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A MONTE-CARLO APPROACH TO INTERACTIVE GAMING

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ABSTRACT

This paper presents an alternative simulation methodology for interactive business computer games. Interactive gaming methodology and the Monte-Carlo approach to simulation are defined and then compared. The entire paper is dedicated to improve the quality of an individual simulation method, which in turn improves the overall quality of computerized business games, and finally, but most importantly, improves the instructional and educational benefits for the students, our future decision makers.

INTRODUCTION

During the last decade there have been many new and highly innovative methodologies developed for business computer simulations. [10] One of the most important changes has been the development of the interactive gaming format.

The interactive gaming format, as a simulation methodology, is interactive in two respects. [4] The first way is by allowing players to almost instantly receive their outputs from their inputs displayed on the computer terminal. The second way occurs when players interact in real time with other competitive players during the simulation. In other words, the results of team ill's profitability are directly affected by the amounts of the input variables of price, promotion and product quality determined by teams #2 - 10, the competition.

Within the spirit of the ABSEL tradition this paper will be an attempt (1) to improve the existing interactive simulation methodology and (2) to report its recommendations to practitioners designing their own computer simulations.

PURPOSE

The purpose of this paper is to present an alternative simulation methodology for the interactive business computer game. The new alternative will make use of the Monte-Carlo simulation method which generates random variables from a uniform distribution and transforms these variables to ones which correspond to the distribution of interest. [6]

The importance of developing this alternative simulation methodology is threefold: (1) The reduction of time delays, (response time), (2) The elimination of most hardware problems and (3) The increasing of the authenticity level for the simulation.

INTERACTIVE GAMING

Before discussing the merits of the Monte-Carlo method, an examination of the workings of the interactive simulation techniques is necessary.

The distinctive feature of interactive simulation is the computer's ability to allow (almost) simultaneous reading of competitors' data files. For example, team i/l has modified several decisions and has requested that these and their other marketing mix variables be now implemented in the form of a profit and loss statement. It then becomes necessary to calculate industry averages which will be used to determine team #1's demand in units. [51 Therefore, it is essential to be able to read competitors' data files at any given moment during the simulation time. Figure I illustrates this dynamic nature of interactive gaming and its necessity to simultaneously access competitors' data files. [3]

The actual procedure is as follows: Team #1's Fortran program opens, reads and then closes team #2 - Team #10's marketing mix data files. See Figure II. This information is then simply calculated to determine industry averages for prices, promotional levels, product quality indices, sales, profits and demand in units. The mathematical calculations are performed in milliseconds; the opening and closing of the files is the very time consuming part of the process (response time associated with I/O functions.) Unfortunately, this time consuming process of opening and closing of files is the exact ingredient that makes interactive gaming so dynamic and realistic. [2] By examining Figure III, it is readily seen that players of the simulation can request information, modify variables or implement decision variables at any time during the simulation game. This flexibility of decision making is unlike the fixed format games when information and variables can only be processed at some predetermined and exact time period, usually quarters.

