Brigitte Endres-Niggemeyer, Jerry Hobbs,
Karen Sparck Jones (editors):

**Summarizing Text for Intelligent
Communication**

Dagstuhl-Seminar-Report; 79 [Short version]
13.12.-17.12.93 (9350)

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B. Endres–Niggemeyer, J. Hobbs, K. Sparck Jones (editors):

Summarizing Text for Intelligent Communication

Dagstuhl Seminar 13.12.–17.12.1993, Dagstuhl, Germany

Dagstuhl–Seminar–Report; 79

Most of the participants

Due to cost reasons, this seminar report exists in three versions:

- Printed Short Version (Dagstuhl–Seminar–Report; 79)
- Printed Full Version for participants
- Full Electronic Material

Table of Contents

of the short (printed) version of the Dagstuhl seminar report about

Summarizing Text for Intelligent Communication

Availability of the Seminar's Material

Availability of the Seminar's Material

Note:

Due to cost reasons, this report has been divided up into a short version (with a higher number of copies), a quite lenghty volume for the participants, and an electronic version containing all material.

Printed versions can be ordered from the

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The materials of Dagstuhl seminar 9350 are available

- in **printed** form (from Dagstuhl office):

    Short Report
    > (Rationale, Program, Question List, Outcome, Participants)

- on the **Internet**
    (Full Version) via WWW and FTP from the following sites:

    Dagstuhl office (main site)
    > http://???.dag.uni–sb.de/???/Abstract/
    > ftp://???/pub/???/Abstract.tar.gz
    > (URL to be announced, mail to office@dag.uni–sb.de for current details and other mirror sites)

    Polytechnic of Hannover, Information and Communication Department (home site)
    > http://www.bid.fh–hannover.de/SimSum/Abstract/
    > ftp://www.bid.fh–hannover.de/pub/Abstract/Abstract.tar.gz

    University of the Saarland, Philosophical Faculty, Information Science (mirror)
    > http://www.phil.uni–sb.de/FR/Infowiss/Abstract/
    > ftp://ftp.phil.uni–sb.de/pub/Abstract.tar.gz

The organizers gratefully acknowledge

The Seminar Rationale

Summarising is a vital information processing task. We have proposed a Dagstuhl seminar on automatic summarising, now, for the following reasons:

- there has been a rapid growth of interest and activity in discourse and text processing in general and summarising in particular

- there has been useful progress in computational text interpretation and generation, for example through the Message Understanding Conferences

- there is a chance to integrate recent and pertinent results from related disciplines, from cognitive science to document retrieval, and to rethink system design in the light of their findings

- there is a manifest need to broaden the approaches used in existing summarising systems, and to adopt new ones, to obtain systems able to handle texts that vary in length, topic type, and form

- there is a clear requirement, for intelligent communication in man–machine interaction, for summaries tailored to specific user needs.

More powerful summarising systems than those developed so far are clearly needed. Today's information systems are not able to summarise in an intelligent way, deriving significant information from their text sources in order to provide the user with material of an appropriate scale, depth and orientation, in a coherent text form. The few systems built so far have been limited in both approach and implementation. They have been based either on shallow, statistically–oriented approaches to identifying salient source content, or on deeper analysis but only within a prespecified topic framework. They have thus been either only weak and uncertain in their ability to capture key information, or effective only within a very narrow application context and not readily extensible.

But summarising is not just a primary task for text handling systems. It is also called for as a subtask in many other information management contexts, for instance in interactive consultation or instruction, so building a flexible summarising capability into systems for these purposes will enhance their performance. At the same time, since summarising depends on discourse interpretation, transformation and generation, it is a crucial test of discourse theory. Developing adequate theories of discourse structure and processing for summarising will thus benefit all areas of language processing.

The Dagstuhl seminar we report on is built on the premise that summarising is a complex,

knowledge–based task to which many different language, text, and world knowledge resources jointly apply. This view of summarising as a composite task implies an interdisciplinary seminar, bringing together both those who are directly engaged with summarising and those contributing to parts or aspects of the whole.

We therefore invited researchers working on automatic summarising, practitioners with experience of abstracting and information retrieval, researchers engaged with text retrieval, computational linguists working on methods of text analysis and production, members of the NLP community attacking specific tasks like message processing and data extractions, or concerned with user interfaces, linguists studying pragmatics and discourse, and psychologists and cognitive scientists especially concerned with text and discourse processing. All of these have an important contribution to make, both to the development of an intermediate summarising technology operating on text, and to longer term research on summarising for which full text understanding is required.

Organisation of the Seminar

Given that we see summarising as a composite task, we organised our specialised international and interdisciplinary workshop in sessions devoted to these five major themes:

1. Human Summarising (HS) – practice and models:

- o Empirical research on abstracting
- o Summarising strategies
- o Textual knowledge processing

2. Automatic Summarising (AS) – implementation and systems:

- o Automatic summarising systems
- o Text and message processing
- o Text typology

3. Related Disciplines (RD) – discourse analysis and use:

- o Discourse theories
- o Text typology
- o Text processing and knowledge use
- o Location of information etc.

