

SIAG Supercomputing (SC)
Charter Renewal Application

This CHARTER RENEWAL APPLICATION applies to the SIAM Activity Group on Supercomputing. The SIAM Activity Group Supercomputing was originally formed under the aegis of SIAM on July 16, 1984 by the SIAM Council and on July 17, 1984 by the SIAM Board of Trustees. Its initial operating period began January 1, 1985 and ended December 31, 1987. Its charter has been renewed by the Council and Board twelve times thereafter. This SIAG had 789 members as of December 31, 2020; of these, 335 were students.

According to its Rules of Procedure, the objectives of the SIAG are to provide an environment for interaction between developers of large-scale applications programs, applied mathematicians, algorithm designers, and computer architects, to foster the development of analytic methods, efficient algorithms, and applications software in context with advances in computer architecture as applied to high performance computing.

Its proposed functions are to:

- 1) Organize minisymposia at the SIAM Annual meeting in years when there is no Parallel Processing Conference.
- 2) Organize a track of at least six minisymposia at the SIAM Annual Meeting at least once every five years.
- 3) Organize a biennial SIAM Conference on Parallel Processing. 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. The organizing committee must be approved by the VP for Programs at least 16 months before the conference.

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

Chair, Olaf Schenk

Vice Chair, Matthias Bolten

Program Director, Keita Teranishi

Secretary, Amanda Randles

1. *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?*

The SIAM SC activity group serves as an international platform for the exchange of competencies in applied mathematics, scientific computing, and computational science and engineering, with a strong focus on methods, tools, algorithms, application challenges, and novel techniques and usage of high-performance computing. With radical changes both in the architectures and the parallel scales of emerging computer systems, substantial challenges for the application scientists are expected to make full utilization of supercomputers. A synergy of computer scientists from different parts of the computing scene will be required to achieve what is considered to be an important common goal: to generate scientific insights. According to various recent announcements from across the globe, exascale systems are projected to be available to users in only a few years from now. Such an enormous increase in computing power will inevitably drive the computational approaches to scientific problems - be it through simulations, data-driven approaches, or even in a combined fashion - to the next level.

The field of high-performance computing continues to expand and remains a dynamic and vibrant field of research. We are continuing to see an international ramp-up to exascale systems, commercial interest in expanding parallel computing capacity in the cloud, and an ever-increasing focus on integrating machine learning into conventional HPC workloads and driving chip design. There is also continued interest in post-Moore computing in terms of reconfigurable processors like FPGAs, the role of ARM-based systems, advanced memory subsystems like HBM, low-precision floating pointing units, and more 'exotic' elements like quantum processors and neuromorphic computing. The last two years have seen an ever-increasing role of machine learning in computational science workloads and the development of new chips to accelerate these. Interdisciplinary research and collaborations are often at the forefront.

All of these factors combined pose a critical question to the SIAG/SC in the field of HPC, namely, how to design algorithms and software that are portable, robust, and scalable despite the changing hardware landscape. The last two years have seen advances in algorithmic thinking (e.g., scalable solvers for data and ML problems, innovations in high-order methods, multi-precision computation) and software (e.g., performance-portable backends, new code generation infrastructure, data movement-centric programming).

2. *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?*

Even with the pandemic, activity has remained fairly stable. In December 2016, there were 797 members, 2018 there were 748, and we now have 804 members. Between 2016 and 2018, we saw a rise in student membership from 316 to 354. This number has continued to grow to 420 student members now. If this trend is maintained, we expect to see steady longer-term growth. Also, over the last few years, the activity group encouraged broader participation "across the computing stack" to include hardware, software, and numerical algorithms. We have continued in this direction by increasing heterogeneity in the fields of interest represented on both the organizing committee for the SIAM Parallel Processing (PP) conference as well as the calls-for-contributions.

An additional major change introduced during the charter period was the decision to solicit technical papers for peer-reviewed archival proceedings to be associated with the PP conference. The three aims for creating a new publication venue were as follows:

- Creating a forum for the distinct work happening within the SIAG-SC.

- Maintaining the overall health of SIAG-SC, particularly with respect to its prizes.

