

THE FUTURE OF TEXTBOOKS AND EVOLUTION OF AN E-BOOK

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ABSTRACT

Paper-based textbooks have problems that are caused by their static nature. A single format must motivate students, provide detail and also be suitable for revision and later reference. It must also cope with students from different application areas and whose courses teach different topics. E-books have the potential to overcome most of these problems and some solutions are presented and illustrated with features added to CAST (Computer Assisted Statistics Textbooks) during its development. CAST started life as a single e-book whose initial goals were to use interactive diagrams for active learning within a textbook and to use dynamic diagrams to explain concepts more clearly. It evolved into a framework with alternative versions of pages for initial study and revision and with examples from different application areas. It has recently been improved with a drag-and-drop user-interface that allows customised e-books to be created. Possible future directions are discussed.

INTRODUCTION: PROBLEMS WITH TEXTBOOKS

Most introductory statistics courses recommend one or more textbooks to students. The lecture notes that students take and the PowerPoint slides that they can access are rarely detailed enough for later study. Therefore, textbooks are often prescribed to provide this detail along with extra examples and exercises. Explanations of concepts that are different from those in lectures may also help consolidate their understanding. Textbooks are often the sole source of study material for distance students.

However traditional textbooks have a few problems that are discussed below.

Roles for textbooks

Textbooks are designed to fill several different roles and these are often in conflict. Firstly, a textbook should motivate students about the importance of statistical methods and their relevance to the students' later careers. Case studies are often used to introduce chapters and to provide practical applications of the methods described, and real-life examples are extensively used to show the wide variety of useful practical applications of the methods.

However students also use textbooks later in their courses. Large numbers of examples and case studies usually result in verbose chapters in which the important points are diffuse. When studying and revising the whole of a course, the level of detail and examples in most textbooks makes it difficult for students to pick out the main points that must be understood. A succinct version of each chapter would be more useful, and some textbooks provide a summary page at the end of each chapter, but it is usually too brief for study.

Many students will also use their textbooks as reference material later in their careers, and this is a third role for a textbook. Again, a more concise and structured approach makes it easier to find relevant material than the slow coverage of topics in most textbooks.

The same format is not ideal for all three purposes, and recent textbooks have, in general, concentrated on the first of the above roles with extensive case studies and examples and very detailed explanations. Textbooks are now routinely 500 or more pages long (and up to 1,000 pages occasionally). As examples, Utts and Heckard (2007) has over 750 pages and contains 27 "case studies" and 273 "examples" of varying length, and Agresti and Franklin (2007) is 700 pages long with 193 "examples" that are usually case-studies of 1-2 pages. Although these case studies and examples are highly motivational during initial study, students would usually skip most of them during revision.

Requirements for different courses

A wide range of statistics courses is taught to students from diverse disciplines including civil engineering, physiology, real estate management and meteorology to name a few. Data sets and scenarios that motivate one group are often of much less interest to others. Examples such as baseball or SAT scores are often used by USA textbooks to span the interests of different groups of students, but they are of as little interest to students from other countries. More seriously, the level and topics covered by courses vary considerably. Topics such as transformations, multiple regression, nonlinear relationships, time series, experimental design, nonparametric statistics and resampling methods are taught in some courses but not others. Textbooks often try to cover everything and this is partly why their page counts are so high. A textbook is unlikely to match exactly the topics in any specific course and, as a result, students must generally be given a list of textbook sections to study, sections to "read but not learn" and sections to ignore. Teachers often try to minimise the mismatch by allowing course content to be largely determined by a textbook that gives the closest match to what they really want to teach.

Other problems with textbooks

Another problem with conventional textbooks is that reading a textbook is not active learning (Scriven, 1967). Reading a textbook may be more 'active' than watching a lecture or video, but students learn better when they are making decisions and seeing their consequences during the learning process.

Finally, book publishers are in business to make money from selling books. New editions of some textbooks seem to be regularly released simply to kill the second-hand market — chapters are rearranged and examples and exercises are changed without obvious improvement and, often, additional bugs. Regular new editions cause extra work to instructors who must revise lists of sections to study and exercises to attempt.

