

# CS 4000: Senior Capstone Design

School of Computing, University of Utah

Fall 2023

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# 1 Course Staff and Meeting Times

Instructors: Professor H. James de St. Germain, [germain@cs.utah.edu](mailto:germain@cs.utah.edu) (he/him/his)  
Assistant Professor Aaron Wood [u0037463@utah.edu](mailto:u0037463@utah.edu)  
Associate Instructor David Bean [u007227@utah.edu](mailto:u007227@utah.edu)

TAs: See Course Page

Office: 3190B MEB

Office Hours: By Appointment

Credit Hours: 3 credits. Hour expectation: 10 hours per week

Web Page: [utah.instructure.com](http://utah.instructure.com)

Lectures: MWF 9:40-10:30  
Web L104  
*Attendance Required*

*This syllabus is meant to serve as an outline and guide for our course. Please note that we may modify it with reasonable notice to you. We may also modify the Course Schedule to accommodate the needs of our class. Any changes will be announced in class/posted.*

## 2 Course Description and Overview

The purpose of the Capstone Project is for seniors in the School of Computing to start to make the transition from student to professional. This is achieved by working collaboratively in a team environment over 2 semesters (~5 months) to produce a polished software product in a process that will both require you both to draw on your cumulative existing skills and to pick up new ones. You can think of this project as forming the “capstone” of your portfolio when applying for a job: you can show off what you did and will be able to have detailed conversations about your development experience in a way that is more personalized than describing past course programming assignments. At the end of this process we want you to have produced a software project that demonstrates your talents and ingenuity and will impress your favorite professor or your future employer. When we push you, we are pushing you to realize this goal!

CS 4000 focuses on all of the “pre” development steps necessary for developing the final project. These steps include: team formation and project ideation, “pitch” presentations and peer critique, feature planning and design work, building a prototype system, etc. Throughout the capstone experience there is a focus on the skills you will need to succeed in your job. That includes both technical development skills and the (often under-practiced) people skills that are necessary to a collegial and productive workplace (e.g., teamwork, oral and written communication skills).

**Learning Objectives:** At the end of the CS 4000, students will be able to more effectively:

- A. Conduct oral presentations, describing projects in various states of completion as well as formally demonstrate a project prototype
- B. Form new teams; work with multiple teammates to accomplish large scale goals; integrate code with that of other developers
- C. Design, research, plan, document, and deliver new prototype software projects over multiple months
- D. Use modern SE design tools, methodologies, and processes, e.g., Agile, sprints, and task-management
- E. Evaluate and provide constructive feedback to peers on their software, presentations, and documentation
- F. Apply past learning as well as independently develop new skills in the process of creating the software project

## 2.1 Tentative Class Schedule

Tentative weekly topic areas include:

- Week 1: Course Welcome; Ideation; Introductions
- Week 2: Individual Presentations
- Week 3: Peer Interviews
- Week 4: Formal Team Formation
- Week 5: Team Project Idea Approval
- Week 6: Project “Research” and Discovery
- Week 7: Team Presentations and Design Document Creation
- Week 8: UI Sketches and Use Case Development
- Week 9: Requirements Analysis
- Week 10: Storyboard Walkthrough Presentation
- Week 11: Design Work and Development Start
- Week 12: Prototype Stage 1 – Asset Accumulation
- Week 13: Prototype Stage 2 – Required Infrastructure Development
- Week 14: Prototype Stage 3 – Complete Path
- Week 15: Final Presentation of Prototype Demonstration Day

# 3 Course Logistics

## 3.1 Prerequisites and Project Goals

All students in CS 4000 must:

1. Take CS 4500 in the following semester
2. Be expecting to graduate during the semester after taking CS 4000 (when they are taking CS 4500)
3. Have completed their upper-division writing course (or be in progress – with approval)
4. Have completed CS 3505 – Software Practice II
5. Have four or fewer remaining CS Elective, Theory, or Required courses
6. Have a strong desire to achieve an excellent Senior Capstone Project

*Capstone* is defined as “the crowning achievement or final stroke; the culmination or acme”. This is the proper way to think of your CS 4000 - CS 4500 experience. Therefore, strongly consider taking all CS core and elective courses needed to complete your Senior Project **prior to your CS 4500 semester**. During implementation of the Senior Project, it is expected that you are applying CS concepts and skills you **have already learned**. For example, if your team is

involved in a web-based application, at least one member should have already completed Web Software Architecture, Databases, and perhaps Human Computer Interaction. While it is expected that there will be some learning of new technologies as you develop your senior project, this should not come at the cost of making good progress and producing excellent work.

