

c u r r i c u l u m v i t a e

DR. HERBERT M. SAURO

MC 107-81

Control and Dynamical Systems

Caltech

Pasadena, CA 91125 USA

Telephone (work): (626) 395-6943 • Fax: (626) 796-8914

Email: hsauro@cds.caltech.edu

Web site: <http://www.cds.caltech.edu/~hsauro>

Alias: <http://www.sys-bio.org>

P R O F E S S I O N A L O B J E C T I V E S

1. Establish a vigorous and cutting edge quantitative research group in bioengineering/computational biology.
2. To develop
 - ...a teaching program for molecular biologists in quantitative, computational and theoretical approaches to understanding living cells.
 - ...a teaching program for engineers and computer science students to introduce them to the basic questions and concepts in molecular biology.
 - ...an advanced teaching program in bioengineering and computational biology.

A C A D E M I C H I S T O R Y

Ph.D.

Oxford Brookes University

Oxford, UK 1985

Major: Computational Biochemistry

Advisor: Professor David Fell

Research Interests: Metabolic and signal transduction networks, simulation, non-linear dynamics, control analysis, software.

M.Sc.

University of York

York, UK 1982

Major: Biological Computation

Content: Calculus, linear algebra, statistics, computing, simulation, databases.

B.Sc.

University of Kent

Canterbury, UK 1981

Major: Biochemistry/Microbiology

Post Graduate Certificate in Education

Aberystwyth, UK

University of Aberystwyth

PROFESSIONAL HISTORY

Roslin Research Centre Postdoctoral Fellow Computer Simulation of Methionine Metabolism	Midlothian, Edinburgh 1986-1987
University of Edinburgh Postdoctoral Fellow with Henrik Kacser, Department of Genetics. Mathematical Analysis of Cellular Networks	Edinburgh 1988-1991
University of Aberystwyth Postdoctoral Fellow Application of Neural Networks in Biochemistry	Aberystwyth, UK 1992-1993
Future Skills Software Developing and Marketing Science Based Educational Software for the UK Market	Aberystwyth, UK 1994-1997
Financial Times Database and User Interface Design	Edinburgh, UK 1998
General Electric Database and User Interface Design	Edinburgh, UK 1998-1999
Caltech Visiting Associate in Control and Dynamical Systems With John Doyle and Hamid Bolouri	Pasadena, USA 2000

RESEARCH INTERESTS

Furthering the discipline of computational biology through teaching, and collaboration with other groups. Understanding complex biological systems, particularly cellular networks. Developing novel computational and visualization techniques. Applying engineering principles to understanding cellular control systems.

RESEARCH SKILLS

Author of SCAMP and Jarnac, the most widely used research software (as measured by citation record) for studying protein and chemical networks using simulation and control analysis.

Patent submission: A technique for the high throughput determination of kinetic constants in cellular networks.

Fluent in the following computer languages: C, Delphi, VB and SQL. I have a working knowledge of C++, Java and C#. Have managed large scale databases including client/server technology, and have direct experience with Sybase, Oracle and InterBase data base engines.

Advisor and committee member to graduate students.

Formal education in biochemistry, microbiology, molecular biology, genetics, calculus, linear algebra, statistics, numerical analysis, object oriented programming and design, general algorithms, data structures, compiler design and language parsing. Developed curriculum and taught science courses to high school and college level students.

Number of publications: 37, plus six commercial scientific software products, workshops presentations and internal documents.

Launched and maintained a successful business which involved design, development and marketing of interactive science/math educational software for the UK market. Future Skills Software (<http://www.fssc.demon.co.uk>)

Developed close working relationships with a number of commercial concerns, including GlaxoWellcome, Physiome and Entelos and recently was invited to attend the Genomics and Medicine conference organised by Nature Biotechnology Journal and corporate sponsors in San Diego.

