School of Computing: Tier 1 Engineering Funds Report

July 23rd, 2024

Executive Summary

As fully described in this report, the SoC has responsibly and strategically stewarded two years of specific funding[1] in support of Tier 1 computational science and engineering goals, which has included:

- Research training for 20 graduate students and 5 undergraduate students
- Seed funding for 12 faculty-led research projects
- Computing infrastructure including GPUs, visualization, and student workstations
- Faculty recruitment (1 tenure track faculty jointly hired with Math and Stats)
- Research scientists (partial support of 1 associate research scientist)

Planned expenditure for FY25 funds include

- Research training for 9 graduate students and 5 undergraduate students
- Seed funding for 5 faculty-led research projects
- Continued faculty/research scientist support

The use of Tier 1 funds is already showing tremendous return on investment, resulting in significant new external funding from federal agencies and industry, new collaborations within CEPS and across the university, energizing the use of the NWSC supercomputer, and contributing to a coherent and visionary plan for Computational and Data Enabled Science and Engineering.

Background

The School of Computing

The School of Computing (SoC) was approved by the Board of Trustees in January 2022. The inaugural director was appointed in March 2022 and is following a 5-year plan developed by a broad faculty committee. Initially administratively incubated in the College of Engineering and Physical Sciences (CEPS), the School seeks to move to be an independent unit led by a Dean reporting directly to the Provost in July 2025. The School of Computing is an interdisciplinary hub of innovation and knowledge exchange for computing and digital skills at the University of Wyoming (UW) impacting research, learning, and engagement across the university. The School works to provide University of Wyoming students, faculty and staff, and Wyoming businesses and citizens with the computational tools, skills, and approaches to drive transformation and innovation in the state.

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[1] SoC was provided with a one-time allocation of $500K of internal (admin reserve) funds to support CSE goals in FY23 (with some of these funds also expended in FY24), from FY24 onwards the SoC receives $500K from Tier 1 funds to support CSE. Since this report was requested on Tier 1 funds only, the use of the one-time internal $500K is included as an appendix.

SoC Tier 1 Engineering Funds

During their 2023 session, the Wyoming legislature appropriated an additional $5.5 million annually to support "Tier 1 Engineering" at the University of Wyoming, with the UW Administration directing that $500,000 of these funds be allocated annually for use in the School of Computing. This allocation is consistent with the original intent of the Tier 1 initiative, which specifically identified "High Performance Computational Science and Engineering" as a priority.

Per the Provost's memo of March 27th, 2023, the expectation is that the primary use of these funds will be to support salaries of faculty, staff, technicians, postdocs, graduate students, or other personnel. Start-up commitments for new faculty and other programmatic support are also appropriate expenditures. The memo describes how the Tier 1 funds allocated to the School of Computing should be used to support people and programs that advance excellence in engineering at UW, and provides examples of disciplines such as robotics, artificial intelligence, and materials science in addition to computational science and engineering.

Note that the expenditures reported here are not the only SoC funds spent to support the aims of the Tier 1 engineering initiative, however the Tier 1 funds provide the capability to focus and provide more resources and emphasis to computational science and engineering while building an enabling, coordinated, and strategic hub for computational science and engineering.

The School of Computing is responsible and strategic in the use of these funds to support the Tier 1 initiative through investment in applied computing and the application of computing across engineering disciplines. In particular, funds will support the expansion of the CEPS-wide program in Computational Science and Engineering (currently offered as both an undergraduate and graduate minor). The long-term plan is for these funds to support tenure track faculty hired into joint positions with engineering units, in areas of importance for Research and Economic Development Division (REDD) strategic initiatives, SoC strategic areas, and CEPS Tier 1 priorities (including artificial intelligence, energy systems, quantum information science and engineering, controlled environment agriculture, HPC/computational science and engineering). In the shorter term these funds support engineering-related faculty and students, and the procurement of important computing infrastructure to support engineering research.
A detailed document for Computational and Data Enabled Science and Engineering that describes the vision, activities, and plans that SoC is already following, including the CSE activities funded outside of the TIER1 funds, will be available by the end of July 2024.

