CS776: Evolutionary Computation

Fall 2023, 1 – 2:15 pm
Location: LME 321
https://www.cse.unr.edu/~sushil/class/gas/
and on Canvas

Course Information

Instructor Information

Instructor: Sushil Louis
Office: WPEB 409
Phone: 7757484315
Email: sushil@unr.edu
Office Hours: MW: 11am to noon and by appointment. Check my calendar for an available time and send me a meeting invitation for that time. In the invitation, let me know what you want to discuss.

Course Description

Theory and practice of evolutionary computing. Applications in search, optimization, and machine learning. Analysis of representations, operators, and fitness landscapes.

Required Texts/Course Materials

List of required course materials for reading, in-class work, writing, homework, viewing, and listening, including calculators, specialized materials or equipment, and computer software.

Textbooks:

- **Required**: David E. Goldberg, Genetic algorithms in search, optimization and machine learning, 1989, Addison-Wesley.
- Recommended: Sutton and Bratko, Reinforcement Learning, An Introduction Second edition, MIT Press.
- Recommended: David Fogel, Evolutionary Computation Towards a new Philosophy of Machine Intelligence, 1995, IEEE Press.
- Recommended: John Holland, Adaptation in Natural and Artificial Systems, 1992, The MIT Press.
- Recommended: John Koza, Genetic Programming: On the Programming of Computers by Means of Natural Selection, 1992, Bradford Books.

- Recommended: Melanie Mitchel, An Introduction to Genetic Algorithms, 1996, The MITPress

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Computing and Networking:

- Remote engineering computing center computing access
    - Windows: Remote ECC Machines: https://remote.engr.unr.edu
    - Windows: Remote Desktops: https://remote.unr.edu
    - Linux: Request remote access to ECC Linux resources using: https://nevada.formstack.com/forms/cse_remote_linux_desktop_request. This is good to have even if you already have a personal linux box.
- If you would like a piece of software added or upgraded, please fill out the form below: Remote Engineering Desktop Software Request

Course objectives, structure, requirements and outcomes

I will introduce search in AI, then genetic algorithms and their theory in the first few weeks of the course. We will then investigate evolution strategies and genetic programming by understanding how they differ from genetic algorithms on the path to a unified understanding of evolutionary computation.

Students will be presenting selected (by me) papers for the next few weeks. You may present an evolutionary computing paper that interests you, but need my prior approval. You can then work in teams on a mutually agreeable research problem or project and are welcome to work on areas that interest you. Again though, you need my approval and a clear understanding of the scope.

This semester I am most interested in evolutionary computing approaches to

- Evolutionary computing in games, simulations, and robotics
- Adaptive Training and Human-AI teaming
- Interactive Evolutionary Optimization
- Scientific discovery - model tuning and inversion
- Multi-objective optimization
- Reinforcement learning and evolutionary computing

Please talk to me soon about projects – the sooner you get started the better you will do. Projects will probably combine one or more of the above topics. For example, you might do multi-objective design optimization. There are several ways to do well in this class.

- Research: Do publishable research. If you do not know how to conduct research this course will also teach you how. You will investigate a research problem that I think I understand and to which I am reasonably sure a solution exists. Write a

publishable quality research paper based on your results. We will aim for a conference publication with deadlines in December and January.

- Research and Development: Apply a genetic or other evolutionary computing technique to solve a well-known NP-Hard/NP-Complete problem (I know this problem can be solved and probably how to solve it using evolutionary computation). Implement a State-Of-The-Art (SOTA) technique from a published paper and put it on the web so that users may input their own problem specification files.

Groups are encouraged but need my permission. Project presentations will be at the end of the semester. While working on your problem, you will find, read, and present historically influential papers that helped define the field, papers pertaining to your problem, and/or papers that you find interesting. Become familiar with library and internet resources. In addition to your presentations, there will be research presentations from graduate students, faculty, and other speakers. Finally, you will learn how to efficiently read technical papers, write technical reports, present technical work, and perform scientific research and development. I encourage and require enthusiastic class participation.

Please look in https://www.cse.unr.edu/~sushil for pointers to papers and other information useful for this course. **This is a research oriented class**. Research projects or research and development projects that you start in this class will usually constitute part, or a majority, of a Master's or Ph.d. thesis or technical paper.

Student Learning Outcomes

- SLO1. Students will be able to identify problems suitable for attack by evolutionary computation and solve such problems using evolutionary computing
- SLO2. Students will be able to compare and contrast evolutionary strategies and genetic programming against canonical genetic algorithms in terms of representation, selection, crossover, and mutation.
- SLO3. Students will be able to perform research and write a research paper or develop an online application using evolutionary computation
- SLO4. Students will be able to read research papers and give research presentations

Course Requirements

Your grade will depend on assignments, presentations, and project reports and we will use the +/- grading system. I will expect to see you after each presentation to discuss the presentation and assign you a grade. Completing assignments is crucial for success in this course.

Note again that this is a research oriented class. **Any person or group producing publishable work gets an automatic A**.

