Biology 444, Fall 2014

Introduction to Bioinformatics

Catalog Synopsis: BCB 444. Introduction to Bioinformatics. **(Cross-listed with BCBIO, BIOL, COM S, CPR E, GEN). (4-0) Cr. 4. F. Prereq: MATH 165 or STAT 401 or equivalent.**
Broad overview of bioinformatics with a significant problem-solving component, including hands-on practice using computational tools to solve a variety of biological problems. Topics include: bioinformatic data processing, Perl programming, genome assembly, database search, sequence alignment, gene prediction, microarray image processing, next-generation sequencing, comparative and functional genomics, and systems biology. Nonmajor graduate credit.

Target Audiences: This course is primarily designed for undergraduate students from all disciplines. Biology and life science students are particularly encouraged to take this course to be familiar with topics in modern bioinformatics and computational biology, and to learn some basic data processing skills. Computer science, computer engineering, mathematic and other types of students can also benefit from this class and learn about modern molecular biology. This knowledge will help them understand where their own disciplines may contribute to the various expanding and exciting new biological research fields.

Course Outlines: This course will roughly be divided into three focus periods about 5 weeks long each. The three focuses will be on bioinformatics, genomics and next-generation sequencing. In each week there will be two 80 minute lectures and a 2 hour lab session. During the lectures the core concept of each topic will be introduced and explained by the instructor. During the lab sessions some topics will be formulated as class projects to help students connect abstract concepts with practices. The instructor and TA will stimulate and encourage class discussions, both during classes and online using the Blackboard Learn discussion forums. It is a requirement of this class that students actively follow the class discussions to learn new material and topics not covered in printed class materials. Because bioinformatics is a fast evolving research field, students should develop the habit of learning not just from prepared or printed material but also from other online information channels.

Learning Outcomes: Students who successfully complete this course with a B- or better grade will acquire the knowledge to answer the following questions:
1) What are bioinformatics and computational biology, and how do they differ and complement each other;
2) What are genomics research and how do bioinformatics and computation biology find important applications in genomics;
3) What are the most popular online biological databases, what kind of data do they host, and how to utilize them to conduct genomic research;
4) Which bioinformatics software tools are commonly used and important, and how to download and install them;
5) How to convert biological data among different formats, form bioinformatic data processing pipelines by combining existing software tools, and automate the data flow;
6) What is next-generation sequencing and how is this hot new technique related to traditional genomics and bioinformatics;
7) What characteristics of next-generation sequencing promote the need to develop new computational algorithms and expanded hardware capabilities (a.k.a. Big Data); and
8) How to become a knowledgeable and productive bioinformaticist regardless of one's own original background discipline?

Reference Books: There is no required textbook for this class. All required class material will be provided by the instructor via Blackboard Learn in the forms of lecture notes, project descriptions and online discussions. The following three reference books are most relevant to this class, but their acquisition is optional and is not essential to the learning in this class:

Learn Perl, 5th or 6th Eds., by Schwartz, Phoenix and foy.
This books can help students learn Perl, but it does not provide any bioinformatic examples. Either the 5th or the 6th edition of this book is helpful to this class. The 6th edition covers the latest Perl 5.14 version while the 5th edition covers the most commonly installed Perl 5.10 version. The Amazon Kindle versions of this book are cheaper and can be installed on an unlimited number of Kindle readers and/or PC or Mac, so the Kindle books may be better choices than printed books.

A Primer of Genome Science, 3rd Ed., by Greg Gibson and Spencer V. Muse
This textbook covers most of the bioinformatic topics we will learn in this class. This book is broader in its coverage of topics than its depth in any specific topic description. It also does not cover latest next-generation sequencing topics. Nevertheless, this book provides a good overview of genomics and covers many applications of genomics in molecular biology research.

Understanding Bioinformatics, by Marketa Zvelebil and Jeremy O. Brown
This textbook was previously used by the combined BCB 444/544 class before it was split into different classes. This book is more rigorous in computational algorithm descriptions but somehow lacking in practical application examples that would be more interesting to undergraduate students. This book will not be used in this class but interested computational-type students may reference this book to understand the detail of some computational algorithms.

Homework: There will be regular homework assignments suggested at the end of each lecture to help students reinforce their learning experience. Completion of the homework assignments is essential to the preparation of midterms and final exam, but homework will not be collected or graded. Instead, homework answers will usually be provided at the following lecture to let students compare and correct their homework answers.

Projects: There will be regular class projects mainly designed to be performed during the lab sessions and only occasionally when necessary, during student off-class hours. These projects will be collected and graded. Completion of all projects is also essential to prepare for the midterms and final exam and to pass the course with good grade.

Grading: Grading will be based on projects and exams. There will be two midterms and one final exam. Each exam will account for 20% of the total semester score. Exam topic areas are mostly non-overlapping, but during the final exam some important concepts that students miss in the midterms may be re-tested. The class projects will account for the remaining 40% of the semester score. Raw semester scores may be nonlinearly scaled or curved according to the overall class performance before being used to determine the final grade. The final letter grade will be determined using the standard grading scheme provided in Blackboard Learn.

Academic Dishonesty: The class will follow Iowa State University's policy on academic dishonesty. Anyone suspected of academic dishonesty will be reported to the Dean of Students Office.

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 the instructor 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 the instructor, 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 policy as noted in section 10.6.4 of the Faculty Handbook. No course assignments shall be due on the Dead Week and most course assignments except the final project will be due before the Dead Week. The final project is due by noon on the day of the final exam.

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 dso-sas@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.