IFORS' Operational Research Hall of Fame

Clóvis Caesar Gonzaga

A leading figure in interior point methods, his analysis of path following methods, presented in the late 1980's, remains the best complexity bound in Linear Programming.

Born: 6 September 1944, Lages, Santa Catarina, Brazil.

Died: 14 August 2021, Florianópolis, Santa Catarina, Brazil.

Education: Electronic Engineering, ITA, São Paulo, Brazil (1967); Master (1970) and PhD (1973) in Systems Engineering and Computer Science, COPPE, UFRJ - Federal University of Rio de Janeiro, Brazil; postdoctoral fellow, University of California System, Berkeley, USA (1976).

Key positions: Full Professor, COPPE UFRJ (1970-1994); Visiting professor University of California System, Berkeley (1985-1987), INRIA, France (1992-1993), Delft University of Technology, Netherlands (1993-1994); Full Professor, UFSC - Federal University of Santa Catarina, Brazil (1995-2013).

Awards: Full member of Brazilian Academy of Sciences since 1998; Great Cross of the Brazilian Order of Scientific Merit (2010); SIAM Fellow (2009); IFORS Lecturer (2013); member of TWAS – Academy of Sciences for the Developing World since 2014; Khachiyan prize awarded by the INFORMS Optimization Society (2014).

Clóvis Caesar Gonzaga was born in Lages, a small town in the state of Santa Catarina in Brazil, on September 6th, 1944. He was an intellectual boy who grew up in Joinville, the largest city in the same state. Clóvis was a passionate and eclectic reader, exploring works by Friedrich Nietzsche, Jorge Amado, Aldous Huxley, Albert Camus. As a young man, he realized that his career would be of a scientific nature. In 1967, he got an Electronic Engineering degree at ITA - an institution maintained by the Brazilian Air Force in São José dos Campos in São Paulo state. He then moved to Rio de Janeiro, to enroll in the graduate

school of COPPE-UFRJ.

Supervised by Jen-Paul Jacob, he concluded his master's degree in 1970. Following that, he was hired by COPPE as a professor, where he completed his doctorate in 1973, advised by Nelson Ortegosa da Cunha. In 1976, he visited the University of California System, Berkeley, USA, as a postdoctoral fellow of Elijah Polak. Some years later, invited by Polak, he held a visiting professor position in Berkeley, a period that was pivotal in his career. In Clóvis' field, Narendra Karmakar had obtained in 1984 an algorithm to solve linear programming problems with a complexity of order $O(n^{7/2}L)$. Clóvis believed it was possible to improve this bound. Much of his time in Berkeley was spent on this endeavor. On Christmas 1986, depressed that he had not been successful, after having lunch at a Chinese restaurant, he opened a "fortune cookie" and found the message

"*You will finally solve a difficult problem that means much to you*".

Clóvis, who was not superstitious, saw this as a sign of Destiny and, encouraged, returned to his office. A few days later, he succeeded in finding an algorithm with a better polynomial complexity, which required only $O(n^3L)$ calculations. This result revolutionized the optimization community worldwide. Despite this success and the invitation to remain at Berkeley, Clóvis returned to Brazil in 1987 and kept his position as a professor at COPPE. As he liked to say, he was too Brazilian to live a happy life out of his country.

In addition to having spent time at Berkeley between 1985 and 1987, Clóvis was visiting professor at INRIA, France, between 1992 and 1993 and at Delft University of Technology, in the Netherlands, between 1993 and 1994. In 1995, he retired from COPPE-UFRJ, and moved back to his birth state, where he got a full professor position in the Department of Mathematics at the Federal University of Santa Catarina.

His seminal result, published with the title "An algorithm for solving linear programming problems in $O(n^3L)$ operations," remains until today, 30 years later, the best complexity bound when solving linear optimization problems. It is fair to say that, with his remarkable talent, Clóvis put Brazil in the map of the international optimization community. He soon became one of the world's foremost experts in the area of continuous optimization, with main interests in fundamental problems of nonlinear programming. In fact, Gonzaga's contributions go well beyond Interior Point methods. His works on augmented Lagrangians, filter methods and, more recently, on convex programming, are yet another example of Clóvis' minimalist and elegant style in Mathematics. He always strived for clarity and conciseness, basing his explanations on geometric, rather than analytic or algebraic, arguments.

