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An open repository containing interactive learning objects for statistics education

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Sub-theme 7

This paper illustrates and reflects upon how the FernUniversitaet in Hagen (Germany), the only public university for distance education in the German-speaking part of Europe, is employing an open repository containing interactive learning objects for statistics education and further education. The award-winning repository aims to visualize statistical methods affiliated to descriptive or inferential statistics as well as interesting data from official statistics (Mittag, 2012a). The user-controlled exploration of data sets and basic statistical concepts is based on experiments that are designed as independent mini-learning worlds. These objects can be embedded in different educational settings, for example as a supplement to traditional textbooks (Mittag, 2012b) and face-to-face lecturing, or in web-based distance learning.

Introduction

Statistical literacy is a key competence of citizens in today's knowledge-driven societies (Gal, 2002). Universities and increasingly also statistical offices (National Statistical Office of Malta, 2009) try to meet the growing demand for statistics education and life-long further education by offering open educational resources (oer), usually online resources complemented by printed media.

So far there have been only two internationally visible attempts to promote international co-operation in statistics education by sharing educational resources. These two projects are SOCR - Statistics Online Computational Resource - (SOCR, 2012) and CAUSE -

Consortium for the Advancement of Undergraduate Statistics Education - (CAUSE, 2012). Both include an online repository containing different types of freely accessible online aids in English for statistics education and statistical computing. According to Downes (2007), Hylén (2006) and Atkins et al. (2007), they represent open educational resources. The repositories contain rather heterogeneous material within the context of media type, design and technical platform from different content providers. They are complemented by communication fora for students and educators. Both projects have been funded by the National Science Foundation of the United States of America and aim mainly to promote statistical literacy in the English-speaking world.

A new open repository for statistics education

The FernUniversitaet in Hagen, the only public university for distance education in the German-speaking part of Europe with some 80,000 students, employs a well-balanced media mix for introductory statistics education. Main pillars of this blended learning arrangement are, in accordance with the definition of Kerres & deWitt (2003):

- up-to-date printed course material, complemented by an interactive online version
- online fora for discussion and storage of additional material (e.g. exercises)
- traditional seminars and communication via phone and e-mail
- a new repository containing uniformly designed interactive and self-contained learning objects aimed at visualizing statistical methods and statistical data.

The Java-based elements of the repository are incorporated into the interactive online course. They can be employed world-wide independently of the original context within any other scenario in statistics education and further education, for instance for self-study purposes or as a complement to textbooks (Mittag, 2012b) and face-to-face teaching.

The new repository supports visual communication of basic statistical methods by enabling the user to “try out” how a statistical method or concept works. Figure 1 illustrates this by means of a dice experiment. The user virtually rolls a die n times, where n can be changed via a menu window. The relative frequencies of scores and the cumulative distribution of scores are displayed (part a), complemented by a table displaying the absolute and the relative frequencies of scores. As an option, the model of the uniform distribution can be inserted in addition to the simulation results (part b).

The model does not usually fit well in cases where n = 10 is chosen, but it does tend to fit well when a large number, say n = 1000 or beyond, is selected. The experiment forges a natural link from descriptive statistics to the wide-spread use of distribution models in inferential statistics.

Figure 1: Distribution of scores (dice experiment)