4. User Adaptation (UA) – needs and strategies

5. Computational Resources (CR) – tools and processes:

- o Text and message processing
- o Text representation

Final Seminar Program
(13.12.93)

Summarizing Text for Intelligent Communication

Building a research platform for theoretical and practical progress in summarizing, as a key task in natural language processing, artificial intelligence, and related disciplines

Date: Dec. 13-17, 1993

Organizers:
Karen Sparck Jones, Univ. of Cambridge (chairperson)
Brigitte Endres-Niggemeyer, Polytechnic of Hannover (organizer)
Jerry Hobbs, SRI International, Menlo Park
Elizabeth Liddy, Syracuse University
Cecile Paris, ISI Marina del Rey

Overview

- INTRODUCTORY SESSION
- HUMAN SUMMARIZING – practice and models: I, II, III
- AUTOMATIC SUMMARIZING – implementation and systems: I, II, III
- RELATED DISCIPLINES – discourse analysis and use: I, II, III, IV
- COMPUTATIONAL RESOURCES: I, II
- USER ADAPTION – needs and strategies
- EVALUATION METHODS for Summarization
- A RESEARCH PLATFORM FOR INTELLIGENT SUMMARIZING: I, II

Monday 13–12–1993

9.00 - 10.30
INTRODUCTORY SESSION
Chairperson: Wolfgang Wahlster
Rapporteurs: Brigitte Endres-Niggemeyer / Paul Jones

Karen Sparck Jones: Introduction *(using a paper by Hutchins)*
Karen Sparck Jones: Summarising: analytic framework,
   key component, experimental method

11.00 – 12.30
HUMAN SUMMARIZING – practice and models I
Chairperson: Gerhard Strube
Rapporteur: Sumiko Mushakoji
Hans Strohner: Inferences in Text Processing: Summaries and Instruction
Rosemarie Gläser: Summarizing Texts as Genres of Academic Writing

14.00 – 15.30
HUMAN SUMMARIZING – practice and models II
Chairperson: Hans Strohner
Rapporteur: Ines Busch-Lauer
Helmut Felix Friedrich: Training of Reductive Text Learning Strategies
Edward Cremmins: Valuable and Meaningful Text Summarization in Thoughts
   Words, and Deeds

16.00 – 17.30
HUMAN SUMMARIZING – practice and models III
Chairperson: Elizabeth Liddy
Rapporteur: Helmut Felix Friedrich
Harold Borko and Brigitte Endres-Niggemeyer: An Empirical Process
   Model of Abstracting

19.00   Guitar Concert and Informal Welcome Party

Tuesday 14–12–1993

9.00 – 10.30
AUTOMATIC SUMMARIZING – implementation and systems I
Chairperson: William Black
Rapporteur: Harold Borko
Udo Hahn: Concept-Oriented Summarizing in the Text Condensation
   System TOPIC: 12 Claims and 6 Desiderata for Design
Ellen Riloff: A Corpus-Based Approach to Domain-Specific Text
   Summarization: A Proposal

11.00 - 12.30
AUTOMATIC SUMMARIZING – implementation and systems II

Chairperson: Udo Hahn
Rapporteur: Ralph Weischedel
Lisa F. Rau: Domain-Independent Summarization of News
Woojin Paik: Chronological Information Extraction System (CIES)

14.00 - 15.30
AUTOMATIC SUMMARIZING – implementation and systems III

Chairperson: Patrizia Violi
Rapporteur: Annely Rothkegel
Elizabeth D. Liddy: Development and Implementation of a Discourse
  Model for Newspaper Texts
Mark T. Maybury: Automated Event Summarization Techniques

16.00 - 17.30
RELATED DISCIPLINES – discourse analysis and use I

Chairperson: Raya Fidel
Rapporteur: Ines Busch-Lauer
Jerry Hobbs: Summaries from Structure

Wednesday 15–12–1993

9.00 - 10.30
RELATED DISCIPLINES – discourse analysis and use II

Chairperson: Nicholas Belkin
Rapporteur: Wojin Paik
Annely Rothkegel: Abstracting in the Perspective of Producing a Text
Livia Polanyi: Linguistic Dimensions of Text Summarization

11.00 - 12.30
RELATED DISCIPLINES – discourse analysis and use III

Chairperson: Livia Polanyi
Rapporteur: Ellen Riloff
Bruce Britton: Summarizing Situation Models. Using Principal
  Components to Reconstitute the Expert's Causal Model in the Reader's
  Mind

14.00 - 15.30   EXCURSION to DFKI, Saarbrücken: System Demonstrations

16.00 - 17.30

18.00   Conference Dinner

Thursday 16–12–1993

9.00 - 10.30
RELATED DISCIPLINES – discourse analysis and use IV
Chairperson: Donia Scott
Rapporteur: Lucia Rino
Sumiko Mushakoji: Constructing 'Identity' and 'Differences' in
   Different Scientific Texts and their Summaries: Its Problems
   and Solutions
Ines Busch-Lauer: Abstracts in German Medical Journals – a Linguistic
   Analysis

11.00 - 12.30
COMPUTATIONAL RESOURCES I
Chairperson: Cecile Paris
Rapporteur: Mark Maybury
Kathleen R. McKeown: Generating
   the Complex Sentences of Summaries Using Syntactic and Lexical
   Constraints: Two Applications
William Black: Parsing, Linguistic Resources and Semantic Analysis
   for Abstracting and Categorisation
[John A. Bateman: Using text structure and text planning to guide
   text summarization] *(paper was not presented)*

