CURRICULUM VITAE

Héctor J. Sussmann

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Department of Mathematics Rutgers University 110 Frelinghuysen Road Piscataway, NJ 08854-8019, USA Home address: 6 Rea Court Piscataway, NJ 08854-2865, USA

Phone: (732) 445-5407 [office], (732) 445-2390 [dept.], (732) 926-9612 [home]

Fax: (732) 445-5530 (Rutgers Mathematics Department); (732) 926-9608 [home]

Email: sussmann@math.rutgers.edu

Web site: http://www.math.rutgers.edu/~sussmann

Born in Buenos Aires, Argentina, April 13, 1946. U.S. Citizen. Married.

Education:

- Ph.D. in Mathematics, September 1969, Courant Institute of Mathematical Sciences, New York University.
- Licenciado en Matemáticas, University of Buenos Aires, Argentina, December 1966.

Full-time positions:

- Rutgers University, Department of Mathematics (Assistant Professor, 1972-74; Associate Professor, 1974-78, Professor I, 1978-83; Professor II, 1983-).
- Department of Mathematics, University of Chicago (Dickson Instructor, 1971-72).
- Division of Engineering and Applied Mathematics, Harvard University (Research Fellow in Decision and Control, 1970-71).
- Department of Mathematics, City College of the City University of New York (Lecturer, 1969-70).

Selected Visiting Positions

- Visiting Professor, University of Padova, Department of Pure and Applied Mathematics, Padova, Italy. September 4 to November 26, 2004.
- Visitor, the Mittag-Leffler Institute, Sweden. January 15 to June 15, 2003. Participant in the Institute's Spring 2003 program on "Mathematical control and systems theory," and member of the program's organizing committee.
- Weston Visiting Professor, The Weizmann Institute of Science, Rehovot, Israel, October 1, 2000 to January 15, 2001.
- University of Groningen, Groningen, The Netherlands, (Johann Bernoulli Distinguished Visiting Professor, March 1-15 and May 15 to July 31, 1999).
- Institut Henri Poincaré, Centre Émile Borel Paris, France (Visiting Professor, January-June 1998).
- University of Buenos Aires, Argentina, (Visiting Professor, August 1997).

- INSA (Institut National de Sciences Appliquées), Rouen, France (Visiting Professor, June 1996 and May-June 1997).
- Université de Paris-Sud, Orsay (Visiting Professor, June 1995).
- Université de Marne-la-Vallée, France (Visiting Professor, June 1994).
- University of Minnesota, Institute for Mathematics and its Applications (IMA), Sept. 1992-July 1993. (Visiting professor and organizer of the Control Theory Year.)
- Université de Lille, France (Visiting Professor, June 1992).
- Université de Paris I (Visiting Professor, June 1991).
- Université de Metz and INRIA de Metz, Visiting Professor, May 1990.
- Université de Paris VI, Jussieu (Visiting Professor, February-July, 1989).
- Centre de Recherche de Mathématiques de la Décision (CEREMADE), Université de Paris IX, Dauphine (Visiting Professor, Spring 1978, May-June 1980, and Spring 1982).
- Ben Gurion University of the Negev, Beer Sheva, Israel (Visiting Professor, December 5, 1977 to January 5, 1978, and December 1-30, 1986.)
- University of Rome, Institute of Applied Mathematics (Visiting Professor, June 1981.)
- Istituto Matematico "Ulisse Dini," Università degli Studi di Firenze, Florence, Italy, (Visiting Professor, October 25-November 25, 1977.)
- Facultad de Ciencias, Universidad Autónoma de Madrid, Madrid, Spain (Visiting Professor, Sept. 21 Oct. 21, 1977.)

