Fall 2016 Course: 11:126:485 / 16:765:585

COURSE SYLLABUS

Location

LECTURE: Foran Hall, Room 138A, Tuesdays, 7th Period, 7:15pm - 8:35pm

JOURNAL CLUB (grad section ONLY): Lipman Hall, Room 325 or 016, Tuesdays, 6pm-7pm

LAB: Foran Hall, Computer Lab, Room 124, Thursdays, 5:35pm - 8:35pm

CLASS E-mail: **yanab@rci.rutgers.edu**

Lecturer:

Dr. Yana Bromberg
Lipman Hall 218
yanab@rci.rutgers.edu

Office Hours: Tuesdays 5-6 or By Appointment

Lab Instructors:

Chengsheng Zhu

Lipman Hall 222
chengzhu@scarletmail.rutgers.edu

Office Hours: By Appointment

Brief Intro:

Bioinformatics as a field attempts to build computational models of the biological systems and mechanisms. More specifically, bioinformatics involves creating algorithms, databases, systems, and web applications to solve problems in molecular biology. Here, all computational advances are "fair game". Bioinformatics tools use artificial intelligence, rely on "cloud" computing, and borrow concepts from signal processing and circuit theory. ALL these developments are necessary to deal with the inordinate amounts of data that is being produced by modern high-throughput experimental techniques. Due to the drop in sequencing costs we are awash in DNA, RNA, and protein sequences. Massive genomics and metagenomics efforts are opening new horizons in variation analysis. The past few years of structural genomics efforts have produced a crystal structure representative of almost every protein family. Microarray technologies allow simultaneous studies of expression of thousands of genes on a single chip. The improvements keep on coming – more information, higher resolution. Yet the unintended result of improved experimental techniques is a flood data that we have yet to make sense of. What does our genome encode? What about the soil metagenome? Can we decipher the mechanisms of disease? How are we different from other organisms? How are we different from each other? Bioinformatics attempts to answer all these questions… and give the statistical significance.

What this course IS:
This course is designed to introduce experimental biologists to bioinformatics concepts, principles, and techniques within the framework of basic shell scripting and web-based databases/tools. Prior to starting class, students are expected to know how to work in a command-line environment and have a basic understanding of programming/scripting. The course includes a brief introduction to working with UNIX/LINUX systems, writing Python scripts, and automating/using existing applications for the analysis of large datasets. All work will be done in a live development environment; *i.e.* students will have access to the same computational resources used by dedicated bioinformatics labs on campus. By the end of this course, students will possess a sufficient bioinformatics skill set, including an informed vocabulary and knowledge of basic script development, for productive collaboration within a multi-disciplined research team.

What this course IS NOT:
This is NOT an applied methods course; rather, this class is aimed at *understanding of underlying algorithms*. We will NOT attempt to list all available tools for every project or teach you how to use them. Method selection, along with the corresponding cutoffs, thresholds, and settings, is specific to each and every research project. If you keep up with the class material you will understand the method underpinnings and be able to able to optimize your project choices on your own.

COURSE OBJECTIVES

1. Introduce students to the current bioinformatics algorithms/concepts and their implementations.
2. Introduce students to the basics of working in a Linux environment, GridEngine submissions for parallel computing, and Python scripting.
3. Teach students to cast a molecular biology problem as a bioinformatic problem, provide them with the skills necessary to independently select relevant tools, optimize their settings, and build pipelines to solve the set problem.
4. Prepare students for more advanced bioinformatics courses involving method development.
5. Teach students a sufficient bioinformatics skill set, including an informed vocabulary and knowledge of basic script development, for productive collaboration within a multi-disciplined research team.

REQUIRED TEXT

There is **NO REQUIRED TEXT** for the lab or lecture.

Suggested textbooks are: **Bioinformatics Algorithms: An Active Learning Approach, 2nd Ed. Vol. 1 and 2,** by Philipp Compeau and Pavel Pevzner. Publisher: Active Learning Publishers; 2nd edition (2015); ISBN-13: 978-0990374619 and 978-0990374626

Suggested Online resource at: http://rosalind.info

LECTURES AND LECTURE SLIDES

Lectures will be taught as a combination of PowerPoints with blackboard and discussions. Slides will be posted, but will contain only an outline of the work done in class. They are intended to help you reconstruct the work from class, but are not intended as a substitute for taking notes. Slides will sometimes be posted before class, but this is not guaranteed. Additionally, these are meant to be drafts, provided as a "heads up" for anyone interested to do some online reading prior to coming to class. Students are not expected to look at them before lecture, and it is possible that corrections will be made to these slides before the final version is posted.

GRADING

Coursework will be weighted as follows:

Class Participation	10%
Lab Homework/Quizzes	30%
Midterm	20%
Final	40%
Journal Club (graduate component only)	No Credit

Attendance / Class Participation

Regular, on-time, attendance is expected of all students. If you are going to miss a class, please inform the instructor ahead of time.

