



CCAM's Full Report (2023-24)

1. Cover Sheet

1- Name of the Center

Center for Computational and Applied Mathematics

2- name and academic title of the person who heads the CCI

Sam Behseta, Professor of Mathematics and Statistics

3- college(s) or other unit(s) [e.g. department or academic degree program] within which the CCI conducts its functions

College of Natural Sciences and Mathematics (CNSM)

4- contact information – phone number, email address, and building/room location

Email: ccam@fullerton.edu

Phone number: X8560

Building Room: MH 531

5- year established

2015

6- year of last review

2018.

7- date the review is being submitted

8 April 2024

8- name of primary author(s) if different from the director(s) of the CCI

NA

2. Missions and Goals

CCAM's Mission (Approved by the Council of Deans 2013-12-11):

CCAM will encourage and facilitate research, education, and outreach in computational mathematics and science through a trans-disciplinary collaboration of a diverse group of faculty, students, and external partners. (Aligns with the CSUF's Mission)

Goals of the Center:

- 1- Attract and bring together faculty, students, and other researchers with related interests. (aligns with CCSUF's Goals 1 and 3)

Objective A: Establish transdisciplinary collaborations among Center faculty members.

Objective B: Recruit students to engage in transdisciplinary research in collaboration with faculty and other students.

- 2- Provide research training to the next generation of students in a transdisciplinary environment. (aligns with CSUF's Goals 1, 2, and 3)

- 3- Develop transdisciplinary research and educational products. (aligns with CSUF's goals 1, 3, and 5)

Objective A: Generate research presentations, publications, grant proposals, and intellectual property.

Objective B: Offer talks, workshops, research group discussions, and the like to educate CCAM faculty and student members.

Objective C: Consider the development of new minors, concentrations, emphases, or the like for participating students.

- 4- Position members to generate external funding unique to the Center's mission. (aligns with CSUF's Goal 4)

- 5- Engage in outreach and community building. (aligns with CSUF's goal 4)

3. Activities

Below, we present the core of CCAM activities during the last period of review in three major categories: 1- Securing large-scale and impactful grants, 2- Energizing CCAM's Advisory Board and its efforts to outreach and securing philanthropic support, 3- CCAM's workshops, educational, and technical presentations.

I: Securing Large-scale and highly impactful grants

1- Acquisition of a new high-performance computing cluster through an Army grant

In 2021, CCAM received a grant from the US Army. This [\\$600,000 funding](#) allowed for acquiring a new high-performance computing (HPC) cluster to [enable faculty and students to engage in cutting edge research](#), facilitated by processing significantly large amount of data, and through complex computational algorithms. This cluster, called Turing, named after the father of modern computing, was the second HPC which has been housed in, and maintained and operated by, CCAM. The previous cluster, Kepler, was acquired in early 2015, at the inception of the Center. Turing is a considerably more advanced, and a far more capable computing machine than Kepler. This accomplishment is in direct agreement with the Center's mission and goals, and in turn, with those of CSUF's.

To elaborate, Turing best suits the needs of CCAM over the next 10-15 years, as it consists of a head node (2 Intel 2.1 GHz 16 core processors, 192 GB RAM, and 184 TB SSD storage), a storage node (2 Intel 2.1 GHz 16 core processors, 192 GB RAM, 224 TB SSD storage), 36 medium compute nodes (2 Intel 2.1 GHz 16 core processors, 192 GB RAM, 8 TB SSD storage), and 5 high-performance compute nodes (32 CPU cores, 384 GB RAM, 7.68 TB SSD storage, and 1 NVIDIA Tesla P100 GPU adapter). The head node supports operations and workloads on 41 compute nodes while the storage node supports backups of the head node as well as large data workloads on the compute nodes. The bulk of the computational work will be performed on the 36 medium compute nodes, which in aggregate provide 1,152 cores and 6,912 GB memory. Memory intensive applications as well as applications that benefit from CUDA will be supported by the 5 high-performance compute nodes. The specifications of the internal networking of the HPC cluster support a high bandwidth for overall cluster operations, parallelism, and data I/O. All of the specifications of the proposed cluster, from CPUs to memory to internal networking, are significantly improved over our current HPC equipment, allowing for more efficient and expansive computational work at CSUF. Specifically, the above aligns with CCAM's goal 3, and CSUF's goal 5.

