School of Chemical Engineering

UNSW Engineering

CEIC6789

Data-driven Decision Making in Chemical Engineering and Food Science

Term 2, 2023

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Priyank Vijaya Kumar	priyank.kumar@unsw.edu.au	Via Teams or Email	Science and Engineering Building, E8, 334	

School Contact Information

For assistance with enrolment, class registration, progression checks and other administrative matters, please see the Nucleus: Student Hub. They are located inside the Library – first right as you enter the main library entrance. You can also contact them via http://unsw.to/webforms or reserve a place in the face-to-face queue using the UniVerse app.

If circumstances outside your control impact on submitting assessments, Special Consideration may be granted, usually in the form of an extension or a supplementary assessment. Applications for Special Consideration must be submitted online.

For course administration matters, please contact the Course Coordinator.

Questions about the this course should normally be asked during the scheduled class so that everyone can benefit from the answer and discussion.

Course Details

Units of Credit 6

Summary of the Course

The recent surge in the volume of data collected owing to technological advances provides opportunities to improve processes and take better decisions across various industries. However, in order to turn large data sets into useful insights, combining the knowledge of right data with right analytical tools is important. Data-driven decision making is an industry-oriented course where students learn data management and analytic skills through a major project and real case studies from the School's research strengths/industrial experience in chemical engineering and food science.

In this course, you will discover advanced methods for obtaining, handling and summarising various categories of data with databases. The course will also focus on how to analyse the collected data efficiently by applying sophisticated analytical techniques including statistical tests, inferences and regression analysis.

A working knowledge of introductory statistics and introductory programming is assumed.

Course Aims

CEIC6789 is an undergraduate elective/postgraduate disciplinary knowledge course where the primary aim is for the students to learn data management and analytic skills in chemical engineering and food science through real case studies and hands-on coding exercises. The course builds upon previous mathematics, computing and experimental courses to develop skills in obtaining, handling and summarizing various categories of data through the use of databases. The course will also focus on how to analyze the collected data efficiently by applying relevant statistical analytical techniques including statistical tests, inferences and regression analysis with a focus on the types of data used by chemical engineers and food scientists. Thus, the aim of the course is to provide practical training to equip students with a range of skills necessary for rapidly increasing data science jobs in industries.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Acquire and verify large data sets from various real-life applications in chemical engineering and food science.	PE1.2, PE2.2
2. Describe the nature of data and distinguish between raw, incomplete, noisy and corrupted data for further analysis.	PE1.2, PE2.2
3. Choose and apply appropriate statistical tools to analyse data sets across industries in chemical engineering and food science.	PE1.4, PE2.2, PE3.6
4. Apply their pre-existing knowledge of food science or chemical engineering to formulate and defend models for selected data sets.	PE1.1, PE3.2

Teaching Strategies

The course consists of a 2 hr/week lecture and a 2+2 hr/week workshop. One of the 2 hr/week workshop slot will be used as office hours, where students can ask questions and discuss topics with the instructor. The purpose of the workshop sessions is to allow students to gain practical experience in programming and working with realistic datasets.

The project assessments will require a significant amount of work outside of class time. It is important that students balance their time between team work, individual research, and overall planning in order to meet their assigned objectives. Lecture materials will identify and discuss central topics in the subject but students must identify, find, and study supplementary information to gain a deeper understanding of the topics covered. If work is carried out in teams, active participation is required of all team members.

Lectures: Lecture material to introduce high-level concepts will be delivered via pre-recorded videos on Moodle; face-to-face lectures will not be held for this course, unless otherwise specified. The lecture material will be available on Moodle as sets of video lessons. You will be able to watch these videos at any time, not just at the time scheduled in the timetable.

Workshops: We will run workshop classes at the time scheduled in the timetable. We will not use all of the timetabled sessions as we have far more than are needed; we will instead use some of those times for detailed discussion about your progress in the major project and to offer advice and assistance.

Programming: This course involves hand-on coding exercises and projects to develop and apply data processing skills. Python will be used as a programming language to demonstrate concepts in this course. You will be asked to use Jupyter notebooks (visit jupyter.org) for your work; you can either install Python and Jupyter on your own device or use CoCalc.com/Google Colab as a free Jupyter online host. Although Python is preferred, students are free to choose between Python, Matlab, Octave and R codes to carry out their exercises and projects.

Additional Course Information

Some requisite knowledge is assumed for this course:

- Introductory statistics and data handling from any relevant courses including MATH1231, MATH2089, MATH1041.
- Discipline specific knowledge from relevant courses, for example CEIC3000, CEIC3004, CEIC3005, FOOD2320, FOOD3801, FOOD3220.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Quiz 1	15%	Week 4	2, 3
2. Quiz 2	25%	Week 9	2, 3
3. Project - Part 1	20%	Week 7	1, 2, 3, 4
4. Project - Part 2	40%	Week 10	2, 3, 4

Assessment 1: Quiz 1

Due date: Week 4

The quiz will assess understanding of lecture content. It will be administered online, which must be completed individually. The quiz will give students a quick source of formative feedback to track their progress throughout the course.

