**STAFF SENATE RESOLUTION #245**

| | |
|---|---|
| **Title:** | **Support for Associated Students of the University of Wyoming Resolution 2757 Regarding the Creation of a School of Computing** |
| **Date:** | **January 5, 2022** |
| **Author:** | **Senator Teng** |
| **Sponsors:** | **Senators Kennedy and McKenna** |

1 WHEREAS, the purpose of the University of Wyoming (UW) Staff Senate is to provide a means

2 of communication between staff and administration relative to issues of mutual concern, and;

3 WHEREAS, the creation of a School of Computing (SoC) was proposed in 2021 as part of UW's

4 proposed Academic Restructuring Plan, and;

5 WHEREAS, according to the University of Wyoming School of Computing Preliminary Plan,

6 the vision of the SoC is "to create a unique and inspirational School of Computing with national

7 impact and global reach, providing Wyoming and the world with agile and ethical computing

8 professionals, empowered to address societal challenges that are inherently interdisciplinary;" as

9 stated on page one (1) of the Request for Authorization (RFA) for the SoC, and;

10 WHEREAS, the Associated Students of the University of Wyoming (ASUW) formed an Ad-Hoc

11 Restructuring Committee and administered a Student Issues Survey to students at UW to come to

12 a well-considered and informed formal recommendation on the proposed SoC, and;

13 WHEREAS, ASUW introduced Senate Resolution #2757, "ASUW's Recommendation

14 Regarding the  Creation of a School of Computing," (Addendum A) which states that while

15 ASUW "understands and supports the vision of the University of Wyoming School of

16 Computing as  outlined in both the Preliminary Plan and the Request for Authorization" they

17 "cannot support the creation of a School of Computing as outlined in the Preliminary Plan due to

18 lack of clarity,  proposed execution strategies, lack of communication and transparency with the

19   UW community, exorbitant additional cost in a time of significant budget reductions," and a lack

20   of  transparently assessed alternatives, and;

21   WHEREAS, Staff Senate passed Resolution #243 supporting ASUW Senate Resolution #2757

22   on November 3, 2021, and;

23   WHEREAS, members of ASUW and Staff Senate have met with President Seidel and other

24   stakeholders responsible for implementing the SoC at UW, and;

25   WHEREAS, concerns expressed by both bodies have been addressed through this process;

26   THEREFORE, be it resolved that UW Staff Senate fully supports the creation of a School of

27   Computing as detailed in the RFA (November 2021) due to conversations alleviating concerns

28   expressed by Staff Senate in Resolution #243, and;

29   THEREFORE, be it further resolved that Staff Senate echoes ASUW's stance of support for a

30   School of Computing as outlined in ASUW Senate Resolution #2765 (Addendum B).


**Date of Passage:** __01/05/2022_____

**"Being enacted on** __01/10/2022_____**, I do hereby sign my name hereto and approve this
Senate action."** _____(Cu)_____

                **Staff Senate President,  Chris Maki**

PASSED 24-0

**SENATE RESOLUTION #2757**

**TITLE:**            ASUW's Recommendation Regarding the Creation of a School of
                     Computing

**DATE INTRODUCED:**   October 19, 2021

**AUTHOR:**            Senators Engel-Cartie and Rhymes; President Swilling; Vice
                     President Anderson; Chief of Legislative Affairs Carrier

**SPONSORS:**          Senators Castronovo, Smith, and Wilkins


1. WHEREAS, the purpose of the Associated Students of the University of Wyoming (ASUW)

2. Student Government is to serve our fellow students in the best manner possible; and,

3. WHEREAS, the creation of a School of Computing (SoC) was proposed in 2021 as a part of

4. the University of Wyoming's (UW) proposed Academic Restructuring Plan; and,

5. WHEREAS, according to the University of Wyoming School of Computing Preliminary Plan

6. (Preliminary Plan) the vision of the SoC is "to create a unique and inspirational School of

7. Computing with national impact and global reach, providing Wyoming and the world with

8. agile and ethical computing professionals, empowered to address societal challenges that are

9. inherently interdisciplinary;" as stated on page one (1) of the Request for Authorization

10. (RFA) for the SoC as shown in Addendum A; and,

11. WHEREAS, the SoC would provide the following academic degrees: "multi-pathway BA

12. and BS programs in Computing, minors in Computing, certificates, possibly stackable, in

13. Digital/Computing, and MA/MS/PhD in Computing," as shown on page three (3) of the RFA

14. in Addendum A; and,

15. WHEREAS, the ASUW has been asked to provide a formal recommendation regarding the

16. SoC by Provost Carman, in accordance with UW Regulation 2-119, which states that the

17. Provost shall include a letter that affirms, among other things, that, "The University

18. community, including but not limited to Executive Team, Deans and Directors, Faculty

19. Senate, Staff Senate, and ASUW, must have been provided the opportunity to review and

20. present feedback."; and,

21. WHEREAS, ASUW is thus obliged to provide a formal recommendation on the proposed

22. SoC; and,

23. WHEREAS, in order to fulfill this duty, and to represent student opinion in the best manner

24. possible, the ASUW Ad-Hoc Restructuring Committee has thoroughly reviewed the

25. authorization request for the SoC and its preliminary draft proposal; and,

26. WHEREAS, the committee has used these discussions, as well as feedback from the Student

27. Issues Survey, as shown in Addendum B, to come to a recommendation; and,

28. WHEREAS, as stated in the request for authorization, computer science and information

29. technologies are transforming all sectors of society and every academic discipline can find

30. use of computing in their curriculum; and,

31. WHEREAS, ASUW recognizes that digital literacy and competencies are critical skills for

32. many students to know in order for them to be competitive in job markets; and,

33. WHEREAS, ASUW recognizes that the UW must be competitive by offering broader, more

34. robust, and intensive studies in digital fields to ensure students are ready for the growing

35. demand and need of computer science workers as stated on page six (6) of the RFA in

36. Addendum A; and,

37. WHERAS, ASUW recognizes that UW contributes to the State of Wyoming's economic

38. development, and educating students for work in emerging fields is critical to the

39. diversification of Wyoming's economy; and,

40. WHEREAS, while the ASUW understands the necessity and importance of achieving

41. these goals, the Preliminary Plan, as well as the RFA, both lack clarity

42. and explanation in how these goals will be achieved; and,

43. WHEREAS, this lack of detail fails to assuage the numerous concerns that have been brought

44. up by various stakeholders involved in this process, including questions regarding execution,

45. communication, transparency, and cost; and,

46. WHEREAS, the plan for executing and creating this school in such an abbreviated timeline is

47. not laid out in any documentation publicly available; and,

48. WHEREAS, ASUW believes there has been a lack of communication with the students,

49. faculty, and staff that comprise the UW community of what the preliminary plan entails and

50. both budgetary and non-budgetary impacts of the plan; and,

51. WHEREAS, this is exemplified by the fact that even after being given a brief synopsis of the

52. proposed plan, 43% of students felt that they did not have enough information to give an

53. opinion regarding the creation of this school, as shown in Addendum B; and,

54. WHEREAS, ASUW feels that student voices have not been sufficiently involved in the

55. creation of this plan; and,

56. WHEREAS, ASUW also feels that student opinion and student voice is an essential

57. component of shared governance, exacerbated in this instance by the fact that the SoC's

58. stated goals are to benefit students and provide them with the skills necessary

59. to succeed in the job market; and,

60. WHEREAS, in addition to a lack of student feedback being incorporated, ASUW also feels

61. that the preliminary plan lacks a critical analysis of the school's potential weaknesses or

62. threats; and,

63. WHEREAS, in addition to concerns with the execution and planning, ASUW also notes that

64. the Preliminary Plan has failed to explicitly detail why the computing discipline is distinct
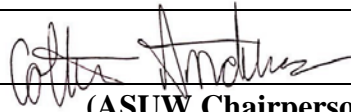
65. from the established computer science discipline, only saying "the computing major would

66. differ in organization and emphasis from the present Computer Science and Computer

67. Engineering degrees, complementing them rather than competing.", and listing credit hour

68. differences, but providing no further details; and,

69. WHEREAS, there is no publicly available information on assessment of potential alternative

70. plans that could achieve similar stated goals as the SoC, such as the combination of already

71. established programs incorporated into the SoC, or the addition of pathway-specific

72. computing classes offered by specific Colleges being integrated into select degree

73. programs; and,

74. WHEREAS, it is unclear why computing programs requires the creation of an entire school

75. with associated expensive start up and administrative costs and what financial and

76. organizational benefits there are from forming an entire SoC; and,

77. WHEREAS, the Preliminary Plan failed to offer reasonable justification for the expense of a

78. new school during a period of financial difficulty for UW and state of Wyoming as a

79. whole; and,

80. WHEREAS, page seven (7) of the RFA as shown in Addendum A outlines the numerous

81. personnel and administrative supports that will be needed; and,

82. WHEREAS, these administrative and personnel costs are concerning given that other

83. portions of the University are seeing a reduction in resources in these areas; and,

84. WHEREAS, the ASUW believes that the proposal for the SoC, while containing elements

85. that will benefit students and the state, needs organizational reform and communicative

86. clarity before it can be effectively implemented in a way that benefits the UW and the state

87. as a whole population.

88. THEREFORE, be it resolved that the Associated Students of the University of Wyoming

89. (ASUW) Student Government understands and supports the vision of the University of

90. Wyoming School of Computing as outlined in both the Preliminary Plan and the Request for

91. Authorization; and,

92. THEREFORE, be it further resolved that although the ASUW supports this vision, the

93. ASUW cannot support the creation of a School of Computing as outlined in the Preliminary

94. Plan due to lack of clarity proposed execution strategies, lack of communication and

95. transparency with the UW community, and exorbitant additional cost in a time of significant

96. budget reductions; and,

97. THEREFORE, be it further resolved that the ASUW will offer support for the creation of this

98. school once communication increases, transparency is seen, alternatives have been

99. transparently assessed, and the aforementioned concerns have been addressed.

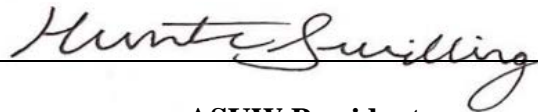**Referred to:** Ad-Hoc Restructuring; Advocacy, Diversity, and Policy; Programs and Institutional Development

**Date of Passage:** October 26, 2021     **Signed:** _____

(ASUW Chairperson)

**"Being enacted on** October 26, 2021 **, I do hereby sign my name hereto and**
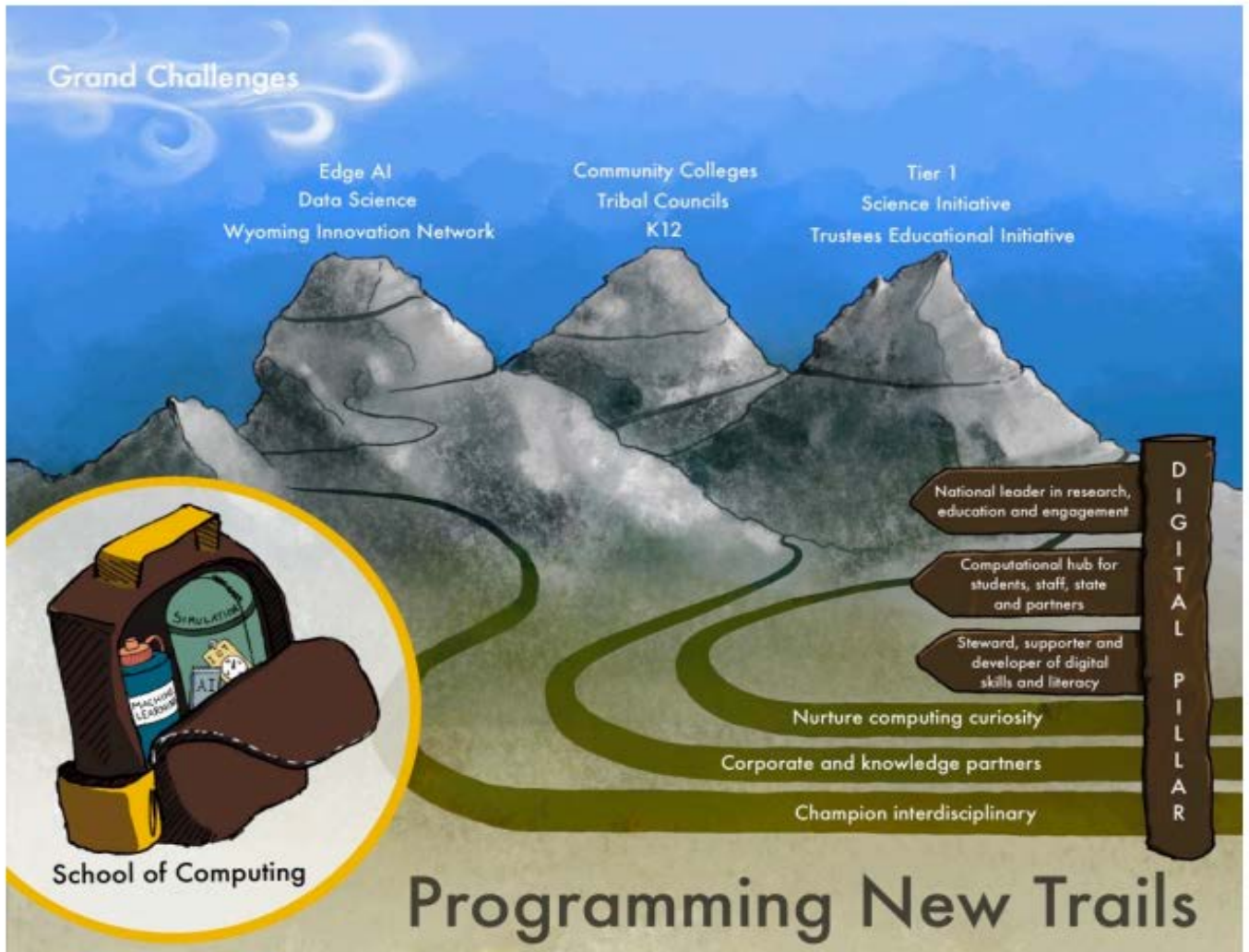
**approve this Senate action."** _____

**ASUW President**

**Addendum A**

**Authorization Request for the School of Computing (SoC)**

**August 2021**



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

The SoC will be a hub of innovation and knowledge exchange providing UW students, faculty and Wyoming businesses and citizens with a "**backpack**" of computational tools and approaches to drive transformation.

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

## 1. Introduction

This document is a Request for Authorization (RFA) to establish a School of Computing (SoC) at the University of Wyoming. The request describes characteristics of a BA and a BS degree in Computing that will be SoC's initial curricular foci and will provide the foundation and structure for future minors to be developed and offered with other departments and programs across the campus. These degree programs will be fully developed in the first 18 months of the SoC, and informed by a new Dean and new hires and a SoC Curriculum Advisory Committee that will include faculty from UW and experts from outside UW. Additionally, a description of the SoC's leadership role in the campus-wide effort to make UW more digital is given. The BA and BS, as well as future curricular programs (e.g. minors, MA, MS and PhD degrees in Computing) will follow the approval process at the appropriate times in coming years.