Moreover, access to this cutting-edge computing cluster will enable CSUF's faculty and students to define new research activities and to significantly expand their existing projects. To give a few examples, CCAM PIs and their students are currently engaged in cutting-edge computational research, in a host of topics, including computational chemistry to photochemistry and reactive intermediates; exploring properties of

nanomaterials and the role of surfaces in chemical reactions; rational design of composite soft materials by multiscale computation; and evolutionary genetics and genomics; and the analysis of national Alzheimer's data repositories. These activities, and their byproducts, resulting in new publications, patents, and grant proposals are in direct agreement with the Center goals 1, 3, 4, and 5; and CSUF's goals 1,3, 4, and 5.

Additionally, Turing has been utilized for teaching in a variety of undergraduate and graduate courses, including the graduate-level Statistical Machine Learning, Introduction to Bioinformatics, Computational Physics, Physical Chemistry Laboratory, and Computational Chemistry. This agrees with CCAM's goal 2, and CSUF's goals, 1,2, and 3.

2- Scott Jewett Grant in Social Justice

CCAM was one of the six recipients of the prestigious [Scott Jewett grant in 2023](#). This project, funded for \$149,000, will create a summer undergraduate research experience for 30 CSUF students in 2024 and 2025. Under the mentorship of CSUF faculty, these students will engage with cutting-edge research projects involving high-performance computing (HPC) and big data. HPC and big data are increasingly important to modern research, impacting areas ranging from science and engineering to public health and finance. By providing equitable learning through HPC and performing research on big data, we are providing CSUF students with transformational experiences that will make them more marketable in the workforce. Moreover, this project provides opportunities in the form of workshops, seminars, and summer research experiences.

In the first year of its activities, CCAM has attracted nine exciting new projects from NSM and ECS, including the analysis of Endometriosis data, modeling the chemical properties of photobases, modeling the patterns of services provided by selected pharmacies, analysis of genomes associated with evolutionary processes, and building high frequency predictive models for stock markets.

This project is in full agreement with CCAM's goals 1-4, and CSUF's goals 1-5.

3- Other large-scale grants declaring CCAM as their major hub

During the last period of review, several large-scale fundings, have been leveraged through the members of CCAM. Specifically, grants, sponsored by the NSF, NIH, and Foundation for California Community Colleges, have been empowered by CCAM's core activities and mission. In each instance, grant reviewers from funding agencies, have explicitly commented on the importance and the critical role that Center can play in coordinating, shaping, and facilitating the proposed activities in those grant proposals.

For example, in 2021, the director of the center and his colleagues, [secured a \\$1.5 million grant from the NSF](#), in which students become familiar with the ideas, concepts, and methods of data science, and are provided with the opportunity to contribute to real-life, complex research projects during an intense summer program. This project, entitled, SoCal Data Science program, has made a [significant impact](#) in the life and careers of the participating underrepresented students.

Moreover, [project PIPE-LINE](#) (Programs for Institutional Pathway Engagement — acceLerating INfrastructure and Education), a \$1.3 million grant, acquired through California Learning Lab, an affiliate of the Foundation for California Community Colleges, aims to attract historically underrepresented students into STEM majors, establish institutional pathways and transferable courses in data science among the institutions and foster a sustainable data science culture that inspires and supports a diverse group of faculty and students. In this grant, CCAM is showcased in its ability to provide infrastructural computing facilities and training materials to the participating Fellows, selected across multiple institutions, including CSUF, Rio Hondo Community College, Riverside City College, and UC Irvine.

It should be noted that this grant has empowered a Data Science Initiative at CSUF: in August 2023, and per the invitation of CSUF's Provost, Dr. Amir Dabirian, The Dean of NSM, Dr. Marie Johnson spearheaded a campuswide Data Science Committee whose charge is to study, envision, design, initiate, and implement new data science degree programs in our campus. The committee, consisting of representatives from multiple colleges across the campus, has already designed a minor degree in data science, and has submitted it to Curriculog for further campuswide negotiations and approvals. This is a significantly important step towards establishing new data science degrees and creating a robust data science culture at CSUF.

Additionally, [faculty members affiliated with CCAM](#), continuously utilize CCAM's facilities, including the Center's two HPCs to move their groundbreaking research agendas forward, and to submit further competitive proposals to national funding agencies.

The above-mentioned activities align with CCAM's goals 1-5 and CSUF's goals 1-4.

