Embedding and Perspectives of the Professorship “Algorithms and Complexity” at the Department of Computer Science at RPTU Kaiserslautern-Landau

Research

The areas of algorithms and complexity form the methodological foundation of computer science and, at the same time, represent a central lever for the further development of modern theory. As part of the strategic reorientation of the department, the professorship will be embedded in the context of the emerging theory cluster (working title: *Certified Verification and Applications*). The aim of this cluster is to equip computational systems—from AI applications to complex software systems—with provable guarantees regarding correctness, reliability, fairness, and security.

A consistently formal approach is pursued: instead of purely empirical validation, the focus lies on mathematically grounded verification methods that guarantee system properties for all possible executions. A key challenge is the scalability of verification. While the checking of proofs can be performed efficiently, their construction is algorithmically highly complex. This is where the professorship comes in by developing algorithmic and complexity-theoretic foundations for scalable verification and automated proof search. This includes, in particular, the combination of classical algorithmic methods with modern AI-based approaches, as well as the use of proof assistants such as Lean or Isabelle.

The professorship will collaborate closely with existing groups in the theory domain at RPTU Kaiserslautern-Landau as well as with the Max Planck Institute for Software Systems (theory groups). In this environment, complementary expertise in algorithmic verification, automated reasoning, programming languages, distributed systems, and machine learning comes together. The professorship contributes to conceptually integrating and further developing these activities in order to establish a coherent and internationally visible research profile in the area of reliable, certified systems.

Furthermore, there are close links to strategic initiatives such as *AI, Computing & Society (AICS)* and *Autonomics*. In particular, the professorship contributes to the theoretical foundations of trustworthy AI, for example through formal models and efficient algorithms to ensure fairness, explainability, and robustness. In doing so, it supports the development of systems whose properties can not only be empirically observed but also formally guaranteed.

Teaching

In teaching, the professorship plays a central role in the foundational area of algorithms and complexity. This includes, in particular, the core compulsory course “Algorithms and Data Structures” in the bachelor’s program, as well as advanced courses at the bachelor’s and master’s levels (e.g., Advanced Algorithms, Complexity Theory, Graph Algorithms).

In line with the strategic direction, the professorship is expected to actively contribute to the development of a coherent and forward-looking curriculum in theoretical computer science.

This should in particular integrate topics such as formal verification, automated reasoning, proof assistants, and AI-assisted algorithmic methods. The goal is to establish Kaiserslautern as a visible training location for modern theory with strong connections to applications.

In addition, participation in related core courses of the bachelor's curriculum is expected, as well as contributions to teaching at the interfaces between theoretical foundations and applications, particularly in areas such as algorithmic verification, software engineering, and machine learning.

Overall, the professorship represents a key building block in the further development of a coherent, internationally competitive theory cluster in Kaiserslautern.