School of Computer Science and Engineering

UNSW Engineering

BINF3010, BINF9010

Applied Bioinformatics

Term 2, 2023

Course Overview

Staff Contact Details

Convenors

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Lecturers

Name	Email	Availability	Location	Phone
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School Contact Information

This course outline sets out description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle/WebCMS/course web pages should be consulted for the up to date class descriptions. If there is

any inconsistency in the description of activities between the University timetable and the course web pages, the description in Moodle/WebCMS/course web pages applies.

Course Details

Units of Credit 6

Summary of the Course

Bioinformatics (the use of computing methods for the management and analysis of molecular biology data) has become an integral component of biomolecular sciences, especially genomics and proteomics. This course focuses on the principles and practical use of bioinformatics methods and resources for the analysis of DNA and protein sequences and structures, as well as results from microarray and proteomics, with emphasis on their evolutionary underpinnings and statistical foundations.This course does not require programming, however it does involve the use of Linux.

Course Aims

- Provide an introduction to commonly used bioinformatics resources, methods and software, with an emphasis on their use, capabilities and limitations
- Provide an introduction to bioinformatics as an application area of mathematical and computational sciences

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Explain the fundamental biology concepts that provide the context for bioinformatics, including sequence, structure and function as they relate to biological information macromolecules and molecular evolution	PE1.1
2. Use the UNIX shell to manage and analyse biological sequence and functional genomics data	PE2.2
3. Choose and use bioinformatics tools and databases to analyse biological sequences, structures and functional genomics data	PE2.2
4. Identify the strengths and limitations of the main approaches used in sequence and structural bioinformatics, functional genomics and systems biology.	PE2.2
5. Analyse data from high-throughput molecular biology experiments using the R environment	PE2.2
6. Interpret and analyze data generated by proteomics experiments using bioinformatics	PE2.2
7. Choose and apply computational methods for predicting protein tertiary structure	PE2.2

UNSW Graduate Capabilities

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

The skills involved in scholarly enquiry – students need to research, compare and evaluate different bioinformatics methods as part of the practical work and final examination

An in-depth engagement with the relevant disciplinary knowledge in its interdisciplinary context – bioinformatics is presented in the context of its applications to biology, and of the computer science methods it draws on

The capacity for analytical and critical thinking and for creative problem-solving – laboratory work and assignments require students to solve a range of problems by choosing appropriate bioinformatics methods and applying them

The ability to engage in independent and reflective learning – the midsession and final examinations require students to reflect and provide a critical synthesis of the course contents

The skills required for collaborative and multidisciplinary work – the laboratory exercises are to be carried out in teams of mixed student background

The skills of effective communication – written communication is assessed principally through laboratory reports and the examinations. Effective communication between students of different backgrounds is also necessary for carrying out the laboratory assignments.

Teaching Strategies

Bioinformatics now pervades biological research, and new methods and technologies are constantly developed. This course is aimed at teaching bioinformatics from a *user*'s perspective (as opposed to that of a *developer*), to emphasise the use of bioinformatics to assist in biological discovery. Since bioinformatics constantly evolves the goal is not to teach the use of specific tools and methods but to focus on *principles*, *limitations* and *assumptions* of common approaches to provide the means for students to research and evaluate new methods and apply them intelligently to produce meaningful results.

- In order to establish the link between the topics being covered and the current state of the art in bioinformatics research, each topic is presented by a lecturer active in research in that area or its applications
- Hands-on practical computer laboratories require the students to use a range of bioinformatics methods described in the lectures and reflect on the results they obtain
- Bioinformatics is a new discipline that changes quickly, and it is important for graduates to be able to keep in touch with the state of the art in bioinformatics methods, rather than just learn about a standard set of tools that will soon be obsolete. The course therefore emphasises fundamental principles and requires the students to demonstrate the ability to research and evaluate new methods.

Additional Course Information

Assumed Knowledge

This course is about *using* bioinformatics methods for biological research. It is *not* about developing new bioinformatics methods. As such it assumes a working knowledge of molecular biology. Biology provides the context of the content and all the examples used in its presentation, and **students with no knowledge of biology are likely to fail the course** (this is especially important for postgraduate BINF9010 students as no biology prerequisite is available for these students). In terms of computing, the course only assumes ability to use computers, although a working knowledge of the UNIX command line and of the basics of the R statistical computing environment is an advantage. Some resources will be provided for students new to UNIX and R.

Assessment

The exact exam platform is still being decided, and will be announced closer to the exam date.

The use of LLMs/ChatGPT is not allowed in exams as it is difficult to distinguish between justifiable use (eg to correct English expression and writing) and use that contravenes the university's plagiarism policy. If an exam is not face to face/invigilated, answers are likely to be processed through plagiarism-detection software which also identifies potential use of LLMs to write answers.

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Lab quiz	30%	Week 2, Week 3, Week 4, Week 5, Week 7, Week 8, Week 9, Week 10, Stuvac	2, 3, 5, 6, 7
2. Mid Term Exam	35%	Not Applicable	1, 4, 7
3. Final Exam	35%	Not Applicable	1, 4, 5, 6

Assessment 1: Lab quiz

Due date: Week 2, Week 3, Week 4, Week 5, Week 7, Week 8, Week 9, Week 10, Stuvac

Quizzes assessing completion of labs

Assessment criteria

Quizzes are set in Moodle and automarked by comparison with the correct answer

Assessment 2: Mid Term Exam

Start date: 13/07/2023 04:00 PM

Exam assessing weeks 1-6 content

Assessment criteria

Exam will be marked by the lecturers who set the questions, based on correctness, comprehensiveness, relevance, structure and clarity of the answers. For high marks, answers need to demonstrate understanding and integration of the material in the wider context of the course, as opposed to simple factual recall of course materials.

