CZECH TECHNICAL UNIVERSITY IN PRAGUE
Faculty of Civil Engineering
Department of Mathematics
Thákurova 7, 166 29 Praha 6

Prague, December 2nd, 2019

Report on the Habilitation Thesis
Error Contaminated Linear Approximation Problems:
Analysis and Methods
submitted by RNDr. Iveta Hnětynková, Ph.D.

The habilitation thesis represents contributions to the theory of linear approximation problems leading to various types of solution approaches still providing a number of open questions. There are two main fields focused in the thesis: analysis of solutions of total least squares (TLS) problems with multiple observations and methods for ill-posed linear approximation problems where the solutions can be affected by the noise of the right hand side. The presented results directly influence (implementation of) relevant algorithms in scientific computation, medicine, and industry.

Basic questions about the TLS methods for $AX \approx B$ are about the existence and uniqueness of the solution. Iveta Hnětynková coauthored in [C1] (18 citations in Scopus) the first complete classification dividing the whole set of TLS problems for multiple right hand sides into four classes according to ranks of certain 2×3 blocks of the right singular value decomposition (SVD) eigenvectors of $[B|A]$. The blocks are defined by the dimensions of X and by the singular values of $[B|A]$. This result influences also TLS algorithms. Another view to the TLS problem is given by the core reduction concept, which is well developed for problems with a single right hand side. In papers [C2] and [C3] the core problem for a multiple right hand side and a corresponding algorithm were introduced. The core problem has a wedge-shaped form. Matrices of this form are then studied separately in [C5]. I would like to emphasize that the detailed understanding the TLS problems with more than one right hand side allows one to study even more complex problems or huge problems with special structures of data, such as Kronecker products or their sums appearing often in statistical computation.

Noise of a single right hand side b propagated to the solution x of an ill-posed problem can be reduced by regularization. In [C11] the Tikhonov regularization solution is obtained from some block decomposition of the right vectors of the SVD of $[A|B]$. These results can serve as a theoretical tool for further research of Tikhonov regularization. Iterative Krylov subspace methods are connected to iterative Golub-

ČTU in Prague
Faculty of Civil Engineering
Department of Mathematics
Thákurova 7
166 29 Praha 6

tel.: (+420) 224 354 390
fax: (+420) 233 332 732
www.fsv.cvut.cz

IN: 68407700
Bank connection: KB Praha 6
acc.no. 19-5504610227/0100

Kahan bidiagonalization, which can be thus used as a fundamental part of iterative regularization. Propagation of a white noise of b to the bidiagonalization vectors is presented in [C8] (23 citations in Scopus). Based on these, for specific projection methods the explicit relations between residual vectors and the bidiagonalization vectors are found. Again, these findings are applicable in many practical problems.

In summary, Iveta Hnětynková is a distinguished person in the field of numerical linear algebra. She obtained and published important results. Her papers appear in top research journals: SIAM journals, Linear Algebra and Its Applications, BIT. She collaborates with scientists world-wide; Professors Sabine Van Huffel and Rosemary Anne Renaut belong to her coauthors.

Moreover, Iveta Hnětynková is an excellent speaker and talented teacher being able to pass non-trivial results in a clear and obvious form to students or to audience. She was appreciated by students of the Faculty of Mathematics and Physics of Charles University as one of the most popular teachers several times. Her doctoral student Marie Kubínová has successfully started her professional-scientific carrier recently.

I strongly recommend that the applicant Iveta Hnětynková should be appointed as an associate professor.

Sincerely,

Doc. RNDr. Ivana Pultarová, Ph.D.

Department of Mathematics
Faculty of Civil Engineering, CTU in Prague
Thákurova 7, 166 29 Prague 6