This RFA references

a) A **feasibility study and market analysis** on the BS in Computing Degree from the Education Advisory Board (EAB).
b) The **School of Computing Preliminary Plan** that provides a detailed description, analysis and tentative budget for all aspects (Educational, Economic and Workforce Development, Research, Partnerships, and enhanced funding opportunities).
c) The **Notice of Intent** and the accompanying presentation to the Board of Trustees.
d) The **Digital Pillar Report** prepared in Spring 2021 by a committee of 19 UW faculty, staff and students at the bequest of the UW Provost that gives a broad overview of the need, the benefits and suggest actions for UW to become more digital.
e) **Various reports** from national organizations and think-tanks on the need for computing.

For convenience each of these is included in the package for this request, or can be accessed via the link: supporting files.

## 2. Purpose and need for the proposed Academic Program

The following quotes from two recent studies summarize the overarching needs for the proposed academic programs at UW.

> Computer science and information technologies have transformed all sectors of society, businesses, and government. Today, the transformation continues and much is driven by artificial intelligence, robotics, the Internet of Things, information security, and data science. A wide range of jobs in virtually all sectors demand computing skills to an unprecedented extent. And every academic discipline finds itself incorporating computing into its research and educational mission. [NAS 2018]

> Computing is and will continue to be an essential component in shaping the future for humanity, The computing disciplines need to attract quality students from a broad and diverse cross-section of the public and prepare them to be capable and responsible professionals. [CC2020]

These needs are even deeper at UW. The productivity across UW in computational education and research is far below that of our peers, and the needs of UW graduates.[1] Access to cutting-edge research, world-class infrastructure and

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[1] "It is important to note the scale that is needed for UW 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 relative sizes of CS departments is only one, very limited indicator, but it does give a sense of where UW is. In 2020 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 UWs size and has more than 4 times our CS faculty, and a unit like our ARCC with over 50 staff (almost entire funded on soft money through grants). In all cases these activities are a foundation for economic development in their region." [S20]

workforce training in computing and data is therefore critical for Wyoming citizens, and most importantly for UW's students.

The primary purposes of the SoC curricular programs are to

- lead UW in the incorporation of value-added, disciplinary-specific **digital experiences in all** disciplines,
- **provide more students with career pathways that utilize** the power of computing and technology,
- provide new opportunities to **increase the diversity among UW students utilizing computing** in their disciplines and careers, and
- establish **a pipe-line of tech-savvy graduates for Wyoming's and the global economy**.

Additionally, the SoC will provide UW researchers new tools and cutting-edge computational expertise to better address grand challenge problems of importance to Wyoming and region that they are studying, and serve as a hub for Wyoming's innovation economy.

### 3. Proposed curriculum

The SoC is envisioned to ultimately house the following academic programs:

- Multi-pathway BA and BS programs in Computing,
- Minors in Computing,
- Certificates, possibly stackable, in Digital/Computing,
- MA/MS/PhD in Computing.

When feasible, all parts of the curricula will be offered online. The SoC will also work with Academic Affairs to be the champion for the envisioned "Digital for All" component of the USP.

The initial ideas of these programs are more fully discussed in the SoC Preliminary Plan, and the Digital Pillar report. The full development of these programs will involve Academic Affairs, Faculty Senate, the USP committee, faculty and students, and will be overseen by a SoC Curriculum Advisory Committee. All will be fully studied and follow the process for approval and creation of new academic programs.

Here we focus primarily on the characteristics and vision for the BA and BS in Computing programs; as they are the most critical for UW students and for Wyoming, and will be the first developed. Before that we will briefly describe the vision and plans for the other programs. All programs will be greatly informed by the recently released report "*Computing Curricula 2020: Paradigms for Global Computing Education* [CC2020] that was developed by a 50-member task force drawn from 20 countries, CC2020 outlines international recommendations for baccalaureate degrees in computing.

### Digital For All Experiences.

The Digital Pillar report recommends that the university community consider the creation of a "digital course" requirement in the University Studies Program for all students. Their reasoning is that it is important that all UW undergraduate students learn how digital and computational methods/tools/approaches are increasingly part of their chosen discipline and all aspects of life. At a general level, students should be exposed to the variety of ways that digital tools can be used to accomplish task (many of them are 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 gain understanding of how to analyze the human, social and scientific impacts the existence and use of these tools bring. At a specific level, students 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. The SoC plan proposes an Associate Dean with joint appointment between the SoC and Academic Affairs tasked with leading efforts to make UW more digital through the proposed digital curriculum embedded in the USP.

### Minors in Computing.

Job prospects likely also contribute to the demand for CS courses from non-majors, but this portion of the enrollment increase is also driven by the impact of CS and computing in other fields. Computer

science and its related endeavors such as data science have produced powerful tools and software systems that are used by and affect every discipline, giving rise to exciting subfields, such as computational biology, computational economics, computational chemistry, and digital humanities, with more emerging. These subfields require expertise in the traditional domain and a general fluency in tools and methods from computer science. The advantages of a deeper knowledge of computer science in many domains has also led to the recent emergence of new degree programs at several institutions that fuse curricula and formal requirements of CS with those for one of a range of disciplines (referred to as "X+CS"). [NAS 2018}

As the above quote indicates, increasingly students in many disciplines find great value-added in incorporating computing classes into their studies. Having disciplinary minors in computing will give UW Alums a competitive advantage throughout their careers, catalyze working partnerships between UW departments and the SoC faculty, and will be a valuable recruiting tool for students, graduate students and faculty. All minors will be vetted, and submitted through approval through the standard UW processes.

**Certificates, Possibly Stackable, in Digital/Computing.**
The Digital Pillar Report mentions the emerging mechanisms of certificates and stackable certificates in higher education. The SoC envisions partnering with entities like the Ellbogen Center, the Visualization Center, the Innovation Wyrkshop, the Advanced Research Computing Center and UW Libraries to explore the feasibility of developing suites of (possibly stackable) certificate courses that enable a diverse audience of students, including non-traditional students and life-long learners, the opportunities to gain specific 21$^{st}$-century skills through short-courses, self-paced courses with competency exams.

**Graduate degree programs.**
In years 2 and 3, the SoC will plan and developing MA and MS degrees in Computing, with a focus on creation and use of innovative computing tools in the context of grand challenge problems in a wide range of disciplines. Desired characteristics of these programs will be diversity of student body, various academic pathways for entrance, collaborative projects involving different disciplines and stakeholders, ties through internships/externships with Wyoming and regional companies. A PhD in Computing will be studied and considered in years 4 and 5; other Schools of Computing support robust PhD programs through corporate partnerships, external funding, and partnerships with national labs. Initially, the graduate curricula will be operated using existing programs in the ongoing Interdisciplinary Graduate Minor in Scientific Computing.

We now return attention to the most critical programs in the SoC, the BA and BS programs in computing.

**Multi-pathway BA and BS Programs in Computing.**
The BA and BS in Computing will be the initial and central part of the SoC curricula, and form the backbone for multiple minors. The BA/BS in Computing will be distinctly different than those in CS or ECE at UW, and thereby enable UW to serve a more diverse set of students.

The BS and BA programs will be more fully developed during the first 18 months of the SoC and informed and developed by SoC hires and the SoC Curricular Advisory Committee, and be symbiotic with the "new" CS/ECE BS and graduate programs.

It is anticipated that all Computer Science related degrees at UW will share a highly common first year which will aid in recruiting, advising, costs, and most importantly give students the opportunity to discover their own areas of interest within computing.

Characteristics of the proposed undergraduate degrees in computing are described in Table 1. Table 2 gives the basic structure of UW's existing BS in Computer Science. and of the proposed BS and BA degrees in Computing.

**Characteristics of the BA and BS programs in Computing**

**Focus on "computing in context."**
This is the use of computers and related technologies to study complex real-world problems. This will require students to develop disciplinary expertise as well as computing expertise.

**Common set of beginning courses to allow students to explore.**
First year courses will be designed with CS/ECE and other units as an on-ramp to expose students to the power of computing through diverse applications, practical and broad aspects of the development and use of application, and various career tracks in computing. The remainder of the curricula will be designed to offer many possible pathways to students, and to provide a platform for future minors from other disciplines to be offered.

**Competency-based.**

### Competency = Knowledge + Skills + Dispositions… in Context

Following trends supported by educational research and best practices in leading computing program, the curriculum will be designed around competencies and domains, that is, a curriculum that "focuses on an individual's capability to perform and to apply their computing education in a practical and professional service to society. A curriculum founded on students Knowing what, Knowing how and Knowing Why. [CC2020]

"Competency-based curricula provide more pathways for students, the ability to quickly adjust to curricula to cover emerging topics, and provide the ability to "promote and clearly describe the practical benefits of computing programs to stakeholders: students, parents, employers, corporate partners, donors." [CC2020]

Core competencies (e.g. problem-formulation and solving, interpersonal, management and entrepreneurial skills, ethics, collaborating, communicating, working in interdisciplinary and multicultural teams), technical competencies (e.g. DevOps, Software Development, Data Wrangling, Modelling, Technical Writing), and advanced competencies in selected areas of contemporary computing (e.g. Security, Artificial Intelligence, Internet of Things, FinTech, Contemporary Database & Interfaces, Design Tools, Human Computer Interactions) for the programs will be identified as required elements.

Each course offered by the SoC, and its partners including timely topics courses) will have an associated approved list of competencies. Students can master core competencies in different ways based upon their interests and their strengths. Over next year, a list of core competencies will be developed through consultation with an external advisory board, and a SoC Curriculum Advisory Committee that will include representatives from disciplines across UW, and from Wyoming companies.

**Quantitative skills for computing.**
Appropriate Mathematics and Statistics concepts will either be offered within existing quantitative courses, embedded within new SoC courses, or offered in freshly designed courses for SoC majors in mind. Different tracks within quantitative offerings will be available for students with different career interests.

**Experiential and collaborative learning.** This will be emphasized through class projects, internships, externships and senior design projects.

**Table 1. Characteristics of SoC undergraduate programs**

|  | BS in Computer Science | BS in Computing | BA in Computing |
|---|---|---|---|
| **USP outside major** | 18 hours | 18 hours | 18 hours |
| **Quantitative** | 18 hours Calculus based | 15 hours math/stats for computing (modeling, optimization and data) | 9 hours math/stat for arts/humanities/social science applications of computing |
| **Math Science electives** | 12 hours | | |
| **CS core** | 42 hours | 16 hours | 16 hours |
| **SoC core competency courses** | | 12 hours (Computing in context, experiential and project based)) | 12 hours (Computing in context, experiential and project based)) |
| **Disciplinary concentration** | | 12 hours (in agriculture, science , math, statistics or engineering) | 18 hours (in education, arts, humanities, social sciences) |
| **CS electives** | 12-21 hours | | |
| **General electives** | 15 hours | 12 hours | 12 hours |
| **SoC advanced competencies based on interests** | | 15 hours | 15 hours |
| **SoC electives** | | 12 hours | 12 hours |
| **Capstone project** | | 8 hours | 8 hours |
| **Total hours** | 120-128 (depending on concentration) | 120 hours | 120 hours |

**Table 2. A comparison of the different bachelor's programs.**

## 4. Anticipated enrollment in BA/BS programs

The following quote (emphasis added) from the recent report [NAS2018] help frame this discussion.

> The demand for employees with computer science and computing expertise is high and has grown steadily over time. According to data from the Bureau of Labor Statistics (BLS), employment in computer occupations grew by nearly a factor of 20 between 1975 and 2015, nearly twice as fast as production of CIS bachelor's degrees. BLS has projected that **demand for computer science workers will continue to grow over the next decade at a rate higher than that of overall job growth, particularly as computing becomes more central to a wider range of industrial sectors.** Employment demand is particularly intense in some specialty areas, including cybersecurity, data science, and machine learning.

Estimated enrollments for the BS in Computing program given in Table 3 are based on the above report and the data from market research performed by EAB. It is anticipated that enrollments for the BA in Computing program would be similar. Once the BA and BS programs are more fully designed, a market analysis, as well as an evaluation of credential design and curricular recommendations for both programs will be performed.

Estimating enrollments is difficult for the following reasons: we are envisioning programs that have unique components (e.g., a focus on computing in context of applications and interdisciplinarity) and which include emerging areas (e.g., data science) that are too young for EAB or the Bureau of Labor Statistics to include in their analyses. Additionally, the analyses tend to be too broad geographically to capture need in Wyoming and may underestimate demand for new types of occupations. Members of the committee that developed this report, indicate that they have

frequent inquiries from companies in Wyoming about the availability of computing savvy graduates, and that often we are unable to meet their needs. The growth in small tech companies in Wyoming will only increase this demand. In addition to the demand in the marketplace for these types of graduates, there is also a demand among UW students for more opportunities to learn value-added computing skills. It is felt that the estimates are realistic, and perhaps on the conservative side, based on the available data.

| 2023-2024 | 2024-2025 | 2025-2026 | 2026-2027 |
|---|---|---|---|
| 36 | 66 | 91 | 116 |

**Table 3. Estimated enrollments in BS in Computing in first 5 years of program**

We note that in 2019, there were 262 CS majors, and 243 ECE majors. Combining the estimated BA and BS in Computing programs, we estimate the SoC will have around 232 undergraduate majors five years after the program is started.

SoC's education impact down the road will also reach a large number of students (in the range of 240) through computing minors (there are at least 6 departments already considering minor programs). Through its role as champion for "digital for all" the SoC will impact every undergraduate at Wyoming. The demand for these will be evaluated as the programs are developed and proposed.

5. **Budget Narrative and existing or new resources required to deliver the Academic program**

A detailed five year/two-phase plan for the roll-out of the SoC and its associated programs is given in Pages 21-29 of the SoC Preliminary Plan. Table 4 below gives the projected expenses. The full version of this table was presented to the Trustees in their July 2021 meeting. Some notes are the following.

- There are some differences between this table and budget presented in the preliminary SoC plan, and the notice of intent. This is due to a combining of Phase 0 (the initial 6 months) and Phase 1, The budget below should be taken as the formal proposed budget.

- UW administration has identified several possible funding sources for the SoC, including America Recovers Program (ARP) funding for one-time costs. The details of how the State will distribute ARP funding are still being discussed. Thus, details of funding sources for the SoC are not provided at this time. Once the ARP funding and other infrastructure funding is settled, the UW administration will provide a detailed fiscally solid plan for where the SoC funding for its first 5 years comes from.

