

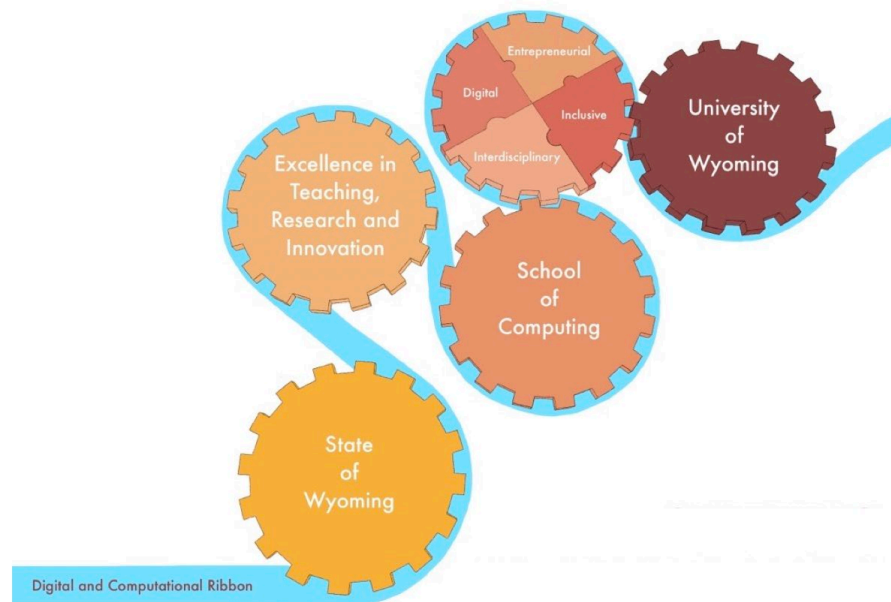
**University of Wyoming School of Computing  
Preliminary Plan  
May 2021**

**0. Preamble**

To accomplish the overarching goal of building UW into a “best-in-class 21<sup>st</sup> century land grant university true to its Wyoming roots,” four focused goals have been identified: make UW more digital, make UW more interdisciplinary, make UW more entrepreneurial, and make UW more inclusive [2]. Central to the goal of making UW more digital is the establishment a School of Computing (SoC),

This preliminary report, prepared at the request of Provost Alexander and President Seidel, explores the programs, infrastructure and organizational structures needed to build out a School of Computing that transforms research and education at UW, while accelerating UWs role as an economic development engine.

A list of people involved in the writing of the document is provided in Appendix A. The Digital Pillar report, which describes all aspects of making UW more digital, can be found in [6].



The School of Computing is designed to strategically mesh together existing resources and initiatives, the other pillars (more inclusive, more interdisciplinary, and more entrepreneurial), UW’s existing strengths in research and teaching, and partnerships throughout UW and across Wyoming, into a system that drives UW to its vision of becoming a best in-class university true to Wyoming’s roots.

## 1. Introduction.

Wyoming has consistently sought to contribute to its future by investing in the education and training of its citizens through the University of Wyoming. Recent investments, including the Tier 1 Engineering Initiative (T-1), Science Initiative (SI), and Trustee's Education Initiative (TEI), along with capital investments in facilities provide a firm basis that focuses on the importance of Science, Technology, Engineering and Mathematics (STEM).

In the past decade, computing has become an increasingly crucial tool for research, for our graduates, and for almost all sectors of the economy. The University of Wyoming has responded by hiring faculty who use computing in their discipline, establishing programs like the Data Science Center and the Advanced Research Computing Center, and by developing a partnership with the University Cooperation for Atmospheric Research (UCAR) and its NSF-funded National Center for Atmospheric Research (NCAR) around the NCAR-Wyoming Supercomputer Center (NWSC). These have supported new modes of faculty research and increased awareness of computing across the campus.

Today, computing's impact is found in virtually every discipline, and simulation and modeling are more important than ever, but are joined by new data science technologies like artificial intelligence (AI), machine learning and blockchain that are starting to transform every academic discipline, every industry, and every aspect of modern society. Access to world-class infrastructure and workforce training in computing and data is therefore critical for Wyoming citizens, and for UW's students.

The productivity across UW in computational education and research is far below that of peers it aspires to be like.<sup>[1]</sup> The 21<sup>st</sup> century skills required by our graduates, the need for a tech-savvy workforce in Wyoming, the expansion of computing as an enabler in virtually every discipline, and the increasing complexity of the grand challenge problems facing researchers mandate a strategic response by UW. The SoC, along with the broader Digital Pillar plan, outline such a strategic response.

Through the SoC there are also great prospects for the University of Wyoming to emerge as a leader in rural computing and data, drive opportunities such as those anticipated via the Endless Frontiers Act and the Wyoming Innovation Network.

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<sup>[1]</sup> It is important to note the scale that is needed to have impact, and what is common across the nation. UW's current CS department has 8 professors (only 2 with an AI specialty) and the Advanced Research Computing Center (ARCC) has 4 current staff. Comparing the size of CS departments is only one, limited indicator, but it does give a sense of where we are. This year, UIUC, about three times UW's size, hired 23 new faculty in CS alone. Boise State, about twice UW's size, has more than 20 CS professors and plans to double in size. Notre Dame, a predominantly humanities and social sciences university, is almost exactly UW's size and has more than 4 times our CS faculty, and a unit like our ARCC with over 50 staff (almost entirely funded on soft money through grants). In all cases these activities are a foundation for economic development in their region. Similar comparisons can be made across other units and with other universities.[2]

## 2. Vision and Goals



Through the SoC, (and each of the other pillars), UW envisions forging new trails that will enable UW to become a **national leader in research, education and engagement**.

The SoC be a hub of innovation and knowledge exchange that will provide UW faculty, students, and Wyoming corporations and citizens, with a backpack of computationally tools to transform their domains.

The SoC will champion the broader efforts aimed at making UW more digital through partnerships throughout UW and the State.

