

# Gaps and Bridges

## New Directions in Planning and Natural Language Generation

*Kristiina Jokinen, Mark Maybury, Michael Zock,  
and Ingrid Zukerman*

■ The workshop entitled “Gaps and Bridges: New Directions in Planning and Natural Language Generation” was held on 12 August 1996 in Budapest, Hungary. This article describes the four sessions of the workshop and summarizes the important themes that were revealed.

The workshop entitled “Gaps and Bridges: New Directions in Planning and Natural Language Generation” was held on 12 August 1996, immediately before the European Conference on Artificial Intelligence (ECAI-96) in Budapest, Hungary. It was planned and coordinated by Kristiina Jokinen (Nara Institute of Science and Technology [NAIST]), Mark Maybury (The MITRE Corporation), Michael Zock (LIMSI-CNRS), and Ingrid Zukerman (Monash University). Thirty scholars from Europe, the United States, Australia, and Japan participated in the workshop.

The purpose of the workshop was to clarify the role of rational and cooperative planning in generation in general and to bridge the gaps that seem to exist between theoretical models of planning agents and practical aspects of natural language generation (NLG) architecture.

In recent years, there has been a focus shift in NLG from the study of well-formedness conditions (grammars) to the exploration of the communicative adequacy of linguistic forms: Speaking is viewed as an indirect means for achieving commu-

nicative goals rather than a formal exercise to produce grammatically correct output. However, recent research on autonomous, cooperative agents has emphasized communication and conversational aspects of the agents, bringing such aspects as rational agency (Cohen and Levesque 1990), conflict resolution (Galliers 1989), and resource-bounded agency (Bratman, Israel, and Pollack 1988) into the focus of planning. Despite a growing awareness of the importance of these factors, few attempts have been made to integrate surface generation into this larger framework or develop a computational model that integrates the individual components that participate in the generation process into a unified whole. One of the goals of the workshop was to improve this situation by identifying and explaining the reasons for the gaps and provide a setting in which these shortcomings could be overcome by establishing links between NLG systems and intelligent planning systems.

The workshop was divided into four sessions, reflecting the topics addressed in the workshop as well as the suggested bridges. The presentations did not represent a shared, or unified, view about a particular research direction; rather, they were geared toward a constructive development through thought-provoking, new ideas. Each session was followed by an open discussion by a multidisciplinary group of expert researchers, which, on the basis of the session's

presentations, attempted to provide further material for building bridges. The workshop finished with a panel on the gaps and bridges theme, summarizing the topics of the workshop, sketching future views, and pointing to new research directions.

### Interaction Gap: Intentions and Communicative Actions

The lack of interaction between an NLG component and an intelligent planner is an obvious first gap. To make an NLG system communicatively adequate, that is, functional, various aspects must be taken into account: cooperation, communicative strategies (goal-pursuit techniques), user's knowledge (appropriateness of content and form), and so on. Although these aspects have been studied extensively, the results have hardly ever been integrated, leading to complete NLG systems. However, to build more general, flexible, and intelligent systems—that is, systems that are capable of performing increasingly sophisticated tasks—communicative behavior needs to be backed up with appropriate linguistic resources and strategically adequate reasoning capabilities as well as a suitable mechanism that allows for interactions between these two components.

The first session was devoted to the interactions between situational, motivational (speakers' and addressees' goals), cognitive, and linguistic constraints. Generation was viewed as a rationally, cooperatively planned, goal-oriented activity, and the discussion dealt primarily with the different aspects of response adequacy.

Jerry R. Hobbs (SRI International) presented joint work with Richmond H. Thomason (University of Pittsburgh) and Johanna D. Moore (University of Pittsburgh) on communicative goals and the inferences that need to be drawn to reconstruct the intended meaning of an utterance. The communicative goals depend to a large extent on higher-level, strategic goals that are related to the conversational context. Inferencing is done by abduction, which, incident-

Insert IUI '98 Ad

ly, can be used both in interpretation and in generation.

Alexandra Klein and Soenke Ziesche's (both of University of Hamburg) views on planning provoked a heated discussion. According to them, the adequacy of an utterance is decided in a three-step evaluation: (1) the basic communicative goal, (2) its contextual relevance, and (3) grammatical soundness. Time limits can cause later stages to be ignored, yielding grammatically, or contextually ill formed, hence odd-sounding, utterances. This is explained by the *adequacy drop principle*, which says that the adequacy steps can be left out in reverse sequential order depending on external constraints in a resource-bounded planning process.

