CHARTER RENEWAL APPLICATION FOR THE SIAM ACTIVITY GROUP ON LINEAR ALGEBRA

This **Charter Renewal Application** applies to the SIAM Activity Group on Linear Algebra. The SIAG/LA was originally formed under the auspices of SIAM on July 19, 1982 by the SIAM Council and July 20, 1982 by the SIAM Board of Trustees. Its initial operating period began January 1, 1983 and ended December 31, 1985. Its charter has been renewed by the Council and Board ten times thereafter. This SIAG has 779 members, including 372 student members, as of 12/31/2020.

According to its Rules of Procedure, the objective(s) of the SIAM Activity Group on Linear Algebra are to identify and explore the links between linear algebra and other applied sciences, to stimulate the applications of linear algebra, and to foster research in linear algebra and its applications. Within the framework of SIAM, the group will conduct activities that forward these goals.

Its purposed functions were:

The SIAG on LA will organize activities in Linear Algebra. The SIAG is expected to:

(1) Subject to the conditions of ARTICLES III and IV, the SIAM Activity Group on Linear Algebra will conduct sessions at regular SIAM meetings, conduct special meetings, and participate in organizing publications in the areas of linear algebra and its applications.

(2) The SIAG shall not present awards or otherwise recognize scientific achievement, professional service, or the like without prior approval by both the SIAM Major Awards Committee and the SIAM Council of the award criteria; the method of selection of recipient(s), the nature of the award, and all other aspects, if any, of each such award must have the prior approval of the SIAM Board of Trustees.

Other activities can include:

(3) Organize minisymposia at the SIAM Annual Meeting in years where there is no SIAG conference.

(4) At least once every five years either organize a track of at least six minisymposia at the SIAM Annual Meeting or have an activity group meeting held jointly with the annual meeting. The VP for Programs and the VP at Large will coordinate the scheduling with the SIAG chair.

(5) Organize a triennial SIAM Conference on Applied Linear Algebra. The SIAG will consider dovetailing specialized workshops and conferences with the SIAM Annual meeting or other SIAG conferences. The chair of the conference organizing committee shall be either the program director or the chairperson of the SIAG or their designee. *If neither the program director nor the chairperson of the SIAG is the chair of the conference organizing committee,*

then the program director of the SIAG shall be a member of the committee. The organizing committee must be approved by the VP for Programs at least 16 months before the conference.

(6) With the approval of the SIAM Program Committee, the SIAG may organize special sessions at SIAM meetings, and conduct special one- or two-day meetings immediately before or after a regular SIAM meeting. Other SIAG meetings may be organized only with the approval of the SIAM president and vice president for programs.

(7) Award the triennial SIAG Linear Algebra Prize; established in 1987.

(8) Award the triennial SIAG Early Career Prize; established in 2017.

(8) Maintain a website for the activity group (http://siags.siam.org/siagla/).

The SIAG has complemented SIAM's activities and supported its proposed functions. The answers to the questions below indicate how this was accomplished and what the officers propose as the future directions for the SIAG.

(1) List all current officers of the activity group (including advisory board, if relevant).

> Chair: Valeria Simoncini Vice
> Chair: Melina Freitag Program
> Director: Miroslav Tŭma
> Secretary: Christine Klymko

(2) How is the field covered by the activity group doing? Is it growing, is the focus shifting? What have been the significant advances over the last three years?

Applied Linear Algebra is a very active research area, as it is fundamental to most areas of computational science and engineering. Classically, discretizations of (stochastic) partial differential equations almost always lead to matrix computations. Large scale computational problems arise in timely data intensive problems, such as optimization problems for training deep neural networks. Graph and network analysis, as well as data analysis and machine learning applications give rise to linear systems and eigenvalue problems whose matrix dimensions are in the hundreds of billions. Data-intensive applications in biology, chemistry, nuclear engineering, and data mining employ high dimensional tensors that overwhelm the computational capabilities of current systems. Many model order reduction and data compression ideas fall within the domain of numerical linear algebra and are recurring themes throughout scientific computing. Structure preserving matrix methods are crucial for the reliable solution of practical scientific and engineering problems, including image processing. Nonlinear eigenvalue problems from civil and mechanical engineering pose substantial theoretical and algorithmic challenges.