At the end of five years the plan targets having the following levels of personnel and programs:

- Dean
- 2 Associate Deans (one devoted to curricula, Digital for All efforts, and programs with community colleges, and one devoted to industry/research lab partnerships and workforce and economic development.
- 1 business manager, 1 office manager, 1 workforce development lead, 1 special projects lead
- a position devoted to working with community colleges
- 21 faculty (3-4 being existing faculty, remaining will new hires with joint appointments in other departments)
- 4 research scientists (it is expected that another 4-5 research scientist will be supported by external grants secured by SoC faculty and research scientists)
- 27 graduate assistants.
- Operating budget
- Start-up funds to be devoted to equipping specialized labs for students, or special computing equipment
- A Visiting Faculty Program
- A Computing Scholars Program for undergraduates

Total projected costs at the end of year 5 are $10.4 M per year.

The following should be noted:

- o   The projected costs are the anticipated all-in costs, and include programmatic elements such as a scholarship fund for undergraduates, and a visiting scholar program;
- o   The targeted size of the SoC is designed to ultimately support the planned MS, MA and PhD programs, as well as aggressive research programs.
- o   To encourage collaborations, help support departments, all SoC faculty will be joint hires with other departments.
- o   All SoC faculty and research scientists will have significant expectations for securing external funding through grants and corporate partnerships; by the end of 5 years SoC faculty and research scientists should bring in an additional $7.5 M/year in external funding.
- o   As with other such schools or centers, the SoC should provide excellent opportunities for investments from corporations, and individuals. Fund-raising to support SoC programs will be a priority of the SoC administration and faculty.
- o   The SoC will work closely with the UW Search Equity Advisors initiative to ensure that the net is cast wide to encourage a large pool of talented diverse candidates.

| EXPENSES | | | FY22 | FY23 | FY24 | FY25 | FY26 |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Administration | | | 934,760 | 934,760 | 1,743,450 | 1,743,450 | 1,743,450 |
| Faculty Compensation | | | 319,500 | 1,739,500 | 3,017,500 | 3,656,500 | 4,295,500 |
| Start-up Funds | | | 900,000 | 3,500,000 | 3,000,000 | 1,500,000 | 1,500,000 |
| Visiting Faculty/Computing Scholars | | | 500,000 | 660,000 | 740,000 | 570,000 | 570,000 |
| Research Scientists | | | 426,000 | 639,000 | 852,000 | 852,000 | 852,000 |
| Graduate Research Students | | | 168,034 | 436,889 | 672,137 | 806,564 | 907,385 |
| Operating expenses | | | 300,000 | 375,000 | 500,000 | 500,000 | 500,000 |
| TOTAL | | | 3,548,294 | 8,285,149 | 10,525,087 | 9,628,514 | 10,368,335 |
| | | | | | | | |
| Funding sources (TBD once ARP, WIP funding is settled) | | | | | | | |

| Student Tuition | | | | 192,000 | 350,000 | 728,514 | 768,335 |
|---|---|---|---|---|---|---|---|

**Table 4. Projected expenses, and tuition revenues for first 5 years**

## 6.   Timeline for implementation

A detailed five year/two-phase plan for the roll-out of the SoC and its associated programs is given in Pages 21-29 of the SoC Preliminary Plan. The timeline for the development and roll-out of the BS and BA computing majors is given in Table 5.

| Spring 2022 | Interim Dean and Associate Deans, and initial SoC faculty will create a Curriculum Advisory Committee that includes international experts in computing education, UW alums using computing in their careers, Wyoming tech companies, UW CS/ECE and Math-Stat faculty to design the courses for the BA/BS. |
|---|---|
| Fall 2022-Spring 2023 | Offer a few trial SoC undergrad courses, fully develop other SoC courses, secure accreditation of BA/BS program, and work through UW's CARF process for pertinent courses, establish 2+2 agreements with Wyoming Community Colleges, recruit first class of SoC undergraduates. |
| Fall 2023 | Enroll inaugural SoC class of undergraduates |
| Fall 2023 and Spring 2024 | Design, develop and seek approval to offer MS and PhD programs in Computing.<br><br>Evaluate, assess and make needed modifications to BA/BS programs.<br><br>Work with other UW programs on developing computing minors. |
| Fall 2024 | Enroll inaugural SoC class of graduate students |
| Spring 2027 | Graduate first SoC class |

**Table 5. Project timeline of SoC roll-out**

7. **Plan to assess the Academic Program**

   Assessment of the proposed BA and BS programs will be based on student attainment of core competencies that outline in Section 3, the learning objectives described in Section 8, and informed by the SoC Educational Board and the studies such as "Computing Curricula 2020" [CC2020].

   Specific assessment activities for the BA/BS programs will include:
   - Pre- and post-degree exams on core and technical computing competencies
   - Capstone course with assessment of final projects, including collaboration, critical thinking and communication;
   - Feedback from corporate and educational partners involved in internships or capstone projects
   - Surveys with Wyoming companies employing SoC graduates
   - Student course evaluations
   - Exit interviews with graduates

8. **Plans for accreditation**

Accreditation for the program will be established through the Higher Learning Commission (HLC), and informed by a SoC Curricular Advisory Committee. In order to enable to train a more, diverse student population in computing the BS/BA programs will not be ABET accredited–ABET accreditation is more restrictive on the disciplinary courses (e.g. must be science oriented) and the mathematics and statistics courses than the envisioned SoC programs. The SoC programs are not intended to be less rigorous, but to have more options in disciplinary content, and have mathematics and statistics courses more aligned with students' interests and with the computing classes. Students desiring an engineering degree can pursue a BS from the ABET accredited program in CS/ECE, and if desired use their elective courses to take courses in the SoC.

Tentative learning outcomes are:

- **Outcome 1 – Communication:** Students will be able to communicate in written and oral forms in such a way as to demonstrate their ability to work with a variety of stakeholders, and to present information clearly, logically, and critically.
- **Outcome 2 – Application:** Students will be able to utilize and modify state-of-the-art computing tools and concepts to explore and analyze disciplinary problems

- **Outcome 3 – Coding:** Students will be able to code efficient programs on their own to model phenomena.
- **Outcome 4 - Depth of Knowledge**: In a selected domain/concentrations students will demonstrate a depth of knowledge appropriate to graduate study and/or lifelong learning in that area. Students should be able to read for understanding materials in that area beyond those assigned in coursework.
- **Outcome 5 - Preparation for Career and Further Education**: Students will be prepared for a career in industry, government agencies or non-profits or for graduate study in scientific or technical fields.

Continuous improvement of the program will be fostered through annual presentations and feedback with the SoC Curriculum Advisory Committee.

## 9. Benefits of the Academic Program to the University

The proposed School of Computing will position Wyoming's 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 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.

## 10. The ability of the University to carry out the Academic Program

UW is positioned well to successful carry out this academic plan, as it will build upon past investments, existing strengths at UW, and can take advantage of many pending opportunities (such as the planned large increases of funding at national agencies, American Rescue Program funding, the Wyoming Innovation Partnership, new technologies and businesses around blockchain, and enhanced corporate partnerships around technology). The new BA/BS curricula will leverage partnerships and in particular in the co-development and delivery of courses whenever possible. The "Digital for All" program is envisioned to be a central part of a newly crafted University Studies Program.

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). These strengths will support the interdisciplinary, computing in context focus of the SoC.

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. The SoC will benefit from as well as greatly strengthen this existing computational ecosystem

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 SoC, along with the broader Digital Pillar plan, outline a strategic response to the computational-related needs of UW and Wyoming Community College students, Wyoming's business and agencies. 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 Partnership.

**11. The likely value to, and impact on, students and residents of Wyoming.**

The BA/BS in Computing will produce professionals fluent in the computing/digital arena. UW graduates interacting with the SoC via interdisciplinary initiatives with departments will benefit from knowledge and experience of the application of computing in their chosen domain, equipping them to be perceptive and cognizant graduates with experience in innovative applications of computing – and thus competitive in the workplace. Specific outcomes for the BA/BS degree are given in Section 8.

The SoC undergraduate programs will provide Wyoming companies and agencies with employees who identify problems (or opportunities for improvement, and successfully bring to bear computing and technology to re-solve the problem  (or help the company or agency advance through seizing the opportunity).

Citizens of Wyoming can from having SoC graduates helping agencies analyze complex problems (e.g. wildfire management, rural health, etc)  of importance to local communities and to Wyoming.
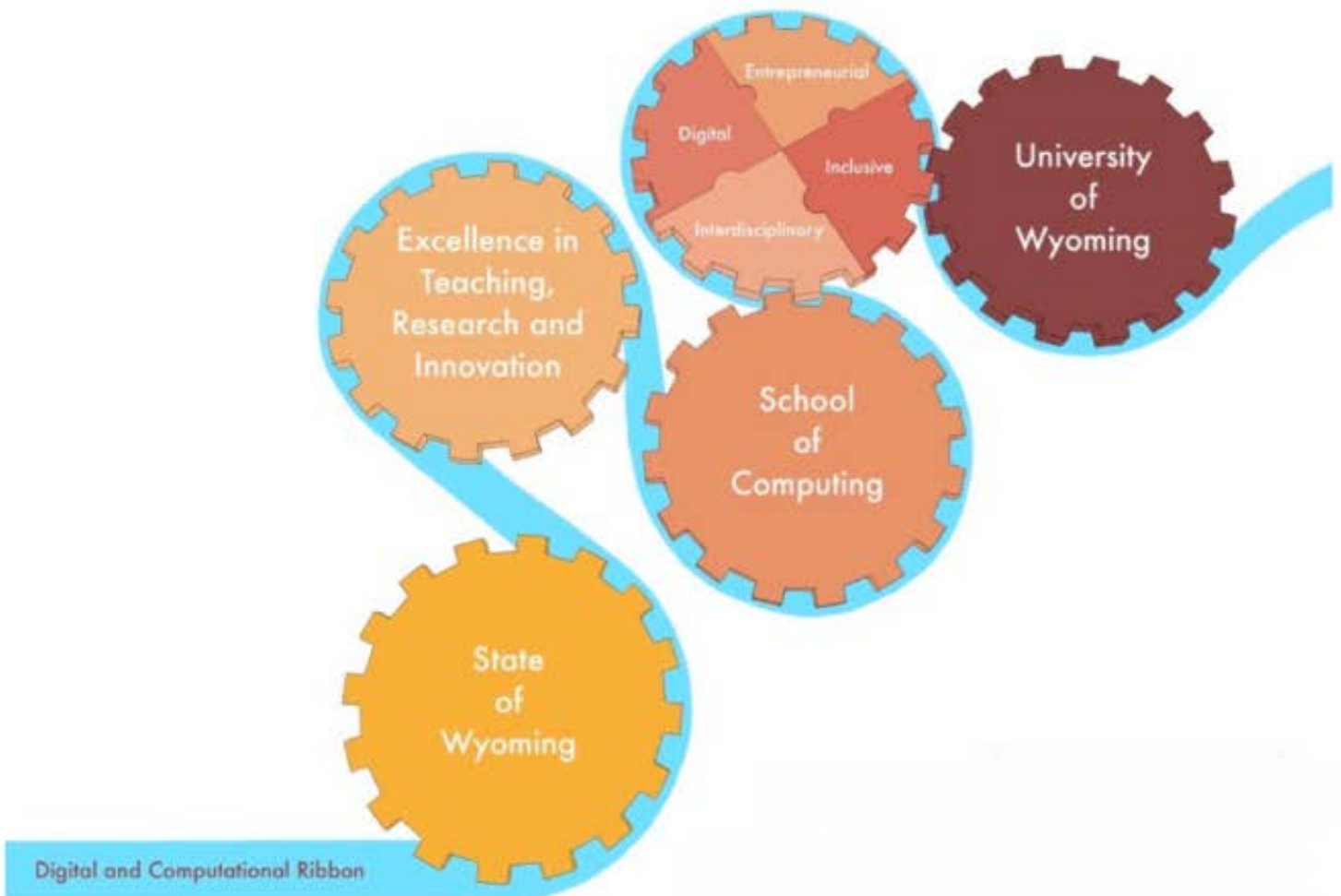
## References

[ABET20] Criterion for accrediting computing programs 2020-2021.
https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-computing-programs-2020-2021/

[CC2020]:  *Computing Curricula 2020 (CC2020): Paradigms for Global Computing Education*, IEEE and ACM joint report, March 2021.
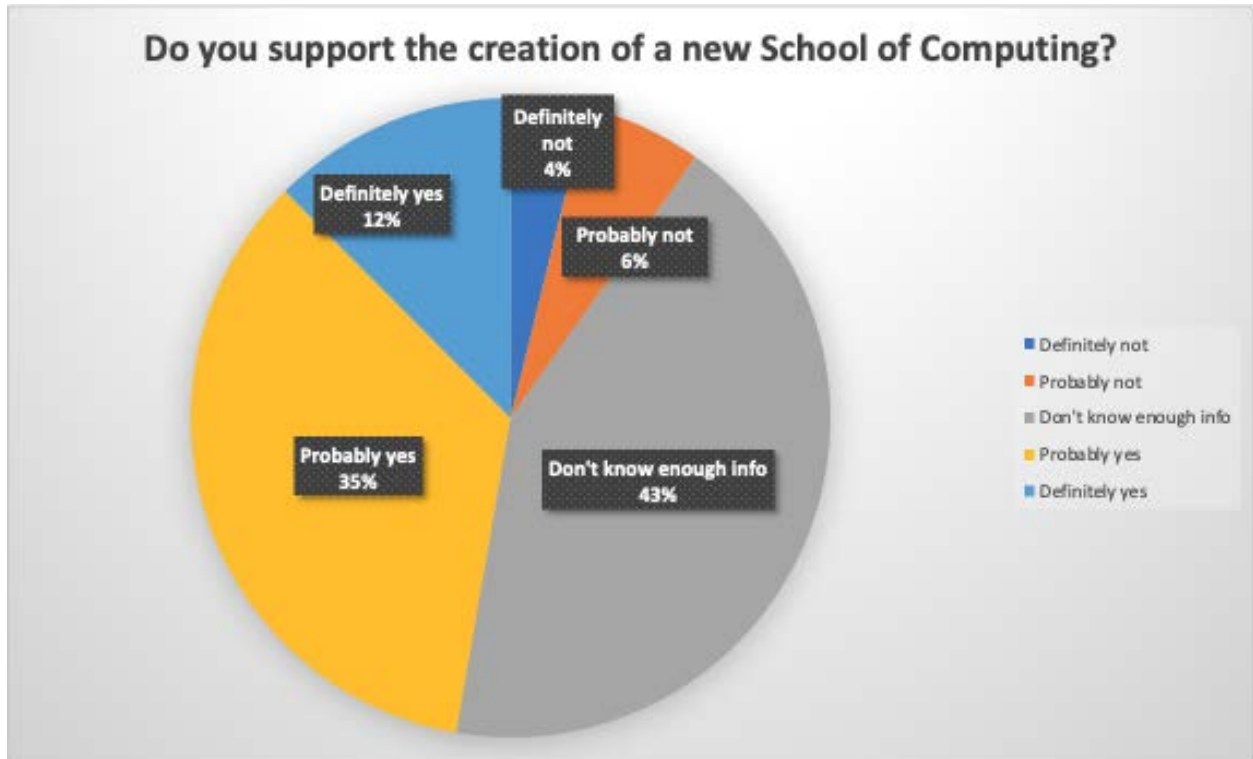
[NAS2018] Assessing and Responding to the Growth of Computer Science Undergraduate Enrollments, The National Academies Press, 2018.