Assessment 2: Quiz 2

Due date: Week 9

The quiz will assess understanding of lecture content. It will be administered online, which must be completed individually. The quiz will give students a quick source of formative feedback to track their progress throughout the course.

Assessment 3: Project - Part 1 (Group)

Due date: Week 7

The team project is a core part of this course and is a team-based activity, giving students an opportunity to apply the knowledge gained throughout the term, study a topic of interest, and practice team working skills which is integral to any workplace. The project is divided into two parts over the term and with Part 1 consisting of data preprocessing, communicated via a report and presentation.

Report marks will be moderated by team assessment of individual contributions to the submission. Presentations will be marked individually and so each team member must speak in order to receive a mark.

Assessment 4: Project - Part 2 (Group)

Due date: Week 10

The team project is a core part of this course and is a team-based activity, giving students an opportunity to apply the knowledge gained throughout the term, study a topic of interest, and practice team working skills which is integral to any workplace. The project is divided into two parts over the term and with Part 2 consisting of data analytics, communicated via a report and presentation.

Report marks will be moderated by team assessment of individual contributions to the submission. Presentations will be marked individually and so each team member must speak in order to receive a mark.

Attendance Requirements

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

Course Schedule

View class timetable

Timetable

Date	Type	Content
O-Week: 22 May - 26 May	Reading	Revision and light reading of pre-requisites
Week 1: 29 May - 2 June	Online Activity	Introduction to data science
	Workshop	Introduction to Jupyter and programming in python
Week 2: 5 June - 9 June	Online Activity	Data preprocessing
	Workshop	Application of data-preprocessing techniques to data sets
Week 3: 12 June - 16 June	Online Activity	Simple and Multiple linear regression
	Workshop	Performing simple and mulitple linear regression analysis on data sets
Week 4: 19 June - 23 June	Online Activity	Additional concepts related to multiple linear regression
	Workshop	Performing multiple linear regression analysis on data analysis with emphasis on concepts such as dummy variables, test-train split etc.
	Assessment	Quiz 1
Week 5: 26 June - 30 June	Online Activity	Simple and multiple logistic regression
	Workshop	Performing logistic regression analysis on data sets
Week 6: 3 July - 7 July	Online Activity	**Flexibility week** Revision and consolidation of Week 1-5; Project discussion
Week 7: 10 July - 14 July	Online Activity	K-means clustering
	Workshop	Performing K-means clustering on data sets

	Assessment	Project - Part 1
Week 8: 17 July - 21 July	Online Activity	Advanced topics (Introduction to non-linear models)
	Workshop	Building and applying non-linear models to datasets
Week 9: 24 July - 28 July	Online Activity	Case studies
	Workshop	Project team meetings and discussion
	Assessment	Quiz 2
Week 10: 31 July - 4 August	Online Activity	Case studies
	Workshop	Project part 2 presentations and discussion
	Assessment	Project - Part 2

Resources

Recommended Resources

Course materials and assessment tasks are delivered through Moodle and students should check regularly for updates. You can also obtain assistance from the UNSW Library. One starting point for assistance is: http://www.library.unsw.edu.au/servicesfor/students.html. Students will also be required to find information to augment lectures and help with their product development projects.

Some useful references are:

- Jacob T. Vanderplas, Python data science handbook: Essential tools for working with data. O'Reilly media Inc., 2017

- U. Dinesh Kumar, Business Analytics: The Science of Data-Driven Decision Making, Wiley. ISBN: 9788126568772

- Andrew Ng, Machine Learning, Coursera (https://www.coursera.org/learn/machine-learning)

- Kevin Dunn, Process Improvement Using Data (https://learnche.org/pid/preface/index)

- G.E.P. Box, J.S. Hunter, and W.G. Hunter, Statistics for Experimenters - Design, Innovation and Discovery, 2nd edition, Wiley. ISBN: 978-0471718130.

Course Evaluation and Development

The School of Chemical Engineering evaluates each course each time it is run through (i) myExperience Surveys, and (ii) Focus Group Meetings. As part of the myExperience process, your student evaluations on various aspects of the course are graded; the Course Coordinator prepares a summary report for the Head of School. Any problem areas are identified for remedial action, and ideas for making improvements to the course are noted for action the next time that the course is run. Focus Group Meetings are conducted each term. Student comments on each course are collected and disseminated to the Lecturers concerned, noting any points which can help improve the course.