Lecture: Attendance is not required, but missed lectures will be counted against your grade for class participation (10% of the total). Consistent minor lateness interrupts class flow and will reduce the percentage for assigned for class participation as well. Since there is no textbook for this course, *attendance* is necessary for understanding of the material. Please note that you are responsible for all material covered in class whether it is present in lecture PowerPoints or not. If you intend to miss classes, find a friend who takes good notes. Note that the entire class consists of 13 inter-dependent lectures. Missing three or more lectures (a quarter of the class) suggests that the information presented in the course was not learned.

Further, class participation is necessary for understanding of the material – your final grade will depend on you asking questions and/or participating in class discussions. Please note that if you do not participate voluntarily, you will be called upon. Class participation grade has nothing to do with being correct – it will only reflect your willingness to work towards a solution for the posed problem.

Lab: Missing any number of labs without a valid (WRITTEN and DOCUMENTED explanation) will result in a FAILING GRADE for the entire class. Since time is short relative to typical lab classes, late attendance is also not acceptable. Important information and quizzes will be typically given at the beginning of class without a make-up option.

Homework / Quizzes

Completed homework assignments are due at the beginning of lab or lecture class one week from the date they are assigned, unless otherwise specified. Late submissions will NOT be accepted. Assignments containing scripts (written code) must run properly in the standard development environment. No submission, empty submissions, or "fake" submissions (i.e. scripts that are clearly not expected to do the assignment) will receive 0% grades. Properly commented scripts that produce errors/warnings and/or fail to provide the correct, formatted output will receive no more than 50% of the grade. That being said, your programs will not be expected to handle user-input errors (unless otherwise specified) and will not be tested for such.

Quizzes will be given at the discretion of the lab/lecture instructor. Quizzes **may be** announced, but **do not have to be**. Quizzes may be written, coding, or both. They may cover lab and/or lecture material, but they will always relate to current topics. We are not looking to "burn" students with Linux questions in week 10, though you should get perfect scores if such a quiz was given. A quiz may be given at any time during any class period - immediately before or after a lecture, during a class, etc. There will be no make-up quizzes.

Midterm/Final

The **midterm** will have a written portion (taken in-class) **and** a take-home programming assignment. It will be based on material covered in lecture AND lab. This should underscore the importance of keeping up with the material. You will have one week to complete the take-home project, including the time in regularly scheduled lab. Your TA will be available during lab-time to discuss assignment problems (NOT to help you solve them). ***Late projects will NOT be accepted.***

The final may (but not necessarily will) have both an in-class and a take-home component. The ***in-class portion of the* final** will be a multi-tool workflow/pipeline exercise (very flexible in implementation, but necessarily well explained and documented), focusing on all techniques learned throughout class.

The ***take-home portion of the final*** will include designing and running a computational analysis of some biological data, using techniques learned in class. The results will need to be described in scientific article format; *i.e.* introduction and background, results, materials and methods, and discussion. You will have at least a week to complete the take-home portion. ***Late projects will NOT be accepted.***

Journal Club (Graduate Component Only)

Graduate students in the class will be **required** to attend journal club meetings. The number of sessions will be adjusted depending on the number of people in the class. In the span of the semester you will be required to read, analyze, and present at least one bioinformatics paper of your choice. The presentations will not be graded, but without a presenting you will be assigned a FAILING grade in the course. Undergraduates are encouraged to attend the journal club, read the papers, and potentially present. Note, however, that this will NOT count as extra credit.

ACADEMIC HONESTY:

Academic honesty is an absolute requirement for students taking Bioinformatics. Dishonesty, in any form, will NOT be tolerated. This includes cheating on homework, quizzes, projects, as well as any form of plagiarism. Please note that working together on homework assignments and submitting identical work is NOT THE SAME; same goes for searching the web for solutions to problems, text for your project written components, and/or ready-made code. ***VERY IMPORTANT***: We read (and write!!) papers and Wikipedia entries too and know where certain texts come from. It's easy to tell when you've copied a sentence or two. It is even easier to tell if script code was copied – please keep this in mind. ALL CHEATING WILL BE REPORTED. The Rutgers University Academic Integrity Policy can be found at: http://academicintegrity.rutgers.edu/integrity.shtml. Students contemplating cheating should consider the severe repercussions of getting caught.

Group work policy: In order to facilitate learning, students are encouraged to discuss homework problems amongst themselves. Copying a solution is not, however, the same as "discussing". According to one colleague, Dr. Iddo Friedberg, a good rule of thumb is the "cup of coffee" rule. After discussing a problem, you should not take away any written record or notes of the discussion. Go have a cup of coffee, and read the front page of the newspaper. If you can still re-create the problem solution afterward from memory, then you have learned something, and are not simply copying.

GROUP WORK ON MIDTERM AND FINAL PROJECTS IS NOT ALLOWED.

CLASSROOM RULES OF CONDUCT

1. No checking email, IM'ing, Texting, looking or catching Pokemon, or talking to friends during class time. Phones must be off, or set to quiet. Repeat offenders will be asked to leave the classroom and downgraded in class participation.
2. Food and beverages are not permitted in the classroom or lab, whether opened or not.
3. Lab time is to be spent on lab work. Lab time is not free time. If you finish early, you may start on the associated homework assignment.
4. Again, please be on time.

