

**apts**.ac.uk  
Academy for PhD Training in Statistics

WEEK 1: UNIVERSITY OF CAMBRIDGE  
14th–18th December 2015

**EPSRC**

Engineering and Physical Sciences  
Research Council

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# Welcome to Cambridge!

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**Workshop registration:** Registration for the APTS week will take place between 11.15am and 12.45pm on Monday 14th December 2015 just inside the main entrance to the Centre for Mathematical Sciences.

You will receive your name badge from the registration desk. Please wear your badge at all times. This will help with security and also help you identify fellow participants.

**Luggage:** You will be able to leave luggage safely in the Centre for Mathematical Sciences on Monday 14th December and Friday 18th December.

**IT:** You are encouraged, if possible, to bring a laptop with R installed for taking part in the Statistical Computing practical sessions. There will also be a computer lab of desktop computers available for the practical sessions.

For email and internet access during lunch times and breaks, you may use the computers in the computer lab GL.04 which is located in the lower ground floor of the Centre for Mathematical Sciences (number 4 on the map). Login and password details will be included in your information pack which you can pick up at the workshop registration.

**Accommodation location:** Most of the APTS participants will be staying on the main Churchill College site, which is a few minutes walk away from the Centre for Mathematical Sciences (see the map).

**Car Parking:** Car parking is available at Churchill College. Please provide your car registration number when you check in at the Porters' Lodge in Churchill. You may park in Churchill along Churchill Road or in the car park at the end of Churchill Road (see the second map).

**Your room:** Workshop participants with accommodation have been booked into single rooms. Bed linen and bath towels will be provided. Bathroom facilities are shared between about six participants. There are tea and coffee making facilities in each bedroom.

Wi-Fi is available, via the Churchill College wireless network, in all bedrooms, meeting rooms and public areas. A wired connection is also available in bedrooms and requires an Ethernet cable. Cables are available for £4.00 at the Porters' Lodge if delegates wish to use a wired connection and are unable to bring their own. No log-in or password is required. There is a maximum download limit of 1GB (gigabyte) for WiFi and 2GB for wired access. Should this limit be exceeded, internet access will be interrupted for a 24 hour period.

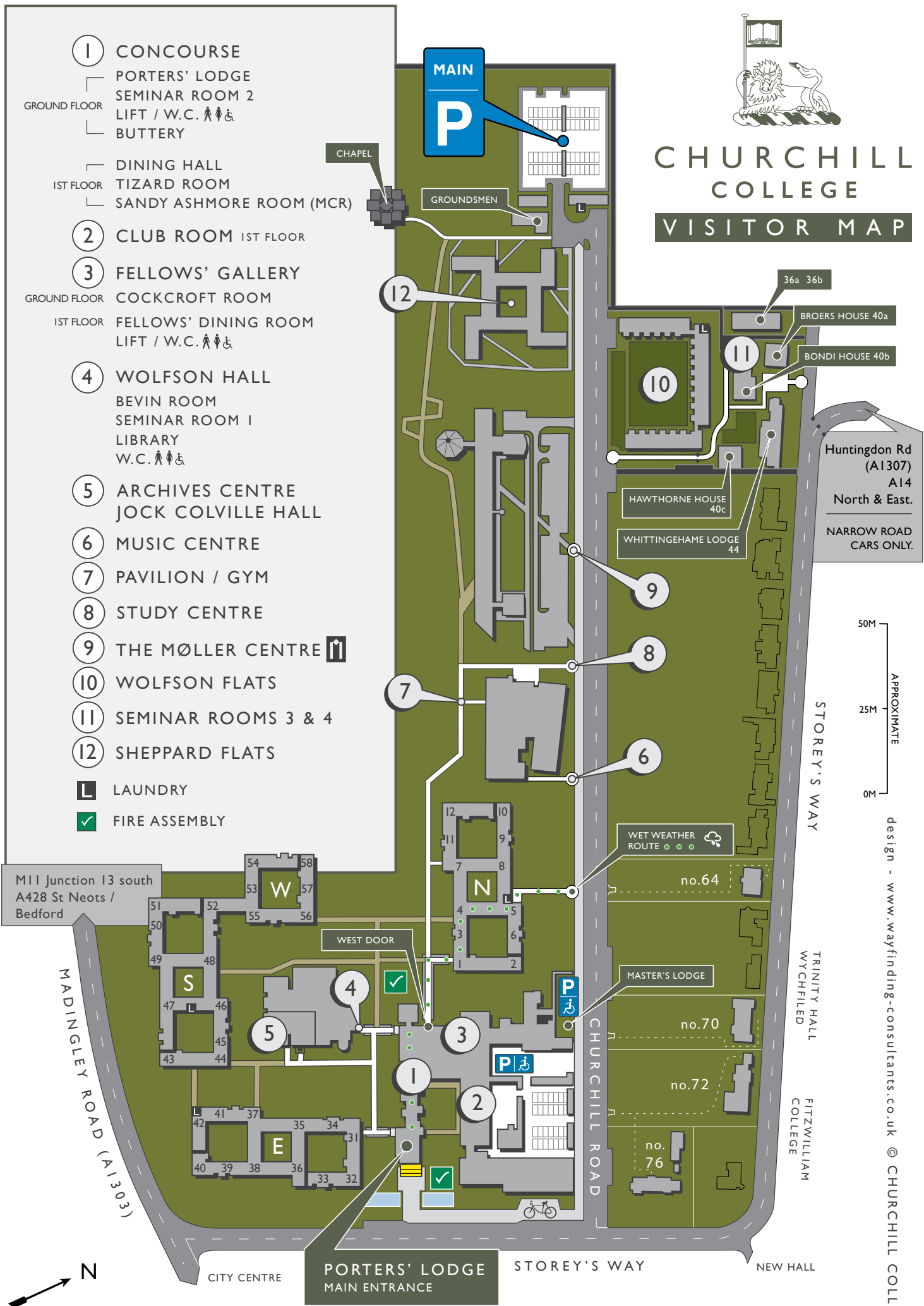
**Checking in/out your room:** On Monday 14th December, you should report to the Porters' Lodge at Churchill College to check in to your accommodation. Rooms will be available after 2pm (guaranteed; it is very likely that it will be possible to check in earlier) for check in. Please vacate your room by 10am on the day of departure.

