Syllabus (Updated: 8-23-2017)	**(BIOS:7600:001) Advanced Biostatistics Seminar** **"Advanced Topics in Biostatistical Computing"**
University of Iowa **College of Public Health** **Department of Biostatistics**	**Fall 2017** **C201 CPHB** **2:00-3:20 PM (Tu/Th)** icon.uiowa.edu grantbrown.github.io/BIOS-7600 bios7600competition.website
Instructor: Grant Brown (PhD) **Office:** N314 CPHB **Phone:** 319-384-1599 **Email:** grant-brown@uiowa.edu **Office Hours:** Mon. 9:00-11:00 AM, Wed. 9:00- 11:00 AM, and by appointment	**DEO:** Joseph Cavanaugh (PhD) **Office:** N332A CPHB **Phone:** 319-384-1602 **Email:** joe-cavanaugh@uiowa.edu

Goals/Content:	This course covers advanced topics in biostatistical computing, with a combined emphasis on advanced computing techniques and algorithms relevant to statistics and scientific computing, as well as tools and best practices for implementing them. This course is designed for Biostatistics PhD students who wish to pursue computationally intensive thesis topics and want to expand their computational skills. The course may also be of interest to other students with a background in probability and statistics and a working familiarity with the R statistical computing environment. Topics covered by this course will include: • Matrix decomposition and sparse matrices • Deterministic and stochastic optimization techniques • Numerical integration and sampling techniques with application to Bayesian computing • A focus on implementing these techniques using computational tools and resources, including but not limited to campus HPC facilities, Rcpp, Knitr, and Git. Instruction will combine in-class lecture and discussion with external reading and tutorial work One of the most important skills of a statistical practitioner is the ability to learn new tools and skills on their own. Coupled with the wide array of excellent online tutorials in nearly all aspects of computing and statistics, this course aims to provide the best of both worlds while avoiding redundancy.

	Class time will be comprised of a combination of short lectures and practical interactive computing exercises, and homework will involve both computing assignments and web-based tutorials and reading assignments. In-class exercises will combine a selection of whole class, group, and individual work, and will serve as the basis for weekly homework assignments.
Tentative Schedule (subject to change)	**(8/22)** • **Code/Tech:** R review, source control • **Theory:** Computer Arithmetic, Numerical Precision • **Exercise:** Numerical stability and computer memory
	(8/29) • **Code/Tech:** Functions, Environments, Errors • **Exercise:** Functions • **Challenge:** Simple statistics on large data sets
	(9/5) • **Code/Tech:** Basic R Package Structure • **Theory:** Matrix Decomposition • **Exercise:** Packages, Matrix Decomposition • **Challenge:** Graham Schmidt
	(9/12) • **Code/Tech:** Packages continued, C++, Rcpp, RcppEigen • **Exercise:** Linear regression • **Challenge:** Linear regression
	(9/19) • **Code/Tech:** Optim • **Theory:** Optimization • **Exercise:** Optimization • **Challenge:** Simple statistics on large data sets (revisited with C++)
	(9/26) • **Theory:** Optimization • **Exercise:** Optimization • **Challenge:** Optimization
	(10/3) • **Code/Tech:** Profiling, Debugging • **Exercise:** Profiling, Debugging • **Challenge: TBD**
	(10/10) • **Code/Tech:** Campus HPC Resources • **Exercise:** Campus HPC

Course Materials	**(10/17)** • **Code:** S3, S4 objects • **Theory:** Object Oriented Programming • **Exercise:** TBD
	(10/24) • **Theory:** Bayesian review, Intro to Bayesian Computing • **Exercise:** Metropolis Hastings • **Challenge:** Metropolis Hastings
	(10/31) • **Theory:** Hamiltonian Monte-Carlo • **Exercise:** HMC • **Challenge:** HMC
	(11/7) • **Code/Tech:** Process level parallelism • **Theory:** Approximate Bayesian Computing, Parallel Programming • **Exercise:**
	(11/14) • **Code/Tech:** Low level parallelism (OpenMP/Threads) • **Theory:** General parallel programming • **Exercise:** Low level parallelism • **Challenge: TBD**
	(11/21) **Thanksgiving Break**
	(11/28) • **Code/Tech:** Low level parallelism (continued) • **Theory:** General parallel programming (continued)
	(12/5) • **Presentations**
	Readings, notes, and assignments will be posted to or linked from the ICON site, as well as announced in class. Exercises, assignments, and some supplemental materials will be posted to the GitHub site linked above. No textbook is required, but reading materials will be provided from a number of sources. Below are several important sources which will be used throughout the course: 1. R packages: http://r-pkgs.had.co.nz/ 2. Advanced R: http://adv-r.had.co.nz/ 3. Writing R Extensions: https://cran.r-project.org/doc/manuals/r-release/R-exts.html

	4. Numerical Linear Algebra for Applications in Statistics: http://www.springer.com/us/book/9780387985428
Assignments:	Assignments will take several forms, depending on the nature of the topic material, and may emphasize computational, statistical, and mathematical concepts. All assignments will be announced on ICON, along with submission instructions. Many (but not all) homework submissions will be made via the supplemental competition website linked above, while others will be submitted via ICON. Competition placement will be based on a combination of computational efficiency and correctness.
Final Project:	Students will select a computational problem to serve as the basis of a final project. This could be an aspect of a student's dissertation work, an extension to one of the course competitions, the implementation of an algorithm from a scholarly publication, or another computationally intensive statistical problem. Additional details will follow mid-course.
Grading Procedures:	This course will use +/- grading. Homework assignments will account for 70% of the final grade, while the final project will account for 20%. A participation grade will be assigned, accounting for 10% of the final grade. Participation includes regular attendance, contribution to classroom discussions, presentation of the final project, and participation in small, informal, presentations about the course competitions (students with winning or otherwise notable submissions will be asked to lead an informal overview of their work). Relative placement in the computations will not impact homework grades, though correctness and adequate computational efficiency will be important aspects of the grade. In addition, assignments which involve coding will be graded on readability. For details on code style, please see the style guide. Students are encouraged to assist each other on assignments, however each submission should be your own. No direct copying is permitted.
Expectations for Attendance and Participation:	Students are expected to regularly attend courses, though students will not be penalized for leaving early during lab-exercise portions of the course, provided they've completed the work and participated in class discussion. As previously noted, both extensive in-class and electronic participation in this course are expected.