CURRENT RESEARCH INTERESTS

I am currently a visiting associate with the Control and Dynamical Systems group at Caltech, Pasadena. Our team is currently focused on:

1. Development of an XML standard to enable different simulation software packages to exchange models (*The first draft has been released – see www.cds.caltech.edu/erato*).
2. Development of a software infrastructure allowing different simulation packages to share functionality. First beta version was released in November, 2001.
3. A study of the MAP Kinase pathway with the view to understand the systems in terms of engineering principles.
4. I have given a number of workshops on our new software developments including demonstration sessions and lectures. Currently we have organised four workshops in the last two years with more scheduled for next year.

Other Software Development:

User friendly front-end to the Segel bifurcation analysis package.

Continued development of the simulation package Jarnac.

Enhancing the visual network designer to allow easier access for biologists to our software tools.

PUBLICATIONS LIST

FELL D. A. and SAURO H. M., (1985) Metabolic Control and its Analysis: Additional Relationships between Elasticities and Control Coefficients. *Eur. J. Biochem.*, 148, 555-561

SAURO H. M., (1986) Control Analysis and Simulation of Metabolism Ph.D. Thesis, Oxford Polytechnic.

SAURO H. M., SMALL J. R., FELL D. A., (1987) Metabolic control and its analysis: Extensions to the theory and matrix method. *Eur. J. Biochem.* 1987, 165, 215-221

ACERENZA L., SAURO H. M and KACSER H., (1989) Control Analysis of Time-dependent Metabolic Systems. *J. Theor. Biol.*, 137, 423-444

KACSER H., SAURO H. M., ACERENZA L., (1989) Enzyme-enzyme interactions and control analysis 1. The case of non-additivity: monomer-oligomer associations. *Eur. J. Biochem.*, 187, 481-491

SAURO H. M. and KACSER H., (1989) Enzyme-enzyme interactions and control analysis 2. The case of non-independence: heterologous associations. *Eur. J. Biochem.*, 187, 493-500

FELL, D. A. and SAURO, H. M., (1990) Metabolic Control Analysis by Computer: Progress and prospects., *Biomed. Biochem. Acta*, 8/9, 811-816

FELL D. A. and SAURO H. M., (1990) Metabolic Control Analysis: the effect of high enzyme concentrations. *Eur. J. Biochem.*, 192, 183-187

SAURO, H.M and FELL, D.A. (1991), SCAMP: A metabolic simulator and control analysis program., *Mathl. Comput. Modelling*, 15, 15-28

SAURO H. M. and KELL, D., (1992) Evaluation of Steady-state Kinetic Parameters of Metabolic Pathways using Neural Networks. *Binary*, 4, 189-190

SAURO, H. M., (1993) SCAMP: a general-purpose simulator and metabolic control analysis program. *CABIOS*, 9 (4), 441-450

- KELL D. B, DAVEY C. L, GOODACRE R and SAURO, H. M., (1993) When Going Backwards Means Progress: On the solution of biochemical inverse problems using artificial neural networks. *Modern Trends in Biothermokinetics*. Ed: Schuster S. et al, Plenum Press, New York, 109-114
- SAURO, H. M., (1993) A Biochemical 'NAND' Gate and Assorted Circuits. *Modern Trends in Biothermokinetics*. Ed: Schuster S. et al, Plenum Press, New York, 133-140
- SAURO, H. M., (1994) Analyses and Simulators: a brief description of two computer programs SCAMP and iMAP. *Biothermokinetics*. Ed: Westerhoff, H, Plenum Press, New York, 213-223
- SAURO, H. M., (1994) Moiety-Conserved Cycles and Metabolic Control Analysis. Analysis of Sequestration and Metabolic Channelling. *Biosystems*, 33, 55-67
- SAURO, H. M., KHOLODENKO, B. N., and WESTERHOFF, H. (1994) Metabolic Control Analysis of Linked Moiety-conserved Cycles. Responses to perturbations of internal variables and conservation totals. *Eur. J. Biochem*, 225, 179-186
- SAURO, H. M. and BARRETT, J., (1995) in vitro Control Analysis of Metabolic Pathways; experimental and analytical developments. *Molecular and Cellular Biochemistry*, 145, 141-150
- KHOLODENKO B. N, SAURO H. M. and WESTERHOFF H V. (1995) Coenzyme Cycles and Metabolic Control Analysis: The Determination of the Elasticity Coefficients from the Generalised Connectivity Theorem. *Biochemistry and Molecular Biology*, 33 (3), 615-625
- SAURO H. M (1995) User Reference Manual EasyGraph. Published by: Future Skill Software
- SAURO H. M (1996) Introduction to Mathematical Modelling using Fplot. Published by: Future Skill Software
- SAURO H. M. (1996) Creatures and Population Modelling. Published by: Future Skill Software
- SAURO H. M. (1997) The Periodic Table. Published by: Future Skill Software
- SAURO H. M (1997) Introduction to Error Analysis in Experimentation using EasyGraph professional. Future Skill Software
- SAURO H. M (1997) Exploring Mathematical Functions using vExplorer. Future Skill Software
- WOODS J. H and SAURO H. M. (1997) Elasticities in Metabolic Control Analysis: algebraic derivation of simplified expressions. *CABIOS (now BioInformatics)* 13 (2), 123-130
- HUCKA, M., FINNEY, A., SAURO, H., BOLOURI, H., DOYLE, J., KITANO, H. The ERATO Systems Biology Workbench: AN Integrated Environment for Multiscale and Multitheatoretic Simulations in Systems Biology. *Foundations in System Biology*, ed, Hiroaki Kitano, MIT Press, 2001
- AGUDA, B., and SAURO, H, M (2001) Computer Simulation of MAPK Signal Transduction in Protocols. *MAPK Signalling* (R. Seger, Ed.), Humana Press, New Jersey, in press

