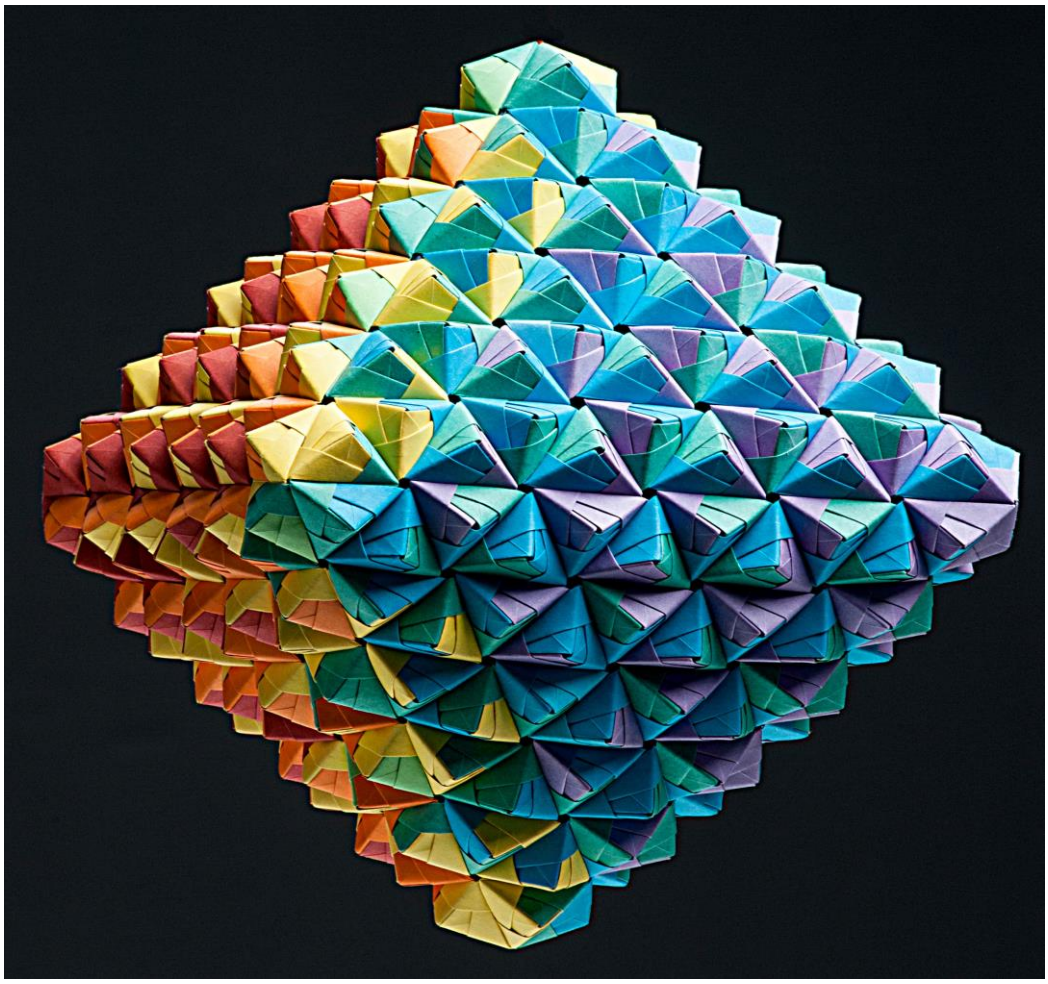
2021

Postgraduate courses

School of Mathematics and Statistics

Te Kura Mātai Tatauranga



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VICTORIA UNIVERSITY OF WELLINGTON
TE HERENGA WAKA

ENROLLING FOR POSTGRADUATE STUDY

The School offers postgraduate programmes in Mathematics, Statistics, Data Science and Stochastic Processes in Finance and Insurance. There are a variety of degree options.

Domestic students should enrol online for Honours, Master of Applied Statistics, Master of Data Science, MSc Part 1 or Diplomas/Certificates. It is advisable to discuss your intended programme first with the Postgraduate Coordinator.

Students can also enrol for Master's by thesis online. To apply for PhD study, please contact the Postgraduate Coordinator and read the application information on the Faculty of Graduate Research website **www.wgtn.ac.nz/fgr**

Staff email: **firstname.lastname@vuw.ac.nz**

STAFF CONTACTS

STAFF		ROOM	CONTACT
Head of School			
A/Prof Ivy Liu		356	463 5648
Deputy Head of School			
Prof Rod Downey		324	463 5067
Mathematics			
Prof Astrid an Huef§	Functional Analysis, Operator Algebras and Dynamical Systems	439	463 6780
A/Prof Lisa Clark	Functional Analysis, Operator Algebras	442	463 6734
A/Prof Peter Donelan†	Singularities, Invariant Theory, Robotics	424	463 5659
Prof Rod Downey	Computability, Complexity, Combinatorics, Algebra	324	463 5067
Prof Noam Greenberg§	Computability Theory, Set Theory	438	463 6778
Dr Brendan Harding	Fluid Dynamic, Iterated Function Systems	433	
Dr Byoung Du (BD) Kim	Number Theory, Arithmetic Geometry	434	463 5665
Dr Hung Le Pham	Functional Analysis	440	463 6732
Dr Martino Lupini	Combinatorics, Dynamical Systems, Operator Algebra, Functional Analysis, Model Theory	426	463 6744
Prof Stephen Marsland	Differential Geometry, Bioacoustics	443	463 9695
A/Prof Dillon Mayhew	Matroids, Complexity, Combinatorics, Graph Theory	435	463 5155
Prof Mark McGuinness	Industrial Applied Maths, Modelling	323	463 5059
Dr Dimitrios Mitsotakis	Numerical Analysis, Differential Equations,	441	463 6739
Dr Dan Turetsky	Computability Theory	436	463 5660
Prof Matt Visser	Black Holes, General Relativity, Cosmology	321	463 5115
Prof Geoff Whittle†	Combinatorics, Matroids, Graph Theory	320	463 5650

Statistics and Data Science

Dr Ryan Admiraal	Social network analysis, disease modelling	536	463 5275
Prof Richard Arnold[§]	Biostatistics, Bayesian Statistics, Statistics in Geophysics	538	463 5668
A/Prof Stefanka Chukova	Warranty Analysis and Reliability	535	463 6786
Dr Laura Dumitrescu	Data Analysis, Robust Estimation, Longitudinal Data, Central Limit Theorems	542	463 5233 ext 8759
Prof Alejandro Frery	Statistical Computing, Signal Image, and Network Analysis, Information Theory, Synthetic Aperture Radar (SAR) imagery	537	463 8699
Dr John Haywood	Time Series, Forecasting, Seasonal Adjustment, Statistical Modelling	541	463 5673
Dr Yuichi Hirose[§]	Estimation Theory, Model Selection, Sampling Methods	546	463 6421
Prof Estate Khmaladze	Asymptotic Statistics, Random Processes, Geometric Methods in Statistics	534	463 5652
A/Prof Ivy (I-Ming) Liu	Categorical Data Analysis	356	463 5648
Dr Louise McMillan	Model-Based clustering, Statistical Ecology	429	463 9545
Dr Binh Nguyen	Machine learning, deep learning, health Informatics, bioinformatics, drug discovery	362	463 8896
Dr Thuong Nguyen	Asymptotic statistics	432	463 5274
Dr Nokuthaba Sibanda[§]	Biomedical Statistics, Statistical Process Control, Applications of Bayesian Statistics	543	463 6779
Prof Peter Smith	Telecommunications, Statistics in Engineering	539	463 6738
Dr Budhi Surya	Levy Process, Optimal Stopping, Applied Probability, Financial Stochastics	544	463 5669
Dr Yuan Yao	Biostatistics and Statistical Inference	533	463 7059

[§] Postgraduate Coordinator

[†] On leave or unavailable for part of this year

MATH Postgraduate Coordinator
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MATH Honours Coordinator
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STAT Postgraduate Coordinator (Taught Course)
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STAT Postgraduate Coordinator (Research programme)
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DATA Postgraduate Coordinator
Prof Richard Arnold
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Email: richard.arnold@vuw.ac.nz

Note: Students must discuss their intended programme with the MATH Honours Coordinator or the relevant Postgraduate Coordinator.

QUALIFICATIONS AVAILABLE

HONOURS AND MSC PART 1

The programme for the **Bachelor of Arts with Honours (BA(Hons)), Bachelor of Science with Honours (BSc(Hons)),** or **Master of Science (MSc) Part 1**, consists of 120 points, typically made up of eight 15-point courses or the equivalent in an approved combination, to be chosen from the courses described below and subject to availability. All Honours students must enrol in 30 points of project-based work.

The Honours degree is intended to be a single offering based on a coherent programme of study. When courses are substituted from other subjects, they must be relevant and complementary to the rest of the programme. At most 60 points may be substituted, that is at least 60 points must be from those listed for the major subject. With permission of the Honours and Postgraduate Coordinator, a part-time student may extend their Honours/Master's Part 1 over more than one year. The maximum time for BSc(Hons) is two years, for BA(Hons) four years.

Those who do MSc Part 1 can do MSc Part 2 the following year and obtain the MSc degree with a class of Honours. However, the School prefers that students do the same two years' work by obtaining a BSc(Hons) degree in the first year, and then enrolling in MSc Part 2 to complete an MSc degree.

There is no MA Part 1. The MA has the same status as MSc Part 2 and, like the BA(Hons), can be taken in Mathematics but not in Data Science or Statistics.

