Teaching mathematical statistics

M. Shelton Peiris, School of Mathematics and Statistics, The University of Sydney
shelton@maths.usyd.edu.au

Abstract: It is recognized that Statistics stands as an integral part of the basic training for citizens of many countries around the world. Although statistical skills are necessary in almost every field of the modern world (e.g. medicine, biology, business, finance, banking, engineering, ecology, etc.), many students continue to find such courses unappealing. At present, there is a growing need to convey the importance of teaching and learning of probability and statistics to students at all levels, particularly undergraduates. On this note, we discuss a process of developing a useful method of teaching mathematical statistics to undergraduates in order to improve their learning skills and understanding.

Introduction

Many teaching goals are shared and understood by almost all teachers in every area of teaching. For example, all teachers want their students:
- to understand certain underlying principles; and
- to improve a range of skills.

In addition to the above goals of teaching activities further questions of interest are:
- how to develop an interest (among students) of the subject? and
- how to encourage high quality learning?

Answers to the above questions relating to mathematical statistics are not easy to derive from traditional teaching methods. The main reason for this is that mathematical statistics is a sophisticated subject in which each branch requires a clear and broad knowledge of mathematics. The purpose of this article is to describe a process of developing a useful method of teaching mathematical statistics to first year undergraduates (with 2 Unit or less mathematics at their HSC) in order to improve their skills and understanding.

Some primary solutions

It is known that the first few weeks of a session are important for students, especially for first year students. Consequently, it is imperative that confidence and interest in the subject must be developed among students within these weeks using one or more of the following aspects:
1. showing the usefulness of this subject in their career;
2. showing the usefulness of this subject in the modern world; and
3. showing the relevance of modern techniques (i.e. computers).

Abstraction is another useful and essential tool to teach in any area of mathematical science as it focuses on key ideas which underline different phenomena and enables one to build his or her own strong foundation. However, abstraction leads to two main difficulties in teaching mathematical statistics. Firstly, the students have to master some basic results of mathematics before starting mathematical statistics. If a student falters without recovering then what follows may become incomprehensible. The student loses confidence and the benefit of subsequent teaching may become lost. Students will falter if the material is presented too quickly or if too much is assumed. Secondly, if the abstraction is not motivated or presented in context then the student loses intuition and interest. In Section 3, we provide some proposals in practical teaching in order to overcome these difficulties.

Teaching in practice

To overcome the first difficulty (confidence) in Section 2 is fairly easy and can be handled by any teacher in his or her own traditional way. However, the two difficulties under abstraction must be considered carefully as follows:

1. Provide written copies of detailed and reliable notes on basic mathematical results which need to develop the subject slowly and carefully. Also provide detailed notes to students so that the student can fall back on these if a lecture is not understood. These notes must provide a substitute and a better explanation of the material.
2. Teachers need to focus on specific concrete problems whose statements can be understood immediately, but the solutions of which depend on material developed during the course.

Flexible teaching and learning

The main part of our role as teachers is to develop the student's intuition by careful choice of pithy but accessible problems and examples and wherever possible to reinforce ideas with analogues and methods of visualizing information. One way of doing this in statistics is, begin each topic with a data set from a real study of current or historical interest to show the importance of the topic, with an emphasis on applications, then slowly proceed towards theoretical work. This has proven to motivate students. To improve the quality of teaching and learning, survey all courses at the end of each lecture (at least in the first few weeks) asking students about the pace and the level of the material. Take advantage of their responses to make decisions about how we might improve the standard of teaching and facilitate high quality learning in subsequent lectures.

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