UCG USED BY RESPONSE GENERATION

K. Taušer and R. Mouček

Department of Computer Science and Engineering
University of West Bohemia in Pilsen
Czech Republic
{tauser, moucek}@kiv.zcu.cz

Abstract: The paper deals with a spoken dialogue system component – response generation module. We are developing the spoken dialogue system called CIC (city information centre) providing a subset of services of a real city information centre. The main focus of this article is an experiment with usage of UCG (Unification Categorial Grammar) for response generation within a dialogue system speaking Czech. The applied UCG is a formalism used for representation of sentence structure.

Keywords: dialogue system, response, response generation, language, speech

1. INTRODUCTION

Nowadays, the great effort is taken to develop hardware and software components enabling an interaction between human and machine using natural speech. Human computer interaction (HCI), especially man- machine communication based on speech, is a multidisciplinary research area drawing knowledge from several research fields. Several interactive information retrieval dialogue systems have been developed to provide information services. Also, the aim of our research is the development of a spoken dialogue system. The object of our interest is a city information centre which mostly provides information about local public transport, location, opening hours and entrance fee of regional and local sights, cinema performances, institutions, accommodation, etc. The city information centres are the typical areas where the application of a spoken dialogue system is convenient. Thus, we are developing the dialogue system called CIC (city information centre) providing a subset of services of a real city information centre. We use typical structure of dialogue system originally designed in the project SUNDIAL (Peckham, 1993) containing: speech recognition module, linguistic analyser, dialogue manager, response generation module and speech synthesiser. The paper describes an experiment with usage of UCG (Unification Categorial Grammar) for response generation within a Czech spoken dialogue system.

1. RESPONSE GENERATION

Although response generation is an important component of an interactive spoken language system, only little research has been done in this area. Dialogue system utterances (responses) are usually generated using concatenation of pre-defined and pre-recorded speech units (e.g.

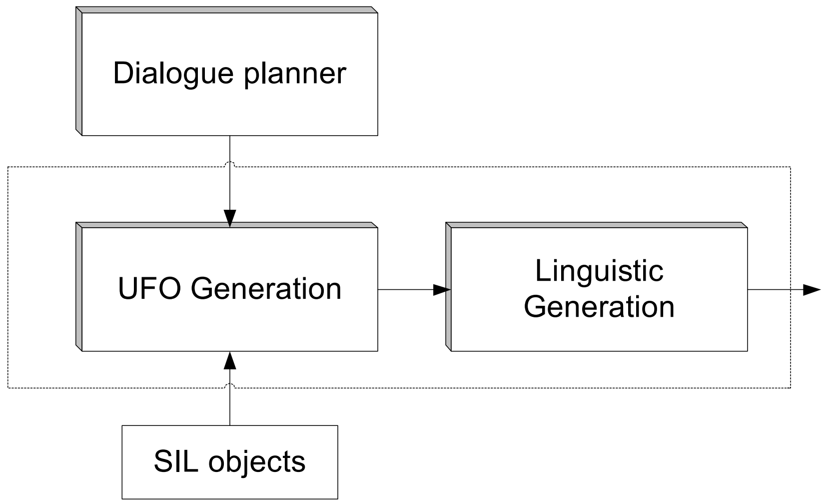

Fig.1. Response generation from concepts

words or smaller units). However, this simple and straightforward technique run into difficulties, whenever it is necessary to extend or modify the set of dialogue system responses. The modification and extension of units is a difficult and expensive operation, since at every update, the original speaker must be available and recorded under the same acoustic conditions, otherwise the whole set of units must be recorded. Moreover, an elaborated response generation is crucial for keeping coherence between user and dialogue system utterances (a dialogue system must response adequate to user's questions). Therefore we decided to prepare an intelligent component generating orthographic form of an utterance from a conceptual representation of an utterance. The generated orthographic form can be then passed to Text-to-Speech module. The response generation process is depicted on Fig.1. The used SIL (semantic interpretation language) provides a simple semantic representation of utterances at two different levels of detail – a linguistically oriented level and a task-oriented level (Youd and McGlashan, 1991). At the linguistically oriented level, this structure corresponds to a compositional semantics representation. There is a common knowledge base of SIL objects arranged into a hierarchy in the dialogue system. The response generation module prepares an UFO (utterance field object) representing semantically a system response (UFO is a structure). The orthographic form of a sentence is then linguistically generated using UCG representing syntax of the sentence structure and a lexicon forming the final word form according to morphological rules.

