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## Academy for PhD Training in Statistics (APTS)

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The aims of APTS are to equip first-year PhD students in statistical sciences in the UK with clear “mental maps” of some important areas in the discipline, and to help them gain confidence and resources (analytical and computing tools, literature entry-points) so that they are enabled to find out more for themselves. The intention is thereby to address (as far as UK statistics PhD students are concerned) the issue raised in the 2004 International Review of UK Research in Mathematics, that *New PhD's from the UK usually have less breadth and experience than their peers from other countries* (Section 2.2 on Post-Graduate Education).

### The beginning

APTS arose out of discussions between representatives of nine UK statistical research groups (Bath, Bristol, Cambridge, Glasgow, Lancaster, Nottingham, Oxford, Southampton and Warwick). Initial contacts were made at a preparatory meeting in spring 2006, organized by EPSRC as part of their call for proposals for Mathematical Science Taught Course Centres for PhD training (<http://www.epsrc.ac.uk/ResearchFunding/Programmes/Maths/Training/Courses.htm>); there followed a vigorous and extended exchange of emails and structural proposals and detailed drafts. It rapidly became plain that the community of UK PhD students in statistical science had a distinctive character which should strongly influence the nature of the training: it is relatively easy to identify a general set of statistical topics which would form a useful introduction and background for most such students; moreover there is a strong tradition of annual meetings run by the students themselves (the Research Students' Conference in Probability and Statistics) which has established a strong pattern of networking at an early stage; finally, the already existing EPSRC/RSS Graduate Training Programme had demonstrated that the statistics postgraduate community responded well to occasional intensive training weeks.

These considerations and the email discussion rapidly determined a working plan for APTS: an annual programme of training in statistical science for first-year PhD students based around 4 intensive residential weeks each containing two 10.5-hour modules of lectures and classes. Statistics students come from diverse mathematical backgrounds; therefore each week would be preceded by up to two weeks of individual study using preparatory materials supplied by module lecturers, so that the actual lectures could presume a common background knowledge. Finally, it was decided that it would not be possible to resource examined assessment by APTS itself, nor would it be desirable; instead of this, APTS module lecturers would provide assessment material for the week following each residential week, to be undertaken by the students and assessed by their home departments in whatever way was

appropriate to the very varied structures of participating departments. The resulting total of 16 weeks would yield a good general preparation for statistical research; there would of course remain a substantial amount of preparation to be carried out by individual supervisors and departments to meet the special and detailed requirements of the student's chosen area of statistical research and the progression requirements of the home department.

### Refining the concept

Funding was granted in September 2006, for a five-year period of which the first year was preparatory. The major elements of preparation were: to devise a programme, to choose module leaders, to determine locations, and to construct a system for registering APTS students at a national scale. Prosecution of the first three of these tasks involved a December 2006 meeting, further extensive email discussion and several iterated electronic voting procedures. Eventually, we settled on a list of modules loosely divided between core statistical material and selected topics in further areas: Statistical Computing, Statistical Inference, Statistical Modelling, Statistical Asymptotics, Applied Stochastic Processes, Computer Intensive Statistics, Spatial & Longitudinal Data Analysis, and Nonparametric Smoothing (detailed descriptions and current module leaders can be found on the APTS web-pages at <http://www.apts.ac.uk>). It was decided as a general policy to keep the choices of topics and module leaders rather stable; APTS training is designed primarily for first-year PhD students and hence a good choice of topics for one year should serve equally well for a number of subsequent years, moreover continuity of module leaders aids the development and refinement of each module.

Considerable care was taken to ensure clear rules of procedure and good communication with the "user-community". Daily business is dealt with at Warwick by the two co-directors (David Firth, Wilfrid Kendall) and the programme manager (initially Stephen Connor, currently Ioannis Kosmidis); larger issues are referred to the Executive Committee (consisting of representatives from the original nine research groups and two representatives elected from the annual Advisory Committee). The annual Advisory Committee is composed of the APTS co-directors, representatives of APTS Member Institutions (see below), APTS student representatives, an EPSRC representative and two additional co-opted representatives of statisticians working outside higher education. This layered structure is designed to ensure good channels of communication and feedback on a regular basis. The APTS constitution (<http://go.warwick.ac.uk/apts/resources/APTS-constitution.pdf>) specifies the working rules in some detail.

A major source of uncertainty in this preparation period was the likely number of students attending. To our

surprise, we could find no complete record of UK PhD students in statistical science accounted for by year of entry. Our best estimate (based on considerations such as attendance at the annual Research Students' Conference in Probability and Statistics) suggested that we should plan for around 60 first-year registrations per week, which also was practical and appropriate when choosing residential locations. Anticipating over-subscription, we devised a careful web-based registration process with explicit priority rules; this together with the general APTS constitution can be found at: <http://www.apts.ac.uk>. In particular, both to provide a basis for representation of the user community in the development of APTS and also to ameliorate the uncertainty of registration numbers, we created a special category of "APTS Member Institution"; institutions registering each year as APTS Member Institutions commit to registering a certain proportion of their first-year statistics PhD students, and obtain in return extra priority in the registration process, the right to send representatives to the annual APTS Advisory Committee, and the right to use the APTS logo in publicity.

