ABE6649C- Advanced Biological Systems Modeling

Section BSMG(24367)

Spring Semester 2020

Spring 2020: 3 credits

Lectures: Monday and Friday, 8:30-9:20: Lab Wed 3-6 pm
Venue: Rogers Hall (Room 106)

Instructors:

Dr. Greg Kiker, Professor
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Pre-requisites: This course requires ABE 5643C as a prerequisite or by admission from one of the instructors.

General Description and Objectives: This course serves as an advanced graduate class for continued modeling of biological processes and systems. It is the second and required course of the Biological Modeling Certificate offered by ABE (http://www.abe.ufl.edu/academics/graduate/certificate-biological-systems-modeling.shtml).

The course extends and deepens the curriculum of ABE5643C in that it covers more advanced modeling topics such as: (1) hands-on experience and confidence in formulating, solving (analytically and numerically with R programming), (2) interpreting the output of dynamic biological models; (3) object-oriented design and programming, cellular automata and agent-based model development, (4) High Performance Computing and Global Sensitivity and Uncertainty Analysis towards subjects of specific interest.

It is expected that students will have access to their own computer for this course. Additionally, access to the UF HyperGator Facility will be provided through this class.

Several different computer programming languages will be used in this course. Freeware compilers and platforms will be used to compile and execute these languages on students' own computers. While some class time will be devoted to programming design, syntax and

debugging, it is expected that the student will spend additional time outside of class to learn the basic rudiments, syntax and logic of these languages.

Class Objectives/Outcomes: At the close of this course, the student will be able to:

1. Conceptualize, design and implement a variety of intermediate and advanced biological system models
    - Translate biological concepts into R code and Unified Modeling Language
    - Translate object designs into equations and object-oriented computer code
2. Utilize advanced model analysis software and tools to objectively test and parameterize models against measured data
3. Assess model performance under uncertain input conditions to analyze models of varying complexity for performance and stability of solutions

Course Format: All topics are delivered through the CANVAS software and will be introduced in the class. The class is team-taught among Prof Huffaker, Prof Kiker and Prof Munoz-Carpena

Huffaker Section (Jan 8 - Feb 23): This section takes a 'workshop' approach to learning. We will use class time to formulate and solve several dynamic biological models. We will see how the models contribute understanding to issues of real-world importance. This requires that students bring their personal laptops to class, and dedicate time outside of class to familiarize themselves with programming basics in R. The class will study journal articles applying dynamic modeling methods to learn how they are employed in applied research. After the first two models are covered, students will have the opportunity to apply classroom experience to solving a dynamic biological model in a take-home midterm.

Course Outline and Schedule (subject to changes/alterations):

Jan 6, 8, 10, 13
Competitive Ecosystem Dynamics
Reading: R. Huffaker, K. Cooper, T. LoFaro (1999). "The resilience of grassland ecosystems." *The UMAP Journal* 20 (1): 29-45.

Jan 15, 17, 22, 24
Dispersive Population Dynamics
Reading: R. Huffaker, K. Cooper, T. LoFaro (1999). "Small mammal dispersion." *The UMAP Journal* 20 (1): 47–65.

Jan 20 – Martin Luthor King Holiday

Jan 27, 29, 31; Feb 3
Population Genetics
Reading: K. Grimsrud, R. Huffaker (2006). "Solving multidimensional bioeconomic problems with singular-perturbation reduction methods: Application to managing

pest resistance to pesticidal crops." *Journal of Environmental Economics and Management* 51:336-353.

Feb 5-21
1. Invasive Species
Reading: The Economist, "Feral cats in Australia: Felicitous felicide," (Jan 24, 2016)
2. Take-Home Midterm

Kiker/Carpena Section (Feb 24 - April 22):

Feb 24 – Feb 28:

1. Review of Global Sensitivity and Uncertainty Analysis (GSUA) and its application on the HyperGator (Carpena)

Readings, Code and Examples: Posted on CANVAS Course System in the Global Sensitivity and Uncertainty Analysis Module

Feb 29 - March 8 Spring Break

Mar 9-27: Continued…Global Sensitivity and Uncertainty Analysis (GSUA) and its application on the HyperGator (Carpena)
Readings, Code and Examples: Posted on CANVAS Course System in the Global Sensitivity and Uncertainty Analysis Module

Mar 30-Apr 22;

2. Introduction to Object-Oriented Design (OOD) and Programming with multiple platforms, Cellular Automata Modeling, and Advanced Agent-Based Simulation (Kiker)
3. Integrated decision analysis with models and GSUA

Lecture Notes, Readings, Code and Examples: Posted on CANVAS Course System in the following modules: Java Resources, Object-Oriented Design and UML, XML, NetLogo, QnD Model, Predator/Prey System for GSUA

Course Texts (accessed through Course Management System or UF Libraries):

- Selected journal articles and web links will be provided in CANVAS

Recommended software (all open-source and freely available):

As models are developed in a variety of platforms and styles, this course will expose students to some of the major groups of languages.