Further, the capstone project should not be about research. There should be a very high likelihood of successfully writing software to solve the project problem. Students interested in research projects should consider taking the CS Thesis course.

Of course, most projects will require students to learn some new techniques and acquire new knowledge, but this should be ancillary to the project. A good example would be extending your existing knowledge of databases (gained from the course you have already taken) to allow more tables with advanced joins or using an entity framework to tie code to data. A bad example would be to choose to use Machine Learning in your project when no team member has any experience in this area.

## **3.2 Course Web Site, Announcements, and Communicating with Course Staff**

**Course Web Site and Announcements.** We will use “Canvas” (utah.instructure.com) for course communications including posting announcements, lecture materials, assignments, etc. You will be responsible for all the material found on the course web page and for monitoring course communications.

**Communicating with Course Staff.** All of the course staff will be available outside of formal classes to answer your questions and help with problems, but in general we expect that you and your team will strive to function as independently as possible. For sensitive issues, please email the course staff directly to set up a private meeting. For questions about grades/assignments/etc. please email one of the course staff or discuss with us during class or team meeting times, as appropriate.

## **3.3 Lecture Format and Attendance**

The class will initially meet in-person three times a week, but the number of class sessions will drop as we move on to the later parts of the course where group meetings will take place instead.

- **Lectures.** The course, especially during the first half, will be structured similar to a traditional lecture course. **You are expected to attend all lectures in person\***. Remember, part of your evaluation will be based on your participation and contributions.

- **Meetings.** As we move into the second half of the semester, there will be meetings between course staff and capstone teams. These will be scheduled based upon team availability, but some of you will need to schedule meetings **outside of the course lecture time** slots. These team meetings will take place either in-person or via Zoom, depending on the preferences of the team. Once again, attendance will be required and [factored into your grade](#).

\* - See Sickness Policy

### 3.3.1 Student Presentations

During certain lectures and specific assignments you will be required to give live individual or group presentations. You will be recorded by the course staff. This video will be shared among the class (students/staff) for the purpose of educational critiques and improvement. (Note: the video will not be shared beyond the class without your permission.)

Students who have concerns should speak to the professors during the first week of classes in order to see if anything can be done.

## 3.4 Expected Time Commitment

This course will require a significant amount of time outside of class times. The reason for this is that creating useful software takes time; design takes time; development (and debugging and testing) take time.

You should expect to spend around 10 hours each week on this course outside of lecture/meetings, i.e. spend the same amount of time on this course that you do on other CS courses.

## 3.5 Required Course Materials

**Textbook:** There is no textbook that you have to buy. Occasional readings may be suggested.

**Computer & Internet Connectivity:** Students will need regular access to a computer and an internet connection for their coursework.

**Webcam:** All students are required to use webcams and turn on their video during team meetings, if you elect to have your team meetings via Zoom. Video presence in meetings offers a number of benefits and is common in remote team meetings in industry, so it's a good idea to get comfortable with it. However, we recognize that there are a number of complicating issues, including shared living spaces (sometimes with children) and financial burden. Please reach out

to us if you have concerns regarding webcam usage so that we can explore potential arrangements, or move to in-person meetings.

**Equipment Purchasing Support / Equipment Loans:** Please feel free to reach out to course staff for pointers to additional resources to reduce the financial burden of access to internet connectivity and/or computing equipment, equipment loans, etc.

