A COMPUTER-BASED LABORATORY

FOR

MATHEMATICAL STATISTICS AND PROBABILITY

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ABSTRACT

The computer provides the capability for simulating many different types of random experiments. In order for the student to write a computer program that will simulate a physical experiment, the student is required to understand the experiment and available simulation techniques. In writing a program to simulate a theoretical result, the student gains a better understanding and appreciation of the theory.

An instructional package has been developed for a computer-based laboratory for a course in mathematical statistics and probability. The package includes over 50 function subprograms and subroutines and a manual with more than 250 exercises. Our laboratory meets for two hours each week and has been in operation for five years. In general student reaction has been favorable.

The subprograms in the package include seven distribution functions, the inverses for four distribution functions, simulation programs for thirteen different distributions, and several graphing routines. The programs can be run either through batch processing or interactively. The laboratory manuals contain exercises for a year-long post-calculus course in probability and statistics. Also included in the manual are complete solutions for 25 exercises.
1. INTRODUCTION

Hope College is a four year, undergraduate, liberal arts college of 2100 students. During their first two years of college, potential mathematics, science, and computer science majors include in their program a full year of calculus and a semester of Introduction to Computer Science in which they learn to program the computer using FORTRAN IV. With this background the student is prepared to take our year-long course in mathematical statistics and probability along with an optional computer-based laboratory.

2. BACKGROUND OF LABORATORY

We began to develop the laboratory materials and supporting computer software during the summer of 1971. It was motivated by students who had taken our statistics course and were interested in using the computer for research projects. The projects often required some sort of simulation. In order for the student to write a computer program to properly perform a simulation, the student not only had to understand the underlying theory but also gained a greater appreciation for this theory. We believed that similar types of experiences for more of our students would be beneficial. This prompted the development of the laboratory.

Dr. Herbert Dershem, Chairman of our Computer Science Department, believed that the integration of computer programming and introductory statistics for students majoring in psychology, sociology, business administration, and economics would be highly beneficial to those students.
We were able to undertake both projects together with financial support from the National Science Foundation* and the able assistance of seven students.

Dr. Dershem's materials are now available from Project COMPUTe, Dartmouth College, Hanover, New Hampshire 03755.

3. LABORATORY MANUAL AND SUBPROGRAMS

An instructional package has been developed for a year long course in mathematical statistics and probability. The package includes a laboratory manual and supporting computer software.

The laboratory manual contains over 250 exercises with complete solutions for 25 of them. The manual parallels the textbook Probability and Statistical Inference by Robert V. Hogg and Elliot A. Tanis [1].

The students write their own programs for solving the exercises. However over 50 subprograms are provided for their use. Among these are:

i. A pseudo-random number generator.

ii. Graphing routines for
   a. the empirical distribution function with the option of superimposing the theoretical distribution function.
   b. a relative frequency ogive curve with the option of superimposing the theoretical distribution function.
   c. a relative frequency histogram with the option of superimposing the theoretical probability density function.
   d. a scatter diagram with the option of adding the least squares regression line.
   e. a relative frequency power function with the option of superimposing the theoretical power function.
   f. printing the graph of any nonnegative valued function.

iii. Programs that give the values of seven distribution functions.

iv. Programs that give the values of the inverses of four distribution functions.
v. Programs that select random samples from the standard distributions.

4. DESCRIPTION OF LABORATORY

Our laboratory is in its sixth year of operation. Students have the option of taking the laboratory for an extra hour of credit. It meets for a two hour block each week. The first hour is spent discussing the computer output of the previous week's assignment and introducing the new assignment. During the second hour the students begin to write their programs.

It is possible for the students to run their programs through batch processing or they may run their programs interactively at a terminal.

Some examples of exercises and typical output are given in two earlier papers that were presented at the Third and Fourth Conferences on Computers in the Undergraduate Curricula [2,3].

5. GOALS

Some of the goals of the laboratory are to:

i. Help the student understand and gain a greater appreciation of the theory.

ii. Illustrate that certain probability models are appropriate for particular random experiments.

iii. Show how the computer can be used as an aid for analysing data.

iv. Expand possibilities for undergraduate research projects.

6. CONCLUSIONS AND RECOMMENDATIONS

This laboratory provides a worthwhile experience for the student. Interactive capabilities have had a positive impact although batch processing is still the best for many students.
It is important to discuss with the students their computer output. They often need help in analysing their results. Discussion also increases the worth of the exercises.

Graphics terminals could have a positive impact on this laboratory. Unfortunately, Hope College does not yet own a graphics terminals, although proposals have been written which include the purchase of graphics terminals.

7. DISTRIBUTION OF MATERIALS

The laboratory manual and subprograms have been favorably reviewed by CONDUIT. Copies of the laboratory manual and a tape containing the subprograms are available from CONDUIT, P.O. Box 388, Iowa City, Iowa 52240.

REFERENCES


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