Assessment 3: Final Exam

Exam assessing weeks 7-10 content

Assessment criteria

Exam will be marked by the lecturers who set the questions, based on correctness, comprehensiveness,

relevance, structure and clarity of the answers. For high marks, answers need to demonstrate understanding and integration of the material in the wider context of the course, as opposed to simple factual recall of course materials.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Schedule

Exact class times and locations are available through http://timetable.unsw.edu.au

View class timetable

Timetable

Date	Type	Content
Week 1: 29 May - 2 June	Lecture	Sequence analysis I (Bruno Gaeta)
	Lecture	Sequence analysis II (Bruno Gaeta)
	Laboratory	Introduction to the labs and to UNIX. Sequence databases and dotplots (Bruno Gaeta)
Week 2: 5 June - 9 June	Lecture	Sequence analysis III (Bruno Gaeta)
	Lecture	Sequence analysis IV (Bruno Gaeta)
	Laboratory	Sequence alignment and database searching (Bruno Gaeta)
	Assessment	Lab quiz
Week 3: 12 June - 16 June	Lecture	Genome Informatics (Irina Voineagu)
	Laboratory	Multiple sequence alignment and phylogeny (Bruno Gaeta)
	Assessment	Lab quiz
Week 4: 19 June - 23 June	Lecture	Structural bioinformatics I (Paul Curmi)
	Lecture	Structural bioinformatics II (Paul Curmi)
	Laboratory	Genome assembly
	Assessment	Lab quiz
Week 5: 26 June - 30 June	Lecture	Structural bioinformatics III (Paul Curmi)
	Lecture	Structural bioinformatics IV (Paul Curmi)
	Laboratory	Structural bioinformatics
	Assessment	Lab quiz
Week 7: 10 July - 14 July	Lecture	RNA-seq (Sara Ballouz)

	Lecture	Single cell transcriptomics (Raymond Louie)
	Assessment	Midterm Exam
	Assessment	Lab quiz
Week 8: 17 July - 21 July	Lecture	Statistics I (Peter Humburg)
	Lecture	Statistics II (Peter Humburg)
	Laboratory	Introduction to R, statistical analysis with R
	Assessment	Lab quiz
Week 9: 24 July - 28 July	Lecture	Proteomics (Mark Raftery)
	Lecture	PTMs and Proteogenomics (Marc Wilkins)
	Laboratory	RNA-seq analysis using R
	Assessment	Lab quiz
Week 10: 31 July - 4 August	Lecture	Protein Interactions and Networks (Marc Wilkins)
	Lecture	ncRNA Analysis (Fatemeh Vafaee)
	Laboratory	Proteomics (Marc Wilkins)
	Assessment	Lab quiz
Stuvac: 7 August - 11 August	Assessment	Lab quiz

Resources

Prescribed Resources

Moodle will be used for resources such as lecture slides and recordings (through echo360), lab specs, quizzes and other assessments

Microsoft Teams will be used for communication including announcements and forum-type discussions

Recommended Resources

There is no textbook for this course. Individual lecturers will provide lists of reference books and articles.

Readings and discussion boards will be made available on Moodle.

A number of bioinformatics textbooks are available through the UNSW Library for reference reading. One starting point for assistance is: info.library.unsw.edu.au/web/services/services.html

Course Evaluation and Development

Feedback on this course and on individual lecturers will be gathered through a survey at the end of session, as part of the MyExperience process. Feedback from this survey is the basis for improving the course in subsequent years. In response to feedback from 2022, some of the course content has been updated and some of the guest lecturers have changed.

Laboratory Workshop Information

Labs help sessions are scheduled on Thursdays 4-6pm. A face to face lab session will run in Brass lab (Aisnsworth Building, J17, level 3) at that time with a demonstrator available as well as a number of CSE lab computers. It is recommended that you attend the face to face session if possible as it is easier for demonstrators to provide assistance if they can see your screen.

For students who cannot attend the face to face lab, an online lab help session with a demonstrator will run on Teams at the same time.

It is OK to work in pairs for the labs (especially in mixed teams with one student with biology background and one student with engineering/computing background) however students must submit their quiz individually.

The labs have been structured so that they can be completed on your own on a lab computer or your own computer as much as possible. The lab sessions are meant to be for consultation and discussion of any difficulties you have encountered doing the lab. Please do not ask questions on the labs outside of the lab sessions as demonstrators are only paid for the scheduled lab time! It is recommended that you attempt to complete the lab by yourself before the corresponding lab session so you can bring your questions for the online lab session. Labs are assessed using a quiz on Moodle. To maximise convenience and flexibility for students this quiz is due one week after the corresponding lab help session. However it is strongly recommended that you aim to submit the quiz by the end of the lab session as help may not be available if you leave it to the last few days before the deadline.

Image Credit

Art by Gene Whitlock

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering problem solving	
PE2.2 Fluent application of engineering techniques, tools and resources	✓
PE2.3 Application of systematic engineering synthesis and design processes	
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in professional and lay domains	
PE3.3 Creative, innovative and pro-active demeanour	
PE3.4 Professional use and management of information	
PE3.5 Orderly management of self, and professional conduct	
PE3.6 Effective team membership and team leadership	