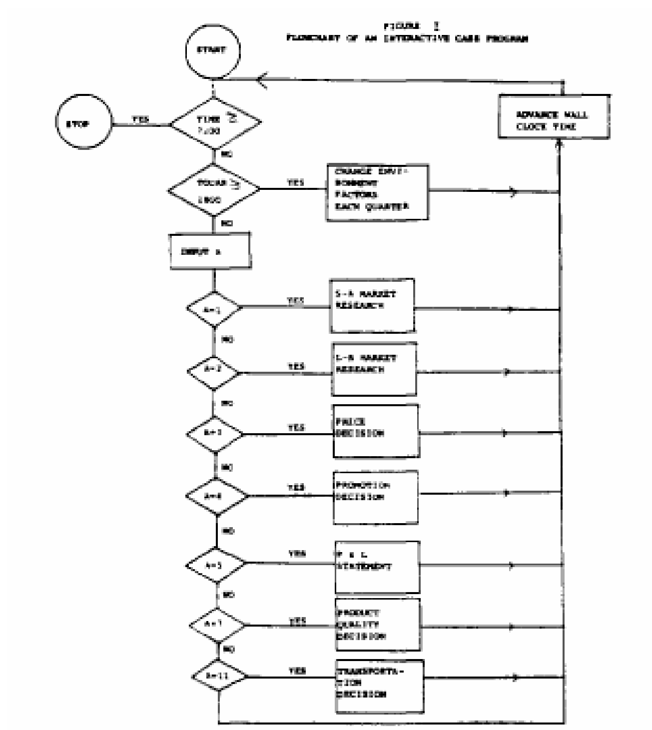

FIGURE I
FLOWCHART OF AN INTERACTIVE GAME PROGRAM

FIGURE II

Flowchart of Data Files

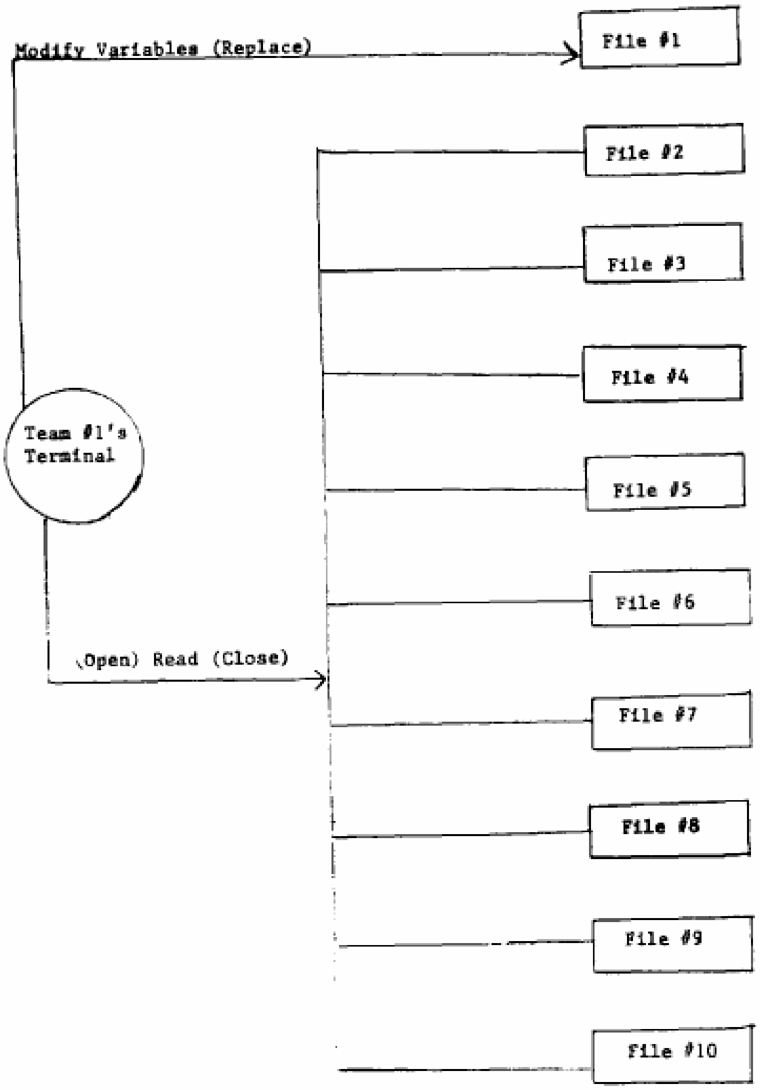

FIGURE III
FILE ACCESS AND MODIFICATION DIAGRAM
(For Two Participants, One File Per Participant)

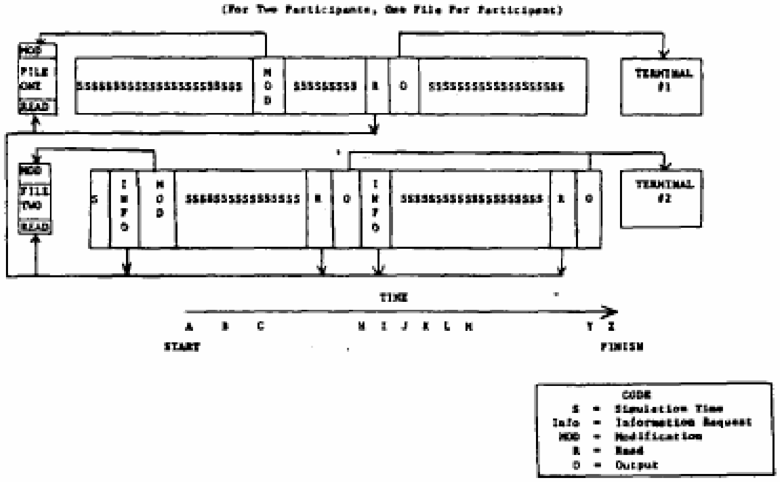

TABLE I
Snapshot prices of Sets
By Team

Times

Teams	11.59	12:06	12:13	12:24	12:28	12:33	12:38	12:46	12:54	12:59	1:21	1:20	1:30	1:50
1	35	35	35	35	35	35	33	33	33	33	33	33	33	33
2	37	40	38	38	38	38	38	38	38	38	37	37	37	37
3	38	38	38	36	36	36	36	36	36	36	34.50	34.50	32	32
4	37	37	37	37	37	37	37	37	37	37	37	35	35	35
5	60	60	60	60	60	50	45	38	38	22	22	22	15	15
6	36	36	36	36	36	36	38	38	36	36	36	36	32	32
1	40	41	40.67	40.33	40.33	38.67	37.63	36.67	36.33	33.67	33.25	32.92	30.67	30.57

MONTE-CARLO METHOD

The Monte-Carlo method is actually a sampling technique and not a simulation method. [7] This paper will be utilizing the term and method which has been commonly called the Monte-Carlo approach [8] towards simulation.