### The first year of operation

In the event there was a very strong response to the first APTS registration process in September 2007. Applications were received for 121 students: for the four individual APTS weeks (held at Warwick, Oxford, Bristol, and Glasgow); the respective numbers applying were 92, 85, 84 and 65. Students applying to take part in all four APTS weeks numbered 44. Of the 121 applications, 78 were for first-year PhD students in statistics or probability, 32 of those 78 first-years were EPSRC-funded. APTS Member Institutions made 112 of the 122 applications, and 109 came from within the UK. Unsuccessful applications were held on an ordered reserve list, to be offered a place in the event of a cancellation. Space constraints made it impossible to offer places to all who applied; however we have made sure that the course material from all APTS modules in a given year is put up on the APTS website for free and unrestricted access as soon as the relevant week is completed.

It is relevant to note that EPSRC-funded students were fully supported from EPSRC funds, except for a registration fee paid by their sending institution; expenses and registration fees of other students were met completely by the sending departments.

Notwithstanding the strenuous nature of the four intensive APTS weeks, the whole programme has been very well received by students, sending institutions, and module leaders. It appears from student feedback forms that the level of the modules is generally good: the majority of students found the level "just right", with in each case just one or two finding it too easy, and in all but one case just

seven or fewer finding it too hard. Bearing in mind the diversity of student backgrounds, this is most satisfactory for a first year of operation. Comment from lecturers and sending institutions is more anecdotal, but the Advisory Committee in September 2008 registered very strong approval based on their own students' experience and on preliminary accounts of student feedback. (A complete review of the first year formed part of the annual Executive Committee meeting in January 2009). As a very objective measure of performance, the second registration process for APTS has resulted in applications being received for 107 students; bearing in mind that registrations for the first year of operation included a substantial number of second-year students, it is clear that demand is holding up. Indeed, the number of applications made for first-year PhD students in statistics or probability – the primary target community for APTS – has increased in 2008 to 85. The major change of substance resulting from the first year of operation is that we are making available a web course on programming in the versatile R statistics computing environment, thanks to the generosity of Oxford Statistics Department. This is in response to the observation that a significant group of students found working in R to be a considerable challenge.

Although the weeks have been intense, time has been found for extra activities in the evenings, including a conversation with a senior statistician from the US, a presentation on statistics and ethics, four separate receptions funded by the Royal Statistical Society (we are most grateful to the RSS for this support), an unforgettable *ceilidh* (including a blues song providing emotional depth to the practice of Markov chain Monte Carlo), a forum on publishing one's work, and a presentation demonstrating how not to give a presentation (we were advised to run this last again next year, but to make it even worse ...). During the course of the year it became amply evident that – as the organising group had hoped and expected – one of the major contributions of APTS will be to establish networking amongst cohorts of UK statisticians at an early stage; we expect to see strong contributions from ex-APTS students at the annual Research Students' Conference in Probability and Statistics and at the newly formed Young Statisticians Section of the RSS. The breadth and variety of statistical science makes networking an especially important component of a research statistician's career; the importance of APTS' contribution to this has been noted both by students and (via the Advisory Committee) by sending institutions.

### **Lessons learned and future challenges**

Naturally, the first year of full operation of APTS has been a learning experience! For the most part, what we have learned is that the initial year of careful preparation paid off; spending time on determining a working constitution and reporting structure, and on devising a clear and

efficient registration scheme, and agreeing a careful selection of topics for the programme was all well-worth-while effort. We are aware of further challenges that lie ahead. One particular challenge, now that the APTS programme is clearly established, is to liaise with other taught-course centres offering statistical topics. These other centres differ in various ways from APTS, and the opportunity presents to leverage these differences so as to provide usefully complementary training. APTS co-directors and executive committee members sit on boards of reference or are otherwise involved with most of these centres, and we will be looking out for occasions to take advantage of this.

A further challenge is to consider how APTS should proceed beyond the initial EPSRC funding period. While there are still three more years of operation under the existing grant, we have already initiated a dialogue about this with our Advisory Committee, whose response has been extremely positive about the need to sustain APTS as a collaborative activity. The most costly aspects of APTS activity are precisely those which are valued most by the students and their home departments: the national community-building possibilities offered by intensive residential courses, and the efficiencies of scale provided by a central infrastructure and common curriculum. EPSRC funding has thus been absolutely vital to the success of APTS: the initial investment by EPSRC in taught-course PhD centres was bold and imaginative, and in the case of APTS it has richly paid off. The challenge now is to capitalise fully, for the longer term, on that initial investment.