Areas of Research

- Systems and Control Theory: Differential Geometric Methods in Control Theory. Nonlinear controllability, observability, and realization theory. Optimal control. Necessary conditions for optimality in smooth and nonsmooth settings. Regularity properties of optimal trajectories and optimal synthesis, and optimal cost functions. Structure of attainable sets. Real analyticity and its consequences in control theory. Nonlinear filtering. Feedback stabilization.
- Analytic Stratifications: Subanalytic sets and stratifications. Real analytic desingularization. Extensions of stratification theory to larger classes of sets.
- *Stochastic processes:* Stochastic differential equations. Robust solutions of the Zakai equation of nonlinear filtering. Discretization schemes for stochastic differential equations.
- *Image processing:* Statistical Mechanical methods. Use of the Metropolis and annealing algorithms in image processing.
- Neural Nets: Information capacity. Convergence of learning algorithms. Boltzmann machines.
- Other areas of interest: Singularities of smooth maps. Catastrophe theory. Spectral theory of ordinary differential operators. Mathematical economics. Philosophical issues and methodological problems in mathematical modelling.

Teaching

- *Graduate courses:* Differential geometry, functional analysis, real variables, complex variables, ordinary differential equations, basic control theory. Advanced courses in nonlinear and optimal control.
- Undergraduate courses: Calculus, linear algebra, differential equations. Have taught, since 1993, the "Mathematics 300" Rutgers course on "Introduction to mathematical reasoning." Teaching material developed for the course is available at H. Sussmann's Web site.

Grants:

- Continued NSF support since 1972. Current grant is for a proposal on "Nonsmooth and geometric methods in nonlinear control," NSF-DMS 01-03901, dates: 9/1/01-8/31/05, amount of the award: \$200,000. (This was actually a 3-year grant, but an extension was requested for a fourth year. A new proposal, for the years 2005-2008, is currently being submitted to NSF.)
- (Joint with E. D. Sontag) CAIP Center Grant, 1986-1991. Approximately \$23,000 per year.
- (Joint with E. D. Sontag) AFOSR equipment grant, \$62,000.
- (Joint with E. Sontag) AFOSR grant for research on Neural Networks, 1991-94 and 1994-97. Amount of the 1994-97 grant: \$ 242,603.00.
- (Joint with J. Maxwell, representing the American Mathematical Society) NSF grant for the 1997 AMS Summer Research Institute on "Differential Geometry and Control," held in Boulder, Colorado, June 30 to July 18, 1997. Amount of the grant: \$ 170,000.00.
- (Joint with R. Nussbaum) NSF block travel grant for U. S. participants in the conference on "Calculus of Variations and Applications," held in Haifa, Israel, March 25 to April 1, 1998. Amount: \$ 13,000.
- (Joint with Q. Zhu B. Mordukhovich; Q. Zhu was the principal investigator) NSF block travel grant awarded to Western Michigan University under the title "Travel support: Variational analysis and geometric methods in optimal control (special sessions of IEEE[†] Conference on Decision and Control); Las Vegas, Nevada," No. NSF-DMS-0245279, dates: 2/15/03-1/31/04, amount: \$8,000.

Awards:

- Fellow of the IEEE, elected in 1995.
- Rutgers University Board of Regents 1997 Award for Excellence in Research (October 1997).
- Award for Outstanding IEEE Control Systems Magazine Paper of the Year, for the paper "300 years of optimal control: from the brachystochrone to the maximum principle," coauthored with J. C. Willems, published in the June 1997 issue of the journal (December 1998).

In addition:

• *Michael Malisoff* received the 1999 IEEE CDC (Conference on Decision and Control) Student Best Paper Award, presented at the 38th IEEE CDC held in Phoenix, AZ, Dec. 7-10, 1999. The citation reads:

[†] Institute of Electrical and Electronic Engineers

In recognition of Michael Malisoff, as the recipient of the 1999 CDC Student Best Paper Award, for the paper "On the Bellman equation for optimal control problems with exit times and unbounded cost functionals," under the guidance of Professor Hector Sussmann.