## Vision Statement

Our vision is to *create a unique and inspirational School of Computing (SoC) with national impact and global reach, providing Wyoming and the world with agile and ethical computing professionals, empowered to address societal challenges that are inherently interdisciplinary.* Motivated by the roots of Wyoming to live each day with courage, the SoC will enrich our global data-driven society with excellence in teaching, research, and innovative entrepreneurialism in order to produce professionals who are fluent in computing, alongside enhancing its citizens' digital competency.

To this end the School of Computing will, in partnership with existing UW and community college units, position our land grant institution as:

- *a national leader in computational research, education, and engagement*, providing academic excellence in teaching, intellectual distinction in research, and transformative innovation for computationally intensive entrepreneurship. The SoC will **champion interdisciplinarity** across campus by fusing computation, digital, and data science curricula with all domains.
- *a computational hub for students, faculty, staff, community and our state, industrial and academic partners.* The SoC will skillfully **leverage corporate and knowledge partnerships** to unite learners, educators, entrepreneurs, and stakeholders, and create a sustainable robust digital ecosystem.
- *a steward, supporter, and developer of digital skills/literacy and computational thinking for all.* The SoC purpose is to **nurture computing curiosity across disciplines and backgrounds**, to enhance interdisciplinarity, and to capitalize upon emerging innovations for teaching, research, and economic diversification.

A School of Computing (SoC) will provide the organizational infrastructure and emphasis to accelerate the growth and impact of computing, AI and data science<sup>2</sup> at UW across research,

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<sup>2</sup> By “computer science” we refer to the core disciplines concerned with the theory and design of computer systems (e.g., algorithms, programming languages, AI, operating systems, networking, databases, distributed systems, software engineering). By “data science” we mean on the interdisciplinary use of statistics, computer science and applied mathematics to operate on data to achieve meaningful outcomes. By “computer engineering” we refer to the fields that contribute to develop computer hardware and software, focusing on how computer systems work and how they integrate into the larger picture. By “computing” we include computer science, computer engineering, data science and their broader applications across disciplines, and as such envisage a broad interdisciplinary scope. By

teaching, entrepreneurship, and engagement. Motivating outcomes for the SoC are to increase UW's ability to address grand challenge problems of critical importance to the state, to better prepare students from diverse backgrounds and in all disciplines for future careers that require computing and data science, to grow the student body in computing and data science, and to support the state in building a new, diverse economic sector based in technology through research partnerships, workforce development, training, and entrepreneurship. Finally, a critical long-term goal of the SoC is to catalyze excellence in research and teaching to help establish UW as an R1 Carnegie-rated university.

While the vision is for the SoC to be the focal point of computing leadership and activity at UW, the aim is to achieve this by integration and collaboration with a broad set of other units including all academic departments as well as libraries, student success programs and discovery programs. In this manner, the SoC will advance educational and basic research in key fundamental areas of computing and support the adoption and use of computational methods as a transformational element of research and teaching across the university. For this reason, we suggest the school be simply named the "School of Computing" with the understanding that this will include informatics, broad applications of computing and information systems, computer science, computer engineering, "computing for all," K-12 education, computational sciences, mathematics/statistics, and others. Including other topics in the name of the school would inevitably seem to exclude fields.

We suggest a school, led by a dean, rather than a college, envisaging that the SoC needs to be interdisciplinary as well as nimble and flexible, and thus avoid the construction of departmental silos. In addition, as described below, we envisage that by developing SoC as a new school that integrates with existing units via joint appointments, there will not need to be a large body of new faculty with tenure in the school. Finally, starting as a school will provide future flexibility to become a college potentially later. In this direction, the committee noted the way that some Colleges of Computing at other universities are moving towards novel organizational structures as computing becomes more pervasive across all disciplines.

Several thoughtful reports lay out the motivation and rationale for establishing a new school or college of computing (e.g., [4-5]), based on a recognition that computing is different from other departments in science or engineering, that it is pervasive across a university, is multidisciplinary requiring potentially broad hiring, will increase research and external funding, and requires university support at the College/School level. In Wyoming, there are additional motivators. The President has included "more digital" as one of the four pillars driving UW over the coming years (and the new SoC will also underpin and support the other pillars: more inclusive, more

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"information science" we mean an interdisciplinary field of inquiry and professional practice concerned with the collection, organization, sharing, and protection of information, and its relationships with society and individuals across a diverse range of contexts. Closely related, "informatics" broadly describes the study, design, and development of information technology for the good of people, organizations, and society.

entrepreneurial, and more interdisciplinary). The whole state is looking to UW to lead in economic opportunities where the technology is a priority, building on the relative nimbleness and adaptability of Wyoming's workforce. Finally, the new Wyoming Innovation Network (WIN) and the already established Wyoming K-12 Computer Science Hub (WyCS) point to opportunities for Wyoming to lead the nation in a coordinated initiative for workforce development for the rural US.

The School of Computing (SoC) is envisioned to be a statewide asset in which the University of Wyoming and all Wyoming Community Colleges (CC) are academic partners, with SoC partner units at each community college. The SoC will contribute to the new Wyoming Innovation Network (WIN), providing advice and classes for a large statewide audience in addition to enrolled students at the schools. We also envisage SoC partners to include the Agriculture Experimental Stations and Tribal Councils. All the partners will expand their digital connections into the SoC, with different emphases. The different CCs have different digital needs and, as the SoC expands its outreach and impact, Wyoming's agricultural sector will expand the digital definition further. There is a real need to expand the impact of the SoC into the state government as soon as possible and then target local governments in later phases. This is envisaged to be particularly powerful as a collaboration between SoC and partnering units from across campus. Within 10 years, the SoC should become the entry point for trusted computing expertise and source of computationally savvy employees in the State of Wyoming.

The SoC should engage in and develop a reputation for world class, high caliber research in areas of computing, recruiting and retaining top faculty and staff. But it must impact the state far beyond a typical research facility. It should develop both undergraduate and graduate level degree programs (e.g., B.S., M.S., and Ph.D.). Minor programs at all levels should be created in collaboration with other departments and programs. Micro-credential offerings for internal and external partners are critical to develop, and those will expand or shrink over time as needs change. These credentialed offerings would serve colleges (e.g., courses on cybersecurity and blockchain for the law school), non-traditional learners (e.g., computing in the 21st century), and critical needs of the state/region (e.g., workforce retraining).

