STAT814

Statistical Design

S1 Day 2018

Dept of Statistics

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Disclaimer

Macquarie University has taken all reasonable measures to ensure the information in this publication is accurate and up-to-date. However, the information may change or become out-dated as a result of change in University policies, procedures or rules. The University reserves the right to make changes to any information in this publication without notice. Users of this publication are advised to check the website version of this publication [or the relevant faculty or department] before acting on any information in this publication.

General Information

Unit convenor and teaching staff

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Credit points
4

Prerequisites

Corequisites
((Admission to MAppStat or GradCertAppStat or GradDipAppStat) and STAT680) or ((admisson to MBiotech or GradDipBiotech or MBioBus or MMarScMgt or MConsBiol or GradDipConsBiol or MLabQAMgt or PGCertLabQAMgt or GradDipLabQAMgt or GradCertLabQAMg or MSc) and STAT830) or (admission to MActPrac)

Co-badged status

Unit description
This unit consists of two modules. The first module is concerned with the design of experiments. Many of the standard designs and their mathematical formulation are discussed, including completely randomised design, complete block design, random effects model, axb factorial treatment design, and 2 to the K factorial and fractional factorial designs, and extensive use is made of Minitab. The second module of the unit is devoted to survey designs. Questionnaire construction, and the theories of sampling, stratified sampling, systematic sampling, ratio and regression estimators, cluster sampling, and multistage sampling are all discussed.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

Understand general mathematical formulation and framework for commonly used experimental and survey designs, completely randomised, randomised block, axb factorial designs, random effects models, and simple random sampling, stratified sampling, clustering sampling and systematic sampling designs.

Demonstrate a good understanding of contrast, orthogonal contrasts, orthogonal contrast set and their statistical and practical implications in experimental designs, and the capability of formulating appropriate ones for answering specific research questions of studies.

Have extensive knowledge of the principles of experimental and survey designs, and the statistical properties of various parameter estimates.

Demonstrate a good understanding of the assumptions and limitations of the statistical methods for each experimental or survey design, and be able to apply appropriate experimental or survey designs to real world studies and analyse data from each design with and without using a statistical software package.

Have extensive knowledge of complex experimental designs including the fractional factorial design and its mathematical formulation, and use it to tackle real world problems.

Be competent in applying complex statistical methods including Yate's algorithm, design resolution and defining contrast algorithm to analyse data from 2k-p fractional factorial designs.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignments	30%	No	Tuesday (Week 6, 8 and 12)
Additional assignment	15%	No	Week 10
Examination	55%	No	University Examination Period

Assignments

Due: **Tuesday (Week 6, 8 and 12)**
Weighting: **30%**

Three assignments (10% each) are set for students to complete independently, applying the knowledge gained from lecture(s) and their own reading and with and without using the statistical software, Minitab. They will be made available on iLearn.

Each of the three assignments should be submitted electronically on the unit iLearn by its due date and time, which will be included in the assignment.Students must keep a soft or hard copy of any assignment submitted. In the event of an assignments being misplaced, a replacement of it will be requested.

In the case of a late submission for the assessments, if no special consideration has been granted, 10% of the earned mark will be deducted for each 24 hour period of part thereof that the submission is late (for example, 25 hours late in submission - 20% penalty), up to a maximum of 50%. After 5 days, counted including weekends and public holidays, a mark of 0% will be awarded. NOTE: It is not the intention of this late penalty policy to cause a student to fail the unit when they have submitted their assignment no more than 5 days after the due date and they would have otherwise passed. In this case, if deductions for late assignments result in the final unit mark for a student being less than 50, when otherwise it would have been 50 or greater, the student's final mark will be exactly 50.