[S20] E. Seidel, "Thoughts on a Broad Vision for Computing in UW and Wyoming", Fall 2020.

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.

**Addendum B**



Do you support the creation of a new School of Computing?

- Definitely not 4%
- Probably not 6%
- Don't know enough info 43%
- Probably yes 35%
- Definitely yes 12%

**Addendum B**

<div align="center">

**SENATE RESOLUTION #2765**

</div>

| | |
|---|---|
| **TITLE:** | ASUW's Updated Recommendation Regarding the Creation of a School of Computing |
| **DATE INTRODUCED:** | November 30, 2021 |
| **AUTHORS:** | President Swilling and Director of Governmental and Community Affairs Brown |
| **SPONSORS:** | Senators Castronovo and Smith; Vice President Anderson |

1. WHEREAS, the purpose of the Associated Students of the University of Wyoming

2. (ASUW) Student Government is to serve our fellow students in the best manner

3. possible; and,

4. WHEREAS, the creation of a School of Computing (SoC) was proposed to the

5. University of Wyoming; and,

6. WHEREAS, according to the University of Wyoming's SoC Preliminary Plan the vision

7. of the SoC is "to create a unique and inspirational School of Computing with national

8. impact and global reach, providing Wyoming and the world with agile and ethical

9. professionals, empowered to address societal challenges that are inherently

10. interdisciplinary;" as stated on page one (1) of the Request for Authorization (RFA)

11. (Aug. 2021) for the SoC as shown in Addendum C; and,

12. WHEREAS, the ASUW passed SR #2757 "ASUW's Recommendation Regarding the

13. Creation of a School of Computing" unanimously on October 19, 2021; and,

14. WHEREAS, SR #2757 states, "be it resolved that the

15. Associated Students of the University of Wyoming (ASUW) Student Government

16. understands and supports the vision of the University of Wyoming School of

17. Computing as outlined in both the Preliminary Plan and the Request for

18. Authorization; and, … be it further resolved that although the ASUW supports this

19. vision, the ASUW cannot support the creation of a School of Computing as outlined in

20. the Preliminary Plan due to lack of clarity [in] proposed execution strategies, lack of

21. communication and transparency with the UW community, and exorbitant additional

22. cost in a time of significant budget reductions; and, … be it further resolved that the

23. ASUW will offer support for the creation of this school once communication increases,

24. transparency is seen, alternatives have been transparently assessed, and

25. the aforementioned concerns have been addressed."; and,

26. WHEREAS, the ASUW Ad-Hoc Restructuring Committee after the passing of this

27. resolution was invited to meet with President Seidel; and,

28. WHEREAS, when meeting with President Seidel, the committee posed the concerns

29. voiced in SR#2757; and,

30. WHEREAS, the ASUW Ad-Hoc Restructuring Committee presented President Seidel

31. with additional concerns to be addressed; and,

32. WHEREAS, President Seidel engaged in repeated discussions to alleviate concerns and

33. clarify areas of uncertainty that were voiced about the SoC in SR #2757; and,

34. WHEREAS, members of the ASUW Ad-Hoc Restructuring Committee continued

35. to meet with President Seidel and SoC stakeholders to address concerns; and,

36. WHEREAS, President Seidel responded to aforementioned concerns in a letter to the

37. ASUW as seen in Addendum A; and,

38. WHEREAS, the updated RFA (Nov. 2021) as shown in Addendum B addresses previous

39. concerns from SR #2757 and the ASUW Ad-Hoc Restructuring Committee including the

40. following changes:

41. SoC to be "incubated" in the College of Engineering & Applied Science, SoC

42. certificates and minors, communication with the student body regarding SoC, state-

43. funding for SoC, and the joint SoC faculty hiring process; and,

44. WHEREAS, the RFA (Nov. 2021) provides further explanations and clarifications from

45. the original RFA (Aug. 2021).

46. THEREFORE, be it resolved the Associated Students of the University of Wyoming

47. (ASUW) Student Government now deems it appropriate to support the

48. creation of a School of Computing (SoC) as it is detailed in the Request for Authorization

49. (RFA) (Nov. 2021) due to changes to the SoC RFA (Aug. 2021) that adequately address

50. the concerns of students and ASUW; and,

51. THEREFORE, be it further resolved the ASUW will continue to work with President

52. Seidel and relevant stakeholders to ensure the development of the SoC is sufficiently

53. communicated to students and will be created with intentions for the betterment of

54. academic development and opportunities for all students at the University of Wyoming.

**Referred to:** Ad-Hoc Restructuring; Advocacy Diversity and Policy; Program and Institutional Development

**Date of Passage:**                       Signed:

                                       **(ASUW Chairperson)**

**"Being enacted on**                        , I do hereby sign my name hereto and

**approve this Senate action."**

                                  **ASUW President**

**Addendum A**

# UNIVERSITY OF WYOMING

November 17, 2021

Associated Students of the University of Wyoming
Electronic delivery: ASUWPRES@UWYO.EDU

President Swilling and members of the ASUW on Restructuring,

Let me begin by thanking you for your willingness to have a sequence of discussions around the School of Computing, and more generally the UW re-organization. Your thoughts and comments were well-thought out, and catalyzed useful discussions that ultimately have improved the plans.

Each paragraph below addresses one of the areas of concerns laid out in your document provided to the SoC planning committee on November 11. References are to the revised Request for Authorization that was provide to you on November 10.

As indicated on page 2, paragraph 2, the SoC will be initially be "incubated" in an existing college, most likely the College of Engineering and Applied Sciences. I believe that this will enable a coordinated development of the SoC and further strengthening of the CS/ECE department.[1] Cam Wright, Dean of CEAS, is willing and in agreement with the benefits of this arrangement.

To benefit UW students as quickly as possible, the SoC's initial curricular efforts will be on shoring up UW's existing computing offerings, developing valued-added certificate courses, and working with departments to develop computing minors (see page 2 paragraph 5. 8 and 9; page 5 paragraph 3, Page 12, table 5

My office is committed to strengthen communications with the UW student body. In particular, my office is working with ASUW's Media office to produce a podcast around UW's new initiatives and the reorganization. My office is also working to schedule monthly events starting next semester where I can informally chat with students about on-going activities at UW and listen to their ideas about how to improve UW and their collegiate experience.

UW leaders presented a Q&A session just for students around the new initiatives: Center for Entrepreneurship and Innovation, School of Computing, Wyoming Innovation Partnership, and the Wyoming Outdoor Recreation Tourism and Hospitality initiative on October 28. Video of this is available at:

https://wyocast.uwyo.edu/WyoCast/Play/52ac1cd293174ab9a00cc74320154b0b1d?catalog=b3edf27df1a34752b149e95d7c7dd95621

Funding for these initiatives totals $5.5M/year, and this past summer the Governor and I agreed to target these funds towards strategic areas that would help the State of Wyoming, UW students, and UW faculty. Of this $3M/year has been targeted for the School of Computing (page 2, paragraphs 3-4, and the yearly budget on page 12).

In its first four years, the SoC plans to hire 8-10 faculty and 2-3 research scientists. To promote interdisciplinarity and to enhance the impact of the SoC across campus, each of the SoC faculty will have a joint appointments with a disciplinary department. Their primary appointment will be in the SoC. UW regulation 2-1 outlines how joint appointments function at UW. The affected departments for each SoC faculty member will develop an MOU regarding how the joint appointment will be handled, Joint appointments are not uncommon at UW; e.g. faculty in the School of Energy resources, and other interdisciplinary faculty have joint appointments. I do note that with the SoC, many of the teaching responsibilities may easily serve both the SoC and the disciplinary department; and thus joint appointments within the SoC should be fairly easy in regards to a faculty's teaching.

I and my office look forward to continuing to work with ASUW and UW students on important initiatives like the School of Computing.

Sincerely,

Ed Seidel
President

# Addendum B

The vision of the School of Computing (SoC) is ambitious!  Through the SoC, UW envisions forging new trails that will enable UW to become **a national leader in education, engagement and research**.

The SoC will be a hub of innovation and knowledge exchange providing UW students, faculty and Wyoming businesses and citizens with a **"backpack" of computational tools and approaches to drive transformation**.

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

## 1. Introduction

This document is an updated Request for Authorization (RFA) to establish a School of Computing (SoC) at the University of Wyoming. It differs from the RFA submitted in early September in the following ways;

   a. To minimize costs and administrative burden, it is proposed that the SoC initially be "incubated" in an existing college. Dean Wright and others have suggested the College of Engineering and Applied Sciences. This can aid in a coordinated development of the SoC and further strengthening of the CS/ECE department.[1] Efforts will need to be made to make sure that the SoC fulfills its campus-wide role of championing the "Digital for All" program during this incubation stage.

   b. A complete budget for the first four years based solely upon the $3M internal funds targeted for the SoC is given. The annual on-going operating budget at the end of the four years is $3M/year, and the total costs, which include one-time costs, over the four years is $12M.

   c. The budget is designed to maximize benefits to student programs and faculty while minimizing administrative costs. The first four years focus on the creation of state-of-the art applied computing labs, joint hires with existing UW departments, and new faculty affiliate programs that catalyze deep inter- and cross-disciplinary collaborations.

   d. The curricular aspects will initially focus on enhancing and supporting UW's existing computing offerings, while developing valued-added certificate courses, and working with departments to develop computing minors, and working to help develop a Digital for All component in the new USP. As student and faculty needs evolve BA and BS curriculums focused on applied computing can be developed in collaboration and in support of other campus units. Initial offerings will be prioritized in collaboration with ASUW and with the community colleges.

The long-term vision for a highly inclusive SoC remains a central tenant to the proposed plan. The SoC will
   e. be a cross university school with joint appointments possible with any department UW,
   f. have robust, multiple pathway degree programs at both the graduate and undergraduate level,
   g. leverage partnerships with UW's corporations, national labs, and UW entities,
   h. ultimately be a separate unit led by a dean (to be recruited internationally).

The long-term vision includes programs and positions that are not in the initial $3M annual budget. These, and plans for how to include these as the SoC is developed are given in Appendix 1. Such positions and programs will only be added when funding is available.

During the incubation period, the SoC curricular activities will focus on identifying and offering needed courses and certificate programs, working with ECE/CEAS and Wyoming's Community Colleges to develop and deliver an engaging, first three semester sequence of courses for students interested in majoring in a computing related program, and partnering with departments to create computing minor programs. Then the SoC will study, and if desirable develop, BA/BS programs in computing. This request describes characteristics of the envisioned BA and a BS degree in Computing. These degree programs will be developed in years two and three of the SoC and informed by new hires and a SoC Curriculum Advisory Committee that will include faculty from UW and experts from outside UW.

Additionally, a description of the SoC's leadership role in the campus-wide effort to make UW more digital is given. All curricular programs (e.g., minors, MA, MS, and PhD degrees in Computing) will follow the approval process at the appropriate times in coming years.

This RFA references

a) A **feasibility study and market analysis** on the BS in Computing Degree from the Education Advisory Board (EAB). While no new degree program is being requested at this time, the study does provide some idea of the need for such programs.

b) The **School of Computing Preliminary Plan** provides a detailed description, analysis and tentative budget for all aspects (Educational, Economic and Workforce Development, Research, Partnerships, and enhanced funding opportunities).

Note that the preliminary plan is a visionary plan. The incubation period will be first steps towards this vision, with an emphasis on hiring high-quality faculty, recruiting UW faculty affiliates, and offering value-added courses for UW students. Reaching this vision will require a mix of additional funds (endowments, philanthropy, grants and indirect costs returns, corporate partnerships, joint hires)

c) The **Notice of Intent** and the accompanying presentation to the Board of Trustees.

d) The **Digital Pillar Report** prepared in Spring 2021 by a committee of 19 UW faculty, staff and students at the bequest of the UW Provost that gives a broad overview of the need, the benefits and suggest actions for UW to become more digital.

e) **Various reports** from national organizations and think-tanks on the need for computing.

For convenience each of these is included in the package for this request, or can be accessed via the link: supporting files.

## 2. Purpose and need for the proposed SoC Academic Programs

The following quotes from two recent studies summarize the overarching needs for the proposed academic programs at UW.

> Computer science and information technologies have transformed all sectors of society, businesses, and government. Today, the transformation continues and much is driven by artificial intelligence, robotics, the Internet of Things, information security, and data science. A wide range of jobs in virtually all sectors demand computing skills to an unprecedented extent. And every academic discipline finds itself incorporating computing into its research and educational mission. [NAS 2018]

> Computing is and will continue to be an essential component in shaping the future for humanity. The computing disciplines need to attract quality students from a broad and diverse cross-section of the public and prepare them to be capable and responsible professionals. [CC2020]

These needs are even deeper at UW. Because of limited staffing and resources in UW's Computer Science department, computational education and research is far below that of our peers, and the needs of UW graduates.[2] Broader access to innovative research, world-class infrastructure and workforce training in computing and data is therefore critical for Wyoming citizens, and most importantly for UW's students.

The primary purposes of the SoC curricular programs are to

- **provide more students with career pathways that utilize** the power of computing and technology,
- provide new opportunities to **increase the diversity among UW students utilizing computing** in their disciplines and careers, and
- establish **a pipeline of tech-savvy graduates for Wyoming's and the global economy**.

---

[2] It is important to note the scale that is needed for UW to have impact, and what is common across the nation. UW's current CS department has 7 professors (only 1 with an AI specialty) and the Advanced Research Computing Center (ARCC) has 4 current staff. Comparing relative sizes of CS departments is only one, very limited indicator, but it does give a sense of where UW is. Boise State, about twice UW's size, has 26 CS professors and plans to double in size. Notre Dame, a predominantly humanities and social sciences university, is almost exactly UWs size and has more than 4 times our CS faculty, and a unit like our ARCC with over 50 staff (almost entire funded on soft money through grants). In all cases these activities are a foundation for economic development in their region. [S20]

Additionally, the SoC will provide UW researchers with new tools and cutting-edge computational expertise to better address grand challenge problems of importance to Wyoming and region that they are studying, and serve as a hub for Wyoming's innovation economy.

### 3. Proposed curriculum

The SoC is envisioned to house the following academic programs in the long-term:

- Certificate programs, possibly stackable, in various aspects of computing
- Minors in computing
- Multi-pathway BA and BS programs in computing,
- MA/MS/PhD in Computing.

When feasible, all parts of the curricula will be offered online. The SoC will also work with Academic Affairs to help champion an envisioned "Digital for All" component of the USP.

