Course Outline

BINF3020
Computational Bioinformatics
Semester 2 2016

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Course Staff

Contact Details

Staff Name	Role	Email	Phone
Mike Bain	Course Convenor	mike at cse.unsw.edu.au	56935

Consultations

Staff Name	Day/Time	Location

Course Details

Course Code:	BINF3020
Course Title:	Computational Bioinformatics
Units of Credit:	6
Course WebSite:	http://www.cse.unsw.edu.au/~bi3020/
Handbook Entry:	http://www.handbook.unsw.edu.au/undergraduate/courses/2016/BINF3020.html

Course Summary

This course explores the computational basis of bioinformatics and complements and extends understanding of bioinformatics tools and resources acquired in other courses.

Course Aims

BINF3020 aims to build on the foundations laid in BINF2010 and BINF3010, and covers a range of core and advanced topics and current research areas in bioinformatics. The course demonstrates the application of computational, mathematical and statistical methods to problems in modern life sciences, through examples in the analysis of nucleotide and protein sequence, gene expression and function, networks of interaction and systems modelling.

As a result of successfully completing this course students will have a working knowledge of key topics in computational bioinformatics, and will be able to demonstrate their knowledge both by describing aspects of the topics and by solving problems related to the topics using well-founded engineering approaches. They will have practical experience with the topics covered in the assignments undertaken.

Student Learning Outcomes

As a result of successfully completing this course students will be able to work independently and in collaboration on advanced-level topics in bioinformatics. By the end of the subject, students should be able to:

1. Reproduce, explain and apply the major methods of pairwise and multiple sequence analysis in bioinformatics
2. Define key computational and statistical concepts in bioinformatics approaches to pairwise and multiple sequence analysis
3. Define Hidden Markov models, describe their associated algorithms, and discuss their application to biological sequence analysis
4. Define and apply methods of clustering and classification in analysis of genome-scale data
5. Express and apply key concepts from graph theory to model biological networks
6. Research, use and explain selected engineering approaches to the representation, execution and evaluation of models of biological processes and their application in systems biology
7. Research and present on a range of open source software tools and techniques available to bioinformatics software developers and use at least one of these in their own software development projects

This course contributes to the development of the following graduate capabilities:

Graduate Capability	Acquired in
scholarship: capable of independent and collaborative enquiry	1-7
scholarship: rigorous in their analysis, critique, and reflection	1-7
scholarship: able to apply their knowledge and skills to solving problems	1-7
scholarship: ethical practitioners	7
scholarship: capable of effective communication	2,6,7
scholarship: information literate	6
scholarship: digitally literate	1-7
leadership: enterprising, innovative and creative	6,7
leadership: capable of initiating as well as embracing change	5-7
leadership: collaborative team workers	6,7
professionalism: capable of independent, self-directed practice	2,6,7
professionalism: capable of lifelong learning	1-7
professionalism: capable of operating within an agreed Code of Practice	7
global citizens: capable of applying their discipline in local, national and international contexts	7
global citizens: culturally aware and capable of respecting diversity and acting in socially just/responsible ways	1-5,7
global citizens: capable of environmental responsibility	1-7

Assumed Knowledge

- have a basic knowledge of mathematical, computational and biological concepts, including basic probability, statistics, logic, computational complexity, basic biology (biochemistry, molecular biology, genetics) and bioinformatics
- be able to program in a number of programming and scripting languages such as C or Java, Perl, etc. under a Unix environment and access and operate bioinformatics tools and resources
- have a working knowledge of fundamental principles and methods in engineering design, development and evaluation

These are assumed to have been acquired in the courses COMP1917, COMP1927, MATH1131, MATH1231, MATH1081, BINF2010 and appropriate BABS courses or equivalent alternatives.

Teaching Rationale

This course is taught to establish links between the topics being covered and the current state of the art in bioinformatics research and applications, with emphasis on proper theoretical foundations coupled with practical experience based on sound computational approaches, designed to engage active learning in lectures and assignments.

