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OxWaSP

**EPSRC & MRC Centre for Doctoral Training in
Next-Generational Statistical Science: the
Oxford-Warwick Statistics Programme**

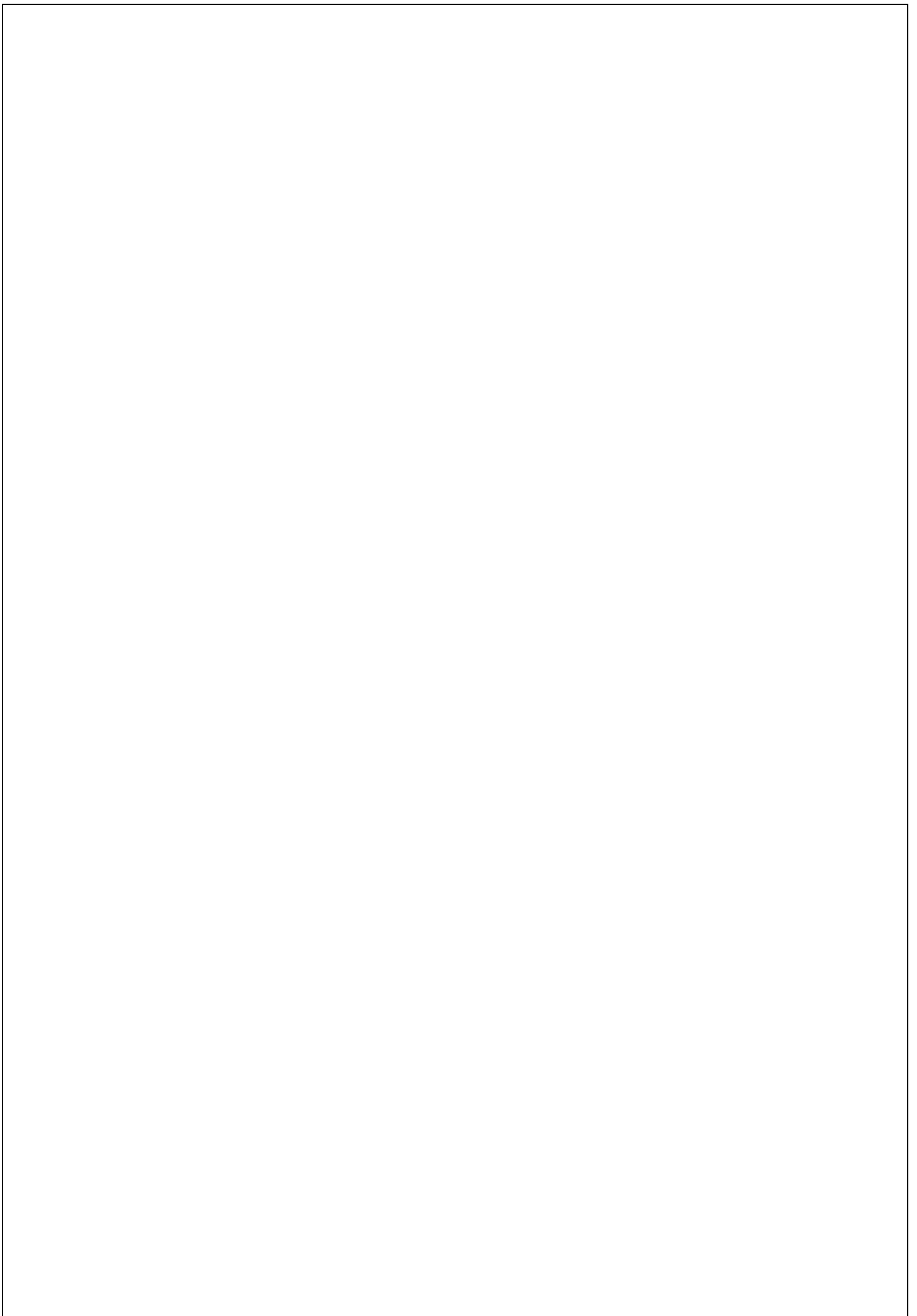
Course Handbook 2017-2018





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1. Introduction

Welcome to the Centre for Doctoral Training (CDT) in Next-Generational Statistical Science. The CDT is run jointly by the Statistics Departments of the University of Oxford and the University of Warwick, and is supported by the Engineering and Physical Sciences Research Council (EPSRC) and the Medical Research Council (MRC).

The CDT aims to produce new research leaders for industry and academia. We will train graduate researchers in the theory, methods and applications of Statistical Science for modern data-intensive environments and large-scale models. This is the first centre of its type in the world.

In developing the CDT we recognised a critical need for the training of a new type of statistical researcher who can meet the emerging challenges of modern statistical data analysis. Statistical researchers will increasingly need to be versed in the manipulation and handling of massive, heterogeneous data. Successful researchers will be able to program on distributed high-performance computing and communicate effectively with ‘data owners’ (before and after the data collection), using these skills and knowledge to develop the new theories, methods and algorithms needed for the analysis of “big data” on massively parallel modern computing devices.

We are witnessing the most exciting of times to be working in Statistics. We hope you find your journey over the next four years challenging, rewarding and ultimately enjoyable.

All the best for your academic year
Professor Chris Holmes
(CDT Director)

This handbook is designed to help you understand the course structure and how the modules are laid out; what is required from you regarding your contribution to this course; who the key contacts are and who you can go to if you need support. Much of the information is focused on your first year. Please be aware that details may be subject to change.

This handbook applies to students starting the OxWaSP programme in October 2017. The information in this handbook may be different for students starting in other years. Every effort is made to ensure that information offered from this handbook is accurate at the time of going online. Notice of misprints or errors of any kind, and suggestions for improvements in this booklet should be addressed to the CDT Administrator in the Department of Statistics, University of Oxford.

The University of Oxford Examination Regulations relating to this course are available at <http://www.admin.ox.ac.uk/examregs/> If there is a conflict between the information in this handbook and the Examination Regulations then you should follow the Examinations Regulations. If you have any concerns then please contact the CDT Administrator.

2. Programme Background

The CDT was created in response to a call from the EPSRC for the funding of centres for doctoral training. Our proposal to the EPSRC responds to the now-critical demand for training centres for doctoral students in modern statistical methods for data intensive environments.

Objectives

- Training researchers in the core statistical methodology, computation and theory underpinning modern applications, involving large high-dimensional, heterogenous data;
- Enhancing interdisciplinary collaboration, methodological rigour and joint understanding in efficient scalable statistical methods for scientific data analysis;
- Building a community of UK and International scholars, concerned with developing these approaches and methodologies;
- Establishing a centre for a network of different interest groups and disciplinary approaches working towards providing future industrial and academic research leaders, by enhancing collaboration between the academic community and practitioners (government, international institutions and private sector);
- Investing in outreach programmes such as the engagement of more women in schools into vocations in statistics.

Training strategies

The CDT will give graduates a breadth of knowledge across multiple domains. A working knowledge of distributed databases and algorithm design, many-core and distributed computing will complement your understanding of core topics in probability, statistical theory and statistical methods. OxWaSP students have the opportunity to engage with over 40 researchers in two world-leading departments. Peer-to-peer learning is another important aspect of the training environment. The CDT will bring students together regularly, to share ideas and develop a broad appreciation of modern statistics.

The CDT will bring together industrial partners to share ideas and give you some insight into the research challenges and opportunities in commercial and social enterprise. The academic training we provide will be enhanced by visits, lectures, internships and co-supervision from global partners such as Amazon, Google, GlaxoSmithKline, MAN and Novartis, as well as smaller entrepreneurial start-ups.

Statistical data analysis in industry and within scientific consortia is increasingly undertaken by large interdisciplinary teams, involving database managers, programmers, domain experts and statisticians. Excellent communication skills, and experience of team building and team working, are needed for success in this space. Our programme builds these skills along the way, through direct training in transferable skills and as an integral part of every module.

In the third year, the CDT facilitates an international study visit for our graduate trainees at some of the world's leading centres in data-intensive statistics, such as UC Berkeley, Columbia University, Duke University, University of Washington, Eidgenössische Technische Hochschule (ETH) Zurich and National University of Singapore (NUS) Singapore. This visit will contribute greatly to your career development and breadth of knowledge.

We are aiming to maximize the opportunity for you to reach your full potential and make major contributions to our field.

3. Course Overview

This is a four year Doctor of Philosophy (DPhil or PhD) in Statistical Science.

In the first year of the programme all students are based at Oxford. Over the first two terms, students work on eight 2-week taught modules, four in each term. Teaching is co-led by faculty from Oxford and Warwick. The 2-week modules have a fairly regular structure. Typically, Monday and Tuesday of the first week of each module is given over to lectures and exercises. Over the next five working days you will read some of the original literature and write a report. The module leaders will direct you as to what is expected. On the Wednesday of the second week you will complete your report. Over a series of 'pizza lunches' organised on these Wednesdays, you will get a chance to interact with people from industry and academia, whose research is in areas related to the topic of the module. At the end of the second week of each module there will be a mini-symposium at Warwick on the theme of the module. The modules content is detailed in section 6.

We will also send you on a 5-day course, at the end of July 2018, run by Prof Mike Giles, Professor of Scientific Computing at Oxford. You will learn about parallel programming on Graphics processing unit (GPUs) using the CUDA programming environment. No prior experience with parallel computing is assumed. Click here for further information <http://people.maths.ox.ac.uk/~gilesm/cuda/>

From April to September in the first year, you will select and complete two mini-projects. You have about 10 weeks to work on each of these. In your mini-project you will review and analyse current and existing research, providing your own commentary and insights. The projects will typically include some small problem for you to solve. The purpose of the project work is twofold. Firstly, to train you to complete a small piece of independent research, and write it up in a coherent way, respecting standard scientific writing conventions. Secondly, this is a chance for you to find out more about supervisors, their subjects and how they work, and decide on potential doctoral supervisors. Further information on mini-projects can be found in section 7.