The initial ideas of these programs are more fully discussed in the SoC Preliminary Plan, and the Digital Pillar report. The full development of these programs will involve Academic Affairs, Faculty Senate, the Graduate Council, the USP committee, faculty and students, and will be overseen by a SoC Curriculum Advisory Committee. All programs will be greatly informed by the recently released report "*Computing Curricula 2020: Paradigms for Global Computing Education* [CC2020] that was developed by a 50-member task force drawn from 20 countries, CC2020 outlines international recommendations for baccalaureate degrees in computing.

All programs will be fully evaluated and follow the process for approval and creation of new academic programs.

We briefly describe each of the envisioned curricular programs.

**Digital for All Experiences.**

The Digital Pillar report recommends that the university community consider the creation of a "digital course" requirement in the University Studies Program for all students. Their reasoning is that it is important that all UW undergraduate students learn how digital and computational methods/tools/approaches are increasingly part of their chosen discipline and all aspects of life. At a general level, students should be exposed to the variety of ways that digital tools can be used to accomplish task (many of them are 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 gain understanding of how to analyze the human, social and scientific impacts the existence and use of these tools bring. At a specific level, students 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.

**Minors in Computing.**

> Job prospects likely also contribute to the demand for CS courses from non-majors, but this portion of the enrollment increase is also driven by the impact of CS and computing in other fields. Computer science and its related endeavors such as data science have produced powerful tools and software systems that are used by and affect every discipline, giving rise to exciting subfields, such as computational biology, computational economics, computational chemistry, and digital humanities, with more emerging. These subfields require expertise in the traditional domain and a general fluency in tools and methods from computer science. The advantages of a deeper knowledge of computer science in many domains has also led to the recent emergence of new degree programs at several institutions that fuse curricula and formal requirements of CS with those for one of a range of disciplines (referred to as "X+CS"). [NAS 2018}

As the above quote indicates, increasingly students in many disciplines find great value-added in incorporating computing classes into their studies. Having disciplinary minors in computing will give UW Alums a competitive advantage throughout their careers, catalyze working partnerships between UW departments and the SoC faculty, and

will be a valuable recruiting tool for students, graduate students and faculty. All minors will be vetted and submitted through approval through the standard UW processes.

**Certificates, Possibly Stackable, in Digital/Computing.**
Even a couple of classes in a particular area can add excellent value to a student's education and their employability. The Digital Pillar Report describes the emerging mechanisms of certificates and stackable certificates in higher education. The SoC envisions partnering with entities like the CS/ECE department, Data Science Center, WyGISC, Ellbogen Center, Visualization Center, Innovation Wyrkshop, Advanced Research Computing Center and UW Libraries to explore the feasibility of developing suites of (possibly stackable) certificate courses that enable a diverse audience of students, including non-traditional students and life-long learners, the opportunities to gain specific 21-st century skills through short-courses, self-paced courses with competency exams.

Based on input from students, the value-added courses, certificate programs and computing minors will be the initial focus of the SoC's curricular efforts.

**Multi-pathway BA and BS Programs in Computing.**
The BA and BS in Computing will ultimately be central to the SoC curricula. The BA/BS in Computing will be distinctly different than those in CS or ECE at UW, and thereby enable UW to serve a more diverse set of students.

It is anticipated that all Computer Science related degrees at UW will share a highly common first year which will aid in recruiting, advising, costs, and most importantly give students the opportunity to discover their own areas of interest within computing.

Appendix 3 gives a proposed basic structure of UW's existing BS in Computer Science. and of the proposed BS and BA degrees in Computing.

**Graduate degree programs.**
After the SoC is stably established, it will evaluate the addition of MA and MS degrees in Computing. The focus on these programs will be the creation and use of innovative computing tools in the context of grand challenge problems in a wide range of disciplines. Desired characteristics of these programs will be diversity of student body, various academic pathways for entrance, collaborative projects involving different disciplines and stakeholders, ties through internships/externships with Wyoming and regional companies. A PhD in Computing will be studied and considered in years 4 and 5; other Schools of Computing support robust PhD programs through corporate partnerships, external funding, and partnerships with national labs. Initially, the graduate curricula will be operated using existing programs in the ongoing Interdisciplinary Graduate Minor in Scientific Computing.

**Characteristics of SoC curricula**

**Focus on "computing in context."**
This is the use of computers and related technologies to study complex real-world problems. This will require students to develop disciplinary expertise as well as computing expertise.

**Common set of beginning courses to allow students to explore.**
First year courses will be designed with CS/ECE and other units as an on-ramp to expose students to the power of computing through diverse applications, practical and broad aspects of the development and use of application, and various career tracks in computing. The remainder of the curricula will be designed to offer many possible pathways to students, and to provide a platform for future minors from other disciplines to be offered.

**Competency-based.**
**Competency = Knowledge + Skills + Dispositions… in Context**

Following trends supported by educational research and best practices in leading computing program, the curriculum will be designed around competencies and domains, that is, a curriculum that "focuses on an individual's capability to perform and to apply their computing education in a practical and professional service to society. A curriculum founded on students Knowing what, Knowing how and Knowing Why. [CC2020]
    "Competency-based curricula provide more pathways for students, the ability to quickly adjust to curricula to cover emerging topics, and provide the ability to "promote and clearly describe the practical benefits of computing programs to stakeholders: students, parents, employers, corporate partners, donors." [CC2020]
    Core competencies (e.g. problem-formulation and solving, interpersonal, management and entrepreneurial skills, ethics, collaborating, communicating, working in interdisciplinary and multicultural teams), technical competencies (e.g. DevOps, Software Development, Data Wrangling, Modelling, Technical Writing), and advanced competencies in selected areas of contemporary computing (e.g. Security, Artificial Intelligence, Internet of Things, FinTech, Contemporary Database & Interfaces, Design Tools, Human Computer Interactions) for the programs will be identified as required elements.
    Each course offered by the SoC, and its partners including timely topics courses) will have an associated approved list of competencies. Students can master core competencies in different ways based upon their interests and their strengths. Over next year, a list of core competencies will be developed through consultation with an external advisory board, and a SoC Curriculum Advisory Committee that will include representatives from disciplines across UW, and from Wyoming companies.

**Quantitative skills for computing.**
Appropriate Mathematics and Statistics concepts will either be offered within existing quantitative courses, embedded within new SoC courses, or offered in freshly designed courses for SoC majors in mind. Different tracks within quantitative offerings will be available for students with different career interests.

**Experiential and collaborative learning.** This will be emphasized through class projects, internships, externships and senior design projects.

**Table 1. Characteristics of SoC undergraduate program**


4. **Anticipated enrollment increases in SoC BA/BS programs and CS-ECE programs**

While SoC undergraduate major programs will not begin to be delivered until 2024, we provide an assessment of expected enrollments in these programs here.

The following quote (emphasis added) from the recent report [NAS2018] help frame this discussion.

> The demand for employees with computer science and computing expertise is high and has grown steadily over time. According to data from the Bureau of Labor Statistics (BLS), employment in computer occupations grew by nearly a factor of 20 between 1975 and 2015, nearly twice as fast as production of CIS bachelor's degrees. BLS has projected that **demand for computer science workers will continue to grow over the next decade at a rate higher than that of overall job growth, particularly as computing becomes more central to a wider range of industrial sectors.** Employment demand is particularly intense in some specialty areas, including cybersecurity, data science, and machine learning.

Estimated increased enrollments in computing or CS program given in Table 2 are based on the above report and the data from market research performed by EAB. It is anticipated that enrollments for the BA in Computing program would attract about 100 majors.

Estimating enrollments is difficult for the following reasons: we are envisioning programs that have unique components (e.g., a focus on computing in context of applications and interdisciplinarity) and which include emerging areas (e.g., data science) that are too young for EAB or the Bureau of Labor Statistics to include in their analyses. Additionally, the analyses tend to be too broad geographically to capture need in Wyoming and may underestimate demand for new types of occupations. Members of the committee that developed this report indicate that they have frequent inquiries from companies in Wyoming about the availability of computing savvy graduates, and that often we are unable to meet their needs. The growth in small tech companies in Wyoming will only increase this demand. In addition to the demand in the marketplace for these types of graduates, there is also a demand among UW students for more opportunities to learn value-added computing skills. It is felt that the estimates are realistic, and perhaps on the conservative side, based on the available data.

| 2024-2025 | 2025-2026 | 2026-2027 | 2027-2028 |
|-----------|-----------|-----------|-----------|
| 36 | 66 | 91 | 116 |

**Table 2. Estimated enrollments in BS in Computing in first 5 years of program**

We note that in 2019, there were 262 CS majors, and 243 ECE majors. Combining the estimated BA and BS in Computing programs, we estimate the SoC will have around 216 undergraduate majors (116 in the BS and 100 in the BA) five years after these programs commence.

SoC's education impact down the road will also reach many students (in the range of 240) through computing minors many departments already considering minor programs). The demand for these will be evaluated as the programs are developed and proposed.

**5. Budget narrative, and existing or new resources required to deliver the Academic program**

The UW leadership's plan is and has been for a long time that there will be a $3M annual allocation from the UW budget for the SoC, of which $500K is earmarked for collaboration with the College of Engineering and Applied Sciences (CEAS). [3]

At the end of five years the plan targets having the following levels of personnel and programs:

- 10-13 FTE faculty in computing, each joint with another department
- 5 Graduate assistants

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[3] Once the SoC is approved searches could commence with some joint SoC/CEAS faculty hires, presumably initially with the new ECE/CS unit in areas of mutual interest.

- 15 Undergraduate scholars
- 10 Faculty affiliates
- Director stipend
- Business manager and Office Manage
- Operational budget of $50K.

The total projected expenses over 4 years are slightly less than $12M. The on-going expenses at the end of FY26 are $3M/year.

The following should be noted:
- The final envisioned size (approximately 24 faculty or research scientists) of the SoC is designed to support the planned MS, MA and PhD programs, as well as aggressive research programs. This initial budget hiring 10-13 FTE faculty or research scientists. As indicated in Appendix 1, additional faculty will be added when justified through joint hires and the CPM process or endowments, and additional (non-extended term track) research scientists through the corporate partnership program, external funding and endowments.
- To encourage collaborations, help support departments, all SoC faculty will be joint hires with other departments.
- All SoC faculty and research scientists will have significant expectations for securing external funding through grants and corporate partnerships; by the end of 5 years SoC faculty and research scientists should bring in an additional $3.5 M/year in external funding.
- As with other such schools or centers, the SoC should provide excellent opportunities for investments from corporations, and individuals. Fund-raising to support SoC programs will be a priority of the SoC administration and faculty.
- The SoC will work closely with the UW Search Equity Advisors initiative to ensure that the net is cast wide to encourage a large pool of talented diverse candidates. fund for undergraduates, and a visiting scholar program.

| Expenses | | FY22 | FY23 | FY24 | FY25 | FY26 | TOTAL |
|---|---|---|---|---|---|---|---|
| Category | | | | | | | |
| Administration | | | | | | | |
| | Director | 50,000 | 112,500 | 112,500 | 75,000 | 50,000 | 400,000 |
| | Business Manager | 30,000 | 120,000 | 120,000 | 120,000 | 120,000 | 510,000 |
| | Office Manager | 11,250 | 45,000 | 45,000 | 45,000 | 45,000 | 191,250 |
| | Fringe Benefits | 43,134 | 133,073 | 133,073 | 116,160 | 104,885 | 530,324 |
| **Subtotal** | | **134,384** | **410,573** | **410,573** | **356,160** | **319,885** | **1,631,574** |
| | | | | | | | |
| Personnel | | | | | | | |
| | *Faculty added in given year* | | 2 Faculty | 2 Faculty, 1 Research Scientist | 2 Faculty, 1 Research Scientist | 2 Faculty, 1 Research Scientist | |
| | Faculty | | 300,000 | 750,000 | 1,200,000 | 1,500,000 | 3,750,000 |
| | Fringe Benefits | | 135,300 | 338,250 | 541,200 | 676,500 | 1,691,250 |
| **Subtotal** | | | **435,300** | **1,088,250** | **1,741,200** | **2,176,500** | **5,441,250** |
| | | | | | | | |
| Students & Affiliates | | | | | | | |
| | GAs 5/year | | 175,000 | 175,000 | 175,000 | 175,000 | 700,000 |
| | Undergrads 15/year | | 150,000 | 150,000 | 150,000 | 150,000 | 600,000 |
| | 12K/month per affiliate | | 240,000 | 240,000 | 240,000 | 120,000 | 840,000 |
| **Subtotal** | | | **565,000** | **565,000** | **565,000** | **445,000** | **2,140,000** |
| | | | | | | | |
| | | | | | | | |
| Operating expenses | | | | | | | |
| | Recruiting costs | | 45,000 | 30,000 | 45,000 | 30,000 | 150,000 |
| | Start-up for labs | | 600,000 | 600,000 | 600,000 | 600,000 | 2,400,000 |
| | Operational budget | 16,667 | 50,000 | 50,000 | 50,000 | 50,000 | 216,667 |
| **Subtotal** | | **16,667** | **695,000** | **680,000** | **695,000** | **680,000** | **2,766,667** |
| **Expenses** | | FY 22 | FY 23 | FY 24 | FY 25 | FY 26 | Total |
| | Total on-going expenses | 151,050 | 1,460,873 | 2,113,823 | 2,712,360 | 2,991,385 | 2,991,385 |
| | Total one-time expenses | - | 645,000 | 630,000 | 645,000 | 630,000 | 2,550,000 |
| **Total expenses per year** | | **151,050** | **2,105,873** | **2,743,823** | **3,357,360** | **3,621,385** | **11,979,490** |

Table 3: Projected Expenses of SoC for first 4 years

| Revenues | | | | | | |
|---|---|---|---|---|---|---|
| | Internal Budget | - | 3,000,000 | 3,000,000 | 3,000,000 | 3,000,000 | 12,000,000 |
| Running total of Revenue – expenses | | (151,050) | 743,077 | 999,255 | 641,895 | 20,510 | |

**Table 4: Summary of Revenue for first 4 years**

## 6. Timeline for implementation

A detailed five year/two-phase plan for the roll-out of the SoC and its associated programs is given in Pages 21-29 of the SoC Preliminary Plan. The timeline for the development and roll-out of the BS and BA computing majors is given in Table 5.

| Spring 2022 | Appoint initial director and hire business and office manager<br>Conduct searches for initial faculty and research scientist positions<br>Establish corporate partnership programs<br>Establish/strengthen partnerships with national labs |
|---|---|
| AY 2022-2023 | Create a Curriculum Advisory Committee that includes international experts in computing education, UW alums using computing in their careers, Wyoming tech companies, UW CS/ECE and Math-Stat faculty to design the courses for the BA/BS.<br>Offer several new SoC undergraduate courses of interest to a broad range of students.<br>Work with CS/ECE on designing and delivering inviting, experiential, and interdisciplinary first year computing courses.<br>Conduct searches for second round of faculty and research scientist positions<br>Work with faculty to develop minors in computing programs<br>Initiate Undergraduate Internships program and Faculty Affiliates program |
| AY 2023-2024 | Secure authorization for BA/BS program, establish 2+2 agreements with CCs<br>Fully develop other SoC courses<br>Recruit first class of SoC majors.<br>Conduct searches for third round of faculty and research scientist positions |
| AY 2024-2025 | Enroll first class of SoC Bachelors students<br>Continue work with other UW programs on development and assessment of computing minors.<br>Conduct searches for fourth round of faculty and research scientist positions |
| AY 2025-2026 | Evaluate, assess, and make needed modifications to BA/BS programs.<br>Consider creating MA/MS/PhD programs |
| Spring 2028 | Graduate first SoC class of undergraduate students |

**Table 5. Project timeline of SoC roll-out**

## 7. Plan to assess the SoC Academic Programs

Assessment of the proposed SoC programs will be based on student attainment of core competencies that are outlined in Section 3, the learning outcomes described in Section 8, and informed by an SoC Educational Board and the studies such as "Computing Curricula 2020" [CC2020].

