PHC 6088: Statistical Analysis of Genetic Data (3 credit hours)

Semester: Spring 2020
Delivery Format: On-Campus

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Preferred Course Communications (e.g. email, office phone): e-mail or Canvas message

Prerequisites

The students should have taken PHC 6092 and PHC6050c, or equivalent. Permission at the discretion of the instructor may be granted if the student is familiar with linear algebra, maximum likelihood, simple hypothesis testing, and linear regression. Students are not required to have any prerequisites in genetics and an overview of relevant genetic concepts will be covered in class.

Purpose and Outcome

Course Overview

An introduction to statistical procedures for genetic studies. Topics that will be covered include: basic population/quantitative genetic concepts (Hardy-Weinberg Equilibrium, linkage disequilibrium, additive/dominant genetic models), QTL mapping, linkage analysis for human diseases, genome-wide association studies, and analysis of gene expression data for eQTL analysis. This class will emphasize the statistical theory behind methods for analyzing genetic data and its application in useful software tools. The goal of this course is to prepare students for potential research in statistical genetics but is also open to a wider community.

Relation to Program Outcomes

To introduce a variety of statistical methods commonly used in analyzing genetic data, with a focus on linkage analysis, disease mapping and association studies.

Course Objectives and/or Goals

Upon successfully completing this course, students should be able to:

1. Describe classical genetic concepts such as chromosomal theory of inheritance and meiotic recombination.

2. Discuss basic population and quantitative genetic principles such as Hardy-Weinberg Equilibrium and be able to estimate allele and genotype frequencies.

3. Discuss the difference between linkage and association studies, and family-based versus population-based studies.

4. Describe differences in statistical methods for QTL mapping in experimental crosses (single-marker, EM, regression) and perform an analysis using the R/qtl software.

5. Discuss methods to analyze family-based linkage studies and genome-wide association studies.

Description of Course Content

Topical Outline/Course Schedule

Instructor reserves the right to modify the course schedule with advance notice provided to students.

Week	Date(s)	Topic(s)	Readings
1	1/7, 1/9	Introduction to Genetics	
2	1/14, 1/16	Introduction to R, Genetic Data in R	Genetics Quiz
3	1/21, 1/23	Experimental Crosses, Heritability	
4	1/28, 1/30	Linkage, Recombination, EM Algorithm	
5	2/4, 2/6	Genetic Distance, Mapping	HW1 due
6	2/11, 2/13	QTL Mapping, LOD scores	
7	2/18, 2/20	QTL Mapping, Thresholds and Confidence Intervals	Project proposal due
8	2/25, 2/27	Advanced QTL Mapping	HW2 due
9		--Spring Break--	
10	3/10, 3/12	RNA-seq	
11	3/17, 3/19	eQTL	HW3 due
12	3/24, 3/26	GWAS	
13	3/31, 4/2	GWAS	HW4 due
14	4/7, 4/9	Multiple Testing, False Discovery Rate (FDR)	
15	4/14	Meta-analysis and integrative analyses	
16	4/16 & 4/21	Student Project Presentations	

Course Materials and Technology

There is no required text. Instead, handouts will be given out over the course of the semester.

The course materials will be available through the Canvas course website at https://ufl.instructure.com. It is imperative that students familiarize themselves with Canvas, check Canvas frequently for possible announcements, and make sure that their e-mail account in Canvas is correct and active.

Students will be required to use their own computers in order to complete the assignments, and homework problems will require R programming. R is freely available to download on all operating systems at https://cran.cnr.berkeley.edu. Help can be found at https://www.r-project.org/help.html.

For technical support for this class, please contact the UF Help Desk at:

- Learning-support@ufl.edu
- (352) 392-HELP - select option 2
- https://lss.at.ufl.edu/help.shtml

Academic Requirements and Grading

Assignments

All assignments must be typed (unless otherwise noted in class) and submitted electronically on Canvas. Your responses must be supported by both written explanations and the code you generate to produce your result.

Quiz: A quiz will be given in the second week of class to ensure students understand the basics of genetics based on material directly in the lecture slides given in the first week.

