

## BEYOND THE MATTRIAD CONFERENCES

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*Abstract.* In this article we present a short history of the MatTriad Conferences, a series of international conferences on matrix analysis and its applications. The name MatTriad originally comes from the phrase Three Days Full of Matrices.

The first MatTriad was held in the Mathematical Research and Conference Center of the Institute of Mathematics of the Polish Academy of Sciences in Będlewo, near Poznań, Poland, 3–5 March 2005, and has since then been organized biennially. The 8th MatTriad was held in Liblice, near Prague, Czech Republic, 8–13 September 2019. The next MatTriad will be held in Curia, near Coimbra, Portugal, September 2021.

*Keywords:* MatTriad conference; linear algebra and its applications; matrix analysis

*MSC 2020:* 15-XX

## 1. BACKGROUND

In the background of the organization of each new conference there is a new idea and people who want to implement it. The idea of MatTriad conferences was born in the minds of a group of mathematicians from Poznań who, more than thirty years ago, were fascinated by their research with matrix properties and their applications, in particular in statistics and numerical analysis. Their cooperation led to the launch of a regular joint seminar by co-opting adjacent people interested in these topics. The history of how the MatTriad organization came about is illustrated below. We begin by describing the development in the spirit of the article “Comments on the development of Linear Algebra in Poznań, Poland”, by Jan Hauke and Augustyn Markiewicz [7].

Linear algebra belongs to the part of mathematics whose development is strongly influenced by proper applications. Among the Polish mathematicians who significantly contributed to linear algebra through applications was Józef Maria Hoene-

Wronski (1776–1853), who used properties of matrices in the study of differential equations, introducing the Wronskian as early as in 1811. Hoene-Wronski was born in Wolsztyn (close to Poznań); there is an archive located in the Kórnik castle (also near Poznań) that includes important parts of his work. Another well-known Polish astronomer and mathematician who dealt with matrices was Tadeusz Banachiewicz (1882–1954), who, in 1922, introduced Cracovians (matrices with specifically defined operations) for use in astronomy; cf. Grala, Markiewicz, and Styan [6].

Linear algebra is frequently applied in statistics, which has been developed in Poland from the beginning of the 20th century, with remarkable contributions by Jerzy Neyman (1894–1981). During the 1970s, there was a group of statisticians, created under the direction of Professor Tadeusz Caliński (b. 1928) at the Agricultural University in Poznań, who started intensive research into matrix methods with applications in statistics; For further details, see “A conversation with Professor Tadeusz Caliński” by Anthony C. Atkinson and Barbara Bogacka [1].

Over the years, there have been remarkable contributions by Jerzy K. Baksalary and Radosław Kala, along with some of their Ph.D. students, who continued the research oriented towards linear algebra, with emphasis on generalized inverses of matrices, projectors, partial orderings, matrix equations and inequalities, and modified matrices. The career of Jerzy is described by O. M. Baksalary and Styan [4] in their article “Some comments on the life and publications of Jerzy K. Baksalary (1944–2005)” in *Linear Algebra and its Applications (LAA)*.

Near the end of the 1970s, Tomasz Szulc started research on applications of matrix analysis in numerical analysis at the Faculty of Mathematics, Physics, and Chemistry (reorganized in 1978–1993 as the Faculty of Mathematics and Physics, and since then the Faculty of Mathematics and Computer Science) of Adam Mickiewicz University in Poznań. In the mid 1990s, Jan Hauke, Augustyn Markiewicz, and Tomasz Szulc started to cooperate by organizing seminars on linear algebra and its applications, later called the Poznań Linear Algebra Group (PLAG); cf. O. M. Baksalary and Styan [3].

One of the most important parts of these activities was to host visitors who would deliver seminars and lectures. This activity started in 1996, in connection with the second part of the “Linear Operators Semester” held at the Banach Center in Warsaw (co-organized by Professor Jaroslav Zemánek from the Institute of Mathematics of the Polish Academy of Sciences). Some of the leading specialists in linear algebra and its applications have visited the Faculty of Mathematics and Computer Science of Adam Mickiewicz University in Poznań within the last two decades; one distinguished visitor was Hans Schneider. Some participants of the “Linear Operators Semester”, as well as guests of the Faculty, also attended the PLAG seminar; among them was Volker Mehrmann, who encouraged the PLAG



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members to attend the 1996 International Linear Algebra Society (ILAS) meeting in Chemnitz.

