Simulation Analysis of Forest Ecosystems (3 credits)

FOR 6156

Lectures and Discussion: MWF Period 2 (8.30 – 9.20 am) in McCarty Hall C, room 426

Instructors:

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Course Description

This course is designed to explore the conceptual basis, evaluation, implementation, testing, and analysis of forest and tree simulation models. Each student will develop and present a modeling project based on their research or other approved topics.

Course is Designed For: Graduate Students

Prerequisites: Undergraduate course(s) in ecology, plant physiology. Ability to use Algebra.

Course Resources:

Books (recommended) :

Modeling Biological Systems. Principles and Applications.
J. W. Haefner. 1996. Chapman and Hall, NY. 473 pp.

Python programming books:

Learning Python. Mark Lutz, David Ascher. 1999. O'Reilly and Associates, Inc. 366 pp. OR

How to Think Like a Computer Scientist. Learning with Python. 2002. A.Downey, et. Al. Green Tea Press. Wellesley, Mass. (pdf)
The latest version is available online as "Think Python 2e":
https://greenteapress.com/wp/think-python-2e/

Python Programs: example programs provided that illustrate each topic

Web Resources:

https://www.anaconda.com/ (download Anaconda, platform for accessing Jupyter notebooks and JupyterLab – tools for Python programming). **Anaconda is all that needs to be downloaded, it includes Python, JupyterLab and Jupyter Notebooks (and all packages that we need).**

http://www.python.org/ (free download of Python for windows, mac, and Unix); Tutorials. **No need to download separately.**

https://jupyter.org/ (software for interactive computing. **No need to download separately.**

http://en.wikibooks.org/wiki/NonProgrammer%27s Tutorial for Python/Contents

https://numpy.org/ (resources and documentation on NumPy, Numerical Python package)

https://scipy.org/ (resources and documentation on SciPy, Scientific Python package)

https://matplotlib.org/ (resources and documentation on matplotlib, visualization package)

https://pandas.pydata.org/ (resources and documentation for Pandas, data science package)

https://seaborn.pydata.org/ (resources and documentation for Seaborn, statistical data visualization package)

Lecture and Discussion Topics:

Introduction to Modeling.

What is a model?
How are models made?
Testing and Evaluation of models.

Haefner Chapt 1 - 3.
Jorgensen, S.E. 2008. Overview of the model types available for development of ecological models. Ecol. Model. 215:3-9.
Caswell, H. 1988. Theory and models in ecology: A different perspective. Ecological Modelling 43:33-44.

Introduction to Python programming.

complete Python tutorial.
turn in first problem set program.

Introduction to Matrix Algebra and Matrix Models

Tree Population modeling
Forest succession modeling
Landscape Transition (Markov) modeling

Pinard, M. 1993. Biotropica 25(1):2-14
Anderson, P.J. and F.E. Putz 2002. For. Ecol. Manage. 170:271-283.
Cropper, W.P. and D. DiResta. 1999. Ecol. Modelling 118:1-15.
Cropper, W.P. and E.L. Loudermilk. 2006. Ecol. Model. 198:487-494.
Dalva, M., et al. 1999. Ecology 80(8):2635-2650
Acevedo, M.F. et al. 1995. Ecological Applications 5(4):1040-1055
Lytle, D.A. and D.M. Merritt 2004. Ecology 85:2493-2503.
Holm et al. 2008. Biotropica 40:550-558.
Haefner Chapter 13

Some useful functions.

Haefner Chapter 4

Introduction to Numerical Integration.

integration error
Introduction to Stella and Berkeley Madonna
simulation packages.
Introduction to Excel spreadsheet for simulation.

Anderson, R.M. et al. 1981. Nature 289:765-771
Ferguson et al. 2003. Nature 425:681-685
Madden, L.V. et al. 2002. BioScience 52:65-74
Earn, D.J.D. 2000. Science 287:667-670.
Hastings, A. 1993. Annu. Rev. Ecol. Syst. 24:1-33
Harwell et al. 1981. Ecological Modelling 12:105-131

Haefner Chapter 6

Disease Modeling.

Differential equation models
Cellular Automata
Agent-based Individually-Based Models

Ferguson et al. 2006. Nature 442:452
Silk, Matthew J., et al. "Using Social Network Measures in Wildlife Disease Ecology, Epidemiology, and Management." *BioScience* 67.3 (2017): 245-257.

Chaos.

Logistic Map (Difference Equation)
Lorenz Chaos (Differential equations)
Matrix population models (Density-Dependent)

Becks et al. 2005. Nature 435:1226-1229
May 1974. Science 186:645-647.
Haefner Chapter 17

Gap Phase Individual-Based Succession Models.