• The article

"Controllability of nonlinear systems," by H. J. Sussmann and V. Jurdjevic (*J. Diff. Equations* **12** (1972), pp. 95-116)

was selected by the IEEE Control Systems Society to be one of the 25 papers included in a volume on the "25 Major Impact Control Papers of the Century," published by the IEEE in the year 2000.

Service to the profession (selected items):

- Member of the Council of the American Mathematical Society, 1982-1984.
- Chairman, Organizing Committee of the 1992-1993 Special Year in Control Theory at the Institute for Mathematics and its Applications, University of Minnesota.
- Organizer, American Mathematical Society (AMS) 1997 Summer Research Institute (SRI), on "Differential Geometry and Control," held at the University of Colorado at Boulder, from June 30 to July 18, 1997.
- Organizer, Short course on Nonlinear Control Theory, 1999 Winter meeting of the American Mathematical Society (AMS), San Antonio, Texas, January 13-16, 1999. (The course consisted of six lectures, one by the organizer and five by other mathematicians.)
- Co-organizer (together with A. Lindquist and C. I. Byrnes, and C. M. Martin) of the Spring 2003 program on "Mathematical control and systems theory"" at the Mittag-Leffler Institute, Sweden, January 15 to June 15, 2003.
- Member of various organizing committees of various SIAM and IEEE mathematical or control conferences, and organizer of sessions. Recent examples:
 - Chairman of the committee to write the guidelines for a new SIAM prize, for research in Control Theory, to be awarded by the SIAM activity group in control. (The proposal written by this committee was approved by the SIAM Council, December 1996.)
 - Member, SIAM 1998 Control Group prize committee.
 - Member, organizing committee of the Fourth SIAM Conference on Control and Its Applications, held in Jacksonville, Florida, May 7-9, 1998.
 - Member, program committee of the 38TH IEEE Conference on Decision and Control, to be held on December 7 to 10, 1999, in Phoenix, Arizona.
- Member of various panels for professional organizations and funding agencies. Recent examples:
 - (i) Panel for selection of speakers for Section 17 of the 1994 International Congress of Mathematicians held in Zurich.
 - (ii) National Science Foundation Systems and Engineering panel, February 29-March 1, 1996.
 - (iii) National Science Foundation Learning and Intelligent Systems panel, August 3-5, 1998.
- Editorial positions:
 - Associate Editor, SIAM Journal on Control and Optimization, 1978-1989.
 - Associate Editor, Systems and Control Letters, 1980-84.
 - Regional Co-managing Editor, Acta Applicandæ Mathematicæ, 1982- .

- Associate Editor, Mathematics of Control, Systems and Signals, 1987-1990.
- Associate Editor, Forum Mathematicum, 1990-
- Associate Editor, Neural Networks, 1993-95.

Membership in Professional Societies:

- American Mathematical Society: Member, 1969- .
- Society for Industrial and Applied Mathematics: Member, 1973-% = .

Ph.D. Thesis Sponsored:

- L.S. Tang, Some generic properties of problems in optimal control theory, 1978.
- J. Darken, Accessible sets for analytic control systems in \mathbb{R}^2 , 1982.
- G.S. Ferreyra, The partial differential equations of nonlinear filtering, 1983.
- H. Schättler, Time-optimal control for single-input systems in \mathbb{R}^3 , 1986.
- G. Lafferriere, Stratification theorems in two and three dimensions for classes of sets larger than that of subanalytic sets, 1986.
- W. Liu, Averaging theorems for highly oscillatory differential equations and the approximation of general paths by admissible trajectories for nonholonomic systems, 1992.
- G. Tang, Structure of optimal trajectories for some optimal control problems in two and three dimensions, 1992.
- Y. Yang, Global stabilization of linear systems with bounded feedback, 1993.
- Y. Chitour, Applied and theoretical aspects of the controllability of nonholonomic systems, 1996.
- M. Malisoff, Viscosity solutions of the Bellman equation for optimal control problems with exit times, 1999.

