

# Applied Cyberinfrastructure 429/529 (3 units)

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Asynchronous Online Format; Weekly modules completed at your own pace.

## Description of Course

This course provides an introduction to applied cyberinfrastructure in collaboration with a virtual training program with National Science Foundation (NSF) CI Compass. This course has two components: (1) Technical Skills and (2) Data Lifecycle.

The technical skills component provides students with experience in technical skills relevant to cyberinfrastructure (i.e., software engineering, cloud computing, data workflows, etc.).

The data lifecycle component provides students with a contextual understanding of the NSF major facilities (MFs) and related cyberinfrastructure through learning about the data lifecycle of specific MFs and engaging with guest speakers from MFs and the greater cyberinfrastructure community.

For the class project, students will research a NSF MF to learn about its science mission, cyberinfrastructure, and data lifecycle.

Students work independently online to gain skills in:

### Technical Skills:

- the command line
- an overview of scientific computing
- best practices in software development
- cloud computing
- software architecture and systems
- digital archives
- machine learning
- neural networks

### Data Lifecycle:

- applied cyberinfrastructure and major facilities
- high-performance computing capabilities through NSF sponsored facilities
- FAIR data
- Professional communication and networking skills

These skills are taught by guest lectures from CI professionals and directors of NSF major facilities, and hands-on learning activities.

## Course Prerequisites or Corequisites

No experience required.

## Tools needed

An Apple or Windows computer. Virtual Machine software. A free account on Amazon Web Services. A free account on GitHub.

## Instructor and Contact Information

- Instructor: Bonnie Hurwitz, Associate Professor, Biosystems Engineering
- Office: Bio5 Keating, Room 223
- E-mail: [bhurwitz@arizona.edu](mailto:bhurwitz@arizona.edu)
- Office Hours: 11:00 AM Friday on Zoom (<https://arizona.zoom.us/my/bonniehurwitz>)
- Course Website: <https://github.com/ci-compass/cicf>

## Course Objectives

The course objective is to gain skills in applied cyberinfrastructure through short lectures from CI experts, and hands-on CI skills. This course introduces techniques CI professionals use daily, from how to manage data, to best practices in software development, to systems and methods to scale analyses to meet today's grand challenges with large-scale datasets, cloud-based and high-performance compute architectures, and massive scalable compute. This course teaches students real-world skills in applied CI broadly to advance scientific computing and biological data analysis.

**Expected Learning Outcomes** This course is designed to provide students with a foundational understanding of applied cyberinfrastructure. Upon completing this course students will be able to:

- Be able to describe what cyberinfrastructure (CI) is;
- Understand how CI is used in major facilities to manage data and analyses;
- Work on the command line;
- Write short Python Programs, work with Jupyter notebooks;
- Use Git and understand coding standards;
- Work with containers and debug them;
- Understand FAIR data principles;
- Understand architectures and archives;
- Access and use cloud resources;
- Create data workflows;
- Describe challenges in using machine learning, AI and neural networks.

All students will complete a class project to investigate how CI is used in major facilities, and present their findings in a 5 minute lightning talk. Graduate students are required to also submit a Deep Dive in Packback on their class project (that is not required for undergraduates).

## Course Format and Teaching Methods

The course is taught using an asynchronous online format, that allows students to work at their own pace through online lectures and technical & coding exercises in GitHub that demonstrate core concepts. An interactive group discussion (via slack) is available to get help from other students and the instructor. Lectures are complemented with discussions in Packback to ask questions and reinforce concepts from lectures. Technical skills are gained through labs that are available in GitHub. Students will complete a poll in Packback after each lab to give their feedback and check in on learning. Importantly, because the technical skills in this class build on each other it is essential to complete all lab assignments each week. Assignments (Discussions and Polls) are due at the end of each week on Sundays at 11:59pm. The class

project gives the students an opportunity to learn about major facilities (MF) that use cyberinfrastructure at NSF. Students research these MFs and complete a project at the end of the semester. The project is due on the last day of classes (5/7/25) at 11:59pm.