SoC Faculty Fellow Program

Web Site: https://www.uwyo.edu/soc/initiatives/faculty-awards.html

The SoC Faculty Fellows program is open to all faculty at UW, Tier 1 funds allow the support of additional engineering-related faculty for projects that will impact the growth of activities in Computational Science and Engineering. A few awards funded from Tier 1 funds to faculty not in a traditional engineering department where the project furthered general computational science initiatives.

The Faculty Fellows program is a competitive program, proposals are reviewed by a faculty peer group with multiple reviews per proposal, and a review panel that meets to discuss the merits of

each proposal. There is a focus on the outcomes, in particular potential for external funding and sustainability. Successful proposals in engineering and physical sciences are typically expected to have a clear proposal target as part of the project. Starting in the 2024-2025 cohort, each Faculty Fellow is assigned a SoC contact to work with throughout the year, and each Faculty Fellow meets with the director to discuss their project and how they can work with SoC. Brief reviews are provided to unsuccessful proposers, who are provided with an option to meet with the Director to discuss their proposal. The SoC works hard to encourage Faculty Fellow applications from applicants with diverse backgrounds, through attention to the solicitation and the review process, the success of these efforts can be seen in the awardees.

SoC Graduate Computing Scholars

Web Site: https://www.uwyo.edu/soc/initiatives/soc-grad-scholars.html

The SoC Graduate Computing Scholars program is open to all graduate students at UW, Tier 1 funds allow the support of additional engineering-related students for projects that will impact the growth of activities in Computational Science and Engineering. A few awards funded from Tier 1 funds to students not in a traditional engineering department where the project furthered general computational science initiatives.

The Graduate Computing Scholars program is a competitive program that fund a one-year research stipend. Student proposals are reviewed by a faculty group with multiple reviews per proposal, and a review panel that meets to discuss the merits of each proposal. The focus for reviews is on the worth of the proposed work, and the impact for the student. In addition to their own research Computing Scholars work on a second smaller SoC project with a mentor, in the future these projects will align with supporting activities in the Advanced Computing center at SoC. Computing Scholars have monthly meetings as a cohort where they discuss their projects and their progress and find colleagues from other disciplines with similar CDSE interests. Computer Scholars are given the opportunity to attend SoC seminars, training and networking events, take part in organized activities (e.g. visiting NWSC, or IEEE Supercomputing Conference). At the end of the academic year the Computer Scholars make final presentations. The SoC works hard to encourage Computing Scholar applications from applicants with diverse backgrounds, through attention to the solicitation and the review process, the success of these efforts can be seen in the awardees.

SoC TIER1 Budget Report FY24

Investment	Description	Beneficiaries	Amount
SoC Faculty Fellows	Allowable expenses appropriate for project	Dejam (Energy and Petroleum Engineering), Nguyen (Electrical Engineering & Computer Science), Sheshappanavar (EECS)	$88,971.25
SoC Graduate Computing Scholars	Stipend, tuition and fees	Reddy, Kashgarani, Pandit (EECS), Li, Oladeji, Shokrgozaryatimdar (Geology and Geophysics), Luo (Physics and Astronomy), Afrifa (Atmospheric Science)	$221,104.64
Faculty Salary	Operational salary	Taylor (SoC/MathStat/EECS), Kirby (SoC)	$157,523.28
Computing Infrastructure	ARCC GPU Node	All SoC and affiliated faculty, staff, students, faculty fellows, graduate computing scholars, SURE undergraduates	$27,485
TOTAL			**$495,084.17**