Specific assessment activities for the BA/BS programs will include:
- o Pre- and post-degree exams on core and technical computing competencies
- o Capstone course with assessment of final projects, including collaboration, critical thinking and communication.

- o Feedback from corporate and educational partners involved in internships or capstone projects
- o Surveys with Wyoming companies employing SoC graduates
- o Student course evaluations
- o Exit interviews with graduates.

## 8. Plans for accreditation

Accreditation for the program will be established through the Higher Learning Commission (HLC) and informed by a SoC Curricular Advisory Committee. To enable training of a more, diverse student population in computing the BS/BA programs will not be ABET accredited–ABET accreditation is more restrictive on the disciplinary courses (e.g., must be science oriented) and the mathematics and statistics courses than the envisioned SoC programs. The SoC programs are not intended to be less rigorous, but to have more options in disciplinary content, and have mathematics and statistics courses more aligned with students' interests and with the computing classes. Students desiring an engineering degree can pursue a BS from the ABET accredited program in CS/ECE, and if desired use their elective courses to take courses in the SoC.

Tentative learning outcomes are:

- **Outcome 1 – Communication:** Students will be able to communicate in written and oral forms in such a way as to demonstrate their ability to work with a variety of stakeholders, and to present information clearly, logically, and critically.
- **Outcome 2 – Application:** Students will be able to utilize and modify state-of-the-art computing tools and concepts to explore and analyze disciplinary problems
- **Outcome 3 – Coding:** Students will be able to code efficient programs on their own to model phenomena.
- **Outcome 4 - Depth of Knowledge**: In a selected domain/concentrations students will demonstrate a depth of knowledge appropriate to graduate study and/or lifelong learning in that area. Students should be able to read for understanding materials in that area beyond those assigned in coursework.
- **Outcome 5 - Preparation for Career and Further Education**: Students will be prepared for a career in industry, government agencies or non-profits or for graduate study in scientific or technical fields.

Continuous improvement of the program will be fostered through annual presentations and feedback with the SoC Curriculum Advisory Committee.

## 9. Benefits of the Academic Program to the University

The proposed School of Computing will position Wyoming's 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 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 l**everage 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.

## 10. The ability of the University to carry out the Academic Program

UW is positioned well to successful carry out this academic plan, as it will build upon past investments, existing strengths at UW, and can take advantage of many pending opportunities (such as the planned large increases of funding at national agencies, American Rescue Program funding, the Wyoming Innovation Partnership, innovative technologies, and businesses around blockchain, and enhanced corporate partnerships around technology). SoC courses and curricular programs will leverage partnerships and in particular co-development and delivery of courses

whenever possible. The SoC be symbiotic with the envisioned "Digital for All" program aspect of the soon-to-be crafted University Studies Program.

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). These strengths will support the interdisciplinary, computing in context focus of the SoC.

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. The SoC will benefit as well as strengthen this existing computational ecosystem.

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 SoC, along with the broader Digital Pillar plan, outline a strategic response to the computational-related needs of UW and Wyoming Community College students, Wyoming's businesses, and agencies. Through the SoC there are also great prospects for the University of Wyoming to emerge as a leader in rural computing and data.

## 11. The likely value to, and impact on, students and residents of Wyoming.
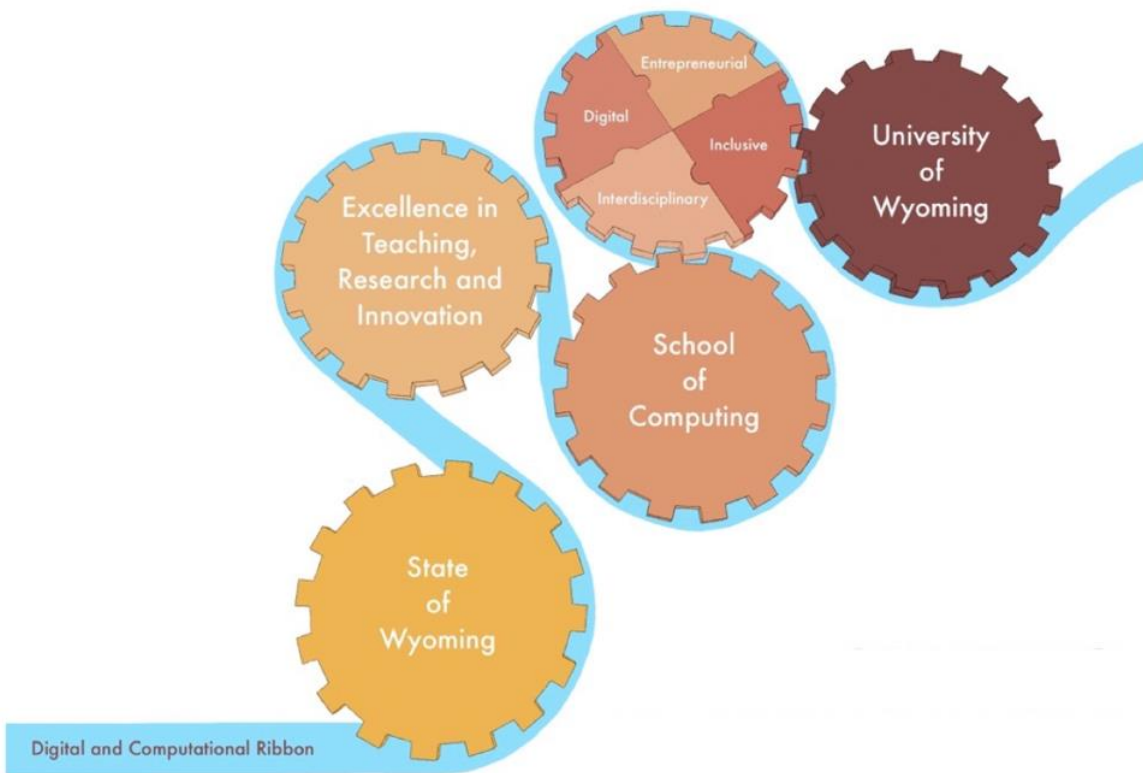
The SoC courses and programs will produce professionals fluent in the computing/digital arena. UW graduates interacting with the SoC via interdisciplinary initiatives with departments will benefit from knowledge and experience of the application of computing in their chosen domain, equipping them to be perceptive and cognizant graduates with experience in innovative applications of computing – and thus competitive in the workplace. Specific outcomes for the SoC courses and programs are given in Section 8.

The SoC curricular programs will provide Wyoming companies and agencies with employees who identify problems (or opportunities for improvement, and successfully bring to bear computing and technology to resolve the problem (or help the company or agency advance through seizing the opportunity).

Citizens of Wyoming can benefit from having SoC graduates helping agencies analyze complex problems (e.g., wildfire management, rural health, etc.) of importance to local communities and to Wyoming.

## References

[ABET20] Criterion for accrediting computing programs 2020-2021.
https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-computing-programs-2020-2021/

[CC2020]: *Computing Curricula 2020 (CC2020): Paradigms for Global Computing Education*, IEEE and ACM joint report, March 2021.

[NAS2018] Assessing and Responding to the Growth of Computer Science Undergraduate Enrollments, The National Academies Press, 2018.

[S20] E. Seidel, "Thoughts on a Broad Vision for Computing in UW and Wyoming", Fall 2020.

Gears diagram showing: "Excellence in Teaching, Research and Innovation", a multi-segment gear labeled "Entrepreneurial", "Digital", "Inclusive", "Interdisciplinary", "University of Wyoming", "School of Computing", "State of Wyoming", connected by a "Digital and Computational Ribbon".

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.

**Appendix 1.**
**Funding plans for future development for SoC**

| Position/Program | Role | Future funding sources |
|---|---|---|
| Dean | A high-quality Dean is critical to the SoC's long-term success. In particular in areas of partnerships, collaborations throughout UW, and fund-raising. | CPM request, endowment |
| Associate Dean for Partnerships and Research | Partnerships with corporations, national labs and other entities will be critical to provide UW students with experiential learning opportunities via capstone courses, interns opportunities, enable new academic-industry research partnerships, and facilitate corporate input to strengthen programs. | Internal candidate with summer stipend from IDCs or Corporate Partnership program |
| Assistant/Associate Dean for Curricula | Oversee development of curriculum, internship program, and Digital for all efforts at UW. | Internal candidate with summer stipend; possibly joint with AA |
| K-14 Education and Workforce Development Staff | The long-term impact of the SoC requires an ecosystem that gives students early and frequent experiences with computing, and a curriculum that produces UW graduates that meet the needs of Wyoming companies. | External funding. ARP requests include a position like this. |
| Special Projects Lead | This lead will help SoC faculty and faculty affiliates to pursue larger federal grants. | Indirect Cost Returns, Corporate partnership program, external grants. |
| Visiting Scholars Program | This program will enable UW faculty in any discipline to work with SoC faculty to identify a project to collaborate on. | Indirect Cost Returns, external grants. UW's ARP request includes this program. |
| 7-10 additional Faculty or Research Scientist positions | This will give the SoC 20-23 faculty or research scientists, and dozens of affiliate faculty. | CPM requests, joint hires with departments. External funding for partial support of Research Scientists. |

**Strengths**
- There exists an increasingly high demand for computing across all disciplines.
- UW's on-going K-14 computing outreach programs and Wyoming's nascent Boot Up initiative can provide UW and the Wyoming CCs with students with strong computing skills.
- There is an increased demand by Wyoming companies and agencies for these computing related skills.
- The SoC will have strong partnerships with the CS/ECE department, WyGiSC, ARCC, Data Science Center, Visualization Center, Makerspaces, and NCAR Wyoming Supercomputing Center
- The SoC builds upon and will enhance ongoing UW initiatives such as SER, the Engineering Initiative, the
- Science Initiative, and the Trustees' Education Initiative.
- The Wyoming Innovation Partnership will provide the platform and network for the SoC to make a statewide impact in economic and workforce development, education, and research of importance to Wyoming.

**Weaknesses**
- UW has very small CS & ECE departments which may make it difficult to attract faculty, and it will take longer for UW to reach competitive staffing levels. As a point of reference in 2013, Boise State University was in a comparable situation with just 7 faculty in CS. Through an investment by the State of Idaho, they have grown to 26 faculty, over 200 CS graduates/year, and over $3M/year in external funding (which represents a larger than 400 times increase in funding since 2013).
- Lack of a Dean early in the process may make it difficult to recruit faculty and raise funding.
- It may be costly to recruit high-caliber faculty to UW. Recruiting will be key.
- UW is starting late in the computing arena compared to some programs. However, UW has strong computational faculty throughout the university, has access to the NCAR Wyoming Supercomputing Center, and a strong core of faculty in the CS and ECE programs.
- Constrained budgets at UW may make it difficult to achieve SoC's vision quickly. This will make the raising funds for the SoC through corporate partnerships, philanthropy, and external grants more critical.
- Expertise in levels of the K-16 pipeline can be difficult to establish and maintain.

**Opportunities**
- Possible **one-time f**unding for SoC through America Recovers Program (ARP) include:

  2022:   $1.15 M confirmed for:
        Software Design Program[4] training with CCs,
        Wyoming Innovation Partnership (WIP) administration,
        Visiting Scholars Program

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[4] The Software Design Program is an associate's degree that has been designed through a collaboration with UW, Cardiff University and Wyoming Community Colleges. Students will be matriculating in the program starting Fall 2022. The CC's finding a pathway for students with this associate's degree to continue towards a 4-year degree, preferably at UW. The confirmed ARP funding will help implement the associate's degree and explore the development of a 4-year degree at UW.

1 Research Scientist, 5 graduate students.

2023-2026:   $23M + (pending) for

WIP Training $3.85 M (includes 3 UW FTEs for 3 years)
Upgrades to UW's Advanced Research Computing Center $10M
Additional start-up funds to build out computing labs $3M
Visiting Scholars program for departments $2M
3 Research Scientists for 3 years
15    graduate research assistants for 3 years available to work on projects for UW faculty

None of this funding is part of the $3M budget given above. This funding, if realized, will be treated as an external grant to the SoC and used only for one-time or short-term commitments.
- Proposed increases federal funding in general, and in specific around AI, high-performance computing, and quantum computing position the SoC well for external funding.
- The UW Foundation is already in conversation around major donations to UW to support computing efforts around blockchain and smart contracts, and the SoC in general.
- Wyoming is a leader in developing the Mountain States Research Partnership with Montana, Idaho, South Dakota, and North Dakota. This partnership will afford many opportunities around computing.
- On-going activities are occurring to develop/strengthen partnerships with national labs and research centers around computing including Pacific Northwest National Lab, Idaho National Lab, Argonne National Lab, and the National Center for Atmospheric Research.
- Wyoming currently has a growing tech-sector with demands for well-prepared computing graduates, and an interest in corporate partnerships with the SoC
- Defense agencies such as the National Security Agency have expressed interest in working with the SoC to develop internships for UW students and programs in high-performance computing

**Threats**
- Another economic downturn for Wyoming could hamper future growth of the SoC. This can be mitigated by corporate partnership programs, active pursuit of philanthropic support and external funding.
- Competitor schools may attract Wyoming students. This emphasizes the need for strong internship programs, engaging, hands-on curricula, and early and frequent recruitment of Wyoming students.
- External funding not coming through at expected levels would put a damper on future growth of the SoC.
- The quality of graduates does not meet Wyoming companies' expectations. UW has a great opportunity to highlight the talents and abilities of its students to Wyoming companies. To have this be successful, it is imperative that while at UW, students learn how to pose and solve complex problems, innovate, and work with various stakeholders.
- The SoC curriculum is not agile enough to provide multiple pathways for students. This can be mitigated having SoC faculty actively working with departments to develop minors, and by working with students and corporate partners to identify needed topics and courses.

