STAT4035

Risk Theory

This course introduces the theory of compound Poisson processes, with a particular emphasis on their application to insurance portfolios (though their applicability in other areas is also noted).

Topics include: Modelling loss distributions; Skewed parametric distribution families; Method of moments, method of percentiles and maximum likelihood estimation; Pearson goodness-of-fit testing for distribution assessment; Truncated and censored data, including applications to reinsurance and policy excess schemes; Random sums, convolutions and compound distributions, particularly for modelling aggregate claim distributions; Normal and gamma approximations to compound distributions; Compound Poisson process theory, including applications to insurance portfolio surplus processes; Ultimate and finite-time ruin probabilities; Adjustment coefficients and optimal reinsurance contracts.

<table>
<thead>
<tr>
<th>Mode of Delivery</th>
<th>On campus</th>
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</thead>
<tbody>
<tr>
<td>Prerequisites</td>
<td>To enrol in this course you must have completed STAT2005 or STAT7004 or STAT3004 or STAT7018.</td>
</tr>
<tr>
<td>Co-taught Courses</td>
<td>STAT3035 and STAT8035. Graduate students attend joint classes with undergraduates but are assessed separately</td>
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<tr>
<td>Course Convener:</td>
<td>Tim Higgins</td>
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<td>Phone:</td>
<td>6125 4507</td>
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<td>Email:</td>
<td><a href="mailto:tim.higgins@anu.edu.au">tim.higgins@anu.edu.au</a></td>
</tr>
<tr>
<td>Office hours for student consultation:</td>
<td>CBE Building Room 4.30. Office hours to be advised</td>
</tr>
<tr>
<td>Research Interests</td>
<td>Income contingent loans, superannuation and retirement income policy, microsimulation modelling</td>
</tr>
<tr>
<td>Relevant administrator</td>
<td>Maria Lander</td>
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<td>Email:</td>
<td><a href="mailto:maria.lander@anu.edu.au">maria.lander@anu.edu.au</a></td>
</tr>
<tr>
<td>Lecturer(s)</td>
<td>The course convener is the lecturer for this course</td>
</tr>
<tr>
<td>Tutor(s)</td>
<td>To be advised</td>
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</tbody>
</table>
COURSE OVERVIEW

Learning Outcomes
To achieve an understanding of and facility in applying and communicating the following topics:

- Demonstrate a superior ability to estimate using skewed distributions with and without the presence of censoring and truncation
- An in-depth knowledge of aggregation of random quantities through compound distribution theory
- To communicate Compound Poisson process theory including approximation of boundary crossing probabilities as applied to calculating risk for insurance portfolios

Assessment Summary

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Value</th>
<th>Due Date</th>
<th>Date for Return of Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Assignment 1</td>
<td>5% (redeemable)</td>
<td>Friday 16 March (Week 4)</td>
<td>Week 5 or 6</td>
</tr>
<tr>
<td>2. Mid-semester examination</td>
<td>30% (redeemable)</td>
<td>Week 6 or 7</td>
<td>Week 7 or 8</td>
</tr>
<tr>
<td>3. Assignment 2</td>
<td>5% (redeemable)</td>
<td>Friday 11 May (Week 10)</td>
<td>Week 11</td>
</tr>
<tr>
<td>4. Final examination</td>
<td>60% to 100%</td>
<td>TBA</td>
<td>TBA</td>
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Research-Led Teaching
The course convenor has 20 years of professional practice and has undertaken research in statistical and actuarial topic areas. Lectures in the course will be informed where possible by practical examples.

Feedback

Staff Feedback
Students will be given feedback in the following forms:

- Following the assignments and mid-semester examination, feedback will be given to the whole class about the general performance on the assessment pieces.
- Marked assignments will be handed back to students, and students will have an opportunity to look over their mid-semester examination script-books during tutorials.
- Students will have the opportunity to speak with the lecturer and seek comments from the lecturer about their individual performance in all assessment pieces.

Student Feedback
ANU is committed to the demonstration of educational excellence and regularly seeks feedback from students. One of the key formal ways students have to provide feedback is through Student Experience of Learning Support (SELS) surveys. The feedback given in these surveys is anonymous and provides the Colleges, University Education Committee and Academic Board with opportunities to recognise excellent teaching, and opportunities for improvement.
For more information on student surveys at ANU and reports on the feedback provided on ANU courses, go to
http://unistats.anu.edu.au/surveys/selt/students/ and
http://unistats.anu.edu.au/surveys/selt/results/learning/

Policies

ANU has educational policies, procedures and guidelines, which are designed to ensure that staff and students are aware of the University’s academic standards, and implement them. You can find the University’s education policies and an explanatory glossary at:
http://policies.anu.edu.au/

Students are expected to have read the Academic Misconduct Rule before the commencement of their course.

