Research Agenda

Cognitive Science Section
Institute of Interactive Systems and Data Science
Graz University of Technology
http://cognitive-science.at/

The Cognitive Science Section (CSS) is a research group at the Institute of Interactive Systems and Data Science (ISDS) at Graz University of Technology (TUGraz), Austria. CSS is an interdisciplinary team consisting of psychologists, computer scientists, and mathematicians that maintains a strong connection to the Department of Psychology at University of Graz, as well as to the Know-Center, a research institution focusing on big data analytics and applications. Since 2001, the group has worked in the context of teaching and learning, secure society, cultural heritage, and smart cities and gained experience in more than thirty research projects on a national and European level.

CSS targets research fields at the intersection of cognitive science and technology. Its research history encompasses cognitive modelling, techniques for adaptation and personalisation, technology-enhanced learning and related technologies, decision making and decision support systems, the application of empirical studies and the analysis of user data, as well as evaluation methodologies and related technical support. CSS follows a multi-disciplinary approach to assemble solid theories, methodologies, and technologies in formal frameworks that guide and integrate research and development. On-going and future research fields are outlined in the following list:

- **Cognitive Modelling and Adaptive Support.** Cognitive modelling describes the specification of runnable computer models that approximate cognitive processes, mechanisms and representations. Our research focuses on the dynamic modelling of user's cognitive traits and sates in the domains of learning, decision making, and information search. Characteristics of user models include knowledge, prior and advancing experiences, motivation, meta-cognitive skills or cognitive workload. To represent users according to such characteristics we develop methods and algorithms that build on explicit and implicit assessment methods, non-invasive data capturing and analytics. Resulting user models can be exploited in various ways, such as the personalisation of learning experiences, the support of decision making, or to influence user behaviour in smart cities.

- **Technology-enhanced Learning.** We undertake research on psychological and pedagogical theories, models, and methods to measure cognitive attributes, assess learner knowledge, personalise the learning experience, and provide adaptive learning and teaching support. Examples are competence models (including structured domain knowledge, meta-cognition, and critical thinking), procedures for assessing the learner's knowledge, tracking the learning behaviour, and multi-adaptive methods for learning support through recommendations, feedback, and learning path creation. Software components and user interfaces apply the theoretical work in practice. Research fields include learning analytics, recommender systems, self-regulated learning, game-based learning, inquiry-based learning, and collaborative learning.

- **Decision Making Support.** Research on decision making is based on cognitive processes, competence models, decision heuristics, and cognitive biases. These underlying models and theories are applied for creating new technical concepts that are included in decision support systems. Particularly, user interface designs, the tracking of user behaviour, and feedback techniques are influenced by this research stream. This impacts the user by providing support for valid and effective decisions and the avoidance of cognitive biases. Research on decision making is predominantly applied in the Secure Society domain, but is not limited to this area.
- **Reflective Information Seeking.** This strand of research investigates models and concepts to support the more reflective search and consumption of information on-line. At the focus are effects that appear in information search and often stronger in social media such as filter bubbles and echo chambers. Methods are researched and that help users identify fake or biased information.
- **Evaluation.** New research, models, theories, and approaches need new evaluation techniques. We address this challenge by continuously updating and developing tailored evaluation strategies and thus enable a scientifically and methodologically sound and correct appraisal of the efficacy and efficiency of new research results. Systematic evaluation is accomplished through holistic evaluation frameworks that define evaluation goals, instruments, and analysis methods. Furthermore, these frameworks are put into practice through our evaluation software component that enables multi-modal and user-centric evaluation.

On the top of our core research areas, we connect with and take into account other fields of research that complement our work, such as:

- **Big Data and Data Analytics.** Big data analytics complement our research streams in many ways. For example, the analysis of user behaviour on a large scale is well suited to feed assessment methods and learning recommendations. Furthermore, data analysed from natural and artificial environments acts as a basis for decision making support.
- **Ethics**. We strongly believe in the compliance of ethical principles in research activities. This is manifested in the conduct of research itself e.g. through the protection of privacy in user studies, and is applied on research outcomes by developing ethical guidelines that determine how developed frameworks and software can be applied in a considerate manner (ethics-by-design approach).
- **Standardisation.** We are involved in standardisation activities of the International Standardisation Organisation (ISO) on defining standards related to learning and teaching. This work is relevant to research on technology-enhanced learning projects.

We are interested to continue collaboration in inter-disciplinary and multi-national projects with strong previous and new partner organizations. Information on current and past projects can be found under: http://cognitive-science.at/

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