The SoC could also provide and support some efficiencies and improvements in UW's computational curricula. For example, having students across UW understand and utilize the same foundational computer platforms or programming languages (at least through the junior year, before specializing in their field) would enable classes to build upon students' basic skill set to explore disciplinary concepts via modelling. Another example is to have a common course module (e.g., basics of scientific computing), taught by various departments as a university-wide short-course, followed by a disciplinary-specific short-course that is experiential or project-based in nature.

The SoC will produce professionals who are fluent in computing, alongside enhancing its citizens' digital competency. UW graduates interacting with the SoC via the interdisciplinary initiatives with departments will benefit from knowledge and experience regarding the application of computing in their chosen domain, equipping them to be perceptive



and cognizant graduates who have experience in innovative applications of computing—and thus competitive in the workplace. The SoC could lead a statewide program of computing engagement by coordinating publicly facing existing UW offerings, such as Digital Badges (from the Innovation Wyrkshop), Short Courses in 360-degree data capture (in the 3D Visualization Center), the Coe Student Innovation Center public activities (in the Coe Library), and the Digital Classes such as Tableau Public Workshops (also in the Coe Library).



The collaborations between the School of Computing, UW's existing infrastructure and initiatives, and the Digital Pillar are critical to the goal of UW becoming more digital. This is illustrated on the left by Borromean rings. These rings are inseparably linked, yet when any one of them is cut and removed the other two rings can be separated.

For the School of Computing to be successful, a strong Advanced Research Computing Center (ARCC) with a close affiliation with the School of Computing is essential. The ARCC focuses on advanced research computing. With a new Director and updated vision, the ARCC should work closely with the Dean of the School of Computing and with faculty researchers to support advanced research computing. It should build on existing resources and NCAR Wyoming Supercomputer Center (NWSC) opportunities and grow ARCC into a unit with research support capacity (both people and facilities) that includes expertise in domains of high strategic interest to the School of Computing, the University, and the state of Wyoming. In turn, the SoC aggregates faculty and researcher needs and opportunities for research infrastructure, providing ARCC with insights and advice, partnering to pursue funding opportunities to expand and support ARCC's computing infrastructure.

It is imperative that the activities and opportunities provided by the SoC are influenced by state, national, and global needs and are subsequently promoted and made accessible to Wyoming citizens. The SoC should expand on the pandemic-led Zoom experiences of our faculty in 2020 to offer at-home and distance learning opportunities. A needs assessment (of the public and corporate leaders of Wyoming industry) here would allow for specific gaps in the market to be targeted and filled with high impact quality product offerings.

The SoC could lead a program of 'Knowledge Transfer, Exchange, and Partnership.' This would benefit internal and external agencies, as well as the SoC. For example, a UW department could benefit from training to support a new class, this transfer of knowledge would empower the department to offer a new topic of study. Alternatively, a UW center might seek to collaborate with the SoC to form a mutually beneficial relationship with both parties bringing

complimentary knowledge and expertise, as well as skillsets and visionary thought, collaborative research grants could be sought using existing (and new) research computing infrastructure, this would constitute a knowledge exchange. Finally, a knowledge partnership could take the form of swapping individuals in positions of employment, such as a research scientist in the SoC and a software engineer at Google, this could be led partly by the Corporate Partnership strategy.

In summary, the opportunities are well defined, the need is great, and the time is right for a School of Computing at UW. Failing to move forward with a SoC will jeopardize the career preparedness, opportunities and competitiveness of our graduates, the professional development staff, the intellectual advancement of faculty, and ultimately the economic and social welfare of our citizens.

### **3. Administration of the SOC**

The SoC will be the primary administrative center for the Digital Pillar and work to accomplish its goals. Cooperating and collaborating with UW areas of computer expertise already present—such as the College of Engineering and Applied Science, the Computer Science department, the Mathematics and Statistics department, and the Data Science Center, to name a few—it will coordinate the implementation of the Digital Pillar and work to achieve the envisioned transformation of Digital Education here at the university. Digital and computational computing empowers all students, and the SoC will work purposely to include all students from diverse backgrounds in its opportunities. The school will pursue three main goals in support of the Digital Pillar.

First, the SoC will be the nexus of computing education. It will develop and support a bachelor's degree in computing, drawing where possible upon already existing courses and supplementing them with its own offerings. In addition, it will work to develop interdisciplinary computing concentration options with other disciplines and departments. By the end of Phase 2, the SoC will develop graduate offerings in computation, including Master's and PhD degrees. It may also house newly created computationally intensive clusters, such as the Laboratory for Earth System Modelling proposed under Wyoming's 2021 NSF EPSCoR Track 1 RII proposal.

Second, the SoC will support the Digital Pillar implementation across campus, providing expertise, resources and programs for students and faculty. On the one hand, it will work with campus student programs, in both academic and student affairs, to create opportunities for digital education and experiences, from Living-Learning communities and Freshman Seminars to University Studies to certificates, minors and majors. On the other hand, it will work with faculty and departments to help them gain abilities and expertise in digital applications in their disciplines through programs, training and support.

Third, the SoC will work with entities outside UW. It will develop corporate partnerships to support its initiatives. It will liaise with state entities and support Wyoming computing initiatives such as the new Wyoming K-12 Computer Science Hub (WyCS), economic programs such as the Wyoming Innovation Network (WIN), and blockchain development. It will work to support digital



applications and education in the community colleges, tribal areas and Agricultural Extension and Experimental Stations.

The School of Computing will have three chief administrators from its inception. It will be led by a dean who will have general responsibility for the school and its assigned duties and who will have primary responsibility for external relations and financial development. Under this position will be two associate deans, each who will maintain their research/scholarship duties, one of whom will have primary responsibility developing the SoC's research partnerships and profile, identifying and orchestrating UW's response to funding opportunities, while the other one will have primary responsibility for the campus-wide Digital Pillar education initiative. SoC's curricula will be informed through partnerships with other universities and awareness of similar programs and developed by committees of SoC faculty.

