PHYS 483: Special Topics in Physics (Spring 2017 - 3 credits)
Computational Skills for Big Data

Instructors: Dr. Sunni Ivey (lead), Dr. Heather A. Holmes, Dr. Anna Panorska, Dr. Katherine Hepworth
Class Meetings: W, 2:00-4:30pm, Room: 113
Email: cesunicai@unr.edu, hholmes@unr.edu, ania@unr.edu, khepworth@unr.edu
Office: Leifson Physics RM 315
Office Hours: TBD, and at other times by appointment
Web Content: UNR Web Campus (https://wcl.unr.edu/), login with UNR NetID

Recommended Materials

Course Description
This course will allow students to become familiar with numerical weather prediction (NWP) models, use statistical methods and software to analyze results, and implement scientific communication techniques to share their findings with broad audiences. The course involves learning and developing the skills to (1) identify appropriate data sources, (2) obtain relevant data including quality checking, (3) load data into computing packages such as Matlab or R, (4) decide what outputs the programs should provide to address specific scientific questions, (5) design algorithms and write programs/codes to read data, implement quality assurance, and check results for correctness, (6) run programs to work with large datasets and format outputs into a usable form, (7) analyze outputs using statistical methods to address scientific questions, (8) write reports and design effective visualizations of the results to communicate scientific findings to the intended audience in appropriate production formats, and (9) document the data processing and results.

Student Learning Outcomes:
1. Students will be able to identify and access computational resources and analyze data related to interdisciplinary modeling including linking numerical weather prediction models, weather extremes, and environmental outcomes.
2. Students will also learn data visualization, quantitative summarization, and visual production techniques that will give them operational strategies to improve their communication effectiveness.

Course Objectives:
1. Access open source data (e.g., reputable data sources, the best file format, metadata).
2. Read and write large datasets in software such as Matlab and R.
3. Write codes to access and use the data (e.g., time series and spatial data).
4. Explore data, work with data arrays, perform calculations, make information based decisions.
5. Implement introductory statistical data modeling, conduct exploratory data analysis, investigate multivariate data, create descriptive and graphical summaries, and deduce information from data.
6. Create visualizations to interpret and share findings and communicate scientific meaning.

Prerequisites: ATMS 317 (Intermediate Meteorology) or MATH 283 (Calculus III) and MATH 352 (Statistics)

Assessment and Grading
Class Participation (10%): Class participation will be graded by in-class discussions of relevant scientific articles. Discussions will occur in the first 15 minutes of class. Students are expected to read the assigned journal article and bring one question or point of interest to the next class. Articles will be made available electronically.

Homework (25%): Homework assignments will be due approximately every two weeks and will cover the preceding two weeks of material. Typically, the assignments will cover material from the statistical and visualization lessons presented during class.

Final Project (40%): The final project will encompass the majority of the grade for the course. Students will be assigned a unique microphysics process to investigate in the Weather Research and Forecasting (WRF) model.
Students will run a 1-month simulation that investigates the sensitivity of the WRF model to variations of their assigned microphysics process. Students are expected to apply concepts learned during class to complete the project tasks. Project requirements include simulating the 1-month period in WRF, writing a 10-page (maximum) report detailing background on the microphysics process, an overview of the simulation results, statistical analyses, and visualizations used in the analyses (a visual abstract, at least one animated figure, and at least one static figure). This will be an individual project, where each student will present their findings at the end of the semester in a 30-minute presentation (20 minutes for talk and 10 minutes for questions). Details regarding the final project and requirements will be assigned within the first two weeks of the semester.

**Visualization Journal (10%)**: Students will complete regular activities for the online visualization component of this course. Visualization activities will build skills that prepare students for the visualization components of the Final Project. These activities will be submitted to the Visualization Journal on WebCampus.

**Midterm Exam (25%)**: One exam will be given worth 25% of the course grade. The tentative date for the exam is **Wednesday, March 15, 2017**. Note, this is subject to change and the exam date will be confirmed in the lecture. The class meeting prior to the exam date will include an exam review. If there is specific material you would like reviewed please come to my office hours and let me know.

**Final letter grades are assigned as follows:**
A = 93% or higher; A- = 90-92.9%; B+ = 87-89.9%; B = 83-86.9%; B- = 80-82.9%; C+ = 77-79.9%; C = 73-76.9%; C- = 70-72.9%; D+ = 67-69.9%; D = 63-66.9%; D- = 60-62.9%; F = < 60%.

