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Multimedia and Multimedia Databases for Teaching Statistics

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Introduction

The breakneck advance of multimedia capabilities and internet technologies offers an unprecedented opportunity to improve the quality of teaching and learning. Nowadays the use of multimedia resources and WWW-supported learning environments is a crucial issue in education and further education. Integrating visualization, animation, interactive experiments, sound and hotlinks to relevant internet sites opens completely new dimensions of learning. Modern multimedia may also incorporate new communication channels and could be part of emerging virtual educational networks.

Statistics seems to be particularly suitable for illustrating the benefits of multimedia-based teaching. On the one hand, Statistics connects quite different fields of application. This interdisciplinary character of the science can be well demonstrated by suitable videos and motivating examples closely related to people's life. On the other hand, multimedia represents an ideal platform for visualizing statistical concepts and for discovering basic statistical principles by self-driven experiments. Multimedia software for Statistics can go beyond closed instructional microworlds by offering properly maintained subject-specific gateways to recent statistical data and supplementary information from the rapidly growing internet.

A multimedia software prototype Descriptive statistics and exploratory data analysis

The German State of North-Rhine Westphalia launched in 1998 a multimedia University network program aiming at building up innovative WWW-supported educational software prototypes for a broad range of sciences. Within this framework a multimedia software "Descriptive statistics and exploratory data analysis" (in German) was developed at the Distance University of Hagen in the period January 1998 – December 1999 as an interdisciplinary project involving a chair for Statistics and Econometrics and a chair for Applied Computer Sciences.

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The project output, in September 2000 nominated for the European Academic Software Award 2000, is a WWW-linked and highly modular structured software package designed in the form of an animated textbook. In order to facilitate orientation, all screen pages show a uniform bipartite layout with the left-hand half allocated to visualization and the right-hand half to the main learning content. The software strongly promotes customized learning by offering different learning levels. The first level, the initial state of a screen page, contains basic textual information of minimal size together with a visualized summary. This level is connected via hyperlinks to an encyclopedia-like glossary.

Figure 1 shows the initial state of a screen page dealing with graphically presenting and describing univariate empirical distributions. The five buttons on the right-hand half of figure 1 refer to the second learning level. These elements are inactive until the learner activates them by simple mouse click.
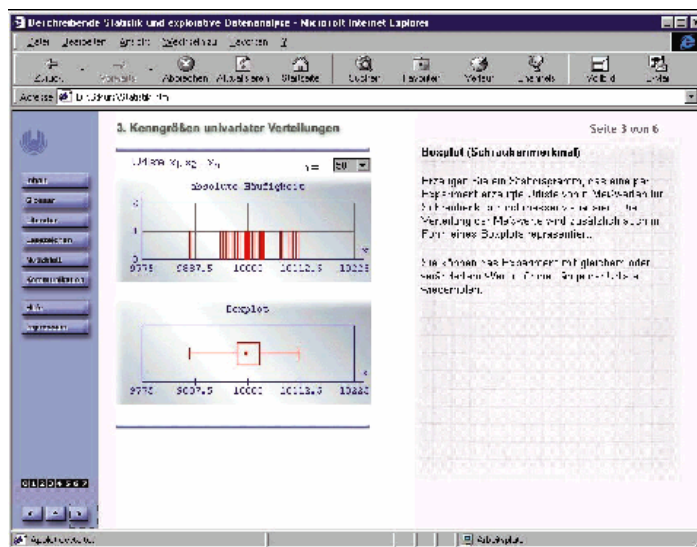

Figure 1: Initial state of a screen page (first learning level with visualized summary)

The elements of the second level are dedicated to the exposition of theory, to examples from a broad range of application fields, to interactive exercises or simulation experiments and to "expert" knowledge for the more advanced learner. After activating one of the differently labelled buttons related to the second level, the visualization on the left-hand half refers to this element. Depending on individual learning strategies, the learner may either start with the theoretical

background of a subject, with an experiment or with an example illustrating the theory.

Figure 2 shows the state of a screen page after activation of a button labelled "interactive experiment". The page deals with the concept of fitting a least squares line to a scatter diagram and measuring the goodness of fit. After mouse-conducted data-point specification, the software automatically displays the least squares line, the slope parameters and the coefficient of determination R^2. The learner may now "play" with the self-defined data by shifting or deleting data points or by creating an outlier and study the effects on the regression line and the measure R^2. In total, the software contains more than 70 Java applets, each emphasizing interactive learning and providing a grounding in basic statistical principles by means of sound-guided animation or self-controlled experiments.

Figure 2: Screen page state after activation of an element of the second learning level (interactive experiment for trying out the least squares principle)

The role of the WWW

The multimedia software described above is, in principle, fully net-operating. The learning contents are laid down in HTML format. An internet browser gives access to the usual communication functions of a virtual educational network, for instance to e-mail connections and course-related newsgroups. Due to today's still unsatisfactory internet capacities and due to cost considerations, the learning process is predominantly organized in the offline mode. Students with internet

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access are free to switch at predefined course points in the course to online learning in order to download the latest data or additional information.