14.00 - 15.30
USER ADAPTATION – needs and strategies
Chairperson: Wolfgang Wahlster
Rapporteur: Edward Cremmins
Raya Fidel: User-Centered Text Analysis
Nick Belkin: On the Relationship between Discourse Structure and
   User Intention

16.00 - 17.30
COMPUTATIONAL RESOURCES II
Chairperson: Kathleen McKeown
Rapporteur: Elisabeth Maier
Ralph Weischedel: From Text to Objects to Summaries

20.00 - 21.30
EVALUATION METHODS for Summarization
(Group Discussion)

Friday 17–12–1993

9.00 - 10.30:
A RESEARCH PLATFORM FOR INTELLIGENT SUMMARIZING I
Chairperson: Jerry Hobbs

Rapporteur: Brigitte Endres-Niggemeyer
The Cognitive View of Discourse and Text:
   A Pragmatic Strategy for Summarizing Systems

11.00 - 12.30:
A RESEARCH PLATFORM FOR INTELLIGENT SUMMARIZING II
Chairperson: Karen Sparck Jones

Rapporteur: Brigitte Endres-Niggemeyer
The Research Agenda for Intelligent Summarizing

End of the seminar

Open Problems in Text Summarizing:

Question List

We asked all participants to consider the following questions to identify important issues.

The answers can be found in the printed long version and in the electronic version, see note to the availability of the seminar's material.

A. GENERAL, for the workshop as a whole:

- **A1.** Can, and should, text summarising be decoupled from text interpretation?
- **A2.** Does summarising depend on recognising global text structure of a particular kind?
- **A3.** Can effective summaries be obtained with purely linguistic processing?
- **A4.** How general-purpose can summarising strategies be?

B. THEME-SPECIFIC:

HS – Human Summarising:

- **HS1.** How far does human summarising depend on task-specific training?
- **HS2.** What specific aspects of human summarising are best candidates for automation?

AS – Automatic Summarising:

- **AS1.** Are current techniques necessarily application-specific (for text type, subject domain user need)?
- **AS2.** How well do current techniques capture large-scale text structure?

RD – Related Disciplines:

- **RD1.** How do human discourse processing strategies bear on summarising?
- **RD2.** What discourse properties are most important for summarising?

UA – User Adaptation:

- **UA1.** How important is it to tailor summaries to the individual user?
- **UA2.** What user features, and tailoring techniques, can we most usefully exploit?

CR – Computational Resources:

- **CR1.** How can current sentence processing methods help identify significant text content?
- **CR2.** Can present template-based processing be developed to find as well as fill templates

A Research Platform for Intelligent Summarizing I

Friday 17–12–1993
9.00 – 10.30

Chairperson: Jerry Hobbs
Rapporteur: Brigitte Endres–Niggemeyer

The discussion was organized along the following list of seven questions. However, not all questions really stimulated reactions. The questions that were not commented upon are skipped in the report.

1. What is a summary? What is its source and its relation to its source?
2. Ideally, what is required for constructing a good summary? Text structure, genre, world knowledge, author's intentions, other text parameters?
3. What are the uses/types of summaries? Is there a "use–neutral" notion of summary? What can we do with current shallow techniques? Physical structure, statistical identification of key sentences/concepts, information extraction techniques, compacting information? What near–term applications are there for current techniques? Are abstracts passe, with interactive systems?
4. What can we do with current shallow techniques? Physical structure, statistical identification of key sentences/concepts, information extraction techniques, compacting information?
5. What near–term applications are there for current techniques?
6. Are abstracts passe, with interactive systems?
7. How to evaluate summaries,e.g., acceptability, readability, coherence, cohesion? Are there cultural differences?

1. What is a summary? What is its source and its relation to its source?

and

3. What are the uses/types of summaries? Is there a "use–neutral" notion of summary?

Summaries seem hard to define: Participants mentioned that

- they are shorter than the source text
- they contain less information
- they may convey explanations missing in the original and thus exceed the original document

in length
- they reduce information to the essential items
- they save reading time
- they are learning tools

One can define the concept "summary" by a set of features according to its uses, without insisting on a common semantic core. The question is if a "use–neutral" partial definition of an abstract is possible. Since the use of a summary or abstract influences its definition, the "use– neutral" definition would be augmented by features won from its uses.

The relation between a summary and its source gave rise to controversial opinions. One may characterize the relation as indicative, informative, or evaluative. While some speakers were in favour of keeping these classical distinctions, it was asked what is meant by "informative", the difference between informative and indicative was judged old–fashioned, and one speaker proposed to describe summaries and abstracts by a set of facets describing the type of information, and to explain what is "informative" or "indicative" by means of these facets.

2. Ideally, what is required for constructing a good summary? Text structure, genre, world knowledge, author's intentions, other text parameters?

To construct a good summary one needs

- techniques for determining what is in the source
- techniques for building the summary

Some subtasks of analysis are easier than others, e.g., it is less hard to find out about the text structure than about the author's intentions.

In summarizing, there is no natural sequence of source interpretation and generation. In particular, it seems often more practical to analyse the source text from a generation perspective, i.e. to find a concrete piece of information that is needed for summary generation.

Both sentence syntax and discourse structure contribute to automatic summarizing of language text. In addition, it is necessary to account for non–linguistic, e.g. multimodal summarizing.