- Details on Funded Faculty Fellow projects (each ~$30K)
  - Dejam (Energy and Petroleum Engineering)
    - Title: *Computational Reservoir Description and Dynamics*
    - *Computing Areas: Simulation and modeling*
    - Student Impact: 1 graduate
  - Nguyen (Electrical Engineering & Computer Science)
    - Title: *Application of Random Matrix Theory in Design and Analysis of Resilient and Adaptive Online Distributed Machine Learning and Optimization Algorithms*
    - Computing Areas: AI/ML, Distributed Computing
    - Student Impact: 1 graduate, 2 undergraduate
  - Sheshappanavar (Electrical Engineering and Computer Science)
    - Title: *OpenGrocery: An Open-Source Grocery Infrastructure to Assist the Visually Impaired and Robotic Navigation*
    - Computing Areas: Computer Vision, Cyberphysical Systems, Software
    - Student Impact: 1 graduate, 2 undergraduate
- Details on Graduate Computing Scholar projects
  - Reddy (Electrical Engineering & Computer Science)
    - Title: *Feasibility and Effectiveness of Brain Biometrics for Building User Authentication Systems*
    - Computing Areas: Cybersecurity, Human Factor Computing
  - Kashgarani (Electrical Engineering & Computer Science)
    - Title: *Optimizing Parallel Computation for AI Problem Solving: A Hybrid Approach of Algorithm Selection and Portfolio Parallelization*
    - Computing Areas: HPC, AI, NWSC
    - Impact: Now senior Computational Scientist at Purdue
  - Pandit (Electrical Engineering & Computer Science)
    - Title: *Optimal Operation of Electric Vehicles to Improve Reliability of Microgrids Using Artificial Neural Network*
    - Computing Areas: AI, Cyberphysical systems
    - Student Impact: IEEE journal publication, Sandia National Labs
  - Li (Geology and Geophysics)
    - Title: *Statistical physics-informed machine learning algorithms for subsurface reservoir characterization*
    - Computing Areas: Modeling, AI/PINNs
    - Impact: Now postdoc at Stanford University
  - Oladeji (Geology and Geophysics)
    - Title: *Forecasting groundwater dynamics in a mountain watershed using deep learning and geophysical monitoring*
    - Computing Areas: AI, modeling, complex systems, data science
    - Impact: publication in Journal of Geophysical Research, AGU conference presentation
  - Shokrgozaryatimdar (Geology and Geophysics)
    - Title: *A Massively Parallel Processing (MPP) System for Physics-based Deep-learning and Its Application in Understanding the Weathering Process*

- Computing Areas: Modeling, AI, HPC
- Student Impact: publication in Bulletin of the Seismological Society of America, pending publications
  - Luo (Physics and Astronomy)
    - Title: *A Computational and Data-Driven Approach for Cloud Motion Prediction using High Performance Computing*
    - Computing Areas: Modeling and simulation, AI, Edge Computing
    - Impact: ANL internship
  - Afrifa (Atmospheric Science)
    - Title: *Bridging the Gap: Understanding Embedded Orographic Convection through High Resolution LES Modeling*
    - Computing Areas: Modeling and Simulation, NWSC
    - Impact: pending publication in Journal of Atmospheric Sciences and multiple conference presentations

Plans for Next Year (FY25)

NB: The failed SoC/EECS multiple faculty search in Spring 2024, and the imminent arrival of a new head for EECS in Fall 2024 following the unsuccessful EECS head search in 2022-2023 means that planning for FY25 and the future is now ongoing.

Investment	Description	Beneficiaries	Amount
SoC Faculty Fellows	Allowable expenses appropriate for project	Demir (Civil and Architectural Engineering and Construction Management), Heinz (Mathematics and Statistics), Sabino (Chemical Engineering), Saraji (Energy and Petroleum Engineering), Shukla (EECS)	$122,144.77
SoC Graduate Computing Scholars	Stipend, tuition and fees	Magar (EECS), Macy, Liu (Civil and Architectural Engineering and Construction Management), Rustamov (Chemical Engineering), Chen (Mechanical Engineering)	$167,825.73
Faculty Salary	Operational salary	Taylor (SoC/Math/EECS), Kirby (SoC)	$157,523.28 (upper limit)
TOTAL			**$447,493.78**