**a. Dean of the School of Computing**

The Dean would have primary authority over the Computing and digital education initiatives being run out of the SoC. They would serve as the school's primary link to the UW administration and to outside entities such as the state, the state government, businesses, and scientific and other key establishments. It will be their responsibility to liaise with state entities to develop cooperative, community efforts between the SoC and communities around Wyoming. They will work to support Wyoming economic development activities, such as WIN, and Wyoming education activities from K-12 to the community colleges. Fund-raising and the development of corporate partnerships will constitute a key aspect of their duties, as well as working with Wyoming state government to create funding opportunities.

**b. Associate Dean for Computing**

This AD will be responsible for the SoC's research and partnership programs, as well as oversee SoC faculty's development of undergraduate and graduate programs. The AD will help identify funding opportunities, establish a team of SoC faculty and research scientists and UW collaborators to pursue funding opportunities that fit UW's expertise and Wyoming's interests. The AD will work to establish new partnerships, both corporate and with national labs and other institutions, and strengthen existing partnerships. This AD will work with departments and faculty outside the SoC to identify potential collaborations. Additionally, this AD will be responsible for working with the ARCC to ensure that the needed computing support and equipment for SoC's research and education programs are developed; and to identify SoC personnel to be part of computational infrastructure proposals led by the ARCC.

**c. Associate Dean for Digital Education**

This AD will have a joint appointment with Academic affairs and will take on the task of implanting the "Digital for All" expansion of digital capabilities across the UW campus at both the student level and the faculty level. As the campus's "Digital Champion," this position's primary responsibility will be to coordinate and implement the Digital Pillar's initiatives within the undergraduate curriculum and with faculty and department professional development to develop instructors and resources for the goal of providing all UW students with education in computing and digital instruction. Their work will primarily be with UW units outside the SoC

They will need to pursue a dual focus: First, they will be responsible for providing students with expanding opportunities for digital education. Second, they will work to develop faculty expertise in digital and computational approaches in different disciplines to offer the courses needed for this transformation in undergraduate learning.

#### **4. Key programmatic elements**

This section provides some more details about key programmatic elements of the proposed SoC.

##### **A concentration of interdisciplinary faculty all having joint appointments.**

All SoC faculty will have joint appointments in a disciplinary program, with the intent of having SoC hiring impact more than SoC, creating natural opportunities for collaborations, etc.

The SoC would house an interdisciplinary concentration of faculty, and its leadership would have reporting lines to the Provost and VPRED to reflect the SoC's academic, research, and economic development missions. The SoC will draw on and add to strengths of the College of Engineering and Applied Sciences, and the College of Arts and Sciences, as is traditional for such a school. But very importantly, the SoC will also work closely with the College of Business and entrepreneurship programs, given the central importance of economic development to the mission of SoC, as well as to the College of Education and the community colleges across Wyoming, given the importance of boosting education in computing, data, and AI across the state.

##### **Pro-active programs to enhance inclusivity.**

Establishing a diverse faculty and student body must be a priority of the SoC, and creative, pro-active programs should be developed to support this. Some possibilities to explore include:

- A robust target of opportunity program that enables the SoC, or the SoC in partnership with a given department, to quickly recruit faculty as opportunities arise (e.g., a domestic partner is being recruited to UW, a highly qualified faculty member at another institute expresses interest in UW).
- An active, funded, seminar series that brings potential recruits to UW (before the hiring season).
- Programs to encourage and support new endeavors in computing and digital research at the faculty and departmental level, including seed money to support new course development.
- Funds to allow targeted recruiting of under-represented minority (faculty, graduate students, and undergraduate students).
- Utilization of a visiting scientist program to enhance inclusivity.
- Long-term programs to develop pipelines (e.g., K-12 programs across the State, a Native American Computing Opportunities program).
- Establish the current pathway for K12 students via the use of WySLICE (Wyoming's School and Libraries Integrating Computer Science in Education) and consider how to strengthen/broaden the existing initiative.

- Encourage the development of Culturally Relevant Computing (CRC), which can 'give voice to the youth' and 'deepen identities' (this applies to adults in education also). See, for example, the article [7]. Look to the examples of how the ACM supports Diversity & Inclusion [8] and consider where existing good practice can be adopted at UW.

The School of Computing will have programs dedicated to Wyoming's Native American population, and to working with the Eastern Shoshone and Northern Arapahoe tribes to identify and support ways that computing, and more broadly digital technologies, can be used to enhance their communities and provide tools and information to study issues of importance to the community. These activities will be in partnership with UW's Native American Education, Research and Cultural Center, and the Native American and Indigenous Studies program, UW's High Plains American Indian Research Institute, and UW's EPSCoR program (which has existing relationships and programs with Central Wyoming College, and the Wind River Communities.). The SoC will regularly meet with Tribal community leaders and follow their lead in identifying, shaping, and delivering programs to serve their communities. Some initial topics that might be explored are:

- Computing and digital education for all ages that reflect community values and vision.
- Nurturing, providing scholarships and internships for students who express interest in computing.
- Use of computing and data-analysis to enhance the communities' values of "preserving, managing, and protecting, resources for future uses by generations to come."
- Use of technology in agriculture, wildlife management, etc.

Central Wyoming College plays a critical role in UW's relationships with the Wind River community. The SoC will work closely with CWC faculty to support the development and delivery of digital curricula of interest and importance to their students.

We propose a joint hire with CWC devoted to computing curricula., and an inclusivity pool to facilitate the SoC to be aggressive in recruiting Native American, as Hispanic, African American and women, faculty, research staff and students.

Beyond the scope of the SoC, but within the digital pillar and UW's mission, is networking. UW, the State, and the Wind River Leadership should work together to provide ample networking for the Wind River communities. The State, UW and the Wind River Tribes should partner to pursue federal funding to support much needed networking upgrades to the Wind River communities.