Core problems in applied mathematics with active research in areas covered by the SIAG/LA (e.g., numerical linear algebra and matrix analysis) include:

- *Nonlinear eigenvalue problems*

- *Tensor algorithms and analysis*
- *Domain decomposition and multilevel methods*
- *Krylov subspace methods for linear systems and eigenvalue problems*
- *Algorithms for structured matrices*
- *Model order reduction and low-rank approximations*
- *Computation of matrix functions*
- *Randomized algorithms*
- *Inverse problems*
- *Network analysis*
- *Application to optimization, differential equations, signal and image processing, control, electronic structure calculations, data analysis and data mining, information retrieval, bioinformatics, as well as structural, mechanical and aerospace engineering.*

Future directions motivated by core problems that are likely to receive substantial attention by researchers in Applied Linear Algebra include:

- *The development of efficient methods in data science, data mining, and machine learning, including data assimilation, physics-based machine learning, search engine technology, and information retrieval.*
- *The contribution of numerical linear algebra to statistics and Bayesian inference, in particular dimension reduction for high-dimensional problems.*
- *The contribution of numerical linear algebra to network science, and computations of matrix functions.*
- *The steadily increasing support in the development of parallel computing and algorithms that can reliably achieve exascale computing, including mixed precision high performance computing (HPC). Fostering the fundamental role of numerical linear algebra in designing communication avoiding algorithms.*
- *Removing the severe restrictions imposed by limited floating point accuracy in extreme matrix computations, such as those arising in search engine applications, including the development of order reduction and low rank methods for such problems.*
- *The development of numerical methods in multilinear algebra for pattern identification and low rank approximations and dimension reduction in high-dimensional data sets.*

(3) How is the activity group doing? Is it remaining vibrant? Is the size of the SIAG stable or increasing? How is the SIAG keeping up with the changes in the field? How are the broader interests of SIAM reflected in the activities of the SIAG?

The activity group had 779 members at the end of 2020, down from 816 at the end of 2017. However, the core non-student membership of the SIAG is very stable and has continued to grow slightly. The decrease from 2017 was mainly due to the decrease in student members, which currently number 372 (down from 415 at the end of 2017). Overall, the membership numbers have been relatively stable over the years.

Given the constraints of the pandemic, which interrupted many conference plans and led to several cancelled meetings, the SIAG has remained very active, with involvement in two online seminars (see below), the SIAG/LA Prize and the SIAG/LA Early Career Prize. Additionally, the triennial SIAM Conference on Applied Linear Algebra, overseen by the SIAG, is continuing this year despite the pandemic, with a pivot from an in-person to an online only meeting. The SIAG/LA is keeping up with changes in the field by organizing and soliciting minisymposia and tracks at SIAM conferences on emerging topics, by selecting researchers at the forefront of these fields as plenary speakers at the SIAM Applied Linear Algebra Conference (as well as ILAS), and by soliciting proposals for the Gene Golub SIAM Summer School (where the last G2S3 on "Theory and Practice of Deep Learning" in 2020 at AIMS in South Africa had to be cancelled and will take place online in 2021). The broader interests of SIAM are served by the SIAG in various ways, for instance by organizing minisymposia on applications of linear algebra that have considerable overlap with other areas of applied and industrial mathematics, such as optimization, inverse problems, image processing, uncertainty quantification (UQ), data mining, PDEs, etc. Finally, the SIAG/LA solicits submission of articles on linear algebra to SIAM News.

(4) Please list conferences/workshops the activity g r o u p has sponsored or co-sponsored over the past three years, and give a brief (one sentence or phrase) indication of the success or problems with each.

The SIAG/LA organizes the triennial conference on Applied Linear Algebra. A list of these conferences may be found at: http://www.siam.org/meetings/archives.php#LA.

