Species Distribution Modeling: ENV 590-38
Course Information: Fall 2015

Instructors:

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Course Schedule:

Lecture/discussion: Tuesdays, 11:45 a.m. – 1:00 p.m., EH 1111
Labs/work sessions: Tuesdays/Thursdays, 4:40 – 5:55 p.m., LSRC A153

Course Goals:

As part of the broader mission of the Nicholas School of the Environment, this course will help you develop skills to:

- Devise and implement effective environmental research;
- Restore and preserve environmental resources; and,
- Develop skills to help adapt to climate change and other anthropogenic effects.

Course Overview:

Habitat classification and species distribution modeling are fundamental tasks in environmental management, especially conservation. With increasing attention to global change, species distribution models are being applied in a range of applications to forecast species response to changes in climate or land use (vegetation) pattern. As the tools of the trade have evolved rapidly over the past decade, these applications are increasingly fraught with ecological as well as statistical nuances that are poorly understood by many practitioners. *This course aims to train you in the science and craft of using species distribution models in modern applications*.

Course Objectives:

By the end of this course you will be able to:

1. Define and construct ecological and data models for a given data set;
2. Develop and provide statistical support and rationales for modeling decisions (e.g. model evaluation and thresholding);
3. Devise and implement a framework for effectively and rigorously planning and executing species distribution modeling in a variety of applications (e.g. conservation, climate change projection, etc.);
4. Recognize the advantages and limitations of species distribution modeling in different applications; and,
5. Evaluate projects using species distribution models for strengths and weaknesses while providing constructive feedback for improvement.

Course Format:

The class consists of short lectures, student presentations, discussion sessions, lab exercises, and work sessions. Lectures and student presentations provide background and technical explanation of the fundamental tasks. Discussion sessions will usually occur prior to labs and involve the assigned readings. Labs are hands-on exercises, using the R statistical computing environment, designed to provide a craftsman's appreciation for conducting, interpreting, and presenting these analyses. Labs will use geospatial data and will sometimes involve analyses in ArcGIS. Work sessions will be time for you to work in small groups on your project and ask questions.

Course Materials:

The following book will be required for the class:

> Franklin, J. 2010. Mapping Species Distributions: Spatial Inference and Prediction. Cambridge University Press. ISBN: 978-0521700023.

Other readings, lecture notes, and lab information will be available via Sakai.

Course Topics:

An outline of the course topics is provided below; a more detailed schedule of daily topics and labs is provided separately. Numbers represent weeks of the semester.

Introduction and preparation

1. What are species distribution models (SDMs) and what are they used for?
2. Ecological models (species response to environment)
3. Data models (species data, variable selection, scaling considerations)

Statistical models

4. GLMs, GAMs
5. Model assessment and evaluation
6. CART, Random Forest, Boosted Regression Trees
7. Maxent (models and maps)
8. *Fall break*
9. Ensemble modeling

Applications

10. Projections: climate change, paleodistribution modeling
11. Projections: invasion biology
12. Habitat connectivity

Term Projects

13. Work sessions
14. Presentation sessions & peer review

Attendance Policy:

Because we will be working collaboratively in this class, you are expected to attend every class meeting unless extenuating circumstances prevent you. Please notify Brenna by email as soon as you know you will have to miss a class. If you miss more than two class sessions, we will ask you to meet with us to determine make-up assignments.

Academic Integrity:

Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Citizens of this community commit to reflect upon and uphold these principles in all academic and non-academic endeavors, and to protect and promote a culture of integrity.

To uphold the Duke Community Standard:

- I will not lie, cheat, or steal in my academic endeavors;
- I will conduct myself honorably in all my endeavors; and
- I will act if the Standard is compromised.

Student Evaluation:

You will be evaluated on the following assignments/projects:

(1) Group research project: 35 points (~20% of final grade)

Each group (2-3 students) will research a topic relevant to the SDM framework. We will provide a set of 2-3 key references, which your group will add to. Your group will give a 15 minute talk to the class that explains the problem and proposed solutions (15 points). You will submit a short (1-2 page) companion summary paper that explains the problem and proposed solutions, and provides an annotated bibliography of at least 5 references (20 points). These summary papers will be distributed to the class and will provide a valuable resource for current and future reference. List of topics:

- Model evaluation and predictive performance
- Model thresholding
- Pseudo-absence selection
- Spatial autocorrelation: problems and solutions
- Projecting SDMs: niche conservatism
- Projecting SDMs: non-analog climates

(2) Individual Term Project: 145 points (~80% of final grade)

You will develop and fully implement an individual SDM project during the course. You will be matched with others who are working on similar projects (e.g. climate change projection) and will work together to review each other's progress toward completing the term project (informally and formally).

Your project will take the form of a scientific presentation with an accompanying write-up that fully explains the methods and results of your analysis. The goal is to produce a polished and scientifically rigorous finished product that is suitable for presentation at a conference and whose content could easily be incorporated into a Master's thesis or Ph.D. dissertation chapter.

Evaluation of the term project will be both formative and summative; formative evaluations will be given full credit if turned in on time. *No late work will be accepted*.

<u>Formative evaluations</u>: 30 points (3 pts each)

- Project proposal
- GLM/GAM write-up
- RF/BRT write-up
- Maxent write-up
- Project write-up: Draft 1
- Project presentation: Draft 1
- Peer review of first drafts (2)
- Project write-up: Draft 2
- Project presentation: Draft 2

<u>Summative evaluations</u>: 115 points

- Project presentation (50 pts)
- Write-up (50 pts)
- Peer reviews (15 pts)