

# Chapter 12

## Jair Minoro Abe on Paraconsistent Engineering

Seiki Akama

*Dedicated to Jair Minoro Abe for his 60th birthday*

**Abstract** An overview of Professor Abe's scientific work is presented, emphasizing the main results obtained by him in his research activity. He has done a lot of work on paraconsistent logics and their applications. We survey his academic career and published works.

**Keywords** Jair Minoro Abe · Paraconsistent logics · Annotated logics

### 12.1 Introduction

Jair Minoro Abe has established itself as one of leading figure in the consolidation regarding to applications of paraconsistent systems, which had one of the introducers the renowned Prof. Newton C.A. da Costa. Abe has dedicated to an important class of paraconsistent logic, namely the paraconsistent annotated logics.

This paper intends to give a short view of activities of Abe. In section, we give his biographical information. In Sect. 12.3, we present a general description of his published works.

---

S. Akama (✉)  
C-Republic, 1-20-1 Higashi-Yurigaoka, Asao-ku, Kawasaki 215-0012, Japan  
e-mail: akama@jcom.home.ne.jp

## 12.2 Biographical Information

Jair Minoro Abe was born on October 6, 1955 in São Paulo City, São Paulo, Brazil, as an eldest son of Tadashi Abe (1923–1984) and Kinuko Abe (1931–), typical Japanese immigrants from the 30s of last century, has two sisters, Marina and Nilza. Abe is married with Tiyo and has two daughters, Clarissa and Letícia.

By the age of four lived with uncles in Mogi das Cruzes city, nearby from São Paulo, where he studied Japanese language, not continuously until late 1962 due health conditions. He went back to São Paulo to start primary school (Grupo Escolar de Vila Ré) until mid 1965 when he moved to a newer building that replaced the old wooden shed and was named “Grupo Escolar Prof. Jose Bartocci”. Abe studied there until 1966, the year that also attended “Externato Cristo Rei” to take the exam to enter to the “Colégio Estadual Prof. Gabriel Ortiz” (junior high school and high school) during the period 1967–1970 and 1971–1973.

Abe mentions that in primarily and high school times experienced one of the most amazing periods of his life either learning, but also meeting teachers and wonderful friends who greatly influenced the subsequent journey. Also in 1973 he attended the “CECA Vestibulares” by action of Prof. Julio Takara electing him as one of the best students, gracing him with a scholarship for preparatory course, which was of great importance for Abe at the time.

In 1974, he began the course of Bachelor of Mathematics at Institute of Mathematics and Statistics, University of São Paulo (USP). He had contact with valuable mathematicians such as M. Peixoto, E. Farah, N. da Costa, L. Berthet, J. Zimbar, C. Höning, O. Alas, A. Gillioli, among others. Shortly after completion, began the Graduate course in Pure Mathematics at same Institute having the supervision of Dr. Newton Costa and wrote his dissertation on foundations of ordered geometry [1].

After completing the master course, he attended a doctorate course at the Faculty of Philosophy, Letters and Human Sciences of University of São Paulo, where he obtained his Doctor degree in Philosophy under the supervision of Dr. Newton Costa [3]. Abe investigated the foundations of annotated logics, an issue that came to the hands of his mentor through an application in logic programming made by Blair and Subrahmanian [19, 32].

The appearance of a paraconsistent system in logic programming would provide the opening for applications, awaited the paraconsistent systems. Abe then had long conversations with Newton Costa on applications of paraconsistent systems and then designed a program to do it. At the time, invited to give a graduate course at Polytechnic School, University of São Paulo with Newton Costa, brought together some disciples to accomplish his project.

By 1996 Abe together with Prado and Avila implemented a logic programming language *Paralog* based on annotated logics [18, 22] independently of Subrahmanian and thus originated the first incursions in Artificial Intelligence (AI): an architecture based entirely on annotated logics and knowledge representation theory via the concept of frames [2].