a. Empirical distribution (n= 10) b. Empirical and theoretical distribution

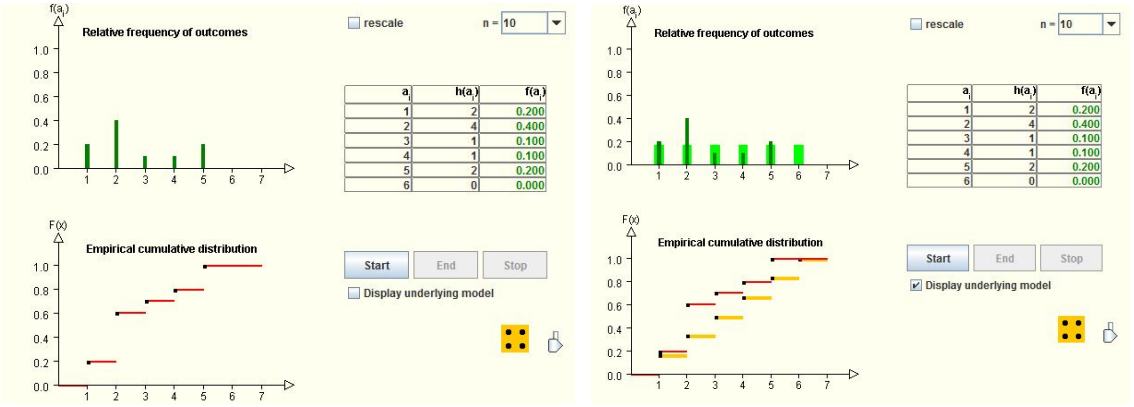
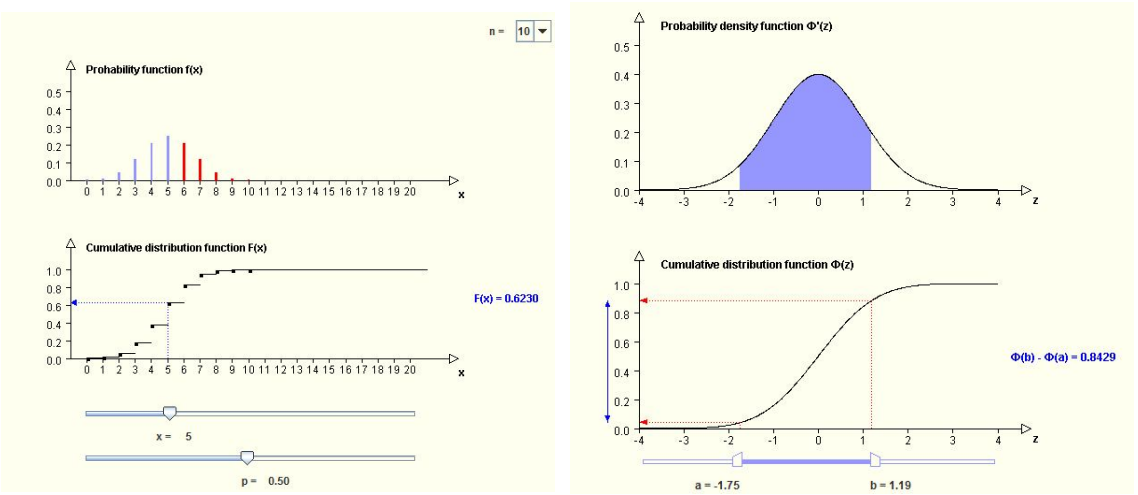


Figure 2 illustrates the flexibility of the Java applets on the basis of two other elements. The elements refer to promoting the employment and understanding of statistical tables for the binomial distribution and the standard normal distribution. The lower part of Figure 2a visualizes the value of the cumulative distribution function F(x) of a binomial distribution with parameters n = 10 and p = 0.5 at x = 5. The upper part of Figure 2a highlights the relationship between F(x) and the probability function or probability mass function f(x). The user is enabled to change the default values of n, p and x and to study the effect of these changes. The lower part of Figure 2b shows the difference $\Phi(b) - \Phi(a)$ between two values of the cumulative density function $\Phi(x)$ of the standard normal distribution. The upper part of the graph provides an interpretation of the result as the area between a and b below the probability density function of the standard normal distribution. Via sliders, the user can change the boundary values a und b. Such experiments go far beyond the presentations of static statistical tables that belong to the appendix of any textbook introducing statistics.

Figure 2: Binomial and standard normal distribution

a. Value F(x) of the cumulative distribution function of the binomial distribution (n= 10, p = 0.5) at x = 5

b. Difference Φ(b) – Φ(a) between two values of the cumulative distribution function $\Phi(x)$ of the standard normal distribution (a = - 1.75, b = 1.19)

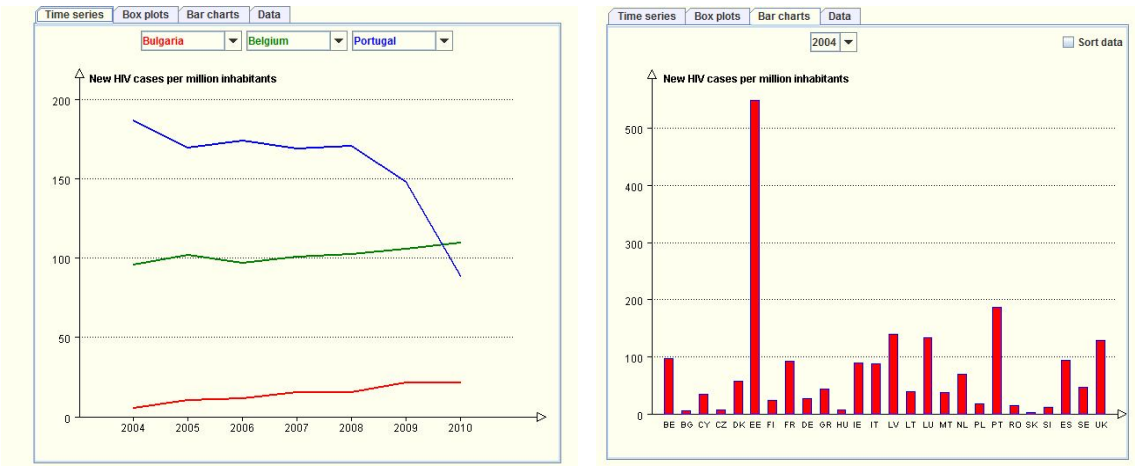


In addition to Java applets visualizing statistical methods, the repository also contains elements that aim to interactively explore interesting data from official statistics. Figure 3 provides an example based on data from the World Health Organization on new HIV cases in the EU 27 during the period 2004 - 2010.

