Instructor: Amanda S. Hering

• Contact Information:
  Office: Chauvenet 235  Phone: 303.384.2462  Email: ahering@mines.edu
• Office Hours: Tues/Thurs: 3:30 – 4:30 pm. Wed: 1 – 3 pm
• Class Day/Time: 2 – 3:15 pm TR,  Class Location: Chauvenet 215
  The username and password will be given in class.

Instructional Activity:  3  Hours Lecture  0  Hours Lab  3  Semester Hours

Course Description:
This is the capstone course in the Statistics Option. The main objective for a “Statistics Practicum” or “Capstone” course is to apply your statistical knowledge and skills to a brand new problem. This course is not structured in a “lecture” format in which you attend class to listen to lectures. Instead, you will gain practice in problem-solving: learning how to learn; working in a team; presentation skills (both orally and written); and thinking independently. There are no exams, but that does not mean that there will be no work. On the contrary, this class is designed to prepare you for real work outside of the classroom, and as such, this class will give you a glimpse of what will be expected of you by future employers.

Text: Readings and book chapters will be posted on the class website.

Course Prerequisites: You are assumed to

1. have a programming language at your disposal, such as R or Matlab, that you either know well or are willing to learn more about;
2. have had an introductory statistics course, covering content such as confidence intervals, hypothesis tests, random variables, p-values, etc. (such as MATH 323 or 530);
3. know linear regression (such as MATH 424 or 531); and
4. know the multivariate normal distribution and its properties (from MATH 334 and/or MATH 437).

Student Learning Outcomes:
In this class, students will:
• explore, plot, and model high dimensional atmospheric data;
• build models to classify precipitation types using vertical temperature profiles;
• apply discriminant analysis techniques, such as:
  – linear and quadratic classification techniques for more than 2 populations
  – neural networks or support vector machines
• evaluate classifications with deterministic and probabilistic approaches;
• participate in final project; and
• communicate your work to scientists, faculty, and your peers.
Class Structure/Vision: Some of you may have taken MATH 437: Multivariate Analysis, and some of you may not have taken it. Even if you have taken it, you may not remember “Discrimination and Classification.” So, the plan for this year’s version of the practicum is to approximately follow this outline:

- Review discriminant and classification analysis via lectures
- Implement packaged \texttt{R} methods on simple datasets; code the same simple methods from scratch
- Explore the large dataset provided by NOAA
- NOAA expert visit and problem explanation
- Implement our expert’s current method for precipitation type (p-type) classification
- Evaluate the p-type classifications
- Teams form and each one develops their own novel approach to the p-type classification problem
  - Additional outside reading may be required
- Teams evaluate their p-type classification methods
- Methodology writing exchange experiment
  - Teams explain their methods in writing and exchange their description with another team. They then try to code the other team’s method based only on the written description.
- Feedback from NOAA expert on methods
- Final projects—written and oral communication of results

Grading Procedures:

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
<th>Grade Range</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Participation</td>
<td>30%</td>
<td>90 - 100%</td>
<td>A</td>
</tr>
<tr>
<td>Homework Assignments</td>
<td>30%</td>
<td>80 - 89%</td>
<td>B</td>
</tr>
<tr>
<td>Final Project</td>
<td>40%</td>
<td>60 - 69%</td>
<td>D</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>Below 60%</td>
<td>F</td>
</tr>
</tbody>
</table>

(1) Class Participation: is composed of two parts

(a) Attendance: Attendance in class is mandatory (unless there is an official excused absence) as the interaction and class environment will be designed to stimulate ideas and learning. Specific tasks may also be given that you should come to class prepared to perform (e.g., find an \texttt{R} package, prepare questions for a guest speaker, run code remotely, etc.)

(b) Discussion Groups: We may have discussion groups, wherein a reading related to the problem (either the methodology or the applied problem) will be assigned with questions to answer designed to ensure that you extract the relevant material. In class, we will go over the questions to ensure that (1) everyone read the material and (2) everyone understood what they read.

This part of your grade will be evaluated by recording attendance and participation in scheduled class activities.

(2) Homework:

Homework will be assigned that is designed to get you to apply the concepts learned in the lectures and/or readings to sample datasets or the class dataset. Depending on the complexity, you will either be given 1 or 2 weeks to complete it, and each student is required to submit it independently. It will typically be a very open-ended assignment, and students will be given some time in class to work on this, to ask questions, and to learn from your fellow students. Later assignments are constructed to help you build toward the final class project. Hard copies of the assignments will be collected at the START of class on the due date. \textit{Late assignments will not be accepted.}
Final Project:
The National Oceanic and Atmospheric Administration (NOAA, [http://www.noaa.gov](http://www.noaa.gov)) is sponsoring this class, meaning that they are providing the problem, the data, and input/advice. For the final project, you may work as a team or individually, but everyone will have the same task: to classify precipitation types using vertical temperature profiles from a numerical weather prediction (NWP) model. Each team must submit a final written report, their programming code, and present their work during the class’ final exam slot. Representatives from NOAA and AMS faculty will be invited to attend the final presentations. Michael Scheuerer is our primary NOAA point of contact ([http://www.esrl.noaa.gov/psd/people/michael.scheuerer/](http://www.esrl.noaa.gov/psd/people/michael.scheuerer/)), and he will present the problem of interest in class near the end of January/beginning of February.