At the end of the first year, subject to supervisor availability and interest, you will choose a supervisor for your main doctoral research project. Students enrolled at Warwick will choose a Warwick supervisor and students enrolled at Oxford will choose an Oxford supervisor. Warwick students will leave for Warwick but continue interaction with Oxford CDT students and academics. We cannot promise you will get your first choice (supervisors have some say, and several students may choose the same supervisor). Having chosen a supervisor you will spend the next two to three years working with your chosen supervisor carrying out a programme of research towards a doctorate.

Academic Terms

The timetable for the CDT runs independently of the Oxford terms structure - please see p37 for the full timetable. It is important to maintain a presence in the department and with your cohort as well as attend the various skills training and attend reading groups.

Induction week for the CDT begins in Week 0 of Michaelmas Term.

The Oxford terms for 2017/2018 are as follows:

MICHAELMAS TERM	Sunday 8 October 2017 to Saturday 2 December 2017
HILARY TERM	Sunday 14 January 2018 to Saturday 10 March 2018
TRINITY TERM	Sunday 22 April 2018 to Saturday 16 June 2018.

Programme outline

First Year - First term (Oxford Michaelmas Term)

Oxford/Warwick Annual Workshop (Induction week)	5
Induction week followed by four two-week assessed modules	
Module 1: Computational Statistics and Statistical Computing	7
Module 2: Applied Statistics	9
Module 3: Probability and Approximation	10
Module 4: Network Analysis	11
Advisor interviews (progress and monitoring)	18
1 st Academy for PhD Training in Statistics (APTS) residential broadening training week	22
Monitoring via termly progress reports	17

First Year - Second Term (Oxford Hilary Term)

Four two-week assessed modules	
Module 5: Time Series and Stochastic Processes	12
Module 6: Bayesian Inference	13
Module 7: Stochastic Simulation	14
Module 8: Machine Learning	15
Advisor interviews (progress and monitoring)	18
2 nd APTS residential broadening training week	22
Monitoring via termly progress reports	17

First Year - Third Term (Oxford Trinity Term)

First mini-project	16
3rd APTS residential broadening training week	22
Advisor interviews (progress and monitoring)	18
Parallel programming course (CUDA)	3
Second mini project	16
4th APTS residential broadening training week	22
Monitoring via termly progress reports	17
Off-site retreat	5

Second year

Assignment of supervisor by the start of the year	18
Monitoring via termly progress reports	17
Amazon study week	5
18 months: first major academic milestone (transfer to PhD/DPhil)	18-21

Third year

International research study visit (subject to progress)	5
Monitoring via termly progress reports	17
36 months: second major academic milestone at the end of this year	18-21

Fourth year

Monitoring via termly progress reports	17
Completions of research and submission of thesis by the end of the fourth year	18-21

All years: transferable skills training, public engagement, annual workshop. Industrial internships are possible in any year including first year mini-projects (further information on internships in section 10).

4. OxWaSP-Funded Research-Network Activities

Oxford/Warwick Annual Workshop

In early autumn each year, you will have the opportunity to attend an Oxford/Warwick workshop at Warwick. All CDT students and members of the supervisor pool will be invited. Second and third year CDT students will present posters on their work to date.

Off-site retreat

Towards the end of the first year, you will attend an off-site 2 day residential training retreat with a small number of chalk talks each day. There will be no computers and lots of time for reading and open discussion. You will be encouraged to view your work from a distance, to think about the year ahead and your aspirations, to consider the really big open questions. You will be assigned to small groups and given two or three papers to read and discuss. You will then be asked to present your major finding to your peers. Each student, in consultation with their supervisor, will also be asked to bring along two or three papers to read while away. In the evening a member of faculty will lead a round table discussion on a high-level topic such as “reproducible research, why bother?”, or “what’s the use of Statistics if all models are wrong?”. The retreat is designed to enhance research independence and help develop communication skills and small group working.

Amazon study trip

In the second year, you will travel to Amazon’s research centre in Berlin. Senior academics and a senior Amazon researcher will co-design and co-lead an advanced training course on topics in Statistical Machine Learning and Computing for big-data analysis.

International study visit in year 3

In your third year, subject to satisfactory progress, you may undertake an international study visit, at an institution such as UC Berkeley, Columbia University, University of Washington Seattle, ETH Zurich and the National University Singapore. These universities have thriving statistics research with substantial PhD programmes in the CDT area of statistical science for data-intensive applications.

5. Staff

Key CDT staff

Listed below are main contacts you will encounter in your day to day activities:



Professor Chris Holmes



Professor Jim Smith



Professor Francois Caron



Joanna Stoneham

<u>Title</u>	<u>Name</u>	<u>Email address</u>
CDT Director	Professor Chris Holmes	cholmes@stats.ox.ac.uk
CDT Co-Director	Professor Jim Smith	J.Q.Smith@warwick.ac.uk
CDT Co-Director	Professor François Caron	caron@stats.ox.ac.uk
CDT Administrator	Joanna Stoneham	stoneham@stats.ox.ac.uk
Postgraduate Support Officer – Warwick	Vacant	stats.pg.support@warwick.ac.uk
Director of Graduate Studies (Oxford)	Professor Gesine Reinert	reinert@stats.ox.ac.uk
Director of Graduate Studies (Warwick)	Professor Wilfrid Kendall	w.s.kendall@warwick.ac.uk
Academic Administrator	Jan Boylan	academic.administrator@stats.ox.ac.uk
Departmental Administrator (Oxford)	Sarah Parkin	parkin@stats.ox.ac.uk
Departmental Administrator (Warwick)	Paula Matthews	Paula.Matthews@warwick.ac.uk
Statistics library	Hannah Harrison	lib@stats.ox.ac.uk
Statistics Reception	Emma Bodger	reception@stats.ox.ac.uk
IT support	Helpdesk	ithelp@stats.ox.ac.uk

Affiliated Staff

The CDT's pool of supervisors is led by CDT Director Professor Chris Holmes at Oxford, CDT Co-Director Professor Jim Smith at Warwick, and Co-Director Professor François Caron at Oxford.

Oxford and Warwick's current pool of Supervisors can be viewed here:

<http://www.oxwasp-cdt.ac.uk/people.html>

Programme Management

Further information on the management structure of the CDT can be found on p29.

6. Modules Outlines

MODULE 1 TITLE: COMPUTATIONAL STATISTICS AND STATISTICAL COMPUTING

Leader: Krzysztof Latuszynski (Warwick) Co-Leader: Robin Evans (Oxford)

Date of Module: 9 – 20 October 2017

Summer Reading

Please go through the R programming notes and practicals on Robin Evans' webpage before the course starts: <http://www.stats.ox.ac.uk/~evans/teaching.htm#R>

We assume that you are either happy and comfortable with the material in the notes or have a list of things you would like better explained when you arrive.

Abstract

Computational statistics is one of the most dynamic areas of research in modern statistics and is key to such fields as Bayesian inference, model choice, graphical models, Big Data and others. In this course, students will be exposed to main concepts of computational statistics and to milestone ideas, such as Monte Carlo, Markov chain Monte Carlo, Sequential Monte Carlo, Reversible Jump, Approximate Bayesian Computation, Intractable Likelihood, Monte Carlo Expectation Maximisation, Simulated Annealing, Belief Propagation, LASSO, LARS, false discovery rate, to name a few, and will study two of them in depth based on original research papers. The study will involve implementing one of the methodologies and may involve analysis of real data. The course is designed not only to cover computational statistics and R, but also to support acquisition of transferable skills such as collaborative work, giving and receiving constructive feedback and good practice in producing code.

Objectives

After the course, you will acquire the following skills:

- Familiarity with R and ability to implement mainstream computational algorithms
- Experience of reading and discussing code; understanding the benefits of producing clear well-written code
- Collaborating in understanding a research problem
- Critically assessing someone else's code and work, giving constructive feedback
- Receiving feedback and using it constructively to improve work
- Exposure to several mainstream topics in computational statistics
- Thorough familiarity with two of these topics (project done + project reviewed)
- Ability to present work and research

Assessment

Each team will produce a report of maximum 8 pages, and return code and graphs in the format of an R vignette. The report will be marked and there will be feedback on the code and presentation.

List of Papers

In 2017 the following papers will be presented along with projects. The list is subject to change, in particular additions, and will be confirmed when the module starts.

1. (2017R) Efron, B.; Hastie, T.; Johnstone, I.; Tibshirani, R. Least angle regression. *Annals of Statistics*, Institute of Mathematical Statistics, 2004, 32, 407-499
2. (2017R) Lauritzen, S.L. and Spiegelhalter, D.J. Local computations with probabilities on graphical structures and their application to expert systems, *Journal of the Royal Statistical Society. Series B.* 50(2): 157-224. 1988.

3. (2017K) J. Bierkens, P. Fearnhead, G. Roberts. The Zig-Zag Process and Super-Efficient Sampling for Bayesian Analysis of Big Data. preprint arXiv:1607.03188
4. (2017K) M. Vihola, J. Helske, J. Franks. Importance sampling type correction of Markov chain Monte Carlo and exact approximations. preprint arXiv:1609.02541
5. (2017K) D. Maclaurin, R.P. Adams. Fire y Monte Carlo: Exact MCMC with Subsets of Data. IJCAI 2015
6. (2017K) Iain Murray, Ryan Prescott Adams, David JC MacKay. Elliptical slice sampling. JMLR 2010
7. (2017R) Piotr Zwiernik, Caroline Uhler, Donald Richards. Maximum likelihood estimation for linear Gaussian covariance models. JRSS-B, 2016.

