')], cat(r), nbr(sg), pers(1)],
6: [ul('vous_pron')], cat(r), nbr(pl), ...],
7: [ul('proposer_v'), subv(vb), cat(v),...],
8: [ul('hotel_de+l+institut'), cat(n),...],
9: [ul('a!2_pp'), cat(s)],
10: [ul('cent_card')], cat(crd)],
11: [ul('cinquante_card')], cat(crd)],
12: [ul('devise_dollar'), cat(n), nbr(pl)],
13: [ul('le_art')], cat(d), gnr(fem), nbr(sg)],
14: [ul('nuit_nf')], cat(n), gnr(fem), nbr(sg)])

3.2 AX and AY

The two EXPANS modules contain French-to-IF dictionaries
which support the initial replacement of French lexical ele-
ments with IF fragments. These dictionaries concentrate upon
nouns and nominal locutions. In figure (b), we show that the
node labeled "hôtel de l'institut" is replaced in the tree in due
course by the sub-tree "argument 'hotel-name'": dominating
"value 'hotel_de_l_institut'";

(b) Dictionary entry:
'hotel_de+l+institut' ==/ 1(2) /
1: 'hotel-name'. Sargument.
2: 'hotel_de_l_institut'. Svalue.

3.3 AS

The ROBRA grammar of this module recognizes such im-
portant structures as those of number, dates, times of day,
prices, and so on. It also handles verbal groups containing
conjugation auxiliaries or modals. In the example, we see that the
sequence "à cent cinquante dollars la nuit" is recognized as
the expression of a price whose structure is given by 9 (10
11, 12 (13, 14), 15 (16))).

(c) Analysis result:
1: 'ultxt' (2: 'ulfra' (3: 'ulsol')
(4: '<agent>'),
5: 'propose_v',
6: 'hotel-name'
(7: 'hotel_de_l_institut'),
8: 'a!2_pp',
9: [ul('price'), dapart(argument), rang(+20)]
10: [ul('currency'), locutor(agent),
dapart(argument), rang(+20)]
11: [ul('dollar'), dapart(value)],
12: [ul('quantity'), dapart(argument),
rang(+20)]
13: [ul('cent_card'), locutor(agent),
nombre(c), cat(crd)],
14: [ul('cinquante_card'), locutor(agent),
nombre(d), sddl(vingt), cat(crd)],
15: [ul('per-unit'), locutor(agent),
temps(timunit), semn(temps),
dapart(argument), rang(+20)]
(16: [ul('night'), dapart(value), rang(-1)])

3.4 TL

The TL module includes one dictionary containing speech act
candidates and a second dictionary which handles the con-
version of named numbers into numerals.

(d) Result of TL:
1: 'ultxt' (2: 'ulfra' (3: 'ulsol')
(4: 'a:', 5: 'suggest',
6: 'hotel-name' (7: 'hotel_de_l_institut'),
8: 'a!2_pp',
9: 'price' (10: 'currency' (11: 'dollar'),
12: 'quantity' (13: '1', 14: '50'),
15: 'per-unit' (16: 'night')))

3.5 TX

The TX module is a dictionary for correcting partially incor-
herent results. In the following example, the dictionary entry
supports the replacement of the concepts 'features+hotel' with
the value "hotel" when the lefthand context is either "desti-
nation" or "origin".

(e) Dictionary entry:
'features+hotel' == ul(@g)-e-'origin'-ou-
ul(@g)-e-'destination'
// 'hotel', Svalue
// 'features+hotel'.

3.6 TS

The TS module is a ROBRA grammar phase. TS erases use-
less nodes such as duplicates, creates default speech act for
utterances which still don't have one, creates a top-level "ul-
fra" for each speech act when there are several speech acts in
the current utterance (a single IF structure can contain only
one), and places IF elements in canonical IF order in cases
where the current order reflects that of the words input to the
AM phase. In the example below, the input utterance is
translated by two IF structures because, in TS, two 'ulfra'
were created, one for each speech act.
3.7 TY

The role of the TY module is to reevaluate inadequate choices, based upon the immediate lefthand and righthand contexts. In the example, "features+flight" is replaced by "flight" whenever this configuration is preceded by either "availability" or "price".

3.8 GS

The GS module contains two grammars which fix the form of the IF structure by flattening the tree and by integrating such syntactic "sugar" as opening and closing parentheses, plus signs, commas, etc.

3.9 GY

The GY dictionary puts on final touches before the final phase of morphological generation.

3.10 GM

The morphological generation module GM, departing from the leaves of its input tree, produces the text of the IF -- the translation of the text submitted to the AM module.

CONCLUSION

Our contribution to the speech translation experiment of the CSTAR consortium allows us to state that the "utopian" interlingual approach becomes practical and viable when it is carried out using a task-oriented semantic pivot. The approach no longer aims for an unreachable universal description of the world. Rather, it sets its sights lower, on a world which is artificial, very limited, and governed by simple laws, such as those concerning quite standardized commercial tourist offerings. Even so, the approach will have to refine its focus and gain in power if it is not to excessively exclude the inherent complexity of worlds -- even worlds constructed from scratch -- in which human beings intervene, e.g. as customers with nonstandard requirements.

We believe that the next decisive step would be a more rigorous definition of IF structures taking greater account of the linguistic and logical structure of spoken utterances.

ACKNOWLEDGMENTS

We thank all of our C-STAR partners in this venture for their sense of teamwork. They have helped us to carry out a novel and enriching experiment. We are grateful to H. Blanchon, our project leader in Grenoble, for having managed to accomplish the impossible by the assigned date, 22 July 1999. And without the logistical support of IBM, the unmatched competence of Pierre Guillaume, and the efficient mediation of Daniel Baud, our Ariane G-5 application could never have run as fast as it did. Last, but not least, we would like to thank M. Seligman for his invaluable help in producing the English version of this paper.

REFERENCES