SIAG Imaging Systems (IS)

Charter Renewal Application

This CHARTER RENEWAL APPLICATION applies to the SIAM Activity Group on Imaging Science (hereafter called SIAG/IS). The SIAG/IS to which this renewal applies was originally formed under the aegis of SIAM on December 11, 1999, by the SIAM Board of Trustees and via electronic voting by the SIAM Council in January 2000. SIAG/IS began its operations on January 21, 2000. Its charter has been renewed by the SIAM Council and Board nine times thereafter. The SIAG had 607 members as of Dec 2018. From those, 294 are student members.

According to its Rules of Procedure, the objectives SIAG/IS are responsible for include:

1) Providing a forum for conferences and scientific interaction between imaging science researchers and practitioners in academia, industry, medicine, and government;

2) Encouraging research that will provide a rigorous mathematical foundation for imaging science;

3) Fostering research in mathematics and computation that has the potential for solving real-world problems in imaging science, and leads to new methods and techniques useful in this subject;

4) Providing the means for rapid publication and dissemination of novel methods in imaging science.

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

- 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 two years?

  Right now, it is an intriguing time for the area of imaging science. We, for instance, observe the frequent emergence of new, highly sophisticated imaging technologies such as in medical imaging, which require the development of novel methodologies from our side. But, maybe even more excitingly, we are witnessing a rapid infusion of machine learning approaches in our area. In fact, a significant percentage of new publications in our area already exploits methodologies such as deep neural networks for imaging science. However, often purely data-driven approaches currently still lack a fundamental mathematical understanding. So on the one hand, there exist numerous methodologies such as variational methods based on models coming from partial differential equations or applied harmonic analysis, for which a profound theoretical underpinning is available. On the other hand, data-driven methods currently already often outperform those approaches, in particular in applications, when precise modeling would be too complex. However, many data-driven methods lack theoretical guarantees, whose development is a central goal of our community. And in this realm, one key question is also, what is an optimal balancing of data-adaptiveness and more traditional modeling, which then often allows a mathematical analysis. In this sense, this is perhaps one of the most exciting times for the area of imaging science.

- 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 SIAG on Imaging Science is doing very well and is tremendously vibrant during these exciting times in our area (see the previous item). While the size of the activity group seems now more or less stable at 615 members, it is very positive to observe that the number of student members is steadily increasing (about 20% growth from 2016 to 2017). The fact that the SIAG is keeping up with the changes in the field can be observed by the topics of the suggested minisymposia at the SIAM Conferences on Imaging Science (152 minisymposia at SIAM IS 2018) and by the submitted manuscripts to the SIAM Journal on Imaging Science. We are particularly proud that seven members of our SIAG (Liliana Borcea, Michael Elad, Peter Kuchment, Helmut Pottmann, Misha Kilmer, Ron Kimmel, and Gitta Kutyniok) have been elected as SIAM Fellows for the 2018 and 2019 class.

- Please list conferences/workshops the activity group 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.

  Our conference, SIAM IS18, was extremely successful with by far the largest attendance of all SIAM IS conferences; in fact, it attracted over 800 participants from various countries worldwide. Our meeting was organized by Omar Ghattas (University of Texas in Austin) and Fiorella Sgallari (University of Bologna) and hosted in Bologna, Italy. Besides five plenary lectures, about 152 minisymposia were organized with topics ranging over the entire landscape of imaging science. We also observed a significant participation from industrial companies, health institutions, and research centers. As the conferences before, the three tutorials attracted many participants, focusing on highly topical areas such as uncertainty quantification. A particular highlight was the Forward-Looking Panel on "Imaging Science in the Age of Machine Learning" with one of the four panelists being from industry (Google), which attracted about 500, foremost young, participants. The Organizing Committee of SIAM IS18 also had assigned two special awards to promote and reward new ideas, which were the best poster award and the best challenging application award, for which worthy recipients were honored during a special ceremony. During its well-attended business meeting, the activity group developed new ideas about how to make poster presentations more attractive at future meetings and expressed general support to keep alternating the venue for SIAM IS between North America and overseas, as has been done in recent years. Another aspect that received a lively discussion was the imaging groups' involvement in the potential foundation of a new activity group and conference series on the mathematics of data science.

- 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 at an annual meeting or meet jointly with the SIAM Annual Meeting?

  The SIAG will hold its meeting jointly with the 2020 SIAM Annual (AN) Meeting. Prior to this, the SIAG last held its meeting jointly with SIAM-AN in 2008.

  The SIAG is co-sponsoring three minisymposia and a forward looking panel session at ICIAM 2019 in Valencia. Note that ICIAM replaces the SIAM Annual Meeting in the years it is held. The scheduled sessions are:

  - *"Theoretical Foundations of Deep Learning" (Kutyniok, et.al.)*
  - *"Optimisation and Inverse Problems in Imaging Science – Mini-symposium dedicated to Prof. Mila Nikolova" (Sgallari, et.al.)*
  - *"Recent Trends in the Mathematics of Images" (Chambolle, et.al.)*
  - *Panel discussion: "The Future of Mathematics in the Age of Machine Learning"(Kutyniok)*

Under the previous SIAG/IS officers, there were 4 minisymposia related to imaging science at the 2018 SIAM Annual Meeting, namely on "Machine Learning for Scientific Computing", "Geometric Deep Learning on Graphs and Manifolds Going Beyond Euclidean Data", "Mathematics of Signal Processing, Optimization and Inverse Problems", and "Harmonic Analysis in Imaging and Signal Processing".