**Meals:** All meals (with the exception of the Academy Dinner) will take place in the main Dining Hall of Churchill College. Breakfast will be from 07.30-09.30, lunch from 12.15-13.45 and dinner from 17.45-19.15 (although you should bear in mind the evening activities beginning at 7.30pm on Monday and Tuesday when deciding when to have dinner). You are booked in for a 2-course lunch and dinner at Churchill.



# CHURCHILL COLLEGE

## VISITOR MAP



- ① CONCOURSE
- PORTERS' LODGE
- SEMINAR ROOM 2
- LIFT / W.C. ♿
- BUTTERY

GROUND FLOOR

- DINING HALL
- TIZARD ROOM
- SANDY ASHMORE ROOM (MCR)

1ST FLOOR

- ② CLUB ROOM 1ST FLOOR

- ③ FELLOWS' GALLERY

GROUND FLOOR

COCKCROFT ROOM

1ST FLOOR

FELLOWS' DINING ROOM

LIFT / W.C. ♿

- ④ WOLFSON HALL

BEVIN ROOM

SEMINAR ROOM 1

LIBRARY

W.C. ♿

- ⑤ ARCHIVES CENTRE
- JOCK COLVILLE HALL

- ⑥ MUSIC CENTRE

- ⑦ PAVILION / GYM

- ⑧ STUDY CENTRE

- ⑨ THE MØLLER CENTRE

- ⑩ WOLFSON FLATS

- ⑪ SEMINAR ROOMS 3 & 4

- ⑫ SHEPPARD FLATS

LAUNDRY

FIRE ASSEMBLY

M11 Junction 13 south  
A428 St Neots /  
Bedford

MADINGLEY ROAD (A1303)

