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3.3 PROFESSIONAL STATISTICAL ACTIVITIES

All professional statisticians need the means to maintain currentness in the profession, whether engaged in applications or research. Statisticians in the United States and Canada are fortunate in the number of society meetings, conferences, symposia, workshops and short courses available to them. Such activities exist in both countries and attract participants from both countries. Rather than attempt to list all such activities, the reader is referred to *International Statistical Information*, the *Biometric Bulletin*, the *Institute of Mathematical Statistics Bulletin*, *Amstat News*, and the *Statistical Society of Canada Newsletter*, the news publications of the International Statistical Institute, the Biometric Society, the Institute of Mathematical Statistics, the American Statistical Association, and the Statistical Society of Canada respectively; each of these publications regularly or periodically provides a calendar of forthcoming meetings on statistics. In addition, universities with programs in statistics hold regular statistics seminars, usually weekly. Community needs of business, industry and education are served by the 74 local or regional chapters of the American Statistical Association which usually have monthly meetings.

A second means of keeping up to date with the profession is through membership in statistical societies and their publications. Additional publications or periodicals in statistics are sponsored by commercial publishers. The Biometric Society's Eastern and Western North American Regions, the Statistical Society of Canada, the Institute of Mathematical Statistics, and the American Statistical Association hold regular annual and regional meetings, often jointly and sometimes separately. Their publications, apart from newsletters, are listed briefly as follows: The Biometric Society – *Biometrics*, The Statistical Society of Canada – *The Canadian Journal of Statistics*, The Institute of Mathematical Statistics – *The Annals of Statistics*, *The Annals of Probability* and *Statistical Science* (new in 1986), The American Statistical Association – *Journal of the American Statistical Association*, *Technometrics* (jointly with the American Society for Quality control), *Current Index to Statistics* (jointly with the Institute of Mathematical Statistics), *The American Statistician*, *The Journal of Educational Statistics* (jointly with the American Educational Research Association), the *Journal of Business and Economic Statistics*, along with *Proceedings* of a number of its sections. Through an agreement with the American Mathematical Society, *Current Index to Statistics* is now electronically searchable as a subfile of the MathSci database; all information in CIS since 1975 may now be so located. Membership directories are available through all of the major statistical societies with heavily overlapping memberships. The American Statistical Association has the most varied activities and the broadest membership base, a membership approaching 15,000. In recent years, it has carried out an expanding program of continuing education in statistics.

CHAPTER 4

The Training of Statisticians in Australia

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4.1 BACKGROUND

The Australian Commonwealth consist of six States, the Australian Capital Territory (which includes the national capital) and the Northern Territory. In order of population size, these are New South Wales (5 million), Victoria, Queensland, South Australia, Western Australia, Tasmania, the Australian Capital Territory, and the Northern Territory, with a total population of rather more than 16 million. English is the universal language.

Each has its own Department of Education, set up under State legislation, which controls the State (Public) schools which are attended by a little less than 80% of the school population. Most of the remainder are at Roman Catholic schools with a smaller number at private schools generally affiliated with religious bodies. Education is compulsory from ages 6 to 16 (Years 1 to 10), with a steadily increasing proportion staying on to Year 12. Course specification for primary education (Years 1 to 6) is more or less directly controlled by Education Departments, while Statutory Authorities (which issue Certificates at the successful completion of Years 10 and 12) prescribe acceptable courses of study and conduct public examinations at the secondary level. A Higher School Certificate (Year 12) is the normal requirement for entry to a tertiary institution, but there are also selective entrance requirements applied by individual institutions.

At post-Secondary level, there are nineteen universities (all funded by the Commonwealth, although, with the exception of the Australian National University, set up under State legislation), some seventy Colleges (or Institutes) of Advanced Education (Commonwealth and State funded), and State Departments of Technical and Further Education (Commonwealth and State funded) which administer Technical Colleges.

4.2 STATISTICAL EDUCATION IN SCHOOLS

The subject which includes most statistics instruction in schools is mathematics, although there is incidental work in some other subjects, e.g. geography, economics and science. The mathematics component typically includes data collection (especially directed to the stability of long run proportions), an introduction to probability (usually based on set algebra), calculations with data, and an introduction to inference

questions. This last topic is treated at greatly varying depths, partly because of State differences but principally because different strands of mathematics programs vary so widely: in some cases there is no statistics component, while in others Markov chains, the normal distribution and regression are included. An introduction to the use of statistical packages is sometimes given.

It is, however, never assumed at the tertiary level that other than the most basic ideas of Statistics have been covered.

Much more detail is given in the relevant chapter of the I.S.I. publication *Teaching Statistics in Schools Throughout the World* (1982).