All of the activities in this course from the online lessons through to the team project have been designed in response to student feedback.

Submission of Assessment Tasks

In the School of Chemical Engineering, all written work will be submitted for assessment via Moodle unless otherwise specified. Attaching cover sheets to uploaded work is not required unless specifically requested for an individual assessment task; when you submit work through Moodle for assessment you are agreeing to uphold the Student Code.

Some assessments will require you to complete the work online and it may be difficult for the course coordinator to intervene in the system after the due date. You should ensure that you are familiar with assessment systems well before the due date. If you do this, you will have time to get assistance before the assessment closes.

All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect. Please make it easy for the markers who are looking at your work to see your achievement and give you due credit.

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Late penalties

Unless otherwise specified, submissions received after the due date and time will be penalised at a rate of 5% per day or part thereof (including weekends) and will not be accepted more than 5 days late. For some activities including Exams, Quizzes, Peer Feedback, and Team Evaluation surveys, extensions and late submissions are not possible.

Special consideration

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to submitting an assessment or sitting an exam.

UNSW has a Fit to Sit / Submit rule, which means that if you attempt an exam or submit a piece of assessment, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

Please note that for **all** special consideration requests (including COVID-19-related requests), students will need documentary evidence to support absences from any classes or assessments.

Academic Honesty and Plagiarism

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage (International Center for Academic Integrity, 'The Fundamental Values of Academic Integrity', T. Fishman (ed), Clemson University, 2013). At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.

Further information about academic integrity and plagiarism can be located at:

- The Current Students site
- The ELISE training site

The Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct.

To help describe what we are looking for, here are some things that we consider to be quite acceptable (even desirable!) actions for many assessments, and some that we consider to be unacceptable in most circumstances. Please check with the instructions for your assessments and your course coordinator if you're unsure. As a rule of thumb, if you don't think you could look the lecturer in the eye and say "this is my own work", then it's not acceptable.

Acceptable actions	Unacceptable actions
✓ reading/searching through material we have given you, including lecture slides, course notes, sample problems, workshop problem solutions	✗ asking for help with an assessment from other students, friends, family
✓ reading/searching lecture transcripts	✗ asking for help on Q&A or homework help websites
✓ reading/searching resources that we have pointed you to as part of this course, including textbooks, journal articles, websites	✗ searching for answers to the specific assessment questions online or in shared documents
✓ reading/searching through your own notes for this course	✗ copying material from any source into your answers
✓ all of the above, for any previous courses	✗ using generative AI tools to complete or substantially complete an assessment for you
✓ using spell checkers, grammar checkers etc to improve the quality of your writing	✗ paying someone else to do the assessment for you
✓ studying course material with other students	

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism. Further information about referencing styles can be located at https://student.unsw.edu.au/referencing.

For assessments in the School of Chemical Engineering, we recommend the use of referencing software such as Mendeley or EndNote for managing references and citations. Unless required otherwise specified (i.e. in the assignment instructions) students in the School of Chemical Engineering should use either the APA 7th edition, or the American Chemical Society (ACS) referencing style as canonical author-date and numbered styles respectively.

Artificial intelligence tools such as ChatGPT, CodePilot, and built-in tools within Word are modern tools that are useful in some circumstances. In your degree at UNSW, we're teaching you skills that are needed for your professional life, which will include how to use AI tools responsibly plus lots of things that AI tools cannot do for you. AI tools already are (or will soon be) part of professional practice for all of us. However, if we were only teaching you things that AI could do, your degree would be worthless, and you wouldn't have a job in 5 years.

Whether the use of AI tools in an assessment is appropriate will depend on the goals of that assessment. As ever, you should discuss this with your lecturers – there will certainly be assessments where the use of AI tools is encouraged, as well as others where it would interfere with your learning and place you at a disadvantage later. Our goal is to help you learn how to ethically and professionally use the tools available to you. To learn more about the use of AI, see this discussion we have written where we analyse the strengths and weaknesses of generative AI tools and discuss when it is professionally and ethically appropriate to use them.

While AI may might provide useful tools to help with some assessments, UNSW's policy is quite clear that taking the output of generative AI and submitting it as your own work will never be appropriate, just as paying someone else to complete an assessment for you is serious misconduct.

Academic Information

To help you plan your degree, assistance is available from academic advisors in The Nucleus and also in the School of Chemical Engineering.