Selected invited talks:

- Selected plenary lectures at national and international conferences:
- 45-minute lecture on "Analytic stratifications and control theory," International Congress of Mathematicians, Helsinki, Finland, August 22, 1978.
- Plenary lecture on Neural Nets, International Symposium on the Mathematical Theory of Networks and Systems (MTNS-89), Amsterdam, The Netherlands, June 1989.
- Plenary lecture on "Recent developments in Nonlinear Optimal Control," Nonlinear Control Systems Symposuim (NOLCOS, an international conference of IFAC, the International Federation for Automatic Control), Capri, Italy, June 1989.
- Plenary lecture, 1991 Winter meeting of the American Mathematical Society, San Francisco, January 17, 1991. Title: "Recent results and open problems in deterministic nonlinear control."
- Plenary lecture, SIAM Control Conference, Minneapolis, MA, September 1992.
- Plenary lecture, IEEE Conference on Decision and Control (CDC), New Orleans, December 1995.
- Plenary lecture, International Symposium on the Mathematical Theory of Networks and Systems (MTNS-96), St. Louis, Mo., June 1996.

- Plenary lecture, Conference in honor of S. Lojasiewicz on the occasion of his 70th birthday; Kraków, Poland, September 1996.
- Plenary lecture, Conference on "Singularities and control theory," held at the Technion, Haifa, Israel, December 29, 1996 to January 6, 1997.
- Plenary lecture, IFIP Conference on "Optimal control: theory, algorithms, and applications," held on February 27, 28, and March 1, 1997, at the University of Florida, Gainesville.
- Plenary lecture, Congreso de Matemática Capricornio (COMCA'97), held in Antofagasta, Chile, July 30 to August 2, 1997.
- Plenary lecture, conference on subriemannian geometry, São Paulo, Brazil, September 1-5, 1997.
- Plenary lecture, conference on "Operators, Systems and Linear Algebra: Three Decades of Algebraic Systems Theory" in Honor of Prof. Paul Fuhrmann, held on Sept 23-26, 1997 at the University of Kaiserslauten, Germany.
- The William B. Kouwenhoven Lecture, Johns Hopkins University, Baltimore, Md., Oct. 22, 1997.
- Plenary lecture, Conference on "Calculus of Variations and Applications," held in Haifa, Israel, March 25 to April 1, 1998.
- Plenary lecture, Conference on "Perspectives in Control," in honor of R. W. Brockett on the occasion of his 60-th birthday, held in Cambridge, Mass., October 23-24, 1998.
- Plenary lecture, The 2nd Michigan Interdisciplinary Mathematics Meeting (MIMM II), on "Optimization, Algorithms and Control." University of Michigan at Ann Arbor, May 6-8, 1999.
- Plenary lecture, Conference on "The mathematics of systems and control: from intelligent control to behavioral systems," September 17-18, 1999, University of Groningen, the Netherlands.
- Plenary lecture, European Control Network Workshop on Nonlinear Control, held at the Centre National de la Recherche Scientifique (CNRS), Paris, France, June 5-7, 2000.
- Plenary lecture, Journée Annuelle de la Société Mathémathique de France, held at the Institut Henri Poincaré in Paris, France, June 17, 2000.
- Plenary lecture, Conference on Mathematical control theory and robotics, organized by SISSA (Scuola Internazionale Superiore di Studi Avanzati), together with the Centro Piaggio and the Steklov Institute. Held in Trieste, Italy, June 25-27, 2000.
- Plenary lecture, Conference on "Geometric control theory and applications, GCTAA-2000," at the Universidad Autónoma de México (UAM), Azcapotzalco, México, September 4,5,6, 2000.
- Plenary lecture, CICINDI 2002 (Conferencia Internacional en control, instrumentación virtual y sistemas digitales 2002). August 26-30, 2002. In the Centro de Investigacióon en Tecnologías de Información y Sistemas, Pachuca, Hidalgo, México.
- Plenary lecture at the conference "New directions in mathematical systems theory and optimization," an international symposium in honor of Anders Lindquist, held at the Royal Institute of Technology (KTH), Stockholm, Sweden, November 15-16, 2002.
- Plenary lecture on "Differentials of non-differentiable maps" 24th Brazilian Colloquium of Mathematics, held at the IMPA, in Rio de Janeiro, Brazil, July 27 to August 1, 2003.
- Plenary lecture at the Workshop on "Variational limits" held at the Weizmann Institute, in Rehovot, Israel, June 15-18, 2004.
- Plenary lecture at the Workshop on "Dynamical systems" held at the Technion, in Haifa, Israel, June 19-22, 2004.