User–oriented tailoring of summaries and abstracts can recycle ideas known from question answering: A summary is then constructed in order to answer a user's question.

Fig.1 gives the overall image of summarizing. Resources involved are listed in its first version, whereas the second one shows where current systems and approaches have put their main emphasis.
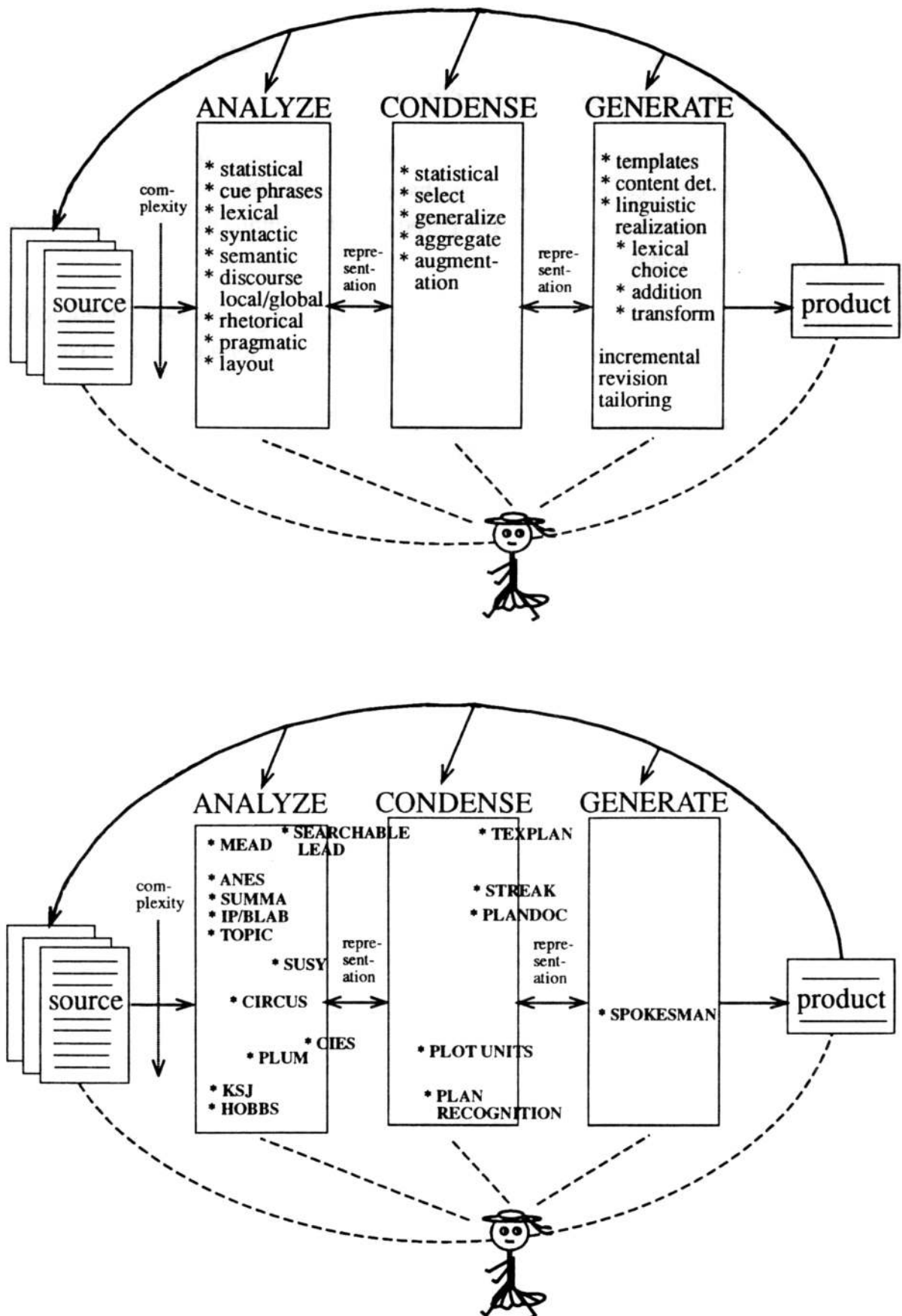
Fig.1: Research in summarizing:
Above: Resources involved,
below: Main emphasis of some current systems and approaches

7. How to evaluate summaries, e.g., acceptability, readability, coherence, cohesion? Are there cultural differences?

It is just as hard to evaluate summaries to decide what is a good text in general. Since one may want to judge how much a system's summaries have improved, the problem of evaluating success adds to the problems of text assessment. The purpose of the summary is important, a classification of inputs and purposes is helpful.

Evaluation techniques can be intrinsic, looking at summaries, e.g., comparing them with guidelines or source texts; and extrinsic, i.e. assessing the abstract's fitness for a particular task.

Both experimental and naturalistic (field work) approaches seem possible. It is important to achieve more than a mere assessment in terms of traditional recall and precision measurements.

A Research Platform for Intelligent Summarizing II

A research agenda for automated summarizing

Friday 17–12–1993
11.00 – 12.30

Chairperson: Karen Sparck Jones
Rapporteur: Brigitte Endres–Niggemeyer

Overview:

1. The starting point of the seminar
2. Preliminary use of the question list
3. A sketch of the current research situation
4. Setting up a research agenda
5. Practical hints

1. The starting point of the seminar

A descriptive framework for summarizing

The discussion of the seminar was guided by a descriptive framework for summarizing proposed by Karen Sparck Jones. It comprises three main classes of factors: input, purpose, and style (see fig.1). The question is how to combine input and purpose to constrain output.