2. UCG

Within the utterance generation based on a conceptual representation, a linguistic theory is needed to provide grammar formalism for representation of syntax structure of a sentence in natural language that is confined to have context-free (CF) structure. The basic formalism, Categorial Grammar (CG), can be used for formal description of a sentence structure. Usually a small set of basic categories is taken: N (noun), NP (noun phrase) and S (sentence) which are themselves sufficient for giving definite string and can combine with derived categories like N\S (intransitive verb) or NP/N (e.g. article) using application rules:

a. $X/Y\ Y \rightarrow X$ (Forward Functional Application - FFA)

b. $Y\ Y\backslash X \rightarrow X$ (Backward Functional Application - BFA)

Unification is also method that can provide linguists with powerful paradigm for natural language description. It is defined basically as a combination of information from two feature structures (structures consisting of set of attribute-value pairs, called also sign). Within unification process a new feature structure is arising which includes information of both original feature structures.

$$\begin{bmatrix} ORTH : orth \\ CAT : cat \\ SEM : sem \end{bmatrix} \quad \begin{bmatrix} RES : cat \\ DIR : dir \\ ACT : sign \end{bmatrix} \quad \begin{bmatrix} CAT-TYPE : cat-type \\ M-FEATS : m-feats \end{bmatrix}$$

a) b) c)

Fig. 2. Signs

Finally, UCG is sign based formalism for natural language representation designed on the basis of CG and unification principle, see (Calder *et al.*, 1998) for more details. We define categories in UCG in following way according to (Zeevat *et al.*, 1987):

a. Primitive (basic) categories are N, NP and S.

b. Any primitive category is a category.

c. If X is a category and E is a sign, then X/E (application category on a sign) is a category.

Sign is simply a feature structure, which contains orthographic, syntactic and semantic information (see Fig. 1a). The category attribute (representing syntax) of a sign is either basic or complex (see Fig. 2a). Basic categories are structures consisting of a category type, and a series attribute value pairs encoding morphosyntactic information (see Fig. 2c). Complex categories are recursively defined by letting the type 'cat' instantiate a feature structure with attributes *RES* (result), *DIR* (direction) and *ACT* (active). The attribute *RES* can take as value either a basic or a complex category, the attribute *ACT* has type 'sign' and the *DIR* attribute encodes order of combination relative to the active part of the sign (e.g. *POST* or *PRE*).

3. CZECH SENTENCE ANALYSIS

The verb has the central role in a sentence in Czech language like in many other languages. Each verb defines the specified number of dependent participants (syntactic positions), each sentence can be represented by a UCG sign (verb and arguments). Some positions are obligatory and some of them are facultative (we have elaborated UCG with optionality). The syntactic categories are constructed using several categories N (noun), V (verb), Adj (adjective), Adv (adverb), Det (determiner), Aux (aux-iliary verb), prep (preposition), Pro (pronoun), conj (conjunction). Grammatical sentence pattern (GSP) stands for describing the structure of the sentence syntax. General form of GSP is defined as shown in (1) according to linguistic analysis of Czech sentences structures. The letter S stands for 'subject', the indices represent the case. The index 'cas' means any case and 'Sent' is a related sentence.

(Snom) - V - Sacc/Sdat/Sins/prep Scas/jako Snom/Sent/Adj/Adv/Inf (1)

We have classified four classes of sentences:

a. 1-valence verb sentence
b. 2-valence verb sentence
c. 3-valence verb sentence
d. 4-valence verb sentence

4. REALIZATION

There were recorded about 500 dialogues with an overall length of more than 13 hours in information centres in different places of the Czech Republic. All these dialogues were transcribed and analysed to determine the course of dialogues and to assess which dialogues and turns are typical (Schwarz and Matoušek, 2001). The responses are divided into 2 classes: information and clarifying questions.