The next years' visitors and collaborators from Poland included, among others, Alicja Smoktunowicz, Zbigniew Woźnicki, and Krystyna Ziętak (working in the area of numerical linear algebra, like Tomasz Szulc). Visitors from abroad included Simo Puntanen, Dietrich von Rosen, and George P.H. Styan, working on the border between linear algebra and statistics; Rafael Bru, Ljiljana Cvetković, Ludwig Elsner, Andreas Frommer, Charles R. Johnson, Volker Mehrmann, Juan M. Peña, and Siegfried M. Rump, working more directly in linear algebra. The seminars have been regularly scheduled for every second Thursday since 1999. These group meetings were actively attended by Jerzy K. Baksalary, his son Oskar Maria Baksalary, Katarzyna Filipiak, and Ph.D. students. So far, seven of the Ph.D. students have successfully completed their theses; three from Augustyn Markiewicz, three from Tomasz Szulc, and one from Charles R. Johnson.

During last years Katarzyna Filipiak (Poznań University of Technology) joined the organizing group of PLAG, mobilizing participation of her Ph.D. students in the seminars.

The PLAG discussions have resulted in a good amount of published papers, several of which have appeared in *LAA*. Jerzy K. Baksalary has published 50 papers in this journal, some of them with Oskar Maria Baksalary, Jan Hauke, Radosław Kala, Augustyn Markiewicz, and Tomasz Szulc as co-authors. (Coincidentally, Jerzy has 50 joint papers with Radosław Kala.) The PLAG members have published more than 100 papers in *LAA*.

## 2. THE FIRST MATTRIAD CONFERENCE IN 2005

Another form of international collaboration was the organization of workshops and conferences. First came the 13th International Workshop on Matrices and Statistics (IWMS), held in Będlewo in 2004 in celebration of Ingram Olkin's 80th birthday, with the participation of prolific mathematicians/statisticians like T. W. Anderson (1918–2016), Gene H. Golub (1932–2007), Volker Mehrmann, and Ingram Olkin himself. (Ingram passed away in the age of 91 in 2016.) Selected papers presented during the conference were published in a special issue of *LAA*, with guest editors Elsner, Markiewicz and Szulc [5].

In 2005, encouraged by Volker Mehrmann, the first conference in the MatTriad series was held at the Mathematical Research and Conference Center of the Institute of Mathematics of the Polish Academy of Sciences in Będlewo, near Poznań, Poland, 3–5 March 2005, cf. the Będlewo Conference Center (Available at: <https://www.impan.pl/en/activities/bedlewo-conference-center/about-center>). Of the first eight MatTriads, four have been organized in Będlewo. According to the original plan, it was supposed to be a rather small conference, mainly with invited speakers, limited to three days. Hence, the name MatTriad was adopted for the conference. However, since 2009, this three-day-rule has not been followed anymore.

As Oskar Maria Baksalary wrote in his report in [2]:

MatTriad 2005—Three Days Full of Matrices, was held at the Mathematical Research and Conference Center in Będlewo, Poland, on March 3–5, 2005. This international workshop attracted 40 participants; 38 representing seven European countries, one from Canada (George P. H. Styan) and one from the USA (Charles R. Johnson). The organizing committee, consisting of Jan Hauke, Augustyn Markiewicz (chair), Tomasz Szulc, and Waldemar Wołyński, did an excellent job in acquiring generous sponsors, and thus there was no registration fee and local expenses, such as food and lodging, were covered.

The following is an up-to-date version of the aims of the MatTriad conferences:

The MatTriad conferences represent a platform for researchers in a variety of aspects of matrix analysis and its interdisciplinary applications to meet and share interests and ideas. The conference topics include matrix and operator theory and computation, spectral problems, applications of linear algebra in statistics, statistical models, matrices and graphs as well as combinatorial matrix theory and others. The goal of this event is to encourage further growth of matrix analysis research including its possible extension to other fields and domains.

Quite soon after the first MatTriad in 2005, the organizing system for the MatTriad found its form as two committees: the Scientific Committee (SC) and the Local Organizing Committee. For several years, the Scientific Committee has comprised Tomasz Szulc (chair), Natália Bebiano (Coimbra, Portugal, belonging to the SC since 2013), Ljiljana Cvetković (Novi Sad, Serbia), Heike Faßbender (Braunschweig, Germany), and Simo Puntanen (Tampere, Finland). In addition, João T. Mexia served as a member of the Scientific Committee in MatTriad-2011 in Tomar.

