

Statistics 416: Statistical Design and Analysis of Microarray and RNA-seq Experiments

Spring 2017

Location: 0611 Gilman
Time: 11:00am-12:20 p.m. Tuesdays and Thursdays
Webpage: Blackboard

Instructor: Peng Liu
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Office Hours: Wednesdays 10-10:50am and Thursdays 10-10:50am, or by appointment

TA: Ran Bi
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Office: 1418 Snedecor Hall
Office Hours/R help session: Wednesdays 3:10-5pm

Learning Objectives:

STAT 416 will emphasize application and practical use of statistical methods for designing and analyzing RNA-seq (and optional microarray) experiments. Students completing STAT 416 should be able to design their own RNA-seq experiments, analyze RNA-seq data from common designs with currently developed methods, and describe their work in a manner suitable for publication. All students should gain a sound understanding of the statistical principles important for good RNA-seq experimental design and analysis.

Prerequisites: STAT 401, Statistical Methods for Research Workers.

Reading materials:

Optional textbook: *Statistical Analysis of Next Generation Sequencing Data* (edited by S. Datta and D. Nettleton, Springer, 2014)

Link to the textbook: <http://link.springer.com.proxy.lib.iastate.edu/book/10.1007/978-3-319-07212-8>

Supplementary readings from various sources will be assigned throughout the semester.

Grading:

Homework (~ every 2 weeks)	30%	
Midterm Exam	20%	Thursday, March 9, 11:00am-12:20 p.m.
Project	20%	
Final Exam	30%	Tuesday, May 2, 9:45-11:45am

The Midterm Exam is *tentatively* scheduled in class on *Thursday, March 9, 11am-12:20pm*. The Final Exam is tentatively scheduled on *Tuesday, May 2, 9:45-11:45am*.

On exam days, be sure to arrive early with a calculator and pen or pencil. No make-up exams will be given unless circumstances are exceptional. Your final course percentage will be determined by the following formula:

$$\text{Course Score} = 0.3 H + 0.2 M + 0.2 P + 0.3 F$$

where H, M, P and F represent the score out of 100 possible on homework, the midterm exam, the project and the final exam, respectively. Below is a rough grading scale that may be made more lenient to compensate for difficult homework and/or exams.

Score	100-93	92-90	89-87	86-83	82-80	79-77	76-73	72-70	69-67	66-63	62-60	59-0
Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F

Homework Guidelines:

- The purpose of all homework assignments is to help you learn the course material.
- All homework assignments are posted at the course webpage on blackboard.
- Due dates are posted on the web site and written on the homework documents.
- **No late homework is accepted.**
- Answers to homework assignments should be neatly written or typed and well organized with no extraneous information.
- You are welcome to work with other students on homework problems. You must, however, write your own answers to the questions. Copying another's work is prohibited.

Computing: This course will emphasize the use of **R** for statistical computing. We will heavily use R packages for the analysis of RNA-seq data.

“R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS.” It can be downloaded from www.r-project.org. There are free documentations on how to use **R** on that webpage as well. Some of the **R** packages to be introduced during the semester provide well-documented user's guides. You may also remote log into the server: TS2.stat.iastate.edu.

Course Coverage:

1. Introduction to RNA-seq and microarray experiments and overview of the data analysis
2. RNA-seq technology and bioinformatics pipeline
3. Variability in RNA-seq data
4. Experimental design of RNA-seq experiments
(introduction, different designs, different phases of RNA-seq design, discussion of replicates, discussion of pooling samples, sequencing depth)
5. Normalization of RNA-seq data
6. Generalized linear model analysis

7. Multiple hypothesis testing and false discovery rate
8. Popularly applied methods for differential expression (DE) analysis of RNA-seq data and utilization of R packages
9. Sample size calculation while controlling false discovery rate
10. Testing gene categories for DE
11. Cluster analysis
12. Miscellaneous topics on the statistical design and analysis of RNA-seq experiments if time allowed
 - a. Analysis of RNA-seq data with random effects (ShrinkSeq)
 - b. Alternative splicing (isoform abundance and differential isoform usage)
 - c. Allele-specific expression
 - d. Samples with 1 or 2 replicates
 - e. ChIP-seq data analysis

Disability Accommodation: Iowa State University complies with the Americans with Disabilities Act and Sect 504 of the Rehabilitation Act. If you have a disability and anticipate needing accommodations in this course, please contact (instructor name) to set up a meeting within the first two weeks of the semester or as soon as you become aware of your need. Before meeting with (instructor name), you will need to obtain a SAAR form with recommendations for accommodations from the [Disability Resources Office](#), located in Room 1076 on the main floor of the Student Services Building. Their telephone number is 515-294-7220 or email disabilityresources@iastate.edu. Retroactive requests for accommodations will not be honored.

Dead Week: This class follows the Iowa State University Dead Week guidelines as outlined in <http://catalog.iastate.edu/academiclife/#deadweek>

Harassment and Discrimination: Iowa State University strives to maintain our campus as a place of work and study for faculty, staff, and students that is free of all forms of prohibited discrimination and harassment based upon race, ethnicity, sex (including sexual assault), pregnancy, color, religion, national origin, physical or mental disability, age, marital status, sexual orientation, gender identity, genetic information, or status as a U.S. veteran. Any student who has concerns about such behavior should contact his/her instructor, [Student Assistance](#) at 515-294-1020 or email dsosas@iastate.edu, or the [Office of Equal Opportunity and Compliance](#) at 515-294-7612.

Religious Accommodation: If an academic or work requirement conflicts with your religious practices and/or observances, you may request reasonable accommodations. Your request must be in writing, and your instructor or supervisor will review the request. You or your instructor may also seek assistance from the [Dean of Students Office](#) or the [Office of Equal Opportunity and Compliance](#).

Contact Information: If you are experiencing, or have experienced, a problem with any of the above issues, email academicissues@iastate.edu.