N

PORTERS' LODGE  
MAIN ENTRANCE

STOREY'S WAY

NEW HALL

STOREY'S WAY

TRINITY HALL  
WYCHFIELD  
FITZWILLIAM  
COLLEGE

WET WEATHER  
ROUTE

MASTER'S LODGE

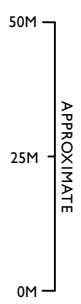
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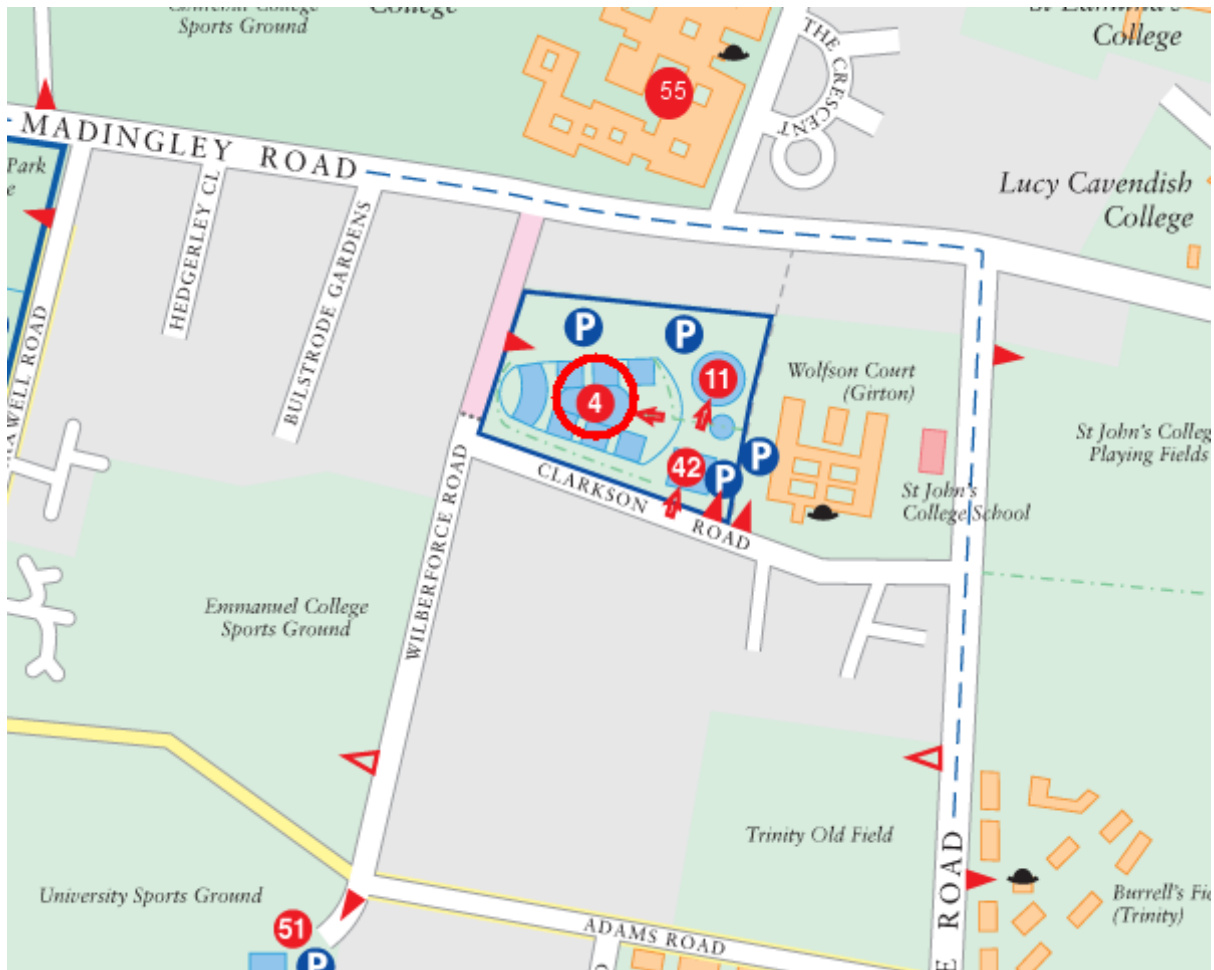
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Huntingdon Rd  
(A1307)  
A14  
North & East.  
NARROW ROAD  
CARS ONLY.



design - www.wayfinding-consultants.co.uk © CHURCHILL COLLEGE.