- Other invited lectures, series of lectures, and short courses (selected items):
 - Invited lectures at all the conferences on control held every two years at the Mathematics Institute in Oberwolfach, Germany, from 1976 to 1996, and every three years since 1996. Most recent meetings: November 24-30, 1996, March 21-27, 1999, and February 24-March 3, 2002.
- Series of five lectures on "Lie brackets and real analyticity in Control Theory," Control Theory Semester, Banach International Center of the Polish Academy of Sciences, November 6-30, 1980.
- Series of five lectures on "Analyticity, Lie brackets and geometric control," Differential Geometric Control Theory Conference, Houghton, Michigan, June 28-July 2, 1982.
- Lecture on "Recent results on the structure of optimal trajectories and optimal synthesis," Conference on Systems and Control, Beijing, China, May 1984.
- Series of 6 lectures on "Lie algebras of vector fields and optimal control theory," Nankai University, Tianjin, China, March 1986.
- Two-week course (12 lectures) on "Systems of vector fields and finite-diensional control theory," Centre de Recehrches Mathématiques, Université de Montréal, July 1992.
- Plenary lecture, INRIA (Institut National de Recherche en Informatique et Automatique) 25th anniversary meeting, Paris, December 1992.
- Series of 2 lectures, Conference on mechanical systems and control, IMPA, Rio de Janeiro, Brazil, March 1993.
- Lecture, Conference on control, Athens, Ohio, March 1993.
- Series of 3 lectures, Conference on control and robotics, Rodez, France, April 1993.
- Series of 5 lectures, Banach Center, Warsaw, Poland, June 1993.
- Plenary lecture, Conference on Control, Jerusalem, Israel, October 1993.
- Plenary lecture, Conference on "Control of uncertain systems: from the Calculus of Variations to Optimal and Robust Control," on the occasion of the 300th anniversary of John Bernoulli's appointment to a professorship in Groningen. Groningen, the Netherlands, August 1995.
- Lecture on "Real analytic stratifications, desingularization, and optimal control," at the Special Session on Real Analytic Geometry and o-Minimal Structures, AMS 1996 Spring Southeastern sectional meeting, Baton Rouge, LA, April 19-21, 1996
- Course on Optimal Control (series of 10 lectures in two weeks), University of Lund, Sweden, Nov. 4-13, 1996.
- Intensive course (a 3-week series, 3 days each week, 5 hours per day) on "Recent results on optimal control" taught at the University of Buenos Aires, August 1997.
- Course on "Recent results on optimal control" (a series of nine 2-hour lectures) taught at the Institut Henri Poincaré, in Paris, France, January-March 1998.
- Lecture, COSY Workshop on "Control of Nonlinear and Uncertain Systems," held at Imperial College and the Royal Society, London, U.K., February 6 - 8, 1998
- Mathematics colloquium, Université Libre de Bruxelles, Brussels, Belgium, February 17, 1998.
- Lecture, workshop on "Relaxation Methods," held at the Weizmann Institute in Rehovot, Israel, March 22-24, 1998.
- Lecture, workshop on "Nonlinear robust and optimal control," held in Würzburg, Germany, March 30-April 3, 1998.
- Intensive course (3 days, 4 hours of lectures each day) on "Recent developments on Geometric and Nonsmooth Optimal Control," University of Ghent, Belgium, APRIL 28-29-30, 1998.
- Course on "Geometry and optimal control" (a series of five 1-hour lectures) taught as part of the Advanced Course in "Mathematical Control Theory," in Levico Terme, Italy, June 1-6, 1998, organized by the Italian National Research Council.