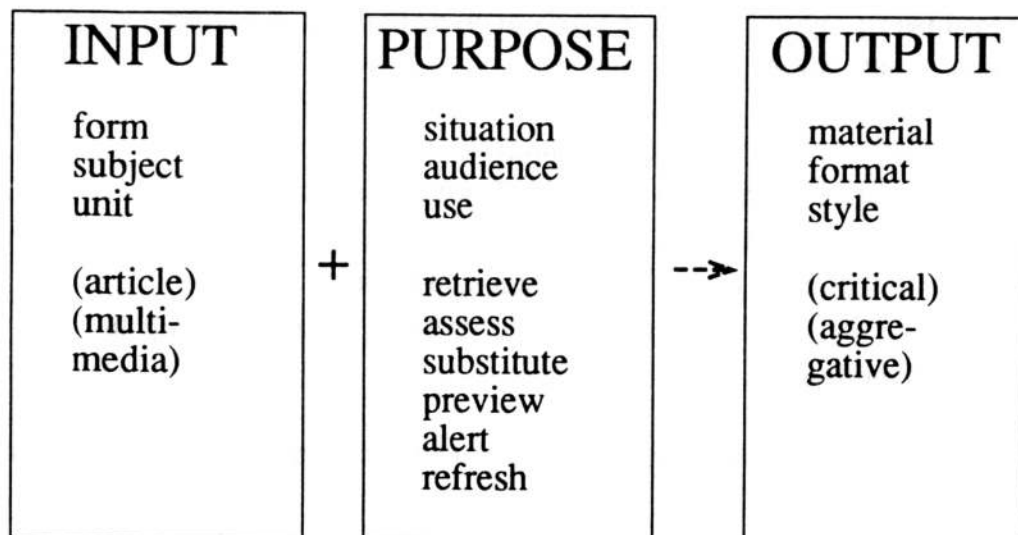| INPUT		PURPOSE		OUTPUT
form subject unit (article) (multi-media)	+	situation audience use retrieve assess substitute preview alert refresh	-->	material format style (critical) (aggre-gative)

Fig.1: Factors of summarizing

We get the process structure of fig.2. There, all representations except the source text are the (intermediate) products of the component processes of summarizing.
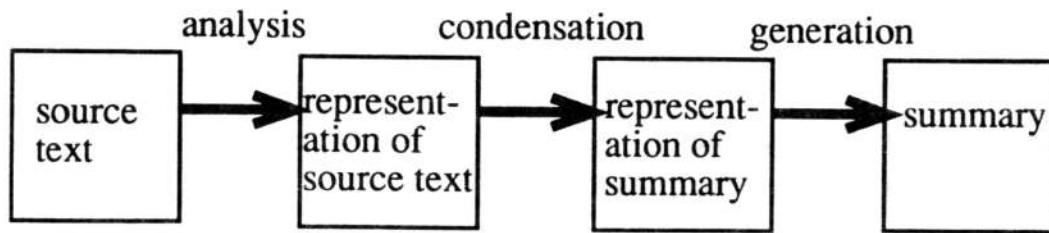
analysis   condensation   generation

```
┌──────────┐      ┌──────────┐      ┌──────────┐      ┌──────────┐
│ source   │ ───▶ │represent-│ ───▶ │represent-│ ───▶ │ summary  │
│ text     │      │ation of  │      │ation of  │      │          │
│          │      │source text│      │summary   │      │          │
└──────────┘      └──────────┘      └──────────┘      └──────────┘
```

Fig. 2: Process structure of summarizing

Issues and goals of research

We started the seminar with a list of issues that might guide our investigation of summarizing:

- the properties of the source representation (text, database) that enable to summarize
- the way action–oriented accounts of summarizing can be integrated with text–oriented ones
- the influences of contexts: types of input materials, specific purposes (genres of text, properties of users, and of what they use summaries for, and so on)
- the importance of deep vs. shallow strategies
- the evaluation of summarizing

Wolfgang Wahlster proposed strategic goals in order to achieve a more comprehensive scientific treatment of summarization:

- a formal definition of an optimal summary
- an assessment of the relative qualities of summaries vs. extracts
- roles for textual, multimodal, or interactive summaries
- the representations required for different summaries
- the nature of the resource limitation, and resource limited techniques
- evaluation methods

Research for automated summarizing may have to be conducted with respect to human summarizing performance.

2. Preliminary use of the question list

For several reasons, only a preliminary discussion of the question list was possible. An educated guess of the participants' opinions as expressed orally during the seminar turned out to be most interesting when uncovering hidden ambiguities and controversial views. The questions A1 and HS1 stimulated most discussion:

A1. Can and should text summarizing be decoupled from text interpretation?

This question may read as "Should one build a source representation before thinking about summarization?" Then the answer is that source representations can be used to decouple text interpretation and summarizing. The model of the text can be independent of the summary representation.

However, the text interpretation that sets up the source representation is part of the later summarization achievement. This means that even through a sequence of representations, the final summary will remain influenced by the interpretation of the source text. No real decoupling takes place.

HS1. How far does human summarizing depend on task–specific training?