Narrative:
- SoC Faculty Fellows and Graduate Computing Scholars will become more targeted to strategic areas, in-line with REDD initiatives, SoC initiatives, and the overall Tier 1 plans. Funds allocated to Faculty Fellows/Computing Scholars will decrease as new faculty are hired. More funds were allocated to these for FY25 due to last year's unsuccessful faculty searches.
- Salary for Research Scientist Kirby is an upper limit, depending on pending proposals for external funding. The aim is for Research Scientists to have much of their funding coming from external sources. In 18 months of employment, Kirby has
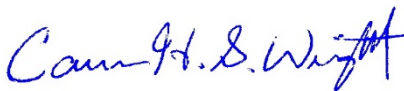
- - *contributed to 10 proposals for external research funding from federal agencies, most in a PI or co-PI role, with a combined total of $18.3M in requested funds, resulting in $6M of funding to UW with another $5.5M pending review.*
    - *led the development of two contracts/projects with industry partners, resulting in nearly $200K of industry funding in first-phase projects that are now anticipated to expand to larger activities.*
- Details on Funded Faculty Fellow projects (each ~$30K)
  - Demir (Civil and Architectural Engineering and Construction Management)
    - Title: *Enhanced Urban Energy Predictions through Deep Learning*
    - Computing Areas: Modeling/NWSC, AI, Visualization, Digital Twins, GIS
    - Student Impact: 3 undergraduates, 1 graduate
    - Partnerships: NWSC, ArcGIS, IDIAP research institute
  - Heinz (Mathematics and Statistics)
    - Title: *Five Questions for Wind Energy Related Computing*
    - Computing Areas: AI, computational mathematics, modeling/NWSC, CFD
    - Student Impact: 1 graduate
    - Partnerships: UW Wind Energy Center, NWSC
  - Sabino (Chemical Engineering)
    - Title: *Developing Computational Modeling Capabilities for Biomedical Applications*
    - Computing Areas: modeling/ARCC/NWSC, experiment-computing interface, early-stage faculty training
    - Student Impact: 1 graduate
    - Partnerships: ARCC/NWSC
  - Saraji (Energy and Petroleum Engineering)
    - Title: Building Research Capacity for Physics-based Deep Learning in Energy Applications
    - Computing Areas: modeling, AI, PINN
    - Student Impact: 1 graduate
    - Partnerships: New SER center planning, multi-institutional workshop
  - Shukla (Electrical Engineering and Computer Science)
    - Title: *Online Dynamics of Fake Information: Exploring GenAI's Impact*
    - Computing Areas: AI, ethics, human factor computing
    - Student Impact: 1 undergraduate and/or 1 graduate
    - Partnerships: Social science, journalism
- Details on Funded Graduate Computing Scholars
  - Magar (EECS)
    - Title: *Composite Power System Reliability Evaluation Using Quantum Computing*
    - Computing Areas: Quantum computing
  - Macy (Civil and Architectural Engineering and Construction Management)
    - Title: *Leveraging Digital Twin Technology to Improve Heating*, Ventilation, and Air Conditioning (HVAC) Systems
    - Computing Areas: Digital twins
  - Liu (Civil and Architectural Engineering and Construction Management)

- - **Title:** *Enhancing Construction Safety Through Computational Predictive Modeling of Hazard Recognition*
    - **Computing Areas:** Modeling
  - Rustamov (Chemical Engineering)
    - **Title:** *Advancing Physics of Fluids Enabled by Computational Data Science*
    - **Computing Areas:** AI/ML, data science, CFD
  - Chen (Mechanical Engineering)
    - **Title:** *Toward Edge Computing Enhanced Next-Generation Composites Additive Manufacturing: Real-Time Print Quality Prediction and Printing Process Optimization by Machine Learning*
    - **Computing Areas:** Edge computing, AI/ML, modeling
- Potential expenditure of un-encumbered funds in FY25 include:
  - Scholarships for the new MS degree programs in Artificial Intelligence and Quantum Information Science and Engineering (AI/QISE)
  - Additional research scientist in HPC/computational science and establishing the SoC Center for Advanced Computing and Digital Engineering
  - Support for advancing the Computational Science academic program
  - Infrastructure important for maintaining close connection with CEPS with the upcoming move of the SoC to Crane Hall

Respectfully submitted,

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Director, School of Computing

Cameron H. G. Wright
Dean, College of Engineering and Physical Sciences

Appendix: SoC CSE Budget Report FY23/FY24

The School of Computing was provided with a one-time allocation of $500K of internal (admin reserve) funds to support Computational Science and Engineering goals in FY23 (with some of these funds expended in FY24). This appendix describes the use of these funds, which while not coming from the Tier 1 initiative, supported initial computational science and engineering activities.