I N P R E P A R A T I O N

“Conservation of Robustness” and Consequences for Biochemical Network Dynamics by J. Doyle, B. Ingalls, J. Goncalves, H. M. Sauro, and T.-M. Yi

A Rationale for the Designer of the MAP Kinase Pathway by H M Sauro

CONFERENCE PROCEEDINGS

FELL D. A. and SAURO H. M., (1985) Substrate cycles: do they really cause amplification?

Biochem. Soc. Trans., 13, 762-763

FELL D. A. and SAURO H. M., (1986) Non-equilibrium/equilibrium reactions: which controls?

Biochem. Soc. Trans., 14, 624-625

SAURO H. M. and FELL D. A., (1987) The role of co-operativity in metabolism.

Biochem. Soc. Trans. 1987, 15, 234-235

FELL, D. A., SAURO, H. M. and SMALL, J. R., (1988) "Le calcul des coefficients de controle par l'algebre matricielle."

Le controle du metabolisme Ed: Mazat, J.P. and Reder C., Published by Universite de Bordeaux II, Bordeaux.

FELL D. A., SAURO H. M., and SMALL J. R. (1990) Ch. 9, 139-148, Control coefficients and the matrix method.

Control of Metabolic Processes. (Cornish-Bowden, A. & Cardenas, M.L. eds.) NATO ASI Series, plenum Press, New York.

SAURO H. M., (1990) Ch. 17, 225-230, Quantification of metabolic regulation by effectors.

Control of Metabolic Processes. (Cornish-Bowden, A. & Cardenas, M.L. eds.) NATO ASI Series, plenum Press, New York.

KACSER H., SAURO H. M., and ACERENZA L., (1990) Ch. 20, 251-257, Control analysis of systems with

enzyme-enzyme interactions. *Control of Metabolic Processes*. (Cornish-Bowden, A. & Cardenas, M.L. eds.) NATO ASI Series, plenum Press, New York.

SAURO, H. M., (2000) Ch. 33, 221- 228, Jarnac: a system for interactive metabolic analysis. *Animating the Cellular*

Map 9th International BioThermoKinetics Meeting (eds: Hofmeyr, J-H. S, Rohwer, J. M, Snoep J. L) Stellenbosch University Press, ISBN 0-7972-0776-7

SAURO, H. M., (2000) Ch. 4, Jarnac: An Interactive Metabolic Systems Language in Computation in Cells:

Proceedings of an EPSRC Emerging Computing Paradigms Workshop Bolouri, Hamid & Paton, Raymond C

(Editors), *Dept. of Computer Science Technical Report No. 345*, University of Hertfordshire, UK, April 2000