A few years later, Da Silva Filho built electronic circuits accommodating inconsistencies. Among contributions in his doctoral thesis was included logic controller based on annotated logics called Para-analyzer. It was soon materialized into a logic controller called paracontrol. To accomplish its functionality it was built the first robot made entirely with hardware based on such logic: Emmy. There have been made many improvements.

Da Silva Filho noted that a convenient combination of algorithm Para-analyzer resulted in a ‘network’ which was named paraconsistent artificial neural network. Effectively it was verified that it had characteristics of an artificial neural network; furthermore such network present useful properties that differ much from existing ones.

Meanwhile, Abe felt the need to broaden the horizons of their research as well as for his collaborators: a feat that direction was the development of an entirely geared congress devoted to applications of logic to AI and technology. Thus the Congress of Logic Applied to technology (LAPTEC) was born. LAPTEC was welcomed with great enthusiasm and had some famous lecturers: P. Suppes, N. da Costa, E.G.K. Lopez-Escobar, M.C. Monard, N. Ebecken, K. Nakamatsu, S. Akama, T. Date, D. Dubois, E. Massad, M. Droste, and others.

At the 1st Congress of Paraconsistency held in Ghent, Belgium, 1997, Abe met K. Nakamatsu and S. Akama for the first time. They were studying annotated logics among their themes and expected to meet with Abe and was, indeed, an important milestone. They then proceeded to have a strong cooperation that last until nowadays.

Abe’s carrier was made mainly hard work, but he thinks that only this it is not enough; it is necessary something more, that he call ‘fortunate’. Abe also mention that he always had the support of his parents and after the death of his father, Abe continued to live whenever possible with his mother who gave him all the necessary support for the day-by-day of his career.

Abe’s academic positions are as follows:

- Assistant Professor, Paulista State University, 1984–1995
- Coordinator of Logic and Science Theory, Institute For Advanced Studies, University of São Paulo, 1987–2016
- Research Associate, University of São Paulo, 1989–2016
- Full Professor, Paulista University, 1996-

All academic activities were done as Full Professor at Paulista University, which has received great deal to accomplish his investigations. Abe supervised many Ph.D. and M.Sc. students; see Ávila [17], Prado [31], Da Silva Filho [24]. Ph.D. students are as follows:

Ph.D. students

- Bráulio Coelho Avila (Computational Intelligence)
- José Pacheco de Almeida Prado (Computational Intelligence)
- João Inácio da Silva Filho (Automation and Robotics)
- João Carlos Almeida Prado (Computational Intelligence)

- Mauricio Conceição Mário (Computational Intelligence)
- Cláudio Rodrigo Torres (Automation and Robotics)
- Marcelo Nogueira (Computational Intelligence)
- Fábio Vieira do Amaral (Computational Intelligence)
- Nélio Fernando dos Reis (Decision-Making)
- Cristina Corrêa de Oliveira (Computational Intelligence)
- Avelino Palma Pimenta Jr (Computational Intelligence)

Abe's undergraduate courses were or are all introductory, having no prerequisites and presupposing no previous knowledge. In each course he takes care making the subject as attractive as possible with applications and/or possible applications.

Many of classes he used to teach playfully, explaining as detailed as possible. Stressing the priority of education, Abe strives to assist his students to think by themselves, that logic is a wonderful tool to do that, to gain independence of judgment. Besides their classes were really good: once da Costa wrote in one of his letters of recommendation that Abe was an excellent expositor. Also many of his students refer to him as master who transform difficult topics to understandable ones.

Among courses that Abe has lectured trough years are: differential calculus, basic algebra, linear algebra, numerical analysis, basic logic, basic non-classical logic, introduction to set theory, matrix theory, basic mathematics, basic statistics, vectors and geometry, computability theory, discrete mathematics, artificial intelligence, intelligent information systems, among others.

Among graduate courses, Abe has lectured: expert systems in production engineering, quantitative method in engineering, introduction to set theory, AI in bioinformatics, introduction to classical logic, introduction to non-classical logic, among others.