- 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 team of officers sends an annual newsletter to the members of the SIAG. This includes key information about life in our SIAG such as information on and calls for our next meeting or calls for nomination for our awards.

Our emailing list "siam-imaging@siam.org" is very active and predominantly used for advertising related conferences and job opportunities. Between January 2018 and March 2019, 74 emails were sent (i.e., about 5 per month).

The activity group also maintains a wiki page that includes a list of related conferences and workshops, recent job postings, and course materials. The website has received about 40 updates during the last 15 months.

The Organizing Committee of SIAM IS18 had assigned two special awards to promote and reward new ideas. In an awards session on the last day of the conference, the Best Challenging Application Award was given to Claudio Belvedere, researcher from Rizzoli orthopedic institute, for his presentation "Multi-instrument Medical Imaging Analysis for Personalized Joint Replacement Design." "A Sequential Monte Carlo for Astronomic Imaging" by Federica Sciacchitano received the Best Poster Award.

Strictly related to and co-located with the Conference SIAM-IS18, there was a Summer School in Bologna coordinated with SIAM-IS18. The Summer School, which was organized one week ahead of the conference, aimed to tackle cross-cutting mathematical approaches to the conference's specific themes, essential for the international audience of young people who are preparing to attend this event for the first time, as well as for young students/researchers interested in discovering the fascinating world of mathematics for imaging. Around 50 students participated and many of them received a grant.

Since Mila Nikolova, who greatly worked to have SIAM IS 18 in Europe, unfortunately, passed away prematurely in 2018, we are currently working on establishing a prize in her honor, which shall be awarded at SIAM IS 20. Since she was very much dedicated to the education of the young generation, this prize shall focus on and support the young scientists in their early career

stage. The SIAG officers also coordinated with the SIIMS editor, Michael Elad, to solicit and support a tribute to Mila that was written by Gabriele Steidl and published in the SIAM News.

The calls for nominations for all 2020 Prizes will be posted very soon via our webpage as well as our newsletter.

The activity group prepared an article about its successful meeting in Bologna, which was published in the SIAM News Blog on August 1, 2018. The article provides a brief overview of the meeting and hyperlinks to materials of the plenary talks.

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

The next biennial SIAM IS20 will be held in Toronto, Ontario, Canada in July 2020. The general Co-chairs are Michael Elad and Stacey Levine. More information will be posted at https://www.siam.org/Conferences/CM/Main/is20. The prize in honor of Mila Nikolova shall be awarded at this event.

The SIAG is currently intensely involved in the organization of the first SIAM Conference on Mathematics of Data Science with Gitta Kutyniok and Joel Tropp being two of the three co-chairs. This conference shall last three days and will focus on various aspects of the mathematics of data science, including the vast problem area of processing imaging data.

- How can SIAM help the activity group achieve its goals?

SIAM Conferences are quite challenging for young researchers, also since when taking place in the US or Canada, SIAM typically chooses expensive large hotel complexes. It would be very welcome if this financial burden would be eased by providing more financial support for young scientists to attend SIAG-IS events.

Having representatives of our activity group in different countries would have significant advantages in receiving information about conferences, jobs, and grant opportunities from the respective country as well as having a channel to broadcast information to the local communities. We are currently aiming to initiate a network by contacting our members. We would regard it as very beneficial if other applied mathematics societies such as GAMM, SMAI, SIMAI, JSIAM, etc. would have a representative in SIAM through which we could then establish a network for our SIAG.

- How can the activity group help SIAM in its general role of promoting applied mathematics and computational science?

Our activity group SIAG/IS supports SIAM by promoting applied and computational mathematics by incorporating the large, vibrant community of imaging science, which encompasses and touches areas of pure and applied mathematics and various application areas, into SIAM. In the dawn of machine learning, SIAM is at the forefront of combining methodologies from mathematics and machine learning, and for resolving application problems in imaging science. In general, our SIAG is also unique in that it covers the entire range from industrial application to very deep mathematical problems reaching far into even pure mathematics.

As a unique activity, we organized a forward looking panel session on "The Future of Mathematics in the Age of Machine Learning" at ICIAM 2019 in Valencia with the panelists being the chairs of the SIAGs on "Analysis of Partial Differential Equations" (Eitan Tadmor), "Computational Science and Engineering" (Hans De Sterck), and "Linear Algebra" (James Nagy)., led by the chair of the SIAG/IS (Gitta Kutyniok).

This SIAG requests that the SIAM Council and Board of Trustees renew its charter for a two-year operating period beginning January 1, 2020, through December 31, 2021.

Signed

Gitta Kutyniok, Chair of the SIAG on Imaging Sciences

April 17, 2019