Publishers are starting to release electronic versions of their textbooks but these usually retain most of the drawbacks described above.

CAST E-BOOKS

Electronic textbooks (e-books) have the potential to solve all of the above problems since the content that is delivered can be tailored to the requirements of different readers. This will be illustrated by describing the evolution of a collection of e-books called CAST (Computer Assisted Statistics Textbooks).

CAST was originally designed as a free e-book for teaching introductory statistics that made extensive use of dynamic and interactive diagrams to help teach statistical concepts and methods. This CAST e-book was implemented using HTML with Java applets for its interactive content and used many data sets of general interest. This e-book now has over 450 interactive diagrams, so most pages contain some active content to help student learning (Stirling, 2011). The e-book is structured in a conventional way as a hierarchy of chapters, sections and pages (see Figure 1 for an example of a typical page).

Although the applets in this e-book provided a certain amount of active learning, its content was fixed so it still exhibited most of the problems with paper-based textbooks that were identified earlier.

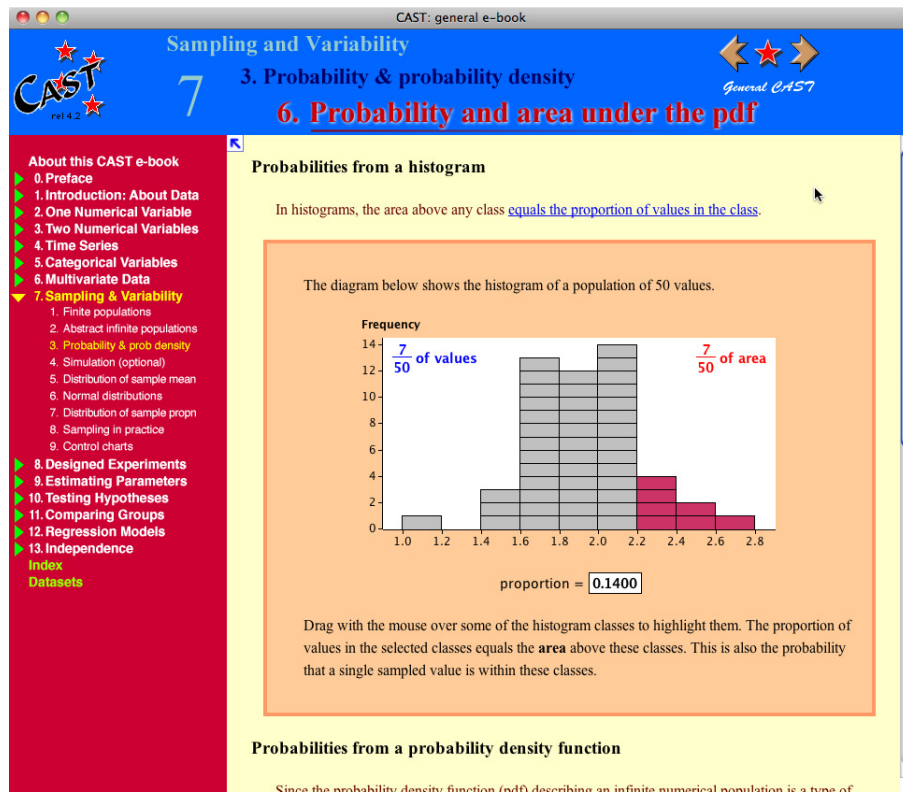


Figure 1: A page from the original CAST introductory statistics e-book (release 4.2).

The problem of students whose main interests were in different application areas was addressed with two new versions of the e-book using different data sets and scenarios. One was aimed at the biological, agricultural and health sciences, and the other was aimed at business students. The structure of CAST allowed these alternative versions of pages to be written by editing HTML without changes to the Java programming of the applets and also made it possible to write additional versions pages targeted at further groups of readers.

Although these new e-books could be opened and read separately, the alternative versions of a page could also be directly displayed from any e-book, as shown in Figure 2, providing extra examples for those who wanted.