Abe organized (or co-organized) several international conferences including *Logic Applied to Technology* (LAPTEC) in 2000, 2001, 2002, 2003, 2005, 2007 (with J.I. da Silva Filho in 2005, K. Nakamatsu in 2007) and *Workshop Intelligent Computing Systems* (WICS) in 2013, 2014, 2015.

He also served as a reviewer for scientific journals including *Mathematica Japonica* (Editorial Board), *Scientiae Mathematicae Japonicae* (Editorial Board), *International Journal of Reasoning-based Intelligent Systems* (Advisory Editor), *Neurocomputing*, *Mathematical Reviews*.

### 12.3 General Description of Published Works

In this section, we briefly describe Abe's work. He has engaged in the following principal areas of research, namely:

1. Annotated logics
2. Artificial neural networks
3. Expert systems in decision-making

4. Automation and robotics
5. Curry algebras
6. Annotated systems and fuzzy set theory
7. Nelson logics
8. Annotated modal systems
9. Annotated logic programming
10. Logic and biology
11. Logic and psychoanalysis

As above, Abe studied many applications of paraconsistent logics to several areas. For a survey on applications to AI, see Abe [5].

Abe undoubtedly made important contributions to *annotated logics* [3, 21, 23], which belong to paraconsistent logics. He was to carry out a systematic study of such logics and was the first to write a dissertation on annotated logics. He established foundations for annotated logics like basic theory of models, including the Łoś theorem [3, 9, 10]. Algebraic versions were also investigated providing, in particular, completeness and decidability theorems.

For *artificial neural networks* [7] and their applications, he started with da Silva Filho, and students, applying in aiding of Alzheimer's disease diagnosis [26], the craniometric variables analysis [27], in speech disorder, typed characters recognition, and other issues [8].

For *expert systems in decision-making*, Abe devoted considerably in implementing the annotated evidential  $E\tau$  paraconsistent logic in the matter of decision-making applied by innumerable MSc students and Ph.D. dissertations [20].

Abe also worked on *automation and robotics* based on paraconsistent logics. Namely, he developed with his students multiple robots resulted from the application of logical controller *Paracontrol*: Emmy, Sofya, Amanda, Hephaestus, all of them by using sensors of different types in order to and an electronic device for visual and/or hearing impaired who named Keller [25].

Abe has applied the concept of *Curry algebras* [6] in order to obtain algebraic versions not only for annotated logics, but also other class of paraconsistent and para-complete systems. Abe has extended to first order monadic calculi of such systems via ideas of Halmos concerning monadic algebras [12].

There are many ways to obtain annotated set theories. One way to do is “inside” of some usual set theory (for instance, ZF-set theory) exactly as classical Fuzzy set theory as did by Zadeh. Abe has studied in this direction and one its versions (annotated set theory) encompasses Fuzzy Set theory [3, 21]. In collaboration to S. Akama, it was possible to adapt annotated axiomatic to obtain some axiomatizations of versions of fuzzy systems, showing the power of these systems [15].

Abe coauthored some papers with Akama in elucidating the operator “negation” in several non-classical logics like *Nelson logics* which have been developed as constructable systems by Nelson [30]. Akama, Abe and Nakamatsu proposed constructive discursive logics in [16].

*Annotated modal systems* can provide the basis for the paraconsistent, paracomplete and non-alethic reasoning, non-monotonic reasoning, defeasible reasoning, deontic reasoning, other doxastic logics, temporal logics, multi-modal logics, among others [4, 11, 14].

Nakamatsu and Abe have organized several invited sessions of several conferences. Abe has also participated actively with Nakamatsu in his research themes that lean on annotated logic programming, including defesiable deontic control systems [28, 29].

With the renowned entomologist N. Papavero, who became interested in the axiomatization of biology, Abe worked in collaboration on the theme in various aspects: firstly they considered Mereology as the basis of the issue, having as primitive concept “is part of” (e.g., ‘the arm is part of the body’). Papavero and Abe also considered set theoretical predicates for axiomatization (in the sense of Suppes [33]) and they have succeed in Cladistics, in the conception of W. Hennig.