- Plenary lecture, European community nonlinear control network workshop on "Stability and stabilization," held in Ghent, Belgium, March 15,16, 1999.
- Lecture, Special session on Variational Analysis and Optimization, The Third World Congress of Nonlinear Analysts, Catania, Sicily, Italy, July 19-26, 2000.
- Series of six lectures at the Mittag-Leffler Institute, in Djursholm, Sweden, January-June, 2003.
- Short course on "High-order conditons and open mapping theorems," at the Third school on analysis and geometry in metric spaces, held in Trento, Italy, May 26-30, 2003.
- Course on "Generalized differentials and geometric control," at the School on geometric nonlinear control held in Campinas, Brazil, July 14-26, 2003.
- Course on "The maximum princple under general technical conditions." CIME (Centro Internazionale Matematico Estivo) course on "Nonlinear and optimal control theory" held in Cetraro (Cosenza), Italy, June 21-29, 2004.

PUBLICATIONS

Items marked [AHP] are available —as compressed Postscript files—from the author's Web site:

http://www.math.rutgers.edu/~sussmann/~currentpapers.html

BOOKS EDITED

- (with R. W. Brockett and R. S. Millman) Differential Geometric Control Theory, Proceedings of the Conference held at Michigan Technological University, Houghton, Mich., June 28-July 2, 1982. Progress in Mathematics 27, Birkhäuser Boston, Boston, Mass., 1983. vii+340 pp.
- Nonlinear Controllability and Optimal Control. <u>Monographs Textbooks Pure Appl. Math.</u>, 133, Marcel Dekker Inc., New York, 1990, viii+472 pp.
- (with B. S. Mordukhovich) Nonsmooth Analysis and Geometric Methods in Deterministic Optimal Control, Proceedings of the Workshop held in Minneapolis, Minnesota, February 8-17, 1993. <u>The IMA Volumes in Mathematics and its Applications</u> 78, Springer-Verlag, New York, 1996, x+246 pp.
- (with J. Baillieul and S. S. Sastry) Essays on Mathematical Robotics, Proceedings of the February 1993 Workshop on Robotics held at the Institute for Mathematics and its Applications (IMA) at the University of Minnesota. <u>The IMA Volumes in Mathematics and its</u> <u>Applications</u> 104, Springer-Verlag, New York, 1998, ix+372 pp.
- (with G. S. Ferreyra, H. Hermes, and R. Gardner) Differential Geometry and Control, Summer Research Institute on Differential Geometry and Control, June 29-July 19, 1997, University of Colorado, Boulder. <u>Proceedings of Symposia in Pure Mathematics</u> 64, American Mathematical Society, 1999, viii+341 pp.

