Peter Naur's contribution to formal notations and beyond

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Seminar Turing Award Winners and Their Contributions

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Formal notations in history

Figure 1: [1]

New need for formal notations

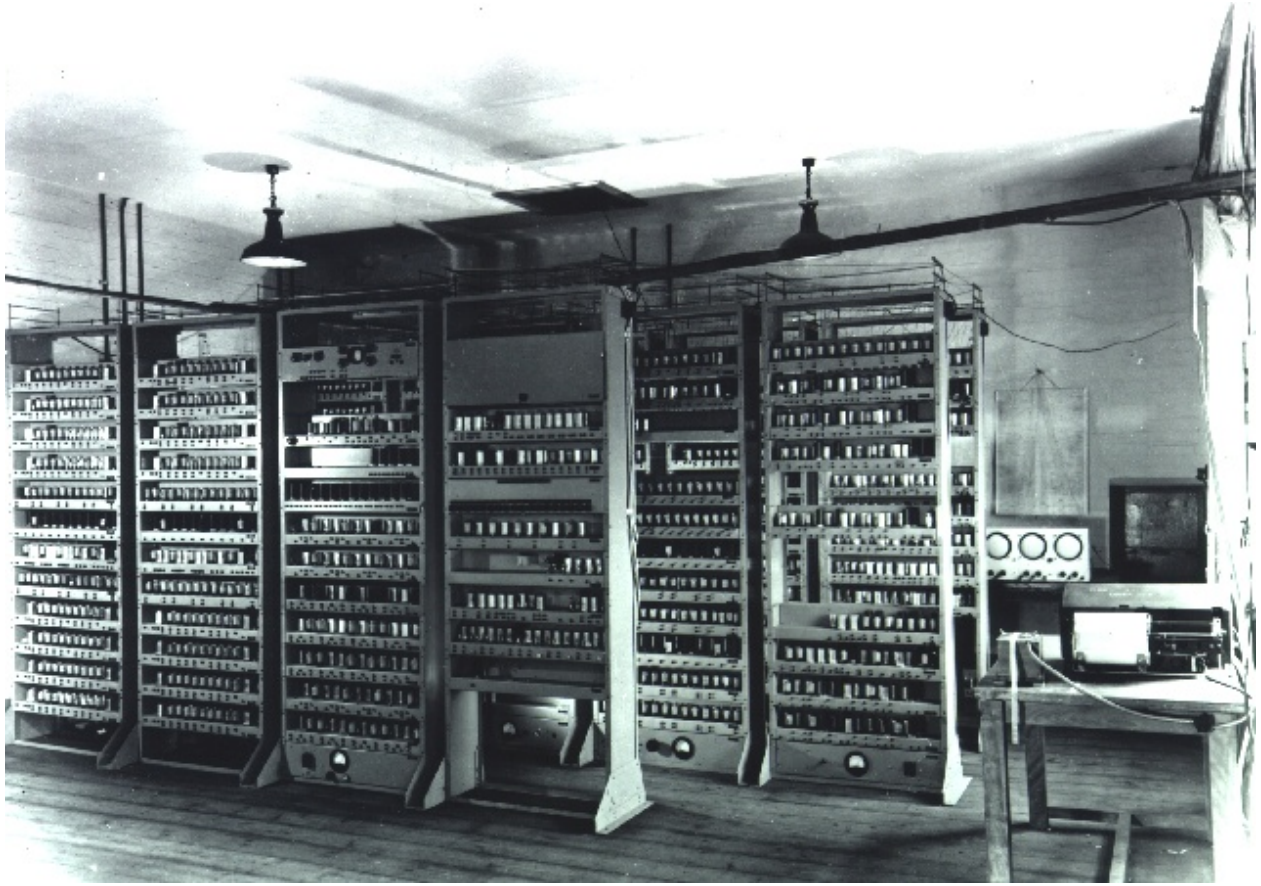


Figure 2: [2]

Peter Naur

Figure 3: [3]

Peter Naur's contribution

"For fundamental contributions to programming language design and the definition of Algol 60, to compiler design, and to the art and practice of computer programming."

