Intelligent Systems and Computing

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Five research groups from the School of Computer Science focus on applied computer science – excellent research is conducted in the areas of artificial intelligence, machine learning, modeling and formalizing of algorithms, data structures as well as in state-of-the-art methods for visual computing and language technologies.

Data Engineering

The Department of Software Engineering deals with search in big structured and unstructured data, such as multimedia, graphs, scientific and bio data. We focus on database methods for similarity search (performance, scalability), modeling and development of alternative means of retrieval, and also similarity modeling in particular data domains. In the multimedia retrieval field, we work with complex image descriptors and modern means of retrieval using database methods based on massively parallel processing. In the bioinformatics domain we focus on the development of algorithms and computational tools to aid analysis of biological data and computational drug discovery. In the big data domain, we develop methods which can be used to automate data integration and extraction. We develop methods which allow people to integrate large heterogeneous data and explore and browse it in a user friendly way. We also research Linked Data methods which provide a unified framework for publishing and interlinking data on the Web. This allows us to enrich given data with the context of thousands of data sources already available on the Web.

Software Systems

The Department of Distributed and Dependable Systems focuses on methods and models that enable systematic development of dependable software for complex and dynamic smart systems. This covers approaches for (i) architectural models based on autonomic component ensembles that are specifically tailored for highly dynamic systems, (ii) models and techniques for runtime self-adaptivity and self-awareness (including awareness of own performance), (iii) methods for data processing in edge-cloud with soft real-time guarantees, (iv) methods and tools for assessing performance and resource consumption. The department further focuses on analysis of software systems. This includes formal verification of properties of software systems implemented in Java and PHP. The department regularly participates in industrial and EU projects (FP7, H2020); its most recent publicly funded projects are AFarCloud and FitOptiVis (ECSEL), ESTABLISH (ITEA3/EUREKA), and Trust 4.0 (TAČR).

Visual Computing

The Computer Graphics Group is one of the leading groups in Computer Graphics research worldwide, with a strong focus on realistic image synthesis and 3D printing. The group's research is strongly rooted in problems encountered in practice: many of the results have been adopted by the renowned graphics production houses, such as Weta Digital, PIXAR Animation Studios, or Chaos Group. Two leading figures contribute to the scientific excellence of the group. Alexander Wilkie focuses on physics related aspects of light transport, material modeling, and color science. Jaroslav Křivánek focuses on radiative transport, Monte Carlo methods, and visual perception. In 2014, he was selected for the New Europe 100 list, "a list of outstanding challengers who are leading world class innovation from Central and Eastern Europe".

Language technologies

The Institute of Formal and Applied Linguistics focuses on language technologies such as machine translation, text analytics, information retrieval and information extraction, as well as dialogue systems. The research areas, headed by two renown experts in computational linguistics and machine translation, Jan Hajič and Ondřej Bojar, represent attractive interdisciplinary tasks relying on computer science, linguistics, statistics and mathematical modeling, with specific challenges to software engineering – as the volume of the data processed typically reaches tens of billions of words. Research in the area of language technologies is supported by the Research Infrastructure LINDAT / CLARIAH-CZ, a joint distributed national node of the Czech Republic in European research infrastructures CLARIN ERIC and DARIAH ERIC . The infrastructure collects and prepares open language resources necessary for all research areas in natural language processing and digital humanities. It also provides open tools and services for both fundamental as well as applied research in these dynamic areas.

Artificial Intelligence

The <u>Department of Theoretical Computer Science and Mathematical Logic</u> does research in the area of artificial intelligence, namely, constraint satisfaction, automated planning and scheduling, knowledge representation and compilation, artificial neural networks, machine learning and data mining, nature-inspired computation and robotics. Specifically, we suggest models of hard combinatorial optimization problems such as manufacturing scheduling and path planning and we use reduction-based techniques to solve the problems (for example by reduction to Boolean satisfiability or constraint satisfaction problems). In general, we deal with formal representation of problems, for example in propositional logic, and with transformations of representations to achieve better solving efficiency. We apply AI techniques on real robots with showcase at events such as Eurobot and Field Robot Event. We also deal with pattern recognition and classification problems and with nature-inspired optimization techniques such as genetic algorithms. Our research is motivated by real-life applications, specifically by various planning, scheduling, and decision making problems.

Selected outputs

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