## Absence and Class Participation Policy

Watching weekly videos and completing technical labs assignments is vital to the class. As such, all assignments are due at the end of the week (Sunday at 11:59 pm). Students who miss assignments due to illness or emergency are required to bring documentation from their health-care provider or other relevant, professional third parties. Failure to submit third-party documentation will result in missing/ungraded assignments for the week.

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at <http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop>

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, <http://policy.arizona.edu/human-resources/religious-accommodation-policy>.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: <https://deanofstudents.arizona.edu/absences>

Makeup Policy for Students Who Register Late Students who register after the first class meeting may make up missed assignments/quizzes within the first two weeks of class.

## Course Communications

Online communication will be conducted through Slack, and grading on D2L. Course materials (video lectures, recommended readings, homework and project assignments) will be available on D2L and the course GitHub site (<https://github.com/ci-compass/cicf>). Students are required to have their own GitHub account and can sign up for a free account here: <https://github.com/>. The GitHub privacy statement is located here: <https://help.github.com/articles/github-privacy-statement>. Slack (<https://slack.com/>) will be used for online class discussion forums, and each student will be invited to the slack channel at the beginning of the semester.

## Required Texts or Readings

None.

## Optional Texts or Readings

None.

## Required or Special Materials

Students will be required to create a free account on GitHub to gain access to technical labs. The course GitHub site is <https://github.com/ci-compass/cicf>. Information on accessing these resources and detailed instructions are documented in week1 in D2L.

## Required Extracurricular, Activities

Optional events related to CI will be announced in D2L.

## Grading Scale and Policies

The final letter grades for the class are based on the TOTAL NUMBER OF POINTS that each student accumulates for the following assessments (see details for each section below):

Point Breakdown per Category:

Category	# Assessments	Points per assessment	Points total
Discussions (40%)	10	40	400
Labs (30%)	10	30	300
Project (30%)	1	300	300
Total			1000

Grading Scale:

Grade	A	B	C	D	F
Points	900 or more	800-899	700-799	600-699	less than 600

University policy regarding grades and grading systems is available at <http://catalog.arizona.edu/policy/grades-and-grading-system>.

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at <http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete> and <http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal> respectively.

Dispute of Grade Policy: Disputes on a grade for an assignment, quiz, or exam must be made within three days of when the grade is posted.

## Weekly Learning Modules

Each week's learning module consists of: instructional videos with recommended reading, a discussion forum based on the videos in Packback, and a hands-on lab assignment (in Github) and Poll in Packback to confirm completion of the lab. All lab assignments are on the course GitHub site <https://github.com/ci-compass/cicf>. All videos, links to resources and recommended readings are on D2L.

## Online videos and discussion (10 discussions, 40 pts each)

Each week, you will learn about cyberinfrastructure components from CI professionals at NSF major facilities. After watching these online videos (on D2L), you will participate in an online discussion in Packback and will write one question, and respond to two questions from fellow students. Weekly discussions need to be completed within the week they are assigned (Sunday by 11:59pm). Optional recommended reading may also be assigned in D2L.

## Labs (10 labs, 30 pts each)

The weekly labs provide you with hands-on practice with CI related skills (command line, python, jupyter notebooks etc). Each week's lab is assigned on Mondays at 8:00am and due on Sundays at 11:59pm. Upon completing the lab, you will need to answer a Poll question in Packback to provide your feedback to the lab and confirm completion.

## Final Project (300 pts)

At the end of the semester, each student will complete a final project. For undergraduates, this will be a 5 minute lightning talk (300 pts) about what you learned about CI from one of the NSF major facilities discussed in this class. The graduate students will be required to complete the 5-minute lightning talk (100 pts) and a deep dive (200pts) in Packback about an NSF major research facility that they researched. Templates and rubrics for lightning talks and deep dives will be provided to help aid in completeness and transparency.

