DEPARTMENT OF RENEWABLE RESOURCES
UNIVERSITY OF ALBERTA

RenR 690 - Multivariate Statistics for the Environmental Sciences

2019 Syllabus

Course Website – http://tinyurl.com/renr690

Instructors
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Office Hours: Appointment or call-to-lab by email

Term
Winter

Times
Wednesdays, 9:00am to 12:00pm, Rm 866 General Services Building,
March 13 and April 10: 8:00am to 12:00pm.

First/last class
January 9 / April 10, 2019

No classes
February 20, 2018 (Reading week)

Credits
*3 credits

Course Description
This course will introduce descriptive multivariate and spatial statistical techniques for analysis of biological and environmental data. The mathematical foundations of techniques will be discussed, but the emphasis of this course is visualization, analysis, and interpretation of complex data sets. Topics include: (1) data management, (2) vector and matrix operations, (3) all basic rotation-based multivariate techniques, (4) distance-based ordination and clustering techniques, (5) direct and indirect gradient analysis, (6) multivariate analysis of spatial data, and (7) ecological modeling applications. Students will conduct a course project based on their own datasets.

Course Format
The course will have a weekly lecture followed by discussion or lab sessions. During the first eight classes, important multivariate techniques and essential skills for student projects will be covered. Attendance is highly recommended. Based on this, students will develop and present a work plan for their course projects analyzing their own data. Subsequent meetings will be opportunities for additional lectures requested by students in support of their projects, student-led seminars, or hands-on technical support for course projects.
**Prerequisites**

Students should have had at least one course in basic statistics and some proficiency in using statistical software packages. Basic knowledge of geographical information systems will be useful, but is not a requirement. Instructor’s consent is required after discussing possible course projects as students must have a suitable dataset for analysis.

**Textbooks**

There are no required textbooks and all course material will be provided. However, these reference works may be useful for the course if you prefer a self-guided approach to learning:


**Marking and Grading**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percent</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation (showing up in class, asking questions, optional seminars, problem solving for class, helping others, letting yourself be helped)</td>
<td>20</td>
<td>N/A</td>
</tr>
<tr>
<td>Draft Project (draft website, 5 minute auto-timed presentation)</td>
<td>20</td>
<td>Mar 13th</td>
</tr>
<tr>
<td>Final Presentation (5 minute, auto-timed presentation)</td>
<td>10</td>
<td>Apr 10th</td>
</tr>
<tr>
<td>Final Project (submit or publish a website of your research project)</td>
<td>50</td>
<td>Apr 15th</td>
</tr>
</tbody>
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*Policy for late submissions:* some deduction depending on how good an excuse you have.

Deadline for project submissions: **Tu, Apr 15, 9:00am**

Previous years’ projects & talks: [http://tinyurl.com/renr690projects](http://tinyurl.com/renr690projects)

**Plagiarism and Cheating:**

The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behaviour (online at www.governance.ualberta.ca) and avoid any behaviour which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

All students at the University of Alberta are subject to the Code of Student Behaviour, as outlined at: [University Governance > Code of Student Behaviour](http://www.governance.ualberta.ca). Please familiarize yourself with it and ensure that you do not participate in any inappropriate behavior as defined by the Code. Key components of the code include the following statements.
30.3.2(1) No Student shall submit the words, ideas, images or data of another person as the Student’s own in any academic writing, essay, thesis, project, assignment, presentation or poster in a course or program of study.

30.3.2(2)c. No Student shall represent another’s substantial editorial or compositional assistance on an assignment as the Student’s own work.”

Students should speak with the course instructor about any questions or concerns about the code. Students should be particularly aware of the code as it pertains to internet and library research, use of previous class notes, reclamation plans of former students and interviews or discussions with others.

Course Objectives

(1) Develop a useful, personal toolbox of analytical methods, using the R programming environment.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Reduce Complexity</th>
<th>Understand Relationships (multiple response variables)</th>
<th>Analyze Treatment Effects</th>
<th>Classification</th>
<th>Prediction (single response variable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technique</td>
<td></td>
<td>(in-) direct</td>
<td>constrained</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotation or metric (scale of variable matters)</td>
<td>PCA CANDISC + clever graphics</td>
<td>PCA CANDISC + 2nd set of vectors</td>
<td>CANCOR(^1) CCA(^1) RDA(^1)</td>
<td>MANOVA</td>
<td>DISCRIM(^c) (what differentiates classes?)</td>
</tr>
<tr>
<td>Distance, non-metric (scale doesn’t matter)</td>
<td>NMDS + clever graphics</td>
<td>NMDS + 2nd set of vectors</td>
<td>dbCCA(^u) dbRDA(^1) MRT(^u)</td>
<td>MRPP db/per-MANOVA</td>
<td>CLUSTER (develop classification system)</td>
</tr>
</tbody>
</table>

\(^1\) linear, \(^u\) unimodal relationships \(\) numeric, \(^c\) class, \(^b\) binary variable

(2) Apply the methods to do some real science. There are a number of other options, but ideally, your course project should be part of your thesis. Make it more than just an exercise for a class.

(3) Have fun working with and learning from your peers.
Course Schedule & Deadlines

Jan 9  –  Introduction, data management, and overview of techniques
        Software essentials, data formats, classification of techniques

Jan 16 –  Multivariate fundamentals: Rotation
        Visualization and scaling of multivariate data, PCA, CANDISK, FACTOR

Jan 23 –  Visualization of multivariate data

Jan 30 –  Working with predetermined groups of multivariate observations
        Inferential statistics with class variables: DISCRIM, MANOVA, MRPP

Feb 6  –  Multivariate fundamentals: Distances
        Grouping observations using multivariate data: CLUSTER, NMDS

Feb 13 –  Distances & predetermined groups
        Inferential statistics with distance measures: MRPP, perMANOVA

Feb 20 –  [ Reading Week – No classes ]

Feb 27 –  Direct and indirect gradient analysis with two datasets
        Analyzing dependencies among two variable sets: CANCOR, REDUND, CCA

Mar 6  –  Classification and regression trees: CART, MRT

Mar 13 –  Presentation of draft projects (Start: 8am)

Mar 20 –  TBA (taking requests, student lectures, project support)

Mar 27 –  TBA (taking requests, student lectures, project support)

Apr 3  –  TBA (taking requests, student lectures, project support)

Apr 10 –  Presentation of projects (Start: 8am)

Apr 15 –  [ 9am – Deadline for project submissions ]