Herbert Kay

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December 1996
Date of Birth: May 1, 1959
Place of Birth: Boston, MA
Marital Status: Married

OBJECTIVE:

A position in applied research where my skills in computer science can be used to solve problems in engineering and the physical sciences. My interests include model-based reasoning, intelligent data acquistion, engineering design, and the integration of symbolic and numerical inference methods.

EDUCATION:

PhD in Computer Science, December 1996
Dissertation Title : Refining Imprecise Models and Their Behaviors
Department of Computer Sciences
University of Texas at Austin
Austin, TX 78712

MA Computer Science, May 1991 GPA 3.9
Thesis Title : Monitoring and Diagnosis of Multi-tank Flows using Qualitative Reasoning
Department of Computer Sciences
University of Texas at Austin
Austin, TX 78712

BS Engineering and Applied Science, June 1981 GPA 3.1
California Institute of Technology
Pasadena, CA 91125

Non-degree Program in Computer Science, 1984-1986 GPA 4.0
Stanford University
Stanford, CA 94305

EXPERIENCE:

June 1989 to present -

Graduate Research Assistant, University of Texas at Austin

Member of Dr. Kuipers' Qualitative Reasoning Group. Explored problems related to improving the expressiveness of behavioral predictions in qualitative models, qualitative modeling of VLSI circuits, and modeling vacuum equipment used in VLSI processing. My primary work involves developing methods for combining qualitative and quantitative simulation techniques and using these methods for monitoring and fault detection of imprecisely-known dynamical systems. In the process of researching my dissertation, I have familiarized myself with using state-of-the-art ODE solvers, non-parametric estimation techniques, Kalman Filtering, system identification, signal processing, and data analysis techniques. I am also well-versed in the use of Artificial Intelligence techniques.

May 1991 to September 1991 -

Summer Research Student, AI Branch, NASA Ames Research Center
Moffett Field, CA 94035

Developed a qualitative model of the Space Shuttle Reaction Control System in collaboration with flight controllers from NASA. The model was designed for use with a semiquantitative monitoring and diagnosis system.

January 1989 to December 1989 -

Teaching Assistant, University of Texas at Austin

> TA for the graduate and undergraduate VLSI design courses in the CS department. Responsible for providing design assistance to the students as well as installing and maintaining design tools.

November 1986 to April 1988 -

Software Engineer, Mettler Instrumente AG
Central Research Group
CH-8606 Greifensee, Switzerland

> Helped design a symbolic curve-recognition system. Responsible for knowledge acquisition and representation scheme. Administered the Central Research Group's wide-band lan together with a Vax, PCs, and a Symbolics machine.

September 1981 to November 1986 -

Member of the Technical Staff, Hewlett-Packard Company
5301 Stevens Creek Blvd.
Santa Clara, CA 95051

> Oct 85 - Nov 86 :
> Principle designer of an expert system for the diagnosis of faults in an IC tester. Responsible for knowledge acquisition, prototype development and Requirements Spec.
>
> Jan 85 - Oct 85 :
> Technical lead on a project to interface CAD systems to an IC tester. Responsible for leading a design team in writing the Source Requirements Spec and External Reference Spec.
>
> June 84 - Jan 85 :
> Principal investigator examining the development of an expert system for the diagnosis of faults in an IC tester.
>
> Sept 83 - June 84 :
> Investigated networking aspects of IC testers. Developed a test plan language for an IC tester.
>
> Sept 82 - Sept 83 :
> Wrote a real-time OS for a 6809-based microprocessor troubleshooting instrument. Helped to design the HPIB interface protocol.
>
> Sept 81 - Sept 82 :
> Wrote software for HP55005A Logic Troubleshooting System. Responsible for design of HPIB interface and circuit fault-finding algorithm, software QA, and transfer of product to manufacturing.

DISSERTATION:

Refining Imprecise Models and Their Behaviors
Available at `file://ftp.cs.utexas.edu/pub/qsim/papers/Kay-PhD-95.ps.Z`
Supervising professor: Benjamin Kuipers

This dissertation describes methods for simulating and refining imprecisely-defined Ordinary Differential Equation (ODE) systems. When constructing a model of a physical process, a modeler must cope with uncertainty due to incomplete knowledge of the process. For tasks such as design and diagnosis, the effects of this uncertainty must be considered. However, predicting the behavior of an imprecisely-defined model is not easy since the model covers a space of many precise instances, each of which behaves differently.