Investment	Description	Beneficiaries	Amount
SoC Faculty Fellows	Allowable expenses appropriate for project	Wang (Civil Engineering), Zhang (Mechanical Engineering), Zhou (Electrical Engineering & Computer Science), Brotherton (Physics & Astronomy), Dale (Physics & Astronomy), Kapoor (Chemical Engineering), Naughton (Mechanical Engineering), Rabiei (Energy and Petroleum Engineering), Saito (Atmospheric Science)	$206,596.13
Faculty Salary	Operational salary	Kirby (SoC, research scientist)	$43,622.64
Computing Infrastructure	Advanced Research Computing Center (ARCC) GPU Node	All SoC and affiliated faculty, staff, students, faculty fellows, graduate computing scholars, SURE undergraduates	$34,811
Computing Infrastructure	UW Explore Collaborative Visualization, in partnership with SER	All CEPS and School of Energy Resources (SER)	$212,794.50 (with equal investment from SER)
Computing Infrastructure	Workstations for SoC Undergraduate Research Experiences	CEPS undergraduates in the SoC SURE program	$2,211.96
TOTAL			**$500,036.23**

Narrative:

- Computing Infrastructure:
    - SoC's GPU node (part of ARCC GPU cluster) provides priority access for the SoC community, including the Faculty Fellows, Graduate Scholars, etc.
    - The UW Explore visualization environment, with the central node deployed at the 3D Viz Center in collaboration with SER, will provide unique resources for collaboration (supporting funded interdisciplinary projects), decision support (and digital twin front end), and pilots for hybrid teaching (including with our community college partners).
- Details on Funded Faculty Fellow projects (each ~$15K)
    - Wang (Civil and Architectural Engineering and Construction Management)
        - Title: *Large Scale Energy Modeling for the Built Environment*
        - Computing Areas: Modeling, NWSC
        - Student Impact: 1 graduate
    - Zhang (Mechanical Engineering)
        - Title: *Physics Informed Neural Networks to Accelerate the Solving of a Large Number of Similar Solid Mechanics Problems: A Comparison with Finite Element Project*
        - Computing Areas: AI, modeling, computational math

- Student Impact: 1 graduate
  - Zhou (Electrical Engineering & Computer Science)
    - Title: *Automatic Digital Twin Generator for Autonomous Vehicles Based on Inverse Reinforcement Learning*
    - Computing Areas: Digital twins, cyberphysical systems, AI/ML
    - Student Impact: no students funded
  - Brotherton (Physics & Astronomy)
    - Title: *Dynamically Modeling Quasars for Better Black Hole Modeling*
    - Computing Areas: Modeling, NWSC, data science
    - Student Impact: 2 graduates
  - Dale (Physics & Astronomy)
    - Title: *Modeling Stellar Clusters Observed by the Hubble and Webb Space Telescopes*
    - Computing Areas: ARCC, HPC, Training
    - Student Impact: 1 graduate
  - Kapoor (Chemical Engineering)
    - Title: *Fostering Inclusivity for Visually Challenged in Computational STEM Research*
    - Computing Areas: Visualization, ARCC, software
    - Student Impact: 1 graduate
  - Naughton (Mechanical Engineering)
    - Title: *High Performance Computing for Processing and Analyzing Wake Measurements*
    - Computing Areas: HPC, CFD, Modeling, NWSC, Data-enabled HPC
    - Student Impact: 1 graduate
  - Rabiei (Energy and Petroleum Engineering)
    - Title: *Synthetic Data for a Machine Learning Based Proxy Model for the Wyoming's Power River Basin's Shale Resources*
    - Computing Areas: Data Science, AI/ML, modeling
    - Student Impact: 1 graduate, 1 undergraduate
  - Saito (Atmospheric Science)
    - Title: *Developing a Framework to Evaluate Solar Energy Resources in Wyoming using Spaceborne Big Data and Derecho Computational Capabilities*
    - Computing Areas: NWSC, remote sensing, AI/ML
    - Student Impact: 1 graduate