Laudation of Professor Aurél Galántai

Professional career
Aurél Galántai born in Budapest on April 18, 1951. Holder of the following academic degrees:
Diploma (MSc-equivalent) in mathematics from Eötvös Loránd University, 1975;
Dr. rer. nat., ELTE TTK, 1975;
Candidate of the Mathematical Sciences, HAS, Budapest, 1980;
PhD in applied mathematics, BME, Budapest, 1994;
Dr.habil., BME, Budapest, 1994;
Doctor of the Hungarian Academy of Sciences, 2005.

Teaching and organisational activities
Aurél Galántai's teaching career is linked to four universities. Immediately after obtaining his MSc degree, he was a lecturer at Eötvös Loránd University (ELTE), then at Gödöllő University (GU), Miskolc University (MU) and finally at Óbuda University (ÓU). He is currently a professor emeritus of Óbuda University. He held the following university positions:
1975-1979: teaching assistant, Department of Numerical and Computer Mathematics ELTE
1979-1984: assistant professor, Department of Mathematics and Computer Science, GU
1984-1990: associate professor, Department of Mathematics and Computer Science, GU
1988-1990: head of department, Department of Computer Science, GU
1990-1995: associate professor, Department of Applied Mathematics, MU
1990-2003: head of Department of Applied Mathematics, MU
1991-2006: director of Institute of Mathematics, MU
1995-2006: professor, Institute of Mathematics, MU
2006-2022: professor, Software Engineering Institute, ÓU
2009-2022: Head of doctoral school of Applied Mathematics and Informatics, ÓU
2023-: professor emeritus, John von Neumann Faculty of Informatics, ÓU

During his university career, but especially since the end of the 1980s, he has been an active participant in the academic life of universities. As the head of different departments, institutes and later the doctoral school of Óbuda University, he played a significant role in the accreditation and implementatiton of university courses. He is the author of 14 higher education textbooks and numerous educational materials in the fields of numerical analysis, operations research, applied mathematics and informatics. As a founding member and leader, he played an outstanding role in the establishment of the ÓE Applied Informatics and Applied Mathematics Doctoral School in 2009, which has since become a thriving and prominent doctoral school in the field of IT and applied mathematics.

Scholarships and research projects
Numerous domestic and foreign research grants in the fields of theoretical and applied mathematical research; longer scholarships; Department of Electrical and Computer Engineering, University of Tucson, Arizona (1985/1986, 12 months), several times 1-3 months a year; Department of Mathematics, Statistics, Informatics and Applications, University of Bergamo, Italy.

Professional activity

He is an active and recognized member of the Hungarian operations research community, and has been a member of the Hungarian Operations Society since the beginning. He represented the interests of operations research and the related professional fields by performing remarkable work in universities, the Hungarian Academy of Sciences and other professional committees. For an extended period, he has taken an active role in the assessment procedures for academic qualifications and titles (DSc, PhD and Dr.habil.). For 9 years, he has represented the Operations Research Committee in the Doctoral Committee of the Mathematics Department of the Hungarian Academy of Sciences, of which he has been an elected member for more than two decades. The members of the Operations Research Committee elected him twice as a member of the Academy General Assembly for 2 terms.

As a lecturer, he is a member of the doctoral schools of several universities. He is a member of the editorial board of several journals and a regular reviewer of international journals.

Awards received in recognition of his professional and teaching work: Gyula Farkas Award 1st degree (1977), Széchenyi Professorial Scholarship (1998-2001) and Officer's Cross of the Hungarian Order of Merit (2020).

Research and professional activities

Aurél Galántai's professional activity covers the broad field of numerical analysis, operations research and applied mathematics, and he is an outstanding, internationally recognized representative thereof. His research work is characterized both by the in-depth mathematical way of thinking and the pursuit of practical, effective computer applicability of theoretical results. He has 149 publications and his research results are published in the most important international journals in the field, as well as in 3 monographs.

Within the framework of the laudation, by no means it is possible to present the scientific career in detail, only partially describe the theoretical and applied mathematical results that are of great importance from the perspective of his career.

After graduating from university, Aurél Galántai worked on convergence and error analysis of numerical methods of ordinary differential equations. He obtained his scientific degree (CSc, 1980, HAS) with the thesis titled "Investigations in the field of convergence and error analysis of numerical methods of ordinary differential equations".

After the appearance of the ABS (Abaffy-Broyden-Spedicato, 1984) family of algorithms and the fruitful professional collaboration with professors J.Abaffy and E.Spedicato, he started to deal with new important tasks from the mid-1980s. These are partly significant for the new ABS methods and their investigation, and partly for the important linear algebraic theoretical results: the basic properties of Egerváry's rank reduction procedure, as well as the LU, LDU, LDLT (here L is a lower triangular matrix, U is an upper triangular matrix, and D is a diagonal matrix) and exact perturbation formulas for Cholesky factorizations, as well as their examination.

The basic task deals with the solutions of the algebraic equations $f(x) = 0$ for the multivariable nonlinear functions f and the qualitative properties of the solutions. The purpose of the studies is to develop effective numerical algorithms that are suitable for solving nonlinear equations, and to explore the convergence, and stability of numerical procedures. In addition to considering floating-point operations, it is also important to analyze the error propagation in the ABS class for linear systems.

