Combined Syllabus CSC/ECE 591, OR 791

Metaheuristics for Search and Optimization

Sections csc 591-023, 591-631 (DE), ece 591-015, and or 791-006

Spring 2024, 3 Credit Hours

Course Description

Nature-inspired metaheuristics use concepts derived from nature to solve computational problems. The course aims to teach students how computational processes can be derived from natural phenomena and how to implement simple nature-inspired algorithms in Julia. We will discuss fundamental algorithms, basic optimization tasks, performance metrics, and applications.

Topics include

- Introduction to Optimization by Metaheuristics
- No-Free Lunch Theorem
- Performance metrics, Tuning and Benchmarking
- Single-State Methods (Hill-climbing, Simulated Annealing, Iterated Local Search etc.)
- Tabu Search
- Genetic Algorithms
- Evolution Strategies, Genetic Programming
- Differential Evolution
- Particle Swarm Optimization
- Ant Colony Optimization
- Whale/Grey-Wolf Optimization
- Research Trends in recent nature-inspired Metaheuristics

This is an approximate list. We will introduce or omit topics as warranted by student interest and time.

Learning Outcomes

Upon completion of the course, students will be able to:

• Explain the basic concepts behind nature-inspired metaheuristics applied to search and optimization problems

• Implement nature-inspired algorithms using the high-level, high-performance, dynamic programming language Julia

• Benchmark search and optimization algorithms

Course Structure

The coursework consists of lectures (paper discussions & lecture material, Julia labs), readings, weekly quizzes or paper summaries, a team project, and 3 homework assignments; CSC 791 students will create an additional in-depth paper focusing on a topic related to their research project.

• Class attendance and participation are mandatory.

• All homework assignments are intended to be individual work.

• Project: in teams of two; mandatory preproposal, proposal, and final report.

• Each team will produce a slide cast of their project.

• Term paper (for CSC 791 students): solo or in teams of two at the student's choice.

Instructors

Steffen Heber (sheber) - *Instructor*
Email: sheber@ncsu.edu
Web Page: https://www.csc.ncsu.edu/people/sheber
Zoom: **https://ncsu.zoom.us/j/6943624188**
Phone: 919-513-1118
Office Location: 2260 EB2
Office Hours: Tuesday 4:00 PM-5:00 PM or by appointment

TA: Anika Bhadriraju
Email: albhadri@ncsu.edu
Office hours: by appointment

Course Meetings

Lecture

Days: F
Time: 12:50pm - 3:35pm
Campus: Centennial
Location: 02213 Engineering Building 3
This meeting is required.

Course Materials

Textbooks

Essentials of Metaheuristics - *Sean Luke*
Edition: Second
ISBN: 1300549629
Web Link: http://cs.gmu.edu/~sean/book/metaheuristics/
Cost: Available for free
This textbook is optional.

Expenses

None.

Materials

None.

Requisites and Restrictions

Prerequisites

Students must have a basic knowledge of discrete mathematics, the design and analysis of algorithms, and the ability to perform basic statistical analyses and hypothesis tests.

Co-requisites

None.

Restrictions

TBD

Transportation

This course will not require students to provide their own transportation.

Safety & Risk Assumptions

None.

Grading

Grade Components

Component	Details	Weights (add up to 105%)		
		CSC/ECE 591	OR 791	DE
quizzes and/or paper summaries	weekly closed-book, in-class quizzes via Moodle, or paper summaries via Moodle. DE section only paper summaries.	15%	15%	20%
team project	teams of 2 (or 3). The project consists of • preproposal & proposal (10%), • milestone report (10%) • final presentation (10%) • template paper presentation via a recorded slide cast (10%) • notebook & verification (25%) • project report (25%) • project artifacts (10%)	45%	40%	50%

term paper	focus on a research question related to your project, contact me to discuss details	NA	10%	0%
homework	three assignments, equal weight, individual work	35%	30%	35%
Attendance and participation	We will measure your attendance and/or participation in programming activities to compute a participation score. You can skip **up to three classes**. You could lose points for participation if you skip more.	5%	5%	0%

- Attendance is mandatory. You don't need to explain skipping **up to three classes**. You could lose points for participation if you skip more.
- We will measure your attendance and participation in class, programming activities, and Piazza to compute a participation score.
- All quizzes are closed book. No cell phones are allowed, but basic calculators are permitted.
- There are no makeups for quizzes and paper summaries. Instead, we will drop your four lowest scores.
- Course grades may be curved up, but they will never be curved down.
- There is a one-week time limit for submission of disputes for quizzes and assignments. The entire quiz or assignment, not just the disputed question, will be re-graded.