Since the last charter renewal application was approved, the Fourteenth SIAM Conference on Applied Linear Algebra was organised by SIAM and the Co-Chairs Misha Kilmer and Andreas Stathopoulos in New Orleans, Louisiana, from May 17-21 2021, which will now (due to the pandemic) take place fully virtually. The conference also embeds the cancelled ILAS meeting of 2020.

A highlight of the conference will be the award of the SIAG/LA Linear Algebra Best Paper Prize, and the SIAG/LA Early Career Prize.

The vibrancy of the field is reflected in the success of E-NLA https://sites.google.com/view/e-nla/home, *an online seminar series dedicated to topics in Numerical Linear Algebra, which started in April 2020 and is organized by Stefan Güttel, Daniel Kressner, Jörg Liesen, Alex Townsend, Bart Vandereycken, and SIAG officers Melina Freitag and Valeria Simoncini. The series, which is endorsed by SIAM, features many eminent speakers in NLA, has over 1000 registered subscribers, and attracts about 100-200 audience members every two weeks (initially, once a week). The youtube channel* https://www.youtube.com/channel/UCl3AmvN5JwD4FUJn2aLKDZQ/videos *is very popular and once posted there, talks receive between hundreds to over a thousand additional views.*

Another online series, called "Communicatons in NLA" https://sites.google.com/view/commnla/home *was established by junior members of the community, and was also endorsed by the SIAG and SIAM.*

The Householder Symposium, supported by SIAM, which was supposed to take place in 2020 in Italy, has been postponed to 2022.

The SIAG/LA maintains its active involvement in the ILAS Conferences with one of the plenary speakers, to be identified as the "SIAG/LA Speaker" on the conference materials; SIAM covers all the expenses for this speaker. The SIAG/LA sponsored David Bindel for ILAS in 2019, the 2020 meeting in Galway was moved to 2022 and in 2021 ILAS is embedded in the SIAG ALA meeting.

The SIAG/LA endorsed ("in cooperation") the conferences:

- *Sixth IMA Conference on Numerical Linear Algebra and Optimization, University of Birmingham, UK, June 2020 (moved to June 29 - July 1 2022)*
- *Householder Symposium XXI, Selva di Fasano (Br), Italy, June 2020 (postponed to June 12 - 17 2022)*
- *Matrix Equations and Tensor Techniques IX (METTIX) Workshop Perugia, Italy, September 09 - 10 2021 (new agreement, this year)*

(5) Please indicate the number of minisymposia directly organized by the activity group at the last two SIAM annual meetings. When did the SIAG last organize a track of minisymposia at an annual meeting or meet jointly with the SIAM Annual Meeting?

The SIAG/LA organized a track of minisymposia at SIAM AN16 in Boston, which included five minisymposia and one minisymposterium.

Although the SIAG/LA held its triennial SIAM ALA Conference in May 2018, the Annual Meeting organizers still requested that we solicit minisymposia and minisymposteria for the meeting in Portland. We managed to recruit 6 different SIAG/LA minisymposia, with 11 parts total, and one minisymposterium (with 5 different posters).

The SIAG/LA is planning to organize a track of minisymposia at SIAM AN22.

There has never been a SIAM ALA meeting held jointly with a SIAM AN meeting.

(6) Please indicate other activities sponsored by the activity group, to include newsletters, prizes and web sites. Have each of these been active and successful?

The SIAG/LA Prize for the best paper in the field of applied linear algebra is awarded every three years at the SIAM ALA meeting.

> *The 2018 prize was awarded to Jiawang Nie ["Generating Polynomials and Symmetric Tensor Decompositions", Foundations of Computational Mathematics 17(2): 423-465 (2017)]. Alison Ramage was Chair of the Prize Committee.*

> *The 2021 prize was awarded to Michel Crouzeix from the University of Rennes and Cesar Palencia from the University of Valladolid ["The numerical range is a $(1 + \sqrt{2})$-spectral set", SIAM J. Matrix Anal. Appl. 38(2): 649-655 (2017)] Melina Freitag was Chair of the Prize Committee.*

The SIAG/LA Early Career Prize (established in 2017) is awarded every three years at the SIAM ALA meeting to recognize an individual who has made outstanding, influential, and potentially long-lasting contributions to applicable linear algebra.