PREREQUISITE FOR HONOURS IN MATHEMATICS

The prerequisite for BA(Hons) or BSc(Hons) in MATH is an undergraduate major in Mathematics, including at least 60 points in 300-level Mathematics courses. An average grade of at least B+ in the relevant 300-level courses is normally required, and students should have completed any specific prerequisites for their proposed courses of study. An equivalent background will be required for a student whose undergraduate study has been undertaken elsewhere.

PREREQUISITES FOR HONOURS IN STATISTICS

You will need a BA or BSc with at least 45 points from DATA 303, MATH 377, STAT 300-399 (with an average grade of B+ or better). Other entry combinations are also possible.

Students with interests in the theoretical aspects of Statistics:
Such students, particularly if they are considering the possibility of a research degree, may wish to strengthen their general mathematical background before specialising. The MATH courses in Differential Equations, Algebra, Analysis and Measure Theory all provide valuable background for different aspects of work in Statistics.

PREREQUISITES FOR HONOURS IN DATA SCIENCE

You will need a BSc in Data Science with at least 60 points from COMP 309, DATA 301-399 (with an average grade of B+ or better). Other entry combinations are also possible.

POSTGRADUATE CERTIFICATE IN SCIENCE

The Postgraduate Certificate in Science (PGCertSc) is offered in all subjects offered for the MSc. Entry requirements are the same as for the MSc, but the grade requirement may be relaxed slightly. The qualification consists of only 60 points of postgraduate courses in the relevant subject, so provides a shorter coursework postgraduate qualification. It may be suitable for a student in full-time work or managing other commitments and may also be used for those who wish to exit early from another postgraduate qualification. Conversely, a PGCertSc may later be abandoned in favour of a PGDipSc if the requirements for that qualification are subsequently met.

A candidate in PGCertSc should be enrolled for at least one trimester and should complete the requirements within two years.

- The **PGCertSc in Mathematics** requires 60 points in approved courses from MATH 401–489.
- The **PGCertSc in Statistics** requires 60 approved points from STAT 401–489.
- The **PGCertSc in Data Science** requires one of (AIML 425, 426, 427, 429), one of (STAT 432, 438); 30 further points from AIML 400-479, COMP 400-479, DATA 400-499, 501, MATH 400-483, STAT 400-483.
- **The PGCertSc in Stochastic Processes in Finance and Insurance** requires 45 points from MATH 441, 442, 477, STAT 433, 435, 457 and a further 15 points from STAT 401–489.

POSTGRADUATE DIPLOMA IN SCIENCE

The Postgraduate Diploma in Science (PGDipSc) is a postgraduate science qualification offered in all subjects offered for the MSc. Entry requirements are the same as for the MSc, but the grade requirement may be relaxed slightly. The PGDipSc requires 120 points of postgraduate study and can be completed in two trimesters (full time) or over four years (part time), and provides an alternative to the Honours and Master's degrees for students.

- The **PGDipSc in Mathematics** requires 120 points in approved courses from MATH 401–489.
- The **PGDipSc in Statistics** requires 120 points from STAT 401–489 or approved alternatives; at least 60 points shall be from 400-level STAT courses.
- The **PGDipSc in Data Science** requires AIML 427, STAT 432, 438; one of (AIML 425, 426, 429); 60 further points from AIML 400-479, COMP 400-479, DATA 400-499, 501, MATH 400-483, STAT 400-483.
- The **PGDipSc in Stochastic Processes in Finance and Insurance** requires 120 points in an approved combination from MATH 441, 442, 461–464, 477, STAT 401–489, or approved alternatives; including at least 45 points from MATH 441, 442, 477, STAT 433, 435, 457.

With permission some optional courses in a PGDipSc may be replaced by substitute courses from other subjects offered for postgraduate degrees.

MASTERS DEGREES

The programmes available at Masters level are:

- Master of Science (MSc) or Master of Arts (MA) in Mathematics
- MSc in Statistics
- MSc in Data Science
- MSc in Stochastic Processes in Finance and Insurance
- Master of Applied Statistics (MAppStat)
- Master of Data Science (MDataSc)

The Master of Science is a two-year programme. Part 1 consists of 120 points of courses. This is followed by Part 2 which consists either of a full year research project (120-point thesis), or (for some subjects only) a combination of a smaller research project (90-point thesis) together with 30 points of taught courses. Students have 12 months in which to complete their research thesis in Part 2. Students who have completed an Honours degree of II(2) or better, or a postgraduate diploma in Science at equivalent standard, can proceed directly to Part 2.

The Master of Arts is a one-year programme and is equivalent to Part 2 of the Master of Science.

Candidates for Master's degrees must enrol each year for the individual courses, projects, theses, etc. they will be doing that year. For each student, the requirements for any such course(s) are worked out in consultation with the Postgraduate Coordinator.

Entry to all Masters programmes requires approval by the relevant Postgraduate Coordinator and depends on an initial agreement on a programme of study. Enrolment in a Master's thesis requires agreement on a supervisor and a provisional thesis topic. Potential areas of research are outlined in the section on the PhD programme.

With the permission of the Associate Dean (Students), study can be undertaken on a part time basis.

MSC OR MA IN MATHEMATICS

PROGRAMME STRUCTURE

MSc Part 1: 120 points of courses in an approved combination from MATH 401-489
MA or MSc Part 2: The programme consists of preparation of a research thesis (MATH 591, 120 points) under the individual supervision of a staff member.

A Master's thesis is normally an exposition of a piece of mathematical work and may contain new results or may represent a study of known material from a fresh point of view, together with some review of the literature. The thesis must be submitted for examination within 12 months of enrolment for the Master's degree.

ENTRY REQUIREMENTS

MSc Part 1: 60 points in approved courses from MATH 300–399.
MA or MSc Part 2: Students entering these programmes will normally have completed BA(Hons) or BSc(Hons) with a class of Honours of II(2) or better, or MSc Part 1.

MSC IN STATISTICS

PROGRAMME STRUCTURE

MSc Part 1: An approved combination from MATH 477, MATH 401-489, STAT 401–489; at least 60 points shall be from MATH 477 or 400-level STAT courses.
MA or MSc Part 2: The programme consists of preparation of a research thesis (STAT 591, 120 points) under the individual supervision of a staff member. Alternatively, students may prepare a smaller research thesis (STAT 592, 90 points) and study 30 points from approved courses.

Areas of interest encouraged by the group are biometrics, categorical data analysis, demography, empirical processes, epidemiology, martingale methods, multivariate analysis, population modelling, production theory, queuing theory, reliability theory, simulation, sorting algorithms, statistical theory of diversity, statistics in geophysics, stochastic processes and their applications, financial stochastics and mathematics, time series analysis and its applications, including seasonal adjustment and forecasting, and signal and image processing.

ENTRY REQUIREMENTS

MSc Part 1: at least 45 points from DATA 303, MATH 377, STAT 300–399 (normally with an average grade of B+ or better).
MSc Part 2: Students entering these programmes will normally have completed a BSc(Hons) with a class of Honours of II(2) or better, or MSc Part 1. Students may also enter the programme following completion of a Postgraduate Diploma in Science or the Master of Applied Statistics.

MSC IN DATA SCIENCE

PROGRAMME STRUCTURE

MSc Part 1: AIML 427, STAT 432, 438, one of (AIML 425, 426, 429), 60 further points from AIML 400-479, COMP 400-479, DATA 400-499, 501, MATH 400-483, STAT 400-483.
MSc Part 2: The programme consists of preparation of a research thesis (MATH 591, 120 points) under the individual supervision of a staff member.

Areas of interest are artificial intelligence, machine learning, clustering, reliability theory, simulation, network analysis. Students can work on projects in the theory and practice of Data Science and may work with researchers from other disciplines who are seeking insight from their data. Staff from both the Schools of Mathematics & Statistics and Engineering & Computer Science are available as supervisors.

ENTRY REQUIREMENTS

MSc Part 1: 60 points in approved courses from COMP 309, DATA 301–399, or equivalent.
MSc Part 2: Students entering this programme will normally have completed a BSc(Hons) with a class of Honours of II(2) or better, or MSc Part 1. Students may also enter the programme following completion of a Postgraduate Diploma in Science or the Master of Data Science.

MSC IN STOCHASTIC PROCESSES IN FINANCE AND INSURANCE

This two-year (combined Parts 1 and 2) programme addresses the growing demand worldwide for postgraduate students who can solve real-world problems in the finance sector and insurance/actuarial science, using high-level technical knowledge in mathematical and statistical aspects of probability.

A core of courses in advanced probability, functional analysis and stochastic processes are taken, together with coursework in one of a number of relevant areas of application including finance, insurance mathematics and demography. This is followed by a research thesis in the area(s) of specialisation, integrating the theoretical and applied aspects of the programme.

PROGRAMME STRUCTURE

Part 1 of the MSc in Stochastic Processes in Finance and Insurance requires 120 points in an approved combination from MATH 441, 442, 461-464, 477, STAT 401-489, or approved alternatives; including at least 45 points from MATH 441, 442, 477, STAT 433, 435, 457.

Part 2 of the MSc in Stochastic Processes in Finance and Insurance must be preceded by Part 1, and requires a satisfactory thesis (SPFI 591 or 592, worth 120 or 90 points respectively) presented in accordance with the MSc statute, with the addition if required of 30 points of approved courses from the schedules to the BSc(Hons), MSc or other postgraduate degrees, including those from specific exchange programmes.

ENTRY REQUIREMENTS

Entry to the MSc in Stochastic Processes in Finance and Insurance Part 1 requires 45 points from MATH 301, 312, 317, 377, STAT 332; a further 30 points in approved 300-level ACTS, DATA, MATH, ECON, FINA or STAT courses. Students should discuss their options for the MSc with the Postgraduate Coordinator, before finalising their course of study.