### **Enhancing research and educational aspects of the Wyoming Data Hub**

A Wyoming Data Hub, which will support students, faculty, administration, and state agencies utilization of data analytic tools and Wyoming-centric data sets to expand the frontiers of knowledge, analyze and propose solutions to problems of interest, and inform policy decisions. By its very nature, and because of the increasing importance of data across all disciplines, the Data Hub will catalyze interdisciplinary research. It is planned for the Wyoming Data Hub to be supported by UW's Advanced Research Computing Center and overseen by UW Libraries. The

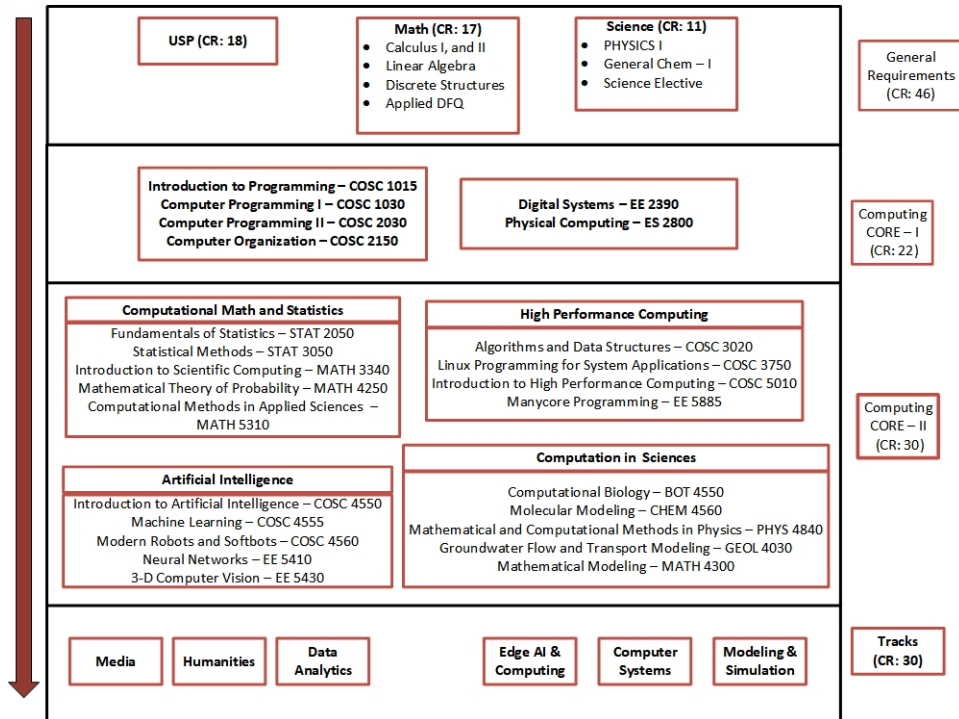
Data Hub will also provide a research tool for SoC faculty and students to develop, evaluation and utilize new computational and analytic tools to mine and synthesize data.

One goal of the proposed Wyoming Data Hub is to make Wyoming-centric data more accessible to Wyoming citizens, agencies, UW students, and facilitate interdisciplinary research addressing critical Wyoming issues and opportunities. The Wind River tribal communities are important constituents who should have access to Wyoming data, and they also are important collectors and providers of data in the state. It is critical that Wind River tribal councils have agency over their own data, and to that end it will be important to develop an agreement with the Wind River Tribes to ensure the sovereignty of data is that of the Tribes. This could be modeled after the existing agreement and operations with UW's EPSCoR office, where a tribal data is stored on a system and server that is off the grid, and all analysis is done on that system.

In this model, no tribal data would be stored on the Wyoming Data Hub, but the Wind River Community would have access to the Wyoming Data Hub. Data analytic tools for the Wyoming Data Hub would be provided, as desired, on a stand-alone system. We envisage in the future, working with the Wind River community to explore opportunities for data sharing that would not violate sovereignty and agency over data, for example, in non-consumptive data analysis.

### **Innovative Curricula to Enhance Workforce**

The SoC will establish a bachelors, MS and PhD degrees that are tied to producing students with a broad range of interests with the needed 21<sup>st</sup> century skills to use computing in their chosen careers. The first degree to be built out will be the bachelor's degree. Initially the existing Interdisciplinary Minor in Scientific Computing will be evolved and utilized as the program for SoC-affiliated graduate students. Near the end of Phase 1 the MS and PhD programs will be built out. Below a more detailed description of the bachelor's degree is given.



**Chart 1: Proposed SoC Bachelor's Degree with example tracks.**

The core bachelor's degree in computing will include courses in Math and Statistics, machine learning, data analysis and management, algorithms, modeling and simulations, game theory, and of course coding. SoC will work with other departments to create interdisciplinary majors. These could include computational mathematics, computational music, archaeoinformatics, computational biology, computational finance, disease informatics, and computational philosophy, to name just a few.

The computing major would differ in organization and emphasis from the present Computer Science and Computer Engineering degrees, complementing them rather than competing. The major would be designed with four course areas (see Chart 1 for more information):

1. General Requirements, 46 credits: Math, Science and University Studies.
2. Computing Core I, 22 credits: Introductory level courses currently offered by Computer Science and ECE departments in programming, computer organization, digital systems, and physical computing.
3. Computing Core II, 30 credits: Four modules of focus, from which students take two. These are: Computational Math and Statistics, High Performance Computing, Artificial Intelligence and Computation in Sciences. These are upper-level courses, and which are currently offered in various departments across UW.
4. Concentration Tracks, 30 credits: Initially these will be computation tracks (Edge AI, Computer Systems, Modeling and Simulation, Data Analytics). Interdisciplinary concentrations will be developed with collaborating departments (e.g., archaeology, history, art, music, philosophy, environmental science, biology).

Additionally, the SoC would provide, or partner in providing, short courses/boot camps for various stakeholders (e.g., INBRE short-courses for computing in the biosciences at Wyoming's community Colleges, boot-camps for incoming graduate students on computing and data analytics, Software Carpentry course for students and faculty, and software engineers at Wyoming agencies.). The SoC will also partners with NVidia, and IBM to offer workshops on the latest computing software and hardware architectures.

### **Digital for All**

Here we briefly describe a vision for SoC's involvement in the Digital Pillar. The SoC will be the champion for UW's digital pillar effort, and this championship will be led by the Associate Dean for Digital Education. The following description echoes descriptions in the larger Digital Pillar report [6].

