CMP_SC 8150 / MUII 8350

Course title: “Integrative Methods in Bioinformatics”

Prerequisites: MUII 7010. An undergraduate course in molecular and cell biology is preferable.

Suggested literature:

- *Computational Methods for Protein Structure Prediction and Modeling, I and II*, - Ying Xu, D. Xu and J Liang, Springer: 2006.
- *A First Course in Systems Biology*, Eberhard Voit, Garland Science; First Edition: 2012
- The major information source is the peer-reviewed papers.

Example of a paper to study:
Alber, F. *et al. Determining the architectures of macromolecular assemblies.* Nature, 2007, Nov 29;450(7170):683-94.

Course outline

With biology entering the Big Data era, scientists are overwhelmed with the amount and the diversity of the experimental, statistical, and evolutionary data about the biological objects they study. As a result, the frontier bioinformatics and computational genomics methods have started to utilize a so-called integrative approach, where the computational and informatics methods are used to combine the high-throughput and low-throughput data. The main objective of this course is to teach students how to integrate non-homogeneous biological data obtained from multiple sources when modeling a complex system, such as protein-protein interaction network, a molecular complex, or 3D structure of a genome. The computational component of the course will include studying of how data mining, machine learning and bioinformatics techniques are used for data integration. The biological component will introduce students to the most popular experimental methods from the point of view of the information sources that can be used in bioinformatics approaches.

Among the topics covered in this course are: experimentally restrained protein docking, large-scale protein interaction network determination, combining imaging and structure data to model molecular assemblies, an integrative approach towards modeling a 3D structure of genome, and others. The course will consist of lectures on the methods and their applications. During the lectures, we will go discuss the state-of-the-art papers in the field and review them simulating a peer-review process. The course will also include a project where students will study a specific complex biological system and learn how to apply an Integrative Modelling Platform (IMP) to extract new knowledge from the system.

Course structure:

Part 1. Introduction and main concepts (3 weeks)

- Basic types of biological macromolecules
- Protein sequence and structure
- Protein-protein interactions
- Protein-DNA interactions
- Protein interaction networks

Part 2. Using experimental data for multidomain proteins and protein complexes (3 weeks, including 1 laboratory work)

- Introduction to restrained macromolecular docking. Basic principles.
- Small-scale experimental methods for characterization of protein-protein interactions
- Experimental methods providing the information about the overall structure of a macromolecule
- Recent methods in experimentally restrained protein-protein docking

Part 3. High throughput methods for large-scale protein interactions (4 weeks, including 1 laboratory work)

- Types of high-throughput methods for determining protein-protein interaction networks
- Using mass-spectrometry data to identify protein complexes
- Using machine learning methods combined with the experimental data to determine an accurate structure of the interaction network
- An approach to obtain structure of a macromolecular assembly by satisfaction of spatial restraints

Part 4. Hybrid methods for macromolecular imaging and 3D genomes (4 weeks, including 1 laboratory work)

- Types of macromolecular imaging
- Combining high resolution substructures with the electron imaging data
- Using high resolution in imaging data
- Using protein structure models to improve an accuracy of the image

Grading: Grading will be based upon the research project, research paper, and the project presentation at the end of the course. An important part of the project would be a series of experiments suggested by the students for potential experimental collaborators, which are designed to improve the accuracy of predictions or provide the missing information about a biological system.

Paper Review Assignments: 25
Paper presentation (team of two): 15%
Project 60%

- Topic selection 5%
- Current literature review (Introduction) 15%
- Project design description (Methods) 20%
- Project results (Results) 20%
- Research paper 20%
- Project presentation 20%

Academic Dishonesty Statement

Academic integrity is fundamental to the activities and principles of a university. All members of the academic community must be confident that each person's work has been responsibly and honorably acquired, developed, and presented. Any effort to gain an advantage not given to all students is dishonest whether or not the effort is successful. The academic community regards breaches of the academic integrity rules as extremely serious matters. Sanctions for such a breach may include academic sanctions from the instructor, including failing the course for any violation, to disciplinary sanctions ranging from probation to expulsion. When in doubt about plagiarism, paraphrasing, quoting, collaboration, or any other form of cheating, consult the course instructor.

ADA Statement

If you need accommodations because of a disability, if you have emergency medical information to share with me, or if you need special arrangements in case the building must be evacuated, please inform me immediately. Please see me privately after class, or at my office.

Office location: 207EBW, Office hours: TBA

To request academic accommodations (for example, a notetaker), students must also register with the Office of Disability Services, (http://disabilityservices.missouri.edu), S5 Memorial Union, 882-4696. It is the campus office responsible for reviewing documentation provided by students requesting academic accommodations, and for accommodations planning in cooperation with students and instructors, as needed and consistent with course requirements. For other MU resources for students with disabilities, click on "Disability Resources" on the MU homepage.

Intellectual Pluralism Statement

The University community welcomes intellectual diversity and respects student rights. Students who have questions concerning the quality of instruction in this class may address concerns to either the Departmental Chair or Divisional leader or Director of the Office of Students Rights and Responsibilities (http://osrr.missouri.edu/). All students will have the opportunity to submit an anonymous evaluation of the instructor(s) at the end of the course.