MASTER OF APPLIED STATISTICS

The Master of Applied Statistics (MAppStat) is a one-year 180-point Master's degree in Applied Statistics. The programme consists of two components: course work and practical training that has a professional focus through the inclusion of practicum and statistical consultancy. These give the programme unique characteristics among applied statistics programmes internationally.

This taught Master's programme may be completed in one year full time (three trimesters: March–June, July–October and November–February) or up to three years part time. Students can start the programme either in March or July.

PROGRAMME STRUCTURE

The MAppStat requires:

- **Part 1**: STAT 487; 105 points from an approved combination of MATH 477, STAT 431-489
- **Part 2**: STAT 480, 501, 581

The Head of School of Mathematics and Statistics may approve substitution of up to 30 points in Part 1 by other relevant 400- or 500-level courses.

A candidate who has completed Part 1 of the degree but not Part 2 may be awarded a Postgraduate Diploma in Science in Statistics.

ENTRY REQUIREMENTS

Students who enter the MAppStat will have completed a Bachelor's degree in a tertiary institution in a relevant subject; and been accepted by the Head of School of Mathematics and Statistics as capable of proceeding with the proposed course of study (normally with an average grade of B+ or better). Students should discuss their course of study with A/Prof Ivy Liu or Dr Yuichi Hirose.

MASTER OF DATA SCIENCE

The Master of Data Science (MDataSc) is a two year 240-point Master's degree for students who have suitable preparation in Statistics or Computer Science. Students with an undergraduate degree in Data Science, or a double major in Statistics & Computer Science are granted a 60-point exemption, and can complete the degree in 12 months, completing only 180 points. The programme combines taught courses, a research project and a workplace practicum.

The 240-point programme can be completed in two years full time or up to four years part time. The 180-point programme can be completed in 12 months full time or up to three years part time. Students can start the programme either in March or July. Students can start the programme either in March or July.

PROGRAMME STRUCTURE

The MDataSc requires:

- **Part 1**: 60 points from AIML 421, DATA 471-474 or approved alternatives;
- **Part 2**: (i) AIML 427, one of (AIML 425, 426, 429), STAT 432, 438, DATA 480, 501, 581;
  (ii) DATA 487 or 489;
  (iii) 30 or 45 further points from AIML 400-479; COMP 400-479; DATA 400-469; DATA 490-499; MATH 400-483; STAT 400-483 or approved alternatives

Students who have a bachelor's degree in Data Science, or a double major in Computer Science and Statistics are exempted from Part 1, and only need to complete Part 2. For other students The Head of School of Mathematics and Statistics can approve exemptions of up to 60 points from Part 1 according to the student's level of preparation.

Some students may need to take courses in undergraduate statistics or computer science concurrently in order to meet the admission requirements.

Students should contact the Postgraduate Coordinator for Data Science to determine their eligibility, and their possible course of study.

ENTRY REQUIREMENTS

Students who enter the MDataSc will have completed a bachelor's degree in a tertiary institution in a relevant subject; and been accepted by the Head of School of Mathematics and Statistics as capable of proceeding with the proposed course of study (normally with an average grade of B+ or better). Where appropriate, recognition will be given to relevant work experience when determining each student's course of study. Students should discuss their course of study with Prof Richard Arnold.

PHD

The PhD degree is the usual entry to a research or academic career and is awarded for a research thesis. Its essential feature is an original contribution to new developments in the field, by way of new theory or new methodology. A candidate for the degree pursues a course of advanced study and research at the University under the immediate direction of a supervisor, or supervisors.

Study is usually full time and is for a period of at least two calendar years (the maximum time if studying full time is 48 months (4 years) and if part time it is 72 months (6 years)) from the date of registration. Local students will usually have completed a Master's degree before entering the PhD programme, but entry direct from an Honours degree is possible.

Full information about the PhD degree, including how to apply, qualifications required, fees and scholarships etc. can be obtained from the website of the Faculty of Graduate Research at **www.wgtn.ac.nz/fgr**

Any student wishing to enrol for a PhD must discuss possible fields of study with staff members.

RESEARCH AREAS IN MATHEMATICS

Discrete mathematics, algebra and number theory

Current staff interests encompass combinatorics, matroid theory, graph theory, general algebra, category theory, number theory and arithmetic geometry. Staff involved include Prof Rod Downey, Dr Byoung Du Kim, Dr Martino Lupini, Dr Dillon Mayhew and Prof Geoff Whittle.

Logic and the theory of computation

This covers aspects of mathematical and philosophical logic and theoretical computer science, including model theory, set theory, computability theory, complexity of computation, algorithmic randomness, algebraic logic, and the mathematics of modal logic. Staff involved include Dr Adam Day, Prof Rod Downey, Prof Noam Greenberg, Dr Martino Lupini, and Dr Dan Duretsky.

Analysis, topology and geometry

There are interests in singularity theory and algebraic invariant theory with applications to robotics (Dr Peter Donelan); functional and harmonic analysis (Dr Hung Le Pham); and differential geometry (Prof Matt Visser). A/Prof Lisa Clark and Professors Astrid an Huef and Iain Raeburn work in Functional Analysis, which is a sub-branch of Analysis dealing with infinite-dimensional phenomena. They study algebra of operators associated to graphs, groups and dynamical systems. Stephen Marsland works on the geometry of infinite-dimensional groups, particularly shape spaces, and their applications in machine learning and bioacoustics

Applied mathematics and theoretical physics

Prof Mark McGuinness has research interests in mathematical modelling with differential equations, with applications in biomathematics, industrial processes, geophysical processes, and two-phase fluid flow in porous media. Prof Matt Visser works in general relativity and quantum field theory, as well as in differential equations and modelling. Dr Dimitrios Mitsotakis' research interests are in the theory and numerical analysis of differential equations and in applications of mathematics in fluid mechanics, coastal hydrodynamics and geophysics.

RESEARCH AREAS IN STATISTICS AND DATA SCIENCE

Bayesian statistics

This covers theoretical developments, computational aspects and applications of Bayesian methods. Staff involved include Prof Richard Arnold, Dr Yuichi Hirose and Dr Nokuthaba Sibanda.

Categorical data

Interests include analysis and method development for categorical data (A/Prof Ivy Liu) and logistic regression methods (Dr Yuichi Hirose).

Operations research

Staff interests include stochastic operations research methods. Specific interests are warranty analysis and reliability theory (A/Prof Stefanka Chukova).

Probability theory and stochastic processes

Prof Estate Khmaladze's research interests include asymptotic statistics, empirical processes, martingale methods in statistics, statistical theory of diversity, and mathematics of finance and insurance. It also includes research in intersection of spatial statistical problems and geometry. Dr John Haywood has research interests in stochastic process applications in time series analyses. Dr Budhi Surya has research interests in Levy processes, optimal stopping, applied probability and financial stochastics.

Statistical modelling, estimation and testing

There are interests in modeling of directional and geophysics data (Prof Richard Arnold), categorical data (A/Prof Ivy Liu) and survival data (Dr Yuichi Hirose). Dr Hirose also has interests in model selection methods, profile likelihood estimation, finite mixture models, EM algorithm and semi-parametric models, sampling (with Prof Richard Arnold) and estimation theory. There are also research interests in goodness-of-fit testing (Prof Estate Khmaladze and Dr John Haywood). Dr Laura Dumitrescu has interests in small area estimation and surveys.

Applications of Statistics and Data Science

A number of staff are involved in statistical and data science applications in various fields. These include: geophysics and epidemiology (Prof Richard Arnold, Dr Yuichi Hirose), biomedical statistics (Prof Richard Arnold, A/Prof Ivy Liu, Dr Nokuthaba Sibanda), finance and insurance (Prof Estate Khmaladze), fisheries science (Prof Richard Arnold, Dr Nokuthaba Sibanda), ecology (Dr John Haywood, Dr Nokuthaba Sibanda), population genetics for ecology (Dr Louise McMillan) and diversity problems in environmental studies and linguistics (Prof Estate Khmaladze).

Clustering

A/Prof Ivy Liu, Prof Richard Arnold, Dr Louise McMillan have interests in model-based clustering of mixed data types, particularly categorical data (nominal and ordinal). They have applied their models and methods in areas such as ecology, fisheries, linguistics and psychology. They are working on applications in population genetics.

Statistics and engineering

Prof Peter Smith has research interests in telecommunications and Statistics in Engineering.

Time series and forecasting

Dr John Haywood has interests in time series, forecasting and seasonal adjustments. Prof Estate Khmaladze has interests in forecasting in financial applications.

Artificial Intelligence and Machine Learning

Dr Binh Nguyen has interests in applications of machine learning, especially deep learning, in different domains, particularly, in health informatics, bioinformatics, and drug discovery. Prof. Alejandro Frery is interested in applications of Statistical Information Theory in signal and image processing. Prof Stephen Marsland works on information geometry -- the mathematical underpinnings of machine learning -- together with applications in representations of shape, and ecology, particularly bioacoustics.

COURSE INFORMATION INDEX

Course code	Course reference number	Title	Points	Trimester
MATH 432	**CRN 7673**	**MATROID THEORY**	**15 PTS**	**1/3**

PLANNING A PROGRAMME IN MATHEMATICS

The Mathematics Honours (BSc(Hons) or BA(Hons)) programme requires 120 points:

- 30 points from MATH 487-489
- 90 points from MATH 401–483

MATH 432 CRN 7673 MATROID THEORY 15 PTS 2/3

Prerequisite: MATH 311, 324 or 335
Coordinator: A/Prof Dillon Mayhew

The notion of dependence occurs naturally in many areas of mathematics: for example, graph theory, linear algebra, and the study of field extensions. These apparently quite different concepts share certain properties. Matroids are the axiomatic mathematical objects that arise from these common properties, in the same way that groups are the objects we discover when we consider the abstract properties of symmetries. This course is an introduction to structural matroid theory, including the basic definitions and results, and excluded-minor characterisations of several classes of matroids.