4.3 STATISTICAL EDUCATION AT TERTIARY LEVEL

The profession of 'Statistician' is not legally defined in Australia (in contrast, e.g., to Engineer, or Medical Practitioner), and there is indeed great diversity of meaning in the description. From the examples which follow a coherent but not sharply defined series of pictures will hopefully emerge: they correspond to very different backgrounds in particular cases.

Traditionally the Universities have provided the greater part of special-ised statistical education, for large numbers of students in 'service' courses associated with other disciplines (economics, engineering and psychology, e.g.), and for smaller numbers of students with studies in greater depth associated with mathematics and perhaps econometrics. However, in the last ten to twenty years, corresponding perhaps to the enormously greater degree of quantification appearing in Business (Commerce) courses, the Colleges of Advanced Education have been expanding their statistical (and computing) teaching, though in a more applied fashion.

University undergraduate courses with major studies in Statistics typically contain a substantial component of mathematics in first year with varying amounts of Statistics *per se*. In second and third years, in addition to more intensive studies in Statistics, there are usually concur-rent mathematical and computing requirements leading to the Pass degree of Bachelor. Most Universities also provide a fourth year comprised almost wholly of Statistics, the successful completion of which qualifies for an Honours degree: this is taken by only small numbers of students (e.g. in 1986 by 24 students, in 1985 by 30 and in 1984 by 23). Appendix 1 gives an outline of a not untypical course structure. There are also economics based programs with a greater emphasis on econometrics.

A smaller number of Colleges of Advanced Education (perhaps ten) also provide Bachelor degree programs with a good deal of emphasis on Statistics, though with less concentration on the theoretical aspects and more on applications. There are additionally some Diploma courses, also with an applied bias.

Some of the Universities and Colleges provide course work programs open to students with Pass degrees which lead to the degree of Master, these being a growing development usually aimed at the practising statistician who wishes to improve his or her qualifications. Such courses

are therefore frequently offered on a part-time basis. Appendix II gives more structure and topic details. The research degree of Master normally requires a Pass degree and a qualifying course, or an Honours degree, for entry: it is available at most Universities, and 3 were completed in 1985, 3 in 1984 and 5 in 1983.

The research degree of Ph.D. is mostly taken on a full time basis, at Universities only, generally after an Honours degree in Statistics (but perhaps following a Master's qualification). It is on the most common route taken by prospective academic statisticians, but is also used – usually some years after first graduation – by those already working as Statisticians. In 1985 there were 6 Ph.D.'s completed in Statistics, 6 in 1984 and 8 in 1983.

4.4 EMPLOYMENT OF STATISTICIANS

4.4.1 *Universities and Colleges of Advanced Education*

Academic statisticians currently being appointed – those employed by Universities and Colleges of Advanced Education – have relatively homogeneous backgrounds: an Honours degree from a University, a Ph.D. in Statistics, and publications in research – oriented statistical journals. There are some exceptions, and there were more in the past, where on-the-job experience accompanied by a suitable publication record is regarded as equivalent.

4.4.2 *Research Organisations*

The Division of Mathematics and Statistics of the Commonwealth Scientific and Industrial Research Organization (CSIRO, a Statutory Authority of the Australian Government) employs Research Officers with much the same background as academic statisticians, and Experimental Officers with Bachelor and Master qualifications, with a total professional staff of about 100. The Division cooperates actively with other Divisions of CSIRO, and carries out independent research activity in Statistics: however, the whole structure of CSIRO is at present under review.

Other much smaller research groups are located in major industries, and are more conveniently discussed under the next heading.

4.4.3 *Industry*

Australia does not have a history of strong involvement with industrial research, and correspondingly there have been only small Research Laboratories (as they have been typically called) associated with even the largest companies, generally dealing with very practical and immediate problems. With the advent of comprehensive computing systems, the emphasis has tended to be on computing specialists rather than on statisticians even though much of the data processing and decision

making is now based on bought-in software rather than that developed in-house. It is perhaps becoming more common now to see advertisements for statistical analysts as well as, or instead of, those for computer analysts, but there is a long way to go before this becomes a substantial field of employment for Statisticians. The few to be found in this area tend to have very varied backgrounds with a predominance of training in professional areas other than Statistics. (See also the next section.)

4.4.4 Agriculture and Biology

Agriculture has had a long association with statistics both at Commonwealth (partly through CSIRO) and State levels, and the Statisticians who (e.g.) take part in designing and analysing varietal trials have generally come through statistical, agricultural or biometrical courses at Universities. (The first Chair at an Australian University in BioStatistics was established in 1985, but courses in Biometry have been taught for many years.) Because of time constraints in undergraduate courses, it is common for those working in these areas to enrol in part-time post-graduate statistics courses to improve and update their knowledge.

