ASCI 896-004 Statistical Genomics

Spring 2017

Instructor

- Name: Gota Morota
- Office: A218f Animal Science Building
- Email: morota@unl.edu
- Web: http://morotalab.org/
- Office Hours: By appointment

Time and Location

- Tues./Thurs. 9:30-10:45am
- Animal Science Building, Room A228

Prerequisites

- STAT 802 or equivalent, or permission of the instructor
- Knowledge of statistical programming language R

Course Description

This course will cover quantitative genetic analysis of complex trait genetics with emphasis on the use of molecular markers spanning the entire genome. We will discuss statistical methodologies for connecting phenotypes with high-dimensional genomic information to better understand polygenic traits from both prediction and inference perspectives. Topics will include genomic relatedness, linkage disequilibrium, population stratification, genomic heritability, missing heritability, genome-enabled prediction of complex traits, causal inference, and statistical learning. We will use examples from the animal, plant, and human genetics literature. Additional topics will be briefly touched upon, including sequence data, gene expression, epigenetics, and bioinformatics. Homework assignments involve hands-on analysis of simulated and real genomic data available at public repositories. The course will use R/Bioconductor software for statistical computing tools.

Learning Objectives

After taking this course, the student will be able to:

- understand the statistical theory behind commonly used quantitative methods in genomics

- apply statistical methods to high-dimensional genomic data and analyze them using statistical computing tools
- critically review current literature in statistical and quantitative genetics

Texts and Reading Materials

Lecture slides will be provided on the class website. There will be no required textbook.

Tentative schedule

1. Overview of statistical genomics - Prediction vs. Inference
2. Ordinary least-squares and the curse of dimensionality
3. Linkage disequilibrium
4. Relatedness due to expected resemblance - Additive relationships
5. Relatedness due to expected resemblance - Non-additive relationships
6. Relatedness due to genetic markers - Additive relationships
7. Relatedness due to genetic markers - Non-additive relationships
8. Population structure and cryptic relatedness
9. Likelihood and Bayesian approaches in quantitative genetics
10. Whole-genome regression - Penalized regression
11. Whole-genome regression - Bayesian alphabet regression 1
12. Whole-genome regression - Bayesian alphabet regression 2
13. Whole-genome regression - Genomic BLUP 1
14. Whole-genome regression - Genomic BLUP 2
15. Introduction to whole-genome regression software
16. Whole-genome regression - Semi-parametric regression 1
17. Whole-genome regression - Semi-parametric regression 2
18. Estimation of heritability using pedigree and twin data 1
19. Estimation of heritability using pedigree and twin data 2
20. Estimation of heritability using genomic data
21. Population stratification - Principal component analysis
22. Population stratification - Mixed-linear-model association 1
23. Population stratification - Mixed-linear-model association 2
24. Population stratification - Genomic control

25. Missing heritability - Related vs. unrelated individuals
26. Deterministic equations for genome-enabled prediction
27. Statistical genomics of disease - Liability threshold model 1
28. Statistical genomics of disease - Liability threshold model 2
29. Multiple-trait model
30. Genotype x environment interaction
31. Student presentation

Grading

There will be bi-weekly take-home projects to analyze simulated or real data sets and the final exam at the end of course. In addition, each student will give a 15 minute in-class presentation/discussion during the course. Grades will be based on the data analyses (worth 70% of grade or 70 points), the final exam (worth 20% of grade or 20 points), and presentation (worth 10% of grade or 10 points). The final grade will be based on the following scale:

Points	Grade
> 95	A+
90-94	A
85-89	A-
80-84	B+
75-79	B
70-74	B-
65-69	C+
60-64	C
55-59	C-
$>$ 50-54	F

Emergency Response Information

- Fire Alarm (or other evacuation): In the event of a fire alarm: Gather belongings (Purse, keys, cellphone, N-Card, etc.) and use the nearest exit to leave the building. Do not use the elevators. After exiting notify emergency personnel of the location of persons unable to exit the building. Do not return to building unless told to do so by emergency personnel.
- Tornado Warning: When sirens sound, move to the lowest interior area of building or designated shelter. Stay away from windows and stay near an inside wall when possible.
- Active Shooter
  - Evacuate: if there is a safe escape path, leave belongings behind, keep hands visible and follow police officer instructions.
  - Hide out: If evacuation is impossible secure yourself in your space by turning out lights, closing blinds and barricading doors if possible.

  - Take action: As a last resort, and only when your life is in imminent danger, attempt to disrupt and/or incapacitate the active shooter.

- UNL Alert: Notifications about serious incidents on campus are sent via text message, email, unl.edu website, and social media. For more information go to: http://unlalert.unl.edu.

- Additional Emergency Procedures can be found here: http://emergency.unl.edu/doc/Emergency_Procedures_Quicklist.pdf

Students with Disabilities

Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3737 voice or TTY.

Student Code of Conduct

Students are expected to adhere to guidelines concerning academic dishonesty outlined in Section 4.2 of the Universitys Student Code of Conduct (http://stuafs.unl.edu/ja/code/). Students are encouraged to contact the instructor for clarification of these guidelines if they have questions or concerns.