MATH 433 CRN 7674 MODEL THEORY 15 PTS 2/3

Prerequisite: MATH 309
Coordinator: Dr Dan Turetsky

This course will introduce students to fundamental notions, ideas, and techniques from model theory, such as structures and formulas, the ultraproduct construction, the compactness theorem, and quantifier elimination. We will also present application to concrete examples from algebra and discrete mathematics, such as fields, groups, and graphs.

MATH 434 CRN 7675 SET THEORY 15 PTS 1/3

Prerequisite: MATH 309
Coordinator: Prof Rod Downey

Set theory lies at the foundations of mathematics - all objects of mathematical interest can be construed as sets. Contemporary set theory explores some of the rich structure of the class of all sets, and the limitations of the theory. The course uses ideas from MATH 309, but is not a strict continuation of that course.

MATH 436 CRN 7677 GALOIS THEORY AND NUMBER THEORY 15 PTS 2/3

Prerequisite: MATH 311
Coordinator: Dr Byoung Du Kim

Galois theory is a fascinating mathematical theory that brings together several branches of mathematics. This course starts with the historical question of solving polynomial equations by radicals. We will rediscover the method with which Galois determined whether a given polynomial is solvable by radicals or not. However, this course goes even further: Galois theory grew to become an interconnection between different areas of algebra such as roots of polynomials, field extensions, algebraic and transcendental numbers, Galois groups, and also algebraic number theory, and we will explore some aspects of it. Galois theory is a natural bridge between algebra and number theory, and in the second half of this course, we will study how algebra is applied to number theory.

MATH 439 CRN 7676 CATEGORY THEORY 15 PTS 1/3

Prerequisite: MATH 311
Coordinator: Dr Martino Lupini

Introduction to the basic ideas and perspectives of category theory: - the definition of “category” with examples, - constructions in categories: limits and colimits, - functors and natural transformations, - adjunctions. Coverage of further topics will depend on time available.

MATH 441 CRN 7680 MEASURE THEORY 15 PTS 1/3

Prerequisite: MATH 312 or MATH 317
Coordinator: Dr Hung Le Pham

Much of modern mathematics, both pure and applied, and ranging from number theory to quantum mechanics, depends on having a method of integrating functions that applies to more functions and has better properties than the Riemann integral taught in undergraduate courses. Such a method was invented by Lebesgue; it depends on the idea of ‘measure’, which can be thought of as, in origin, an extension of the concepts of ‘area’ and ‘volume’, but which was subsequently seen to be precisely what is needed to found a rigorous theory of probability. This is an introduction course on measure theory. Topics cover include: measurable spaces and measures (specific examples include Lebesgue measure on the real line and unordered sums on general sets), integration theory on measure spaces, important convergence theorems (bounded convergence, monotone conver- gence, dominated convergence theorems), some applications to classical function theory on the real line (e.g. when a function is Riemann integrable or a generalisation of the fundamental theorem of calculus) and to probability.

MATH 443 CRN TBC OPERATOR ALGEBRA 15 PTS 1/3

Prerequisite: MATH 318
Coordinator: Prof Astrid an Huef

Operator algebras have a rich algebraic and analytic structure modelled on the properties of bounded linear operators on Hilbert space. This course introduces the basic theory of Banach and C*-algebras with an emphasis on how it is used.

MATH 452 CRN 591 TOPOLOGY 15 PTS 1/3

Prerequisites: MATH 317 or 318
Coordinator: AProf Lisa Orloff Clark

Topology is one of the cornerstones of modern mathematics. It appears everywhere. This course is an introduction to point-set topology; it will give students the background in Topology that they need to pursue higher level mathematics.

Topology is very abstract. The entire subject is built from a few set-theoretic definitions that can be used in a wide variety of situations. For example, many topologies are induced by metrics, but there are topological spaces that are not metric spaces.

This course will include a study of abstract notions of continuity, compactness and connectedness along with an introduction to topological groups.

MATH 461 CRN 7684 DIFFERENTIAL EQUATIONS 15 PTS 2/3

Prerequisite: MATH 301
Coordinator: Dr Dimitrios Mitsotakis

This course is about *asymptotic methods*, for finding approximate solutions to linear and nonlinear ordinary differential equations, as well as for approximately evaluating integrals. To quote Bender and Orszag: In contrast to methods which we would describe as exact, rigorous, systematic, limited in scope and deadly, these new methods are approximate, intuitive, heuristic, powerful and fascinating.

We will study mainly the following:

- Local Methods: Method of dominant balance, Asymptotic series.
- Asymptotic Expansion of Integrals: Laplace's method, Watson's Lemma, stationary phase method, the method of steepest descents.
- Perturbation Methods: Regular perturbation, Singular perturbation, Boundary layer analysis.

MATH 462 CRN 7685 CHAOTIC DYNAMICS 15 PTS 2/3

Prerequisite: MATH 301
Coordinator: Prof Mark McGuinness

A gourmet’s sampling from the smorgasbord of delights in chaos and dynamical systems, from the Cantor set to strange attractors, including the iteration of maps, symbolic dynamics, and Smale horseshoes.

Dynamical systems model aspects of real world, either discretely with maps or continuously with differential equations. We study maps in one and two dimensions and use their properties to understand systems of differential equations via the idea of Poincaré sections. As a result, we are led from fixed points via periodic to chaos and fractals.

MATH 464 CRN 10021 DIFFERENTIAL GEOMETRY 15 PTS 1/3

Prerequisite: MATH 301
Coordinator: Prof Matt Visser

This course introduces the notation and ideas of modern Differential Geometry that form an essential background to many fields in Mathematics and Physics. It develops the theory of manifolds and bundles from a largely intuitive standpoint, and discusses the geometric notions of metric, connexion, geodesic, curvature and sectional curvature. Extensive notes are supplied. The course is an essential prerequisite for MATH 465. Topics include:

- topological manifolds and differentiable structure
- affine connexion and curvature: the Riemann tensor
- exterior differential forms: generalized Stokes’ theorem.

MATH 465 CRN 10022 GENERAL RELATIVITY AND COSMOLOGY 15 PTS 2/3

Prerequisite: MATH 464
Coordinator: Prof Matt Visser

This course introduces Einstein's general relativity, black holes, gravitational waves, some idealised models of the universe, and a brief discussion of some extensions to the theory. Topics may include:

- special relativity: R^4 with a Lorentzian metric; the Lorentz group; causal structure
- Lorentzian (pseudo-Riemannian) geometry
- general relativity: the Einstein equivalence principle
- Einstein's equations (vacuum); Schwarzschild solution
- Einstein's equations with matter
- gravitational waves
- idealised cosmologies; FLRW universes.

MATH 466 CRN 23076 TOPICS IN APPLIED MATHEMATICS 15 PTS 1/3

Prerequisite: MATH 301 or 321 or 322
Coordinator: Prof Mark McGuinness

Two topics of a more advanced nature in applied mathematics or mathematical physics from a selection that may include: classical mechanics, fluid mechanics, quantum mechanics, special relativity. Topics may not include any already or concurrently taken in MATH 321, 322 or 323 or in MATH 467.

MATH 467 CRN 23075 TOPICS IN APPLIED MATHEMATICS 15 PTS 2/3

Prerequisite: MATH 301 or 321 or 322
Coordinator: Prof Mark McGuinness

Two topics of a more advanced nature in applied mathematics or mathematical physics from a selection that may include: classical mechanics, fluid mechanics, quantum mechanics, special relativity. Topics may not include any already or concurrently taken in MATH 321, 322 or 323 or in MATH 466.

MATH 477 CRN 29142 PROBABILITY 15 PTS 1/3

Prerequisite: MATH 377
Restrictions: STAT 437
Coordinator: Prof Estate Khmaladze

The course starts with weak and almost sure convergence, then covers limit theorems and semi-groups of distributions, infinitely divisible and stable distributions and Lévy processes, with emphasis on compound Poisson processes, random walks and Brownian motion. The material is illustrated by real-life examples from finance, insurance and other fields.

MATH 440 CRN 15207 DIRECTED INDIVIDUAL STUDY 15 PTS 1/3
MATH 460 CRN 15208 DIRECTED INDIVIDUAL STUDY 15 PTS 2/3

Prerequisite: Permission of Course Coordinator
Coordinator: Prof Astrid an Huef

The directed individual study (DIS) label can be used to provide a reading course when there is no suitable Honours course available. The student follows an individual course of study under supervision.

A DIS label can sometimes be used to enable study in a field taught in a 300-level MATH course not previously passed. As well as attending the 300-level course at its regular time and fulfilling its requirements, the student will be required to prepare additional material for assessment, demonstrating an understanding of a suitable topic at a level appropriate to an Honours degree; it will typically count for 20% of the course grade. At most **one** 15-point course of this nature may be included in an Honours degree, and only at the discretion of the coordinator of the associated 300-level course. It may not count towards the minimum of 60

MATH points required for Honours in Mathematics. It also requires a specific justification, such as the need to provide prerequisite material for some other course in the student's individual Honours programme.