Summarizing is a part of normal human language processing. Therefore, a basic competence in summarizing would not need task–specific training.

There are, however, important variations in human summarizing skills and summary quality. They are due to task–specific training. Consequently, human summarization relies heavily on task–specific training as soon as more than basic skills are considered.

3. A sketch of the current research situation

Only a part of the concepts that seem useful for automatic summarizing have been investigated rather thoroughly. Fig.3 places the better investigated concepts on top. Concepts that found scarce or no attention in research figure at the bottom.
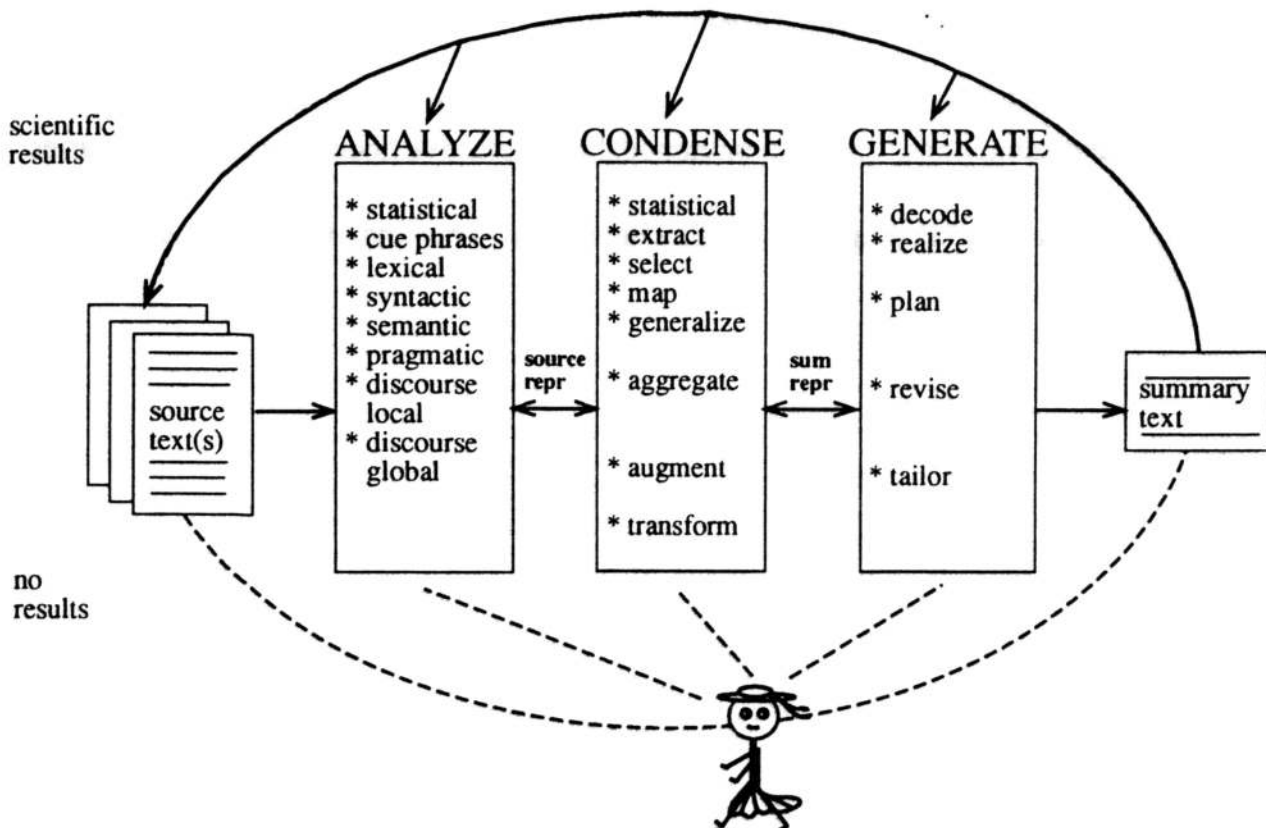

Fig.3: What research has been done in automated summarizing (bottom: scarce activity, top: substantial research, feedback loops shown)

4. Setting up a research agenda

According to what we have learned during the discussions of the week, a research agenda for summarizing should focus on uses and users of summaries (see fig.4).

Uses of summaries are manifold: retrieval, assessment of documents or the database, preview, substitute of the original document, refreshing, alerting, and so on.

By focusing on uses and users, we can decompose the broad factors in input, purpose, and output (see above) into features. For instance, if one wants a summary to refresh knowledge, or to preview a later complete reading of the original text, one can decide what kind of properties the summary needs in order to support the chosen function.

It is important to concentrate on the points that make summarization unique: condensation with subfunctions like generalisation and aggregation. This is the more true since they happen to be among the least explored areas of text processing.

From the lack of existing research in condensation follows the need to develop both principles and technologies. We have to ask what it means to develop new automatic methods, instead of providing ad–hoc methods without a valid functional interpretation. Meaningful methods can be attained more easily by approaching summarization through its uses.

In addition, we have to identify the influences on analysis and generation which are specific to summarization. The question is how current analysis or generation components must be changed when integrated into a summarization system.

Since summarization happens in a rapidly changing media environment, we have to deal with new forms of texts and summaries, e.g., with multimodal or interactive documents and summaries.