4 Department of Applied Mathematics and Theoretical Physics (DAMTP)  
 Department of Pure Mathematics and Mathematical Statistics  
 Cambridge Computational Biology Institute (CCBI)  
 Cambridge eScience Centre  
 Centre for Mathematical Sciences  
 Centre for Theoretical Cosmology  
 Institute for Aviation and the Environment  
 Institute of Theoretical Geophysics  
 Millennium Mathematics Project  
 Statistical Laboratory

11 Betty and Gordon Moore Library

42 Isaac Newton Institute for Mathematical Sciences

51 Sports clubs of the University - Athletics  
 Sports clubs of the University - Hockey  
 Wilberforce Road Sports Ground

55 Churchill College

## APTS timetable

	Monday 14th Dec	Tuesday 15th Dec	Wednesday 16th Dec	Thursday 17th Dec	Friday 18th Dec
09.15 – 10.45		<b>Statistical Inference</b>	<b>Statistical Inference</b>	<b>Statistical Inference</b>	<b>Statistical Inference</b>
10.45 – 11.15		Tea and Coffee			
11.15 – 12.45	Registration	<b>Statistical Computing</b>	<b>Statistical Computing</b>	<b>Statistical Computing</b>	<b>Statistical Computing</b>
12.45 – 13.45	Lunch				End
13.45 – 15.15	Welcome <b>Statistical Inference</b>	<b>Statistical Inference</b>	Free Afternoon	<b>Statistical Inference</b>	
15.15 – 15.45	Tea and Coffee			Tea and Coffee	
15.45 – 17.15	<b>Statistical Computing</b>	<b>Statistical Computing (Practical session)</b>		<b>Statistical Computing (Practical session)</b>	
18.00 – 21.00	Dinner				
Evening	RSS Reception (19.30 – 20.45)	Pub Quiz (19.30 – )	Free evening	Academy dinner sponsored by ATASS Sports (19.30 – )	

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## Local information

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**Location of lectures:** All APTS lectures and workshops will take place in the Centre for Mathematical Sciences. The lectures will be held in MR2; the practical sessions will be in MR3, GL.04 and DL.07. All of these rooms are on the lower ground floor.

**Tea and coffee breaks:** Refreshments will be served in the central core of the Centre for Mathematical Sciences (on the ground floor, the same floor as reception).

**Evening events:** The Royal Statistical Society has very generously decided to host a reception on Monday 14th December at which refreshments will be served. The reception will take place in the central core of the Centre for Mathematical Sciences (just inside the main entrance) from 7.30pm to 8.45pm.

The Tuesday evening event, a Pub Quiz, will begin at 7.30pm in Churchill College Bar.

The Academy Dinner, sponsored by ATASS Sports, will take place at St John's College at 7.30pm on Thursday 17th December. A map showing St John's College will be included in your information pack.

**Sports facilities:** Several sports facilities are available at the Kelsey Kerridge sports centre (see <http://www.kelseykerridge.co.uk> for details and prices). Furthermore, next door is the Parkside swimming pool (see <http://www.better.org.uk/leisure/parksidepools>). These facilities are about 2 miles from Churchill College.

**Things to do in Cambridge:** Cambridge is a beautiful and historic city with many local attractions. Some suggestions on activities of interest are given below:

**Visiting Colleges.** Most of the Colleges admit tourists, though there may be a small entrance fee. The local organiser would be happy to provide advice on particular Colleges to visit.

**Fitzwilliam Museum.** The Fitzwilliam Museum (<http://www.fitzmuseum.cam.ac.uk>) houses world-class collections of works of art and antiquities spanning centuries and civilisations. Highlights include masterpieces of painting from the fourteenth century to the present day, drawings and prints, sculpture, furniture, armour, pottery and glass, oriental art, illuminated manuscripts, coins and medals and antiquities from Egypt, the Ancient Near East, Greece, Rome and Cyprus.

**University Botanical Gardens.** Another popular site is the University Botanical Gardens, "A 40 acre oasis of beautifully landscaped gardens and glasshouses right in the heart of the city" (<http://www.botanic.cam.ac.uk>).

**River Cam.** If the weather is good, you might like to try punting on the river Cam (<http://www.scudamores.com>). You can either hire punts yourselves or have a chauffeured tour.

**Local cafes, restaurants, pubs, shopping centres etc.** The local organiser will be happy to offer advice on local cafes, pubs, restaurants, shopping centres, cinemas and theatres.

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## Emergency details

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**Medical Assistance:** Please contact a local member of staff who will alert the appropriate services.

**Messages:** The telephone number for colleagues or family to leave an urgent message for you during office hours is +441223 765000. For emergency messages outside these times, please call the main University Switchboard on +441223 337733.