ARTICLES IN REFEREED JOURNALS

- "Nonspectrality of a class of second order ordinary differential operators." Comm. Pure and Applied Math. 23, 1970, pp. 819-840.,
- 7. "The bang-bang problem for certain control systems in $GL(n, \mathbb{R})$." SIAM J. Control 10, 1972, pp. 470-476.
- (with V. Jurdjevic) "Controllability of nonlinear systems." J. Diff. Equations 12, 1972, pp. 95-116.
- 9. (with V. Jurdjevic) "Control systems on Lie groups." J. Diff. Equations 12, 1972, pp. 313-329.
- 10. "The control problem x' = (A(1-u) + Bu)x: a comment on an article by J. Kucera." *Czech.* Math. Journal 22, 1972, pp. 423-426.
- **11.** "The control problem x' = A(u)x." Czech. Math. Journal **22**, 1972, pp. 490-494.
- (with R. W. Brockett) "Tangent bundles of homogeneous spaces are homogeneous spaces." Proc. Amer. Math. Soc. 35, no. 2, 1972, pp. 550-551.
- "Generalized spectral theory and second order ordinary differential operators." Canad. Math. Journal 25, 1973, pp. 178-193.
- "Orbits of families of vector fields and integrability of systems with singularities." Bull. Amer. Math. Soc. 79, no.1, 1973, pp. 197-199.
- "Orbits of families of vector fields and integrability of distributions." Trans. Amer. Math. Soc. 180, 1973, pp. 171-188.
- "An extension of a theorem of Nagano on transitive Lie algebras." Proc. Amer. Math. Soc. 45, 1974, pp. 349-356.
- "On quotients of manifolds: a generalization of the closed subgroup theorem." Bull. Amer. Math. Soc. 80, 1974, pp. 573-575.
- "On the number of directions needed to achieve controllability." SIAM J. Control 13, 1975, pp. 414-419.
- "A generalization of the closed subgroup theorem to quotients of arbitrary manifolds." J. Diff. Geometry 10, 1975, pp. 151-166.
- 20. "Catastrophe theory." Synthese 31, no. 2, 1975, pp. 229-270.
- 21. (with N. Levitt) "On controllability with two vector fields." SIAM J. Control 13, no. 6, 1975, pp. 1271-1281.
- 22. "On some properties of vector fields that are not altered by small perturbations." J. Diff. Equations 20, no. 2, 1976, pp. 292-315.
- "Minimal realizations and canonical forms for bilinear systems." J. Franklin Institute 301, no. 6, 1976, pp. 593-604.
- "Existence and Uniqueness of minimal realizations of nonlinear systems." Math. Systems Theory 10, no. 3, 1977, pp. 263-284.
- 25. "An interpretation of stochastic differential equations as ordinary differential equations which depend on the sample path." *Bull. Amer. Math. Soc.* 83, no. 2, 1977, pp. 296-298.
- 26. (with R. Zahler) "Catastrophe theory: exaggerated claims, meager accomplishements." Nature 269, 1977, pp. 759-763.
- (with R. Zahler) "A critique of applied catastrophe theory in the behavioral sciences." Behavioral Sci. 23, no. 5, 1978, pp. 383-389.