Homework: There will be four homework assignments throughout the course. Two weeks will be given to complete homework assignments and more specific information will be given in class. A typical assignment will include a variety of problems. Students may be asked to: calculate or estimate various statistics, simulate data from a particular statistical model and vary initial parameter settings or compare models, derive new estimates of statistics used in genetic studies and compare to ones derived in class, critically examine relevant literature. For problems involving calculations, all work (or code) must be shown to receive full credit. For problems involving comparisons of models or examinations of the literature, homework questions are written to elicit thoughtful responses (e.g. questions starting with Why?). *Discussion on homework in allowable, but plagiarism is prohibited.* Students must submit their own assignments written in their own words and own code. Copying of code or explanations is prohibited and will warrant a score of zero. Homework solutions will be reviewed in class.

Final Project: The goal of the final project is complete a genetic data analysis from start to finish. Students should download publicly available genetic data and re-analyze the data differently than the original authors (or subsequent publication) using methods described in class or newly published statistical methods. Students can either form groups of 2 themselves or work individually. A final report is required and should contain an introduction and description of the data, the biological question of interest, detailed descriptions of the analysis and statistics performed, and a discussion of the results. The final report should also include the R code used in the analysis. Detailed instructions about the final project and paper will be described in class on Thursday Jan 16. A brief project proposal will be due on Thursday Feb. 20 and is part of the final project grade. In addition to the report, an in-class presentation (10-15 min) will be scheduled for April 16 and April 21, the exact details will depend on the size of the class. The final report is due on the day of the presentation. Details regarding expectations of the final report will be discussed in class.

Grading

Requirement	Due date	% of final grade
Quiz (Genetics)	January 16	10%
Homework 1	February 6	10%
Project Proposal	February 20	10%
Homework 2	February 27	10%
Homework 3	March 19	10%
Homework 4	April 2	10%
Project Presentation	April 21	20%
Project Paper	April 21	20%

Point system used:

Points Earned	**93-100**	**90-92**	**87-89**	**83-86**	**80-82**	**77-79**	**73-76**	**70-72**	**67-69**	**63-66**	**60-62**	**Below 60**
Letter Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E

Letter grade to grade point conversions are fixed by UF and cannot be changed.

Letter Grade	**A**	**A-**	**B+**	**B**	**B-**	**C+**	**C**	**C-**	**D+**	**D**	**D-**	**E**	**WF**	**I**	**NG**	**S-U**
Grade Points	4.0	3.67	3.33	3.0	2.67	2.33	2.0	1.67	1.33	1.0	0.67	0.0	0.0	0.0	0.0	0.0

Please be aware that a C- is not an acceptable grade for graduate students. The GPA for graduate students must be 3.0 based on 5000 level courses and above to graduate. A grade of C counts toward a graduate degree only if based on credits in courses numbered 5000 or higher that have been earned with a B+ or higher.

More information on UF grading policy may be found at:
http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Exam Policy

Policy Related to Make up Exams or Other Work

Full credit will be given for assignments turned in on the due date (by 11:59pm). 80% credit for one day late. Assignments turned in the next school day after the due date will have a maximum possible credit of 80%. 50% credit for two days late. Assignment turned in two school days after the due date will have a maximum credit of 50%. NO credit given after two days late. If you are out sick, no deduction will be taken if you inform me before the homework is due that you are ill. Please stay home and do not get other people sick. Just turn in your homework as soon as you can. If you are going to miss school on the day the homework is due (going out of town, religious holiday, etc.) please turn your homework in early.

Please note: Any requests for make-ups due to technical issues MUST be accompanied by the UF Computing help desk (http://helpdesk.ufl.edu/) correspondence. You MUST e-mail me within 24 hours of the technical difficulty if you wish to request a make-up.

Policy Related to Required Class Attendance

Attendance is not taken for a grade, but students are expected to be at all class sessions and are responsible for any missed materials. If you know you will be absent, please notify me in advance.

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

Excused absences must be consistent with university policies in the Graduate Catalog (http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance). Additional information can be found here: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

Student Expectations, Roles, and Opportunities for Input

Expectations Regarding Course Behavior

Students are expected to spend an average of at least 2-1/2 hours per week per credit hour on the course exclusive of class time. This time includes but is not limited to reading, research, preparation for class, and course work. Cell phones should not be used in class. Laptops are permissible and encouraged for note-taking or class related exercises. Questions in class are highly encouraged and should be addressed to the entire class to benefit everyone. Private conversations regarding course material should be conducted outside of class.