Biology overlaps with the pharmaceutical industry, and this is a small but growing area of employment for statisticians.

4.4.5 Commerce and Business

With the increasing replacement of 'hunch' by 'analysis' (or at least 'hunch' by 'hunch better based on data'), and the spread of computers, especially perhaps at the micro level, throughout the business world, the demand for people able to interpret figures and to obtain them from more or less complex data base systems is increasing rapidly. Most of these appear to come through Commerce programs, at Universities and Colleges of Advanced Education, but it is very difficult to discern any uniformity in training or in the technical level of statistics required in employment, so that to apply the classification 'Statistician' to most would be highly speculative. However, there is a continuing demand for graduates from Commerce (often in Economics, or Econometrics) with substantial components of at least Statistical Methods in their courses.

Further, many of the relatively new Graduate Management Schools include much sophisticated statistical and computing material: graduates from these Schools, and especially from the (national) Australian Graduate School of Management appear to be in good demand.

4.4.6 Australian Bureau of Statistics

The largest single employer of Statisticians in Australia is the Australian Bureau of Statistics, but it also employs many other professionals (e.g. economists, computer scientists). A Statistician may enter after the completion of a Pass degree, or may as a Bureau cadet complete an Honours Fourth Year. Staff are encouraged to enrol in post-graduate

courses, and in-service training (particularly in the area of survey sampling, one not extensively taught at tertiary institutions) is also carried out.

4.4.7 Insurance and Actuarial Studies

Actuaries form a specialised group of Statisticians, and entry to it is controlled by the Institute of Actuaries. Most tertiary studies give little formal accreditation as an Actuary, but Macquarie University, alone in Australia, has courses which are accepted by the Institute.

4.5 PROFESSIONAL SOCIETIES

The Statistical Society of Australia, with branches in New South Wales, Victoria, South Australia, Western Australia, Canberra (ACT) and Queensland, has a membership of more than 900, and is the primary association for Statisticians. It has six Sections: Statistics in the Medical Sciences, Statistics in the Earth Sciences, Statistics in the Biological Sciences, Survey and Management, Statistical Education, and Statistical Computing. Regular meetings are held by the Branches and Sections, and Symposia on statistical topics of current interest (with a high educational content) are conducted. The Society also publishes *The Australian Journal of Statistics*.

The Australian Mathematical Society also caters for more theoretical Statisticians (espcially probabilists) and the Economic Society of Australia for those in that and related fields.

J.B. DOUGLAS

APPENDIX I *A 'typical' structure for a three year Bachelor's degree programme in Statistics*

First year

Mathematics, a little probability and statistics, and other subjects.

Second year

At the rate of about 6 hours per week of lecture, tutorials and laboratory classes:
Probability and random variables
Statistical inference
Computation and simulation
Non-parametrics
Additional mathematical and computing subjects.

Third year

At the rate of about 8 hours per week:
Stochastic processes
Linear models
Statistical computation
Design and analysis of experiments
Statistical inference
Additional mathematical and computing subjects.

Fourth year

A small proportion of students go on to a Fourth, Honours, Year to complete a Bachelor's degrees with Honours. This year consists almost wholly of Statistics.

APPENDIX II

Course work Master's programmes are relatively new at most institutions, but are developing rather rapidly. The Master of Statistics programme at the University of NSW is one of the older ones, and an outline of its structure, taken from a University handbook follows.

The Master of Statistics Course covers a wide range of statistical theory and practice and provides advanced training for practising statisticians. The course may be completed in two years of full-time or four years of part-time study, and it is available to graduates with a pass degree in statistics or an honours degree in a related field (commonly mathematics) with supporting study in statistics. Honours graduates in statistics may be exempted from a maximum of half the course. The conditions for the award of the degree are set out later in this handbook.

The academic requirement for the degree is 24 credits.

Compulsory Subjects	Credits
Experimental Design 1	2
Stochastic Processes	2
Multivariate Analysis 1	2
Statistical Inference	2
Project	2

Elective Subjects	
Experimental Design 2	2
Time Series	2
Multivariate Analysis 2	2
Sample Survey Design	2
Sequential Analysis	2
Non-Parametric Methods	2
Special Topic*A	2
Special Topic*B	2
Discrete Distributions	2
Optimal Control Theory or Higher Optimal Control Theory	3

Up to 6 credits may be taken in graduate subjects offered by other Departments or Schools within the University, subject to the approval of the Head of School. Such subjects include:

Theory of Land Use/Transport Interaction	2
Urban Transport Planning Practice	2
Transport and Traffic Flow Theory	4
Optimization Methods or Higher Optimization Methods	3
Econometrics B	2
Simulation in Operations Research	2

*To be arranged e.g. biological statistics, further work on order statistics, population statistics, non-linear programming, discrete distribution theory.