It became a tradition that an important part of the conference program are the short courses, given by Invited Lecturers. The work of young scientists has had a special position in the MatTriad conferences. Young Scientist Awards (YSA) have been given to the best poster, as well as the best talk, of graduate students or scientists with a recently completed Ph.D. Prize-winning works are widely publicized and promoted by the conference, and winners have previously been invited as speakers for the next edition of the conference.

### 3. LIST OF THE EIGHT MATTRIAD CONFERENCES

We now present a list of the eight MatTriad conferences that have been held from 1990 to 2019, leading up to the ninth one to be held in Curia, near Coimbra, Portugal, in September 2021. The symbol “ $n$ ” below refers to the number of participants.

2005/1: The first MatTriad Conference, Będlewo, Poznań, Poland, 3–5 March 2005,  
 $n = 40$ .

Chair of the Organizing Committee: Augustyn Markiewicz.

Book of Abstracts. Available at <http://people.uta.fi/~simo.puntanen/AbstractBook-MatTriad-2005-Bedlewo.pdf>.

Program. Available at

<http://people.uta.fi/~simo.puntanen/MatTriad-2005-program.pdf>.

Report in *Image*. Available at

<http://people.uta.fi/~simo.puntanen/report-MatTriad-2005-Bedlewo.pdf>.

2007/2: The 2nd MatTriad Conference, Będlewo, Poznań, Poland, 22–24 March 2007,  $n = 64$ .

Local Chair: Augustyn Markiewicz.

Book of Abstracts. Available at <http://people.uta.fi/~simo.puntanen/AbstractBook-MatTriad-2007-Bedlewo.pdf>.

Program. Available at

<http://people.uta.fi/~simo.puntanen/MaTriad-2007-program.pdf>.

Flyer. Available at

<http://people.uta.fi/~simo.puntanen/MatTriad-2007-announcement.pdf>.

Report in *Image*. Available at

<http://people.uta.fi/~simo.puntanen/MatTriad-2007-Bedlewo-report.pdf>.

*Invited Speakers*: Rafael Bru, Ludwig Elsner, Daniel A. Griffith, Charles R. Johnson, Thomas Klein, João T. Mexia, Juan M. Peña, Friedrich Pukelsheim, Siegfried M. Rump, George P. H. Styan, Götz Trenkler, and Roman Zmysłony.

*YSA*: Vladimir Kostić (Serbia), Miguel Fonseca (Portugal), Dorota Kubalińska (Germany), and Iwona Wróbel (Poland).

*Birthday Boys*: Erkki Liski; Available at <http://people.uta.fi/~simo.puntanen/Erkki-Liski-Bedlewo-MatTriad-AbstractBook-23march07.pdf>.

George P. H. Styan; Available at <http://people.uta.fi/~simo.puntanen/George-Styan-Bedlewo-MatTriad-AbstractBook-23march07.pdf>.

Daniel A. Griffith chaired a special session “Statistics and Linear Algebra in Practice”, devoted to applications of statistics in pharmacy and medicine.

2009/3: The 3rd MatTriad Conference, Będlewo, Poznań, Poland, 23–27 March 2009,  $n = 56$ .

Local Chair: Augustyn Markiewicz.

Book of Abstracts. Available at <http://people.uta.fi/~simo.puntanen/AbstractBook-MatTriad-2009-Bedlewo.pdf>.

Program. Available at

<http://people.uta.fi/~simo.puntanen/MatTriad-2009-program.pdf>

Announcement. Available at <http://people.uta.fi/~simo.puntanen/Announcement-MatTriad-2009-Bedlewo.pdf>.

Report in *Image*. Available at

<http://people.uta.fi/~simo.puntanen/report-MatTriad-2009-Bedlewo.pdf>.

*Invited Speakers*: S. Ejaz Ahmed, Charles R. Johnson, João T. Mexia, Juan M. Peña, Dietrich von Rosen; Vladimir Kostić, Miguel Fonseca, Dorota Kubalińska, and Iwona Wróbel (YSA-2007).

*Lecturers*: Andrzej Cegielski, Charles R. Johnson.

*YSA*: Ricardo Covas (Portugal), Aneta Sawikowska (Poland).

2011/4: The 4th MatTriad Conference, Tomar, Portugal, 12–16 July 2011,  $n = 76$ .

Local Chair: Francisco Carvalho.

Website Available at

<http://www.mattriad2011.ipt.pt/>.