On successful completion you will be able to:

- Understand general mathematical formulation and framework for commonly used experimental and survey designs, completely randomised, randomised block, axb factorial designs, random effects models, and simple random sampling, stratified sampling, clustering sampling and systematic sampling designs.
- Demonstrate a good understanding of contrast, orthogonal contrasts, orthogonal contrast set and their statistical and practical implications in experimental designs, and the capability of formulating appropriate ones for answering specific research questions of studies.
- Have extensive knowledge of the principles of experimental and survey designs, and the

statistical properties of various parameter estimates.

- Demonstrate a good understanding of the assumptions and limitations of the statistical methods for each experimental or survey design, and be able to apply appropriate experimental or survey designs to real world studies and analyse data from each design with and without using a statistical software package.

Additional assignment

Due: **Week 10**
Weighting: **15%**

This additional assignment (**Assignment 4**) is based on the three additional lectures on 2^k factorial and fractional factorial designs available under Weeks 6-8 sections on the unit iLearn, and specifically designed for STAT814/STAT714 students to complete independently. It will be made available under the Assignments section on the unit iLearn. **Details about its due date and submission will be included in the assignment.** Students must submit the assignment electronically on the unit iLearn by its due date and time.

Students must keep a soft or hard copy of any assignment that they submit. In the event of their assignment being misplaced, a replacement will be requested.

In the case of a late submission for the assessments, if no special consideration has been granted, 10% of the earned mark will be deducted for each 24 hour period of part thereof that the submission is late (for example, 25 hours late in submission - 20% penalty), up to a maximum of 50%. After 5 days, counted including weekends and public holidays, a mark of 0% will be awarded. NOTE: It is not the intention of this late penalty policy to cause a student to fail the unit when they have submitted their assignment no more than 5 days after the due date and they would have otherwise passed. In this case, if deductions for late assignments result in the final unit mark for a student being less than 50, when otherwise it would have been 50 or greater, the student's final mark will be exactly 50.

On successful completion you will be able to:

- Have extensive knowledge of complex experimental designs including the fractional factorial design and its mathematical formulation, and use it to tackle real world problems.
- Be competent in applying complex statistical methods including Yate's algorithm, design resolution and defining contrast algorithm to analyse data from 2k-p fractional factorial designs.

Examination

Due: **University Examination Period**
Weighting: **55%**

There will be a three-hour written examination that will be timetabled within the official University

Examination Timetable. The University Examination Timetable will be available in draft form approximately eight weeks before the commencement of the the University examinations and in final form approximately four weeks before the commencement of the examinations at: http://students.mq.edu.au/student_admin/exams/

The only excuse for not sitting an examination at the designated time is because of documented illness or unavoidable disruption. In these special circumstances you may apply for special consideration via ask.mq.edu.au.

If you receive special consideration for the final exam, a supplementary exam will be scheduled in the interval between the regular exam period and the start of the next session. By making a special consideration application for the final exam you are declaring yourself available for a resit during the supplementary examination period and will not be eligible for a second special consideration approval based on pre-existing commitments. Please ensure you are familiar with the policy prior to submitting an application. You can check the supplementary exam information page on FSE101 in iLearn (bit.ly/FSESupp) for dates, and approved applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination.

On successful completion you will be able to:

- Understand general mathematical formulation and framework for commonly used experimental and survey designs, completely randomised, randomised block, axb factorial designs, random effects models, and simple random sampling, stratified sampling, clustering sampling and systematic sampling designs.
- Demonstrate a good understanding of contrast, orthogonal contrasts, orthogonal contrast set and their statistical and practical implications in experimental designs, and the capability of formulating appropriate ones for answering specific research questions of studies.
- Have extensive knowledge of the principles of experimental and survey designs, and the statistical properties of various parameter estimates.
- Demonstrate a good understanding of the assumptions and limitations of the statistical methods for each experimental or survey design, and be able to apply appropriate experimental or survey designs to real world studies and analyse data from each design with and without using a statistical software package.
- Have extensive knowledge of complex experimental designs including the fractional factorial design and its mathematical formulation, and use it to tackle real world problems.
- Be competent in applying complex statistical methods including Yate's algorithm, design resolution and defining contrast algorithm to analyse data from 2k-p fractional factorial designs.