**Specific Project Resources (e.g, cloud computing time):** We do not require that capstone projects will need additional financial resources from students. You may, however, end up wanting to explore resources such as free credits for students on cloud computing platforms. Additionally, while funding is not available from the School of Computing for this purpose, the University of Utah may have some relevant funding opportunities<sup>1</sup>, the CADE lab offers some computing resources for students, and AWS provides some computational resources for students.

**Demo Day Hardware:** Teams will be expected to provide their own computers (i.e., laptops) for their demonstration. Teams will be encouraged to bring larger monitors (as well as donuts for the course staff... ;^)

**GitLab Server:** All student projects will need to be saved on the Capstone GitLab server: <https://capstone-cs.eng.utah.edu>.

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<sup>1</sup> <https://capstones.utah.edu/>, <https://lassonde.utah.edu/uec/>, <https://lassonde.utah.edu/getseeded/>

# 4 Coursework Grading

## 4.1 Assignments

Homework in CS 4000 will be a combination of written assignments, individual and group oral presentations, team meetings, self-evaluations, prototyping, etc. Most weeks you will be producing documentation and/or presentations about either yourself, your team, or your project. See the [Tentative Class Schedule](#) section for an overview of coursework topics and the approximate proportion of the course spent on each.

During the last month of the semester, your team will produce a prototype of your proposed software. The goal of the prototype is to show us the scope of your vision and convince us you can get there (in a way that a static “design document” does not). You will be graded on how well you perform over the course of the total Software Development Cycle. ***Final grades will not only be determined by your regular assignments but will also be greatly influenced by the quality of your prototype and your individual contribution to your team over the semester*** (see sections on [Holistic Grade Modifier](#), [Teamwork](#)).

## 4.2 Exams

There will be no traditional exams in this course. Teams will present their final projects to the class and to the course staff.

## 4.3 Grading Scale

CS 4000 grades will follow the official University of Utah guidelines:

- A: Excellent performance, superior achievement
- B: Good performance, substantial achievement
- C: Standard performance and achievement
- D: Substandard performance, marginal achievement
- E: Unsatisfactory performance and achievement

You can expect the standard grading brackets (i.e., [100, 94]: A, (94, 90]: A-, (90, 87]: B+, (87, 84]: B, (84, 80]: B-, (80, 77]: C+, (77, 74]: C, (74, 70]: C-, Below 70 - D, etc.). While the instructors reserve the right to apply a curve to the grades, this is rarely necessary.



Below, the grading categories are listed again but reframed instead as what an industry hiring manager might “think” about the candidate.

- Superior (High A)
  - Hire this person today!
  - Keep them in mind for leading teams on future projects
- Good (Low A)
  - Hire this person
  - Assign them to figure out interesting problems
- Adequate (B)
  - This person deserves a look
  - Make sure they are assigned to a manager who can help them produce results
- Needs Work (Low C)
  - Look for someone else
  - The “cost-benefit ratio” might be too high
- Poor (Low D)
  - Something must have gone wrong...
- Unacceptable (Zero)
  - We should be concerned about hiring graduates from the University of Utah’s School of Computing

## **4.4 Grading Breakdown**

- 25% Presentations (~8% each)
- 20% Design Document
- 35% Prototype
  - 5% first half of prototype development
  - 6% first half prototype individual contribution
  - 18% second half of prototype development
  - 6% second half prototype individual contribution
- 10% Supporting Documents/Extra Development Steps
- 10% Effective Participation
  - (e.g., in team, peer grading assignments, use of Task Management System, progress reports)

## 4.5 Team Contribution and Project Quality

The School of Computing has high standards for our graduates, expecting the project to be excellent and each team member to contribute substantially to it.

Expectations include:

- the team produces high quality work,
- all members appropriately contribute,
- the team works well together.

***It is strongly recommended that individuals join teams in which each member has the same level of skill, motivation, and available time.*** For example, teams in which one member spends 5 hours a week and another spends 15 hours a week will often find a discrepancy in both their final grades and their satisfaction with the experience.