MATH 480–483: SPECIAL TOPICS

The special topic label can be used to create 30-point, or 15-point courses tailored to particular interests, or to introduce new topics that may be offered in a particular year. One Special Topic label may be used for different subject matter for different students. There are four labels that can be used, two for 30-point full-year courses, and two for 15-point one-trimester courses that are each available in both 1/3 and 2/3:

	PTS	CRN	
MATH 480	Special Topic	30	6891 (1/3+2/3) **Not offered 2020**
MATH 481	Special Topic	30	6892 (1/3+2/3) **Not offered 2020**
MATH 482	Special Topic	15	9758 (1/3) as below
MATH 483	Special Topic	15	6894 (1/3) **Not offered 2020**

MATH 482 CRN 9758 TOPICS IN INFINITE COMBINATORICS 15 PTS 1/3

Prerequisite: MATH 309
Coordinator: Dr Martino Lupini

This course will focus on the application of infinitary methods (logic, topology, dynamical systems) in Ramsey theory and the combinatorial study of finite discrete structures. Ramsey Theory studies, broadly speaking, the following question: which combinatorial configurations can be found in a sufficiently large finite structure? This course will provide an overview of this subject, with a special emphasis on its interactions with logic and dynamics.

MATH 487	**CRN 33112**	**RESEARCH PROJECT 1**	**15 PTS**	**1/3**
	CRN 33113	**RESEARCH PROJECT 1**	**15 PTS**	**2/3**
	CRN 33114	**RESEARCH PROJECT 1**	**15 PTS**	**3/3**
MATH 488	**CRN 27014**	**RESEARCH PROJECT 2**	**15 PTS**	**1/3**
	CRN 7693	**RESEARCH PROJECT 2**	**15 PTS**	**2/3**
MATH 489	**CRN 7694**	**RESEARCH PROJECT**	**30 PTS**	**1+2/3**

Prerequisite: Permission of the Honours Coordinator
Coordinator: Prof Astrid an Huef

These courses offer the experience of exploring the literature on a certain topic and writing a report that gives a coherent survey of findings and demonstrates mastery of the material. Supervision takes the form of regular meetings between the student and supervisor. It is expected that MATH Honours students take 30 points of project-based courses.

A list of possible project topics and supervisors is available on the project homepage. The Coordinator will allocate a supervisor and topic to each student, taking into account the overall preferences of students and staff.

SUBSTITUTION FROM OTHER SUBJECTS

Up to half of a Mathematics Honours degree can consist of courses from other subjects. The overall selection of courses must still form a coherent programme and requires approval from the Mathematics Postgraduate Coordinator.

PLANNING A PROGRAMME IN STATISTICS

TAUGHT COURSES AND PROJECTS: HONOURS, PGDIPSC, MAPPST AND MSC

The Statistics Honours programme requires 120 points:

- 30 points from STAT 480, 487-489
- 90 points from MATH 477, STAT 401–479, 481–483.

The PGDipSc and the MSc Part 1 in Statistics also require 120 points:

- At least 60 points from MATH 477, STAT 401-489
- Further approved courses to total 120 points from MATH 401-489, STAT 401-489

The MAppSt Part 1 requires:

- 120 approved 400- or 500-level points including STAT 487 or 489 (STAT 480, STAT 501 and STAT 581 are required in Part 2)

Course code	Title	Prerequisites
TRIMESTER 1		
MATH 477	Probability	MATH 377
STAT 431	Biostatistics	One of (STAT 332, 393, 394)
STAT 435	Time Series	One of (MATH 377, STAT 332)
STAT 439	Sample Surveys	STAT 193 or equivalent; 30 approved 200/300 level pts
STAT 440	Directed Individual Study	
STAT 452	Bayesian Inference	One of (STAT 332, 393, 394)
STAT 487	Research Project 1 (15 pts)	
STAT 489	Research Project (30 pts)	
TRIMESTER 2		
STAT 432	Computational Statistics	One of (STAT 332, 393, 394)
STAT 433	Stochastic Processes	One of (MATH 377, STAT 332)
STAT 438	Generalised Linear Models	One of (STAT 332, 393, 394)
STAT 434	Statistical Inference	MATH 377 recommended
STAT 441	Directed Individual Study	
STAT 451	Official Statistics	STAT 193 (or equivalent), 30 approved 200/300 level pts
STAT 482	Special Topic: System Modelling and Analysis in Science and Engineering	Permission of course coordinator
STAT 488	Research Project 2 (15 points)	
STAT 489	Research Project (30 points)	
STAT 501	Statistical Consulting	Enrolment in the MAppStat; 30 approved STAT points at 400-level or above

TRIMESTER 3

STAT 480	Research Preparation	Enrolment in the MAppStat
STAT 487	Research Project 1 (15 points)	
STAT 588	Applied Statistics Project (45 points)	
STAT 581	Statistical Practicum (30 pts)	Enrolment in the MAppStat; 60 approved STAT points at 400-level or above

400-LEVEL COURSES

MATH 477 CRN 29142 PROBABILITY 15 PTS 1/3

Prerequisite: MATH 377
Restrictions: STAT 437
Coordinator: Prof Estate Khmaladze

The course starts with weak and almost sure convergence, then covers limit theorems and semi-groups of distributions, infinitely divisible and stable distributions and Lévy processes, with emphasis on compound Poisson processes, random walks and Brownian motion. The material is illustrated by real-life examples from finance, insurance and other fields.

STAT 431 CRN 23080 BIOSTATISTICS 15 PTS 1/3

Prerequisite: One of (STAT 332, 393, 394)
Coordinator: Dr Budhi Surya

This course aims to give a basis for modelling of survival time and EM algorithm. Topics will be selected from: review of maximum likelihood estimator; large sample tests (Likelihood Ratio test, Wald test, Score test); information criteria (AIC, BIC); Mixture model and EM algorithm; Kaplan-Meier estimator and log-rank test; Cox-proportional hazard model and its extension.

STAT 432 CRN 23079 COMPUTATIONAL STATISTICS 15 PTS 2/3

Prerequisite: One of (STAT 332, 393, 394)
Coordinator: Dr Louise McMillan

This course is a practical introduction to computationally intensive methods for statistical modelling and inference. Topics covered will be chosen from: the jackknife and bootstrap methods for bias correction and variance estimation; permutation tests; maximum likelihood estimation using the EM algorithm; random number generation; simulation from probability distributions; sampling algorithms, mixture models. It is desirable that students enrolling in this course have some knowledge of R.

STAT 433 CRN 23078 STOCHASTIC PROCESSES 15 PTS 2/3

Restriction: STAT 441 (up to 2011)
Coordinator: Prof Estate Khmaladze

We begin with the fundamental concepts of filtrations, i.e. an abstract model of the ‘flow of growing information’, then adapted processes, i.e. processes adapted to these filtrations, then Doob decomposition, all studied in discrete time first. Then we consider Brownian motion and Brownian bridge, their main distributional properties and different forms, properties of their trajectories, Wiener stochastic integral and function-parametric Brownian motion. Next, comes stochastic analysis ’proper’: Ito stochastic integrals, stochastic differentiation and Ito formula, followed by stochastic differential equations (SDE). Ornstein-Uhlenbeck process, Brownian bridge and Geometric Brownian motion are derived as solutions of the linear SDE. Very wide range of their applications is described through examples.

STAT 434 CRN 8109 STATISTICAL INFERENCE 15 PTS 2/3

Prerequisite: MATH 377 recommended
Restrictions: STAT 332
Coordinator: Dr Yuan Yao

In-depth cover of classical statistical inference procedures in estimation and hypothesis testing. Topics include: limit theorems; theory of parametric estimation; sufficiency and efficiency; uniformly most powerful tests and likelihood ratio tests. As time permits, a selection of notions from Bayesian, nonparametric and robust statistics, will be discussed. This course is co-taught with STAT 332.

STAT 435 CRN 8110 TIME SERIES 15 PTS 1/3

Prerequisite: One of (MATH 377, STAT 332)
Coordinator: Dr John Haywood

A general introduction to the theory and practice of time series analysis. Topics will include: the basic theory of stationary processes; spectral or Fourier models; AR, MA and ARMA models; linear filtering; time series inference; and the sampling of continuous time processes. This foundation course has broad application in many areas. The statistical system R will be used for graphical displays, data analysis and simulation studies.

STAT 436 CRN 8111 FORECASTING 15 PTS 2/3

Prerequisite: 30 approved 300-level ECON, MATH, QUAN or STAT pts
Coordinator: Prof Estate Khmaladze

Students will be placed in the position of a financial analyst in an imaginary financial institution and given real data on prices (electricity prices and foreign exchange rates). They will be asked to answer questions typical for real problems of the financial industry. Specific topics include estimation and analysis of trends, detection of abrupt changes in market conditions, estimation of the change-point, selection of models for stationary time-series, analysis of marginal distributions and detection of mixtures of distributions.

STAT 438 CRN 8113 GENERALISED LINEAR MODELS 15 PTS 2/3

Prerequisite: One of (STAT 332, 393, 394)
Coordinator: Dr Yuichi Hirose

Brief outline of generalised linear model theory, contingency tables, binary response models, log-linear models (for contingency tables), repeated measures, GEE analysis, logit models for multinomial responses, and ordinal response models.

STAT 439 CRN 10019 SAMPLE SURVEYS 15 PTS 1/3

Prerequisites: STAT 193 or equivalent; 30 approved 200/300-level pts
Restrictions: STAT 392
Coordinator: Prof Richard Arnold

An introduction to practical aspects of survey sampling, including sampling theory, sample design, basic analytic techniques, non-response adjustment, questionnaire design and field work. Practical aspects of survey design and implementation form part of the course, including students developing their own survey proposals. Some use of a statistical package such as SAS or Excel will be required. The ability to write good English is expected, as some assignments are to be presented as reports. Students unfamiliar with or unpracticed at report writing are advised to take the course WRIT 101. This course is co-taught with STAT 392.

STAT 451 CRN 28349 OFFICIAL STATISTICS 15 PTS 2/3

Prerequisites: STAT 193 (or equivalent), 30 points at 200-level or above (including STAT 292 or STAT 392 or STAT 439)

Coordinator: Prof Richard Arnold

This course provides an overview of key areas of Official Statistics. Topics covered include data sources (sample surveys and administrative data); legal and ethical framework of official statistics; introductory demography; collection and analysis of health, social and economic data; data visualisation including presentation of spatial data; data matching and integration; the system of National Accounts. This course is taught jointly across several New Zealand Universities using videoconferencing.