MODULE 2 TITLE: APPLIED STATISTICS

Leader: Chris Holmes (Oxford)

Co-Leader: Jane Hutton (Warwick)

Date of Module: 23 October – 4 November 2017

Abstract

This module will emphasise the principles and best practice lifecycle of good statistical data analysis and reproducible research. We will emphasise the importance of reproducibility and transparency in statistical analysis and how these can be supported through the use of statistical notebooks in markdown languages (such as R markdown) coupled with version control repositories such as GitHub.

We will cover issues in optimal experimental design, data exploration and graphical statistics, clustering algorithms, tentative model design and model building, exploration of model fit, unbiased assessment of model performance and model adequacy, and model uncertainty including variable selection and stability. The module will consider both Bayesian and classical approaches to statistical analysis. The emphasis will be on teaching through real world applications and hands on data analysis using R.

Assessment

Students will be asked to undertake an illustrative data analysis project keeping a study log-book of their activities, as well as review exemplar papers of good and bad statistical practice. Individual reports should be handed in by Thursday 9.00am of week 2 of the module. Students will work in small teams on a real-world study and present their insights and analysis on the Friday of week 2 of the module.

Suggested Background Reading

Hastie et al. (2009) Elements of Statistical Learning, Springer

Gelman et al. (2013) Bayesian Data Analysis, CRC Press

Tufte (2001) The visual display of quantitative information

MODULE 3 TITLE: PROBABILITY & APPROXIMATION

Leader: Wilfrid Kendall (Warwick)

Co-Leader: David Steinsaltz (Oxford)

Dates of Module: 6 – 17 November 2017

Abstract

Approximation methods in probability have played a significant role in statistics since the inception of mathematical probability (for example, the key results of laws of large numbers, central limit theorems, laws of iterated logarithm, large deviations). More recently, there has been intense interest in rigorous approximation methods, especially the famous Stein approximation, with particular bearing on the complex data problems arising in computational biology and in network theory. Modern approaches to mathematical statistics make intense use of probabilistic tools such as exponential inequalities. Finally the new paradigm "big n, big p, little t" is placing a high premium on essentially probabilistic methods to carry out rapid approximation of key statistical quantities for complicated and very large datasets.

We will begin by discussing notions of probabilistic convergence and approximation, and then describe the classical probabilistic limit theorems in situations of natural generality and emphasizing the links between them. We will discuss approaches which can be seen as precursors to the notions of Stein approximation, and this will lead naturally on to discussion of approximation particular in the Poisson case (the celebrated Stein-Chen approximation methodology, which is now finding widespread application in applied problems). We will then conclude by discussing some examples of recent work: perhaps including work of Witten and Candès on random linear algebra which has great relevance to fast calculations for big data, or recent developments in the area of perfect simulation.

Assessment

Students will be asked to individually review various different aspects of recent papers on probability and approximation drawn from the recent literature. These should be handed in by Thursday 9.00am of the second week of the module. Teams of students will then give joint critical presentations on the papers they have studied - we will seek to balance the teams to ensure that people with strong theoretical background work together with people of strong computational background to allow them to learn from each other as well as from the material which they will be studying.

Suggested Background Reading

Arratia, R., Goldstein, L., & Gordon, L. (1990). *Poisson Approximation and the Chen-Stein Method*. Statistical Science Volume 5, Number 4 (1990), 403-424.

Barbour, A. D., Holst, L., & Janson, S. (1992). *Poisson approximation*. OUP.

Chen, L.H.Y, Goldstein, L, & Shao, Q.-M. (2011). *Normal Approximation by Stein's Method*. Springer-Verlag. Berlin & Heidelberg.

Grimmett, G. R., & Stirzaker, D. (2001). *Probability and random processes*. OUP.

Lecture notes available in PDF form from OxWaSP administrator

Old lecture notes *Warwick ST202, second year module on Markov chains*. It would be good to read through this if you are worried that all your probability will be a bit rusty.

Old lecture notes *Warwick ST333, third year module on applied stochastic processes*. This includes useful material on Poisson process and queues, as well as other more advanced material.

MODULE 4 TITLE: NETWORK ANALYSIS

Leader: Gesine Reinert (Oxford)

Co-Leader: David Firth (Warwick)

Date of Module: 20 November – 1 December 2017

Abstract

Networks are increasingly used as representation of complex data. Often these data arise from observations which are far from independent. The dependence presents a challenge both for modelling networks and for drawing statistical inference from networks.

This module starts with some exploratory network analysis. Then we shall discuss probabilistic models for networks and investigate the behaviour of some standard network summary statistics under these models. This investigation will lead to statistical inference on networks. Frustratingly, many real networks are not well modelled using available probabilistic models. Hence we shall also cover methods for network inference without assuming a parametric underlying model.

Network data often arise naturally from comparisons, contests or other directed links between pairs of items (or sometimes larger sets of items). Interest then shifts to modelling the *direction* of such links, either to rank items (as in the ranking of web pages by a search engine, for example), or to explain why some types of item are more frequently “winners” than others. The Bradley-Terry-Luce models are among the standard statistical devices for such situations, and can usefully be compared with algorithmic alternatives such as PageRank.

Assessment

Students will form 3 teams to work on a micro-project suggested by the module leaders. Each team will submit a report, of maximum 8 pages, by 9 am on Thursday of the second week. Each team will present their work on Friday of the second week.

Suggested preparation

Adamic, L.A. and Glance, N., 2005, August. The political blogosphere and the 2004 US election: divided they blog. In *Proceedings of the 3rd International Workshop on Link Discovery* (pp. 36-43). ACM.

Kolaczyk, E.D. and Csárdi, G., 2014. *Statistical Analysis of Network Data with R* (Vol. 65). New York: Springer.

The introduction (Chapter 1) of Newman, M., 2010. *Networks: an Introduction*. Oxford University Press.

Chapter 9, *Rating Systems*, in Vojnović, M., 2016. *Contest Theory*. Cambridge University Press.

MODULE 5**TITLE: TIME SERIES AND STOCHASTIC PROCESSES**

Leader: Jim Smith (Warwick)

Co-Leader: François Caron (Oxford)

Date of Module 15 – 26 January 2018**Abstract**

Time series models are widely required in many domains in science and commerce where data is very rich and processes complex. The module will begin by introducing the basic (multivariate) dynamic linear model (DLM) and derive the updating equations that are used for filtering, prediction and smoothing in state space models. We will then consider more complex modelling approaches including trends, covariates, oscillations and nonlinearities and briefly discuss how far these can be accommodated in a classic state space modelling framework and what the current limitations are (hence leading to open research problems). A further session will then be devoted to introducing spectral analysis of time series processes, the use and meaning of the spectral density and its empirical counterpart, the periodogram, as a partition of the time series process into harmonic components. Multiple time series and cross spectra will be considered briefly as an extension. All methodologies will be demonstrated by applications to real data using examples from ongoing research in systems biology and medicine. The second part of the module will cover some popular stochastic processes (Lévy processes, Poisson processes, Dirichlet processes, Chinese restaurant process), their properties and a few applications to finance or unsupervised learning.

Assessment

Students will be asked to review various different aspects of papers drawn from the recent literature and/or provide some practical work applying time series methods to real data. The projects will be in groups of 3 students and should be handed in by Thursday (week 2 of the module) 11.00am. The teams of student will then give joint critical presentations on their project on Friday week 2.

Suggested Background Reading

A. E. Kyprianou (2006) *Introductory Lectures on Fluctuations of Lévy Processes with Applications*, Chapter I, Springer.

West and Harrison (1997). *Bayesian Forecasting and Dynamic Models*, Springer.

Brockwell and Davis (1996). *Introduction on time series and forecasting*, Springer.

Kingman, J. F. C. (1992). *Poisson processes (Vol. 3)*. Clarendon Press.

MODULE 6**TITLE: BAYESIAN INFERENCE**

Leader: Christian Robert (Warwick)

Co-Leaders: Chris Holmes (Oxford), Judith Rousseau (Oxford)

Date of Module: 29 January – 9 February 2018

Abstract

The Bayesian approach to statistics offers a holistic perspective on the field in that it allows for a complete coverage of the various purposes of Bayesian inference and design. The introduction we propose in this module will remain at the level of classical parametric models in finite dimension, but will address the specificities and challenges of the Bayesian approach to statistics. We will cover the fundamental connection between statistical decision theory and Bayesian statistics, the finite and asymptotic properties of the Bayesian procedures, the construction and assessment of prior distributions, the different approaches to Bayesian testing and model choice, and the specific case of hierarchical models. While the material is mostly theoretical, there will be illustration labs in R to gain some intuition about the construction and manipulation of posterior distributions.

Assessment

Students will be asked to individually review and assess some reference papers in the Bayesian literature or reproduce analyses found in the recent literature. These should be handed in by Thursday 9.00am. Three teams of students will then give three joint critical presentations on the papers they have studied that very day.

Suggested Background Reading

Gelman et al. (2013) *Bayesian Data Analysis*, CRC Press

Ghosal S. and Van der Vaart, A. (2007) Convergence rates of posterior distributions for non i.i.d observations . *Annals of Statistics*, 35, 192-223.

Hoff (2009) *A First Course in Bayesian Statistical Methods*, Springer

Marin and Robert (2014) *Bayesian Essentials with R*, Springer

Robert (2007) *The Bayesian Choice*, Springer

MODULE 7 TITLE: STOCHASTIC SIMULATION

Leader: Arnaud Doucet (Oxford)

Co-Lead: Adam Johansen (Warwick)

Date of Module: 12 – 23 February 2018**Abstract**

For most complex statistical models such as latent variable models or spatial models, inference cannot be carried out analytically and we must rely upon simulation techniques. The aim of these lectures is to introduce modern stochastic simulation methods. We will concentrate on Markov chain Monte Carlo (MCMC) methods and Sequential Monte Carlo (SMC) methods. The material is primarily theoretical but the use of these techniques will be illustrated using various applications.