> *The 2021 prize was awarded to Theo Mary, CNRS Researcher at Sorbonne, Paris. Valeria Simoncini was Chair of the Prize Committee.*

Christine Klymko manages the SIAG/LA website and sends out announcements.

Melina Freitag manages the SIAG/LA Twitter account.

The SIAG/LA website is located at: http://siags.siam.org/siagla/index.html.

Recently, there has been a move to the new SIAM Engage platform for the announcements.

The SIAG/LA officers solicited the article, "Learning with Nonnegative Matrix Factorizations" by Nicolas Gillis for the June 2019 edition of SIAM News. Other articles by prominent NLA researchers were in the works before being delayed due to the pandemic.

The SIAG/LA Business Meeting took place online (April 28th, 2021) and was independent of the forthcoming SIAM ALA meeting, for the first time this year. The agenda included an engaging talk by Nick Higham on a mathematically accessible topic. We believe the meeting was well received and well attended, and we may consider replicating the event in a somewhat similar format in future occasions.

(7) What activities are planned and proposed for the next period of the charter? Please describe scheduled and suggested future activities in detail

The main event currently being planned is: SIAM ALA 2024. The SIAG/LA Officers will solicit input from all members on proposed locations for the meeting, and had a short discussion during the SIAG/LA Business Meeting which took place online. Proposals have been invited, and there has also been a suggestion to hold it in New Orleans (the intended location of the now-online SIAM ALA 2021). The SIAG/LA Officers will complete the work on finalizing location, date and conference co-chairs in summer, 2021.

In addition, the SIAG/LA is involved in the 2022 ILAS Conference (Galway, Ireland, June 20-24), and the 2022 Householder Symposium (Selva di Fasano Italy, June 12-17). SIAG/LA members have submitted minisymposia proposals for the SIAM Annual meeting in 2021 and will continue to do this in future annual meetings.

The current officers plan to continue to solicit articles related to numerical linear algebra to be published in SIAM News.

It should be mentioned that the four current SIAG/LA officers are reaching the end of their term in December 2021; a nominating committee will be formed to identify candidates for the four officer positions. Election of new officers will take place in the fall of 2021.

(8) How can SIAM help the activity group achieve its goals?

It would be helpful to be prompted about important to-do items, such as when to form the nomination committee for the next election of SIAG officers.

In addition, when a SIAG has a whole new set of officers, it is difficult for them to know precisely all of the critical activities that should be addressed during their term. It would be helpful if SIAM could work with SIAG officers to prepare a list of critical items, which could be continually updated, archived by SIAM, and passed on to newly elected officers. We initiated such a list for internal SIAG/LA use, but formally coordinating with SIAM would be helpful in making sure the list remains current. This list of critical activities could also serve SIAM as a mechanism for sending out reminders to SIAG officers when certain critical activities need to be done.

Another possibility is to have a "lag/shift" in the term time for the officers, in order to maintain some continuity.

(9) How can the activity group help SIAM in its general role of promoting Linear Algebra?

The SIAG/LA has been very active in terms of conference organization and co-sponsorship, minisymposia and tracks at other meetings, the award of the SIAG/LA Prizes, the Summer Schools, the web site and the Newsletter.

The SIAG/LA web site and Newsletter are particularly important for providing mechanisms to advertise conferences, summer schools, workshops, and jobs related to Linear Algebra. During the past 2 years we had issues in accessing the web site, due to SIAM changing the backend platform and update access being dependent on "permitted" IP addresses rather than a password. This took over a year to initially diagnose and since it has been a struggle to ensure that access remains as officers move/update internet routers/etc... This is likely to continue to remain a problem going forward if SIAM does not take specific actions to address the issue.

This SIAG requests that the SIAM Council and Board of Trustees renew its charter for a three year operating period beginning January 1, 2022.

Valeria Simoncini and Melina Freitag
SIAG/LA Chair and Vice-Chair
14 May 2021