Communication Guidelines

For posting on Canvas or e-mails, please adhere to Netiquette Guidelines: http://teach.ufl.edu/wp-content/uploads/2012/08/NetiquetteGuideforOnlineCourses.pdf

Academic Integrity

Students are expected to act in accordance with the University of Florida policy on academic integrity. As a student at the University of Florida, you have committed yourself to uphold the Honor Code, which includes the following pledge:

"**We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity**."

You are expected to exhibit behavior consistent with this commitment to the UF academic community, and on all work submitted for credit at the University of Florida, the following pledge is either required or implied:

"On my honor, I have neither given nor received unauthorized aid in doing this assignment."

It is your individual responsibility to know and comply with all university policies and procedures regarding academic integrity and the Student Honor Code. Violations of the Honor Code at the University of Florida will not be tolerated. Violations will be reported to the Dean of Students Office for consideration of disciplinary action. For additional information regarding Academic Integrity, please see Student Conduct and Honor Code or the Graduate Student Website for additional details:
https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/
http://gradschool.ufl.edu/students/introduction.html

Please remember cheating, lying, misrepresentation, or plagiarism in any form is unacceptable and inexcusable behavior.

Online Faculty Course Evaluation Process

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/ . Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

Policy Related to Guests Attending Class

Only registered students are permitted to attend class. However, we recognize that students who are caretakers may face occasional unexpected challenges creating attendance barriers. Therefore, by exception, a department chair or his or her designee (e.g., instructors) may grant a student permission to bring a guest(s) for a total of two class sessions per semester. This is two sessions total across all courses. No further extensions will be granted. Please note that guests are **not** permitted to attend either cadaver or wet labs. Students are responsible for course material regardless of attendance. For additional information, please review the Classroom Guests of Students policy in its entirety. Link to full policy:
http://facstaff.phhp.ufl.edu/services/resourceguide/getstarted.htm

SUPPORT SERVICES

Accommodations for Students with Disabilities

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the Disability Resource Center by visiting https://disability.ufl.edu/students/get-started/ . It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester. The College is committed to providing reasonable accommodations to assist students in their coursework.

Counseling and Student Health

Students sometimes experience stress from academic expectations and/or personal and interpersonal issues that may interfere with their academic performance. If you find yourself facing issues that have the potential to or are already negatively affecting your coursework, you are encouraged to talk with an instructor and/or seek help through University resources available to you.

- The Counseling and Wellness Center 352-392-1575 offers a variety of support services such as psychological assessment and intervention and assistance for math and test anxiety. Visit their web site for more information: http://www.counseling.ufl.edu. On line and in person assistance is available.

- You Matter We Care website: http://www.umatter.ufl.edu/. If you are feeling overwhelmed or stressed, you can reach out for help through the You Matter We Care website, which is staffed by Dean of Students and Counseling Center personnel.

- The Student Health Care Center at Shands is a satellite clinic of the main Student Health Care Center located on Fletcher Drive on campus. Student Health at Shands offers a variety of clinical services. The clinic is located on the second floor of the Dental Tower in the Health Science Center. For more information, contact the clinic at 392-0627 or check out the web site at: https://shcc.ufl.edu/

- Crisis intervention is always available 24/7 from:
  Alachua County Crisis Center:
  (352) 264-6789
  http://www.alachuacounty.us/DEPTS/CSS/CRISISCENTER/Pages/CrisisCenter.aspx

Do not wait until you reach a crisis to come in and talk with us. We have helped many students through stressful situations impacting their academic performance. You are not alone so do not be afraid to ask for assistance.

Inclusive Learning Environment

Public health and health professions are based on the belief in human dignity and on respect for the individual. As we share our personal beliefs inside or outside of the classroom, it is always with the understanding that we value and respect diversity of background, experience, and opinion, where every individual feels valued. We believe in, and promote, openness and tolerance of differences in ethnicity and culture, and we respect differing personal, spiritual, religious and political values. We further believe that celebrating such diversity enriches the quality of the educational experiences we provide our students and enhances our own personal and professional relationships. We embrace The University of Florida's Non-Discrimination Policy, which reads, "The University shall actively promote equal opportunity policies and practices conforming to laws against discrimination. The University is committed to non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information and veteran status as protected under the Vietnam Era Veterans' Readjustment Assistance Act." If you have questions or concerns about your rights and responsibilities for inclusive learning environment, please see your instructor or refer to the Office of Multicultural & Diversity Affairs website: www.multicultural.ufl.edu.