Assessment

Students will be asked to individually review and assess some reference papers in the statistics literature or reproduce analyses found in the recent literature. These reviews and analyses should be handed in by Thursday 9.00am. Three teams of students will each give a critical presentation on the papers they have studied on that very day.

Suggested Background Reading

Liu, J.S., Monte Carlo methods for scientific computing, Springer.

Robert, C. and Casella, G., Monte Carlo statistical methods, Springer.

MODULE 8

TITLE: MACHINE LEARNING

Co-Leaders: Yee Whye Teh (Oxford), Matt Kusner (Warwick), Cedric Archambeau (Oxford)

Date of Module: 26 February – 9 March 2018

Abstract

Machine learning is a wide range of statistical and computational methods allowing machines to “learn” from data. . For example, modern machine learning algorithms can produce text similar to Shakespeare (Karpathy, 2015), paintings similar to Picasso (Gatys et al., 2016), and music similar to Miles Davis (Gillick et al., 2010). They can play Go and identify image content better than humans (Silver et al., 2016; He et al., 2015).

In this module you will be exposed to the important concepts underpinning machine learning (supervised and unsupervised learning, reinforcement learning, generalization, overfitting, bias/variance tradeoff, empirical risk minimization).

Assessment

Students will form into teams, with each team investigating a set of related techniques solving a particular problem. This will involve reading and digesting the core papers of an area, implementing the techniques, and applying them to datasets (including pre-processing and analyses of results). A report (maximum 8 pages in NIPS proceedings format, including figures, tables and references) is expected by the second Thursday, followed by a presentation on Friday.

Potential topics are:

- deep learning, neural network and their applications in AI applications
- kernel methods and distributional testing
- probabilistic learning, approximate inference and learning, Gaussian processes, and applications in topic models and collaborative filtering.

Suggested Background Reading

I Goodfellow, Y Bengio, A Courville. Deep Learning, MIT Press.

K Murphy. Machine Learning: a Probabilistic Perspective, MIT Press.

D Koller & N Friedman. Probabilistic Graphical Models: Principles and Techniques, MIT Press.

C Bishop. Pattern Recognition and Machine Learning. Springer.

M Wainwright & M Jordan (2008). Graphical Models, Exponential Families, and Variational Inference, Foundations and Trends in Machine Learning.

Suggested Background Viewing

Ruslan Salakhutdinov's http://videlectures.net/deeplearning2015_salakhutdinov_deep_learning/

Kyunghyun Cho's http://videlectures.net/deeplearning2016_cho_language_understanding/

Shakir Mohamed's http://videlectures.net/deeplearning2016_mohamed_generative_models/

Joelle Pineau's http://videlectures.net/deeplearning2016_pineau_reinforcement_learning/

Zoubin Ghahramani's http://videlectures.net/mlss05us_ghahramani_bl/ and

http://videlectures.net/mlss07_ghahramani_grafm/

Carl Rasmussen's http://videlectures.net/epsrcws08_rasmussen_lgp/

References:

[1] Gatys, Leon A and Ecker, Alexander S and Bethge, Matthias. Image style transfer using convolutional neural networks. CVPR, 2016.

Content of modules may be subject to some change and students will be informed where this is the case.

7. Projects and Supervisors

Mini-Projects

You will undertake two mini-projects within your first year (the first between **Tuesday 3 April** and **Wednesday 6 June** and the second between **Monday 18 June** and **Wednesday 6 September**). Students are required to produce a dissertation for each project in the style of a research paper with a limit of 5,000 words including references, abstracts and appendices. While original and independent insight is important, you are not required to make substantial research contributions at this stage. The mini-project dissertations will be assessed by the project supervisor and the CDT director/co-directors.

A list of mini-project titles for your first mini-project, proposed by the CDT's Supervisory Pool (Oxford/Warwick) will be circulated to you in December. You will choose the names of your Supervisor and the titles your first mini-project from this list. You may be asked to provide several choices, as some projects may be particularly popular with students. In some cases, project supervisors may be able to accommodate more than one student on a project. You can construct your own project or revise one of the published projects. You will be able to choose a mini-project supervisor from the combined pool of Oxford and Warwick. Since you are expected to choose a thesis supervisor from the University that admitted you, you should almost certainly take at least one project with your 'home' institution.

The deadline for submitting the names of your supervisor and the mini-projects is **Friday 16 March**. We will publish the titles of any additional mini-projects available for the second mini-projects series on **Friday 20 April**. For your second mini-project, we will expect the names of your proposed Supervisors and choices of mini-project titles to be submitted by **Friday 25 May**.

Each project should have a different supervisor. You should send your 2nd mini-project choice to the CDT Administrator along with a note about how it complements your 1st project and shows diversity of supervision. It may be possible for the supervisor of your 1st project to act as your co-supervisor for the 2nd project if the topic is sufficiently different. This would require strong justification.

Submission dates for the mini-projects, via the WebLearn assignment tool, are as follows:

- 1st mini-project deadline: **Midday, Wednesday 6 June 2018**
- 2nd mini-project deadline: **Midday, Wednesday 6 September 2018**

Choosing a Thesis project and Supervisor

During the year there are opportunities to meet potential supervisors and discuss projects. You will spend time with the module leaders and co-leaders, and other members of the supervisor pool will give talks in the course of the taught modules in the first two terms. It is likely, but not essential, that one of your project supervisors will become your thesis supervisor. Certainly, the mini-projects are a good way to get to find out if some particular area is of interest to you. Towards the end of the first year, late in the second mini-project, you will submit the names of a few potential supervisors and research areas to the CDT Management Committee. The Committee will match supervisors and students. The Committee will do all it can to meet supervisor and student demands. However, we cannot promise you will get your first choice, so make sure you have identified at least three potential supervisors with exciting projects.

The Supervisory Relationship

This is a crucial relationship and will underpin the success of your research studies. The Oxford Learning Institute's Research Supervision website (<http://www.learning.ox.ac.uk/supervision>) is useful to DPhil students although it is also aimed at research supervisors. The EPSRC also provides advice for students on their website (<https://www.epsrc.ac.uk/skills/students/help/guidance/>).

8. Feedback, Monitoring and Assessment

Assessment

Your work will be assessed via termly reports from you and your supervisor in years 2-4, and through formal milestones at 18 months and 36 months. Progression and milestones are described in section 9 of this document.

In your first year, you submit a report (towards the end of the second week of each module) and give a short presentation (on Friday of the second week, at Warwick) for each module. These are marked and given a single combined grade on a three-level scale by the module leaders: "Needs improvement", "Good" or "Excellent". Feedback is an important part of teaching and learning. The primary purpose of our assessment is to help you develop as an independent researcher. The module leader will give you more informal oral feedback on your report (later in the second week) and presentation (Friday of the second week). You can expect further oral feedback from your peers and other invited participants.

You will receive oral and written feedback on your two mini-projects, which will also be graded.

Monitoring

There are other less formal milestones which are part of our progress monitoring. In your first year, each student will have a short end-of-term interview with the CDT Directors. In years 2-4, supervisors and students agree a termly report. This is reviewed by the CDT Directors, and by an independent departmental Graduate Tutor.

Feedback

There will be other formal and informal channels for you to feed back to the Directors, and their institutions, on your experience of the course. In the first year we will be asking you for regular feedback on how well we are doing. Termly monitoring reports are another conduit for feedback. Each term, it is **compulsory** for students to write a short report on their progress, including training, on the Graduate Supervision System (GSS) <http://www.gss.ox.ac.uk/>. GSS is open for student reporting in weeks 6 and 7 of each Oxford term. From week 8 onwards each term, the supervisor is responsible for writing a report about the student on GSS. We will also ask you to fill in a feedback form at the end of Induction Week and at the end of each Module. This information will be fed back and used to improve the Programme and secure new students for the coming years.

CDT students are invited to elect one or two representatives who can act as a link with the staff in the Department of Statistics, and in particular bring to light and discuss any general concerns that might arise. The representative(s) will be invited to attend the Graduate Liaison Group which meets once a term. See www.stats.ox.ac.uk/current_students/research_degrees/graduate_liaison_group.

9. Progression and Graduation

Progression and Graduation for Oxford-bound CDT students

During your first year you will be assessed in the same way as the Warwick-bound CDT students. At the end of your first year you will choose a supervisor at Oxford and continue at Oxford.

Your first important milestone is at approximately 18 months (before the end of the fifth term). It is called “Transfer of Status”. New research students join the University as Probationer Research Student (PRS). You should apply to transfer to DPhil status ***before the end of the fifth term from admission***.

You should complete the ‘**Preparing for Transfer of Status**’ form to complete your termly reflective progress report for the term before you expect to transfer, following your supervisions/meetings with your supervisor(s), and upload it to GSS using the ‘Upload File’ facility. The questions are designed to help you reflect on the criteria your assessors will be considering for your transfer examination.

The MPLS Division has prepared a useful **checklist for transfer of status** and a **project initiation plan**, which you should consult: <https://www.mpls.ox.ac.uk/graduate-school/information-for-postgraduate-research-students/progression>

In order to pass the transfer of status milestone you submit a report outlining the research you have done and what you plan to do for your thesis. You will have an interview with two assessors. The assessors review the transfer report and any reports on transferable and broadening training) and give feedback to you and your supervisor. This feedback will include an assessment of the viability and suitability of the proposed research, and of its completion on a reasonable timescale. Your assessors may recommend a range of possible outcomes, including transfer to DPhil status without reservations, transfer to DPhil status with conditions, or transfer to the relevant lower degree, subject to the opportunity to make a further application.