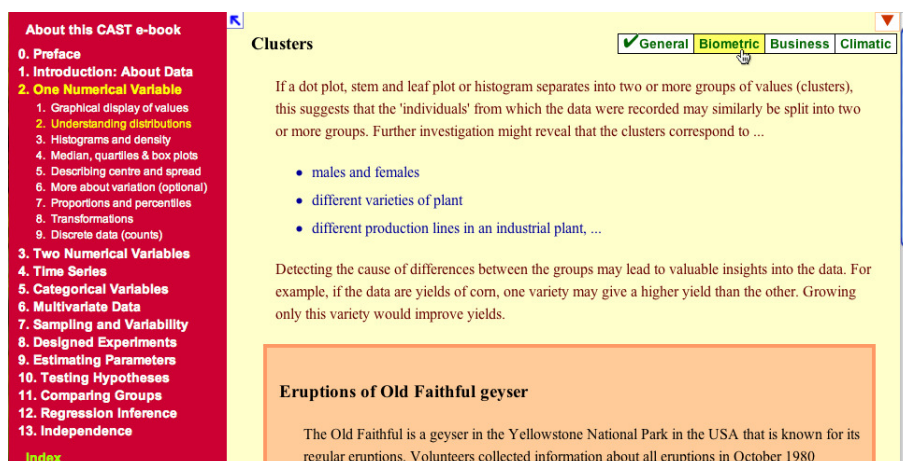


Figure 2: Menu on top right of a CAST page allows choice of versions of the page using different data sets.

However these CAST e-books still suffered from one of the main problems that were identified with paper-based textbooks. Although the dynamic and interactive material in the

CAST e-books provided a measure of active learning and effectively explained concepts, the applets were less well suited for students' revision.

To address this problem, summary versions were written for all pages in the introductory e-books. These concisely explain the main points using static diagrams and can be accessed from a tab at the top of the page, as shown in Figure 3. Students can revise from these summary pages. (The summary versions of all pages in a chapter can also be printed using an icon in the banner beside the Summary tab.)

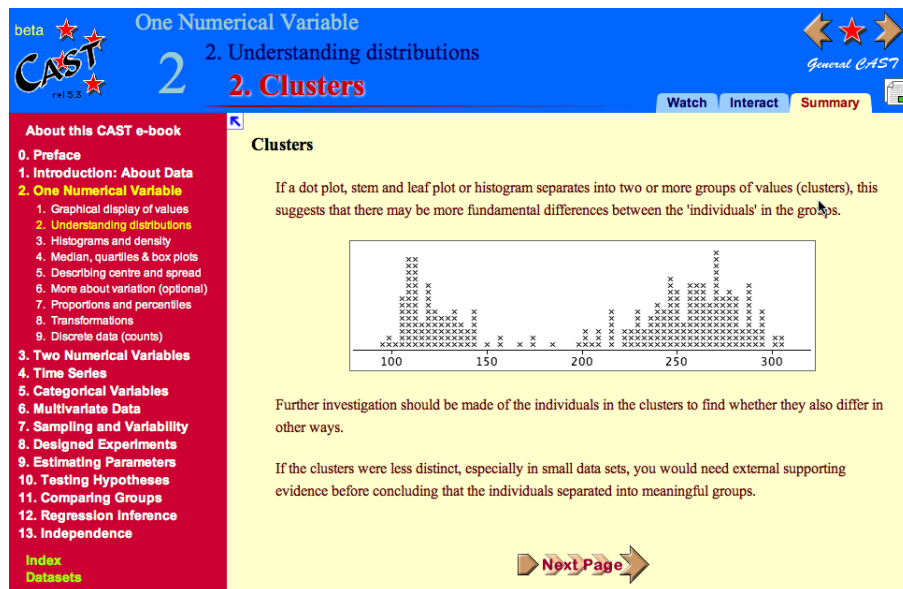


Figure 3: Summary version of the page shown in Figure 2.

