Spring 2009 – URI Bioinformatics I
Tuesdays & Thursdays 5-6:15 p.m. Fogarty 120
Professors Kowalski (CSC), Martin (CMB) & Udwary (BPS)

CSC 522, STA522, MIC522, BCH, 522 or BPS 542
Bioinformatics I: 3-4 credits*

* Note: Computer science students seeking credit for a graduate “design” course must have CSC 305 or the equivalent in advance of this class, must sign up for 4 credits, and must carry out a substantial software design and documentation as a part of their project. Biology and statistics students seeking 4 credits for this class must carry out an additional laboratory or biomathematics project or be engaged in software design and implementation.

Instructional Materials:
Class Website: [http://homepage.cs.uri.edu/courses/spring2009/csc522s1](http://homepage.cs.uri.edu/courses/spring2009/csc522s1)

Introduction: This course is intended to prepare students from the biological sciences and the computing sciences to do research in bioinformatics. This is a discipline in which, computer science, information science, and statistics constructs, tools and procedures are used to support research in the biological sciences. Biologists are increasingly dependent upon complicated computer programs that allow them to analyze modern data sets. Knowledge of the programs that are available, and an ability to use the array of programs is now important to support biological research. Bioinformatics research supports the growing need for experts with multidisciplinary backgrounds to address the development, improvement and maintenance of these technologies.

This course will be problem based in that students will work on problems that are consistent with the research goals of teams of biological science, computer science and statistics professors on the URI campus. Students are not required to have statistics, computer science and biological science background, but junior status (or higher) in at least one is required. The goals of the course are to:

- Help students to tackle emerging bioinformatics research problems in Rhode Island. These are to include such computational domains as data mining (for example genomic, proteomic and bio-imaging data), algorithms, statistical methods, visualization, data exchange, and data security.
- Cover introductory computational molecular biology, computer science, and statistics material to inform the biologists to statistical and computing techniques, and the computer scientists and statisticians to biological techniques as appropriate to support the problems that are assigned to the student teams.
- Learn to use a set of bioinformatics software tools, such as those available and supported by the departments of biomedical & pharmaceutical sciences (see [http://www.uri.edu/inbre/bioinfo/](http://www.uri.edu/inbre/bioinfo/)) & cell and molecular biology ([http://www.uri.edu/research/gsc/](http://www.uri.edu/research/gsc/))
Topics to be covered in class through readings and lecture:

1. Biological and Physical Chemistry, Atoms, Molecules, Bonds, Electrons
2. Introduction to Molecular Biology and Genomics Part 1 (Sequencing technology, organisms)
3. Genomics Part 2 (evolution, comparative genomics, and metagenomics)
4. Databases and bioinformatics resources
5. File formats and archiving of biological data
6. Sequence alignment
7. Phylogeny
8. Proteins and protein structure
9. Protein structure/function prediction and modeling
10. Proteomics (Microarrays and mass spectrometry)
11. Systems biology
12. Statistics and bootstrapping?
13. Computer Applications
   a. Database structure, design, and queries
   b. Data mining strategies and algorithms
   c. Graphics tools
14. Algorithms and Data Structures for Genome/Proteome Analysis
   a. Strings
   b. Arrays
   c. Searching/sorting
   d. Trees and graphs
   e. Computational complexity
15. Software Processes
   a. Language types (scripting, OO, procedural)
   b. Requirements extraction
   c. Software life cycle (specification, design, testing, maintenance)
Deliverables:

The students will define semester projects in teams (or, in some cases, individually) under the direction of a faculty member. The project should address the research needs of the faculty member who is conducting bioinformatics research in Rhode Island. Quizzes, homework exercises, etc. will be used infrequently and only where needed; there will be no exams. The students and teams will deliver the following during the semester; this will be the basis of the grades:

a) Project proposal, draft, and final version – 25%
b) Paper/Report (Every team will write a final paper or project report; drafts will be reviewed by classmates) – 25%
c) Prototype implementation, where appropriate (a part of the 25% in b). Balance of implementation and time spent on paper will determine how much each counts in the grade.
d) Final group project presentation (and prototype demo) – 15%
e) Evaluations of team mates and other teams (through walkthrough, final team evaluation, etc.) – 5%
f) Class participation – The students must illustrate that they are doing the required reading, and attending and actively participating with good questions, observations, and suggestions related to the topics being covered. Attendance is of course required in a course of this nature, and written summaries of some course material will be assigned and handed in for grading – 15%
g) Class presentations and walkthroughs – Each student will be asked to present at least once during the semester (not counting your own team final project presentation). Groups will also participate in at least one walkthrough (where you walk another group through your project and request feedback). – 15%

a) Draft Project Proposal Guidelines

In 1-3 pages, please identify the following items. (This is not a full set of requirements, just an initial project proposal):

• Name of the project
• Names of team members and contact information
• Team leader/facilitator(s) and contact information
• Planned project and scope of work (briefly, what do you expect to do and what do you expect to deliver at the end of the semester)
• Researchers with whom you will be working
• Time each week that you will be meeting with your team (1 – 1 1/2 hours outside of class time is recommended. It must be a time that all members can be present.)
• Resources that you think you will need to accomplish the project
• Skills that each team member brings to the project
b) Paper/Report

Submitted by each team at the end of the semester. This is due on the day of your final presentation to the class. This does not have to be organized as given below. This is to serve as a checklist or items that should be included as you see fit.

1. Introduction
   a. Problem in context of what is already “out there”
   b. Usefulness for the biological sciences
   c. References should be woven throughout this and other sections. If it makes more sense, you can also have a section devoted to related work.

2. Problem definition, and
   a. List of accomplishments expressed in terms of the problem that is defined
   b. Problems encountered
   c. Who did what
   d. Implementation status
   e. Words of wisdom to anyone using this work or embarking on a similar project

3. Results
   a. Time to be a sales person and talk about accomplishments in context of novel and useful research/work.

4. Future work and conclusions

5. Appendix
   a. With design, code, external docs, testing, defect report, etc.

Don’t hesitate to contact a professor for guidance. We are happy to answer any questions. Be sure that you “load balance” the work so that everyone on the team helps with this, even though some who are not bearing other heavier project burdens might contribute more to the final deliverable. You will reflect this in 2c). We will also be asking for peer reviews of teammates.

c) & d) Final group project presentation (and prototype demo)

The code and all written docs and final PowerPoint presentation must be delivered as instructed by our systems staff. More on that later. We are working out the best way to archive your work online at our bioinformatics site.
Bioinformatics I, Student Information Sheet

Name:

Phone no.: E-mail (please print neatly):

Major:

Employment:

Reasons for taking this class?

Other?

d) Presentations, Evaluation Sheet

Good use of media & teammates (board, projector, etc.) 20% ___

Well organized presentation 20% ___

Analysis of the topic 20% ___

Explains bioinformatics contribution 20% ___

Communication/Fielding of questions 10% ___

Participation in other presentations 10% ___