Guidelines for Teaching and Learning Statistics using the Statistics Online Computational Resources: Taking Computer-Based Learning to the Next Step

Juana Sanchez, Nicolas Christou & Ivo D. Dinov
UCLA Department of Statistics, Los Angeles, CA 90095
www.SOCR.ucla.edu

Summary

We will introduce the SOCR resource, describe the pedagogical utilization of the SOCR tools, conduct interactive activities to demonstrate their in-class use and introduce our collaborative working environment for development and exchange of tools and instructional materials.

Introduction

In this session, activities from the Statistics Online Computational Resources (SOCR) will be conducted with the participants in the same way they are introduced in our Introductory Statistics and Probability classes. Participants will also learn about the available SOCR tools, how to use them and how to contribute to these activities using the SOCR Wiki collaborative environment (http://wiki.stat.ucla.edu/socr). Many of the SOCR resources are dynamic and are readily adaptable as the activities for the specific classrooms. Until now, educators have adopted various applets, and many have created their own out of dissatisfaction with the existing applets. SOCR **philosophy** is that to provide excellent science, technology, engineering, and mathematics (STEM) education for all undergraduate students and to involve instructors of diverse backgrounds to exchange ideas and interact in the development of educational materials. We do not distribute static instructional materials; instead we develop and extend the framework that allows instructors to custom-design activities and tools that fit their specific course, student population and topics covered.

The efforts of the SOCR resource are to develop the foundation of tools and instances of instructional activities. These include open-source Java applets, computational probability and statistics Java library, class notes and collaborative activities. This infrastructure enables educators to go to the next level in information technology based instruction.
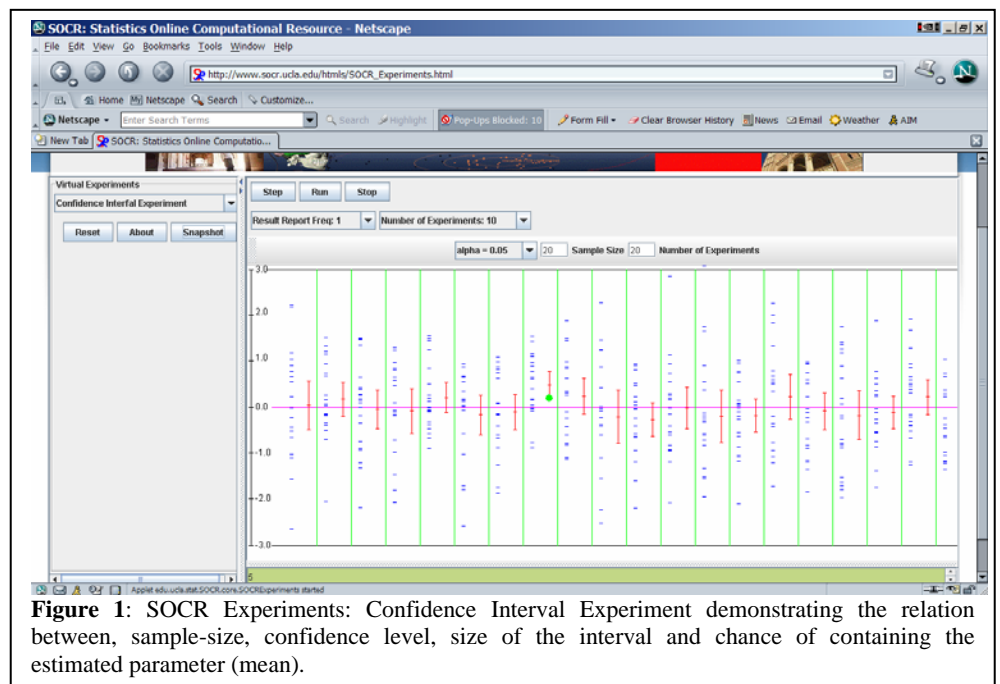
The SOCR was founded in 2002 and initially funded by UCLA Office of Instructional Development. Later in 2005 SOCR was funded as an NSF DUE resource (0442992). The main objective of SOCR is to offer a homogeneous interface for online activities appropriate for the Introductory Statistics Course, Introductory Probability course and other advanced Statistics courses that rely on hands on demonstrations and simulation to illustrate Statistical concepts. A common portal for all SOCR activities is very important to minimize the amount of time that students have to spend learning the technology. SOCR materials and activities have received recognitions from several international, educational and technology-based initiatives (http://www.socr.ucla.edu/htmls/SOCR_Recognitions.html). SOCR has been tested in the classroom on several occasions. Most recently with an experimental study we conducted led us to conclude that using SOCR for the teaching of Introductory Statistics and Probability was effective (Dinov, Sanchez and Christou, 2006).