At PP20, we had 11 papers accepted out of 18 submitted. These papers were presented at PP20. The paper conference proceedings are unique in emphasizing the intersection between high performance scientific computing and scalable algorithms, architectures, and software.

3. *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.*

The three major activities in which SIAG/SC has focused its efforts during this charter period are as follows:

- Gene Golub SIAM Summer School 2019, on High-Performance Data Analytics. The focus of the school was on large-scale data analytics, which lies at the intersection of data analytics algorithms and high-performance computing.
- SIAM Parallel Processing 2020, US (Seattle, Washington)
- SIAM Parallel Processing 2022, US (Seattle, Washington)

4. *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 last organized a track at SIAM AN17. In accordance with SIAM guidelines or co-location or a track at the Annual Meeting once every 7 years, we anticipate SC will organize a track at the 2024 or 2025 conference.

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

Since 2010, SIAG/SC awards the SIAG/Supercomputing Career Prize and the SIAG/Supercomputing Earlier Career Prize. Since 2016, SIAG/SC also awards the SIAG/Supercomputing Best paper prize for the most outstanding paper, as determined by the prize committee, published in a peer-reviewed journal bearing a publication date within the four calendar years before the year of the award. In 2020, we awarded the following SIAG/SC prizes:

- SIAM Activity Group on Supercomputing Best Paper Prize
- SIAM Activity Group on Supercomputing Early Career Prize
- SIAM Activity Group on Supercomputing Career Prize

There is an active effort to solicit again nominations during the present charter period, with the aim of making awards at PP22. The creation and continuation of SIAM/SC proceedings, as noted above, is part

of a longer-term strategy to maintain the viability of these prizes.

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

As noted above, the main upcoming activities are PP22 (Seattle, Washington, USA). For the next charter period, SIAG/SC should seek ways to capitalize on the fact that it cuts across mathematics and computing in unique ways among SIAM's activity groups. As noted above, aspects of the computing stack that have implications for higher-level parallel numerical algorithms include new approaches to hardware. One of our primary focuses would be to solicit high-quality contributions of the proceedings of the SIAM PP Conference. We are aiming for contributions related to supercomputing, scientific computing in all of the areas of computational and applied mathematics. Topics of interest for these proceedings would include, but are not limited to:

- Extreme scalable methods in computational science and engineering, such as algorithms and software for scalable multi-scale, multi-physics, and high-fidelity computational science and engineering problems.
- Effective use of advanced computing systems for large-scale scientific applications, including modern multi- and many-core CPUs and accelerators with deep memory hierarchies and energy-efficient architectures.
- Best practices and tools for productive and sustainable scientific and engineering software development.
- Reproducibility for computational science and engineering.
- Algorithms and strategies for effective use of machine learning, deep learning, or AI to accelerate computational science.
- Numerical algorithm development for exascale computing, including, but not limited to, communication avoiding algorithms, use of reduced or mixed precision, and integration of scalable numerical libraries in application software.

7. *How can SIAM help the activity group achieve its goals?*

Overall, SIAM provides an excellent level of support to SIAG/SC in achieving our goals of building and sustaining a community our HPC and supercomputing. The SIAG officers would appreciate discussions with SIAM on consolidating the SIAG/SC papers series in a long term, e.g., by publishing these SIAG/SC conference proceedings in the SIAM Journal of Scientific Computing. It would also be beneficial to highlight the research of the SIAG/SC on all SIAM-related promotional material, e.g. on <https://www.siam.org/>, is research area on computing is not even listed or highlighted (although SIAM is listing over 18 other research areas).

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

One area in which SIAG/SC may be able to help SIAM promote applied mathematics and computational science is through its unique connections to computing more broadly. Also, SIAG/SC is a natural home for algorithms and applications on candidate post-Moore computing systems, including quantum computing, neuromorphic systems, probabilistic systems, and reconfigurable systems. A coordinated action might be useful to bring the research groups (and their postdoc and students) closer to SIAG/SC (and to SIAM as well). We also noticed that many colleagues who are regularly attending SIAM/SC are not members of SIAM/SC, so some coordination and action might be needed here.

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

Signed

Olaf Schenk, Chair of the SIAG on Supercomputing

5/18/21