Grading Criteria, Scale, and Standards

Your grade will be calculated from the following table.

Item	Percentage
Assignments	10%
Quizzes	20%
Presentations	10%
Project and paper	60%

Late Work or Make-up Exams Policies

You may submit one assignment late by up-to three days, with a 10% penalty per day.

Laboratory Settings

Ensure you have remote access to the engineering computing center (ECC) computing resources on both **linux** and windows. Request Linux instance using: https://nevada.formstack.com/forms/cse_remote_linux_desktop_request. Your assignments will require linux access. You may also ensure that you have linux (and other OSs) on your computing desktop or laptop using other means.

University Policies

Statement on COVID-19 Policies

Face Coverings
Pursuant to Nevada law, NSHE **employees, students and members of the public are not required to wear face coverings while inside NSHE buildings irrespective of vaccination status.** However, students may elect wear face coverings if they choose.

Disinfecting Your Learning Space
Disinfecting supplies are provided for your convenience to disinfect your learning space. You may also use your own disinfecting supplies.

Testing Positive for COVID-19 or Exhibiting COVID-19 Symptoms
Students testing positive for COVID 19 or exhibiting COVID 19 symptoms will not be allowed to attend in-person instructional activities and must leave the venue immediately. Students should contact the Student Health Center or their health care provider to receive care and information pertaining to the latest COVID 19 quarantine and self-isolation protocols. If you are required to quarantine or self-isolate, you must contact your instructor immediately to make instructional and learning arrangements.

Accommodations for COVID 19 Quarantined Students
For students who are required to quarantine or self-isolate due to testing positive for COVID or exhibiting COVID 19 symptoms, instructors must provide opportunities to make-up missed

course work, including assignments, quizzes or exams. In courses with mandatory attendance policies, instructors shall not penalize students for missing classes while quarantined.

Failure to Comply with Policy (including as outlined in this Syllabus) or Directives of a University Employee

In accordance with section 6,502 of the University Administrative Manual, a student may receive academic and disciplinary sanctions for failure to comply with policy, including this syllabus, for failure to comply with the directions of a University Official, for disruptive behavior in the classroom, or any other prohibited action. "Disruptive behavior" is defined in part as behavior, including but not limited to failure to follow course, laboratory or safety rules, or endangering the health of others. A student may be dropped from class at any time for misconduct or disruptive behavior in the classroom upon recommendation of the instructor and with approval of the college dean. A student may also receive disciplinary sanctions through the Office of Student Conduct for misconduct or disruptive behavior, including endangering the health of others, in the classroom. The student shall not receive a refund for course fees or tuition.

Statement on Academic Dishonesty

"The University Academic Standards Policy defines academic dishonesty, and mandates specific sanctions for violations. See the University Academic Standards policy: UAM 6,502."

Statement of Disability Services

For Traditional and Seated Classrooms:

"Any student with a disability needing academic adjustments or accommodations is requested to speak with me or the Disability Resource Center (Pennington Achievement Center Suite 230) as soon as possible to arrange for appropriate accommodations."

For Online Courses:

"If you are a student who would normally seek accommodations in a traditional classroom, please contact me as soon as possible. You may also contact the Disability Resource Center for services for online courses by emailing drc@unr.edu or calling 775-784-6000. Academic accommodations for online courses may be different than those for seated classrooms; it is important that you contact us as soon as possible to discuss services. The University of Nevada, Reno supports equal access for students with disabilities. For more information, visit the Disability Resource Center."

This course may leverage 3ʳᵈ party web/multimedia content, if you experience any issues accessing this content, please notify me (sushil@unr.edu).

Statement on Audio and Video Recording

"Surreptitious or covert video-taping of class or unauthorized audio recording of class is prohibited by law and by Board of Regents policy. This class may be videotaped or audio recorded only with the written permission of the instructor. In order to accommodate students with disabilities, some students may have been given permission to record class lectures and discussions. Therefore, students should understand that their comments during class may be recorded."

Statement on Maintaining a Safe Learning and Work Environment

The University of Nevada, Reno is committed to providing a safe learning and work environment for all. If you believe you have experienced discrimination, sexual harassment, sexual assault, domestic/dating violence, or stalking, whether on or off campus, or need information related to immigration concerns, please contact the University's Equal Opportunity & Title IX office at 775-784-1547. Resources and interim measures are available to assist you. For more information, please visit the Equal Opportunity and Title IX page**.**

- **Communications**: If I need to communicate with the class as group I'll email you through canvas. You are required to check canvas and your UNR email every day. Make sure your email information in MyNevada and Canvas is up to date and implement mail forwarding if you need to. Other resources can be found on the class web page

- **Statement for Academic Success Services**: "Your student fees cover usage of the Math Center (775) 784-4433, Tutoring Center (775) 784-6801, and University Writing Center (775) 784-6030. These centers support your classroom learning; it is your responsibility to take advantage of their services. Keep in mind that seeking help outside of class is the sign of a responsible and successful student."