Delivery and Resources

Classes

Internal students are required to attend a 3-hour lecture per week (together with STAT373 students) beginning in Week 1, and may also attend **(not compulsory)** a 1-hour tutorial class designed for STAT373 students beginning in Week 2.

Times and locations for all classes can be found on the University web site at: www.timetables.mq.edu.au. In the case of changing classes, time and/or location, you will be informed at the lecture and/or on the unit iLearn in advance.

You are also required to attend three extra lectures for the additional topics that are specially designed for STAT814/STAT714 **from Week 6 to Week 8** (currently scheduled on Tuesday). These will be made available after Week 5 on the unit iLearn (https://iLearn.mq.edu.au/). Assignment 4 is based on these three additional lectures.

Note: You are welcome to come to see the lecturer during staff consultation time with questions related to the unit. You could also contact the lecturer by e-mail or telephone. Only the **Macquarie University student e-mail accounts** may be used to communicate with staff.

For external students only:

> There is **no** on-campus session for distance (external) students in this unit;

> Questions relating to **course administration** should be directed to the postgraduate administrator:

Ms Lesley Mooney

Level 6,12 Wally's Walk; phone: +61 2 9850 8550

E-mail: lesley.mooney@mq.edu.au

Course materials, recommended text and other references

Weekly lecture notes will be made available on the unit iLearn (https://iLearn.mq.edu.au/) at least one day before the lecture. Internal students should print out and bring the relevant lecture notes into the lecture.

Recommended text:

Kuehl, R.O. (2000 or newer). Statistical Principles of Research Design and Analysis, Second edition, Duxbury Press, *for Experiment Design*; Lohr, S.L. (2010). Sampling: Design and Analysis, Duxbury Press, *for Survey Design*. These are available from the Co-Op Bookshop and the University library.

Other useful references (available in library Reserve):

Lindman HR (1992). Analysis of Variance in Experimental Design.

Montgomery DC. Design and Analysis of Experiments, 5th or 4th Edition.

Neter J, Wasserman W and Kutner M. Applied Linear Statistical Models.

Scheaffer RL, Mendenhall W and Ott RL (1996). Elementary Survey Sampling, 5th (or newer) Edition.

Cochran WG (1977). Sampling Techniques.

Moser CA & Kalton G (1971). Survey Methods in Social Investigations.

Barnett V (1974). Elements of Sampling Theory.

Technology Used and Required

Software: Minitab is used in this unit. Information about Minitab can be found on its web site at http://www.minitab.com. This software is provided for free to Macquarie students, and can be downloaded from the student portal at http://students.mq.edu.au/home/ for home use. Students can also use Minitab online via iLab **(**https://wiki.mq.edu.au/display/iLab/About**). Remember that any work or results produced via iLab in all computing labs on the University campus must be saved onto iLab desktop and then emailed to yourself.**

Calculator: An electronic calculator is required throughout this unit. Only calculators with no text retrieval capacity are permitted to be used in the examination.

Unit Web Page and iLearn access: Enrolment in STAT814 should automatically make the STAT714/814 iLearn site available to you from the start of semester. To access it, log in at https://ilearn.mq.edu.au/login/MQ/ and select STAT714/814 from your list of iLearn units. If STAT714/814 doesn't appear, though, and you enrolled in the unit more than 24 hours ago, please contact the Unit Convenor immediately. Note that you should visit this web site regularly for course materials including lecture slides, lecture recordings, tutorials and assignments, and also possible announcements placed by the Lecturer.

The **Discussion Forum** on the unit iLearn can be used for online discussion with other students enrolled in STAT814 & STAT714 on any problems or topics related to the unit. The lecturer will visit the Forum from time to time.