The research agenda should comprise the following actions. They may be investigated in parallel (after the first ones):

STUDY USES
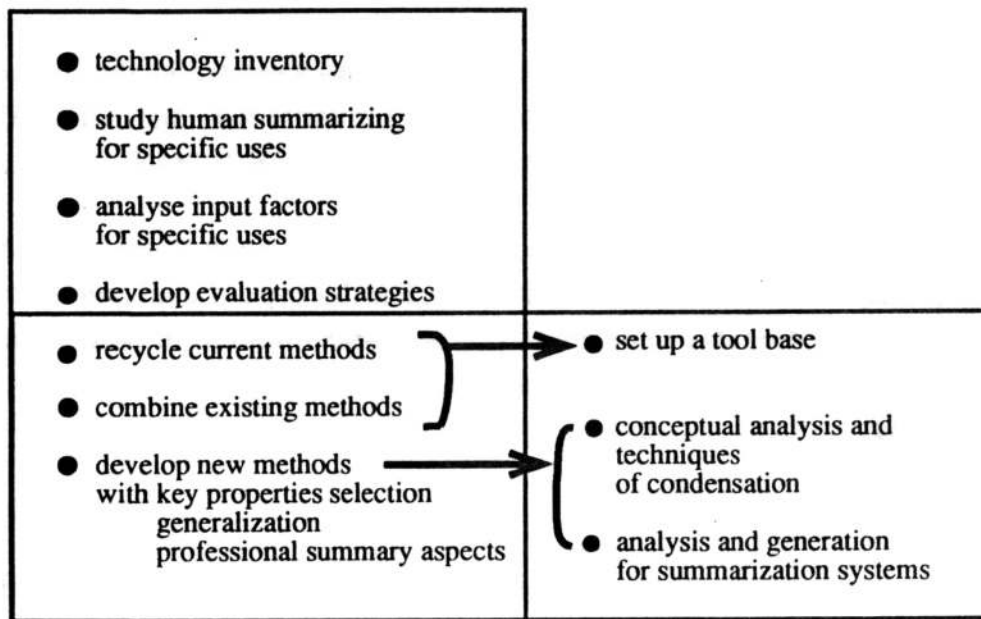
ALL APPROACHES IN PARALLEL

Fig.4: The research agenda

The technology inventory

A technology inventory or tool base for automatic summarizing should start with existing automated methods. This should be enhanced with concepts that are not yet implemented, but belong to the conceptual apparatus of competent human summarizers.

Studying human summarizing

When studying human summarizing, we have to focus on summarizing for different uses and users, on what human summarizers or abstractors are doing when summarizing for a particular use.

Analyzing input factors for particular uses

Input factors as subject, domain, jargon, what kind of audience the original document was addressing, or genres all influence the derivation of an abstract for a certain task. Up till now, research has rather wrapped up these factors as features of text, instead of tracing their individual consequences systematically. We have to ask which effects these features have on summarizing for a particular use.

Evaluation strategies for automatic summaries

Evaluation can follow two models:

- Intrinsic evaluation, i.e., asking, e.g., how well the summary represents the source text, about its cohesion, its adherence to guidelines, or its similarity to human summaries which are assumedly always better than automatic ones. This evalation type has its merits, without appearing completely satisfactory.
- Extrinsic evaluation based on summary use. A summary is as good as the level of performance a user using it can reach with its help. For this type of evaluation, experimental and naturalistic methodologies can be developed or adapted from information retrieval. But since summaries are much richer objects than queries, their use risks to be much richer, too, and their evaluation more demanding.

Recycling current methods

We need to find out more about known technologies, about what we can do with them. Even the rather crude extraction strategies may be adequate in some contexts (cf. the success of machine translation systems like Systran or Metal). If so, existing methods can be recycled for specific uses. Tool sets or databases are useful for both recycling and combination (see below) of known methods.

The combination of known methods

For specific uses, existing methods may be more appropriate when combined in a productive way. In order to allow for the combination of existing methods and systems, we have to develop interfaces and representation languages for defining, e.g., document structures.

Developing new methods

The development of new summarizing methods should concentrate on the condensation subtask because captures the kernel functionality of summarizing best, and because we lack know–how precisely about this core task of summarizing. Both concepts and techniques must be developed.

5. Practical hints

We set up a common bibliography of the scattered summarization research from the different disciplines. Please send your references to Brigitte Endres–Niggemeyer.

Ed Cremmins offers to procure summarizing literature from the Library of Congress and other libraries in and around Washington DC.

The organizers' conclusions

Dagstuhl works like a scientific greenhouse. There, a week's discussion on automatic summarization led us to a research agenda which invites – among other things – to combine existing summarization tools, to develop evaluation strategies, to study human performance, to conceive new implementable summarization concepts and techniques, and to consider summarization not as a uniform activity, but as a flexible process adapting to context factors as the intended use of the summary.

The soft greenhouse climate eases communication and new insights. If these insights are viable is decided outside, in the wide landscapes of cognitive science, information systems research, AI, and computational linguistics. Therefore the following sketch highlights macroscopic features of the scientific and technical background that we had in mind during our discussions and explains how the discussions of this report integrate with the overall research field. On the whole, we observe an increasing demand for automatic summarizing, for more diversified and sophisticated summarization products and styles, the growing affinity of automatic and human summarizing research, and a need for better scientific methods.

