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Eighth International Workshop on Qualitative Reasoning about Physical Systems

Toyoaki Nishida, Tetsuo Tomiyama, and Takashi Kiriyama

■ The Eighth International Workshop on Qualitative Reasoning about Physical Systems (QR '94) was held on 7–10 June 1994 in Nara, Japan. Fifty-three people participated, and 34 papers were presented in either oral or poster sessions. The papers either addressed core issues of qualitative reasoning or extended the field along three axes: (1) cognitive modeling, (2) mathematical sophistication, and (3) application. Mita's self-maintenance copier and IBM's mechanism design and analysis using configuration spaces were demonstrated, convincing the participants of the promising role of qualitative-reasoning techniques in engineering and manufacturing domains.

The International Workshop on Qualitative Reasoning about Physical Systems is an annual forum for the qualitative reasoning community to exchange ideas and debate critical issues in the field. Since the first workshop in 1987, the workshop site has altered between the United States and Europe.

The eighth workshop was in Nara, Japan, celebrating the community's escape from a simple flip-flop behavior and its voyage to a more complex behavior. Interestingly, this transition from the simple behavior to the complex coincides with the recent shift of the community's concern from simplistic toy problems to complex real-world problems. In fact, several demonstrations, including Mita's self-maintenance copier (physical demonstration) and IBM's mechanism design and analysis using configuration spaces (videotaped demonstration), convinced the participants of the promising role of qualitative-reasoning techniques in engineering and manufacturing domains. Together with the poster presentations, the demonstrations resulted in intensive discussions among the participants.

To promote focused, intensive discussions, the number of participants was limited to approximately 50. We asked potential participants to either submit a paper or write a letter describing their research interests. We received 53 submissions and selected 14 papers for oral presentation and 20 papers for poster presentation. Roughly speaking, the papers either addressed core issues of qualitative reasoning or extended the core along three axes: (1) cognitive modeling, (2) mathematical sophistication, and (3) application, as shown in figure 1.

The core issues of qualitative reasoning included qualitative and causal modeling of the world, automated modeling, and qualitative simulation. Among others, modeling attracted the attention of many participants. The major progress in the field is represented by the report by David Bell and his colleagues (Xerox Palo Alto Research Center [PARC]) on constructing a component-based model for the input-document handler of a photocopier; Elizabeth Bradley's (University of Colorado) REFINEMENT, which builds ordinary differential equation models based on mathematical theories and domain-specific rules; and Donal Finn (Hitachi Dublin Laboratory) and Padraig Cunningham's (University of Dublin) COBRA, which generates partial differential equation models of heat transfer. Works on basic issues of modeling were reported by Diane Chi and Yumi Iwasaki (both of Stanford University), Daniel Clancy and Benjamin Kuipers (both of University of Texas at Austin), Bert Bredeweg and his colleagues (University of Amsterdam), Kyungsook Han and Andrew Gelsey (both of Rutgers University), Sowmya Ramachandran and her colleagues (University of Texas at Austin), and Shinji Yoshikawa and his colleagues (Power Reactor and Nuclear Fuel Development Corporation and Osaka University). Other issues were discussed by David Hibler (Christopher Newport University), Marie Lee (CSIRO Division of Information Technology) and Paul Compton (University of New South Wales), Munehiko Sasajima and his colleagues (Osaka University and Power Reactor and Nuclear Fuel Development Corporation), Q. Shen and his colleagues (Heriot-Watt University), and Takashi Washio (Mitsubishi Research Institute, Inc.).

A hot issue in cognitive modeling is spatial and diagrammatic reasoning. Monika Lundell (Swiss Federal Institute of Technology, Lausanne) presented a qualitative method of interpreting spatially distributed observations. Yusuf Pisan and Kenneth D. Forbus's (both of Northwestern University) SKETCHY demonstrated visual reasoning by line graphs. N. Hari Narayanan and his colleagues (Advanced Research Laboratory, Hitachi Ltd.) exploited an architecture of qualitative visual reasoning about physical devices. Boi Faltings (Swiss Federal Institute of Technology, Lausanne) presented a formalization of computing the topology of configuration space.

There is continuous effort in mathematical sophistication to base qualitative reasoning on a firm ground. Brian C. Williams (Xerox PARC) and Jonathan Cagan (Carnegie Mellon