**A comparison of envisioned SoC BA/BS in computing and existing BS in CS programs**

| | BS in Computer Science | BS in Computing | BA in Computing |
|---|---|---|---|
| **USP outside major** | 18 hours | 18 hours | 18 hours |
| **Quantitative** | 18 hours Calculus based | 15 hours math/stats for computing (modeling, optimization, and data) | 9 hours math/stat for arts/humanities/social science applications of computing |
| **Math Science electives** | 12 hours | | |
| **CS core** | 42 hours | 16 hours | 16 hours |
| **SoC core competency courses** | | 12 hours (Computing in context, experiential and project based)) | 12 hours (Computing in context, experiential and project based)) |
| **Disciplinary concentration** | | 12 hours (in agriculture, science, math, statistics, or engineering) | 18 hours (in education, arts, humanities, social sciences) |
| **CS electives** | 12-21 hours | | |
| **General electives** | 15 hours | 12 hours | 12 hours |
| **SoC advanced competencies based on interests** | | 15 hours | 15 hours |
| **SoC electives** | | 12 hours | 12 hours |
| **Capstone project** | | 8 hours | 8 hours |
| **Total hours** | 120-128 (depending on concentration) | 120 hours | 120 hours |

**Appendix 4**
**FAQs**

- **Did we look at other models, e.g., a department in Engineering…why create an entire "school"?**
  Several models were considered, including an institute, a department within a college, a school within a college. Institutes tend to focus on research and would not support the SoC's educational vision. A department within a college would not support the interdisciplinary nature and desired campus-wide impact of the envisioned SoC. A school, like UW's SER, allows for an outward facing organization that can work with companies and more easily work with donors and respond to strategic needs of the university.

- **Why do we need both a school and a department of Computer Science & Electrical and Computer Engineering?**
  This will allow UW to address the need for a more robust computing community more quickly, better position itself for the projected funding opportunities around computing, provide UW students multiple pathways to computing-enabled careers, produce graduates with a more diverse set of backgrounds and experiences (e.g., business analytics and computing, digital humanities, digital forensics, AI-enabled human resource management)

  A separate school better provides an entity to be a hub of computing across UW and the State. Much as a School of Energy Resources provides a hub for energy related research, and the Haub School for environment and natural resources.

- **Why are the salaries so high?**
  As noted in the preliminary plans, the numbers for the salaries included fringe benefits, which are 45.1% for faculty. The budget in this proposal separates the salary and fringe. The budget used a target of an average salary of $150K/FTE. For faculty in some disciplines (AI), or faculty with industry experiences can be significantly higher. Additionally, to get the SoC established it is preferable to target proven faculty or rising stars. This type of quality and experience costs. At established schools of computing, salaries for associate professors are in the $200K range, and full professors in the $250K range. At schools more like UW, with strong computing programs, salaries for associate professors are in the 140K range and full professors in the $160K range are in the 140K range and full professors in the $160K range.

  It should also be noted that the expectations of securing external grants for faculty and for research scientists are significant.

  The preliminary plan targeted a salary of $350K for a dean. UW Deans currently make in the $250-270K range. Deans of established SoC make in the $400K range. It was intended that part of this salary would be covered by endowments. Note this updated plan does not include a Dean during the incubation period. UW and the SoC will need to consider the need for a Dean as the SoC matures.

- **Where is the funding for the SoC coming from?**
  As part of discussions related to the most recent budget cut, the Governor and UW leadership agreed to set aside $5.5M/year for strategic initiatives for the State. These include the Wyoming Innovation Partnership, the Wyoming Outdoor Recreation and Hospitality initiative, the Center for Entrepreneurship and Innovation, and the School of Computing. Of the $5.5M, UW leadership targeted $3M/year for the School of Computing.

- **Why does the original plan for the SoC appear to be so top-heavy?**
  The preliminary plan for the SoC included a Dean, 2 Associate Deans, and two project leads. As has been done elsewhere, one way to jump-start a new initiative is to recruit and hire a highly regarded Dean, and then use the Dean's reputation to recruit faculty and the Dean's expertise to shape the new programs. To initially focus on students, faculty and the State, it was decided to incubate the SoC and forego a Dean until the SoC has matured and external funding has been secured.

One of the Associate Deans was to be heavily involved in the proposed campus-wide "Digital for All" effort, and the other in developing corporate, academic and agency partnerships for all of UW. The budgets for the Associate Deans were full salaries, with the intent to provide the Associate Dean a small stipend and use the rest of the salary in his/her home department to cover their responsibilities there while they were in the associate deanship.

One of the staff was targeted to be leading the development of an internship program and UW's connections to Wyoming's K-14 efforts in computing.

- **Where will the SoC be physically located?**
  In the short term, the plan to incubate the SoC in an existing college facilitates the use of existing spaces in that college. As the SoC matures, a permanent location will need to be determined. Identifying such space within existing UW buildings will need to be considered early in the SoC's development.

- **What is in it for faculty?**
  The budget presented in this RFA would yield 10-13 FTE faculty/research scientists, depending on the market for chosen expertise and experience of hires. The long-term vision for the SoC targets 20-25 ☐ faculty/research scientists. All faculty will have joint appointments with a department outside of the SoC. It is anticipated that there will be dozens of SoC affiliate faculty who are working with SoC faculty and students on projects.

  All SoC faculty positions are intended to be joint appointments with other departments and programs at UW and should help meet departments' computational curricular and research needs.

  A Visiting Scholars program will (on a competitive bases) allow faculty to invite computational scholars in their disciplines to UW to explore collaborations, identify ways that a program or department become "more digital" to enhance their scholarship and add value to their students' education.

  A New Faculty Affiliates program will provide faculty in any discipline having a desire to more fully incorporate computing into their scholarship or teaching to work with the SoC faculty (and in particular one-on-one with on Research Scientist) for a couple of months to identify computational projects in their discipline to collaborate on.

  Through student internships and the SoC curricular programs, UW will have a larger number of tech-savvy students with diverse disciplinary internships. It is anticipated that these students can serve as "computational" enablers in projects with faculty outside of the SoC.

- **What is in it for staff?**
  Staff can utilize certificate and short courses in areas such as visualization, data-mining, and artificial intelligence either to gain emerging skills needed in their positions, advance within the UW system, or position them for a different career.

- **What is in it for students?**
  Majors will have multiple pathways towards careers that utilize computing; and their courses will focus on learning-in-context in collaborative settings with a rich set of internship opportunities. All students will have access to value-added courses and certificate programs.

**Addendum C**

**Authorization Request for the School of Computing (SoC)**
**August 2021**



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

The SoC will be a hub of innovation and knowledge exchange providing UW students, faculty and Wyoming businesses and citizens with a "**backpack" of computational tools and approaches to drive transformation.**

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

## 1. Introduction

This document is a Request for Authorization (RFA) to establish a School of Computing (SoC) at the University of Wyoming. The request describes characteristics of a BA and a BS degree in Computing that will be SoC's initial curricular foci and will provide the foundation and structure for future minors to be developed and offered with other departments and programs across the campus. These degree programs will be fully developed in the first 18 months of the SoC, and informed by a new Dean and new hires and a SoC Curriculum Advisory Committee that will include faculty from UW and experts from outside UW. Additionally, a description of the SoC's leadership role in the campus-wide effort to make UW more digital is given. The BA and BS, as well as future curricular programs (e.g. minors, MA, MS and PhD degrees in Computing) will follow the approval process at the appropriate times in coming years.

This RFA references

a) A **feasibility study and market analysis** on the BS in Computing Degree from the Education Advisory Board (EAB).
b) The **School of Computing Preliminary Plan** that provides a detailed description, analysis and tentative budget for all aspects (Educational, Economic and Workforce Development, Research, Partnerships, and enhanced funding opportunities).
c) The **Notice of Intent** and the accompanying presentation to the Board of Trustees.
d) The **Digital Pillar Report** prepared in Spring 2021 by a committee of 19 UW faculty, staff and students at the bequest of the UW Provost that gives a broad overview of the need, the benefits and suggest actions for UW to become more digital.
e) **Various reports** from national organizations and think-tanks on the need for computing.

For convenience each of these is included in the package for this request, or can be accessed via the link: supporting files.

## 2. Purpose and need for the proposed Academic Program

The following quotes from two recent studies summarize the overarching needs for the proposed academic programs at UW.

> Computer science and information technologies have transformed all sectors of society, businesses, and government. Today, the transformation continues and much is driven by artificial intelligence, robotics, the Internet of Things, information security, and data science. A wide range of jobs in virtually all sectors demand computing skills to an unprecedented extent. And every academic discipline finds itself incorporating computing into its research and educational mission. [NAS 2018]

> Computing is and will continue to be an essential component in shaping the future for humanity, The computing disciplines need to attract quality students from a broad and diverse cross-section of the public and prepare them to be capable and responsible professionals. [CC2020]

These needs are even deeper at UW. The productivity across UW in computational education and research is far below that of our peers, and the needs of UW graduates.[1] Access to cutting-edge research, world-class infrastructure and

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[1] "It is important to note the scale that is needed for UW 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 relative sizes of CS departments is only one, very limited indicator, but it does give a sense of where UW is. In 2020 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 UWs size and has more than 4 times our CS faculty, and a unit like our ARCC with over 50 staff (almost entire funded on soft money through grants). In all cases these activities are a foundation for economic development in their region." [S20]

workforce training in computing and data is therefore critical for Wyoming citizens, and most importantly for UW's students.

The primary purposes of the SoC curricular programs are to

- lead UW in the incorporation of value-added, disciplinary-specific **digital experiences in all** disciplines,
- **provide more students with career pathways that utilize** the power of computing and technology,
- provide new opportunities to **increase the diversity among UW students utilizing computing** in their disciplines and careers, and
- establish **a pipe-line of tech-savvy graduates for Wyoming's and the global economy**.

Additionally, the SoC will provide UW researchers new tools and cutting-edge computational expertise to better address grand challenge problems of importance to Wyoming and region that they are studying, and serve as a hub for Wyoming's innovation economy.

## 3. Proposed curriculum

The SoC is envisioned to ultimately house the following academic programs:

- Multi-pathway BA and BS programs in Computing,
- Minors in Computing,
- Certificates, possibly stackable, in Digital/Computing,
- MA/MS/PhD in Computing.

When feasible, all parts of the curricula will be offered online. The SoC will also work with Academic Affairs to be the champion for the envisioned "Digital for All" component of the USP.

The initial ideas of these programs are more fully discussed in the SoC Preliminary Plan, and the Digital Pillar report. The full development of these programs will involve Academic Affairs, Faculty Senate, the USP committee, faculty and students, and will be overseen by a SoC Curriculum Advisory Committee. All will be fully studied and follow the process for approval and creation of new academic programs.

Here we focus primarily on the characteristics and vision for the BA and BS in Computing programs; as they are the most critical for UW students and for Wyoming, and will be the first developed. Before that we will briefly describe the vision and plans for the other programs. All programs will be greatly informed by the recently released report "*Computing Curricula 2020: Paradigms for Global Computing Education* [CC2020] that was developed by a 50-member task force drawn from 20 countries, CC2020 outlines international recommendations for baccalaureate degrees in computing.

**Digital For All Experiences.**
The Digital Pillar report recommends that the university community consider the creation of a "digital course" requirement in the University Studies Program for all students. Their reasoning is that it is important that all UW undergraduate students learn how digital and computational methods/tools/approaches are increasingly part of their chosen discipline and all aspects of life. At a general level, students should be exposed to the variety of ways that digital tools can be used to accomplish task (many of them are 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 gain understanding of how to analyze the human, social and scientific impacts the existence and use of these tools bring. At a specific level, students 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. The SoC plan proposes an Associate Dean with joint appointment between the SoC and Academic Affairs tasked with leading efforts to make UW more digital through the proposed digital curriculum embedded in the USP.

**Minors in Computing.**

Job prospects likely also contribute to the demand for CS courses from non-majors, but this portion of the enrollment increase is also driven by the impact of CS and computing in other fields. Computer

science and its related endeavors such as data science have produced powerful tools and software systems that are used by and affect every discipline, giving rise to exciting subfields, such as computational biology, computational economics, computational chemistry, and digital humanities, with more emerging. These subfields require expertise in the traditional domain and a general fluency in tools and methods from computer science. The advantages of a deeper knowledge of computer science in many domains has also led to the recent emergence of new degree programs at several institutions that fuse curricula and formal requirements of CS with those for one of a range of disciplines (referred to as "X+CS"). [NAS 2018}

As the above quote indicates, increasingly students in many disciplines find great value-added in incorporating computing classes into their studies. Having disciplinary minors in computing will give UW Alums a competitive advantage throughout their careers, catalyze working partnerships between UW departments and the SoC faculty, and will be a valuable recruiting tool for students, graduate students and faculty. All minors will be vetted, and submitted through approval through the standard UW processes.

### Certificates, Possibly Stackable, in Digital/Computing.
The Digital Pillar Report mentions the emerging mechanisms of certificates and stackable certificates in higher education. The SoC envisions partnering with entities like the Ellbogen Center, the Visualization Center, the Innovation Wyrkshop, the Advanced Research Computing Center and UW Libraries to explore the feasibility of developing suites of (possibly stackable) certificate courses that enable a diverse audience of students, including non-traditional students and life-long learners, the opportunities to gain specific 21$^{st}$-century skills through short-courses, self-paced courses with competency exams.

### Graduate degree programs.
In years 2 and 3, the SoC will plan and developing MA and MS degrees in Computing, with a focus on creation and use of innovative computing tools in the context of grand challenge problems in a wide range of disciplines. Desired characteristics of these programs will be diversity of student body, various academic pathways for entrance, collaborative projects involving different disciplines and stakeholders, ties through internships/externships with Wyoming and regional companies. A PhD in Computing will be studied and considered in years 4 and 5; other Schools of Computing support robust PhD programs through corporate partnerships, external funding, and partnerships with national labs. Initially, the graduate curricula will be operated using existing programs in the ongoing Interdisciplinary Graduate Minor in Scientific Computing.

We now return attention to the most critical programs in the SoC, the BA and BS programs in computing.

### Multi-pathway BA and BS Programs in Computing.
The BA and BS in Computing will be the initial and central part of the SoC curricula, and form the backbone for multiple minors. The BA/BS in Computing will be distinctly different than those in CS or ECE at UW, and thereby enable UW to serve a more diverse set of students.

The BS and BA programs will be more fully developed during the first 18 months of the SoC and informed and developed by SoC hires and the SoC Curricular Advisory Committee, and be symbiotic with the "new" CS/ECE BS and graduate programs.

It is anticipated that all Computer Science related degrees at UW will share a highly common first year which will aid in recruiting, advising, costs, and most importantly give students the opportunity to discover their own areas of interest within computing.

Characteristics of the proposed undergraduate degrees in computing are described in Table 1. Table 2 gives the basic structure of UW's existing BS in Computer Science. and of the proposed BS and BA degrees in Computing.

**Characteristics of the BA and BS programs in Computing**

**Focus on "computing in context."**
This is the use of computers and related technologies to study complex real-world problems. This will require students to develop disciplinary expertise as well as computing expertise.