Other key policies include:

- Student Assessment (Coursework)
- Student Surveys and Evaluations

Examination material or equipment

Both the mid-semester and final examinations will be closed book exams. Students will be permitted to bring in a non-programmable calculator and an unmarked paper based dictionary.

Recommended Resources

Comprehensive lecture notes and lecture slides will be made available on Wattle. There are no prescribed texts besides the lecture notes, however, there are optional texts listed below if you wish to read further material:

Optional Reading


COURSE SCHEDULE

The course notes (available on Wattle) consist of five parts:

1 – Introduction

2 – Fitting Loss Distributions (including Generalised Linear Models (GLM))

3 – Reinsurance and Policy Excesses

4 – Aggregate Claims Modelling

5 – Ruin Theory

The schedule on the next page is a guide only. The course material covered in each week may differ slightly from what is listed below depending on how we progress throughout the semester.
<table>
<thead>
<tr>
<th>Week</th>
<th>Summary of Activities</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>• Course overview. &lt;br&gt; • Section 1 – Introduction. &lt;br&gt; • Section 2.1-2.3 – Exponential distribution; parameter estimation techniques: method of moments, method of percentiles, maximum likelihood estimation. Estimator precision. Pearson chi-square goodness of fit testing.</td>
<td></td>
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<tr>
<td>2</td>
<td>• Section 2.4.1 – Gamma distribution. &lt;br&gt; • Section 2.4.2 – Log normal distribution.</td>
<td>Assignment 1 available</td>
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<tr>
<td>3</td>
<td>• Section 2.4.3 – Weibull distribution. &lt;br&gt; • Section 2.4.4 – Mixture distributions; Deriving the Pareto distribution. &lt;br&gt; • Section 2.4.4 – Deriving the negative binomial distribution.</td>
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<tr>
<td>4</td>
<td>• Section 2.5 – Generalised linear models.</td>
<td>Assignment 1 due</td>
</tr>
<tr>
<td>6</td>
<td>• Section 4.1-4.2 – Aggregate Claims Modelling: Collective Risk Model. Compound Poisson, Binomial and Negative Binomial distributions. &lt;br&gt; • Section 4.2.4 – Compound distributions and reinsurance.</td>
<td>Mid-semester examination (Week 6 or 7)</td>
</tr>
<tr>
<td>7</td>
<td>• Section 4.3 – Approximating Compound Distributions for the Collective Risk Model. &lt;br&gt; • Section 4.4 – Aggregate Claims Modelling: Individual Risk Model</td>
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<tr>
<td>8</td>
<td>• Section 4.4.1 – Poisson Collective Risk Approximation to the Individual Risk Model. &lt;br&gt; • Section 4.4.2 – Parameter Variability. &lt;br&gt; • Section 5.1 – Ruin Theory: Introduction, the surplus process, introduction to probability of ruin.</td>
<td>Assignment 2 available</td>
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<tr>
<td>9</td>
<td>• Section 5.2 – 5.3 – Compound Poisson Process. Calculating Ruin Probabilities.</td>
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</tr>
<tr>
<td>10</td>
<td>• Section 5.3 – Calculating Ruin Probabilities (continued). Adjustment Coefficients. Differential equations for ruin probabilities</td>
<td>Assignment 2 due</td>
</tr>
<tr>
<td>11</td>
<td>• Section 5.3 – Differential equations for ruin probabilities (continued) &lt;br&gt; • Section 5.4 – Finite time ruin probabilities</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>• Section 5.5 – Ruin theory and reinsurance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Examination period</td>
<td>Final examination</td>
</tr>
</tbody>
</table>
ASSESSMENT REQUIREMENTS

Assessment Tasks

Assessment Task 1: Assignment 1

Details of task: This assessment will count for 5% of your final grade but it is optional and redeemable. The assignment will be made available towards the end of Week 2 and is due on Friday, 16 March (Week 4). The assignment will consist of questions that cover materials from Weeks 1 to 3 of the course.

Estimated return date: The marked assignment will be returned in tutorials in Week 5 or 6.

Assessment Task 2: Mid-Semester examination

Details of task: 10 minute reading time; 90 minutes writing time. The mid-semester examination will count for 30% of your grade but it is optional and redeemable for this course. No deferred mid-semester examinations will be offered, instead the weighting will be moved to the final exam.

The exam will cover material from Weeks 1 to 5 of the course. The exam will be closed book, but a formula sheet will be provided for use during the exam. Copies of the formula sheet will be made available through Wattle in the weeks prior to the examination.