1. Larger systems increase the demand for summarization

In information systems of the future, full text data bases, distributed data bases, integrated multimedia and hypertext information systems will all contribute to present users with more material. Since users cannot expand their information absorption capability correspondingly, summarization will be more necessary than ever to keep information sizes manageable. In addition to their basic alerting and reference function, summaries must help systematically to make an intelligent use of information, for instance by previewing larger items (documents, or document collections) and by organizing informational contexts for users venturing into more or full informational detail. With increasing information sizes, summarization becomes not only more important, it gains additional functions as well.

2. Multimedia communication and emphasis on summarizing principles

In the same time, the arrival of interactive hypermedia and multimedia frees automatic summaries from the ASCII characters constraint that imposed the format of written language text. In current systems, both computerized documents and their summaries may be multimedia texts, including images or even a sound track.

Since media (image, text, graphics, sound, etc.) can be chosen in order to render the informational content most clearly and concretely, summaries, e.g., scientific abstracts, risk to change their

appearence dramatically. Times are gone when a summary may have appeared as a "Ding an sich". Today's researchers in automatic summarization can start out from text processing and choose additional media deliberately where their forefathers were bound to written text.

The technological shift to multimedia environments affects not only the outer appearance of summaries, but also the structure of automatic summarizing systems. As the presentational form of a summary becomes a matter of choice, the summarization process wins more independence from its source and its product. Please imagine a summarization system using ad–hoc surface cues of different media only, instead of summarizing content in a media independent object representation. Without such a representation, the system would neither be able to integrate information from different media, for instance, from an image and a textual statement, nor would it be able to allocate information intelligently to appropriate media. Presentational flexibility makes it harder to achieve defendable summarization–like results by shallow or ersatz operations, without applying real meaningful summarization concepts. By doing so, it supports a more principled approach to automatic summarization, and a decoupling of the working process from the surface features of both input and output media.

Multimedial presentation is currently the most conspicuous advance in computer communication to influence summarizing, but by no means the only one: In particular, interactive systems invite to conceive summarization as an interactive process instead of a simple display of summaries. The consequences for the design of interactive summarization systems are just as evident as for systems that would tailor summaries to particular uses: These systems will need more theoretical underpinnings than earlier solutions.

3. Coming nearer to human summarizing functionality

As technical development frees summaries from presentational restrictions, summarization systems need more intelligence to cope with the additional degrees of freedom. Like this, technical advance presses for a more articulated and penetrating view of automatic summarization, and in the same time it reduces the conceptual distance between automatic and human summarizing. Where earlier researchers in automatic summarization saw no chance to learn something implementable from the overly complex skills of human summarizers, their colleagues of today acknowledge that automatic summarizing has to be defined with respect to human performance. After all, competent human summarizers dispose of the most elaborated summarizing competence available, and more intelligent summarization concepts can be won naturally by studying human skills. Consequently, cognitive approaches have more impact on system design than in former times.

A basic observation tells us that cognitive systems like human summarizers do not summarize texts, but states and events in the real world which may be reconstructed from a written text or an image sequence by understanding. When the task is to summarize from a text, discourse features

are helpful, but the condensation process essentially reworks the object representation built up by text understanding and derives a summary representation that is uttered as spoken or written discourse. System design can follow the human process architecture.

4. Towards a science of summarizing: More empirical foundations, more formal accounts, more interdisciplinarity

Although systems that realize a shallow concept of summarization may be satisfactory in limited environments, real summarizing is a complicated intellectual process where many pieces of knowledge are combined in an organized way. Unfortunately, we lack concrete knowledge about many of its features. The current concept of a summary, for instance, describes a conciser statement of the most important items of a larger unit like a text. For use in automatic summarization, it appears poor. Indeed, more meaningful summarization theories are needed for more sophisticated systems.

Even though formal definitions of a summary or of summarization seem out of reach, it is desirable and feasible to provide implementable accounts of summarization which are more organized, more complete and empirically and formally more valid than approaches of the past. This is in part a matter of methodology. Summarization research is still improving its scientific methods, e.g., by imports from related disciplines like information retrieval. Most interesting are methods that allow a modularization of summarizing, implementing a holistic "divide and conquer" approach aimed at empirically and formally well–founded accounts of interesting features like subtasks, or special types of summaries. New concepts may be won by formal (deductive), by constructive and by empirical procedures.

Since summarization is defined by the related human skills and concepts, cognitive approaches help to establish how a summarization process is organized, which features of the source text influence the resulting summary, how intended uses shape the summary, and so on. Evaluation methods are just as important as empirically founded constructive methods.

Because knowledge about different types of objects (discourse types, cognitive processes, representation formalisms, etc.) must be combined to explain summarization, successful research is hard to imagine without interdisciplinary cooperation.

Most interestingly, modular theories of summarization allow to single out the specific condensation processes of summarizing, and to separate them in particular from general purpose text understanding. Like this, summarization research can concentrate on the functional kernel of summarizing. In a second move, general text understanding and production components can be adapted to summarization systems. Basically the same modularization strategy can serve to enrich our knowledge of texts and summaries. By subspecifying source documents and summaries with specific features, e.g., drawn from uses like "an alerting summary for social scientists", one can improve definitions that are too pale to guide production and to support evaluation.

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Status of 19.2.94 with updates for Bateman, Endres–Niggemeyer, Rothkegel, and Sigel

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