Figure 3 illustrates this hybrid feature of the software. The left-hand half in figure 3 shows a table with unemployment data from the German Statistical Office. After activation of a button labelled "update tabular values", the most recent official unemployment data for Germany are immediately presented and evaluated in case of an existing WWW gateway.
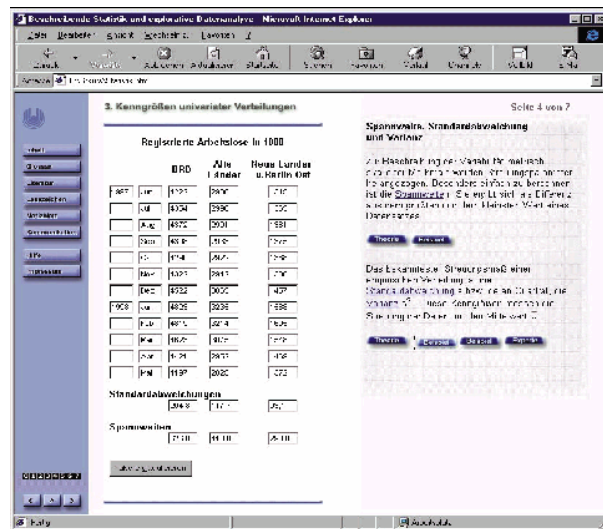
Figure 3: Use of the internet for feeding in latest statistical data
(unemployment data from the German Statistical Office)

Hence the internet is used for improving the communication between the agents of the learning process and as a source of the latest information. After release of forthcoming revisions, the revised submodules could be downloaded via the net. In the near future, high-speed internet channels will also open the chance to use the WWW as a medium for transporting the complete software from a server to any network-linked PC.

Databases for statistical Java applets and multimedia components as an alternative approach

The CD ROM or, before long, a DVD-based software "Descriptive statistics and exploratory data analysis" could be translated and adapted by partners interested in establishing internationally oriented multimedia cooperation. More detailed

information related to the project output and a demo version are available via http://www.FernUni-Hagen.de/STATISTIK. An adaptation of the software to the specific needs of other Universities is facilitated by the strictly modular course design. Due to the involvement of sound and to the necessary synchronization of sound and every animation step, a translation requires a substantial input of financial and personal resources.

The modular course design also suggests the separation of all interactive experiments and other multimedia-based components, such as animations with step-by-step derivations of theory or examples from real life for illustrating theory, from the original textbook-like environment. After removal, these components could be integrated as independent parts into a net-operating database aiming at efficiently supporting the learning and teaching of Statistics. This approach is already under test at the University of Hagen, in order to evaluate the didactical pros and cons, and is an alternative to the more extensive and more ambitious animated textbook concept sketched above.

Figure 4 shows an interactive Java applet after its removal from the textbook-like environment. The applet represents a self-controlled simulation for generating and graphically displaying univariate sample data of self-defined sample size. Originally this experiment was linked with the screen page represented in figure 1. Whereas in figure 1 the simulation was hidden behind the last button on the right-hand half and linked with the first learning level, the experiment shown in figure 4 has an independent character. The sound, the glossary and all communication functionalities from the more comprehensive multimedia software version may be partly or completely retained. In contrast to figure 1, the sound in figure 4 is displayed as a supplement in written form on the right-hand half substituting for the original main learning content.
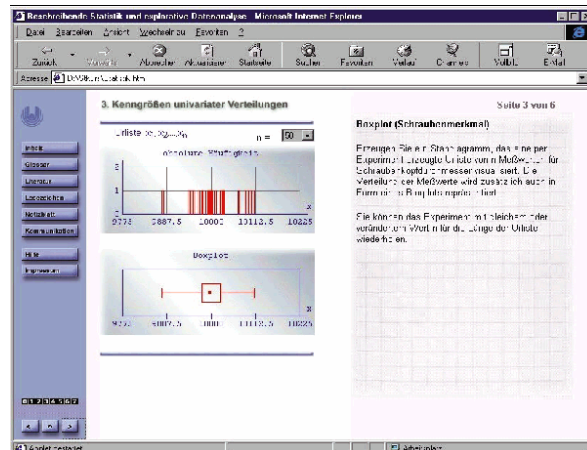
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Figure 4: Element of a database for Java applets or multimedia components
(interactive simulation for generating and visualizing data sets of variable size)

A database containing a collection of unconnected Java applets or multimedia components, each enriched with supplementary didactical comments, has some advantages over the alternative concept of using linked submodules and graduated learning levels. For example, one advantage is that independent and small components could be easily exchanged between international partners. Each partner could modify the content with very limited input and, if necessary, also change the language of the written or spoken didactical comments related to a submodule. Another benefit is that a database for statistical Java applets and multimedia components could be easily complemented by elements covering further topics of Statistics, for instance by experiments related to probability and distributions of random variables or to statistical inference. Hence there is a good case for starting international multimedia cooperation in Statistics on the basis of a database of net-operating statistical Java applets and multimedia components. The elements of such a database could efficiently support the teaching of Statistics at secondary schools, colleges, universities, and the framework of training on the job in industry. On the other hand, such components could facilitate the learning of Statistics by self-study and serve as a supplement to traditional instructional media.

A plea for improved international cooperation in multimedia development

Interactive educational software, WWW-supported tools and databases for Java applets and multimedia components offer huge potential to improve the quality of

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Statistics teaching and the intensity of international cooperation in this field. Up until now there have been only a few surveys on useful internet resources for Statistics, see for instance the surveys of WEST et al. (1998) or SAPORTA (1999). Some forward-looking universities and individuals have already developed very useful WWW resources and multimedia-based software but there is still a lack of systematic cooperation. A small number of highly motivated statisticians have invested much time and energy to fit together developments from different sources and to establish their personal database of interactive statistical experiments and other tools suitable for modern statistical education. One impressive example is the internet site http://noppa5.pc.helsinki.fi of Juha Puranen from Finland. Such individual attempts, while commendable, only facilitate a superficial orientation in the subject, based on existing resources. A systematic cooperation between different educational institutions, coordinating their development of Java applets and multimedia components and exchanging such elements, would be a more far-reaching and cost-effective approach.

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