Examples: Jabowa, Linkages

Haefner p. 338
Post, W.M. and J.Pastor. 1996. Climatic Change 34:253-261
Wyckoff, P.H. and J.S. Clark. 2002. Journal of Ecology 90:604-615.
Liu, J. and Ashton. 1995. Forest Ecology and Management 73:157-175.

Landscape Modeling.

Higgins, S.I., et al. 2000. Ecological Applications 10:1833-1848
Fitz, H.C. et al. 1996. Ecological Modelling 88:263-295
Loudermilk, and Cropper. 2007. Can. J. For. Res. 37:2080-2089
Haefner Chapter 15, 16, and 18

Modeling Plant Competition.

Competition and coexistence - the effects of resource transport and supply rates.

Huston M.A., DeAngelis D.L. 1994. Amer. Nat. 144 (6): 954-977.
Loreau, M. 1998. Proc. Natl. Acad. Sci. 95:5632-5636.

Haefner Chapter 14

Modeling Soil Nitrogen Dynamics and Decomposition.

Nitrification
Denitrification
Mineralization
Uptake

Muller, C. Modelling Soil-Biosphere Interactions.
CABI Publishing. Chapt. 2
Gholz et al. 1985. For. Sci. 31:463-478.
Kruys et al. 2002. Ecol. Applications 12:773-781.
Comerford et al. 2006. Can. J. Soil Sci. 86:665-673.
Allison and Martiny. 2008. PNAS 105:11512-11519.

Biological Inspired Modeling: Neural Nets and Genetic Algorithms

Cropper and Anderson 2004. Ecol. Modelling 177:119-127
Cropper and Comerford 2005. Ecol. Modelling 185:271-281
Lek and Guegan. 1999. Ecol. Modelling 120:65-73.

Haefner Chapters 19 and 20

Modeling Tree Physiology.

assimilation
respiration
transpiration
estimation of parameters

van den Berg, M. et al. 2002. Ecol. Mod. 148:233-250.
Chen, J.M. et al. 1999. Ecol. Mod. 124:99-119.
Friend, A.D. 2001. Global Ecol. Biog. 10:603-619.
Wang, Y.-P. et al. 1998. Global Change Biology 4:797-807
Wang, YP and Jarvis. 1990. Ag. For. Met. 51:257-280.
Cropper, W.P. and Gholz. 1993. Ecol. Mod. 66:231-249
Cropper, W.P. 2000. For. Ecol. Man. 126:201-212.

Course Requirements:

Although collaboration is an important part of science, learning modeling techniques is best done individually. No collaboration (except with the instructor) is expected for the weekly problem sets or modeling project.

Problem sets (25%) Due dates will depend on our progress through the topics. Python Programming skills and simulation modeling exercises will be used.

Presentation and leading discussion of published forest modeling paper (25%) Variable due date after the first 3 weeks of class.

Modeling project and oral presentation. A written report describing objectives, significance, model structure, and results and discussion is due on the last day of class (Wed. April 24, 2019). (50%)

Participation is required; discussions of topics, homework, assigned papers and projects are an essential part of this course.

Grading Scale:

93% - 100% A
90% - 92.9% A-
86% - 89.9% B+
83% - 85.9% B
80% - 82.9% B-
76% - 79.9% C+

73% - 75.9% C
70% - 72.9% C-
60% - 69% D
Below 60% E

UF grading policies:
http://www.registrar.ufl.edu/catalog/policies/regulationgrades.html

Minus grades: http://www.isis.ufl.edu/minusgrades.html

Course Policies

Students are expected to attend class, engage in discussion, and submit assignments on time. Problem sets may be revised after initial grading without penalty. A new due date will be assigned for revised problem sets. A 10% late penalty will be assessed for work turned in or presented after the due date. Students must complete a written report of the modeling project, as well as an in class presentation to receive credit for the project. You must receive an A on the project to receive an A for the course.

University of Florida Policies

Academic Honesty

As a result of completing the registration form at the University of Florida, every student has signed the following statement: "I understand that the University of Florida expects its students to be honest in their academic work. I agree to this commitment to academic honesty and understand that my failure to comply with this commitment may result in disciplinary action up to and including expulsion from the University."

UF Counseling Services

Resources are available on campus for students having personal problems or lacking clear career and academic goals with interfere with their academic performance. These resources include:

University Counseling Center, 301 Peabody Hall, 392-1575 (personal and career counseling); Student Mental Health, Student Health Care Center, 392-1171 (personal counseling); Center for Sexual Assault /Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161 ext. 4231 (counseling related to sexual assault and abuse); Career Resource Center, Reitz Union, 392-1601 (career development assistance and counseling).

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.

Accommodations for Students With Disabilities

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.