STAT 452 CRN 28350 BAYESIAN INFERENCE 15 PTS 1/3

Prerequisite: One of (STAT 332, 393, 394)

Restriction: STAT 482 (up to 2015)

Coordinator: Dr Nokuthaba Sibanda

Topics covered will be chosen from: the Bayesian approach, likelihood principle, specification of prior distributions, posterior distribution computation, Bayesian regression models, model determination, Bayesian models for population dynamics, sampling methods, Markov Chain Monte Carlo. The software programme R will be used for Bayesian computation.

STAT 456 CRN 28366 OPTIMISATION IN OPERATIONS RESEARCH 15 PTS

This course is not offered in 2021.

STAT 457 CRN 28358 STOCHASTIC MODELS IN WARRANTY AND MAINTENANCE 15 PTS 1/3

Prerequisite: Approval of Postgraduate Coordinator

Coordinator: A/Prof Stefanka Chukova

An advanced course in: mathematical and statistical techniques for analysis of warranty/maintenance; warranty/maintenance cost models; some engineering aspects of warranty/maintenance. Topics covered include: basic concepts and ideas in warranty/maintenance analysis; types of warranty/maintenance policies; overview of renewal theory and its application in warranty/maintenance analysis. The course involves several guided research projects. Students must have programming experience and basic understanding of probability theory.

STAT 480 CRN 27124 RESEARCH PREPARATION 15 PTS 3/3

Prerequisites: Enrolment in the MAppStat

Coordinator: Dr Laura Dumitrescu

This course consists of self-directed learning with three one-day workshops, including an introduction to LaTeX, reading research papers; using library resources; constructing literature reviews; developing and discussing research questions; and presenting a research proposal in both written and oral form. Throughout the course, each student will be guided by a mentor in a specific field of research to write a research proposal and will be expected to attend school research seminars.

STAT 481	**CRN 13703**	**SPECIAL TOPIC 1: MATHEMATICAL DEMOGRAPHY AND LIFE INSURANCE MATHEMATICS**	**15 PTS**	**1/3**

Prerequisite: Approval of Postgraduate Coordinator
Coordinator: Prof Estate Khmaladze

This course represents fundamental models of an individual lifetime as a random variable: rates of mortality, distributions of remaining life times, life tables, specific parametric models for these, including: Statistical analysis of cohorts and mixed populations; pricing of insurance contracts, endowments and annuities, analysis of longevity, basic models of population dynamics and analysis of portfolios. Students will be also required to apply the concepts presented during the course to real demographic data and life-insurance data.
Note: This course is not offered in 2021.

STAT 482	**CRN 13704**	**SPECIAL TOPIC 2: STOCHASTIC SYSTEMS: MODELLING AND ANALYSIS IN SCIENCE AND ENGINEERING**	**15 PTS**	**2/3**

Prerequisite: Approval of Postgraduate Coordinator
Coordinator: Prof Peter Smith

An overview of statistical modelling and analysis of systems in science and engineering. Modelling topics include fitting and selecting statistical distributions associated with the system. Analysis topics include simulation and the algebra of random variables, such as the use of transformation theory, conditioning and characteristic functions.

STAT 483	**CRN 28351**	**SPECIAL TOPIC: DATA MANAGEMENT, PROGRAMMING AND APPLICATIONS**	**15 PTS**	**2/3**

This course is not offered in 2021.

STAT 487	**CRN 28354**	**RESEARCH PROJECT 1**	**15 PTS**	**1/3**
	CRN 28438	**RESEARCH PROJECT 1**	**15 PTS**	**2/3**
	CRN 28377	**RESEARCH PROJECT 1**	**15 PTS**	**3/3**
STAT 488	**CRN 28355**	**RESEARCH PROJECT 2**	**15 PTS**	**2/3**
STAT 489	**CRN 28367**	**RESEARCH PROJECT**	**30 PTS**	**1/3**
	CRN 28378	**RESEARCH PROJECT**	**30 PTS**	**2/3**
	CRN 28379	**RESEARCH PROJECT**	**30 PTS**	**3/3**
	CRN 28380	**RESEARCH PROJECT**	**30 PTS**	**1+2/3**
	CRN 28381	**RESEARCH PROJECT**	**30 PTS**	**2+3/3**
	CRN 28382	**RESEARCH PROJECT**	**30 PTS**	**3+1/3**
STAT 588	**CRN**	**APPLIED STATISTICS PROJECT**	**45 PTS**	**3/3**

Postgraduate Coordinator: Dr Yuichi Hirose

Students should meet with the Postgraduate Coordinator to identify their areas of interest, for assistance in identifying a suitable supervisor and then contact potential supervisors directly. Fifteen-point projects are usually completed in one trimester. Thirty-point projects can be completed within either a single trimester, or two successive trimesters, and should take 300 hours of study, supervision meetings and writing. The 45-point project STAT 588 is available to students in the Master of Applied Statistics who, with permission, are replacing the combination of the work placement STAT 581 and project STAT 487 with a larger research project.

STAT 440	**CRN 28352 DIRECTED INDIVIDUAL STUDY**	**15 PTS**	**1/3**
STAT 440	**CRN 28376 DIRECTED INDIVIDUAL STUDY**	**15 PTS**	**3/3**
STAT 441	**CRN 28353 DIRECTED INDIVIDUAL STUDY**	**15 PTS**	**2/3**

Prerequisites: Approval of Postgraduate Coordinator
Postgraduate Coordinator: Dr Yuichi Hirose

The Directed Individual Study label can be used to provide a reading course when there is no suitable Honours course available. The student follows an individual course of study under supervision. One DIS label may be used for different subject matter for different students.

A DIS label can sometimes be used to enable study in a field taught in a 300-level STAT course not previously passed. As well as attending the 300-level course at its regular time and fulfilling its requirements, the student will be required to prepare additional material for assessment, as specified by the course coordinator. At most **one** 15-point course of this nature may be included in an Honours degree, and only at the discretion of the coordinator of the associated 300-level course. It may not count towards the minimum of 60 STAT points required for Honours in Statistics. It also requires a specific justification, such as the need to provide prerequisite material for some other course in the student's individual Honours programme.

STAT 501	**CRN 27125 STATISTICAL CONSULTING**	**15 PTS**	**2/3**

Prerequisites: Enrolment in the MAppStat
Corequisites 30 points from 400-level STAT courses or approval of Postgraduate Coordinator
Coordinator: Prof Peter Smith

This course provides training in statistical consulting for practical research in other disciplines. Following formal development of skills to determine appropriate analysis methods for clients, students will complete projects based on supervised consultancy with students or staff members.

This course will be taught with a combination of lectures and practical training.

- Lectures: the skills required for statistical consulting, such as client engagement; statistical packages; paper reviews for various types of analysis in Biology, Psychology, etc.
- Practical training: face-to-face meetings with clients (students or staff members in other disciplines); discussion with academic mentors about the methodology used for the clients' projects; report preparation.

STAT 581	**CRN 27154 STATISTICAL PRACTICUM**	**30 PTS**	**3/3**

Prerequisites: Enrolment in the MAppStat; 60 approved STAT points at 400-level or above
Coordinator: A/Prof I-Ming (Ivy) Liu

This course enables students to gain professional work experience in the application of statistics. Each student is supervised by a host organisation involved in statistical consulting or statistical applications in the public or private sectors. The placement allows students to develop teamwork and communication skills in the real world.

This course consists of:

- Practicum briefing: understanding professional expectations and responsibilities; dealing with problems arising in the workplace.
- Placement: working on specific projects with significant statistical content assigned by a host employer; developing teamwork and communication skills; and writing a portfolio.
- Seminar: presenting the findings from the projects and sharing the placement experience with the class.

SUBSTITUTION FROM OTHER SUBJECTS

Up to half of a Statistics Honours degree can consist of courses from other subjects as listed below. Information about these courses is contained elsewhere in this prospectus, or in the relevant Postgraduate Prospectus or websites of the School responsible for it. The overall selection of courses must still form a coherent programme and requires approval from the Statistics Postgraduate Coordinator (Taught Course). Examples of such courses are listed below.

Course code	Title
Trimester 1	
AIML 420	Artificial Intelligence
AIML 427	Big Data
BIOL 420	Conservation Ecology (30 points)
BIOL 426	Behavioural Ecology (30 points)
DATA 472	Data Management and Programming
DATA 474	Simulation and Stochastic Models
ECON 408	Advanced Econometrics A
FINA 401	Current Topics in Asset Pricing
FINA 413	Risk Management and Insurance
PHYG 414	Climate Change: Lessons from the Past
PSYC 434	Conducting Research across Cultures
PUBL 401	Craft and Method in Policy Analysis
Trimester 2	
AIML 421	Machine Learning
AIML 425	Text Mining and Natural Language Processing
AIML 426	Evolutionary Computation and Learning
AIML 429	Probabilistic Machine Learning
DATA 492	Data Science Algorithms
ECON 409	Advanced Econometrics B
FINA 402	Current Topics in Corporate Finance
FINA 403	Derivative Securities
FINA 406	Fixed Income Securities
GEOG 415	Introduction to Geographic Information Science and its Applications
GPHS 425	Numerical Weather Prediction
GPHS 446	Advanced Seismology

PLANNING A PROGRAMME IN DATA SCIENCE

TAUGHT COURSES AND PROJECTS: HONOURS, PGDIPSC, MDATASC AND MSC

The Data Science Honours, PGDipSc and MSc Part 1 programmes require AIML 427, STAT 432, 438 and a further 75 points in an approved combination from AIML 420-429, DATA 400-499, STAT 400-499 or approved alternatives (up to 60 points).

