CE 563 SYSTEMS OPTIMIZATION USING EVOLUTIONARY ALGORITHMS
Tu-Th 2:30p-3:45p
205 S Henderson South

INSTRUCTOR: Dr. Patrick Reed
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EMAIL: preed@engr.psu.edu
OFFICE HOURS: Tuesday 9am –11am, Thursday 9am-11am or by appointment. I highly recommend emailing me to schedule meeting appointments since I am teaching a large undergraduate course this semester.

REQUIRED TEXT:

Bäck, T., Fogel, D., and Michalewicz, editors (2000). *Handbook of Evolutionary Computation*, IOP Publishing Ltd. and Oxford University Press. (Electronic Access on the course's ANGEL website)

TEXTS ON RESERVE:

Goldberg, D. E. (1989). *Genetic Algorithms in Search, Optimization and Machine Learning*. Addison-Wesley Publishing Company, Reading, Massachusetts.

Deb, K. (2001). *Multi-Objective Optimization using Evolutionary Algorithms*, John Wiley & Sons LTD, New York, NY.

Schwefel, Hans-Paul (1995). *Evolution and Optimum Seeking*. John Wiley & Sons, Book and Disk edition, ASIN # 0471571482.

RECOMMENDED REFERENCES:

Cantu-Paz, E. (2000). *Efficient and Accurate Parallel Genetic Algorithms*, Kluwer Academic Publishers, Norwell, Massachusetts.

Coello Coello, C. A., D. A. Van Veldhuizen, and G. B. Lamont. (2002). *Evolutionary Algorithms for Solving Multi-Objective Problems,* Kluwer Academic Publishers, Norwell, Massachusetts.

Dasgupta, D. and Z. Michalewicz. (1997). *Evolutionary Algorithms in Engineering Applications*, Springer-Verlag, New York, NY.

Z. Michalewicz and D. Fogel. (2000). *How to Solve It: Modern Heuristics*, Springer-Verlag, New York, NY.

COURSE DESCRIPTION:

Evolutionary algorithms (EAs) are global optimization heuristics that search for optima using a process that is analogous to Darwinian natural selection. Since their inception in the 1960s, evolutionary algorithms have been used in a tremendous array of applications. The growing popularity of evolutionary algorithms stems from their ease of implementation and robust performance for difficult engineering and science problems.

This course provides a comprehensive introduction to the field of genetic and evolutionary computation (GEC). The course will emphasize state-of-the-art methods for designing and implementing evolutionary algorithms for computationally intensive engineering and science problems.

COURSE GOALS:

I intend for this course to assist you in using EAs in current or future research. After this course, you will be able to

- Implement evolutionary algorithms on challenging engineering and science applications
- Work collaboratively in interdisciplinary teams
- Design and parameterize evolutionary algorithms for maximum efficiency
- Critically assess the relative benefits and limitations of available algorithms
- Effectively present and communicate your EA-based results

CLASS FORMAT:

Class periods will be a mixture of lecturing and group discussion. I will expect you to ***actively participate*** in each lecture. Your participation will require that you keep current with the course reading assignments and actively participate in group discussions. As the semester progresses, a portion of class periods will be dedicated for discussion of homework assignments, case studies, final projects, and your course-related research interests. This course is uniquely interdisciplinary and should be viewed as a forum for building a broad understanding of the challenges and benefits of using EAs.

PREREQUISITES:

I will assume that you have a basic familiarity with computer programming and optimization. You should have at a minimum Math 220, Math 250, and CMPSC 201. You will be expected to perform straightforward programming using Fortran or C source code.

HOMEWORK:

The homework should be done in groups with approximately 3 students. There will be 2 homework assignments that will require the formulation, implementation, and solution of problems using an array of the EAs. These assignments will require each group to present their results in well written professional reports (report clarity and quality will be graded).

The homework due dates will be strictly enforced. You will lose 10% of your grade for every day your assignment is late up to a maximum of 5 days after which you will receive no credit.

In addition to these assignments, each group will asked to prepare a lecture that presents emerging topics in the GEC field and their application to science-and-engineering. I will work with each group in the selection of their lecture topics and the preparation of the lecture. This will be a great way for us to share research ideas in a "think-tank" setting!

TERM PROJECT:

You will be required individually or in your groups to apply one of the methods we discuss in class. These applications should fall in one of the following categories:

(a) Real-world application
(b) Algorithm modification or development to solve a problem class of interest to you
(c) Theoretical analysis of evolutionary algorithm performance

You may use any existing source code or software available to you. This project is meant to help you integrate your research into the course. You will be required to prepare a detailed project proposal early in the semester, a midterm progress report, and submit a final written paper with an accompanying in-class presentation at the end of the semester. See the following example reports:
http://www.engr.psu.edu/ce/Divisions/Hydro/Reed/Reports.htm

GRADING:

Participation	10 %
Homework	30 %
Lecture	20 %
Final Project	40 %

Letter grades will be based on the weighted average specified above and assigned as follows:

- A = 94-100%
- A- = 90-93%
- B+ = 87-89%
- B = 84-86%
- B- = 80-83%
- C+ = 76-79%
- C = 70-75%
- D = 60-69%
- F < 60%

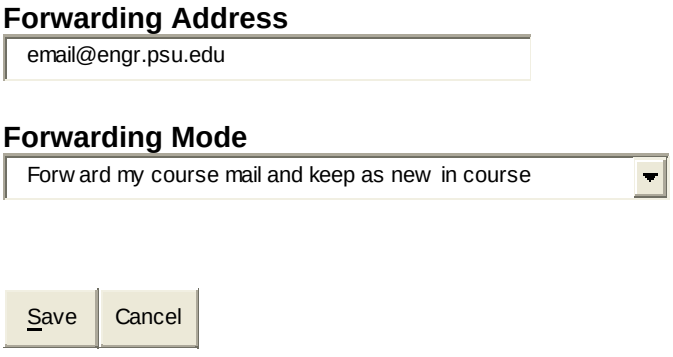
I reserve the right to adjust your grades. Your grade will only improve if adjustments are necessary. Feel free to contact me during office hours or by appointment if you have grade-related questions or concerns.

ON-LINE CLASS PARTICIPATION:

All course emails and web postings will be made using the ANGEL course management software. You will need to regularly login (**https://cms.psu.edu/frameIndex.htm**) to check course announcements, download lectures, and access posted readings.

Important: When you 1st login into the system you must configure "My Settings" to forward course emails to your primary email account as follows:

Step 1: Login into system
Step 2: Click "My Settings"
Step 3: Click "System Settings"
Step 4: Type your Primary Email under "Forwarding Address" and set "Forwarding Mode" as shown below:



Step 5: Click "Save". You now should receive all course announcements in your primary email account as well as your ANGEL account.

ACADEMIC INTEGRITY

The University's statement on academic integrity, from which the following statement is drawn, is available at **http://www.psu.edu/dept/oue/aappm/G-9.html**

Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle. Consistent with this expectation, the University's Code of Conduct states that all students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts.

All students are expected to act with civility, personal integrity; respect other students' dignity, rights and property; and help create and maintain an environment in which all can succeed through the fruits of their own efforts. An environment of academic integrity is requisite to respect for self and others and a civil community.

Academic integrity includes a commitment to not engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty include cheating or copying, plagiarizing, submitting another persons' work as one's own, using Internet sources without citation, fabricating field data or citations, "ghosting" (taking or having another student take an exam), stealing examinations, tampering with the academic work of another student, facilitating other students' acts of academic dishonesty, etc.

Students charged with a breach of academic integrity will receive due process and, if the charge is found valid, academic sanctions may range, depending on the severity of the offense, from F for the assignment to F for the course.

TENTATIVE COURSE SCHEDULE (SPRING 2004)

LEC DATE	TOPIC	READING
1/11	Introduction	NONE
1/13	Review of Nonlinear Optimization	NONE
1/18	Introduction to Evolutionary Computing	A1.1-A1.3, A2.3
1/20	Basic Evolutionary Algorithms	B1.1-B1.3
1/25	Representing & Evaluating Your Designs	C1.1-C1.7, C4.1-C4.3
1/27	Fundamental Operators—Selection	C2.1-C2.8
2/1	Fundamental Operators—Mating & Mutation	C3.1-C3.4
2/3	Constrained Optimization	C5.1-C5.6 **(HW # 1 & Term Project Proposals Due)**
2/8	The Race, The Hurdle, The Sweet spot	HANDOUT 1
2/10	Design & Parameterization for Single Objective Applications	HANDOUT 2
2/15	Competent Genetic Algorithms	HANDOUT 3
2/17	Competent Genetic Algorithms	HANDOUT 3
2/22	STUDENT GROUP LECTURE	TBA
2/24	STUDENT GROUP LECTURE	TBA
3/1	STUDENT GROUP LECTURE	TBA
3/8	SPRING BREAK NO CLASS	NONE
3/10	SPRING BREAK NO CLASS	NONE
3/15	Multimodal Optimization Problems	C6.1-C6.2
3/17	Introduction to Multiobjective Optimization	C4.5 **(Term Project Status Report Due)**
3/22	Multiobjective Evolutionary Algorithms	HANDOUT 4
3/24	Multiobjective Evolutionary Approaches	HANDOUT 4
3/29	Design & Parameterization for Multiple Objective Applications	HANDOUT 5 **(HW #2 Due)**
3/31	STUDENT GROUP LECTURE	TBA
4/5	STUDENT GROUP LECTURE	TBA
4/7	STUDENT GROUP LECTURE	TBA
4/12	STUDENT GROUP LECTURE	TBA
4/14	Enhancing Efficiency—Hybridization	D3.1-D3.2, Handout 6
4/19	Parallelization Approaches	C6.3-C6.4 **(SWAP TERM PROJECT DRAFTS) Strict Deadline**
4/21	Parallelization Theory	None
4/26	Enhancing Efficiency—Fitness Evaluation Relaxation	Handout 7 **(REVIEWS DUE) Strict Deadline**
4/28	Term Project Presentations	None
4/29		**FINAL PROJECT REPORTS DUE!! Strict Deadline**