**Fire Procedures:** If the fire alarm sounds for more than five seconds and there has been no warning of a prolonged test, you must leave the building by the nearest emergency exit. All exits are well signed. Do not stop to collect personal belongings. Make your way to the nearest evacuation point, standing well clear of the building. Do not re-enter the building until told to do so by the Fire Services or the University security staff.

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## Module details

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### Statistical Computing

MODULE LEADER: F. LINDGREN

Aim: To introduce, in a practical way, the fundamentals of numerical computation for statistics, in order to help students to write stable, fast and numerically accurate statistical programs.

Learning outcomes: After taking this module students will

- understand the importance of stability, efficiency and accuracy in numerical computations, and how these may be promoted in practical statistical computation;
- understand the main difficulties and other issues that arise in the topics given below;
- be aware of standard computational libraries and other resources.

Prerequisites: In preparation for this module, students should obtain an elementary knowledge of the use of R. (Knowledge also of a lower level language such as C, Pascal or Fortran would be an advantage but will not be presumed.) Preparation for this module should also (re-)establish familiarity with Taylor's theorem and with basic matrix algebra e.g., notion of an inverse and eigenvalues, manipulation of matrix expressions, the numerical unsuitability of Cramer's rule for computation of an inverse.

Topics:

- Finite-precision arithmetic; related types of error and stability (probably mostly covered, in context, as part of other topics).
- Numerical linear algebra (with statistical applications): basic computational efficiency, Choleski, QR, stability (e.g. Normal/Choleski vs QR for LS), eigen and singular value decompositions. Standard libraries.
- Optimization: Newton-type methods; other deterministic methods; stochastic methods; using methods effectively in practice; what to use when.
- Differentiation and integration by computer: finite differencing (interval choice, cancellation and truncation errors); automatic differentiation; quadrature methods; stochastic integration.
- Basics of stochastic simulation.
- Other types of problem (e.g. sorting and matching); the pervasiveness of efficiency and stability issues; where to find out more.

Assessment: A short project bringing together several of the topics covered. For example writing a routine to estimate a linear mixed model by (RE)ML.



# Statistical Inference

MODULE LEADER: J.C. ROUGIER

Aims: To explore the basic principles of statistical inference: its origins in decision support, the nature of statistical parameters, the different viewpoints of Bayesian and Frequentist approaches, and the meaning and value of ubiquitous constructs such as  $p$ -values, confidence sets, and hypothesis tests.

Learning outcomes: An appreciation for the complexity of statistical inference, a recognition of its inherent subjectivity and the role of expert judgement, knowledge of the key choices that must be made, and scepticism about apparently simple answers to difficult questions.

Preliminaries. Students should have done at least one course in probability and one in statistics. Preliminary reading will cover the necessary material on probability. For statistics, students should be familiar with: the idea of a statistical model, statistical parameters, the likelihood function, estimators, the maximum likelihood estimator, confidence intervals and hypothesis tests,  $p$ -values, Bayesian inference, prior and posterior distributions.

Further information on all of these topics can be found in standard undergraduate statistics textbooks, for example

- J.A. Rice, 1999, *Mathematical Statistics and Data Analysis*, 2nd edn, Duxbury Press (more recent edition available); or
- Morris H, DeGroot, and Mark J Schervish, 2002, *Probability & Statistics*, Addison Wesley, 3rd edn. Prof. Schervish maintains a list of *errata* at <http://www.stat.cmu.edu/~mark/degroot/index.html>.

More advanced treatments can be found in

- G.A. Young and R.L. Smith, 2005, *Essential of Statistical Inference*, Cambridge University Press.
- A.C. Davison, 2003, *Statistical Models*, Cambridge University Press. This book also contains a wealth of applications. Prof. Davison maintains a list of *errata* at <http://statwww.epfl.ch/davison/SM/>.

Topics:

0. Expectation, conditional expectation, and probability. Probability mass functions, and their main functional equalities. (This material is covered in the preliminary reading.)
1. Modes of statistical inference: Frequentist, Neo-Bayesian, Modern Bayesian. Models, parameters, and prior distributions. Computational challenges.
2. Decision theory: Bayes Rules, admissibility, and the Complete Class Theorems. Implications for point and set estimation, and for hypothesis testing.
3. Confidence sets, hypothesis testing, and  $P$ -values. Good and not-so-good choices. Level error, and adjusting for it. Interpretation of small and large  $P$ -values.

Assessment: Exam-style questions on the implementation of different approaches in particular types of inference, possibly involving additional reading.