**Common set of beginning courses to allow students to explore.**
First year courses will be designed with CS/ECE and other units as an on-ramp to expose students to the power of computing through diverse applications, practical and broad aspects of the development and use of application, and various career tracks in computing. The remainder of the curricula will be designed to offer many possible pathways to students, and to provide a platform for future minors from other disciplines to be offered.

**Competency-based**.

**Competency = Knowledge + Skills + Dispositions… in Context**

Following trends supported by educational research and best practices in leading computing program, the curriculum will be designed around competencies and domains, that is, a curriculum that "focuses on an individual's capability to perform and to apply their computing education in a practical and professional service to society. A curriculum founded on students Knowing what, Knowing how and Knowing Why. [CC2020]

"Competency-based curricula provide more pathways for students, the ability to quickly adjust to curricula to cover emerging topics, and provide the ability to "promote and clearly describe the practical benefits of computing programs to stakeholders: students, parents, employers, corporate partners, donors." [CC2020]

Core competencies (e.g. problem-formulation and solving, interpersonal, management and entrepreneurial skills, ethics, collaborating, communicating, working in interdisciplinary and multicultural teams), technical competencies (e.g. DevOps, Software Development, Data Wrangling, Modelling, Technical Writing), and advanced competencies in selected areas of contemporary computing (e.g. Security, Artificial Intelligence, Internet of Things, FinTech, Contemporary Database & Interfaces, Design Tools, Human Computer Interaction*s)* for the programs will be identified as required elements.

Each course offered by the SoC, and its partners including timely topics courses) will have an associated approved list of competencies. Students can master core competencies in different ways based upon their interests and their strengths. Over next year, a list of core competencies will be developed through consultation with an external advisory board, and a SoC Curriculum Advisory Committee that will include representatives from disciplines across UW, and from Wyoming companies.

**Quantitative skills for computing.**
Appropriate Mathematics and Statistics concepts will either be offered within existing quantitative courses, embedded within new SoC courses, or offered in freshly designed courses for SoC majors in mind. Different tracks within quantitative offerings will be available for students with different career interests.

**Experiential and collaborative learning.** This will be emphasized through class projects, internships, externships and senior design projects.

**Table 1. Characteristics of SoC undergraduate programs**

| | BS in Computer Science | BS in Computing | BA in Computing |
|---|---|---|---|
| **USP outside major** | 18 hours | 18 hours | 18 hours |
| **Quantitative** | 18 hours Calculus based | 15 hours math/stats for computing (modeling, optimization and data) | 9 hours math/stat for arts/humanities/social science applications of computing |
| **Math Science electives** | 12 hours | | |
| **CS core** | 42 hours | 16 hours | 16 hours |
| **SoC core competency courses** | | 12 hours (Computing in context, experiential and project based)) | 12 hours (Computing in context, experiential and project based)) |
| **Disciplinary concentration** | | 12 hours (in agriculture, science , math, statistics or engineering) | 18 hours (in education, arts, humanities, social sciences) |
| **CS electives** | 12-21 hours | | |
| **General electives** | 15 hours | 12 hours | 12 hours |
| **SoC advanced competencies based on interests** | | 15 hours | 15 hours |
| **SoC electives** | | 12 hours | 12 hours |
| **Capstone project** | | 8 hours | 8 hours |
| **Total hours** | 120-128 (depending on concentration) | 120 hours | 120 hours |

**Table 2. A comparison of the different bachelor's programs.**


## 4. Anticipated enrollment in BA/BS programs

The following quote (emphasis added) from the recent report [NAS2018] help frame this discussion.

> The demand for employees with computer science and computing expertise is high and has grown steadily over time. According to data from the Bureau of Labor Statistics (BLS), employment in computer occupations grew by nearly a factor of 20 between 1975 and 2015, nearly twice as fast as production of CIS bachelor's degrees. BLS has projected that **demand for computer science workers will continue to grow over the next decade at a rate higher than that of overall job growth, particularly as computing becomes more central to a wider range of industrial sectors.** Employment demand is particularly intense in some specialty areas, including cybersecurity, data science, and machine learning**.**

Estimated enrollments for the BS in Computing program given in Table 3 are based on the above report and the data from market research performed by EAB. It is anticipated that enrollments for the BA in Computing program would be similar. Once the BA and BS programs are more fully designed, a market analysis, as well as an evaluation of credential design and curricular recommendations for both programs will be performed.

Estimating enrollments is difficult for the following reasons: we are envisioning programs that have unique components (e.g., a focus on computing in context of applications and interdisciplinarity) and which include emerging areas (e.g., data science) that are too young for EAB or the Bureau of Labor Statistics to include in their analyses. Additionally, the analyses tend to be too broad geographically to capture need in Wyoming and may underestimate demand for new types of occupations. Members of the committee that developed this report, indicate that they have

frequent inquiries from companies in Wyoming about the availability of computing savvy graduates, and that often we are unable to meet their needs. The growth in small tech companies in Wyoming will only increase this demand. In addition to the demand in the marketplace for these types of graduates, there is also a demand among UW students for more opportunities to learn value-added computing skills. It is felt that the estimates are realistic, and perhaps on the conservative side, based on the available data.

| 2023-2024 | 2024-2025 | 2025-2026 | 2026-2027 |
|-----------|-----------|-----------|-----------|
| 36 | 66 | 91 | 116 |

**Table 3. Estimated enrollments in BS in Computing in first 5 years of program**

We note that in 2019, there were 262 CS majors, and 243 ECE majors. Combining the estimated BA and BS in Computing programs, we estimate the SoC will have around 232 undergraduate majors five years after the program is started.

SoC's education impact down the road will also reach a large number of students (in the range of 240) through computing minors (there are at least 6 departments already considering minor programs). Through its role as champion for "digital for all" the SoC will impact every undergraduate at Wyoming. The demand for these will be evaluated as the programs are developed and proposed.

5. **Budget Narrative and existing or new resources required to deliver the Academic program**

A detailed five year/two-phase plan for the roll-out of the SoC and its associated programs is given in Pages 21-29 of the SoC Preliminary Plan. Table 4 below gives the projected expenses. The full version of this table was presented to the Trustees in their July 2021 meeting. Some notes are the following.

- There are some differences between this table and budget presented in the preliminary SoC plan, and the notice of intent. This is due to a combining of Phase 0 (the initial 6 months) and Phase 1, The budget below should be taken as the formal proposed budget.

- UW administration has identified several possible funding sources for the SoC, including America Recovers Program (ARP) funding for one-time costs. The details of how the State will distribute ARP funding are still being discussed. Thus, details of funding sources for the SoC are not provided at this time. Once the ARP funding and other infrastructure funding is settled, the UW administration will provide a detailed fiscally solid plan for where the SoC funding for its first 5 years comes from.

At the end of five years the plan targets having the following levels of personnel and programs:

- Dean
- 2 Associate Deans (one devoted to curricula, Digital for All efforts, and programs with community colleges, and one devoted to industry/research lab partnerships and workforce and economic development.
- 1 business manager, 1 office manager, 1 workforce development lead, 1 special projects lead
- a position devoted to working with community colleges
- 21 faculty (3-4 being existing faculty, remaining will new hires with joint appointments in other departments)
- 4 research scientists (it is expected that another 4-5 research scientist will be supported by external grants secured by SoC faculty and research scientists)
- 27 graduate assistants.
- Operating budget
- Start-up funds to be devoted to equipping specialized labs for students, or special computing equipment
- A Visiting Faculty Program
- A Computing Scholars Program for undergraduates

Total projected costs at the end of year 5 are $10.4 M per year.

The following should be noted:
- o The projected costs are the anticipated all-in costs, and include programmatic elements such as a scholarship fund for undergraduates, and a visiting scholar program;
- o The targeted size of the SoC is designed to ultimately support the planned MS, MA and PhD programs, as well as aggressive research programs.
- o To encourage collaborations, help support departments, all SoC faculty will be joint hires with other departments.
- o All SoC faculty and research scientists will have significant expectations for securing external funding through grants and corporate partnerships; by the end of 5 years SoC faculty and research scientists should bring in an additional $7.5 M/year in external funding.
- o As with other such schools or centers, the SoC should provide excellent opportunities for investments from corporations, and individuals. Fund-raising to support SoC programs will be a priority of the SoC administration and faculty.
- o The SoC will work closely with the UW Search Equity Advisors initiative to ensure that the net is cast wide to encourage a large pool of talented diverse candidates.

| EXPENSES | | | FY22 | FY23 | FY24 | FY25 | FY26 |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Administration | | | 934,760 | 934,760 | 1,743,450 | 1,743,450 | 1,743,450 |
| Faculty Compensation | | | 319,500 | 1,739,500 | 3,017,500 | 3,656,500 | 4,295,500 |
| Start-up Funds | | | 900,000 | 3,500,000 | 3,000,000 | 1,500,000 | 1,500,000 |
| Visiting Faculty/Computing Scholars | | | 500,000 | 660,000 | 740,000 | 570,000 | 570,000 |
| Research Scientists | | | 426,000 | 639,000 | 852,000 | 852,000 | 852,000 |
| Graduate Research Students | | | 168,034 | 436,889 | 672,137 | 806,564 | 907,385 |
| Operating expenses | | | 300,000 | 375,000 | 500,000 | 500,000 | 500,000 |
| TOTAL | | | 3,548,294 | 8,285,149 | 10,525,087 | 9,628,514 | 10,368,335 |
| | | | | | | | |
| Funding sources (TBD once ARP, WIP funding is settled) | | | | | | | |

| Student Tuition | | | | 192,000 | 350,000 | 728,514 | 768,335 |
|---|---|---|---|---|---|---|---|

Table 4. Projected expenses, and tuition revenues for first 5 years

6. Timeline for implementation

A detailed five year/two-phase plan for the roll-out of the SoC and its associated programs is given in Pages 21-29 of the SoC Preliminary Plan. The timeline for the development and roll-out of the BS and BA computing majors is given in Table 5.

| Spring 2022 | Interim Dean and Associate Deans, and initial SoC faculty will create a Curriculum Advisory Committee that includes international experts in computing education, UW alums using computing in their careers, Wyoming tech companies, UW CS/ECE and Math-Stat faculty to design the courses for the BA/BS. |
|---|---|
| Fall 2022-Spring 2023 | Offer a few trial SoC undergrad courses, fully develop other SoC courses, secure accreditation of BA/BS program, and work through UW's CARF process for pertinent courses, establish 2+2 agreements with Wyoming Community Colleges, recruit first class of SoC undergraduates. |
| Fall 2023 | Enroll inaugural SoC class of undergraduates |
| Fall 2023 and Spring 2024 | Design, develop and seek approval to offer MS and PhD programs in Computing.<br><br>Evaluate, assess and make needed modifications to BA/BS programs.<br><br>Work with other UW programs on developing computing minors. |
| Fall 2024 | Enroll inaugural SoC class of graduate students |
| Spring 2027 | Graduate first SoC class |

**Table 5. Project timeline of SoC roll-out**

7. **Plan to assess the Academic Program**

Assessment of the proposed BA and BS programs will be based on student attainment of core competencies that outline in Section 3, the learning objectives described in Section 8, and informed by the SoC Educational Board and the studies such as "Computing Curricula 2020" [CC2020].

Specific assessment activities for the BA/BS programs will include:
- Pre- and post-degree exams on core and technical computing competencies
- Capstone course with assessment of final projects, including collaboration, critical thinking and communication;
- Feedback from corporate and educational partners involved in internships or capstone projects
- Surveys with Wyoming companies employing SoC graduates
- Student course evaluations
- Exit interviews with graduates

8. **Plans for accreditation**

Accreditation for the program will be established through the Higher Learning Commission (HLC), and informed by a SoC Curricular Advisory Committee. In order to enable to train a more, diverse student population in computing the BS/BA programs will not be ABET accredited–ABET accreditation is more restrictive on the disciplinary courses (e.g. must be science oriented) and the mathematics and statistics courses than the envisioned SoC programs. The SoC programs are not intended to be less rigorous, but to have more options in disciplinary content, and have mathematics and statistics courses more aligned with students' interests and with the computing classes. Students desiring an engineering degree can pursue a BS from the ABET accredited program in CS/ECE, and if desired use their elective courses to take courses in the SoC.

Tentative learning outcomes are:

- **Outcome 1 – Communication:** Students will be able to communicate in written and oral forms in such a way as to demonstrate their ability to work with a variety of stakeholders, and to present information clearly, logically, and critically.
- **Outcome 2 – Application:** Students will be able to utilize and modify state-of-the-art computing tools and concepts to explore and analyze disciplinary problems

- **Outcome 3 – Coding:** Students will be able to code efficient programs on their own to model phenomena.
- **Outcome 4 - Depth of Knowledge**: In a selected domain/concentrations students will demonstrate a depth of knowledge appropriate to graduate study and/or lifelong learning in that area. Students should be able to read for understanding materials in that area beyond those assigned in coursework.
- **Outcome 5 - Preparation for Career and Further Education**: Students will be prepared for a career in industry, government agencies or non-profits or for graduate study in scientific or technical fields.

Continuous improvement of the program will be fostered through annual presentations and feedback with the SoC Curriculum Advisory Committee.


## 9. Benefits of the Academic Program to the University

The proposed School of Computing will position Wyoming's 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 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 l**everage 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.


## 10. The ability of the University to carry out the Academic Program

UW is positioned well to successful carry out this academic plan, as it will build upon past investments, existing strengths at UW, and can take advantage of many pending opportunities (such as the planned large increases of funding at national agencies, American Rescue Program funding, the Wyoming Innovation Partnership, new technologies and businesses around blockchain, and enhanced corporate partnerships around technology). The new BA/BS curricula will leverage partnerships and in particular in the co-development and delivery of courses whenever possible. The "Digital for All" program is envisioned to be a central part of a newly crafted University Studies Program.

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). These strengths will support the interdisciplinary, computing in context focus of the SoC.

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. The SoC will benefit from as well as greatly strengthen this existing computational ecosystem

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 SoC, along with the broader Digital Pillar plan, outline a strategic response to the computational-related needs of UW and Wyoming Community College students, Wyoming's business and agencies. 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 Partnership.

**11.  The likely value to, and impact on, students and residents of Wyoming.**

The BA/BS in Computing will produce professionals fluent in the computing/digital arena. UW graduates interacting with the SoC via interdisciplinary initiatives with departments will benefit from knowledge and experience of the application of computing in their chosen domain, equipping them to be perceptive and cognizant graduates with experience in innovative applications of computing – and thus competitive in the workplace. Specific outcomes for the BA/BS degree are given in Section 8.

The SoC undergraduate programs will provide Wyoming companies and agencies with employees who identify problems (or opportunities for improvement, and successfully bring to bear computing and technology to re-solve the problem  (or help the company or agency advance through seizing the opportunity).

Citizens of Wyoming can from having SoC graduates helping agencies analyze complex problems (e.g. wildfire management, rural health, etc)  of importance to local communities and to Wyoming.

# References

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