Clóvis was proud of having created computational algorithms used in the area of Energy Optimization. Based on graph optimization, the program he developed in the 1970s, called TANIA, was for many years a reference at Eletrobras, the largest Brazilian electric energy generation company, for planning the expansion of the electricity transmission network in Brazil. In 2017, he resumed his focus on energy problems, participating in the LYNX project of Parana state,

related to the application of optimization to hydrothermal planning problems.

Clóvis was one of the founders of the Systems Engineering and Computer Science program at the Federal University of Rio de Janeiro, where he was the first person in Brazil to teach nonlinear programming. He was a true pedagogue, active in teaching and in spreading the interest for continuous optimization. His 1992 SIAM Review manuscript "Path following methods for linear programming" is among the most influential papers in the area and, as such, has inspired and motivated many researchers throughout the world.

Clóvis Gonzaga had outstanding skills to communicate complex concepts in an intelligible manner. He could spend a night awake, pondering and ruminating, to produce a clear crystal drawing that would synthesize the essence of his message. Everybody who had the privilege of attending one of Clóvis' talks will for sure remember the "blue worms" he used to describe the path following iterations along the central path, as well as the happy jumping Obelix that illustrated the variant with long steps; see Figure 1.

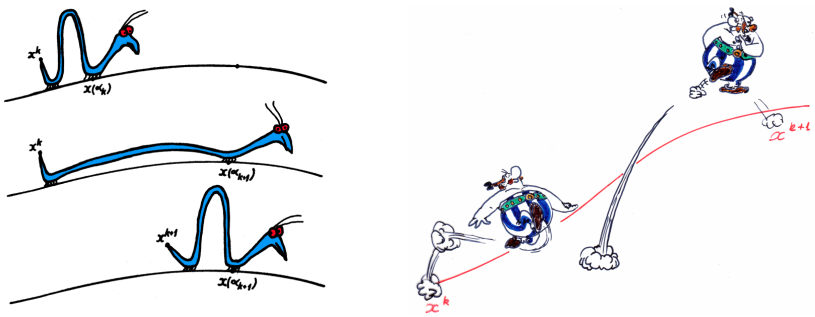

Figure 1: Clóvis Gonzaga illustration of short steps (left) and large steps (right) in a path following interior point method.

The legacy of Clóvis to the optimization community is enormous, particularly in Brazil. His PhD students were taught that a researcher should look for trees that would bear a lot of fruit, and not just pick leftover fruit from trees that had already been harvested. This permanent search for creativity and excellence was a trademark of Clóvis Gonzaga. He will be greatly missed, but not forgotten, for his teaching and attitude towards research remain in his colleagues, friends, and students.

Celina de Figueiredo, Elizabeth W. Karas, and Claudia Sagastizábal

Selected original works

GONZAGA, C. C.. An algorithm for solving linear programming problems in $O(n^3L)$ operations. In: N. Megiddo. (Org.). Advances in mathematical programming - Interior point and related methods. New York: Springer Verlag, p. 1–28, 1989.

GONZAGA, C. C.. Path following methods for linear programming. SIAM Review, v. 34, n. 2, p. 167–227, 1992.

GONZAGA, C. C.. Large step path-following methods for linear programming, part I: barrier function method. SIAM Journal on Optimization v. 1 n. 2, p. 268–279, 1993.

GONZAGA, C. C., Castillo, R. A.. A nonlinear programming algorithm based on non-coercive penalty functions. Mathematical Programming v. 96 n. 1, p. 87–101, 2003.

GONZAGA, C. C., Karas E.W., Vanti M.. A globally convergent filter method for nonlinear programming. SIAM Journal on Optimization v. 14 n. 3, p. 646–669, 2004.

Gilbert, J, C., GONZAGA, C. C., Karas E. W.. Examples of ill-behaved central paths in convex optimization. Mathematical Programming v. 103 n. 1, p. 63–94, 2005.

GONZAGA, C. C., Karas E. W.. Fine tuning Nesterov's steepest descent algorithm for differentiable convex programming. Mathematical Programming v. 138 n. 1, p. 141–166, 2013.

Biographical material

Announcement of the Khachiyan prize (2014): by INFORMS `https://connect.informs.org/optimizationsociety/prizes/khachiyan-prize/2014`, and by the Brazilian Academy of Sciences, in Portuguese, `http://www.abc.org.br/2014/09/26/clovis-c-gonzaga-ganha-o-optimization-society-khachiyan-prize/`