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Preface

A brief biography and appreciation of Miroslav Fiedler with a bibliography of his books and papers

We present a brief biography and appreciation of Miroslav Fiedler, to whom this special issue of Linear Algebra and Its Applications is devoted on the occasion of his 80th birthday, accompanied by a current bibliography of his books and papers.

Miroslav Fiedler was born on April 7, 1926 in Prague. His mathematical career started at the Charles University in Prague where he earned the degree RNDr. (Rerum Naturalium Doctor) in 1950. Continuing his studies at the Mathematical Institute of the Czechoslovak Academy of Sciences he received two scientific degrees, CSc. (Candidate of Sciences, equivalent of Ph.D.) and DrSc. (Doctor of Sciences) in 1955 and 1963, respectively. He was appointed a full professor at the Charles University in 1965, at the age of 39. Since the early days of his research career, his favourite subjects have been geometry, graph theory, linear algebra, and their applications to numerical computations. Through 2006, he has authored or co-authored six books (two of which have been published in English) and close to 200 of papers in these and related fields (a bibliography is attached). Some of his results have shaped entire research areas, and his work has deeply influenced scientific computing in general. For many years he lectured at universities throughout the former Czechoslovakia. He always cared about talented students on the high school level – for 50 years he has been a leading figure in organizing mathematical competitions including the Mathematical Olympiad.

M. Fiedler's public service activities include not only chairmanships of Czechoslovak and Czech Committees for Mathematics but a remarkable list of journals where he served as a member of editorial board, distinguished editor, honorary editor or chief editor. For 26 years he was a member of Householder Symposia Steering Committee.

M. Fiedler has been awarded the Czechoslovak National Prize (jointly with V. Pták) in 1978, B. Bolzano Medal in 1986, Hans Schneider Prize of the International Linear Algebra Society in 1993, and the honorary medal De Scientia et Humanitate Optime Meritis, the highest possible award of the Academy of Sciences of the Czech Republic, in 2006.

For many years, M. Fiedler shared his office with another distinguished mathematician, Vlastimil Pták. Their life-long friendship and collaboration (Vlastimil Pták passed away in 1999) represents an example of personal and scientific relationship of exceptional value, and it will certainly be recognized by historians of mathematics. Since there is a nice survey of the scientific contributions of M. Fiedler and V. Pták published 10 years ago in this journal (Miroslav Fiedler

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and Vlastimil Pták: Life and Work, by Z. Vavřín, 223/224: 3–29 (1995)), we will concentrate on some of the newer results of M. Fiedler. Some of these results were obtained in collaboration with T. Markham, Z. Vavřín and others. It is remarkable that since 1995 more than 40 of his articles and two of his books have appeared, despite his being well past the age at which most people retire. The results cluster around several main topics.

1. Matrix theory with a focus on special matrices

A quest for a deeper insight into properties of various classes of special matrices has continued to be one of the favourite research fields of M. Fiedler. In particular, investigation of matrices possessing consecutive-row and consecutive-column properties over a ring with identity led to development of a factorization theorem utilizing bidiagonal matrices [160]. These results were further developed and applied in a series of papers that resulted in a new generalization of totally positive matrices [166], and a new generalization of totally nonnegative matrices [173]. This research was continued by investigations on basic matrices, i.e. those matrices with subdiagonal and superdiagonal rank at most one [178], complementary basic matrices [180], generalized oscillatory matrices [174] and treatment of sign-nonsingular matrices [185].

In [26] Fiedler and Pták introduced the class of Z-matrices and they substantially developed the theory of M-matrices. Many of the new results return to this classical field. Matrices of e-simple digraphs, which were introduced by M. Fiedler in the sixties [31], were further analyzed in [182]. This lead to a new algorithm for their inversion. Assumptions of the algorithm are in some cases trivially satisfied, for example, if the matrix having e-simple digraph is an M-matrix. Another paper considers a new generalization of the Bergström inequalities for some M-matrices [163]. The new block generalization of comparison matrices belongs to this group of results as well [159]. The new characterization of matrices whose inverses are weakly diagonally dominant symmetric M-matrices (inverse M-matrices) gives as a corollary the known theorem that a strictly ultrametric matrix is nonsingular and an inverse M-matrix [161].

Other results cover simple generalizations of biorthogonal systems to sets of linearly dependent vectors based on the Moore–Penrose inverse, new factorizations of companion matrices of polynomials of order n into a product of n matrices [175], new results for equilibrated Monge matrices related to their eigenvalue properties [172], and analysis of completion problems for 2-subtotally positive matrices and their additive counterparts, anti-Monge matrices [186].

2. Computational and numerical aspects in linear algebra

M. Fiedler was one of the first to recognize the importance of graphs for studying sparse linear systems. He considered this topic already in [31] and [38], then again in [47,76,82], and returned to it recently in [183]. However, the most important of Fiedler's contributions to this area was in his discovery of properties of the second smallest eigenvalue of the Laplacian matrix of a graph [60]. He called it algebraic connectivity and studied [73] properties of the corresponding eigenvector. This theoretical approach, as is usual in mathematics, found its applications much later, not only in graph theory but in many other fields. In numerical mathematics, the remarkable properties of the eigenvector for this eigenvalue (now generally called Fiedler vector) and the related spectral graph partition became basis of spectral partition methods.

Although M. Fiedler is mostly a theoretician, his work has and will have, as mentioned above, a significant impact in matrix computations.

One of the new trends in this field is to describe sparsity of system matrices using unions of some simple structures. Consequently, results for particular structurally simple matrices may find important applications there.

Nice new results for generalized Hessenberg matrices were developed jointly with Z. Vavřín, in particular, in studying invariance of a premultiplication or postmultiplication by a nonsingular triangular matrix [179], with a link to totally nonnegative matrices.

Another interesting paper deals with the new measure for irreducibility of stochastic matrices [147]. This measure can be used to estimate the second largest eigenvalue of a weighted graph, which represents a very practical subject.

Further results in this category include derivation of new bounds for some functions of eigenvalues of Hadamard products of matrices [148], showing new conditions for reducibility of matrices into a row-rhomboidal form, defining new positive definite geometric mean of positive definite matrices [156], and investigation of mutually orthogonal vectors which are eigenvectors of acyclic matrices [157]. All these results have strong potential for practical applications.

3. Euclidean geometry

Deep interest in Euclidean geometry is clearly visible behind many new developments of M. Fiedler. In particular, new results on symmetric matrices with exactly one positive eigenvalue, so-called elliptic matrices, were provided [168]. These results allow explicit construction of the elliptic matrices from a given spectrum or from the complete interlacing system.

His long-term interest in the Laplacians of graphs culminates in the paper [184] on simple geometric interpretation of the Laplacian of a graph including interpretation of its eigenvectors. This interpretation makes use the notions of quadrics geometry in a related Euclidean space.

An overview of Fiedler's results in Euclidean geometry can be found in his chapter [188, Chapter 66] of the new reference book *Handbook of Linear Algebra*.

The breadth and scope of M. Fiedler's work was well summarized by a colleague who remarked that it is always intimidating to see him in the audience when one is speaking at a conference, as there is a good chance he will very politely point out that a much shorter proof of the main result can be obtained from one of his earlier results. Originality, mathematical elegance, and vision are the hallmarks of the work of Mirek Fiedler.

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