Letter Grades
This Course uses Standard NCSU Letter Grading:

97	≤	A+	≤	100
93	≤	A	<	97
90	≤	A-	<	93
87	≤	B+	<	90
83	≤	B	<	87
80	≤	B-	<	83
77	≤	C+	<	80
73	≤	C	<	77
70	≤	C-	<	73
67	≤	D+	<	70

63	≤	D	<	67
60	≤	D-	<	63
0	≤	F	<	60

Requirements for Credit-Only (S/U) Grading

Performance in research, seminar, and independent study types of courses (6xx and 8xx) is evaluated as either "S" (Satisfactory) or "U" (Unsatisfactory), and these grades are not used in computing the grade point average. For credit-only courses (S/U), the requirements necessary to obtain the grade of "S" must be clearly outlined.

Requirements for Auditors (AU)

The course cannot be audited.

Information about and requirements for auditing a course can be found at http://policies.ncsu.edu/regulation/reg-02-20-04.

Policies on Incomplete Grades

If an extended deadline is not authorized by the Graduate School, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions), or (b) by the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that change to F will count as an attempted course on transcripts. The burden of fulfilling an incomplete grade is the responsibility of the student. The university policy on incomplete grades is located at http://policies.ncsu.edu/regulation/reg-02-50-03. Additional information relative to incomplete grades for graduate students can be found in the Graduate Administrative Handbook in Section 3.17.G at http://www.ncsu.edu/grad/handbook/index.php .

Late Assignments

All assignments and deliverables should be submitted via Moodle and are due at 9 PM on the due date. Late homework will be accepted only in circumstances that are grounds for excused absence under university policy (policies.ncsu.edu/regulation/reg-02-20-03, item 3). The university provides mechanisms for documenting such reasons. Arrangements for turning in late homework must be made by the day preceding the due date, if possible. Unexcused late submissions will result in a 10%/40% point reduction on the first/second day after the due date. No credit will be given for submissions three or more days late.

Attendance Policy

Attendance is mandatory. You don't need to explain skipping **up to three classes**. You could lose points for participation if you skip too many classes or attend but do not participate adequately.

For complete attendance and excused absence policies, please see http://policies.ncsu.edu/regulation/reg-02-20-03 .

Absences Policy

None.

Makeup Work Policy

None.

Additional Excuses Policy

None.

Academic Integrity

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Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct at http://policies.ncsu.edu/policy/pol-11-35-01 and the Pack Pledge.

- Academic integrity is not negotiable. Every piece of work except the team project and the paper presentation is required to be completed individually.
- Academic integrity violations will be handled per the Student Discipline Procedures (NCSU REG 11.35.02).
- If an academic integrity violation occurs, the offending student(s) will be assessed a penalty at least as severe as getting a 0 for the whole assignment for which the violation occurred. The case will always be reported to the Office of Student Conduct.
- Any tool/resource must be approved by the instructor and identified and acknowledged clearly in any work turned in; anything else is plagiarism.

Honor Pledge

Your signature on any test or assignment indicates, "I have neither given nor received unauthorized aid on this test or assignment."

Digital Course Components

Students may be required to disclose personally identifiable information to other students in the course via digital tools, such as email or web postings, where relevant to the course. Examples include online discussions of class topics and the posting of student coursework. All students are expected to respect each other's privacy by not sharing or using such information outside the course.

Digital Course Components: Online course components include Moodle, Zoom, Google Suite, Panopto, and Piazza. Lectures will be recorded and made available on Panopto. Please let me know if you wish to avoid being recorded, and we can discuss options.

We will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, the TA, and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. If you have any problems or feedback for the developers, email team@piazza.com.

Find our class signup link at https://piazza.com/ncsu/spring2024/cscece0r591791 .

We may use plagiarism-detection software tools to review your deliverables. These tools may include iThenticate, MOSS, and others.

Accommodations for Disabilities

Reasonable accommodations will be made for students with verifiable disabilities. To take advantage of available accommodations, students must register with the Disability Resource Office at Holmes Hall, Suite 304, 2751 Cates Avenue, Campus Box 7509, 919-515-7653. For more information on NC State's policy on

working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (NCSU REG 02.20.01) (https://policies.ncsu.edu/regulation/reg-02-20-01/).

Non-Discrimination Policy

NC State provides equal opportunity and affirmative action efforts. It prohibits all forms of unlawful discrimination, harassment, and retaliation ("Prohibited Conduct") that are based upon a person's race, color, religion, sex (including pregnancy), national origin, age (40 or older), disability, gender identity, genetic information, sexual orientation, or veteran status (individually and collectively, "Protected Status"). Additional information on each Protected Status is included in NCSU REG 04.25.02 (Discrimination, Harassment and Retaliation Complaint Procedure). NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at http://policies.ncsu.edu/policy/pol-04-25-05 or https://oied.ncsu.edu/divweb/. Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Institutional Equity and Diversity (OIED) at 919-515-3148.

Course Schedule

The Course Schedule (including assignments) is posted on our Moodle page in a separate file, Schedule_591_791.

NOTE: Course schedule and syllabus are subject to change.