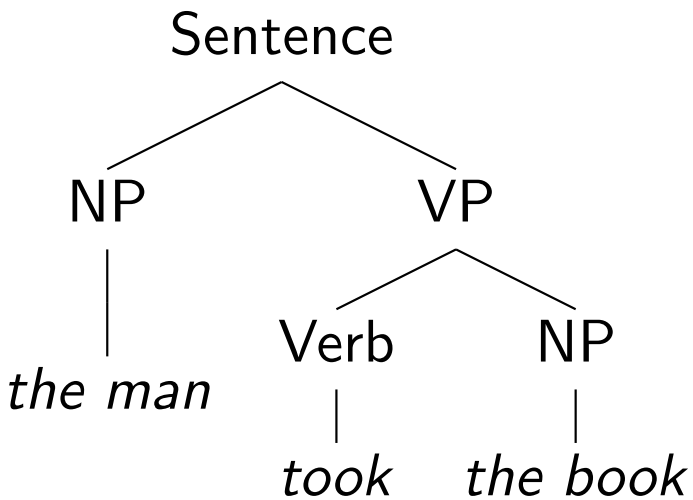
Overview

1. Formal notations
   - Phrase structure grammars
   - Backus Naur form
   - Programming languages, natural languages and mathematical languages
2. Peter Naur's contribution
   - Algol 60
   - Compiler Design
   - Art and practice of computer programming
3. Computing vs. Human Thinking
4. Conclusion

Phrase structure definition

$$
\begin{aligned}
\sum &: \#Sentence\# \\
F &: \\
Sentence &\rightarrow NP\_VP \\
VP &\rightarrow Verb\_NP \\
NP &\rightarrow \text{the man, the book} \\
Verb &\rightarrow \text{took}
\end{aligned}
\tag{1}
$$

Phrase structure in tree form



(2)

Backus Naur form

$$
\begin{aligned}
< \textit{sentence} > ::= & < \textit{NP} > \quad < \textit{VP} > \\
< \textit{VP} > ::= & < \textit{Verb} > \quad < \textit{NP} > \\
< \textit{NP} > ::= & \text{ the man } | \text{ the book} \\
< \textit{Verb} > ::= & \text{ took}
\end{aligned}
\tag{3}
$$

Comparison of levels of formalization

- Natural languages
- Mathematical languages
- Programming languages

Historical context

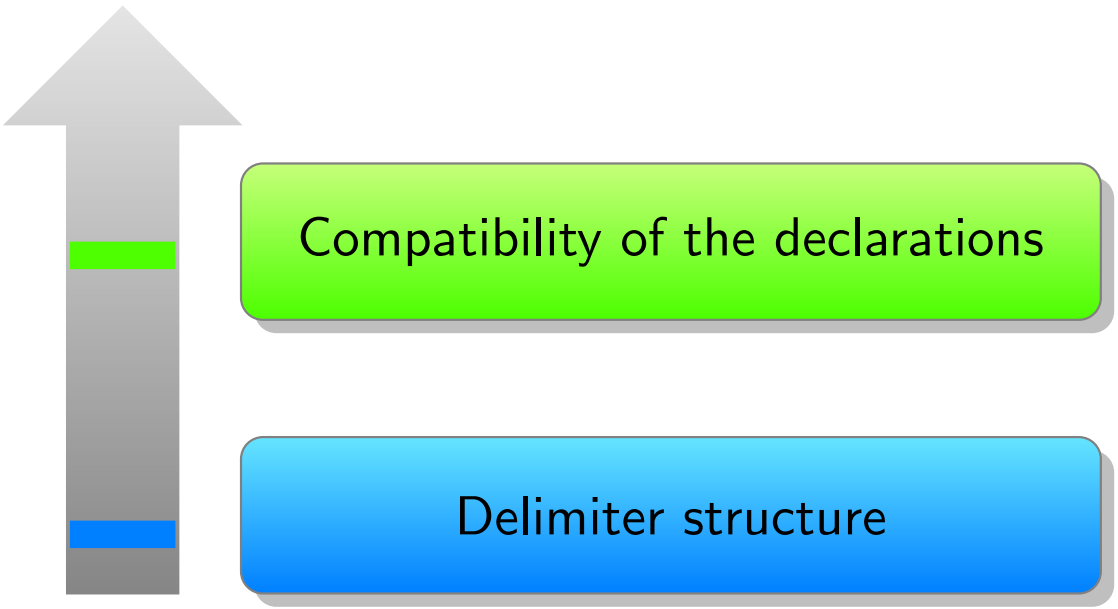
Properties of Algol 60

- Block scope
- Call-by-value and call-by-name parameter passing
- Formal specification
- No I/O facilities

Formal description of Algol 60

$$
\begin{aligned}
&< \text{digit} > ::= 0|1|2|3|4|5|6|7|8|9 \\
&< \text{unsigned integer} > ::= < \text{digit} > \; | \; < \text{unsigned integer} >< \text{digit} > \\
&< \text{integer} > ::= < \text{unsigned integer} > \; |+ < \text{unsigned integer} > \; | \\
&\qquad\qquad - < \text{unsigned integer} >
\end{aligned}
\tag{4}
$$