**Additional Information**

**Classroom Behavior:** All students are expected to behave in a professional and respectful manner. This includes (but is not limited to) being respectful of your peers during classroom discussions, being a team player on group projects, showing up on time to class, no cell phones in class, no listening to music, and no typing on laptops during lecture. Any behavior that disrupts the class is not allowed.

**Research participation:** This course is part of a pedagogical research project. Anonymized data will be collected from pre/post tests and biweekly evaluations and used in the research project. By participating in this course and staying in this course you are knowingly participating in this research activity.

**Special Needs:** Any student with a disability needing academic adjustments or accommodations is requested to contact the instructor as well as the Disability Resource Center in the Pennington Student Achievement Center (Suite 230) as soon as possible to allow for appropriate arrangements.

**Academic Success Services:** Your student fees cover use of -
- Math Center (784-443 or www.unr.edu/mathcenter/)
- Tutoring Center (784-6801 or www.unr.edu/tutoring/)
- University Writing Center (784-6030 or www.unr.edu/writing_center)
These centers support your classroom learning; it is your responsibility to take advantage of their services. Seeking help outside of class helps you develop as a responsible and successful student.

**Recording:** Surreptitious or covert videotaping of class or unauthorized audio recording of class is prohibited by law and by Board of Regents policy. This class may be videotaped or audio recorded only with the written permission of the instructor. In order to accommodate students with disabilities, some students may have been given permission to record class lectures and discussions. In those cases, students should understand that their comments during class might be recorded.

**Academic Honesty:** All coursework must meet the UNR Standards for Academic Policy (http://www.unr.edu/student-conduct/policies/university-policies-and-guidelines/academic-standards/policy). Working in groups on the homework assignments is encouraged but each student must turn in their own work. Any homework that is directly copied from another student or copied from a solutions manual will not be given any credit. As the homework deadlines are close to exam dates late homework will not be accepted for grading.
**Missed Exam Policy:** It is your responsibility to be on time for tests, and to contact your instructors well before the test if you absolutely cannot attend. In most cases, it is possible to take a test before its scheduled date, but it is not possible to make it up afterwards. Students who arrive after the first person has completed the test will automatically receive a zero on that exam or quiz. **Oral make-up examinations** will be given only with a medical doctor’s note requesting permission in the case of illness, or a death certificate in the case of a family member death.

### Tentative Course Schedule: PHYS 483 Spring 2017

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Class Topic</th>
<th>Online Visualization Topic</th>
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<tbody>
<tr>
<td>1</td>
<td>25-Jan</td>
<td>Introduction to Linux, High-Performance Computing, and Yellowstone</td>
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<tr>
<td>2</td>
<td>1-Feb</td>
<td>Numerical Weather Prediction Models, Microphysics, and WPS</td>
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<td>3</td>
<td>8-Feb</td>
<td>WRF Initialization</td>
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<td>4</td>
<td>15-Feb</td>
<td>Investigating and Analyzing WRF Data</td>
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<td>5</td>
<td>22-Feb</td>
<td>Introduction to NetCDF and Matlab</td>
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<td>6</td>
<td>1-Mar</td>
<td>External Data Analysis</td>
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<tr>
<td>7</td>
<td>8-Mar</td>
<td>External Data Analysis</td>
<td>Introduction to Design for Visualization</td>
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<tr>
<td>8</td>
<td>15-Mar</td>
<td>Midterm and Work on Projects</td>
<td>Visualization for Analysis I</td>
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<td></td>
<td>22-Mar</td>
<td>Spring Break: No Class</td>
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<tr>
<td>10</td>
<td>5-Apr</td>
<td>Exploratory Data Analysis: Numerical and Graphical Summaries</td>
<td>Visualization for Analysis III</td>
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<td>11</td>
<td>12-Apr</td>
<td>Model Fitting, Goodness of Fit</td>
<td>Visualization for Sharing Knowledge I</td>
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<td>12</td>
<td>19-Apr</td>
<td>Correlation/Regression Topics</td>
<td>Visualization for Sharing Knowledge II</td>
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<td>13</td>
<td>26-Apr</td>
<td>Multiple Linear Regression Topics</td>
<td>Visualization for Sharing Knowledge III</td>
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<td>14</td>
<td>3-May</td>
<td>Wrap-up, End of Course Info</td>
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<td>10-May</td>
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<td>Student Help Hours</td>
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<td>15</td>
<td>11-May</td>
<td>Final Project Presentations</td>
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