He succeeded in generalizing the ABS method developed for linear systems (together with Abaffy and Spedicato, 1987) to nonlinear systems and proving the local convergence of the method under fairly general conditions. The developed method has many good properties: as a special case, it includes Gay's generalization of the Brown and Brent methods, it preserves

Seidel's relaxation principle, it gives an exact solution in the case of linear equations, and another important advantage is simple programmability

In a later paper (1995), he proves the monotonic convergence of ABS methods (partially according to arrangement) for a wide class of nonlinear problems, which gives an opportunity to estimate the accuracy of the approximations. Among the proof techniques, an important role is played by the LU factorization of matrices and the proof of some properties related to this. The usual assumptions on the functions (f is a continuously differentiable convex function, its Jacobi matrix is a non-singular M-matrix and isotone) prove the global convergence of the procedure, i.e. that the procedure is convergent starting from an arbitrary starting point.

Regarding the Quasi-Newton ABS methods, a joint publication with A.Jeney introduces and examines effective methods for solving nonlinear equations, which is created as a combination of the nonlinear ABS method and the quasi-Newton method. The numerical results obtained with the developed computer program proved that the multi-step quasi-Newton ABS method is better in the use of machine time than the best-known Broyden method.

Galántai devoted serious attention to the study of the rank reduction procedure and related factorization and conjugation algorithms. The ranking reduction algorithm is based on a procedure developed by Egerváry in the mid-1950s. The motivation of this research is that the base of the ABS conjugation procedure is a rank reduction procedure. He gives a necessary and sufficient condition for the case when the procedure can be performed, gives the canonical form of the rank reduction procedure and the base factorization resulting from the procedure as a function of the parameters. The proofs reveal that the base factorization shows a close relationship with the LDU factorizations. As an application of the results, several well-known results are obtained as special cases, necessary and sufficient conditions for notable factorizations can be obtained, and a conjecture of Chu, Funderlic and Golub is also proved.

Different triangular factorizations of matrices (LU, LDLT, LDU, and Cholesky factorizations) have long played an important role in various numerical procedures, but e.g. they are also of decisive importance in multivariate stochastic modeling problems. The accuracy of the procedure depends to a large extent on the stability of the factorizations, so it is important to examine the perturbation tasks. The most important and very impressive result of Galántai (2003) is that he managed to solve the perturbation equations and gave exact formulas for the perturbations of the factors in matrix factorization. These results are valid for all matrix perturbations that preserve the factorizability and nonsingular properties. Although the solutions of the perturbation equations are different for different triangular factorizations, what they have in common is that each proof relies on the properties of specific projectors. With the help of the exact formulas, it was possible to partly improve and partly make the estimates for the perturbations of the factorizations known so far more precise.

The monograph published in 2004 (Projectors and Projection Methods, Kluw) gives a unified survey on projector and projection methods. It covers the presentation of the general theoretical background and then examines the projections for solving linear and nonlinear systems of algebraic equations and convex optimization problems in finite dimensional Euclidean and partially in Hilbert spaces.

Together with Cs. Hegedűs (2008), using elementary methods, they derive a global and a local perturbation theorem on polynomial zeros. This result significantly improved Ostrowski's (1940) classic result on the perturbation of the roots of polynomials, known to be accurate until then. In the paper, Using the matrix theoretical approach we also improve the backward stability result of Edelman and Murakami.

In the 2010s, one of Galántai's main research areas was always convergent methods for solving nonlinear equations and minimization problems. In relation to these problems, he achieved numerous results alone and together with J. Abbafy by developing different methods with different constraints on the domain and the nonlinear function. The computer implementations and performance of the developed algorithms are investigated in detail, which support the effectiveness of the results.
In the last few years, since the end of the 2010s, Galántai has been dealing with the convergence analysis of the Nelder-Mead method in several articles. This method is a direct simplex method for the solution of the minimization problem and widely used in derivative-free optimization and application fields. He developed a matrix form of the Nelder-Mead simplex method and showed that its convergence is related to the convergence of infinite matrix products. This approach made it possible to prove a general convergence theorem for the simplex sequences generated by the method and to give a sufficient condition for a certain type of convergence behavior of the Nelder-Mead simplex method. He also proved that the Nelder–Mead simplex method converges in the sense that the simplex vertices converge to a common limit point with a probability of one, which gives a general explanation for the effectiveness of the method.
In addition to the theoretical research, it should be mentioned that Aurél Galántai also achieved during his career significant results in the field of applied mathematics. His most important research results were achieved in the following fields of application: numerical solution of various models in connection with biomedical modeling; agricultural application of operational research methods for simulation modeling of field energy use; in relation to the tasks of electron-optical applications: optimization of electrostatic lenses, development of optimization models and procedures; programming, finding a new lens with significantly improved properties; in terms of crystal physics applications: development of a model and numerical procedure for determining the shape of the sample when growing rotationally symmetric crystals of a given shape; optimization of steel structures (structure optimization), numerical solution of specific tasks.

We think the scientific achievements of Professor Aurél Galántai are outstanding. He plays an important role in the professional community. His educational and research activities are valuable contributions to the Hungarian Operational Research.