



Hoàng Tuy (7 December 1927–14 July 2019)—in Appreciation

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Abstract

This article is intended to honor the late Professor Hoàng Tuy, a highly respected researcher and author in the field of Global Optimization. It summarizes our interaction with him and some of his many contributions to the field of optimization as well as his difficult road to success and international recognition.

Keywords Nonconvex optimization · Global optimization · Bilevel programming

1 How and When We Met Hoàng Tuy

In 1987, we were both, A. Migdalas and P. Värbrand, preparing the final stages of our PhD Theses under the supervision of Prof. Kurt Jörnsten—who was the head of the optimization group in Linköping. A. Migdalas was working on a theme on traffic planning and network design. The network design problem either in its classical form or in its two-level form is essentially a nonconvex problem. At the same time, P. Värbrand was starting to look at linear bilevel problems and we both realized that in order to attack these problems, we would need to deepen our knowledge in nonconvex or global optimization—and we came in contact with the work of Hoàng Tuy. In 1988, A. Migdalas got a position at Århus University in Denmark, in the optimization group under the leadership of Prof. Jörgen Tind. During this stay, Jörgen Tind invited Hoàng Tuy for a short visit and that was our first meeting. We started to discuss several problems, including single- and two-level network design problems and we held contact and continued to

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discuss these problems even after Hoàng Tuy's departure to Germany where he was preparing the first book on "Global Optimization" in collaboration with Reiner Horst.

In 1989, A. Migdalas was back in Linköping and together with Prof. Sven Erlander (President of Linköping University and former head of the optimization group), the three of us succeeded with an application to the Swedish funding agency SIDA that made it possible to invite Hoàng Tuy to join the optimization group as visiting professor. In total, Hoàng Tuy spent more than 2 years in Linköping during approximately a decade or so. During the first stay in 1989, a new PhD student, Saied Ghannadan, joined P. Värbrand and A. Migdalas and together, we started to develop this research direction within the group. During these years, quite a few scientific papers were produced in this area, and a PhD, that of Saied, was completed.

Besides the scientific output, we also organized a number of workshops during this period. In 1995, for example, we organized the First International Workshop on Bilevel and Hierarchical Programming with Hoàng Tuy as key note speaker. In 1997, we organized an International Workshop with the title From Local to Global Optimization to celebrate Hoàng Tuy's 70th birthday and his outstanding achievements in Optimization. Prominent researchers and academicians from both West and East, including Jonas Mockus, Antanas Zilinskas, J. B. Rosen, C. A. Floudas, N. V. Sahinidis, T. Rapsak, G. Isac, P. M. Pardalos, and many more, contributed to the success of the workshop. In addition, we made a short visit to Hoàng Tuy in Hanoi the same year.

In 1998, A. Migdalas accepted a position in Crete, Greece, and left Sweden. In the same year, Hoàng Tuy made a short visit to P. Värbrand in Sweden and a short visit to A. Migdalas in Greece. It was our last meetings in person with Hoàng Tuy. Since then, we have only had occasionally exchanged emails on different occasions. This was mainly due to changed working conditions for both A. Migdalas (in his new mission in Greece) and P. Värbrand (who moved into administration and Academic leadership).

2 Hoàng Tuy's Internationally Recognized Contributions

Hoàng Tuy was a pioneer in the field that came to be called "Global Optimization" and he is broadly recognized as a prominent father of the subject, although he has contributed to a much broader scientific area beyond global optimization covering subjects such as fixed point computational theory, minimax problems, measurable functions, and others, as he initially started in the field of real analysis.

Hoàng Tuy became early known to the world of optimization with his publication "Concave programming under linear constraints" published in 1964 by the Soviet Mathematics Doklady, Volume 5, pages 1437–1440. Within these few pages, the "Tuy cut" was born and it initiated an intensive research around the world. Furthermore, his contributions in the form of "DC Programming" brought a true breakthrough for the solution of many important nonconvex optimization problems.

Since then, Hoàng Tuy has written numerous papers contributing to the advancement of the field of Global Optimization and optimization in general. He has authored and co-authored several books, including a first complete book on "Global Optimization" in 1990, as well as the books "Optimization on Low Rank Nonconvex Structures" in 1996, and "Convex Analysis and Global Optimization" in 1998.

Despite his high age, Hoàng Tuy continued to work with clear spirit and delight, generating new ideas and new publications. In 2016, he revised and updated the book “Convex Analysis and Global Optimization” to include modern approaches to minimax, fixed point, and equilibrium theorems, and to nonconvex optimization and new topics on monotonic optimization, polynomial optimization and optimization under equilibrium constraints, bilevel programming, multi-objective programming, and optimization with variational inequality constraint.

In 2007, another international conference on Nonconvex Optimization was held in France in order to pay tribute to Hoàng Tuy on the occasion of his 80th birthday and in recognition of his pioneering work and contributions to the field of Global Optimization.

Hoàng Tuy spent considerable time as invited guest professor at leading universities around the world, including Linköping University, as we mentioned above.

In 1995, Hoàng Tuy accepted an honorary doctor’s degree from the Technical Faculty at Linköping University at a time when Prof. Sven Erlander was spending his last term as President of Linköping University.

3 Hoàng Tuy’s Path to Recognition

Hoàng Tuy lived most of his early life under difficult conditions due to the Vietnam War. He was an outstanding high school teacher and even wrote a text book on geometry that was published by the Vietnamese guerrilla in 1949. In 1951, Hoàng Tuy made the long walk to north along the Ho Chi Minh trail carrying only his math books and some rice and salt.

Hoàng Tuy was to large extent a self-taught mathematician. Indeed, he followed the Soviet university program in mathematics on his own! After moving to Moscow, he received the PhD degree from the Moscow University under the supervision of Prof. Vladimir Menshov and Prof. Georgiy E. Shilov in just one and half years of study. He even published five papers in real analysis in Soviet journals written in Russian, a language that he succeeded to learn by studying mathematics from Russian books.

Hoàng Tuy’s interest and desire, however, had always been to use mathematics in order to solve practical problems that would help develop the Vietnamese economy. Therefore, Hoàng Tuy became interested in Operations Research, and, consequently he visited Prof. Leonid V. Kantorovich in Novosibirsk in 1962 and 1964. This step brought him into the realm of Optimization and, in turn, it would lead to decisive and substantial contributions to the field by Hoàng Tuy. Indeed, up to that time, Nonconvex Optimization had been looked upon by the majority of the research community as an area of research that was almost hopelessly difficult to cope with and the existing contributions were few and of lesser importance.

It should be noted that Hoàng Tuy’s interest in Optimization grew out of his interest in solving practical problems, in particular those that arise in transportation and logistics. However, due to the war conditions in the mother country, this turned out to be difficult to realize in collaboration with the surrounding society. Therefore, his major contributions came to be in the theory of Optimization.

Hoàng Tuy became vice chairman of the Institute of Mathematics in Hanoi when it was established in 1970 and he served as chairman from 1980. He became General Secretary of the Vietnamese Mathematical Society the same year.

4 Conclusion

We are very proud and deeply grateful for having had the privilege to work with Hoàng Tuy. His inspiration, knowledge, and encouragement during his regular visits to Linköping University in the late 1980s and early 1990s has meant a lot to us personally but also to the whole Optimization division. We have learned to know Hoàng Tuy as a very kind and wise man with an extraordinary background and life experience. There does not seem to exist any difficulty or challenge in academics or life that he has not turned into a success. Ultimately, we will miss Hoàng Tuy, a friend, a tutor, and mentor. The field of optimization has lost a source of creativity, inspiration, and impactful contributions.

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