Alison Cawsey (Heriot Watt University) addressed the problem of how the nature of communicative goals and changes in the user's cognitive attitudes affect the planning and realization processes. The joint work by her and Floriana Grasso (Heriot Watt University) concerns the genera-

tion of personalized health-education material. Their analysis of the task and the capabilities of current discourse-planning techniques led them to conclude that these techniques have not yet reached a level that supports the automatic generation of all texts that are appropriate for the delicate communicative goals at hand. They further proposed an approach where text generated by schemas and even canned text can be interleaved with automatically generated text.

The discussant of the session, Galja Angelova (Bulgarian Academy of Sciences), discussed some general problems of planning, relating the topics of the presentations to her joint work with Kalina Boncheva (Bulgarian Academy of Sciences) concerning the generation of hypertext documents.

### Argumentation Gap

Besides NLG-specific gaps, the use of computers in collaborative settings has revealed another gap: the use of effective, argumentative strategies

and their computational modeling. For example, knowledge-based systems must present convincing arguments to justify their recommendations, intelligent tutoring systems need to explain why a particular proposition is or isn't true, and negotiation systems need to justify why a particular course of action is better than some alternative. Although there is agreement that elaborated reasoning is necessary to select effective argumentative strategies, there is hardly any consensus about the nature of such structures. Previously, argumentative structures have been cast as text schemata (Toulmin 1958), but the extension of these simple structures to more complex arguments is a nontrivial task. Moreover, the identification of different parameters that affect argumentation, and the determination of appropriate ways of presenting an argument, must be considered during the planning process.

Thus, the next session was devoted to computational models of argumentation. Ingrid Zukerman (Monash University) presented the architecture of the NAG (nice argument generator), a system capable of generating and analyzing arguments. NAG, which was designed together with Kevin Korb and Richard McConachy (both of Monash University), produces arguments to convince the user of the correctness of a goal proposition. The model relies on a variety of knowledge sources, exhibiting abductive behavior during analysis as well as during generation by consulting a user model.

Nikos I. Karacapilidis (German National Research Center for Information Technology) presented an argumentation-based framework that supports defeasible and qualitative reasoning. In this framework, each agent has a position with respect to the issues that are relevant to a particular proposition. The system then attempts to build an argumentation that defends its position.

In his spirited presentation, Daniel Marcu (University of Toronto) provided a compilation of features that affect the persuasiveness of an argument and should be taken into account

when developing an argumentation system. Chris Reed (University College at London) described joint work with Derek Long and Maria Fox (both of University of Durham) concerning the planning of persuasive arguments. They proposed a four-level architecture for argumentation, where different types of operator are used for linking premises to conclusions. They also suggested the use of stylistic heuristics to increase the persuasive force of an argument.

The discussants in this session addressed issues pertaining to computational models of argumentation, such as the determination of appropriate ways of presenting an argument and the identification of parameters affecting argumentation. The discussions concerned different viewpoints and showed the interdisciplinary spirit of the workshop.

### Generation Gap: Planning and Generation

The famous gap between strategic and tactical planning (Meteer 1991) becomes even more obvious and wider when communicatively appropriate planning is emphasized. The linguistic realization of the speaker's goals is usually organized in such a way that macroplanning precedes the microplanning of a specific syntactic structure and choice of words. However, to integrate the complex communicative needs of a planning agent to language-specific constraints, more sophisticated system architectures are called for. Opportunistic planners, allowing for distributed processing, hence, going beyond the traditional two-stage generation model, seem to be valuable candidates.

The first afternoon session explored the effects of the various constraints on the generation process as a whole. Eduard Hovy (USC/Information Sciences Institute) focused on sentence planning requirements and outlined an innovative architecture for generation, considering sentence generation as a distinct phase of the generation process. He proposed a blackboard-based sentence planner that deals with different subtasks by activating independent modules that

Insert Information Resources Ad

incrementally rewrite and flesh out a text structure into a fully specified list of sentence specifications. This work has been carried out together with Leo Wanner (University of Waterloo).

Stephen Beale (New Mexico State University) discussed an architecture for context-dependent, multilingual planning based on the semantic interactions of words in a sentence. The starting point of the work, done together with Evelyne Viegas (New Mexico State University), is the problem of semantic mismatches between languages. The architecture is based on the hunter-gatherer control strategy, which combines localized problem solving with solution synthesis methods, using branch-and-bound and constraint-satisfaction techniques to prune nonoptimal solutions. This constraint-based system also supports the interaction between intelligent planning and linguistic realization components.

Laurence Balicco reported on joint work with Georges Antoniadis (both of Université Stendahl) concerning a

central problem in tactical planning: microplanning. Their work focuses on linguistic operations (grouping and referential operations), which provide the basis for linguistically correct and unambiguous text generation.