Teaching Strategies

- Lectures introduce concepts, show examples and are supplemented by tutorials and computer assignments that require students to implement algorithms discussed in lectures, design solutions to practical problems, and analyse software environments and published research
- Group assignments and class presentations assess research, teamwork, leadership and communication skills

Assessment

Details of assessment items

Assessment	Description	Marks	Due

component		available	date
Mid-semester exam	Covers material up to week 5	10	Week 6
Final exam	Covers potentially all material, but with emphasis on material not covered in mid-semester exam	40	Exam period
Assignment 1: protein sequence evolution	Design, implement, test and evaluate a protein sequence evolution simulator and optimal alignment system, with a written report	20	Three parts, due end of weeks 2, 4 and 5
Assignment 2: software environments for bioinformatics	Group assignment to select software environment and tools (e.g., BioPerl, BioJava, BioConductor, etc.), use and critically evaluate them, report and present results to the class to assess how these resources can assist in bioinformatics software development.	10	Week 9
Assignment 3: bioinformatics systems engineering	Group assignment to research into, design and implement a web-based platform to enable the engineering evaluation of a biological system model; results to be demonstrated and summarised by the group in a written report.	20	Week 13

Note: all dates subject to change !

The course mark will be the sum total of the component marks.

Programming assignments will be marked on the ability of the software to generate correct output with both provided and new test input. Reports and class presentations will be marked on content, organization and quality of writing and oral presentation skills.

Assignments involving software construction or other written material will usually require submission via `give`. Presentations or demonstrations will be during scheduled class times.

Late submission penalties for assignments will be given as part of each specification.

Academic Honesty and Plagiarism

Plagiarism is defined as "using the words or ideas of others and presenting them as your own". UNSW and CSE treat plagiarism as academic misconduct, which means that it carries penalties as severe as being excluded from further study at UNSW. There are several on-line sources to help you understand what plagiarism is and how it is dealt with at UNSW:

- Learning Centre: Plagiarism and Academic Integrity
- MyUNSW: Plagiarism and Academic Misconduct
- CSE: Addendum to UNSW Plagiarism Guidelines
- CSE: Yellow Form (whose terms you have agreed to)

Make sure that you read and understand these. Ignorance is not accepted as an excuse for plagiarism.

Course Schedule

Schedule of topics, organised by week

Week	Topic
01	Optimal methods of sequence alignment
02	Heuristic methods of sequence alignment
03	Statistics of sequence alignment
04	Multiple sequence alignment and analysis
05	Hidden Markov Models
06	Phylogeny and tree-building algorithms
07	Gene expression and functional genomics 1
08	Gene expression and functional genomics 2
09	Biological Network Analysis
10	Systems biology modelling 1
11	Systems biology modelling 2
12	Biomedical semantics, ontologies and data integration

Note: topics and dates subject to change !

Resources for Students

Texts and recommended readings:

The course has two possible recommended textbooks (you don't need to buy both - pick the one which best matches your interests). Copies should be available through the UNSW bookshop and in the Library.

- "Bioinformatics Algorithms: An Active Learning Approach (Volumes I and II)", Phillip Compeau and Pavel A. Pevzner. Active Learning Press, 2015. (also available to order from here). If you can't source a copy then the earlier version will suffice: "An Introduction to Bioinformatics Algorithms", Neil C. Jones and Pavel A. Pevzner, MIT Press, 2004.
- "Computational Modelling Of Gene Regulatory Networks - A Primer", Hamid Bolouri, Imperial College Press, 2008.

A number of other bioinformatics textbooks are available through the UNSW library for reference reading. One starting point for assistance is the University library catalogue. Pointers to other resources will be given during the course.

Course Evaluation and Development

This course is evaluated each session using the CATEI system.

In the previous offering of this courses, students noted that lab time could be useful.

Based on these comments, we will be exploring the use of online resource Rosalind, a platform for learning bioinformatics and programming.