Your second major milestone is at 36 months (before the end of the 9th term). It is called “Confirmation of Status”. The purpose of confirmation of status is to check you are on track to submit within approximately 6 months. You should apply for confirmation of DPhil status ***no later than the end of the ninth term from admission***. In order to pass this milestone you should submit a summary of your work to date (usually publications or draft chapters from your thesis) and a timetable for submission of your thesis. You will have an interview with two assessors. The assessors review your work and check that you have completed the necessary broadening and transferable-skills training and give feedback on your research. The feedback content is usually suggestions for further research or minor corrections. If a candidate’s application for confirmation of status is unsuccessful, the board may approve a transfer from DPhil to MSc by Research status, subject to the opportunity to make a further application.

There are other milestones at the end of each term (approximately every 3 months) at which you and your supervisor give progress reports via the Graduate Supervision System. For further information see section 8. These are reviewed by the CDT directors and the Director of Graduate Studies at Oxford. If for a short time you are unable to pursue your research, due to sickness or other exceptional circumstances you may apply for suspension of your student status. Time spent in this state does not count towards your next milestone deadline.

You are expected to submit your thesis within four years of full-time study. Your supervisor will consult with you on the appointment of examiners, and two examiners will be chosen. You will be examined on your thesis in a viva. Further information on the viva process can be found here:

<https://www.mpls.ox.ac.uk/graduate-school/information-for-postgraduate-research-students/examination>

For transfer confirmation, examination, extension of time, suspension of status and withdrawal please refer to http://www.stats.ox.ac.uk/current_students/research_degrees.

Examination Procedures and Course Regulations

Information regarding the university's examination procedures can be found here:

<http://www.ox.ac.uk/students/academic/exams>

Information about the stages of the research degree and examination regulations for the course are available via <http://www.ox.ac.uk/students/academic/guidance/graduate/research>.

Progression and Graduation for Warwick-bound CDT students

18 month review

The second review takes place after 18 months and consists of a report, and about 3 weeks later, a meeting between the panel and the student. The report should be about 20-30 pages in length. The meeting is open to other members of staff, but not other postgraduate students. The meeting may be expected to take between one and two hours.

The primary purpose of this review is to enable the panel to make a recommendation to the Director of Postgraduate Studies as to whether you should be allowed to proceed on to the PhD programme. In making their recommendation the panel will take into account your performance during the first year of OxWaSP.

The 18 month review is key to considering if you are capable of successfully completing a PhD thesis, and whether it is in your best interests to be allowed to proceed.

24 month review

The third review takes place after 24 months. On this occasion you are asked to produce a research report, to give a thesis outline, and, in consultation with your supervisor, to give an estimated completion date. The report may be in the form of a research article (possibly jointly with the supervisor) or a thesis chapter, and should form a prototype for a paper in a good journal. The panel will provide written feedback to you, and a written recommendation to the Director of Postgraduate Studies.

30 month review

After 30 months, you should provide a signed overview of the thesis plan to the Director of Postgraduate Studies, together with a provisional submission date. Your supervisor should indicate their support by signing the document.

The Department expects that students will complete their study in a period of three to three and a half years. For those students who require more than three years, the procedure is as follows.

36 month review (if necessary)

This stage must be completed by 36 months, and if requests for an extension or funding are required, then it is in your interests for this stage to be completed promptly. There are two possible processes depending on whether you plan to submit between 36 and 39 months, or later than 39 months.

Submission planned between 36 and 39 months

You should submit a revised thesis plan to the Director of Postgraduate Studies, with an intended submission date. Your supervisor should indicate their agreement.

Submission planned later than 39 months

In addition, a review takes place after 36 months. You should produce a thesis plan and a research report, and, in consultation with your supervisor, give an estimated submission date. Your supervisor should indicate their agreement to the proposed timetable. The research report may be in the form of a research article or a thesis chapter, and should be substantially different from the material given after 24 months. About three weeks after the submission of the report, the panel meets with you to discuss the research report and your progress. This meeting takes the form of a viva.

42 month review (if necessary)

If after 42 months you have not submitted then you should provide the Director of Postgraduate Studies with an overview of your thesis and a predicted submission date. Your supervisor should indicate their agreement, as before.

It is not possible to extend registration beyond 48 months. In exceptional circumstances (see University guidance) students are required to apply for temporary withdrawal and may do so within 48 months of registration.

The results of all reviews will be communicated to you by your supervisor, or a deputy appointed by the supervisor, as soon as possible after the review, and normally within one week of presentations and one month of the submission of written reports.

Time frame for reports and presentations over the course of 4 year PhD

Progress Review	Report Submitted	Presentation Date	Feedback
18 month	End of March	Mid-April - organised by student	Within 1 month
24 month	End of September	n/a	Within 1 month
30 month	End of March	n/a	Within 2 weeks
36 month	Beginning of October	Meeting with panellists arranged by student	Within 2 weeks
42 month	End of March	n/a	Within 2 weeks

Thesis examination

A research thesis is normally examined by two examiners, a member of the Department and an external examiner who is an expert in the particular topic. The external examiner is usually a senior member of staff from another university.

Your supervisor will submit an Examiner Nomination Form, via the Student Support Office, to the Graduate School who will then send you further instructions on submitting your thesis. The Internal Examiner will then communicate with the External and your supervisor to arrange a suitable date for the viva. **All correspondence with your examiners prior to the viva should be done via your supervisor.**

After reading the thesis the examiners will hold an oral examination where you will be asked questions about your work and about your wider knowledge of the subject. Award of the PhD follows a satisfactory report from the examiners.

Minor revisions to a PhD thesis may be required. Alternatively, the degree of MPhil may be awarded instead of the PhD, or you may be required to resubmit the thesis with or without a further oral examination. Exceptionally, the examiners can decide not to award a degree.

Progress on the PhD programme

If at any stage in the review process the panel feels that you are failing to make adequate progress then they may recommend that you withdraw or write up for an MSc by Research or an MPhil. In such cases the Director of Postgraduate Studies, possibly in conjunction with Research Committee, will decide whether to allow you to progress. If the decision is not to allow you to progress then you are entitled to ask for a second review within 3 months. This is usually invoked automatically by the Department by devising a 3 month action plan. If the panel and the Director of Postgraduate Studies remain of the opinion that you are not making adequate progress then you will be required to withdraw or write up for an MSc by Research or MPhil. At this stage you may appeal to the University, subject to the rules and regulations for such appeals.

Further information on the progression processes at Warwick can be found here:

<http://www2.warwick.ac.uk/services/academicoffice/gsp/guidingyouthrough/guidelines/submissionsexaminations/infoforstudents>

10. Skills Learning

Transferable Skills Training

The DPhil is a period of professional research training during which you will develop advanced specialist skills and knowledge, as well as broader transferable skills to equip you for a range of careers.

You are expected to engage in at least 10 days of transferable skills training, per year and in fact we anticipate your spending rather more time than this.

Skills Training in year one (Oxford based)

You will need to ensure by the time you reach your Transfer of Status (18 months from the start of this programme), you have spent a minimum of 10 days on transferable skills courses. Engagement with transferable skills training is a requirement of your Transfer of Status. You will be directed to transferable skills courses/opportunities and you will need to keep your own record throughout the year. Here are some possible courses.

Foundation Phase: 0-12 months	Intensive Research Phase: 12-30 months	Completion Phase 24+months	Anytime during the DPhil
Finding Research Information	Conferences: Choosing, Funding, Networking	Finish your DPhil	Academic English
Foundations for a Successful DPhil	GRAD Challenge	Viva preparation & practice	Communication Science
Introduction to Research Data Management	Making a Difference: Applying your Research		Introduction to Public Engagement
Managing your supervisory relationship	Poster Design & Presentation		Translating your research into hands on activity
Narrative Skills	Scientific Writing: Getting your paper published		Scientific Writing: core skills
Presentation Skills	Teaching and Learning: Tutors & Class assistants		Thesis & report writing
	Navigator for men/ Springboard for women		

See the following for further information:

<http://www.mpls.ox.ac.uk/training/course-programme-for-graduate-students/training-framework-for-dphil-students>

<http://www.mpls.ox.ac.uk/training/course-programme-for-graduate-students>

Training in years two to four

In years 2-4 you will be encouraged to choose courses of interest to you from a wide array of courses on offer in the two universities to further develop your transferable skills. The MPLS Division also offers training to help you in your journey to become a successful researcher:

<https://weblearn.ox.ac.uk/portal/hierarchy/mpls/gap> (can only be accessed once you have your university single sign on and username).

Broadening Training

You will spend a minimum of 100 hours in training in mathematical and statistical methods outside your area in the course of your doctoral training. This is recorded and monitored at the key transition points in the degree. You can choose from a wide range of courses available to you at your university. At Oxford this is centrally organized through the MPLS Graduate Academic Program (GAP). Warwick students have similar freedom. 75 out of the 100 hours will be committed to Academy for PhD Training in Statistics (see below).

Academy for PhD Training in Statistics (APTS)

The Academy for PhD Training in Statistics is collaboration between major UK statistics research groups to organise courses for first-year PhD students in statistics and applied probability nationally. The intention of APTS is to provide courses which will be attractive and relevant to the research preparation and background education of all statistics and probability PhD students in the UK. You will gain a wide appreciation of other important statistical research themes through APTS, as well as enlarge your network of peer and senior research contacts. All CDT students are expected to attend as part of their fulfilment to the programme. The first three weeks of APTS are **mandatory** and you will be registered for these:

Week 1: Monday 11 – Friday 15 December 2016, Cambridge

Week 2: Monday 16 – Friday 20 April 2017, Nottingham

Week 3: Monday 9 July – Friday 13 July 2017, Southampton

Week 4: Monday 20 August – Friday 24 August 2017, Glasgow is optional.