Figure 3: HIV infection in the European Union 2004 - 2010

a. Time series graphs for 3 user-selected countries

b. Bar chart for 27 countries referring to a user-selected year



The user has the option of graphically presenting the data by employing time series graphs, bar charts and boxplots, or by looking at the data in tabular form. Strict avoidance of information overload was a principle observed when programming the applets of the new repository. Hence, for example, a time series graph does not include 27 countries, but only a small user-selected subset.

Another design principle was to minimize the text load on the screen in order to facilitate translation of the applets into other languages. For the time being, the elements are available in English and in German and partly in Japanese.

Future development

Ubiquitous, networked and mobile computers in their diverse forms are the backbone of modern distance learning (Jancke, Götter, Vogt, & Zawacki-Richter, 2012; Kukulska-Hulme & Traxler, 2005; Lee, 2010; Pea, 2010). The digital code in the form of software makes it possible to create individual (learning) worlds on digital platforms as described by Weizenbaum (1976, p. 155). A few statistical experiments have already been adapted for use on Android-based mobile devices. But the code for education applications should no longer be trapped in proprietary software. Instead, web technology with its openness and generally binding standards, such as for example HTML-5, will represent the future for mobile learning. The best app is the browser. In the medium term, native apps will, for economic reasons, only be sustainable for well-defined cases, such as applications involving intensive numerical computing. The attainment of full platform-independence including coverage of further languages will be the next step.

References

Atkins, D. E., Brown, J. S., & Hammond, A. L. (2007). A review of the open educational resources (OER) movement: Achievements, challenges, and new opportunities. Retrieved from www.hewlett.org/uploads/files/ReviewoftheOERMovement.pdf

CAUSE. (2012). Consortium for the Advancement of Undergraduate Statistics Education. Retrieved August 1, 2012, from http://www.causeweb.org/

Downes, S. (2007). Models for sustainable open educational resources. *Interdisciplinary Journal of Knowledge and Learning Objects*, *3*.

Gal, I. (2002). Adults' Statistical Literacy: Meanings, Components, Responsibilities. *International Statistical Review*, *70*(1), 1–25. doi:10.1111/j.1751-5823.2002.tb00336.x

Hylén, J. (2006). Open educational resources: Opportunities and challenges. Retrieved from www.oecd.org/dataoecd/5/47/37351085.pdf

Jancke, A., Götter, R., Vogt, S., & Zawacki-Richter, O. (2012). iAcademy – an innovative mlearning approach for lifelong learning. In I. A. Sánchez & P. Isaías (Eds.), *Proceedings of the IADIS International Conference Mobile Learning 2012* (pp. 377–379). Presented at the IADIS International Conference Mobile Learning 2012, Berlin: IADIS Press.

Kerres, M., & deWitt, C. (2003). A Didactical Framework for the Design of Blended Learning Arrangements. *Journal of Educational Media*, *28*(2-3), 101–113. doi:10.1080/1358165032000165653

Kukulska-Hulme, A., & Traxler, J. (2005). *Mobile learning : a handbook for educators and trainers*. Open and flexible learning series. London: Routledge.

Lee, T. (2010). KNOU mobile learning for innovation in statistics education. Retrieved from http://www.stat.auckland.ac.nz/~iase/publications/icots8/ICOTS8_9E3_LEE.pdf

Mittag, H.-J. (2012a). Virtual repository containing interactive experiments for statistics education. Retrieved June 1, 2012, from http://www.fernuni-hagen.de/jmittag/repository/

Mittag, H.-J. (2012b). *Statistik : Eine interaktive Einführung*. Springer textbook (2nd edition, German). Berlin: Springer.

National Statistical Office of Malta (2009). eCourse "Statistical Literacy". Retrieved August 1,

2012, from http://www.fernuni-hagen.de/statliteracy/

Pea, R. (2010, June 10). *Developments in the Learning Sciences and Technologies*. Presented at the LPCH Leadership Forum, Stanford University. Retrieved from http://www.slideshare.net/roypea/roy-pea-lpch061010

SOCR (2012). Statistics Online Computational Resource. Retrieved August 1, 2012, from http://www.socr.ucla.edu/

Weizenbaum, J. (1976). *Computer power and human reason*. San Francisco: Freeman.