Presentation at The First International Conference on Systems Biology (ICSB2000), Tokyo, Japan, November 2000,

put together by Herbert Sauro, Michael Hucka, Andrew Finney and presented by Hamid Bolouri

Michael Hucka, Herbert Sauro, Andrew Finney, Hamid Bolouri, John Doyle, Hiroaki Kitano, Foundations of

Systems Biology, ed. Hiroaki Kitano, *MIT Press*, Cambridge, Massachusetts, 2001 Presentation at the First

International Symposium on Computational Cell Biology, Lenox, Massachusetts, USA, March 2001

Andrew Finney, Michael Hucka, Herbert Sauro, Hamid Bolouri, John Doyle, Hiroaki Kitano. First presented at the

First International Symposium on Computational Cell Biology, Lenox, Massachusetts, USA, March 2001.

WORKSHOPS

Workshop on modelling cellular processes at University of Stellenbosch, 10-14 April 2000,

see <http://www.sun.ac.za/biochem/btk/workshop.html>

Second Workshop on Software Platforms for Systems Biology, May 2000, ERATO Kitano Systems Biology Project.

Held at Caltech.

Third Workshop on Software Platforms for Systems Biology, June 2001, ERATO Kitano Systems Biology Project.

Held at Caltech.

Fourth Workshop on Software Platforms for Systems Biology, November 2001, ERATO Kitano Systems Biology

Project. Held at Caltech.

Publicly Available Documents but non-refereed (from ww.cds.caltech.edu/erato).

All Dated 2000/2001

Systems Biology Markup Language (SBML) Level 1: Structures and Facilities for Basic Model Definitions.

SCHUCS: A UML-Based Approach for Describing Data Representations Intended for XML Encoding.

Internal Discussion Document: Possible Extensions to the Systems Biology Markup Language.

Introduction to the Systems Biology Workbench (SBW)

Programmer's Manual: for the Systems Biology Workbench (SBW) C++; manuals were also published in C, Java, Delphi and Python (in preparation).

The Systems Biology Workbench Concept Demonstrator A Comparison of Two Alternative Message-Passing Approaches for SBW.

EDITORIAL ACTIVITIES

Referee for papers published in *BioInformatics*, *J. theor. Biol.*, *Biophysical J.*, and *Biosystems*.

REFERENCES

Professor Adam Arkin

Department of Bioengineering and Chemistry

University of California, Berkeley CA, 94720

Telephone: (510) 495-2366 • Fax: (510) 486-6059

email: aparkin@lbl.gov

Professor Dennis Bray

Joint author of Molecular Biology of the Gene

Downing Street, Cambridge, CB2 3EJ, United Kingdom

Telephone: +44 (0) 1223 336602 • Fax: +44 (0) 1223 336676

email: d.bray@zoo.cam.ac.uk

Professor John Doyle

Professor of Control and Dynamical Systems, Electrical Engineering, and Bio-Engineering

Mail Code 107-81, California Institute of Technology Pasadena, CA 91125

Telephone: (626) 395-4808 • Fax: (626) 796-8914

email: doyle@cds.caltech.edu

Website: <http://www.cds.caltech.edu/~doyle>

Professor David A. Fell

School of Biological and Molecular Sciences

Oxford Brookes University, Headington, OXFORD, OX3 0BP, UK

Telephone: (+44) (0)1865 483247

email: daf@bms.brookes.ac.uk

Professor Mustafa Khammash

Associate Professor, Systems & Control

3132 Coover Hall, Department of Electrical & Computer Engineering, Iowa State University, Ames, Iowa 50011

Telephone: (515) 294-9950 • Fax: (515) 294-8432

email: khammash@iastate.edu

OTHER INTERESTS AND ACTIVITIES

Roman Archaeology

Was a member of the Scottish Caving Club

Used to climb the Scottish Mountains, but now instead explore and hike some of the amazing landscapes in southwest USA.

Cycling

Was an active member of Latin American and Scottish dance clubs.

Movies, going out, the usual stuff

residence

Dr Herbert M Sauro

1115 E. Cordova St., Apt. 108

Pasadena, CA 91125

Tel: (626) 792-7878

Nationality: British (Currently holding a US visa)