YOUR IDEAS, EVALUATIONS, ETC.

In general, your ideas, comments, suggestions, questions, grade challenges, etc. are welcome. Your discretion in these matters is expected, however. No part of your grade will be based on anything other than your coursework and attendance.

SUGGESTIONS FOR SUCCESS

Make sure you stay on top of your homework assignments. Waiting until the last minute to complete an assignment will not work in this course.

TENTATIVE SCHEDULE (subject to change)

6-Sep	Intro to Bioinformatics	8-Sep	Intro to Linux
13-Sep	Gene Finding	15-Sep	Intro to Python
20-Sep	Pairwise sequence alignment, deriving BLOSUM	22-Sep	Python II / EMBOSS / BLAST
27-Sep	BLAST, affine gap costs, database searches	29-Sep	Python III / PSI BLAST
4-Oct	MSAs and domain families	6-Oct	AmiGO
11-Oct	Sequence signatures and motifs	13-Oct	InterPro
18-Oct	Structural Bioinformatics	20-Oct	Python IV, Chimera
25-Oct	***Midterm in-class and take-home portion assigned (collected Oct 28th)***		
1-Nov	Structural Bioinformatics and Phylogenomics	3-Nov	MAFFT
8-Nov	Phylogenomics	10-Nov	MG-RAST lab
15-Nov	Metagenomics	17-Nov	Microarray lab
22-Nov	LAB SCHEDULE (SNAP, Weka I)	24-Nov	Thanksgiving Break, no class
29-Nov	Gene expression and Microarrays	1-Dec	Weka II
6-Dec	Variation and molecular level natural selection	8-Dec	LECTURE starting at 5:35 in lab space: Disease gene prioritization ***Take-home portion of final assigned***
13-Dec	Precision Medicine (won't be in final)	15-Dec	**In-class Final; starting 5:35pm In Lab Space, 3 hours required;** ***Take home portion of finals due***

HAVE A GREAT VACATION

ACCOMODATIONS FOR STUDENTS WITH DISABILITIES

Please follow the procedures outlined at https://ods.rutgers.edu/students/registration-form. Full policies and procedures are at https://ods.rutgers.edu/

ABSENCE POLICY

Students are expected to attend all classes; if you expect to miss one or two classes, please use the University absence reporting website https://sims.rutgers.edu/ssra/ to indicate the date and reason for your absence. An email is automatically sent to me.

FINAL EXAM/PAPER DATE AND TIME

Online Final exam Schedule: http://finalexams.rutgers.edu/

ACADEMIC INTEGRITY

The university's policy on Academic Integrity is available at http://academicintegrity.rutgers.edu/academic-integrity-policy. The principles of academic integrity require that a student:

- properly acknowledge and cite all use of the ideas, results, or words of others.
- properly acknowledge all contributors to a given piece of work.
- make sure that all work submitted as his or her own in a course or other academic activity is produced without the aid of impermissible materials or impermissible collaboration.
- obtain all data or results by ethical means and report them accurately without suppressing any results inconsistent with his or her interpretation or conclusions.
- treat all other students in an ethical manner, respecting their integrity and right to pursue their educational goals without interference. This requires that a student neither facilitate academic dishonesty by others nor obstruct their academic progress.
- uphold the canons of the ethical or professional code of the profession for which he or she is preparing.

Adherence to these principles is necessary in order to ensure that

- everyone is given proper credit for his or her ideas, words, results, and other scholarly accomplishments.
- all student work is fairly evaluated and no student has an inappropriate advantage over others.
- the academic and ethical development of all students is fostered.
- the reputation of the University for integrity in its teaching, research, and scholarship is maintained and enhanced.

Failure to uphold these principles of academic integrity threatens both the reputation of the University and the value of the degrees awarded to its students. Every member of the University community therefore bears a responsibility for ensuring that the highest standards of academic integrity are upheld.

STUDENT WELLNESS SERVICES

Just In Case Web App http://codu.co/cee05e

Access helpful mental health information and resources for yourself or a friend in a mental health crisis on your smartphone or tablet and easily contact CAPS or RUPD.

Counseling, ADAP & Psychiatric Services (CAPS)

(848) 932-7884 / 17 Senior Street, New Brunswick, NJ 08901/ www.rhscaps.rutgers.edu/

CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professional within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS offers a variety of services that include: individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community and consultation and collaboration with campus partners.

Violence Prevention & Victim Assistance (VPVA)

(848) 932-1181 / 3 Bartlett Street, New Brunswick, NJ 08901 / www.vpva.rutgers.edu/

The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling and advocacy for victims of sexual and relationship violence and stalking to students, staff and faculty. To reach staff during office hours when the university is open or to reach an advocate after hours, call 848-932-1181.

Disability Services

(848) 445-6800 / Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854 / https://ods.rutgers.edu/

Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: https://ods.rutgers.edu/students/documentation-guidelines. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form on the ODS web site at: https://ods.rutgers.edu/students/registration-form.

Scarlet Listeners

(732) 247-5555 / http://www.scarletlisteners.com/

Free and confidential peer counseling and referral hotline, providing a comforting and supportive safe space.