UW undergraduate students should learn that digital and computational methods/ tools/ approaches are becoming increasingly part of all disciplines of knowledge and aspects of life. At a general level, they should be exposed to the variety of ways that digital tools can be used to accomplish tasks—many of them new tasks never before possible—in areas from medicine to art and music to engineering and society--and gain introductory experience in using them. Students should also learn how to analyze the human, social and scientific impacts the existence and use of these tools bring. At a specific level, they should learn in greater detail and expertise how to use the digital tools available in their fields of study and understand the theory of how digital approaches and computational methods will change their fields in the future.

These curricular goals can be accomplished by placing digital education (including computational approaches) into the undergraduate experience in the following ways.

- Foster the creation of a digital course requirement in the University Studies Program for all students.
- Create different digital/computational groups within UW's Living Learning Community.
- Provide Freshman Seminars about digital and computational approaches within different disciplines or as they apply to different interdisciplinary questions.
- Design four-course certificates and six-course minors open to all students for cross-disciplinary skill learning. These could be in areas such as 3D modeling (digital and physical), coding skills, analysis of society and the internet, GIS, and blockchain.
- Help organize majors to include digital and computation components in disciplines across the campus. Whole new majors could be developed as well.

The AD in Digital Education will also work to develop faculty expertise in digital and computational approaches in different disciplines to offer the courses needed for this transformation in undergraduate learning. They will support the disciplines that already make extensive use of computational and digital approaches in their research and teaching. Departments in these areas will be able to take advantage of UW's new digital emphasis by creating a few new courses—perhaps for non-majors—or a slight redesign of their curriculum. The AD will work with the many other departments which have little experience with teaching students about digital or computational matters in their field, even if some of their faculty use



such methods in their own research. The AD would work to develop digital and computational expertise among existing faculty and departments. A high-level, campus-wide program should be available to encourage, nurture, guide and train faculty and departments in digital skills and knowledge. Its goal would be to encourage and support the development of digital expertise among individual faculty, disciplinary faculty groups within departments and interdisciplinary groups of faculty across departments.

The Digital for All program would support diverse types of educational and recruiting activities for faculty, such as the following.

- Invited speakers from a variety of disciplines who use digital or computation approaches in their research. These could come from both UW and outside.
- Assisting individual researchers in the acquisition digital skills by encouraging pedagogical and/or research projects with seed money, equipment, and software support centers--both existing (e.g., 3D visualization center and makerspaces) and newly developed. The aim would be to help these individuals develop one or two digitally oriented courses in their area.
- Helping to form disciplinary and cross-disciplinary faculty teams to provide a coordinated curriculum of courses.
- Providing support to these faculty groups to enable them to devise long-term strategies to pursue research or teaching goals. Such support could range from meeting space to consultation opportunities to small seed grants.
- Implement the strategies to support digital research through activities such as writing grant applications, undertaking pilot projects, composing exploratory papers, and so on.

Finally, there are many groups and units across campus which have been pioneering a variety of digital initiatives. The Digital for All program aims to work with these existing programs, coordinating with them and helping them build upon the success they have already achieved. Some are research oriented while others are student oriented. They range from the 3D Visualization Center and the Center for Data Analytics to the makerspaces and Studio Coe.

### **Wyoming Computing Scholars Program**

This campus-wide program will

- Attract a diverse pool of Wyoming high school graduates with an interest in computing to the University of Wyoming.
- Retain promising students at UW through early involvement in computing research, and SoC seminars and outreach events.
- Pair talented college students with a faculty mentor who oversee student progress, nurture their development, and help them identify opportunities at the SoC, as well as with SoC national partners.
- Strengthen each scholar's soft skills through opportunities to work in collaborative, interdisciplinary teams, and give oral and written presentations.

The program will be competitive, and open to students of all disciplines. Students from Wyoming Community Colleges would be eligible for the program.

### **Internship programs**

The SoC will partner with or create internship programs to enhance the learning experiences of its students at both the undergraduate and graduate level.

An example of a promising partnership is the Technology Associate Program (TAP) housed in UW's 3D Viz Center. Through the TAP, students can receive academic credit and income through an internship that is focused on technology, software, and applications development and testing. They select or move between a technical and a creative track and undertake packages of work which are either training orientated or work projects for a real-world client.

Through recent collaboration with EERB Makerspace, the components of work on the 3D Viz Center TAP are being translated to take the form of digital badge; this compartmentalizes the learning into bite sized sections. The future goal of the TAP program is to see students move between sections of UW offering TAP internships. Students can attend for a maximum of 19 hours per week and are required to support in person visits to highlight technology in the 3D Viz Center. Students typically attend for a TAP internship when they want to top up their experience in a specific area of interest and skill. In 7 years over 50 internships have taken place in the 3D Viz Center, a relationship is maintained with the graduates' students who return to present to the current cohort and address how their intern experiences impact their career.

Following the lead of other schools of computing, UW's SoC would also develop a corporate scholar's program, as described below. The SoC **Corporate Scholars Program** will be developed in close liaison with the Digital Pillar corporate partnerships program, and the newly seed funded UW Pioneer Program. The Pioneer Program is a 'Knowledge & Expertise Exchange Connecting Skilled Students with Wyoming Entrepreneurs'. It will build a team of "Pioneers," undergraduate and graduate students trained in over 70 existing emergent technology competencies, and match those selected with the regional (or otherwise) businesses seeking assistance. The primary goal is 'that this project-based, competency-driven program is to develop a network that connects Wyoming businesses seeking help with innovative projects with students whose academic experiences have helped them develop design thinking mindsets, collaborative, and interdisciplinary approaches to work, and proven technological skills'. This framework would be broadened to encompass the prospect of collaborative research projects, the overlap with back-end infrastructure and front-end corporate dev with the Digital Pillar is significant.

### **Corporate and Lab partnerships**

The federal government, and the private sector continue to invest in computing, and in particular artificial intelligence. At the federal level, these investments are in traditional areas such as military, energy, and science and engineering, as well increasingly in areas such as health, homeland security, securities and exchange. In the public sector, there are major investments in the US (and indeed in Wyoming) in the use of AI in transportation, business services, medicine,

and life-science applications. These investments are projected to continue to increase and broaden.