## Scheduled Topics/Activities

Videos and Slides will be available on D2L. The course GitHub Site is <https://github.com/ci-compass/cicf>

Assignments (due on Sundays the week they are assigned at 11:59pm, unless stated): D: Packback Discussions based on video lectures (1 question, 2 answers) P: Packback Polls feedback from completing labs (1 poll question) L: Course Project (1 -lightning talk in Voicethreads on D2L) DD: Course Project (1 - Deep Dive in Packback) **for graduate students only**

## Spring 2025 Schedule

week	Technical Skills	Data Life Cycle	dates	assignments
[Week 0][vm]	Setting up a virtual machine	N/A	1/20-1/24	
[Week 1][week01]	Command line	Intro to CI	1/27-1/31	P1, D1
[Week 2][week02]	Python programming	Guest - NCAR	2/3-2/7	P2, D2
[Week 3][week03]	Scientific computing	Guest - TACC	2/10-2/14	P3, D3
[Week 4][week04]	Git and coding standards	Guest - RCRV	2/17-2/21	P4, D4
[Week 5][week05]	Containers and debugging	Project work	2/24-2/28	P5, D5
[Week 6][week06]	FAIR data and systems	Guest - ORCID	3/3-3/7	P6, D6
UA Spring Break	N/A	N/A	3/10-3/14	
[Week 7][week07]	Architecture + Archives	Guest - MagLab	3/17-3/21	P7, D7
[Week 8][week08]	Cloud computing	Guest - NEON	3/24-3/28	P8, D8
Week 9	N/A	Communication skills	3/31-4/4	

week	Technical Skills	Data Life Cycle	dates	assignments
[Week 10][week10]	Data workflows	Guest - OOI	4/7-4/11	P9, D9
[Week 11][week11]	Machine Learning	Project work	4/14-4/18	P10, D10
[Week 11b] [week11b]	Neural Networks	Project work	4/21-4/24	
Weeks 16 and 17	N/A	Presentations	4/28-5/7	L and DD on 5/7

No Final!

## Honors Credit

Students wishing to use this course for Honors Credit should email me to set up an appointment to discuss the terms of the contract. Typically undergraduate honors students implement an additional project for the final project. Information on Honors Contracts can be found at <http://www.honors.arizona.edu/faculty-and-advisors/contracts>.

## Classroom Behavior Policy

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.). Threatening Behavior Policy The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See <http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>.

## Accessibility and Accommodations

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, you are welcome to let me know so that we can discuss options. You are also encouraged to contact Disability Resources (520) 621-3268 to explore reasonable accommodation.

If our class meets at a campus location: Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

## Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described

in the UA General Catalog. See <http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity>.

The University Libraries have some excellent tips for avoiding plagiarism, available at <http://new.library.arizona.edu/research/citing/plagiarism>. Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

## Statement on the use of Generative AI

In this course any and all uses of generative artificial intelligence (AI)/large language model tools such as ChatGPT, Dall-e, Google Bard, Microsoft Bing, etc. will be considered a violation of the Code of Academic Integrity, specifically the prohibition against submitting work that is not your own. This applies to all assessments in the course, including coding assignments, discussions, quizzes, and exercises. This course policy is driven by the learning goals and desired learning outcomes for the course (see above).

The following actions are prohibited:

- entering all or any part of an assignment statement or test questions as part of a prompt to a large language model AI tool;
- incorporating any part of an AI-written response in an assignment;
- using AI to summarize or contextualize reading assignments or source materials; and
- submitting your own work for this class to a large language model AI tool for iteration or improvement.

## UA Nondiscrimination and Anti-harassment Policy

The University is committed to creating and maintaining an environment free of discrimination; see <http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy> Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

## Additional Resources for Students

UA Academic policies and procedures are available at <http://catalog.arizona.edu/policies> Student Assistance and Advocacy information is available at <http://deanofstudents.arizona.edu/student-assistance/students/student-assistance>

## Confidentiality of Student Records

<http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa>

## Subject to Change Statement

The information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.