The MDataSc requires AIML 427, DATA 480, 487, 501, 581 STAT 432, 438 and one of AIML 425, 426, 429. The 180-point programme (available to Data Science graduates) requires 45 further approved points from 400 level AIML, DATA, MATH and STAT, or approved alternatives. The full 240-point MDataSc requires a further 60 points from AIML 421, DATA 471-474 or approved alternatives.

Course code	Title	Prerequisites
TRIMESTER 1		
AIML 420	Artificial Intelligence	60 300-level COMP, DATA, SWEN or NWEN pts
AIML 427	Big Data	One of (AIML 420, 421, COMP 307, 309, STAT 393, 394); one of (ENGR 123, STAT 193, MATH 177, QUAN 102)
AIML 428	Text Mining and Natural Language Processing	60 300-level COMP, DATA, NWEN, STAT or SWEN pts
DATA 472	Data Management and Programming	60 300-level pts from (COMP, DATA, STAT, NWEN, SWEN)
DATA 473	Statistical Modelling for Data Science	30 300-level pts from (COMP, DATA, NWEN, SWEN); STAT 292 or comparable background in Statistics
DATA 474	Simulation and Stochastic Models	30 300-level pts from (COMP, DATA, STAT, NWEN, SWEN); STAT 292 or comparable background in Statistics
DATA 481	Special Topic 1 (Not offered in 2021)	
DATA 482	Special Topic 2 (Not offered in 2021)	
DATA 487	Project (15 points)	
DATA 489	Project (30 points)	
DATA 491	Mathematics for Data Science	30 300-level pts from (COMP, DATA, NWEN, SWEN); STAT 292 or comparable background in Statistics
TRIMESTER 2		
AIML 421	Machine Learning	60 300-level COMP, DATA, NWEN, STAT or SWEN pts
AIML 425	Neural Nets and Deep Learning	AIML 420 or COMP 307
AIML 426	Evolutionary Computation and Learning	AIML 420 or COMP 307

AIML 429	Probabilistic Machine Learning	AIML 420 or COMP 307; one of (MATH 177, STAT 292, 293) or approved background in Mathematics or Statistics.
DATA 471	Practical Data Science	DATA 201, 202
DATA 483	Special Topic 3 (Not offered in 2021)	
DATA 487	Project (15 points)	
DATA 489	Project (30 points)	
DATA 492	Data Science Algorithms	DATA 491
DATA 501	Advanced Techniques for Data Science	30 approved 400-level pts from (AIML, COMP, DATA, STAT)
STAT 432	Computational Statistics	DATA 303 or DATA 473; STAT 391 or DATA 491
STAT 438	Generalised Linear Models	DATA 303 or DATA 473; STAT 391 or DATA 491

TRIMESTER 3

DATA 480	Research Methods	Enrolment in the MDataSc
DATA 487	Project (15 points)	
DATA 588	Project (45 points)	
DATA 581	Data Science Practicum (30 pts)	Enrolment in the MDataSc

400-LEVEL COURSES

AIML 420 CRN 33065 ARTIFICIAL INTELLIGENCE 15 PTS 1/3

Prerequisite: 60 300-level COMP, DATA, SWEN or NWEN pts
Restrictions: COMP 307, 420
Coordinator: Prof Mengjie Zhang

This course addresses concepts and techniques of artificial intelligence (AI). It provides a brief overview of AI history and search techniques, as well as covering important machine learning topics and algorithms with their applications, including neural networks and evolutionary algorithms. Other topics include probability and Bayesian networks, planning and scheduling. The course will also give a brief overview of a selection of other current topics in AI. This course is co-taught with COMP 307.

AIML 421 CRN 33066 MACHINE LEARNING TOOLS AND AND TECHNIQUES 15 PTS 2/3

Prerequisite: 60 300-level COMP, DATA, NWEN, STAT or SWEN pts
Restrictions: COMP 309
Coordinator: A/Prof Will Browne

This course addresses the use of machine learning tools and techniques for analysing data and automatically generating applications. The course will explore a range of tools and techniques for classification, regression, image analysis, clustering, text mining, and preprocessing data. It examines the applicability and limitations of the techniques and methods for analysing and evaluating the outcome of using machine learning tools. Students will gain practical experience in applying a range of tools to a range of different problems from different domains. This course is co-taught with COMP 309.

AIML 425 CRN 33067 NEURAL NETWORKS AND DEEP LEARNING 15 PTS 2/3

Prerequisite: AIML 420 or COMP 307
Restrictions: The pair (COMP 421, 422)
Coordinator: tbc

This course addresses the fundamentals of neural network based deep learning. It covers the commonly used deep learning architectures such as fully connected networks, resnets, variational autoencoders, and generative adversarial networks. It discusses functional blocks such as convolutional nets, recurrent neural nets such as LSTMs, and the common objective functions and regularization procedures. Examples will discuss applications such as object classification, classification of sequential text, and the generation of realistic human faces.

AIML 426 CRN 33068 EVOLUTIONARY COMPUTING AND LEARNING 15 PTS 2/3

Prerequisite: AIML 420 or COMP 307
Restrictions: COMP 422
Coordinator: tbc

This course addresses evolutionary approaches in machine learning and optimisation. The course will cover both evolutionary algorithms and swarm intelligence as well as some other population-based techniques for problem solving. It will include a range of real-world application domains such as classification, regression, clustering, and optimisation.

AIML 427 CRN 33069 BIG DATA 15 PTS 1/3

Prerequisite: One of (AIML 420, 421, COMP 307, 309, STAT 393, 394);
one of (ENGR 123, STAT 193, MATH 177, QUAN 102)
or comparable background in Statistics
Restrictions: COMP 424, COMP 473 (2016-2018)
Coordinator: A/Prof Bing Xue

Big Data refers to the large and often complex datasets generated in the modern world: data sources such as commercial customer records, internet transactions, environmental monitoring. This course provides an introduction to the theory and practice of working with Big Data. Students enrolling in this course should be familiar with the basics of machine learning, data mining, statistical modelling and with programming.

AIML 428 CRN 33070 TEXT MINING AND NATURAL LANGUAGE PROCESSING 15 PTS 2/3

Prerequisite: 60 300-level COMP, DATA, NWEN, STAT or SWEN pts
Co-requisite: AIML 420 or COMP 307
Restrictions: COMP 423
Coordinator: tbc

This course focuses on text mining and natural language processing. It covers a variety of topics including text representation, document classification and clustering, opinion mining, information retrieval, recommender systems, query expansion, and information extraction.

AIML 429 CRN 33071 PROBABILISTIC MACHINE LEARNING 15 PTS 2/3

Prerequisite: AIML 420 or COMP 307; one of (MATH 177, STAT 292, 293)
or approved background in Mathematics or Statistics.
Coordinator: tbc

This course teaches the ideas, algorithms and techniques of probabilistic machine learning. Topics include Bayesian inference, discriminative and generative classifiers, the EM algorithm, Gaussian processes,

Markov Chain Monte Carlo, hidden Markov models, belief nets and other graphical models, and causal modelling.

DATA 471 CRN PRACTICAL DATA SCIENCE 15 PTS 2/3

Prerequisite: DATA 201; one of (DATA 202, SCIE 201 in 2017–2018)
Restrictions: DATA 301
Coordinator: Dr Louise McMillan

A course in practical data science. The course will introduce interactive displays, infographics and dashboards, focussing on communication, reporting and visualisation. It will bring together techniques in statistical and mathematical modelling with programming as well as social and ethical perspectives on data science. This course is co-taught with DATA 301.

DATA 472 CRN DATA MANAGEMENT AND PROGRAMMING 15 PTS 1/3

Prerequisite: 60 300-level pts from (COMP, DATA, STAT, NWEN, SWEN)
Restrictions: DATA 202, SCIE 201 (2017-2016), STAT 483 (2017-2020)
Coordinator: Prof Richard Arnold

A course in the practical aspects of data management for those who work with data sources. Students will apply programming and data management techniques using a high-level language and SQL. Web scraping, data transformation, data cleaning, summary and visualisation. Students will create a web-based application to investigate, analyse and display a data set. This course is co-taught with DATA 202.

DATA 473 CRN STATISTICAL MODELLING FOR DATA SCIENCE 15 PTS 1/3

Prerequisite: 30 300-level pts from (COMP, DATA, NWEN, SWEN); STAT 292 or comparable background in Statistics
Restrictions: DATA 303
Coordinator: Dr Nokuthaba Sibanda

The course develops aspects of statistical modelling and inference underpinning data science, including binary and count data. The role of data and modelling in decision-making is examined in a variety of contexts. This course is co-taught with DATA 303.

DATA 474 CRN SIMULATION AND STOCHASTIC MODELS 15 PTS 1/3

Prerequisite: 30 300-level pts from (COMP, DATA, STAT, NWEN, SWEN); STAT 292 or comparable background in Statistics
Restrictions: COMP 312, DATA 304, OPRE 354
Coordinator: A/Prof Stefanka Chukova

Simulation and modelling of stochastic systems, covering examples from Operations Research and Computer Science, including queues, networks and computer systems. Design, analysis and validation of simulation experiments. This course is co-taught with DATA 304.

DATA 480 CRN RESEARCH PREPARATION FOR DATA SCIENCE 15 PTS 3/3

Prerequisite: Enrolment in the MDataSc
Coordinator: Dr Laura Dumitrescu

This course provides students with an opportunity to develop their research skills in Data Science, including use of library resources, constructing literature reviews, developing research questions, writing research proposals, and developing skills in oral presentation.