Abstract Book. Available at <http://people.uta.fi/~simo.puntanen/AbstractBook-MatTriad-2011-Tomar.pdf>.

Program. Available at  
<http://people.uta.fi/~simo.puntanen/MatTriad-2011-Tomar-Program.pdf>

Poster. Available at  
<http://people.uta.fi/~simo.puntanen/MatTriad-Tomar-poster-2011.pdf>

Announcement. Available at <http://people.uta.fi/~simo.puntanen/MatTriad-2011-Tomar-Announcement.pdf>.

Report in *Image*. Available at  
<http://people.uta.fi/~simo.puntanen/report-MatTriad-2011-Tomar.pdf>.

*Invited Speakers:* Natália Bebiano, Jeffrey J. Hunter, Charles R. Johnson, Juan M. Peña, Ricardo Covas, and Aneta Sawikowska (YSA-2009).

*Lecturers:* Narayanaswamy Balakrishnan, Ali S. Hadi, Volker Mehrmann.

*YSA:* Paulo C. Rodrigues (Portugal), Olivia Walch (USA).

2013/5: The 5th MatTriad Conference, Herceg Novi, Montenegro, 16–20 September 2013,  $n = 70$ .

Local Chair: Ljiljana Cvetković.

Website. Available at  
<http://mattriad2013.pmf.uns.ac.rs/>.

Abstract Book. Available at  
<http://people.uta.fi/~simo.puntanen/MatTriad-13-bookofabstracts.pdf>.

Program. Available at <http://people.uta.fi/~simo.puntanen/Program-MatTriad-2013-Montenegro.pdf>.

Poster. Available at  
<http://people.uta.fi/~simo.puntanen/mattriad.jpeg>.

Report in *Image*. Available at <https://people.uta.fi/~simo.puntanen/report-IWMS-2013-Toronto-MatTriad.pdf>.

*Invited Speakers:* Richard A. Brualdi, Stephen J. Kirkland, and Paulo C. Rodrigues (YSA-2011).

*Lecturers:* Siegfried M. Rump, Adi Ben-Israel.

*YSA:* Jaroslav Horáček (Czech Republic), Maja Nedović (Serbia).

2015/6: The 6th MatTriad Conference, Coimbra, Portugal, 7–11 September 2015,  $n = 170$ .

Local Chair: Natália Bebiano.

Website. Available at  
<http://www.mattriad.ipt.pt/>.

Book of Abstracts. Available at  
<http://www.mattriad.ipt.pt/download/2015/Book/abstracts.pdf>.

Program. Available at

<http://www.mattriad.ipt.pt/download/2015/Program/MatTriadProgram.pdf>.

Poster. Available at [http://www.mattriad.ipt.pt/download/2015/Poster/cartaz-mattriad2015-completo\\_v2.pdf](http://www.mattriad.ipt.pt/download/2015/Poster/cartaz-mattriad2015-completo_v2.pdf).

Report in *Image*. Available at

<http://people.uta.fi/~simo.puntanen/report-MatTriad-2015-Coimbra.pdf>.

*Invited Speakers:* Peter Benner, Marija Dodig, Froilán M. Dopico, Moshe Goldberg, Christian Mehl, Dietrich von Rosen, Roman Zmysłony, Karol Zyczkowski; Jaroslav Horáček, and Maja Nedović (YSA-2013).

*Lecturers:* Friedrich Pukelsheim, Peter Šemrl.

*YSA:* Ernest Šanca (Serbia), Jolanta Pielaszkiwicz (Sweden).

Nine invited minisymposia were included in the program. To end the five-day conference, a talk on “Linear Algebra in Portugal” was delivered by José Vitória. The conference dinner included a celebration in honour of Simo Puntanen’s 70th birthday, with speaker Alexander Kovačec. The program also included a Special Session in memory of Glória Cravo about eigenvalues, multiplicities and graphs, with speaker Charles R. Johnson.

2017/7: The 7th MatTriad Conference, Będlewo, Poland, 25–29 August 2017,  $n = 64$ .

Local Chair: Augustyn Markiewicz.

Website. Available at

<https://mattriad.wmi.amu.edu.pl/>.

Book of Abstracts. Available at [https://mattriad.wmi.amu.edu.pl/files/Book\\_of\\_abstracts.pdf](https://mattriad.wmi.amu.edu.pl/files/Book_of_abstracts.pdf).

Program. Available at

<http://people.uta.fi/~simo.puntanen/Program-MatTriad-2017-Bedlewo.pdf>

Report in *Image*. Available at <http://people.uta.fi/~simo.puntanen/Report-on-MatTriad-2017-Bedlewo.pdf>.