Although the interactive versions of CAST pages involve active learning, a few disadvantages have become apparent. The most effective way for students to learn is by discovering the answers to questions through free use of applets but some students need more detailed guidance (Lane and Peres, 2006). As a textbook, each applet must therefore be accompanied by detailed instructions about how to interact with it and the accompanying text must clearly describe the main points that it explains or illustrates. This can be brief in simple applets such as the one shown in Figure 1, but interactions with more complex applets must be described by several paragraphs of text. Equally seriously, the applets were implemented in Java and tablet computers (iOS and Android) currently do not support Java.

To help with this problem, a third version of each page is being prepared in the introductory e-books, replacing the applets (and some of the longer sections of text) with short videos. Most of these videos are based on applets, but use voice-over, call-outs and annotation to explain and highlight what the applets are teaching. These videos can provide much more complete explanations than the short paragraphs that are required in the interactive pages and they can be used on tablet computers.

The video versions of pages can be accessed from the "Watch" tab at the top of each page, as shown in Figure 3. Students are recommended to first watch the video version of each page before studying the interactive version on the "Interact" tab and finally checking the "Summary" version.

CUSTOMISATION

Although the developments described above allowed the three introductory CAST e-books to be used in different application areas and to cope with different learning styles, they still contained fixed material and were therefore unlikely to match the content and approach of any specific course. For several years, it has been possible for the author to generate customised e-

books for the specific courses that he taught but the process was not straightforward enough to be made available to others.

Recent changes to the structure of CAST allow customised e-books to be generated fairly easily by any instructor based on material from existing CAST e-books. In addition to the three introductory e-books, the core release of CAST includes an e-book of exercises (Stirling, 2010a), advanced e-books about regression (Stirling, 2006) and experimental design (Stirling, 2010b), and a few modules about other topics such as simulation and data presentation. Pages from any of these can be incorporated into a customised e-book, along with new HTML pages that are specifically written for the customised e-book. The current framework can even be used to write e-books about non-statistical topics.

Downloaded copies of CAST include a "manager" program that is used for customisation. Its main window shows a list of the core e-books in CAST, plus any customised e-books that have been created, such as the e-book "massey120" on the top left of Figure 4. Buttons in this window can duplicate existing e-books for customisation or create new empty e-books; they will then appear in the list with buttons to edit and "build" the customised e-books.

Clicking the "Edit" button for a customised e-book shows the chapters and sections in it, as on the top right of Figure 4, and this is where the structure of chapters and sections in the e-book is defined. Chapters and sections can be rearranged and can be dragged in from other e-books. Material can also be deleted and new chapters and sections created. The pages within any section can be edited as shown at the bottom of Figure 4, both in terms of structure and the text that summarises the pages.

The customisation features are very flexible and allow e-books to be created with arbitrary content. New pages can be created from scratch in HTML provided a few simple guidelines are followed and the framework even allows e-books to be written without any content from the core CAST e-books.

CONCLUSION

Development of CAST has shown that many of the limitations of paper-based textbooks can be overcome if textbooks are delivered electronically as e-books. In particular, interactive content, videos and summary versions of pages provide useful features that cannot be replicated on a static medium. More importantly, e-books can be customised for particular groups of students, both with data sets and scenarios relevant to their particular interests and with topics that are chosen and arranged to match their specific courses.

CAST (Stirling, 2009) is freely available under a Creative Commons Licence and CAST 5.2 can be accessed at the URL:

<http://cast.massey.ac.nz>

At the time of writing this paper, the video versions of the pages in the general CAST e-book are incomplete and only available in the beta version of CAST 5.3 at the URL:

<http://castBeta.massey.ac.nz>

The general introductory e-book can be opened from the tab "The e-books". Similarly, the customisation program is only part of this beta version of CAST but will eventually be in the full version of CAST 5.3. The core e-books can be viewed directly at the above URL, but clicking the "Download" tab gives access to an installer and the customisation features.

Planned future developments include the ability to upload customised e-books to the CAST servers and browse customised e-books written by others. New e-books about statistical theory and other advanced topics are planned and will add to the pool of pages that can be used in a customised e-book.