- Procedural languages
  - FORTRAN - http://www.codeblocks.org/
  - BASIC - http://justbasic.com/
  - Python – http://www.python.org
- Object-oriented design and programming
  - Unified Modeling Language (UML) Design: Astah-Community (http://astah.net/download#community)
  - Eclipse Integrated Development Environment (www.eclipse.org) with Java (www.java.com)
- Free form environmental models (using Object-oriented implementation)
  - Nova – www.novamodeler.com
  - NetLogo – Agent-Based Modeling (http://ccl.northwestern.edu/netlogo/)
- Statistical languages
  - R - http://www.r-project.org/
- Model analysis software
  - FITEVAL (http://abe.ufl.edu/carpena/software/FITEVAL.shtml)
  - SIMLAB (https://ec.europa.eu/jrc/en/samo/simlab)

Homeworks: This course is primarily graded on a series of assignments (approximately 5 to 7) to create an overall term project/portfolio. Each student will submit individual written reports, designs and/or presentations that will be graded by the instructor.

Huffaker Section: After the initial models are covered, students will have the opportunity to apply classroom experience to solving a dynamic biological model in a take-home exam.

- Take-Home Exam (Huffaker): (40%)
- HW 1 and 2: High Performance Computing (HPC) and Global Sensitivity and Uncertainty Analysis (10%)
- HW 3: Object Oriented Design (OOD), Unified Modeling Language (UML) Programming and elementary Java programming (10%)
- HW 4: Linking UML and Java code development (10%)
- HW 5: Object Oriented and Agent-Based modeling (10%) QnD, MARS and/or NetLogo
- HW 6: Integrated analysis of models/GSUA/MCDA (20%)

Assignments: This course will utilize the E-Learning (CANVAS) system for the submission of all homework assignments

GRADING:
Class Assignments: 100%

- Homework will be assigned and will be due up to 7 - 14 days later.
- Peer grading (if assigned) will be due from 2 to 7 days later.
- Late homework will be accepted at a cost of 10% per day late (Up to a maximum of 50%).

GRADING SCALE;

A: 93 ≤ Average ≤ 100; A-: 90 ≤ Average < 93
B+: 87≤ Average < 90; B : 83≤ Average < 87; B- : 80≤ Average < 83;
C+: 77≤ Average < 80; C : 73≤ Average < 76; C- : 70≤ Average < 73;
D+: 67≤ Average < 69; D : 63≤ Average < 67; D- : 60≤ Average < 63;
E : ≤ Average =< 60

ATTENDANCE AND MAKE-UP WORK
Requirements for class attendance and make-up exams, assignments and other work are consistent with university policies that can be found at: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx.

ONLINE COURSE EVALUATION PROCESS
Student assessment of instruction is an important part of efforts to improve teaching and learning. At the end of the semester, students are expected to provide feedback on the quality of instruction in this course using a standard set of university and college criteria. These evaluations are conducted online at https://evaluations.ufl.edu. Evaluations are typically open for students to complete during the last two or three weeks of the semester; students will be notified of the specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results.

ACADEMIC HONESTY
As a student at the University of Florida, you have committed yourself to uphold the Honor Code, which includes the following pledge: "*We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.*" You are expected to exhibit behavior consistent with this commitment to the UF academic community, and on all work submitted for credit at the University of Florida, the following pledge is either required or implied: *"On my honor, I have neither given nor received unauthorized aid in doing this assignment*."

It is assumed that you will complete all work independently in each course unless the instructor provides explicit permission for you to collaborate on course tasks (e.g. assignments, papers, quizzes, exams). Furthermore, as part of your obligation to uphold the Honor Code, you should report any condition that facilitates academic misconduct to appropriate personnel. It is your individual responsibility to know and comply with all university policies and procedures regarding academic integrity and the Student Honor Code. Violations of the Honor Code at the University of Florida will not be tolerated. Violations will be reported to the Dean of Students Office for consideration of

disciplinary action. For more information regarding the Student Honor Code, please see: http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code.

SOFTWARE USE
All faculty, staff and students of the university are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

SERVICES FOR STUDENTS WITH DISABILITIES
The Disability Resource Center coordinates the needed accommodations of students with disabilities. This includes registering disabilities, recommending academic accommodations within the classroom, accessing special adaptive computer equipment, providing interpretation services and mediating faculty-student disability related issues. Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation

0001 Reid Hall, 352-392-8565, **www.dso.ufl.edu/drc/**

CAMPUS HELPING RESOURCES
Students experiencing crises or personal problems that interfere with their general well-being are encouraged to utilize the university's counseling resources. The Counseling & Wellness Center provides confidential counseling services at no cost for currently enrolled students. Resources are available on campus for students having personal problems or lacking clear career or academic goals, which interfere with their academic performance.

- *University Counseling & Wellness Center, 3190 Radio Road, 352-392-1575,* **www.counseling.ufl.edu/cwc/**
  Counseling Services
  Groups and Workshops
  Outreach and Consultation
  Self-Help Library
  Wellness Coaching

- U Matter We Care, **www.umatter.ufl.edu/**

- *Career Resource Center,* First Floor JWRU, 392-1601, **www.crc.ufl.edu/**