You need to let the CDT Administrator know by **12 noon on Monday 24 October at the latest**, whether you will be applying for the final week. Please seek advice from the CDT Director and Co-Directors.

Each week is composed of two modules. You may not take individual modules: applications have to be for one or more whole APTS weeks. Students attending a module are expected to engage (before attendance) in a two-week period of preparatory study directed by web-based material; this is to enable students to ensure that they have covered prerequisites necessary for the module, and to enable the module leaders to make efficient use of the training-week time. After each module there will be an assignment (exercises or mini-project), to be undertaken back in the student's home institution and to be assessed by home-institution staff.

Applying for APTS weeks is a firm commitment to attend. Last minute cancellation of a place on an APTS week may cost several hundred pounds. More detail is available at the APTS website: <http://www2.warwick.ac.uk/fac/sci/statistics/apts/>.

Public Engagement

Public engagement is becoming increasingly important in the field of academia and is applicable to many other career paths also. The CDT aims to build a supportive culture for public engagement whereby each student from both Oxford and Warwick cohorts is involved in public engagement on a regular (at least annual) basis. Students are required to report back on their involvement in public engagement activities. An introductory training session on public engagement will be organised by the CDT. There is also support available from the MPLS division in terms of further training and opportunities to get involved with public engagement activities: <https://www.mpls.ox.ac.uk/support-services/get-inspired-and-develop-your-skills>

Enterprise Skills Programme

The MPLS Division has designed a programme of courses and events which use Enterprise as a forum for developing research skills and Research as a way of highlighting all that enterprise might offer: <https://www.mpls.ox.ac.uk/enterprise>

Industry Lunchtime Seminars i.e. "pizza lunches"

Throughout the programme, you will be encouraged to develop an awareness of the importance of your doctoral training not only within the international development of statistical methodology and analysis but also its relevance to industry and society. There will therefore be the opportunity to invite industrial partners to attend and speak at our industry lunchtime seminars, which will take place every Wednesday of the second week of the module.

Graduate Academic Program (GAP)

The GAP system allows MPLS students to book places on graduate training courses run in departments across the division. CDT courses are among those listed and small numbers of graduate students from other departments regularly attend CDT modules on a one off basis.

Lists of available courses and instructions on booking can be found at:

<http://www.mpls.ox.ac.uk/training/course-programme-for-graduate-students/welcome-to-the-graduate-school-and-the-graduate-academic-programme>

Departmental Graduate student poster presentations

For Oxford students, in your second and third year you will be expected to present a poster at the departmental graduate poster session which takes place in late Hilary or Trinity Term. This is an opportunity to showcase your research to other students and members of the faculty. This will be replaced by a talk to the wider department in your fourth year. OxWaSP students are also expected to present posters at the Annual Workshop in early October.

Seminars in Statistics

The Department of Statistics organises distinguished speaker seminars usually on Fridays during term. Further information can be found at http://www.stats.ox.ac.uk/events/distinguished_seminars.

Probability Workshops

Probability workshops take place every Monday 12:00 – 13:15 during term time at the Mathematical Institute, Andrew Wiles Building, Radcliffe Observatory Quarter.

https://www.stats.ox.ac.uk/events/probability_workshops

Reading Groups

See <https://www.stats.ox.ac.uk/events> for links to other departmental reading groups.

Departmental Graduate Lectures

Students are also welcome to attend the Graduate Lectures,

http://www.stats.ox.ac.uk/events/graduate_lectures, which are aimed specifically at research students.

Teaching

Being taught to teach is regarded as a fundamental part of training for an early career researcher and an opportunity for you to engage and be integrated into the life of your host department. Starting in the second year, you will teach in your host department. This will be approximately 12 contact hours (paid) per year for years 2-4. Warwick students will deliver half these hours in each of the first two terms. You may teach undergraduate or graduate courses. This is mentored teaching, beginning with marking, to reach a point where you are leading whole classes of 10 or 12 undergraduate students. You will have the support of a mentor and get written feedback at the end of each block of teaching.

Oxford based students wishing to take on additional paid college-based teaching should check with their supervisor and the Director of Studies, Dr Neil Laws (laws@stats.ox.ac.uk), before making any commitment. This does not count towards the 12 hours of teaching the Department expects.

Conference Attendance/Travel Funding

OxWaSP has provision for travel for research collaboration and training. Besides the regular travel between Oxford and Warwick, there is funding for an annual workshop, a two-day retreat for first year students, the Amazon study trip to Berlin in the second year, and the international study visit in third year. There is also up to £1000 in EPSRC and MRC funding to support one or more conference trips for each student for the programme duration. Additional monies may be available from your college and from your Department. You should discuss conference travel with your supervisor in your second year.

Internships

There are opportunities to undertake industrial placements and have joint supervision from industry. The CDT has a number of partners in industry, including some of the world's leading pharmaceutical, consumer, technology, and finance firms. You may have the opportunity to spend some time in your first year with one of these partners as part of your mini-project work. This will depend on the availability of joint projects, though you may have a hand in shaping these if you are keen. You should discuss your interests with potential supervisors. There will also be the potential to work on joint projects with our industrial partners for your thesis.

Students who wish to undertake a work placement or internship should discuss this with their supervisor in the first place and obtain the department's agreement in advance of organising the placement/internship which should be well justified, i.e. related to the student's training as well as providing valuable transferable skills. An agreement from the department is subject to a satisfactory status of the student's academic progression and agreement from supervisor.

The placement may be an integral part of the PhD, in which case a suspension/temporary withdrawal of the student's registration time is not required, provided the placement meets the rules of the funder/sponsor (see below). In other cases the internship is not directly integral to the PhD and the student will be required to suspend the PhD which usually is a preferable solution as it 'stops the clock' with respect to the registration time and thus does not eat into the total time available for PhD research.

Students who wish to take an internship or placement need to make sure they are acting according to the rules of their funders/sponsors. In particular, students receiving funding from the EPSRC or RCUK (check with the CDT Administrator if you are unsure) are required to adhere to the **Training Grant guidelines** of their scholarship available at <http://www.rcuk.ac.uk/documents/publications/traininggrantguidance-pdf/> and should be aware, that if they are receiving payment for the placement then the studentship must be suspended.

11. Resources

Computing

Students will be provided with a computer and desk space in a shared office. For the first year, this will be located in an office shared with other CDT students. When Oxford students begin their DPhil research, they move to an office shared with other DPhil students in their research group, until the end of year 4.

Students have access to the Department of Statistics computing facilities. Other courses, particularly those on high-level programming languages, which are provided by the University's IT Services in Banbury Road may be of interest to students <http://www.it.ox.ac.uk/>.

You should also make yourself aware of the following departmental documents:

Guide to Computing Services
Guidelines for Examining Users' Data
Security and Privacy of Files
Policy Statement on Computer Use, Monitoring and Surveillance.

These are available at http://www.stats.ox.ac.uk/about_us/it_information/generalaccess/new_users_start_here along with details of how to use your laptop on the Oxford Wireless LAN.

Libraries

The Department of Statistics has its own small library in G.01 (ground floor).

The University Card also serves as a library card and will allow access to the Radcliffe Science Library (RSL) in Parks Road, and also the Social Studies Library, Manor Road. A map can be found at <http://www.ox.ac.uk/visitors/maps-and-directions/museums-libraries-and-places-of-interest>.

The Physical Sciences Librarian with responsibility for the statistics collection in the RSL is Ljilja Ristic (email ljilja.ristic@bodley.ox.ac.uk). A specific training session for statistics research is held in Michaelmas Term. Nuffield College, located on New Road, has a good selection of staff books which can be borrowed by statistics research students.

College libraries may also be useful although access is usually restricted to members of that college.

Links to the University's e-resources, including electronic journals can be found at <http://www.bodleian.ox.ac.uk/english/eresources>

Process for borrowing a book at Department of Statistics

A current University card is required for registering and for entry to the library.

Most of the departmental books and journals are catalogued on SOLO, the University's on-line catalogue. SOLO can be accessed through the library terminal. The lending books are currently undergoing a process of re-shelving using **Library of Congress** classifications (eg QA273 for Probability and QA276 for Mathematical Statistics). Shelves have been marked accordingly.

The other library sections are as follows:

100. White spine labels - Main statistics lending section
200. Yellow - Probability and operational research
300. Green - Genetics and Biology

400. Orange - Mathematics and computation

700. Gold - Reference only. These books may not be borrowed.

The books in each of the main sections are in alphabetical order of the surname of the first author or editor.

Dissertations and theses are for reference only.

Books are borrowed on a self-issue basis by scanning into the self-issue computer firstly the barcode from the reader's University card, and then the barcode sticker inside the front cover of the book to be borrowed.

Each book borrowed **must be recorded** on the self-issue computer in the library. Stolen books have to be replaced, reducing the budget for new books.

To return a book

Books should be left in the **returns box** in the library. If books are overdue then reminder notices will be sent out by email. If a book is reserved by another reader or needs to be recalled then a reader may receive a notice, again by email.

To reserve a book

Reservation requests can be made via SOLO, the University's library catalogue. Reserved books can be collected from Hannah Harrison in room G.11.

Loan periods

Research students can borrow books for four weeks and then can renew them online unless recalled by the library.

Loans may be renewed either by using SOLO before the due date, by checking them out again, or by e-mailing lib@stats.ox.ac.uk

Rules of conduct

These rules apply to all library readers. Breaches of library rules may lead to suspension of borrowing privileges, fines or suspension from the use of the library.