Questions you should be asking yourself at the end of the Capstone experience are:

1. Was our project of high quality<sup>2</sup>?
2. Did I individually clearly contribute to the team's success via my contributions to the team across all areas:
  - a. Software development (e.g., code produced),
  - b. Planning
  - c. Writing
  - d. Team organization and positive collaborative environment
3. Was I reliable throughout the semester? Did I communicate, make the meetings, and hit my deadlines (e.g., check in my code, proof the report, make my slides available before the team practice)?
4. Did I contribute at an Excellent level to the entire project?

Students who can answer yes to all of these questions will certainly receive high marks at the end of the semester.

## 4.6 Grade Adjustments

Most of the time student teams function well, each team member contributes significantly and approximately equally, and the final project is feature rich and significant. In these cases, the grades as indicated on Canvas will be used to compute each member's final grade.

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<sup>2</sup> An understanding of what high quality work means can be developed throughout the semester based on conversations with course staff and peer/course staff feedback.

Occasionally, teams find that, as a whole, they are tired and just “ready to be done”. They go through the motions and produce an acceptable product, but don’t push themselves, nor complete significant features. In this case, the team grade may be in the low B or C range. Usually this is (also) reflected in the weekly Canvas assignments. If you and/or your team is feeling “burnt out” as the year progresses, talk to the course staff about what approaches you might take to finishing on a high note.

Finally, it happens that on at least one team every year, a team member contributes significantly less code (and/or non-coding material) to the project. In these cases, the team member may earn a grade level (or two) lower than that of the other team members. For example, a team that produces at a good, but not excellent, level for the semester may earn a B+. If one of the team members has substantially underperformed the team, that team member may earn a C+ or even a C- in the course. If one team member has really “carried” the team, that team member may earn an A-. In these cases, the final letter grade may not be reflected in Canvas, as the week to week grades reflect a grade assigned to the team as a whole with the assumption that each team member is contributing equally.

While it almost never happens, if a team member contributes close to zero to their team, they may receive a grade lower than a C- for the course, and be forced to repeat CS 4000. **Important:** The lack of contribution will be analyzed based on the weekly peer surveys and the GitLab commit history.

To help make these scenarios as rare as possible, please be rigorous in your weekly evaluations describing the state of your team. These surveys help the course staff understand early on what is happening, and take appropriate steps to try and remedy such a situation.

## **4.7 Late Work, Expectations, Regrades**

CS 4000 and CS 4500 are attempting to help you prepare for a workplace environment. If you have a job, there are expectations in terms of showing up to the team meetings, turning in requested status updates, meeting deadlines, etc. Thus, it is expected that you and your team will complete all required assignments on time.

Of course, sickness and accidents do happen, and in recent years there has been a higher than typical potential for unexpected situations. If for any reason you are struggling to focus and contribute, please reach out to your team and to the course staff. Also, please see the section below on [Wellness, Resiliency, Self-Care, and Productivity](#).

Late assignments will be accepted for no penalty if a valid excuse is communicated to the instructors **before** the deadline (this can be done by emailing the course professor(s) directly).

After the deadline you must meet with the course professor(s) to identify what the problem was and how it can be resolved.

In the case of extended sickness, please communicate with the course staff (and your team) in order to determine the best path forward. Ideally, some flexibility will be available<sup>3</sup>, but in the worst case, you may have to withdraw and retake CS 4000 next semester.

**Presentations and the Prototype:** In general, presentations must be given on the date assigned and the prototype must be delivered on time. That being said: again, teams should communicate with the course staff when unforeseen complications arise.

**Regrades:** If you believe that your work has not been evaluated correctly, you should bring this up during your next meeting with the course staff. Please provide a **written statement** explaining:

1. How you feel the grading is inaccurate
2. What you believe the proper resolution should be

## 4.8 Peer Grading

Some grading will be done by your peers. Peer grading will often occur with evaluation of your oral and written communications. You will also be asked to review the work of other teams. Further, once teams are formed, each week you will be asked to evaluate the performance of your teammates. Completing these evaluations will also be awarded credit. These grades will affect your final course letter grade<sup>4</sup>.