$$\begin{bmatrix} id : answ1 \\ mod : inform \\ type : goansw \\ thedesc : \begin{bmatrix} id : go1 \\ type : go \\ thetheme : \begin{bmatrix} id : obj1 \\ type : object \\ value : bus \end{bmatrix} \\ thetime : \begin{bmatrix} id : time1 \\ type : time \\ value : 7 \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Fig. 3. UFO representation of sentence “Autobus jede v 7”

$$\begin{bmatrix} lexeme : jet \\ syntax : \begin{bmatrix} head : v[person : 3] \\ args : \begin{bmatrix} \begin{bmatrix} syntax : [np[nom]] \\ semtype : object \\ direction : pre \\ optional : no \\ adjacency : any \end{bmatrix} \\ \begin{bmatrix} syntax : \begin{bmatrix} prep(to) \\ case : gen \end{bmatrix} \\ semtype : location \\ direction : post \\ optional : yes \\ adjacency : any \end{bmatrix} \\ \begin{bmatrix} syntax : [prep(in)] \\ semtype : time \\ direction : post \\ optional : yes \\ adjacency : any \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ semantics : [type : go] \end{bmatrix}$$

Fig. 4. Sign for verb “jet” (to go)

We have defined an initial set of UFO structures representing responses in city information centres (see an example of UFO on Fig. 3 – the sentence means "the bus goes at 7"). An intuitive graphical tool for creation of UFOs is preparing (it enables to generate final C structures definitions) which facilitate the work. The initial set of UCG signs has been defined. Each verb-lexem is represented by a sign containing category (syntax attribute), which instantiates arguments of verb predicate. In Fig.4, there is a sign for verb "jet" (to go). We have modified and elaborated UCG, for instance optionality and adjacency of an argument have been added. The designed generation algorithm is based on finding a sign having semantics unified with that of the input, then recursively generating its arguments. For the final generation, there is a morphological lexicon containing knowledge for building a final word form (with declination suffixes dependent on person, number, gender, etc). Such lexicon has been programmed in ORACLE environment. Thus, there is a record for each word containing morphological root and links to tables with declination rules, morphological suffixes and declination exceptions.

CONCLUSION

Several dialogue systems have been developed so far which deal with providing information about train timetables, flight reservations, etc. The response generation is usually based on weak technique using concatenation of speech units. More sophisticated way is to generate orthographic form of response from conceptual representation. We realize a response generation module based on UCG within a developed spoken dialogue system. We summarize that a basic set of UFO for system utterances, basic set of UCG signs and the UCG generation algorithm have been defined. The lexicon keeping morphological information has been programmed and manually filled by initial set of words and their forms. The future work will be concentrated to:

- filling of lexicon using an tagged Czech corpus by an automatic tool
- extension of UFOs set and UCG signs set
- implementation of the generation algorithm
- testing within a dialogue system

ACKNOWLEDGEMENT

This research is in part supported by Grant of Czech Republic Ministry of Education,
MSM 235200005 Information Systems and Technologies.

REFERENCES

Calder, J., Klein, E., Zeevat, H. (1998): Unification categorial grammar: a concise extendable grammar for natural language processing. In *Proceeding of 12th Conference COLING*, pp. 83-86, Budapest, Hungary.

Peckham, J. (1993): A new Generation of Spoken Dialogue Systems: Results and Lessons from the SUNDIAL Project. In*: Proceedings of the 3rd European Conference on Speech Communication and Technology*, pp 33—40, Berlin, Germany.

Schwarz J., Matoušek V. (2001): Creation of a Corpus of Training Sentences Based on Automated Dialogue Analysis. In *Proceedings of TSD 2001, Železná Ruda-Špičák, Czech Republic*, pp. 418-426, Springer-Verlag, Heidelberg.

Youd, N. J., McGlashan, S. (1991): Semantic Interpretation in Dialogue. *SCS Research Report*, Department of Sociology, Surrey University, England

Zeevat, H., E. Klein and J. Calder (1987): An Introduction to Unification Categorial Grammar. In *N. J. Haddock, E. Klein and G.Morrill (eds.): Working Papers in Cognitive Science, **Vol. 1**: Categorial Grammar, Unification Grammar, and Parsing*, Edinburgh, Scotland