II: Outreach and Attracting Philanthropic support for CCAM's activities

In 2020, Dr. Tien Nguyen, from Aerospace Corporation, was appointed as the Director of CCAM's advisory board. Dr. Nguyen is an experienced scholar with a considerably vast network of academic, professional, and business connections. Upon his appointment, Dr. Nguyen quickly assembled a group of highly accomplished leaders of industry and academia to serve in the [Center's advisory board](#), and to provide meaningful and objective support for the Center, expanding its technical and philanthropic reach to a significantly wider community of professional and expert audiences.

The advisory board, consisting of experts from established corporations, such as Raytheon and Aerospace Corp., community business leaders, independent research groups, and CSUF faculty, met frequently, and defined roadmaps, and strategies, for energizing student-based projects at the Center as well as attracting philanthropic support for its activities.

Specifically, CCAM's director and the director of the advisory board have energized the center's community building efforts. Specifically, during the last period of review, and with the tireless support of Dean Johnson, Michael Karg, and Toni Miller, CSUF's Executive Director and Senior Directors of Development, and Dr. Alfonso Agnew, the

former Chair of the Mathematics Department, CCAM has attracted more than \$100,000 in philanthropic support. Related, the Center was showcased during the university's 2023 Day of Giving campaign.

Currently, there are ongoing conversations with business leaders in the community to provide more funding support for CCAM's research programs conducted by faculty and students, and to strengthen the Center's infrastructure.

These activities are aligned with CCAM's goals 1-5 and University's goals 1-4.

III: Workshops, seminars, and other educational activities sponsored by CCAM

During the period of review, CCAM has sponsored more than 30 workshops, seminars, and general talks, and has also contributed to the culminating projects of graduate students in the Applied Mathematics and Statistics programs in their respective department. These include, invited talks by experts from Airforce Research Lab, UC Berkeley, UC Irvine, CSUF's faculty and scholars; workshops on programming languages such as Python, SAS, and R, foundations of AI and Machine Learning, data analytics, and careers in data science; and defining, supervising, and incorporating complex computational modeling strategies for the research work of students at the graduate level. CCAM is extremely proud of its educational and outreach programs and will undoubtedly expand its technical and educational efforts in the future.

Moreover, CCAM is planning to collaborate with the North Orange County Community College District (NOCCCD), and the Anaheim Union High School District (AUHSD) to develop accessible outreach presentations to expose thousands of predominantly Hispanic and underserved students in those communities to career paths involving computation and data science.

The activities align with CCAM's goals 1-3 and University's goals 1-3 and 5.

4. Organizational Structure and Governance

As articulated in the above, CCAM is a Center under CNSM. As such Dr. Marie Johnson oversees its activities. The Director of CCAM, Dr. Sam Behseta reports to Dean Johnson. CCAM has an Advisory Board, comprised of industry, academic, and community leaders, and has two active committees. The Computation Committee, oversees, and provides advice on CCAM's computational facilities, including the two HPCs, as well as its computational workshops and educational efforts. The Research Committee provides advice on new opportunities and develops plans for expanding the net of interested students and faculty across the campus.

5. Resources and Sustainability

As demonstrated in section 1, CCAM is the custodian of two major supercomputers on campus: Kepler and Turing. Turing is a new acquisition and based on its specifications it has a 10-year expected productivity. The advantage of HPCs in contrast to most existing cloud-based

computational tools is twofold: 1- significant flexibility and adaptability with the new scientific software and technology, and 2- dynamic bandwidth expansion of its node structure, allowing for the system to grow, somewhat exponentially in terms of computational speed and storage capacity, as needed. Additionally, the ever-expanding capacities of the HPCs facilitate CCAM's presence as a computational hub for the Orange County's scientific and industrial research communities.

CCAM's community-building program, predominantly guided by its Advisory Board will facilitate long-term industrial and philanthropic ties with our professional and business allies. The engagement of the industrial partnership with leading enterprises such as Raytheon, JPL, and Aerospace Corp, will provide numerous opportunities for CCAM research students. These include internship positions, and involvement with R&A units in the respected institutions, with the potential for permanent employment for CCAM's research students. Moreover, CCAM faculty will also be beneficiaries of this program, as their collaboration with leading industrial outfits create new and unbounded opportunities in external funding and contribution to cutting-edge and applied research work.

6. Highlights and Accomplishments

In the last five years, CCAM has positioned itself as a hub for computing at the CNSM. Numerous faculty and students have been utilizing its resources, and benefiting from the educational programs it sponsors. Moreover, through providing funding for faculty and student teams, CCAM creates new opportunities for computationally oriented programs.