Learning and Teaching activities

Lectures: Lectures begin in Week 1. Students are required to attend a 3-hour lecture each week. Topic(s) for each week are set in the Unit Schedule in this unit guide. Students are encouraged to read the relevant chapter(s) recommended before coming to the lecture.

An iLecture will be recorded for each lecture **when possible** and made available on the unit iLearn (under echo360) soon after the lecture is completed.

Tutorial Exercises: Each week a set of tutorial exercises will be available on iLearn for students to practice. Its solution will be discussed during the STAT373 tutorial class in the following week and also made available on iLearn after then.

Assignments: Three (*normal)* assignments and one additional assignment are set for students to complete independently. To assist with further learning, solutions to the assignments (when possible) will be made available later (on iLearn).

Unit Schedule

STAT 814/STAT714

Experimental design:

Week	Topic	Chapter (Kuehl)
1	Designed experiments vs observational studies; Completely randomized design (CRD): one-way ANOVA	1, 2
2	One-way ANOVA (contd); Contrasts	2, 3
3	Contrasts (contd); Multiple comparisons; Model checking	3, 4
4	More on CRD; Randomized block design (RBD)	4, 8
5	Factorial experiments: two-way ANOVA; Random effects – one-way	6, 5 , 11
6	Analysis of covariance	7, 17, 11
(6-8)	For **STAT814/STAT714 ONLY**, three (3) extra pre-recorded lectures and notes of additional topics on 2^k factorial and fractional factorial designs will be made available **on the unit iLearn.**	

Survey design:

Week	Topic	Chapter (Lohr)
7	Introduction to surveys: sample survey and its principal steps, probability and non-probability sampling, and sources of error	1
8	Simple random sampling (SRS); Parameter estimation	2
9	SRS (contd): estimation of proportion; Stratified random sampling	2, 4
10	Stratified random sampling (contd); Choosing strata sample sizes	4, 3
11	Ratio and regression estimators	3
12	Cluster sampling; Systematic sampling	5
13	Revision	

Note: *There may be minor deviations from this timetable if insufficient time is available for some topics.*

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Undergraduate students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

Results

Results shown in *iLearn*, or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au.

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

PG - Capable of Professional and Personal Judgment and Initiative

Our postgraduates will demonstrate a high standard of discernment and common sense in their professional and personal judgment. They will have the ability to make informed choices and decisions that reflect both the nature of their professional work and their personal perspectives.

This graduate capability is supported by:

Learning outcomes

- Understand general mathematical formulation and framework for commonly used experimental and survey designs, completely randomised, randomised block, axb factorial designs, random effects models, and simple random sampling, stratified sampling, clustering sampling and systematic sampling designs.
- Demonstrate a good understanding of the assumptions and limitations of the statistical methods for each experimental or survey design, and be able to apply appropriate experimental or survey designs to real world studies and analyse data from each design with and without using a statistical software package.
- Have extensive knowledge of complex experimental designs including the fractional factorial design and its mathematical formulation, and use it to tackle real world problems.

Assessment tasks

- Assignments
- Additional assignment
- Examination

PG - Discipline Knowledge and Skills

Our postgraduates will be able to demonstrate a significantly enhanced depth and breadth of knowledge, scholarly understanding, and specific subject content knowledge in their chosen fields.

This graduate capability is supported by:

Learning outcomes

- Understand general mathematical formulation and framework for commonly used experimental and survey designs, completely randomised, randomised block, axb factorial designs, random effects models, and simple random sampling, stratified sampling, clustering sampling and systematic sampling designs.
- Demonstrate a good understanding of contrast, orthogonal contrasts, orthogonal contrast set and their statistical and practical implications in experimental designs, and the capability of formulating appropriate ones for answering specific research questions of studies.
- Have extensive knowledge of the principles of experimental and survey designs, and the statistical properties of various parameter estimates.
- Demonstrate a good understanding of the assumptions and limitations of the statistical methods for each experimental or survey design, and be able to apply appropriate experimental or survey designs to real world studies and analyse data from each design with and without using a statistical software package.
- Have extensive knowledge of complex experimental designs including the fractional factorial design and its mathematical formulation, and use it to tackle real world problems.
- Be competent in applying complex statistical methods including Yate's algorithm, design resolution and defining contrast algorithm to analyse data from 2k-p fractional factorial designs.