Abe has given assistance for the study of Lacan’s proposal, aiding in the logical concepts used on his books of the Seminar.

For books, Abe, Akama and Nakamatsu published a book “Introduction to Annotated Logics” in 2015, which describes the theoretical basis of annotated logics [13]. In the same year, Abe also edited a book “Paraconsistent Intelligent Based-Systems” [8] entirely devoted to the applications of annotated systems. Abe, Akama and Nakamatsu plan to write more books on application of paraconsistent systems.

Outside the academic sphere, Abe want mention his taste for classical music and popular music. Like so many of his generation was influenced by various types of music of his time, but it highlights his taste for American singer Johnny Mathis, bossa nova rhythm, and pop music is 60s and oldies.

Abe also always liked pets (he’d had many of them through his life) that helped to distract in his spare time and also cultivated photographs, interest in past times events. Also he likes play regularly tennis and he regularly monitors major tournaments.

**Acknowledgments** I am grateful to Prof. Jair Minoro Abe for his valuable comments.

## References

1. Abe, J.M.: Fundamentos da Geometria Ordenada (in Portuguese). MSc Thesis, University of São Paulo, São Paulo (1983)
2. Abe, J.M.: Lógica e Paraconsistencia, em: Novo pacto da Ciência, pp. 185–191. A Crise das Paradigmas, Anais, Escola de Comunicação e Artes - USP (1991)
3. Abe, J.M.: On the Foundations of Annotated Logics (in Portuguese). Ph.D. Thesis, University of São Paulo (1992)
4. Abe, J.M.: On annotated modal logic. *Mathematica Japonica* **40**, 553–560 (1994)
5. Abe, J.M.: Some recent applications of paraconsistent systems to AI. *Logique et Analyse* **157**, 83–96 (1997)
6. Abe, J.M.: Curry algebra  $P\tau$ . *Logique et Analyse* **161-162-163**, 5–15 (1998)