While model uncertainty cannot be completely eliminated, it is possible to reduce it. Model refinement uses observations of a physical process to rule out portions of the model space that could not have produced the

observations. As more experience with the physical process is gained, the imprecision in the model is further reduced.

This dissertation describes three methods for reasoning with imprecise ODE models. SQSim is a simulator that produces a guaranteed bound on the behavior of an imprecise ODE model. By using a multiple-level representation and inference methods that span the qualitative-to-quantitative spectrum, SQSim produces predictions whose uncertainty is consistent with model imprecision. We demonstrate SQSim on a complex, nonlinear chemical process and compare it to other methods for simulating imprecise ODE models.

MSQUID is a function estimator for fitting (and bounding) noisy data that is known to be monotonic. It uses a neural-network inspired model and nonlinear constrained optimization to search a space of monotonic functions. We prove that MSQUID can estimate any monotonic function and show that it produces better estimates than does unconstrained optimization.

SQUID, which uses SQSim and MSQUID as components, is a system identification method that refines an imprecise model using a stream of observations from a physical process. SQUID uses refutation to rule out portions of the model space that are inconsistent with the observations. We show that this approach to refinement is significantly more efficient than parameter estimation for models with functional uncertainty and that it provides greater robustness in the face of uninformative observations.

PUBLICATIONS:

Refereed Conferences:

Herbert Kay. Robust Identification Using Semiquantitative Methods. IFAC SAFEPROCESS'97 Symposium. Hull, U.K. Submitted.

Herbert Kay. Semiquantitative Simulation: Successes, Failures, and Future Directions. In *Working Notes from the Second Engineering Problems for Qualitative Reasoning Workshop (IJCAI-95)*, pages 30–42, Montreal, Quebec, 1995.

Herbert Kay. Making Useful Predictions From Imprecise Models. Computer Sciences Industrial Forum. Department of Computer Sciences, The University of Texas at Austin. February 1995.

Herbert Kay and Benjamin Kuipers. Numerical behavior envelopes for qualitative models. In *Proceedings of the Eleventh National Conference on Artificial Intelligence (AAAI-93)*, pages 606–613, 1993.

Herbert Kay and Lyle H. Ungar. Deriving monotonic function envelopes from observations. In *Working Papers from the Seventh International Workshop on Qualitative Reasoning about Physical Systems*, pages 117–123, Rosario Resort, Washington, 1993.

E. Gazi, H. Kay, B. J. Kuipers, W. D. Seider, L. H. Ungar. Controller verification using qualitative reasoning. (Extended abstract) American Institute of Chemical Engineers, 1993 meeting.

Herbert Kay and Benjamin Kuipers. Numerical behavior envelopes for qualitative models. In *Working Papers from the Sixth International Workshop on Qualitative Reasoning*, pages 252–267, Edinburgh, Scotland, 1992.

Deepak Kulkarni, Herbert Kay, and Peter Robinson. Diagnosis of Shuttle Reaction Control System (Extended Abstract). In *NASA Workshop on Monitoring and Diagnosis*, Pasadena, CA, January 1992.

William Athas, Herbert Kay, and John Bunda. A Microprocessor Project for an Introductory VLSI Design Class. In *Proceedings of 1990 VLSI Education Conference and Exposition*, July 1990.

Technical Reports:

Herbert Kay. SQSIM: A simulator for imprecise ODE models. Technical Report AI96–247, Artificial Intelligence Laboratory, University of Texas at Austin, Austin, Texas 78712, March 1996.

Herbert Kay. A qualitative model of the space shuttle reaction control system. Technical Report AI92–188, Artificial Intelligence Laboratory, University of Texas at Austin, Austin, Texas 78712, September 1992.

LANGUAGES AND SYSTEMS:

LISP, PROLOG, C, C++, PASCAL, FORTRAN, and various assemblers.

UNIX, VMS, Genera, MAC-OS.

HOBBIES:

Hiking, cycling, reading, cooking.