Communication:	Students are encouraged to attend instructor office hours. Questions may also be directed to the discussion page of the course ICON site. The instructor will also be available by Email, however any questions students have are likely shared by other members of the class, and may therefore be more appropriately posted to ICON. The instructor will attempt to respond to questions within 24 business hours. Students are expected to regularly check their University of Iowa email addresses.
Exams:	There are no formal exams in this course.
Prerequisites:	None
Recommendations:	BIOS:5510, proficiency in R, familiarity with the Linux command line
Credit Hours:	2 or 3 Students taking the course for 2 credit hours are excused from completing the final project.
Course Competencies:	

	Competency	*Evaluated*
	1B9. Interprets quantitative and qualitative data	Assignments, Project
	1B11. Uses information technology to collect, store, and retrieve data	Assignments, Project
	1B12. Uses data to address scientific, political, ethical, and social public health issues	Assignments, Project
	6C7. Critiques the limitations of research findings	Assignments, Project

Administrative Home
This course is given by the College of Public Health. This means that class policies on matters such as requirements, grading, and sanctions for academic dishonesty are governed by the College of Public Health. Students wishing to add or drop this course after the official deadline must receive the approval of the Associate Dean for Academic Affairs in the College of Public Health. Details of the University policy of cross enrollments may be found at:
Cross-Enrollment Policy

Electronic Communication
University policy specifies that students are responsible for all official correspondences sent to their standard University of Iowa e-mail address (@uiowa.edu). Students should check this account frequently.

Accommodations for Disabilities
The University of Iowa is committed to providing an educational experience that is accessible to all students. A student may request academic accommodations for a disability (which includes but is not limited to mental health, attention, learning, vision, and physical or health-related conditions). A student

seeking academic accommodations should first register with Student Disability Services (SDS) and then meet with the course instructor privately in their office to make particular arrangements. Reasonable accommodations are established through an interactive process between the student, instructor, and SDS. See http://sds.studentlife.uiowa.edu/ for more information.

Academic Misconduct

Academic misconduct is defined by the University of Iowa in its Code of Student Conduct here: Policies & Regulations Affecting Students. Please take the time to read this short description. Academic misconduct refers primarily to plagiarism or cheating. **It is the student's responsibility to seek clarification from the course instructor of any situation in which he/she is uncertain whether academic misconduct is/has been involved.**

Plagiarism includes but is not limited to the following:

- presentation of ideas of others without credit to the source;
- use of direct quotations without quotation marks and without credit to the source;
- paraphrasing without credit to the source;
- participation in a group project which presents plagiarized materials;
- failure to provide adequate citation for material obtained through electronic research;
- downloading and submitting work from electronic databases without citation;
- submitting material created/written by someone else as one's own, including purchased term/research papers;

Cheating includes but is not limited to the following

- copying from someone else's exam, homework, or laboratory work
- allowing someone to copy or submit one's work as his/her own;
- accepting credit for a group project without doing one's share;
- submitting the same paper in more than one course without the knowledge and approval of the instructors involved;
- using notes or other materials during a test or exam without authorization;
- not following the guidelines specified by the instructor for a "take-home" test or exam.

Academic misconduct is a serious matter and is reported to the departmental DEO and to the Associate Dean for Education and Student Affairs. Instructors and DEOs decide on appropriate consequences at the departmental level while the Associate Dean enforces additional consequences at the collegiate level. For example, an incident involving plagiarism will result in consequences to the student ranging from a grade of 0 for that assignment to being terminated from his/her graduate program. Egregious acts of misconduct, such as cheating on a final exam, may result in the course grade being reduced to an F. Additional details concerning the consequences associated with acts of plagiarism, including a student appeals process, is provided in the Graduate College Manual section IV.F.

Concerns about Faculty Actions

Students who have a concern about a faculty action should first address the issue with the instructor, then the course supervisor (if there is one), and then the departmental DEO. Students may also contact the Associate Dean for Academic Affairs in the College of Public Health. Another resource for students is the Office of the University Ombudsperson. If a complaint cannot be resolved at the departmental and/or collegiate level, students may file a formal complaint utilizing the procedure specified in the Operations Manual.

Sexual Harassment/Misconduct and Class Accommodations

Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community have a responsibility to uphold this mission and to contribute to a safe environment that enhances learning. Incidents of sexual harassment should be reported to the UI Office of Sexual Misconduct Coordinator (OSMRC), or to the Office of Equal Opportunity and Diversity (EOD). Students impacted by a Title IX issue (sexual misconduct, dating/domestic violence, or stalking) may be eligible to request an academic accommodation. See the OSMRC for assistance, definitions, and the full University policy at Office of the Sexual Misconduct Response Coordinator. Additional information about confidential resources for students subject to sexual harassment/misconduct is available at Confidential Resources for Students.

Reacting Safely to Severe Weather

In severe weather, class members should seek appropriate shelter immediately, leaving the classroom if necessary. The class will continue if possible when the event is over. For more information on Hawk Alert and the siren warning system, visit Hawk Alert