Assessment tasks

- Assignments
- Additional assignment
- Examination

PG - Critical, Analytical and Integrative Thinking

Our postgraduates will be capable of utilising and reflecting on prior knowledge and experience, of applying higher level critical thinking skills, and of integrating and synthesising learning and knowledge from a range of sources and environments. A characteristic of this form of thinking is the generation of new, professionally oriented knowledge through personal or group-based critique of practice and theory.

This graduate capability is supported by:

Learning outcomes

- Understand general mathematical formulation and framework for commonly used experimental and survey designs, completely randomised, randomised block, axb factorial designs, random effects models, and simple random sampling, stratified sampling, clustering sampling and systematic sampling designs.
- Demonstrate a good understanding of contrast, orthogonal contrasts, orthogonal contrast set and their statistical and practical implications in experimental designs, and the capability of formulating appropriate ones for answering specific research questions of studies.
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- Have extensive knowledge of complex experimental designs including the fractional factorial design and its mathematical formulation, and use it to tackle real world problems.

Assessment tasks

- Assignments
- Additional assignment
- Examination

PG - Research and Problem Solving Capability

Our postgraduates will be capable of systematic enquiry; able to use research skills to create new knowledge that can be applied to real world issues, or contribute to a field of study or practice to enhance society. They will be capable of creative questioning, problem finding and problem solving.

This graduate capability is supported by:

Learning outcomes

- Demonstrate a good understanding of contrast, orthogonal contrasts, orthogonal contrast set and their statistical and practical implications in experimental designs, and the capability of formulating appropriate ones for answering specific research questions of studies.
- Have extensive knowledge of the principles of experimental and survey designs, and the statistical properties of various parameter estimates.
- Have extensive knowledge of complex experimental designs including the fractional factorial design and its mathematical formulation, and use it to tackle real world problems.
- Be competent in applying complex statistical methods including Yate's algorithm, design resolution and defining contrast algorithm to analyse data from 2k-p fractional factorial designs.

Assessment tasks

- Assignments
- Additional assignment
- Examination

PG - Effective Communication

Our postgraduates will be able to communicate effectively and convey their views to different social, cultural, and professional audiences. They will be able to use a variety of technologically supported media to communicate with empathy using a range of written, spoken or visual formats.

This graduate capability is supported by:

Learning outcomes

- Understand general mathematical formulation and framework for commonly used experimental and survey designs, completely randomised, randomised block, axb factorial designs, random effects models, and simple random sampling, stratified sampling, clustering sampling and systematic sampling designs.
- Have extensive knowledge of complex experimental designs including the fractional factorial design and its mathematical formulation, and use it to tackle real world problems.
- Be competent in applying complex statistical methods including Yate's algorithm, design resolution and defining contrast algorithm to analyse data from 2k-p fractional factorial

designs.

Assessment tasks

- Assignments
- Additional assignment
- Examination

PG - Engaged and Responsible, Active and Ethical Citizens

Our postgraduates will be ethically aware and capable of confident transformative action in relation to their professional responsibilities and the wider community. They will have a sense of connectedness with others and country and have a sense of mutual obligation. They will be able to appreciate the impact of their professional roles for social justice and inclusion related to national and global issues

This graduate capability is supported by:

Learning outcome

- Have extensive knowledge of complex experimental designs including the fractional factorial design and its mathematical formulation, and use it to tackle real world problems.

Assessment tasks

- Additional assignment
- Examination

Changes from Previous Offering

No major differences from previous offering.

Changes since First Published

Date	Description
14/02/2018	Fixing some small typos.