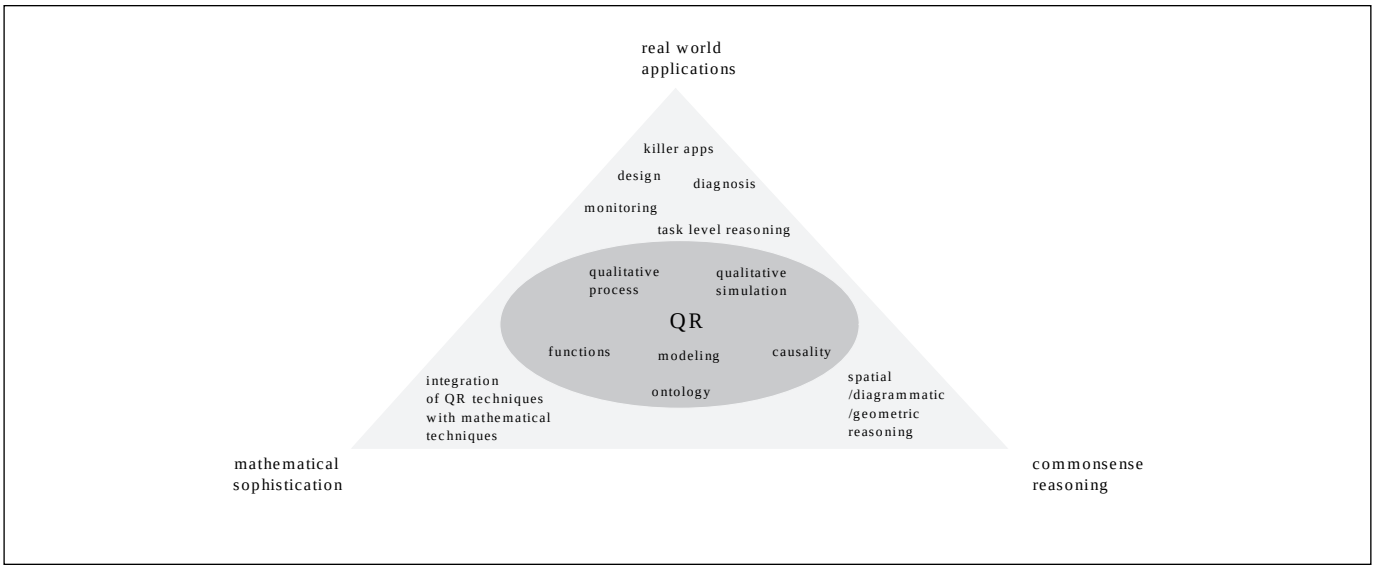

Figure 1. Concurrent View of Qualitative Reasoning.

University) presented activity analysis, demonstrating how qualitative techniques help eliminate large subspaces in optimization. Kenneth Man-kam Yip (Yale University) reported the procedural implementation of the renormalization method for transforming hard problems into a sequence of similar but simpler problems. Feng Zhao (The Ohio State University) described an intelligent numeric simulation technique and its application to CONTROL ENGINEER'S WORKBENCH. Kuipers and Benjamin Shults (University of Texas at Austin) presented a method using modal and temporal logic to prove properties of the behavior of a continuous physical system. Hiroshi Tanaka and Susaku Tsumoto (both of Tokyo Medical and Dental University) proposed the use of infinitesimal analysis.

Applications are the driving force of the field. Richard Doyle (Jet Propulsion Laboratory, California Institute of Technology) presented a technique for focusing attention in SELMON, a model-based monitoring system for complex physical systems. Yang Gao and Hugh Durrant-Whyte (both of University of Oxford) reported an application of integrating qualitative simulation for numeric data fusion in a monitoring and fault-detection system for a process plant. Peter Struss (Technical University of Munich) presented a novel theory of model abstraction that makes test generation feasible for continuous physical systems. Kiyoshi Itoh (Sophia University) described the integration of qualitative and quantitative techniques for parameter tuning of queuing networks. Forbus and Peter Whalley (University of Oxford) presented CYCLEPAD for building articulate software for thermodynamics education. Tools are crucial for supporting the progress and distributing the idea. They include Adam Farquhar (Stanford University) and Giorgio Brajnik's (Universita di Udine) SQPC for semiquantitative modeling and simulation, Forbus and Brian Falkenhainer's MK3 (Xerox Modeling Research and Technology) for polynomial-time self-explanatory simulation, and L. Ironi (Istituto di Analisi Numerica del CNR) and M. Stefanelli's (Dipartimento di Informatica e Sistemistica dell'Universita di Pavia) QCMF for generating qualitative models from compartmental structures.

An important decision made during general discussions was to drop the phrase *about physical systems* from the title of the workshop. This change reflects the recent broadening of qualitative-reasoning techniques into many domains.

QR '95 is scheduled to be held in Amsterdam, The Netherlands, on 16–19 May and chaired by Bert Bredeweg. QR '96 will be co-chaired by Iwasaki and Farquhar and will be held in Monterey, California.

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Toyoaki Nishida is a professor in the Graduate School of Information Science, Nara Institute of Science and Technology, Nara, Japan. His current research interests include qualitative reasoning, knowledge sharing, and knowledge media.

Tetsuo Tomiyama is an associate professor in the Department of Precision Machinery Engineering, Graduate School of Engineering, The University of Tokyo. His current research interests include design theory and methodology, knowledge-intensive engineering, and the application of qualitative physics.

Takashi Kiriyamayama is a lecturer in Research into Artifacts, Center for Engineering, the University of Tokyo. His current research includes artifactual engineering, qualitative physics, and knowledge sharing.