Estimated return date: Your mark for the mid-semester exam will be available in Week 7 or 8 and you will be able to look through your marked mid-semester exam papers during tutorials.

Assessment Task 3: Assignment 2

Details of task: This assessment will count for 5% of your final grade but it is optional and redeemable. The assignment will be made available towards the end of Week 8 and is due on Friday, 11 May (Week 10). The assignment will consist of questions that cover materials from Weeks 1 to 9 of the course, with an emphasis on material from Weeks 6 to 9.

Estimated return date: The marked assignment will be returned in tutorials in Week 11.

Assessment Task 4: Final examination

Details of task: 15 minute reading time; 3 hour writing time. The final exam will count for a minimum of 60% of your grade and a maximum of 100%. It will cover material from all weeks of the course. The exam will be closed book, but a formula sheet will be provided for use during the exam. Copies of the formula sheet will be made available through Wattle in the weeks prior to the examination.

Examinations

Both the mid-semester and final examinations will be closed book exams. A formula sheet will be handed out at the start of the exams. Copies of the formula sheets for the mid-semester and final examinations will be made available through Wattle prior to the exams.
**Assignment submission**

**Hard Copy Submission**: Students are required to hand in a hard copy of their assignments to the assignment boxes for Risk Theory (STAT3035/4035/8035) outside the RSFAS office on level 4 of the CBE building. Assignments must include the cover sheet which will be made available to download via Wattle. Please keep a copy of tasks completed for your records.

**Extensions and penalties**

Extensions and late submission of assessment pieces are covered by the Student Assessment (Coursework) Policy and Procedure.

The Course Convener may grant extensions for assessment pieces that are not examinations. If you need an extension, you must request it in writing on or before the due date. If you have documented and appropriate medical evidence that demonstrates you were not able to request an extension on or before the due date, you may be able to request it after the due date.

No submission of assessment tasks without an extension after the due date will be permitted. If an assessment task is not submitted by the due date, a mark of 0 will be awarded.

**Returning assignments**

Assignments will be returned in tutorials.

**Scaling**

Your final mark for the course will be based on the raw marks allocated for each of your assessment items. However, your final mark may not be the same number as produced by that formula, as marks may be scaled. Any scaling applied will preserve the rank order of raw marks (i.e. if your raw mark exceeds that of another student, then your scaled mark will exceed the scaled mark of that student), and may be either up or down.

**Privacy Notice**

The ANU has made a number of third party, online, databases available for students to use. Use of each online database is conditional on student end users first agreeing to the database licensor’s terms of service and/or privacy policy. Students should read these carefully.

In some cases student end users will be required to register an account with the database licensor and submit personal information, including their: first name; last name; ANU email address; and other information.

In cases where student end users are asked to submit ‘content’ to a database, such as an assignment or short answers, the database licensor may only use the student’s ‘content’ in accordance with the terms of service – including any (copyright) licence the student grants to the database licensor.

Any personal information or content a student submits may be stored by the licensor, potentially offshore, and will be used to process the database service in accordance with the licensors terms of service and/or privacy policy.

If any student chooses not to agree to the database licensor’s terms of service or privacy policy, the student will not be able to access and use the database. In these circumstances students should contact their lecturer to enquire about alternative arrangements that are available.
**Tutorial Seminar Registration**

Tutorial signup for this course will be done via the Wattle website. Detailed information about signup times will be provided on Wattle or during your first lecture. When tutorials are available for enrolment, follow these steps:

1. Log on to Wattle, and go to the course site
2. Click on the link “Tutorial enrolment”
3. On the right of the screen, click on the tab “Become Member of…..” for the tutorial class you wish to enter
4. Confirm your choice

If you need to change your enrolment, you will be able to do so by clicking on the tab “Leave group…..” and then re-enrol in another group. You will not be able to enrol in groups that have reached their maximum number. Please note that enrolment in ISIS must be finalised for you to have access to Wattle.

**SUPPORT FOR STUDENTS**

The University offers a number of support services for students. Information on these is available online from [http://students.anu.edu.au/studentlife/](http://students.anu.edu.au/studentlife/)

**Exemption from Actuarial Professional examination**

The Australian National University is accredited by the Actuaries Institute (IAAust) to provide students with exemptions from the Part I professional examinations of the Institute. Exemptions are recommended subject to obtaining sufficiently high grades in designated courses.

In conjunction with STAT3036/4036/8036 (Credibility Theory), this course provides for an exemption from the IAAust professional examination CT6. The standard for exemption is a Credit average across the two courses (note that 59% in one course and 60% in another does not constitute an exemption) with a minimum of 50% P in each relevant subject. A grade of 50% PS which is achieved if a student sits and passes a supplementary exam is NOT sufficient.