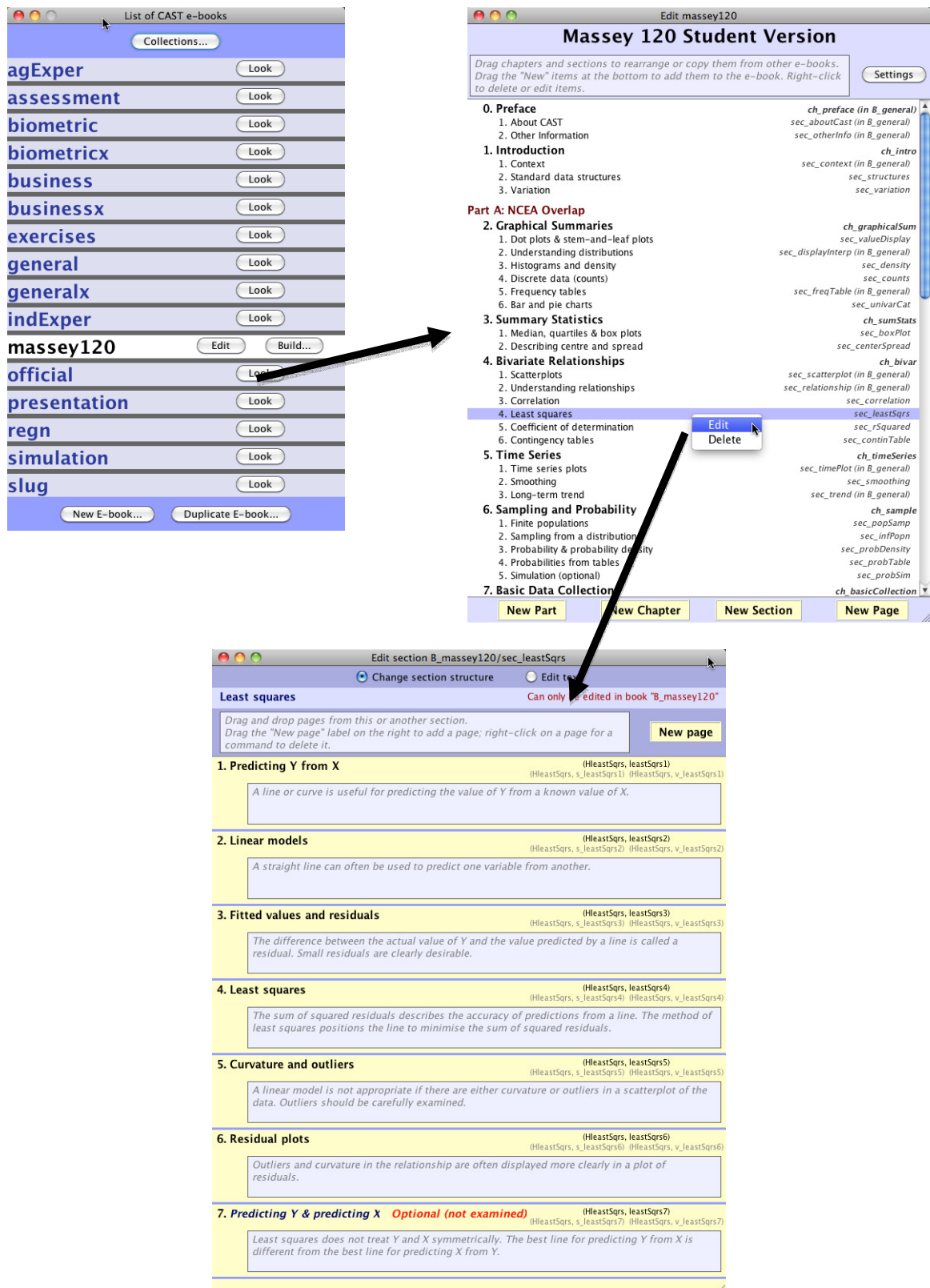


Figure 4: A list of core CAST e-books plus one customised e-book is shown on the top left. The main edit window for an e-book on the top right lists its chapters and sections. Drag-and-drop allows them to be rearranged or added from other e-books, and right-clicking shows a menu that allows chapters and sections to be deleted. Right-clicking also allows the contents of sections to be edited, as in the bottom window, again using drag-and-drop.

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