DATA 487	**CRN**	**RESEARCH PROJECT**	**15 PTS**	**1/3**
	CRN	**RESEARCH PROJECT**	**15 PTS**	**2/3**
	CRN	**RESEARCH PROJECT**	**15 PTS**	**3/3**
DATA 489	**CRN**	**RESEARCH PROJECT**	**30 PTS**	**1/3**
	CRN	**RESEARCH PROJECT**	**30 PTS**	**2/3**
	CRN	**RESEARCH PROJECT**	**30 PTS**	**3/3**
	CRN	**RESEARCH PROJECT**	**30 PTS**	**1+2/3**
	CRN	**RESEARCH PROJECT**	**30 PTS**	**2+3/3**
	CRN	**RESEARCH PROJECT**	**30 PTS**	**3+1/3**
DATA 588	**CRN**	**RESEARCH PROJECT**	**45 PTS**	**3/3**

Postgraduate Coordinator for Data Science: Prof Richard Arnold

Students should meet with the Postgraduate Coordinator to identify their areas of interest, for assistance in identifying a suitable supervisor and then contact potential supervisors directly. Fifteen-point projects are usually completed in one trimester. Thirty-point projects can be completed within either a single trimester, or two successive trimesters, and should take 300 hours of study, supervision meetings and writing. The 45-point project DATA 588 is available to students in the Master of Data Science who, with permission, are replacing the combination of the work placement DATA 581 and project DATA 487 with a larger research project.

DATA 491	**CRN**	**MATHEMATICS FOR DATA SCIENCE**	**15 PTS**	**1/3**

Prerequisite: 30 300-level pts from (COMP, DATA, NWEN, SWEN);
STAT 292 or comparable background in Statistics
Restrictions: MATH 277, STAT 391
Coordinator: Dr Yuan Yao

This course covers key mathematical methods used in the construction and maximisation of likelihoods, analyses of experimental data and general linear models, and exploration of probability distributions. Topics will include differentiation and optimisation of functions, matrices and their properties, probability distributions and integration. The statistical software R will be used. The mathematical methods will be implemented and illustrated using R including the use of simulation, numerical methods and graphics. This course is co-taught with STAT 391.

DATA 492	**CRN**	**DATA SCIENCE ALGORITHMS**	**15 PTS**	**2/3**

Prerequisite: DATA 391 or 491 or equivalent preparation in mathematics
Coordinator: Prof Stephen Marsland

This course will derive the fundamental algorithms of data science from mathematical and statistical principles. Algorithms for regression, clustering, dimensionality reduction and stochastic optimisation will be derived, together with methods to generate pseudo-random numbers and samples from probability distributions, including the use of Markov Chain Monte Carlo samplers. Practical work will be used to develop understanding of how the algorithms work in practice and the limits on their use.

DATA 501	**CRN**	**ADVANCED TECHIQUES FOR DATA SCIENCE**	**15 PTS**	**2/3**

Prerequisite: 30 approved 400-level pts from (AIML, COMP, DATA, STAT)
Coordinator: Prof Richard Arnold

A course in the application of Data Science techniques to a problem. Each student will develop a distributable software package to process, investigate, analyse, manipulate, summarise and visualise data from a data source. The package will be developed in a standard programming environment and will be fully

documented and peer tested. Students will write an accompanying critique of relevant data limitations and any legal or ethical considerations.

DATA 581 CRN DATA SCIENCE PRACTICUM 30 PTS 3/3

Prerequisites: Enrolment in the MDataSc

Coordinator: A/Prof Ivy Liu

This course enables students to gain professional work experience in the application of Data Science. Each student is supervised by a host organisation involved in the practice of Data Science in the public or private sectors. The placement allows students to develop teamwork and communication skills in the real world. This course consists of:

- Practicum briefing: understanding professional expectations and responsibilities; dealing with problems arising in the workplace.
- Placement: working on specific projects with significant Data Science content assigned by a host employer; developing teamwork and communication skills; and writing a portfolio.
- Seminar: presenting the findings from the projects and the placement experience.

STAT 432 CRN 23079 COMPUTATIONAL STATISTICS 15 PTS 2/3

Prerequisite: One of (STAT 332, 393, 394) or equivalent preparation

Coordinator: Dr Louise McMillan

This course is a practical introduction to computationally intensive methods for statistical modelling and inference. Topics covered will be chosen from: the jackknife and bootstrap methods for bias correction and variance estimation; permutation tests; maximum likelihood estimation using the EM algorithm; random number generation; simulation from probability distributions; sampling algorithms, mixture models. It is desirable that students enrolling in this course have some knowledge of R.

STAT 438 CRN 8113 GENERALISED LINEAR MODELS 15 PTS 2/3

Prerequisite: One of (STAT 332, 393, 394) or equivalent preparation

Coordinator: Dr Yuichi Hirose

Brief outline of generalised linear model theory, contingency tables, binary response models, log-linear models (for contingency tables), repeated measures, GEE analysis, logit models for multinomial responses, and ordinal response models.

SUBSTITUTION FROM OTHER SUBJECTS

Honours, Postgraduate Diploma and Master's degrees can include approved courses from other subjects as listed below. Information about these courses is contained from elsewhere in this prospectus, or in the relevant Postgraduate Prospectus or websites of the School responsible for it. The overall selection of courses must still form a coherent programme and requires approval from the Postgraduate Coordinator for Data Science. Examples of such courses are listed below.

Course code	Title
Trimester 1	
AIML 430	Applications and Implications of Artificial Intelligence
ECON 408	Advanced Econometrics A
FINA 401	Current Topics in Asset Pricing
FINA 413	Risk Management and Insurance
PUBL 401	Craft and Method in Policy Analysis
STAT 431	Biostatistics
STAT 435	Time Series
STAT 452	Bayesian Statistics
STAT 457	Statistical Models in Warranty and Maintenance
Trimester 2	
AIML 431	Current Topics in Artificial Intelligence
ECON 409	Advanced Econometrics B
FINA 402	Current Topics in Corporate Finance
FINA 403	Derivative Securities
FINA 406	Fixed Income Securities
GEOG 415	Introduction to Geographic Information Science and its Applications
STAT 436	Forecasting
STAT 451	Official Statistics

EXAMPLE COURSES OF STUDY IN THE MDATASC

Each student's course of study must be approved by the postgraduate coordinator. Some examples of courses of study are shown in the table below.

Note that students with an undergraduate major in Data Science, or a double major in Statistics and Computer Science, can complete the MDataSc in 12 months and only complete 180 points. Other students will need to complete the full 240-point qualification.

Some courses (such as AIML 420 Artificial Intelligence and DATA 491 Mathematics for Data Science) may be required for students as preparation for courses later in the degree. Also note that some students may need to take additional prerequisite courses (such as COMP 132 Programming for the Natural and Social Sciences, or STAT 292 Applied Statistics 2A) concurrently with the MDataSc. Recognition can be given for work experience as well as prior study when assessing the need for these prerequisites.

Example programmes in the MDataSc

Year/Trimester	(a) Data Science graduates, or double majors in Statistics and Computer Science (180 points)	(b) Statistics graduates (240 points)	(c) Computer Science graduates (240 points)
Y1/T1	AIML 420 (AI) + AIML 427 (Big Data) DATA 491 (Mathematics) + STAT 452 (Bayesian Stats) o	AIML 427 (Big Data) STAT 431 (Biostatistics) o DATA 472 (Programming) *	DATA 491 (Mathematics) + DATA 472 (Programming) * AIML 427 (Big Data) *[+ optionally STAT 292]*
Y1/T2	AIML 425 (Neural Nets) STAT 432 (Comp Stat) STAT 438 (Gen Lin Models) DATA 501 (Data Science)	AIML 421 (Mach. Learn) * DATA 471 (Data Science) * STAT 438 (Gen Lin Models)	AIML 425 (Neural Nets) AIML 429 (Prob ML) o DATA 471 (Data Science) *
Y1/T3	DATA 480 (Research Prep) DATA 487 (Project) DATA 581 (Practicum)	DATA 480 (Research Prep) DATA 487 (Project) DATA 581 (Practicum)	DATA 480 (Research Prep) DATA 487 (Project) DATA 581 (Practicum)
Y2/T1		AIML 420 (AI) + DATA 474 (Simulation) * STAT 452 (Bayes Stats) o	AIML 428 (Nat Lang) o DATA 474 (Simulation) * DATA 473 (Statistics) *
Y2/T2		AIML 425 (Neural Nets) DATA 501 (Data Sci) STAT 432 (Comp Stat)	DATA 501 (Data Sci) STAT 432 (Comp Stat) STAT 438 (Gen Lin Models)

* = Part 1 course; o = Elective course; + = Required prerequisite course

WHO TO CONTACT

Student Services provides a range of services to all students to help you make the most of your time at university. If you have an issue, need guidance to get through your studies, help is available.
www.wgtn.ac.nz/students/support

STUDENT AND ACADEMIC SERVICES—FACULTY OF SCIENCE

Te Wāhanga Pūtaiao
Address: Level 1, Cotton Building
Phone: 04-463 5101
Email: science-faculty@vuw.ac.nz
Web: www.wgtn.ac.nz/science
Hours: 8.30am–4.00pm Monday, Wednesday, Thursday, Friday
9.30am–4.00pm Tuesday

At the Faculty of Science Student Administration Office, student advisers can help with admission requirements, degree planning, changing courses and transfer of credit from other tertiary institutions. They also deal with other aspects of student administration such as enrolment, exams organisation and the maintenance of student records.

Patricia Stein manages all postgraduate students:
patricia.stein@vuw.ac.nz 04-463 5982

Johan Barnard	Manager, Student and Academic Services	04-463 5980
Gillian Turner	Associate Dean (Postgraduate Students)	04-463 6478