Conclusion

As an interdisplinary field, computational linguistics is composed of different areas of science, each with its own goals, methods, and historical background. Thereby it is not clear which components fit together and which do not. This implies three possible variants of designing a computational linguistics textbook.

The first variant proceeds from one's own school of science, attempting to extend it to as many aspects of automatic language analysis as possible. As a consequence, compatibility with other approaches in the interdisciplinary field need not be analyzed and one's assumptions are questioned at best in connection with 'puzzling problems.'

The second variant takes the viewpoint of an objective observer and aims at surveying the interdisciplinary field as completely as possible. However, the great number of different schools, methods, and tasks necessitates a subjective selection. Furthermore, the presumed neutrality provides no incentive to investigate the compatibility between the pieces selected.

The third variant aims at solving a comprehensive task. Relative to this task, the different approaches are ordered. To arrive at the desired solution, suitability and compatibility of the different pieces must be investigated for the task at hand.

In this textbook, the survey chapters 1 and 2 are based on the second variant, while the remaining chapters 3 to 24 are based on the third. The comprehensive task chosen is the design of a robot which can freely communicate in natural language. In the course of completing this task, there evolved the following criteria for a successful construction.

1. No simulating simulation
   The theory must aim at a robot construction which functions in the real world, presupposing its task environment as given. This is in contrast to approaches which model both, the cognitive agent and its environment, e.g., on the computer screen or in a logical model.
2. Separating the levels of language and context
   The internal structure of the robot must distinguish systematically between the level of context and the level of analyzed language signs. The context is a database comprising the automatic representation of the external environment, memories of earlier states and actions, plans and desires as well as information transmitted by means of language.

3. Requirement of procedural realization
   The construction of the robot must be based on a declarative description shown to be suitable for a procedural realization. This is in contrast to, e.g., a metalanguage definition of infinite sets of possible worlds.
4. Real time requirement
   The components of syntax, semantics, etc. used in the construction must have an algebraic definition on the basis of which they are shown to be of sufficiently low mathematical complexity. This is in contrast to existing components with exponential, undecidable, or unknown complexity.
5. Input-output equivalence requirement
   A realistic model of natural language communication requires that the robot be input-output equivalent with the natural speaker-hearer. It follows that the robot's algorithms for analysis and interpretation must be time-linear.
6. Sign-theoretic realization of reference
   The construction of the robot requires a theory of signs for explaining how the different sign types of natural language relate to the context of interpretation. Thereby, the different mechanisms of reference must be reconstructed in a functional manner suitable for the computer.
7. Separating motor algorithms and propositional content
   Reading language- and context-based recognition into and action out of the internal database of the robot requires a distinction between the motor algorithms powering the operations and the given propositional contents transmitted by the operations.
8. Complete treatment of basic cognitive states
   The construction of the robot must model the relation between language-based and context-based recognition and action. This requires that the information received in the hearer mode can be verbalized in the speaker mode or realized as non-verbal action. Furthermore, the system must be able to describe non-verbal recognition in language, as well as memories, sensations, plans, etc.

With these criteria the different – and often implicit – assumptions, goals, and methods of a multitude of existing approaches were classified and analyzed with respects to their suitability for modeling the mechanism of natural language communication. It turned out that a coherent functional theory of this mechanism has so far been missing in computational linguistics. In order to achieve the chosen task, the foundations of different approaches were first explained in detail and then developed systematically into components of a naturally communicating robot which fulfills the above criteria.