*Lecturers:* Lynn Roy LaMotte, Fuzhen Zhang.

*Invited Speakers:* Narayanaswamy Balakrishnan, Andreas Frommer, Volker Mehrmann, K. Manjunatha Prasad, Miroslav Rozložník; Jolanta Pielaszkiwicz, and Ernest Šanca (YSA-2015).

*YSA:* Álvaro Barreras (Spain), Ryo Tabata (Japan).

There was also a session in memoriam of Professor Jaroslav Zemánek.

2019/8: The 8th MatTriad Conference, Liblice, near Prague, Czech Republic, 8–13 September 2019, registered as an ILAS-Endorsed meeting,  $n = 91$ .

Local Chair: Miroslav Rozložník.



Website. Available at

<http://mattriad.math.cas.cz>.

Abstract Book. Available at [http://people.uta.fi/~simo.puntanen/](http://people.uta.fi/~simo.puntanen/AbstractBook-MatTriad-2019-Liblice.pdf)

[AbstractBook-MatTriad-2019-Liblice.pdf](http://people.uta.fi/~simo.puntanen/AbstractBook-MatTriad-2019-Liblice.pdf).

Program. Available at [https://mattriad.math.cas.cz//assets/](https://mattriad.math.cas.cz//assets/mattriad_2019_program.pdf)

[mattriad\\_2019\\_program.pdf](https://mattriad.math.cas.cz//assets/mattriad_2019_program.pdf).

Flyer. Available at [http://people.uta.fi/~simo.puntanen/](http://people.uta.fi/~simo.puntanen/flyer_mattriad19.pdf)

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Chateau Liblice Available at

<http://www.chateau-liblice.com/>.

Report in *Image*. Available at

<http://people.uta.fi/~simo.puntanen/report-MatTriad-2019-Liblice.pdf>.

*Invited Speakers*: Dario Bini, Mirjam Dür, Arnold Neumaier, Martin Stoll; Álvaro Barreras, and Ryo Tabata (YSA-2017).

*Lecturers*: Shmuel Friedland, (The Hans Schneider ILAS Lecturer), Zdeněk Strakoš.

*YSA*: Marie Kubínová (Czech Republic), Yuki Nishida (Japan).

Four special sessions were organized. MatTriad-2019 was a satellite meeting of the International Congress on Industrial and Applied Mathematics ICIAM, held in Valencia, Spain, 15–19 July, 2019.

2021/9: The 9th MatTriad Conference, Curia, near Coimbra, September 2021.

Local Chair: Natália Bebiano.

In progress.

#### 4. SPECIAL ISSUES AND PROCEEDINGS DEVOTED TO THE MATTRIAD

Selected refereed papers presented at the MatTriad have been (or are about to be) published in the following journal special issues/Proceedings:

2012: A special issue of ELA - *Electronic Journal of Linear Algebra*, vol. 25 (2012), devoted to MatTriad-2011, Tomar, Portugal, 12–16 July 2011. Available at <https://journals.uwo.edu/index.php/ela/issue/view/49>. Guest Editors: Oskar Maria Baksalary, Natália Bebiano, Ljiljana Cvetković and Simo Puntanen. Preface.

2017: Natália Bebiano (editor) (2017). *Applied and Computational Matrix Analysis: MatTriad, Coimbra, Portugal, September 2015, Selected, Revised Contributions*. Springer Proceedings in Mathematics and Statistics, vol 192. DOI: 10.1007/978-3-319-49984-0.

- 2018: A special issue of ELA - *Electronic Journal of Linear Algebra*, vol. 33 (2018), devoted to MatTriad-2017, Będlewo, Poznań, Poland, 25–29 September 2017. Available at <https://journals.uwo.edu/index.php/ela/issue/view/65>. Guest Editors: Oskar Maria Baksalary, Natália Bebiano, Heike Faßbender and Simo Puntanen. Preface.
- 2020: A special issue of *Applications of Mathematics*, devoted the MatTriad-2019, Liblice, Czech Republic, 8–13 September 2019. Available at <http://am.math.cas.cz/>. Guest Editors: Miroslav Rozložník and Milan Hladík. Available at [https://mattriad.math.cas.cz/assets/mattriad\\_2019\\_si.pdf](https://mattriad.math.cas.cz/assets/mattriad_2019_si.pdf). In progress.

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