Gier Algol Compiler



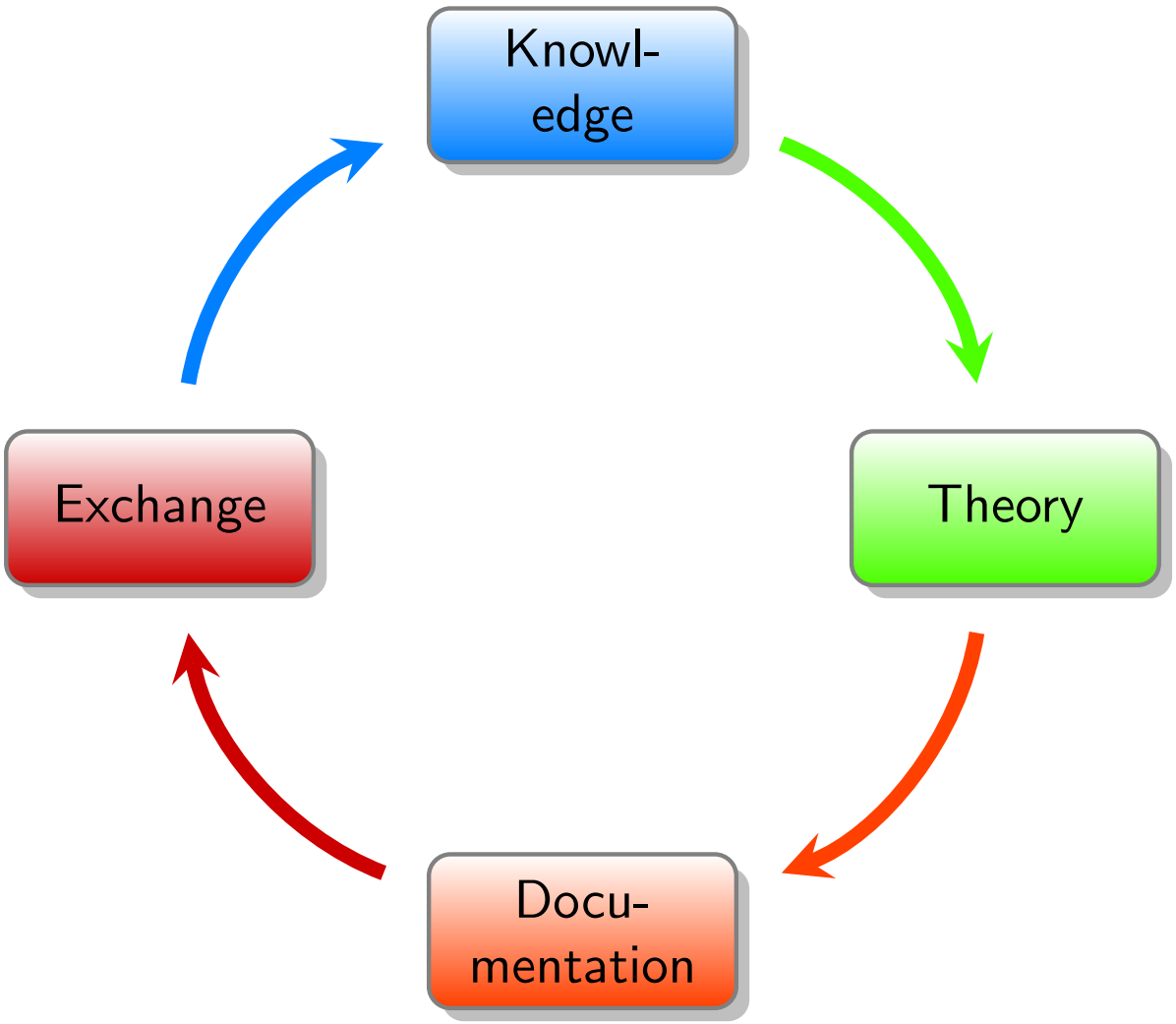
Delimiter structure check

- Use phrase structure grammar
- Check if terminal and reachable string

Programming as theory building

- Source code contains theory
- Transfer theory to next programmer
- Theory should be observable

Role of formal descriptions



Problems of over-formalization

- Hard to exchange
- Prone to errors
- Goal in itself
- Disconnected from environment

Computing Versus Human Thinking

- Description of computers
- Description of human thinking

Discussion

Do you think that human thinking will be formally describable?

Importance of formal notation

For achieving clarity any formal mode of expression should be used, not as a goal in itself, but wherever it appears to be helpful to authors and readers alike.

(Peter Naur)

The End

References

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