### Interest Gap: Explanation and Dialogue

There seems to be a long-standing difference in the scientific approaches taken by theorists and engineers. Theorists tend to emphasize the innovative aspects of research, but engineers strive for applications that prove the usefulness of a theory for practically oriented work. Of course, to succeed, both approaches are needed, and interaction between them is important. A theoretical model that cannot be applied or tested in practice is hardly of any use, and thus, discussion of practical applications as test beds for a particular theory should be encouraged. However, practical aspects

should not be overestimated because the implementation does not guarantee that the particular theory is valid or that the application is useful in its own right. Thus, a common ground allowing a constructive interaction between these two groups is needed. Furthermore, a common language is necessary because many communication problems stem from the lack of well-defined, joint terminology.

The final workshop session concentrated on discourse generation and the use of techniques developed in AI and computational linguistics. Birgitta Lastow (Lund University) described an implemented system, designed together with Bengt Sigurd and Tomas Vävargård, which generates weather forecasts in Swedish and English. Of particular interest was the application of generation techniques that cover a wide range of generation issues.

Yllias Chali (Université Aié) explored the process of incrementally producing longer, more elaborated versions of a core text. The joint work with Elsa Pascual (IRIT-Université Paul Sabatier) and Jacques Virbel (IRIT-CNRS) is based on a Harrisian type of sentence representation and a question-answer structure that reflects the semantic links between sentences.

### Panel: Future Directions

The workshop finished with a panel that examined a number of areas for future work in gaps and bridges. The panel was led by Jokinen, and the discussion took place between Helmut Horacek (University of Constance), Ivan Rankin (Linköping University), Arne Jönsson (Linköping University), Zock, and Maybury.

Jokinen introduced the panel topics by discussing problems concerning the definition of conversational adequacy, pointing out that in dialogue situations, planning an appropriate response is a reactive, rather than a deliberative, process; it actually starts from the interpretation of the partner's contribution. As one of the new directions for future research, she mentioned system evaluation, which has received considerable interest recently. Although not a

workshop topic, system evaluations are important when it comes to applying a theory for building practical systems.

Horacek examined the use of planning techniques in NLG. He focused especially on the problems and reasons for the problems that the planning paradigms create for NLG. He emphasized the specific characteristics of natural language, concluding with several prospects of NLG within the different types of planning. Rankin concentrated on argumentation issues; he analyzed different aspects of argumentative assertions, especially evaluation, commenting on a proposed problem solution. Jönsson discussed user-friendly cooperative response generation in natural language interfaces. He suggested building more effective dialogue models that need not exhibit the same degree of variation as human interaction but that provide the user with meaningful responses that enhance the habitability and transparency of a system. Zock raised the question of whether the planning paradigm could or should be used as a uniform mechanism throughout the generation process, that is, from deep generation, where it is a fairly obvious candidate, to surface generation. Indeed, it has still to be shown that the planning paradigm could or should be extended to such tasks as word choice and computation of syntactic structure.

Maybury summarized the workshop themes. He pointed out that two big gaps originate from the interaction between the user and the interface system on the one hand and the interaction between the interface system and the application on the other hand. He also emphasized the crucial role of bridges in society: They connect things in a manner that ensures both safe and efficient passage. In a similar vein, the workshop aimed at connecting different entities along various dimensions: connecting data, processes, and systems to one another, including the use of common standards and software infrastructure and services to do so, and, perhaps more importantly, connecting people and ideas to one another.

### Summary

The range and depth of the papers presented at the workshop revealed various problems in trying to connect intelligent planners to NLG systems. It was clear from the lively workshop discussions that there were many unresolved issues. This view was shared by all participants. At the same time, the workshop also revealed that active research on these issues is being done, leading to firmer conclusions and better results.

One of the objectives of the workshop was to bridge different gaps by connecting researchers, theories, and systems. The workshop also showed that this kind of interdisciplinary exchange is important for speeding the process of gaining insight while minimizing the danger of reinventing the wheel. We hope that this workshop has been a step in the right direction and will help foster the scientific interchange necessary to solve many of the remaining fundamental problems.

### References

- Bratman, M.; Israel, D.; and Pollack, M. E. 1988. Plans and Resource-Bounded Practical Reasoning. *Computational Intelligence* 4:349-355.
- Cohen, P. R., and Levesque, H. J. 1990. Rational Interaction as the Basis for Communication. In *Intentions in Communication*, eds. P. R. Cohen, J. Morgan, and M. E. Pollack, 221-255. Cambridge, Mass.: MIT Press.
- Galliers, J. R. 1989. A Theoretical Framework for Computer Models of Cooperative Dialogue, Acknowledging Multi-Agent Conflict, Technical Report, 172, Computer Laboratory, University of Cambridge.
- Meteer, M. 1991. Bridging the Generation Gap between Text Planning and Linguistic Realization. *Computational Intelligence* 7:296-304.
- Toulmin, S. E. 1958. *The Uses of Argument*. Cambridge, U.K.: Cambridge University Press.