Additional support for students

- Current Student Gateway for information about key dates, access to services, and lots more information
- Engineering Student Life - Current Student Resources for information about everything from getting to campus to our first year guide
- Student Support and Success for our UNSW team dedicated to helping with university life, visas, wellbeing, and academic performance
- Academic Skills to brush up on some study skills, time management skills, get one-on-one support in developing good learning habits, or join workshops on skills development
- Student Wellbeing, Health and Safety for information on the UNSW health services, mental health support, and lots of other useful wellbeing resources
- Equitable Learning Services for assistance with long term conditions that impact on your studies
- IT Service Centre for everything to do with computing, including installing UNSW licensed software, access to computing systems, on-campus WIFI and off-campus VPNs

Course workload

Course workload is calculated using the Units-Of-Credit (UOC). The normal workload expectation for one UOC is approximately 25 hours per term. This includes class contact hours, private study, other learning activities, preparation and time spent on all assessable work.

Most coursework courses at UNSW are 6 UOC and involve an estimated 150 hours to complete, for both regular and intensive terms. Each course includes a prescribed number of hours per week (h/w) of scheduled face-to-face and/or online contact. Any additional time beyond the prescribed contact hours should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations. Most 6 UoC courses will involve approximately 10-12 hours per week of work on your part. If you're not sure what to do in these hours of independent study, the resources on the UNSW Academic Skills pages offer some suggestions including: making summaries of lectures, read/summarise sections from the textbook, attempt workshop problems, reattempting workshop problems with some hints from the solutions, looking for additional problems in the textbook.

Full-time enrolment at university means that it is a *full-time* occupation for you and so you would typically need to devote 35 hours per week to your studies to suceed. Full-time enrolment at university is definitely incompatible with full-time employment. Part-time/casual employment can certainly fit into your study schedule but you will have to carefully balance your study obligations with that work and decide how much time for leisure, family, and sleep you want left after fullfilling your commitments to study and work. Everyone only gets 168 hours per week; overloading yourself with both study commitments and work commitments leads to poor outcomes and dissatisfaction with both, overtiredness, mental health issues, and general poor quality of life.

On-campus class attendance

In 2023, most classes at UNSW are running in a face-to-face mode only. Attendance is expected as is

participation in the classes. As an evidence-driven engineer or scientist, you'll be interested to know that education research has shown students learn more effectively when they come to class, and less effectively from lecture catch-up recordings. If you have to miss a class due to illness, for example, we expect you to catch up in your time, and within the coming couple of days.

For most courses that are running in an "in person" mode:

- Lectures are normally recorded to provide an opportunity to review material after the lecture; lecture recordings are not a substitute for attending and engaging with the live class.
- Workshops/tutorials are not normally recorded as the activities that are run within those sessions normally cannot be captured by a recording. These activities may also include assessable activities in some or all weeks of the term.
- Laboratories are not recorded and require in-person attendance. Missing laboratory sessions may require you to do a make-up session later in the term; if you miss too many laboratory sessions, it may be necessary to seek a Permitted Withdrawal from the course and reattempt it next year, or end up with an Unsatisfactory Fail for the course.
- Assessments will often require in-person attendance in a timetabled class or a scheduled examination.

This course outline will have further details in the Course Schedule and Assessment sections.

Class numbers are capped in each class to ensure appropriate facilities are available, to maintain student:staff ratios, and to help maintain adequate ventilation in the spaces. Only students enrolled in each specific classes will be allowed in the room. Class rosters will be attached to corresponding rooms and circulated among lab demonstrators and tutors. No over-enrolment is allowed in face-to-face classes.

In certain classroom and laboratory situations where physical distancing cannot be maintained or the staff running the session believe that it will not be maintained, face masks will be designated by the course coordinator as **mandatory PPE** for students and staff. Students are required to bring and use their own face mask. Mask can be purchased from IGA Supermarket (Map B8, Lower Campus), campus pharmacy (Map F14, Middle Campus), the post office (Map F22, Upper Campus) and a vending machine in the foyer of the Biological Sciences Building (Map E26, Upper Campus).

Your health and the health of those in your class is critically important. You must stay at home if you have COVID-19 or have been advised to self-isolate by NSW health or government authorities.

Asking Questions

Asking questions is an important part of learning. Learning to ask good questions and building the confidence to do so in front of others is an important professional skill that you need to develop. The best place to ask questions is during the scheduled classes for this course, with the obvious exception being questions that are private in nature such as special consideration or equitable learning plans. Between classes, you might also think of questions — some of those you might save up for the next class (write them down!), and some of them you might ask in a Q&A channel on Teams or a Q&A forum on Moodle. Please understand that staff won't be able to answer questions on Teams/Moodle immediately but will endeavour to do so during their regular working hours (i.e. probably not at midnight!) and when they are next working on this particular course (i.e. it might be a day or two). Please respect that staff are juggling multiple work responsibilities (teaching more than one course, supervising research students, doing experiments, writing grants, …) and also need to have balance between work and the rest of their life.

Note: 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 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 Outline (as updated in Moodle), the description in the Course Outline/Moodle applies.

Image Credit

Pilot Hall with experiment rigs // UNSW Chemical Engineering

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	✓