Notes: A few more things...

- More information on the final project will be given as the class proceeds. Rubrics to score your teamwork (if you’re working in a team); the written report; and the final presentation will be made available so you will know the criteria against which you are being evaluated.
- If you have questions about your class participation grade, feel free to inquire with me at anytime.
- The class website contains the daily schedule, readings, data, code, etc. that will be needed throughout the class, so please check it frequently for updates.
- I would like to know about any particular academic difficulties or personal problems that are affecting a student’s performance.

Coursework Return Policy:
Barring any unforeseen circumstances, coursework will be graded and returned to students within two weeks. Feedback will be provided on all coursework or solutions will be posted.

Absence Policy:
The website [http://inside.mines.edu/Student-Absences](http://inside.mines.edu/Student-Absences) outlines CSM’s policy regarding student absences. It contains information and documents to obtain excused absences. Note: “All absences that are not documented as excused absences are considered unexcused absences. Faculty members may deny a student the opportunity to make up some or all of the work missed due to unexcused absence(s). However, the faculty members do have the discretion to grant a student permission to make up any missed academic work for an unexcused absence. The faculty member may consider the student’s class performance, as well as their attendance, in the decision.”

Disability Accommodations:
The website [http://disabilities.mines.edu/accommodations.html](http://disabilities.mines.edu/accommodations.html) outlines CSM’s disability services. The AMS department requests that any student requiring accommodations contact the instructor via email or individual meeting within the first two weeks of class or within two weeks of receiving the accommodation.

Policy on Academic Integrity/Misconduct:
The Colorado School of Mines affirms the principle that all individuals associated with the Mines academic community have a responsibility for establishing, maintaining an fostering an understanding and appreciation for academic integrity. In broad terms, this implies protecting the environment of mutual trust within which scholarly exchange occurs, supporting the ability of the faculty to fairly and effectively evaluate every students academic achievements, and giving credence to the universityys educational mission, its scholarly objectives and the substance of the degrees it awards. The protection of academic integrity requires there to be clear and consistent standards, as well as confrontation and sanctions when individuals violate those standards. The Colorado School of Mines desires an environment free of any and all forms of academic misconduct and expects students to act with integrity at all times. Academic misconduct is the intentional act of fraud, in which an individual seeks to claim credit for the work and efforts of another without authorization, or uses unauthorized materials or fabricated information in any academic exercise. Student Academic Misconduct arises when a student violates the principle of academic integrity. Such behavior erodes mutual trust, distorts the fair evaluation of academic achievements, violates
the ethical code of behavior upon which education and scholarship rest, and undermines the credibility of
the university. Because of the serious institutional and individual ramifications, student misconduct arising
from violations of academic integrity is not tolerated at Mines. If a student is found to have engaged in such
misconduct sanctions such as change of a grade, loss of institutional privileges, or academic suspension or
dismissal may be imposed.
The complete policy is online at [http://bulletin.mines.edu/undergraduate/policiesandprocedures/](http://bulletin.mines.edu/undergraduate/policiesandprocedures/)

Course Schedule and Important Dates:

<table>
<thead>
<tr>
<th>Week</th>
<th>Semester Dates</th>
<th>Important Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Jan. 14</td>
<td>First Day of Class</td>
</tr>
<tr>
<td>1</td>
<td>Jan. 19/21</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Jan. 26/29</td>
<td>Jan 28th last day to add/drop</td>
</tr>
<tr>
<td>3</td>
<td>Feb. 2/4</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Feb. 9/11</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Feb. 16/18</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Feb. 23/25</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>March 1/3</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>March 8/10</td>
<td></td>
</tr>
<tr>
<td>–</td>
<td>March 15/17</td>
<td>Spring Break—No Class</td>
</tr>
<tr>
<td>9</td>
<td>March 22/24</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Mar 29/31</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>April 5/7</td>
<td>Apr 7th last day to withdraw</td>
</tr>
<tr>
<td>12</td>
<td>April 12/14</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>April 19/21</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>April 26/28</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>May 3/5</td>
<td>Last day of classes, May 5th</td>
</tr>
<tr>
<td>16</td>
<td>May 7-12</td>
<td>Final Exams</td>
</tr>
</tbody>
</table>