1 Who am I? (Executive Summary)

I am a researcher and teacher in logic and artificial intelligence seeking to put information and knowledge management practices in the STEM[1] disciplines onto a new, semantic foundation. My background is in mathematics, automated reasoning and natural language semantics and I specialize in semantic technologies, knowledge management and a Semantic Web for scientific/technical applications.

My research approach is to transport problems and solutions between the disciplines in the triangle of mathematics, formal logic, and natural language. This trans-disciplinary approach allows me to employ methods I have acquired in pure mathematics and computational logics in highly interesting application domains such as knowledge management, technical documentation, user assistance, or computational linguistics. To name just one example, we were able to use linguistic techniques of semantics construction to convert mathematical formulae in presentation markup (generated from LaTeX) into content markup , index them with a technique from theorem proving that allows efficient unification queries, and thus obtain a semantic formula search engine for scientific archives like `arXiv.org` . Importantly, research in the triangle mentioned above also satisfies my interest for cognitive aspects in AI.

My work and research style is project-oriented, in particular, I like to work with colleagues and students in larger project contexts: In my tenure at Jacobs University I have built up the KWARC research group (see section **??**) whose topics range from the theoretical foundations of logics (Dr. Florian Rabe) and mathematics to applied research in information systems (Dr. Heinrich Stamerjohanns), and semantic interaction design (Dr. Andrea Kohlhase) so that theory and practice aspects can stimulate and inform each other. To embed the KWARC group into the research community, I have established an active network of international collaborations. Furthermore, I have been active in promoting our research area by organizing workshops, conferences, and academic societies. For instance, I have initiated and coordinated the CALCULEMUS (integrating deduction and computation) and MKM (Mathematical Knowledge Management) conferences and EU networks, serve as the president of the OpenMath society, and have been active in the OpenMath and MathML standardization activities. Serious collaborations with industry have only started recently, but are something that I would like to strengthen in the future.

One of the great challenges of the coming "Knowledge Society" will be the development of a semantics-based infrastructure for web-based knowledge processing and distributed inference. My main contribution is in the study of the interplay of formal and informal (natural language) elements and structures (flexiformality) in knowledge and document representations. Flexiformal formats like OMDoc— my XML-based representation format for mathematic/technical discourses can serve as the basis for novel services in document collections and knowledge spaces. OMDoc is currently used for tasks including the communication between mathematical software systems and the generation of personalized course materials in IT-supported education. For extending the interface between man and

[1] Science, Technology, Engineering, and Mathematics

machine, knowledge processing acquires a central position.

At the moment, we make use of the extended knowledge representation capabilities of OMDoc in semantics-based e-learning systems that produce just-in-time course materials based on the students abilities and preferences and monitor the interaction for user modeling purposes. I am currently setting up an e-learning competence center to deploy these techniques at Jacobs University. I believe that teaching and direct student contact is a defining academic task.

I have always liked teaching and have taught courses and seminars since 1994. While e-learning systems will never be a substitute for human teachers, they can alleviate routine tasks and free humans to concentrate on teaching subtasks they excel in: motivation, academic discourse, or teaching by example. Moreover, semantics-based e-learning systems can individualize certain teaching tasks to personality types, minority- and special-need groups, and gather feedback data that allows to fine-tune curricula and teaching methods.