As discussed in section 1 of this document, the accomplishments of the Center can be highlighted around three themes of providing new opportunities for research through securing large-scale research and training grants, acquiring cutting-edge high performance computer clusters, and building alliances with industrial and community partners (see subsections I-III in section 1 of this document.)

7. Planning and Strategic Outlook

In accordance with the Center and University's mission and goals, our strategic plan builds around four principles: a) expanding CCAM's student centric research and training projects, b) engaging faculty from various colleges across the campus with CCAM's programs, c) increasing CCAM's resources through pursuing and securing more grant and philanthropic funding opportunities, and d) incorporating the tenets of diversity, equity, and inclusion in CCAM's computational research and training programs.

I. Expanding CCAM's student centered activities.

The center will continue to expand its student-oriented activities. These activities primarily consist of new research and training programs. Chiefly, the center has a mission of educating our students with the new developments associated with artificial intelligence, big data, and the role they play in our lives. This is also empowered by the newly proposed minor degree in data science in which a campuswide curricular enterprise will help with communicating the foundational ideas of data science, not only

to the STEM students but also to those who are pursuing majors in areas outside STEM. As such, CCAM is positioned to provide much needed computational support for a successful delivery of data science courses to its wide audiences. As an example, the introductory courses to machine learning, statistics, and programming can be elevated by providing HPC accounts for their participating students. This way not only the instructors will provide training with the foundations of programming, statistics, and A.I., but also will help students to learn how to prepare, submit, and execute jobs via computing servers. Moreover, a significant component of the newly proposed minor program in data science is built around the notion of offering hands-on experiences obtained through conducting research in the context of a 499 course with advisors whose expertise spans from data science to various fields of application. In that regards, CCAM's HPC resources can support many simultaneously executed research programs. Lastly, CCAM will continue its search for securing new funding opportunities for both research and training purposes, similar to the ongoing efforts described in section 1 of this document.

II. engaging faculty from various colleges across the campus with CCAM's programs

There is a significant number of faculty in various scholarly disciplines whose research are computationally oriented. CCAM is positioned to support their research through offering computational and technical resources, to build infrastructure supporting interdisciplinary work, as well as providing workshops and training programs with the aim of expanding their knowledge base. Moreover, faculty are at the forefront of CCAM's grant writing and philanthropic programs. The Center's mission in facilitating new opportunities for research is directly tied to this component of our vision. This is also manifested through an understanding that by strengthening ties with our industrial partners, local community colleges, and high schools, we will be able to showcase the work of CSUF faculty and the role it can play in enriching the societal experiences of Southern California's communities.

III. Securing more grant and philanthropic funding opportunities

There are multiple efforts conducted by the members of the Center to secure more funding for its activities. The grand vision of the Center is to effectively build a network of external expertise and community-based leadership to amplify our scholarly and educational work through external support and philanthropic giving. In that regard, the advisory board of the Center play a crucial role, as it has striven to pursue multiple avenues of collaboration that can eventually translate to large-scale philanthropic support for the Center. Moreover, and as described in Parts I and II of this section, CCAM's leadership will continuously envision, formulate, and submit new training and research proposals to support our students and faculty. The forte of this strategy is that by continuously pursuing various funding opportunities, we will enhance our proposals to the level that can be highly competitive in any national or local setting. To give an example, a series of collaborative research proposals have been conducted by the members of the Center with expertise in Statistics, Computer Science, and Engineering. Additionally, Multiple ongoing efforts for grant writing are in progress that will bring a broader community of experts from STEM areas, Public Health, Finance, and Social Sciences together.

IV. Expanding the role of diversity, equity, and inclusion in CCAM's programs

As the growing literature in the ethics and applications of computational and analytics demonstrate, diversity, equity and inclusion have multiple manifestations in modern computational research. Primarily, there is a growing literature offering ideas in identifying and removing algorithmic biases in already-built software with mass consumption. These include gender and racially biased pattern recognition algorithms that have been implemented in a variety of A.I. applications. As an educational unit, CCAM will play an important role in making the CSUF community aware of the flaws associated with existing algorithms. Moreover, through inviting experts to campus, CCAM will publicize the ongoing efforts in confronting this important societal issue. Additionally, CCAM will showcase the pioneering work of minority scholars in data science. As part of our vision, we will bring well known scholars from minority groups to the campus to demonstrate their cutting-edge computational and analytics work and to further inspire our diverse body of faculty and students.