- 28. (with R. Zahler) "Catastrophe theory as applied to the social and biological sciences: a critique." Synthese 37, no. 2, 1978, pp. 117-216.
- 29. "A sufficient condition for local controllability." SIAM J. Control 16, no. 5, 1978, pp. 790-802.
- 30. "On the gap between deterministic and stochastic differential equations." Annals of Probability
 6, no. 1, 1978, pp. 19-41.
- 31. "Subanalytic sets and feedback control." J. Diff. Equations 31, no. 1, 1979, pp. 31-52.
- **32.** "A bang-bang theorem with bounds on the number of switchings." SIAM J. Control and Optimization **17**, no. 5, 1979, pp. 629-651.
- **33.** "Single-input observability of continuous-time systems." *Math. Systems Theory* **12**, no. 4, 1979, pp. 371-393.
- 34. "Analytic stratifications and control theory." In Proceedings of the International Congress of Mathematicians (Helsinki, 1980), Acad. Sci. Fennica, Helsinki, 1980, pp. 865-871.
- 35. "Les semi-groupes sous-analytiques et la régularité des commandes en boucle fermée." (French) In Systems Analysis (Conf., Bordeaux, 1978), Astérisque (Soc. Math. de France) 75-76, Paris, 1980, pp. 219-226.
- 36. (with R. Bumby, E. D. Sontag and W. Vasconcelos) "Remarks on the pole-shifting problem over rings." J. Pure and Applied Algebra 20, no. 2, 1981, pp. 113-127.
- 37. "Bounds on the number of switchings for trajectories of piecewise analytic vector fields." J. Diff. Equations 43, no. 3, 1982, pp. 399-418.
- **38.** "Approximate finite-dimensional filters for some nonlinear problems." *Stochastics* **7**, no. 3, 1982, pp. 183-204.
- "Lie brackets and local controllability: a sufficient condition for scalar input systems." SIAM J. Control and Optimization 21, no. 5, 1983, pp. 686-713.
- 40. (with M. Hazewinkel and S. I. Marcus) "Nonexistence of finite-dimensional filters for conditional statistics for the cubic sensor problem." Systems and Control Letters 3, no. 6, 1983, pp. 331-340.
- 41. (with S. Lojasiewicz Jr.) "Some examples of reachable sets and optimal cost functions that fail to be subanalytic." *SIAM J. Control and Optimization* 23, no. 4, 1985, pp. 584-598.
- 42. "A weak regularity theorem for real analytic optimal control problems." *Revista Matemática Iberoamericana* 2, no. 3, 1986, pp. 307-317.
- **43.** "A general theorem on local controllability." *SIAM J. Control and Optimization*, **25**, no. 1, 1987, pp. 158-194.
- 44. "The structure of time-optimal trajectories for single-input systems in the plane : the C^{∞} nonsingular case." SIAM J. Control and Optimization, 25, no. 2, 1987, pp. 433-465.
- 45. "The structure of time-optimal trajectories for single-input systems in the plane: the general real-analytic case." SIAM J. Control and Optimization 25, no. 4, 1987, pp. 868-904.
- 46. "Regular synthesis for time-optimal control of single-input real-analytic systems in the plane." SIAM J. Control and Optimization 25, no. 5, 1987, pp. 1145-1162.
- 47. "Small-time local controllability and continuity of the optimal time function for linear systems."
 J. Optim. Theory and Applications 53, no. 2, 1987, pp. 281-296.
- 48. (with H. M. Schättler) "On the regularity of optimal controls." Zeitr. Angew. Math. Phys. 38, no. 2, 1987, pp. 292-301.
- **49.** "On the number of memories that can be perfectly stored by a neural net with Hebb weights." *IEEE Transactions on Information Theory* **35**, no. 1, 1989, pp. 174-178.

- **50.** (with E. D. Sontag) "Backpropagation can give rise to spurious local minima even for networks without hidden layers." *Complex Systems* **3**, no. 1, 1989, pp. 91-106.
- (with E. D. Sontag) "Further comments on the stabilizability of the angular velocity of a rigid body." Systems and Control Letters 12, no. 3, 1989, pp. 213-217.
- (with P. V. Kokotovic) "A positive real condition for global stabilization of nonlinear systems." Systems and Control Letters 12, no. 2, 1989, pp. 125-133.
- (with P. V. Kokotovic and A. Saberi) "Global stabilization of partially linear composite systems." SIAM. J. Control Opt. 28, no. 6, 1990, pp. 1491-1503.
- 54. "Real analytic desingularization and subanalytic sets: an elementary approach." Trans. Amer. Math. Soc. 317, no. 2, 1990, pp. 417-461.
- **55.** "Limitations on the stabilizability of globally minimum phase systems." *IEEE Trans. Automat. Control* **AC-35**, no. 1, 1990, pp. 117-119.
- 56. "A proof of the realization theorem for convergent generating series of finite Lie rank." Rutgers Center for Systems and Control Technical Report 90-02, April 1990. To appear in *Mathematics* of Control, Signals and Systems.
- **57.** (with E. D. Sontag) "Backpropagation separates when perceptrons do." *Neural Networks* **4**, 1991, pp. 243-249.
- 58. (with P. V. Kokotovic) "The peaking phenomenon and the global stabilization of nonlinear systems." *IEEE Trans. Automat. Control* AC-36, no. 4, 1991, pp. 424-440.
- **59.** [AHP] (with G. Q. Tang) "Shortest paths for the Reeds-Shepp car: a worked out example of the use of geometric techniques in nonlinear optimal control." Rutgers Center for Systems and Control Technical Report 91-10, September 1991. To appear in *SIAM J. Control.*
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 $^{^{\#}}$ This is the only non-mathematical item in the publication list.