These investments and interest in computing, positions the SoC to quickly become a nexus for partnerships with corporations and national laboratories. Partnerships with National Laboratories provide a wealth of (often life-changing) opportunities for UW students and graduates, gives access for UW researchers to large grants and research projects, and provides UW a seat at the table in discussions about computing and computing education at the national level. Partnerships with corporations provide new opportunities for students and faculty to work on “real-world” problems and a new revenue stream for funding of students and research projects. Partnerships with Wyoming corporations and State Agencies can help the SoC directly, and quickly impact workforce development in Wyoming.

Section 5 of the Digital Pillar report [6] provides recommendations and details of how UW and will grow and strengthen partnerships, and outlines SoC’s leading role in these endeavors.

#### **Workforce and economic development and statewide engagement.**

The stated mission of the SoC is to provide Wyoming with the computing professionals to advance the state’s economy. To this end, contributing to workforce development, economic development and statewide engagement are essential components of the school. As the lead for a top-level academic unit, the SoC Dean will be fully included and engaged in the university’s strategic planning and strategic programs.

The SoC should include an FTE devoted to workforce development. This person would oversee the Computing Scholars program, and the Corporate Internship program. Additionally, they would act as the SoC’s liaison to UW’s Career Services Center and facilitate workforce development activities included in SoC faculty grants.

Section 6 of the Digital Pillar report [6] provides details about statewide engagement regarding computing, and the SoC will be integrally involved in these efforts.

The SoC should include one FTE that is joint with the Office of Research and Economic Development, devoted to working with Wyoming companies and SoC faculty and affiliates to support economic development through building an awareness of, and joint exploration of, new opportunities enabled by computing and related technologies spur on new business opportunities; working with other State, regional and UW entities to help recruit support new Wyoming’s growing tech economy.

#### **Partnerships to ensure Wyoming is a leader in computing education at the K-12 level.**

Due to the State’s forward-looking adoption as Computer Science as a required academic content for all students throughout the K-12 experience, existing computing-related programs for

students and teachers led by UW and CC faculty UW is uniquely positioned to help the meet the challenge of providing Wyoming's K-12 students with the critical basic computational skills.

SoC's efforts in this regard will focus on developing partnerships to support and leverage the wealth of existing programs, and on providing a hub for statewide computing-related outreach. Serving as a hub will facilitate SoC faculty and affiliates to work with existing programs to develop broader impact activities for grant proposals rather than create short-lived programs that duplicate existing efforts. This can provide stability and fresh perspectives for existing programs. With SoC leadership, long-term studies on the impacts of these programs could not only help Wyoming faculty and the State improve these programs but could provide compelling stories of the positive impacts of the programs throughout Wyoming and in Wyoming's students.

A couple of prototypes of high-quality programs that SoC could leverage through partnerships are the following.

- Several summer outreach activities are conducted by faculty in computer science, computer engineering and college of education, to introduce computing to K-12 teachers. The goals of the outreach activities are to have trained K-12 teachers as the best conduits for educating K-12 students in areas crucial for the economic development of the state and workforce development such as Computer Science, Engineering, STEM and futuristic technologies like AI, and Internet of Things.
- The computer engineering department currently hosts two summer workshops for K-12 teachers. The Engineering Summer Program for Teachers (ESP4T) is a four-day long workshop on Physical Computing. Physical Computing combines programming and programming applications in STEM areas. The K-12 teachers are trained in using programming with edge devices to address a science or math or arts concepts to K-12 students. The ESP4T workshop was initiated in 2016, and each year ninety-six K-12 teachers have participated in this workshop.
- In 2021 summer, a pilot workshop titled "Machine Learning for High School Teachers" (ML4HST) will be introduced. One of the goals of the ML4HST is to introduce teachers for grades 8-12 in STEM areas to basic concepts of Machine Learning and applications in various fields. The pilot workshop has accepted eighteen teachers from across the state.

## **5. Phased plans for development of School of Computing**

### ***Phase 0 (3 months) Recommendations***

1. The UW Provost should outline an appropriate process to select and appoint an interim dean, associate deans (all existing faculty at UW) and internal steering committee.
2. Appoint an internal steering committee for the startup phase of the SoC that includes representation from key units to advise in guiding build out, maintaining stakeholder relationships, and identifying initial thematic areas and faculty.

3. Appoint an interim dean and administrative staff (including an executive assistant and staff for programs in education/workforce development and corporate partnerships). The interim dean should be a UW faculty member with proven leadership, effective communication skills, and broad knowledge of computing. The ideal candidate will have experience or knowledge of other schools of computing and will have contributed to building a diverse and inclusive culture. Two associate deans from the UW faculty should also be appointed.
4. The School of Computing's success will be critically dependent on a vibrant Advanced Research Computing Center (ARCC) with strong, inventive leadership. ARCC does not presently have a permanent leader, but attracting one is a high priority of UW. With ARCC continuing to report to ORED, the ARCC leader must be capable of leading the organization in tight cooperation with the School of Computing in response to its evolving interests. A permanent ARCC leader should be energetic, creative, and collaborative, with experience and interest in both computing center operations and computationally driven research. This director should be capable of optimizing the operations of a core research computing center while recruiting a team over the long run that serves both the operational interests of ARCC and the strategic research interests that will be supported by the School of Computing.
5. Secure appropriate space on or near the campus for the startup phase of the new school. This space should include office space for the Dean and administrative staff, faculty/researcher/visitor offices and space to gather for meetings, seminars, training events etc.
6. Develop and promote a set of values and clear mission statement for the SoC that will drive future development. For example, it is important to develop a supportive, inclusive, and interdisciplinary culture from the very start.
7. Develop and initiate a marketing and communication plan for the SoC with internal and external key stakeholders.