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<sup>3</sup> In general, sickness resulting in missing more than three weeks will result in a student having to withdraw.

<sup>4</sup> The course instructors will take into consideration all peer feedback but have the final say on grades.

## 4.9 Teamwork

The first third of the semester will be graded mostly on an individual basis. The second two-thirds of the semester (once teams are formed) will be graded mostly on a team basis. In general, the same grade will be given to each member of the team, though as noted above, the course instructor(s) will adjust individual grades of team members when performance within the team is not uniform.

Once teamwork begins, you will be asked to regularly reflect on the contributions of both yourself and your teammates. These evaluations will help the course staff understand:

- How each team member is contributing to the entire team
- In what areas each member is succeeding
- In what areas a team member may need improvement or extra help/guidance
- Where there are rising problems either in terms of contributions to team productivity or interpersonal interactions

## 4.10 Team Dissolution and Repeating CS 4000

Unfortunately, while it's rare, irreconcilable issues can arise that result in team members no longer being able to work with each other.

When appropriate, we will attempt to facilitate incorporating someone left without a team into another capstone team so that they may continue into CS 4500.

If there have been ongoing concerns regarding your contributions to the team (e.g., via submitted team status reports) and/or no other teams are willing to add you for CS 4500, **you may have to repeat CS 4000.**

***Teams may only “fire” a team member if there have been ongoing, documented concerns that the team members have attempted to address with the help of the course staff.***

## 4.11 Academic Misconduct

While it is likely at this point in your degree that you are well aware of what is considered appropriate academic behavior, please be aware that the standard School of Computing policies regarding academic misconduct apply. Individual assignments are to be done by the student alone. Team assignments are to be done only by the team. Team written assignments should be completed and reviewed **as a team**. Any material you leverage for your project must be documented/referenced: teams are required to document (and get approval for) any code, libraries or assets that are used in the project but not directly created by team members. Please

reach out to the instructors with any questions about what does vs. does not qualify as academic misconduct.

Failure to abide by the highest ethical standards will be grounds for removal from the class with a failing grade.

**College and School Guidelines (information on academic misconduct, withdrawing from courses, appealing grades, etc.):**

- <https://www.coe.utah.edu/students/current/semester-guidelines/>
- <https://handbook.cs.utah.edu/current/Academics/policies.php>

## 5 Statement on “Reasonable” “Human Beings” and Course Environment

We invite you to think of your professors as reasonable human beings who want to help facilitate the learning of other reasonable human beings. This means that:

- If you have legitimate problems that you **communicate ahead of time**, there is a high chance that something can be worked out.
- If your communications are **professional, kind, constructive, and well-reasoned**, it is more likely (see “professors are human” above) that you will be treated in the kind, professional, and reasonable manner that you would want to be treated and that your concern will be resolved more quickly and to your satisfaction.
- Use these **same principles when interacting with TAs and other students**, even in meetings within the team.
- Please see in the [Campus Resources](#) section the university’s statement about discrimination and harassment (and how to report it). Please also keep in mind that [microaggressions](#) - subtle, even unintentional remarks - also contribute to an unwelcoming environment. Recognizing microaggressions in yourself and others and how to balance things like humor and team bonding with professionalism should be part of an ongoing learning process for yourself both in this course and in the workplace.

**Inclusive Environment:** It is our intent that students from all diverse backgrounds and perspectives be well-served by this course, that students’ learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a resource, strength and benefit. It is our intent to present materials and activities that are

respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture. Feel free to reach out to us if you would like to make us aware of ways that the classroom environment or teaching materials could be improved.

**The Pledge of the Computing Professional.** All students in the course will be encouraged to take this pledge.

## 6 Academic Accommodations

We require that students arrange their accommodations through the CDA (see paragraph below). If you are aware that you qualify as having a disability or believe that you might qualify, we encourage you to reach out to the CDA as soon as possible. You can always choose not to use accommodations recommended by the CDA, and School of Computing faculty and staff are not made aware of your arrangement until you notify them.