- Every book borrowed must be recorded on the self-issue computer in the library. Books must be returned by the due date or renewed. Any book recalled by the library must be returned as soon as possible.
- Returned books must be replaced in the returns box. A reader is responsible for a book until it is returned to the library.
- Replacement costs will be charged for lost, damaged or defaced books.
- The library self-issue and catalogue computers **must not** be unplugged or switched off.
- Personal belongings should not be left unattended in the library at any time. Any such items will be removed. The Department will not be responsible for personal belongings which are stolen or damaged.
- Photocopies may only be made in compliance with copyright law.

12. Administrative Matters

Programme Management

Management Committee

OxWaSP will be managed on a day-to-day basis by a management committee. The membership of this committee is as follows:

Director (Prof Chris Holmes, Oxford)
Co-Director, Oxford (Prof François Caron)
Co-Director, Warwick (Prof Jim Smith)
CDT Administrator (Joanna Stoneham)
Director of Graduate Studies, Oxford (Prof Gesine Reinert)
Director of Graduate Studies, Warwick (Prof Wilfrid Kendall)
Two academics from Warwick
Two academics from Oxford

External Advisory Board

Our External Advisory Board provides independent advice to the Management Committee to help it achieve its aims. This includes building links with industrial partners and maximising opportunities for international collaboration in training. Our members are:

Anthony Ledford (AHL)
Marc Kennedy (Food and Environment Research Agency FERA)
Andrew Rose (Lubrizol)
Chris Holmes (University of Oxford)
Jim Smith, Co-Director, (University of Warwick)
François Caron, Co-Director (University of Oxford)
Joanna Stoneham, CDT Administrator (University of Oxford)
Martine Barons (University of Warwick)
Wilfrid Kendall (University of Warwick)
Geoff Nicholls (University of Oxford)
Byron Jones (Novartis)
Michele Erat (EPSRC)

Attendance

During the taught modules in the first year you are expected to attend the CDT from Monday - Friday. Days 1 – 2 and 10 of each two week module, are predominantly teaching days. Days 3 – 9 inclusive typically require you to work on your project either individually or in teams. This also includes all organised events: workshops, away days, mini-symposia, graduate seminars and poster presentations. If you need to be away for some good reason, please ask a member of staff. It is important you let your module leader and the CDT Administrator know if you are going to be absent at any point. Attendance is full time and this should be reflected in your hours ~ 40 hours a week.

Holidays

You should agree any days off in the working week (Monday-Friday) with your Module Leader or Supervisor, depending on the time of the year. In the first year, your holiday is built into the timetable (see p37). For years 2-4, as a minimum you should take 20 workdays leave in addition to bank holidays (8 days) and periods of fixed closure for the Department (at Christmas and Easter, 6 days in total).

Absence/Illness

If you are unable to attend the CDT due to illness or unforeseen circumstances, please you contact the CDT Administrator, stoneham@stats.ox.ac.uk, as soon as possible. It is important for us to know your whereabouts as we have a duty of care.

Residence Requirements (Oxford)

For information required minimum residence requirements regarding your DPhil for Oxford students, please see

<http://www.ox.ac.uk/admissions/graduate/why-oxford/living-oxford/accommodation#residency>

Student parents

Information for students who are, or who are about to become parents can be found at

<https://www.ox.ac.uk/students/welfare/childcare?wssl=1>

Travel Insurance

Where students are travelling on University of Oxford business, a University travel insurance scheme operates. Please consult the CDT Administrator, room G.11, before making travel bookings; application and risk assessment forms should be completed if insurance is required.

Statement of Expectation for RCUK students

The Research Councils have released a single statement on how research organisations, students and their respective training environments must operate for all students funded by RCUK.

<http://www.rcuk.ac.uk/documents/skills/statementofexpectation-pdf/>.

Academic Integrity and the avoidance of Plagiarism

Academic integrity

The University's code of practice concerning academic integrity in research is set out on the website at <http://www.admin.ox.ac.uk/personnel/cops/researchintegrity/>, and, while the code's principles relate specifically to the conduct of research, *all* graduate students are advised to make themselves aware of the document's contents. The University code of practice on Public Interest Disclosure can be found at <http://www.admin.ox.ac.uk/personnel/cops/pid/>.

Plagiarism

University Definition – see <http://www.ox.ac.uk/students/academic/guidance/skills/plagiarism>

Plagiarism is the copying or paraphrasing of other people's work or ideas into your own work without full acknowledgement. All published and unpublished material, whether in manuscript, printed or electronic form, is covered under this definition. Collusion is another form of plagiarism involving the unauthorised collaboration of students (or others) in a piece of work.

Cases of suspected plagiarism in assessed work are investigated under the disciplinary regulations concerning conduct in examinations. **Intentional or reckless plagiarism may incur severe penalties, including failure of your degree or expulsion from the university.**

Why does plagiarism matter?

It would be wrong to describe plagiarism as only a minor form of cheating, or as merely a matter of academic etiquette. On the contrary, it is important to understand that plagiarism is **a breach of academic integrity**. It is a principle of intellectual honesty that all members of the academic community should acknowledge their debt to the originators of the ideas, words, and data which form the basis for their own work. Passing off another's work as your own is not only poor scholarship, but also means that you have failed to complete the learning process. Deliberate plagiarism is unethical and can have serious consequences for your future career; it also undermines the standards of your institution and of the degrees it issues.

What forms can plagiarism take?

- **Verbatim quotation of other people's intellectual work without clear acknowledgement.** Quotations must always be identified as such by the use of either quotation marks or indentation, with adequate citation. It must always be apparent to the reader which parts is your own independent work and where you have drawn on someone else's ideas and language.
- **Paraphrasing the work of others by altering a few words and changing their order,** or by closely following the structure of their argument, is plagiarism because you are deriving your words and ideas from their work without giving due acknowledgement. Even if you include a reference to the original author in your own text you are still creating a misleading impression that the paraphrased wording is entirely your own. It is better to write a brief summary of the author's overall argument in your own words than to paraphrase particular sections of his or her writing. This will ensure you have a genuine grasp of the argument and will avoid the difficulty of paraphrasing without plagiarising. You must also properly attribute all material you derive from lectures.
- **Cutting and pasting from the Internet.** Information derived from the Internet must be adequately referenced and included in the bibliography. It is important to evaluate carefully all material found on the Internet, as it is less likely to have been through the same process of scholarly peer review as published sources.

- **Collusion.** This can involve unauthorised collaboration between students, failure to attribute assistance received, or failure to follow precisely regulations on group work projects. It is your responsibility to ensure that you are entirely clear about the extent of collaboration permitted, and which parts of the work must be your own.
- **Inaccurate citation.** It is important to cite correctly, according to the conventions of your discipline. Additionally, you should not include anything in a footnote or bibliography that you have not actually consulted. If you cannot gain access to a primary source you must make it clear in your citation that your knowledge of the work has been derived from a secondary text (e.g. Bradshaw, D. *Title of book*, discussed in Wilson, E., *Title of book* (London, 2004), p. 189).
- **Failure to acknowledge.** You must clearly acknowledge all assistance which has contributed to the production of your work, such as advice from fellow students, laboratory technicians, and other external sources. This need not apply to the assistance provided by your tutor or supervisor, nor to ordinary proofreading, but it is necessary to acknowledge other guidance which leads to substantive changes of content or approach.
- **Professional agencies.** You should neither make use of professional agencies in the production of your work nor submit material which has been written for you. It is vital to your intellectual training and development that you should undertake the research process unaided.
- **Autoplagiarism.** You must not submit work for assessment which you have already submitted (partially or in full) to fulfil the requirements of another degree course or examination.

The necessity to reference applies not only to text, but also to other media, such as computer code, illustrations, graphs, etc. It applies equally to published text drawn from books and journals, and to unpublished text, whether from lecture hand-outs, theses or other students' essays. You must also attribute text or other resources downloaded from websites.

Cases of apparently deliberate plagiarism are taken extremely seriously, and where examiners suspect that this has occurred, they bring the matter to the attention of the Proctors. Your attention is drawn to the Proctors' and Assessor's Memorandum, Section 9.5, 'Conduct in Examinations' and in particular to sections 4 and 5 and the concluding paragraph of the section:

4 No candidate shall present for an examination as his or her own work any part or the substance of any part of another person's work.

5 In any written work (whether thesis, dissertation, essay, coursework, or written examinations) passages quoted or closely paraphrased from another person's work must be identified as quotations or paraphrases, and the source of the quoted or paraphrased material must be clearly acknowledged.

Although the University strongly encourages the use of electronic resources by students in their academic work, any attempt to draw on third-party material without proper attribution may well attract severe disciplinary sanctions.

13. Student Support

MPLS Division Postgraduate Research information (here you will find lots of useful information relating to the processes for DPhil students in Oxford):

<https://www.mpls.ox.ac.uk/graduate-school/information-for-postgraduate-research-students>

Welfare

Students are always welcome at any time to discuss their concerns with the CDT Director, Co-Directors, CDT Administrator, Academic Administrator and any other member of the department they feel comfortable with.

Support is also available via College Advisors and College Offices.

Every graduate student at Oxford has a College Adviser, who is an academic member of his or her College, usually a Fellow.

The role of the College Adviser is additional and complementary to that provided in the student's department or faculty. The College Adviser is not expected to perform the role of the Department Supervisor, or to be responsible for directing students' academic work. Rather, the intention is to provide a focal point for an individual student's relationship with the College, and general academic or pastoral advice and assistance throughout the student's course of study.