### ***Phase 1 (Years 1 and 2) Recommendations***

8. The interim dean should develop as soon as possible a full operational plan for the SoC that includes a business plan and metrics for evaluation. The plan should detail the various kinds of faculty and staff appointments and clarify IDC recuperation for any split appointments. This planning should be undertaken in coordination with the steering committee and include town halls and other mechanisms for broad faculty and community input.
9. Plan a timescale for and execute an international search for a permanent dean. The dean should have proven skills to communicate with the governor, state and federal officials, the Foundation, tribal leaders, and corporate leaders. Establish an external advisory board including representation from successful external computing schools, industry with a high research component, and geographically broad Wyoming business and entrepreneurial councils.
10. Select key existing UW faculty (e.g., 6-8 faculty) based on background, interests, and commitment to working to achieve the SoC vision. It is essential to work with department

heads so that such changes are welcome and strategic for the units, e.g., providing departments with a new hire (potentially joint with SoC), planning for the transition effect on teaching commitments, so that the SoC faculty provide bridges to former units. The UW faculty forming the initial core of SoC should be strategically selected and targeted towards carefully chosen thematic areas building on existing strengths in core computing topics, developing strategic topics and economic development. Computing, Artificial Intelligence, and Climate and Energy Sciences should be represented in the initial research pillars of the SoC. Additional key areas of interest include the Grand Challenge priority areas and new uses of computing and data in the arts, humanities, and social sciences. Domain experts should enhance external research funding activities in core and application domain areas. Diversity of SoC staff and computing inclusivity should be taken seriously from the start. Faculty will be connected to the SoC in diverse ways, including full appointments with tenure held in the SoC, split appointments between the SoC and another home academic department, affiliate and visiting faculty.

11. Work with the Wyoming's community colleges (potentially via WIN) to ensure that SoC planning includes their needs and vision. Identify initial affiliates for the SoC at each of the community colleges.
12. Identify a diverse collection of a dozen visiting faculty from national and international universities to contribute to the Phase 1 building of the SoC. Host these faculty at the SoC for visits of 1-6 months, with potential continued engagement via longer term visiting affiliate appointments.
13. Work with the deans/department heads and provost on cluster hiring initiatives whereby approximately six new joint hires will be made in Phase 1 to build up SoC faculty.
14. Recruit a few research scientists that work at a similar or higher level than the current faculty but are not tenure track. Develop a culture such that non-tenure track staff are truly valued and respected. Work with other units to place research scientists (e.g., computational scientists at the Center of Innovation for Flow through Porous media (COIFPM) at the SoC or affiliate them with the SoC to strengthen UW's core computational expertise.
15. Expand existing and develop new corporate and national laboratory partners (e.g., National Center for Atmospheric Research (NCAR), Argonne National Lab (ANL), Cardiff University).
16. Working with UW leadership and unit leads, determine which existing entities on campus could/should be closely connected with the SoC and could be included via different mechanisms, e.g., as a reporting unit, affiliate or dual report, or in collocated space. As with all partners, attention will be given to crafting mutually beneficial outcomes. Affiliation with the [Advanced Research Computing Center \(ARCC\)](#) is critical for the SoC. Other entities of high relevance include (this list will grow as the SoC develops!):
  - [Shell 3D Viz Center](#)
  - [Data Science Center](#)
  - [Wyoming Geographic Information Science Center \(WYGISC\)](#)
  - [Wyoming Water Resources Data System \(WRDS\)](#)
  - Center for Blockchain and Digital Innovation



- [Digital Scholarship Center](#)
  - Center for Design Thinking
  - [Center of Innovation for Flow through Porous media \(COIFPM\)](#)
  - [Innovation Wyrkshop](#)
  - [Coe Student Innovation Center](#)
  - [Cybersecurity Education and Research Center \(CEDAR\)](#)
  - [Secure Systems Collaborative](#)
17. Build an initiative with the Foundation that will lead to Phase II and long-term funding for the SoC and develop a robust business plan. This will include immediately working with the Foundation to find \$15-25M in new donorships for the SoC and designing a program of long-term corporate partnerships with relationships of 3-20 years to enable sustained partnerships.
18. Action items have focused on operational issues to establish the SoC, but as soon as faculty are assigned, there will be research, education, and engagement activities. These will include:
- Working with other economic development activities (e.g., in ORED), initiate a corporate partners program to develop research and education links with appropriate industrial partners.
  - Lead interdisciplinary activity across campus, working with departmental liaisons and initiatives such as the Grand Challenges, EPSCOR R1, Science Initiative as well as non-traditional partners such as the Wyoming Institute for Humanities, the Wyoming Arts Council, and the Wyoming Arts Alliance to diligently and impactfully weave computing with other domains, establishing projects and labs in initial thematic areas of emphasis.
  - Define and prototype, with SoC partners, new courses and student programs for UW and Wyoming's Community Colleges. These courses should define what the student experiences are likely to be in first years of study.
  - Implement (and receive regular feedback for advisory broad and UW leadership on) an ongoing evaluation of full implementation plan.

### **Phase 2 (Years 3 to 5) Recommendations**

19. Conduct a review of the SoC and its Dean, evaluating its progress against the strategic plan and the implementation of its commitment to the founding values, vision, and mission. Secure funding for Phase 2 in partnership with the Foundation on major, long-term fundraising from corporations and individuals, e.g.,
- Multiple named professorships (\$2+M each)
  - Graduate student scholarships (\$0.5M each)
  - Named deanship (\$5+M)
  - Named college (\$30+M)
  - Designated, named building or space (\$25-30M) to be started during this phase (completion can be later).
20. Secure a line item in the state budget for the SoC. Depending on how well Phase 1 goes, this might be in there instead.

21. Strategic planning with SoC faculty and other stakeholders to define core areas of emphasis for the SoC, such as
  - Grand Challenges
  - Growth of core areas CS/ECE/Math & Stats
  - NWSC development to drive infrastructure, economic growth, partnerships etc.
  - Identify and grow strategic application areas, e.g., Enhanced Medical Program.
22. Expand the faculty through targeted hires for areas of importance for SoC and strategic joint hires with other UW units.
23. Develop plans for which academic departments could be expanded by faculty members or research scientists to enhance overall facilities and the SoC.
24. Work with colleges and units to expand out digital connections to the SoC.

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## **Appendix A**

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