We also recognize that current circumstances can be very disruptive to established routines and strategies. We are not experts, but we encourage you (if you have not) to consider proactively establishing or re-establishing contact with appropriate groups or professionals in order to explore (for example) what routines or strategies might benefit from being updated given the current global circumstances. Also see the section below on [Wellness, Resiliency, Self-Care, and Productivity](#).

**Americans with Disabilities Act.** The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the [Center for Disability & Access](#), (801) 581-5020. CDA will work with you and the instructor to make arrangements for accommodations.

## 7 COVID-19

- Please refer to <https://coronavirus.utah.edu/> for information about Covid during Fall 2023

## 8 Student Mental Health Resources

- Rates of burnout, anxiety, depression, isolation, and loneliness have noticeably increased during the pandemic. If you need help, reach out for [campus mental health resources](#), including counseling, training, and other support.
- Consider participating in a [Mental Health First Aid](#) or other [wellness-themed](#) training provided by our Center for Student Wellness and sharing these opportunities with your peers, teaching assistants and department colleagues.



## 9 Wellness, Resiliency, Self-Care, and Productivity

Let us all take a moment to acknowledge that CS is a demanding/time consuming degree, filled with stresses and sometimes setbacks. (Hopefully you also experience some joys and victories too!) There is also the pressures of the “outside world”, e.g., work, politics, Covid, children, culture, etc. Some of us may feel that this is an extremely overwhelming and disruptive time. Others may feel that life is just pretty good all around. Regardless, maintaining or adopting new ways to proactively practice “self-care” can help maintain or improve your overall wellness and resiliency, which is valuable both for its own sake and because it can help you succeed academically.

**You might want to consider giving yourself the “homework” - especially early in the semester - of looking through wellness and work-from-home resources/opportunities and then figuring out what works for you. You could think of it as an opportunity to debug and learn how to optimize yourself!**

General strategies for wellbeing include things like: getting enough sleep on a consistent schedule, getting enough exercise and sunlight, interpersonal contact, separation of “work” and “play” time and spaces, accountability structure (e.g., regularly attending lecture), and practicing time management (so that you know what you should be working on when, that you have enough time to get things done based on how things are going, and that you can put work down at the end of the day).

We encourage you to dedicate some intentional time to better understand what helps you feel (and do!) your best so that you are well-equipped for whatever the year brings. The University has resources like:

- [Center for Student Wellness](#)
- [Mindfulness Center](#)
- [Campus Recreation Services](#)
- [University Counseling Center](#)

# 10 Campus Resources

- COVID-19 CENTRAL @THEU: <https://coronavirus.utah.edu/>
- Resources available to students (has a lot of the below, but also a few other additions): <https://attheu.utah.edu/facultystaff/resources-available-to-students/>
- Office for Inclusive Excellence: <https://inclusive-excellence.utah.edu/>
- Center for Ethnic Student Affairs (CESA): <https://diversity.utah.edu/centers/cesa/>
- LGBT Resource Center: <https://lgbt.utah.edu/>
- Black Cultural Center: <https://diversity.utah.edu/centers/bcc/>
- American Indian Resource Center: <https://diversity.utah.edu/centers/airc/>
- Resources for Undocumented Students: <https://attheu.utah.edu/announcements/resources-for-undocumented-students/>
- Office of Equal Opportunity, Affirmative Action, and Title IX: <https://oeo.utah.edu/>
- Campus police courtesy escort: 801-585-COPS (801-585-2677)
- #SAFEU: [safeu.utah.edu](https://safeu.utah.edu)

**Discrimination and Harassment:** Violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression), race, national origin, color, religion, age, status as a person with a disability, veteran's status, or genetic information are civil rights offenses. If you or someone you know has been harassed or assaulted, you are encouraged to [report the incident to the Office of Equal Opportunity And Affirmative Action \(OEO/AA\)](#) or to the [Office of the Dean of Students](#). Counseling is available at the [University Counseling Center](#). Resources for general wellness and resiliency are available at the [Center for Student Wellness](#). To report to the police, contact the [Department of Public Safety](#), 801-585-2677(COPS).