Other sources of advice and help include:

Student Counselling Service	http://www.ox.ac.uk/students/welfare/counselling/
Oxford University Student Union	http://ousu.org/advice/life-welfare/supportservices/
Nightline	http://users.ox.ac.uk/%7Enightln/
Current information for students – health and welfare	http://www.ox.ac.uk/students/shw/

Harassment

The Departmental advisors on matters of harassment are Ms Hannah Harrison (room G.11), tel. x82857, email hannah.harrison@stats.ox.ac.uk or Dr Neil Laws (room 1.04), tel. x72597, email laws@stats.ox.ac.uk. The University's *Policy on Harassment including Bullying* can be found at www.admin.ox.ac.uk/eop/harassmentadvice/

Disability

The Disability Co-ordinator is Mrs Jan Boylan (room G.09, tel. x 72870, email academic.administrator@stats.ox.ac.uk). The academic departmental Disability Lead is Dr Neil Laws (room 1.04), tel. x72597, email laws@stats.ox.ac.uk.

For University guidance and support please refer to www.admin.ox.ac.uk/eop/disab/ and www.ox.ac.uk/students/welfare/disability/.

Childcare Services

Information on the University's childcare services can be found at <http://www.admin.ox.ac.uk/childcare/>

University policies

The University has a wide range of policies and regulations that apply to students. These are easily accessible through the A-Z of University regulations, codes of conduct and policies available on the Oxford Students website www.ox.ac.uk/students/academic/regulations/a-z.

These policies include:

Equal Opportunity Policy for Students <http://www.admin.ox.ac.uk/eop/policy/equality-policy/>

Code of conduct for using IT facilities www.it.ox.ac.uk/rules/

Financial matters

- Information on fees and funding matters can be found at http://www.ox.ac.uk/students/fees_funding_living_costs/
- Information on the length of time given to pay your fees can be found at <http://www.ox.ac.uk/students/fees-funding/fees/liability>
- Information on continuation charges can be found here <http://www.ox.ac.uk/students/fees-funding/fees/liability/graduate-continuation-charge>

The Careers Service

The University Careers Service can be found at 56 Banbury Road with a website at <http://www.careers.ox.ac.uk/>. It is a free service for all Oxford University students including postgraduates, and also for alumni. It provides one to one guidance, support and advice; information on occupations, vacancies and further study; feedback on CVs and application forms; and skills coaching for preparing for interviews and making applications.

The Careers Service also runs the University Internship Programme <http://www.careers.ox.ac.uk/internship-office-and-work-experience/the-internship-programme/>.

University Language Centre

International students, whose first language is not English, are strongly advised to visit the University Language Centre to find out more about the courses on topics such as Academic Writing and Advanced Communication Skills which run during term time. These have a registration fee for graduate students. Details are available at <http://www.lang.ox.ac.uk/courses/english.html>.

Complaints and Appeals

Student complaints regarding any aspect of the first year training at Oxford or Warwick will be handled through the complaints system at Oxford. Complaint issues in later years will be handled by the student's host university. Discipline cases for year 1 students will be referred to Oxford. Oxford will share information with Warwick relating to such cases.

Oxford

<https://www.ox.ac.uk/students/academic/complaints?wssl=1>

http://www.stats.ox.ac.uk/current_students/research_degrees/complaints_and_appeals

Warwick

<https://www2.warwick.ac.uk/services/academicoffice/gsp/guidingyouthrough/guidelines/afteryourexaminations/appeals/>

<http://www2.warwick.ac.uk/services/aro/studentfeedbackandcomplaints>

14. Facilities

Access to the Department of Statistics, Oxford, 24-29 St Giles'

The Department's building at 24-29 St Giles' is accessible by the University card 24 hours a day, 7 days a week including bank holidays; administrative staff are on duty from 8.30 am to 5.00 pm (Monday to Friday).

Care of Buildings

As there is no caretaker for the building, we ask all users of the building to help with security. Please leave doors secure and follow the security notices. Please report any building problems needing attention to building@stats.ox.ac.uk.

Recycling is encouraged. Paper, cardboard, drinks cans, food tins, plastic bottles and marked plastic items (recycling types 1,2,3,5 or 6) should be put in the green topped recycling bins. All recyclables must be empty or rinsed out. No food, liquid or glass should be put in the recycling bins.

Please avoid using the lift out of general office hours, if possible, for safety reasons.

Kitchen facilities

Facilities and provisions for making tea and coffee are on the ground, first, second and third floors. There is also a coffee machine in the ground floor kitchen. The fridges are kept stocked with milk, but otherwise are available for use for storage of small quantities of perishable food. Please keep the kitchen and tea points tidy. Microwaves are also available in the ground floor kitchen.

Please do not take food or drink into the LG.01, LG.02 or LG.03 lecture and teaching rooms.

Post

Pigeonholes for receiving mail and notices on the ground floor are appropriately marked for department members and graduate students.

University Messenger Service collects and delivers mail for the departments and colleges of the University. Items can be left for collection in the tray in Reception.

Telephones

Currently all telephones in public areas have access for internal University use and 999 calls only.

Lost property

Items which have been found are lodged at Reception. Uncollected items are disposed of at the end of each term.

Emergencies, security and safety

Fire:

Please read the blue fire-action notices posted in the buildings and familiarise yourself with the escape routes. If there is a fire emergency, immediately break the glass on the nearest fire alarm point and then call both Security Services (89999) and the Fire Brigade ((9)999). Operate extinguishers only if this does not put you at risk and otherwise vacate the building immediately.

On hearing the fire alarm ringing please leave the building immediately. **DO NOT** stop to pick up your belongings. The assembly point is on the corner of the Physics building in Keble Road. Do not re-enter the building until told by someone in authority that it is safe to do so. Someone in authority means either the Head of Department, the Administrator, Deputy Administrator, or in their absence a fire officer.

Security:

Theft of personal items does occur from time to time. It is important to remain aware of this and help maintain the security of the buildings. Personal belongings should not be left unattended at any time.

The University Security Service can be reached by phone on 89999.

First Aid: lists of qualified First Aiders are posted on each floor and there is a First Aid Kit in the ground floor kitchen. Out of hours, please phone 89999 for first aid assistance. For an ambulance phone (9)999.

Fires, security alerts and serious accidents must be reported to the Administrator or Deputy Administrator and the scene of report must remain undisturbed.

Department of Statistics
University of Oxford
24-29 St Giles'
Oxford
OX1 3LB

Tel: +44 1865 272860 (Reception)
Departmental web-site: www.stats.ox.ac.uk/

Emergency telephone numbers (from any phone) are:
UNIVERSITY SECURITY SERVICES: 89999
FIRE BRIGADE, AMBULANCE SERVICE, POLICE: (9) 999

OxWaSP TIMETABLE 2017-2018

W/C	Ox Term	Monday	Tuesday	Wednesday	Thursday	Friday	
02-Oct	MT 0	Induction at Oxford	Induction at Warwick	College Day	Skills training	Annual workshop	
09-Oct	MT 1	Module 1: Computational Statistics and Statistical Computing					
16-Oct	MT 2						Warwick symposium
23-Oct	MT 3	Module 2: Applied Statistics					
30-Oct	MT 4						Warwick symposium
06-Nov	MT 5	Module 3: Probability and Approximation					
13-Nov	MT 6						Warwick symposium
20-Nov	MT 7	Module 4: Network Analysis					
27-Nov	MT 8						Warwick symposium
04-Dec	MT 9	Preparation for APTS			Industry event - TBC		
11-Dec	MT 10	APTS week 1 - Cambridge					
18-Dec		Holiday					
25-Dec		Holiday					
01-Jan	HT -1	Holiday					
08-Jan	HT 0	Reading week			Mini-project showcase		
15-Jan	HT 1	Module 5: Time Series and Stochastic Processes					
22-Jan	HT 2						Warwick symposium
29-Jan	HT 3	Module 6: Bayesian Inference					
05-Feb	HT 4						Warwick symposium
12-Feb	HT 5	Module 7: Stochastic Simulation					
19-Feb	HT 6						Warwick symposium
26-Feb	HT 7	Module 8: Machine Learning					
05-Mar	HT 8						Warwick symposium
12-Mar	HT 9	Consideration of mini-projects					SUBMIT MINI-PROJECT 1 CHOICE

Additional departmental events to note:

Wednesday 8 th November, 3.30pm – 6.00pm	Florence Nightingale Lecture given by Sir Andrew Dilnot followed by drinks reception
Friday 10 th November, 3.30pm	Distinguished Speaker Seminar – Chris Bishop, Lab Director, Microsoft Research Cambridge
Friday 24 th November, 3.00-4.30pm	Corcoran Memorial Prize Award and Lecture

19-Mar	HT 10	Holiday	
26-Mar		Holiday	
02-Apr		Holiday	Mini project 1
09-Apr		Preparation for APTS/Mini project 1	
16-Apr	TT 0	APTS week 2 - Nottingham	
23-Apr	TT 1	Mini project 1	
30-Apr	TT 2	Mini project 1	
07-May	TT 3	Mini project 1	
14-May	TT 4	Mini project 1	
21-May	TT 5	Mini project 1	SUBMIT MINI-PROJECT 2 CHOICE
28-May	TT 6	Mini project 1	
04-Jun	TT 7	Mini project 1	SUBMIT MP 1
			Full cohort event - Oxford
11-Jun	TT 8	Holiday	
18-Jun	TT 9	Mini project 2	
25-Jun	TT 10	Mini project 2	
02-Jul		Preparation for APTS/Mini project 2	
09-Jul		APTS week 3 - Southampton	
16-Jul		Mini project 2	
23-Jul		CUDA	
30-Jul		Mini project 2	
06-Aug		Mini project 2	
13-Aug		Preparation for APTS/Mini project 2	
20-Aug		APTS week 4 - Glasgow	
27-Aug		Mini project 2	SUBMIT SUP CHOICE
03-Sep		Mini project 2	SUBMIT MP 2
10-Sep			1 st Year Retreat
			Holiday
17-Sep		Holiday	
24-Sep	MT -1	Holiday	