More testing of the effectiveness of SOCR in undergraduate teaching is currently underway at UCLA during the 2006-2007 academic year. The dependence of students' performance in the SOCR-based courses will be studied as a function of their attitudes towards the subject, their learning styles and other student demographics. In this session, we propose to provide hands-on experience on how to use the SOCR resources in the best possible way to achieve the best learning outcomes for different groups of students. Insights from the testing done in our classrooms will be provided.

The SOCR Interface for Teaching and Learning.

Our initial efforts have received international attention following a *Science* magazine review of our SOCR prototype resources (Leslie, 2003). Included in our initial developments were designing, implementing and testing an elaborate web of probability resources for augmenting the instruction in undergraduate probability courses. These resources included virtual probability experiments, games, tools for data modeling and statistical analysis (e.g., Monte Hall Game, Confidence Intervals Experiment, Mixture Distribution Modeling, regression, etc.) Introductory probability courses usually begin by referring to various familiar experiments and games (e.g., rolling dice, dealing cards, tossing coins, playing roulette or crabs, drawing balls from urns, matching hats to people, etc.) Despite the fact that most of these games may seem clearly defined, many students experience difficulties addressing specific questions about such experiments. Some of the problems arise from the need for game abstraction, others are due to inability to create a perfect mental representation of the real experiment. To address these issues we designed a virtual experimentation component of the SOCR resource that contains a number of games and virtual experiments that are used to build intuition and confidence in understanding such problems. These tools allow students to perform virtual experiments, change parameters of the experiments, observe the outcomes, record frequency distributions, compute sample statistics and compare sample and population characteristics (e.g., means, distribution shapes, etc.) Figure 1, shows a demonstration of this virtual experimentation framework, using a Confidence Interval Experiment. This is a dynamic

Figure 1: SOCR Experiments: Confidence Interval Experiment demonstrating the relation between, sample-size, confidence level, size of the interval and chance of containing the estimated parameter (mean).

simulation where the user selects various parameters and starts the experiment. Random samples are generated (from Normal(0,1) distribution, in this case) and plotted along side with the corresponding confidence intervals. Intervals excluding the parameter of interest (μ=0) are marked with large green dots. Many of the SOCR Experiments, Distributions, Analyses and Charts are described in more detail Statistical Computing and Graphics Newsletter (Dinov, 2006).

Examples SOCR Activities

We plan to demonstrate and describe in detail at least two different SOCR activities during this session. These include a Central Limit Theorem (CLT) Activity and Distribution Activity. The CLT activity (http://wiki.stat.ucla.edu/socr/index.php/SOCR_EduMaterials_Activities_CLT) illustrates the properties of the sampling distribution of the sample average and serves to motivate and build students' intuition. The Distribution activity shows how to interact with the SOCR Distributions to obtain probabilities, critical values and visualize the areas of interest for over 45 distinct distributions (http://wiki.stat.ucla.edu/socr/index.php/SOCR_EduMaterials_Activities_Distributions). As time permits we will go over other activities, educational materials and applet demonstrations (http://wiki.stat.ucla.edu/socr/index.php/SOCR_EduMaterials).

References (http://www.socr.ucla.edu/htmls/SOCR_References.html):

Dinov, ID, Sanchez, J. and Christou, N. *Pedagogical Utilization and Assessment of the Statistic Online Computational Resource in Introductory Probability and Statistics Courses*, *in press*, Journal of Computers & Education, 2006.

Dinov, ID. *SOCR: Statistics Online Computational Resource: socr.ucla.edu*, Statistical Computing & Graphics. Vol. 17, No. 1, 11-15, 2006.

Leslie, M. *NetWatch EDUCATION: Statistics Starter Kit*, Science Magazine, Volume 302, Number 5651, Issue of 5 December 2003.