7. Abe, J.M.: Paraconsistent Artificial Neural Networks; An introduction. In: Carbonell, J.G., Siekmann, J. (eds.) *Lecture Notes in Artificial Intelligence*, vol. 3214, pp. 942–948. Springer, Heidelberg (2004)
8. Abe, J.M. (ed.): *Paraconsistent Intelligent Based-Systems*. Springer, Heidelberg (2015)
9. Abe, J.M., Akama, S.: Annotated logics  $Q\tau$  and ultraproduct. *Logique et Analyse* **160**, 335–343 (1997) (published in 2000)
10. Abe, J.M., Akama, S.: On some aspects of decidability of annotated systems. In: Arabnia, H.R. (ed.) *Proceedings of the International Conference on Artificial Intelligence*, vol. II, pp. 789–795. CREA Press (2001)
11. Abe, J.M., Akama, S.: Annotated temporal logics  $\Delta\tau$ . In: *Advances in Artificial Intelligence: Proceedings of IBERAIA-SBIA, LNCS*, vol. 1952, pp. 217–226. Springer, Berlin (2000)
12. Abe, J.M., Akama, S., Nakamatsu, K.: Monadic curry algebras  $Q\tau$ . In: *Knowledge-Based Intelligent Information and Engineering Systems: Proceedings of KES 2007—WIRN 2007, Part II*, pp. 893–900, *Lecture Notes on Artificial Intelligence*, vol. 4693 (2007)
13. Abe, J.M., Akama, S., Nakamatsu, K.: *Introduction to Annotated Logics*. Springer, Heidelberg (2016)
14. Akama, S., Abe, J.M.: Many-valued and annotated modal logics. In: *Proceedings of the 28th International Symposium on Multiple-Valued Logic*, pp. 114–119, Fukuoka (1998)
15. Akama, S., Abe, J.M.: Fuzzy annotated logics. In: *Proceedings of IPMU'2000*, pp. 504–508, Madrid, Spain (2000)
16. Akama, S., Abe, J.M., Nakamatsu, K.: Constructive discursive logic with strong negation. *Logique et Analyse* **215**, 395–408 (2011)
17. Ávila, B.C.: *Uma Abordagem Paraconsistente Baseada em Lógica Evidencial para Tratar Exceções em Sistemas de Frames com Múltipla Herança* (in Portuguese). Ph.D. Thesis, University of São Paulo (1996)
18. Avila, B.C., Abe, J.M., Prado, J.P.A.: ParaLog-e: A paraconsistent evidential logic programming language. In: *Proceedings of the 17th International Conference on the Chilean Computer Society*, pp. 2–8. IEEE Computer Society Press, Valparaiso (1997)
19. Blair, H.A., Subrahmanian, V.S.: Paraconsistent logic programming. *Theor. Comput. Sci.* **68**, 135–154 (1989)
20. Carvalho, F.R., Abe, J.M.: *Tomadas de Decisão com Ferramentas da Lógica Paraconsistente Anotada* (in Portuguese), Editora Edgard Blucher Ltda (2011)
21. da Costa, N.C.A., Abe, J.M., Subrahmanian, V.S.: Remarks on annotated logic. *Zeitschrift für mathematische Logik und Grundlagen der Mathematik* **37**, 561–570 (1991)
22. da Costa, N., Prado, J., Abe, J.M., Ávila, B., Rillo, M.: *Paralog: Um Prolog paraconsistente baseado em Lógica Anotada*, Coleção Documentos, Série Lógica e Teoria da Ciência, IEA-USP, n° 18 (1995)
23. da Costa, N.C.A., Subrahmanian, V.S., Vago, C.: The paraconsistent logic  $PT$ . *Zeitschrift für mathematische Logik und Grundlagen der Mathematik* **37**, 139–148 (1991)
24. Da Silva Filho, J.I.: *Métodos de interpretação da Lógica Paraconsistente Anotada com anotação com dois valores LPA2v com construção de Algoritmo e implementação de Circuitos Eletrônicos* (in Portuguese), Ph.D. Thesis, University of São Paulo (1999)
25. Da Silva Filho, J.I., Abe, J.M.: Emmy: a paraconsistent autonomous mobile robot. In: Abe, J.M., Da Silva Filho, J.I. (eds.) *Frontiers in Artificial Intelligence and its Applications*, pp. 53–61. IOS Press, Amsterdam (2001)
26. Lopes, H.F.S., Abe, J.M., Anghinah, R.: Application of paraconsistent artificial networks as a method of aid in the diagnosis of Alzheimer disease. *J. Med. Syst.* 1–9 (2009)
27. Mario, M.C., Abe, J.M., Ortega, N., Jr, Del Santo, M.: Paraconsistent neural network as auxiliary in cephalometric diagnosis. *Artif. Org.* **34**, 215–221 (2010)
28. Nakamatsu, K., Abe, J.M., Suzuki, A.: Annotated semantics for defeasible deontic reasoning, pp. 470–478. *Rough Sets and Current Trends in Computing, Lecture Notes in Artificial Intelligence series* (2000)
29. Nakamatsu, K., Abe, J.M., Akama, S.: Intelligent safety verification for pipeline process order control based on bf-EVALPSN. In: *ICONS 2012: The Seventh International Conference on Systems*, pp. 175–182 (2012)

30. Nelson, D.: Constructible falsity. *J. Symb. Logic* **14**, 16–26 (1949)
31. Prado, J.P.A.: Uma Arquitetura em IA Baseada em Lógica Paraconsistente. Ph.D. Thesis, University of São Paulo (2006)
32. Subrahmanian, V.: On the semantics of quantitative logic programs. In: Proceedings of the 4th IEEE Symposium on Logic Programming, pp. 173–182 (1987)
33. Suppes, P.: The axiomatic method in empirical science. In: Henkin, L. (ed.) Proceedings of the Tarskian Symposium, pp. 465–479. American Mathematical Society (1974)