The procedure use for the Monte-Carlo approach towards simulation follows:

1. Plot or tabulate the data of interest as a cumulative probability distribution function with the values of the variate on the *x* axis or abscissa and the probabilities from 0 to 1 plotted on the y axis or ordinate.
2. Choose a random decimal number (RN) between 0 and 1 by means of a random number generator.
3. Project horizontally the point on the y axis (ordinate) corresponding to this random decimal number until the projection line intersects the cumulative curve.
4. Project down from this point of intersection on the curve to the x axis (abscissa.)
5. Write down the value of x corresponding to this point of intersection. This value of x is then taken as the sample value. [9]

Table I was compiled from six teams playing the computer game during the summer of 1984. The table illustrates the various amounts teams were pricing Beta throughout the two hour game. For example, Team #5 at the beginning of the game (11:59 a.m.) was pricing the Beta product at $60. However, their price was drastically reduced to $15 by the end of the game (1:50 p.m.). Also included in this table is the average industry price for Beta through time.

Actually, there are 15 tables with this type of snapshot information for the teams' (1) prices, (2) promotional levels and (3) product quality indices for each of the five products being simulated in the game.
(5*3 15).

By analyzing these and past tables, the game designer is aided in determining the limits of each variable. The game designer has the final decision to make with respect to the actual limits of the variables, in other words, the high and low values, parameters.

The next step is the plotting of the cumulative probabilities and the determination of the value being simulated. It is a fairly simple task to accomplish this in a programming language. For example, the game administrator has decided that a given variable be in a range of integers between 120 and 260. This becomes

x=119 + INT ((RND(N)*140)+1).

When the random number (RND)O, then X=120.

When the RND=1, then X=260. Also when (RND)=.5689543, then X=19°. The notation INT means the computer only calculates the resulting integer value.

FINDINGS AND RECOMMENDATIONS

This paper has presented an alternative simulation methodology and will in this Section offer the comparative findings of one method versus the other.

(1)Reduction of time delays. The elapsed time was measured between when a team requested a Profit and Loss Statement be implemented, to the time the output was actually seen on the terminal. The response time was calculated to be approximately three minutes in the interacting format on the average when 40-50 terminals were using the main CYBER computer. The time was unbearably lengthy when the CYBER is servicing 100 or more users, 5 1/2 minutes. There have occasionally been response times exceeding 10 minutes. When response time is at 10 minutes the game absolutely has to be rescheduled. Even at a 3 minute response time, the game players are not able to interact with the computer for (on the average) 36 minutes. Teams usually call for 12 P & L's during a complete beginning-to-finish two hour simulation game. Thirty-six minutes, in my opinion, is too much response time.

When playing the computer game with the Monte-Carlo approach, the response time for the P & L statement's appearance, after being requested, has been usually 10 seconds or less. For 12 P & L's, the total time is only 2 minutes -- compared to the sluggish time of 36 minutes.

(2)Elimination of most hardware problems. One of the reasons why professors need sabbaticals is computer crashes. There is nothing more upsetting than to schedule the exclusive use of an entire computer terminal room and have the system go down right in the middle of your computer game. This is especially fun when the business game counts for 20Z of someone's grade. Complete chaos results. Thirty students instantly panic. Ugliness is rampant. It is very difficult to assure the students that fairness will result if all students must again replay the game from the beginning at time period zero. This situation in the last ten semesters has occurred twice (20Z). Totally, two too much.

Using the Monte-Carlo approach eliminates the above scenario because it is not necessary for the entire class to participate in the business game simultaneously. Also in the Monte-Carlo version, a student is in competition with an industry and not their often random-thinking and predatory classmates.

The reliance on the big CYBER system will be completely eliminated this fall semester with the arrival of 25 new Zenith PC's in the School of Business. The business game with the Monte-Carlo approach will eventually be played in the Basic language. This should reduce the 20% hardware problems to approximately zero percent. If there is a problem with a P.C., a diskette will be removed and another P.C. will be used for the game.

This use of Micro-computers for gaming purposes is just in the beginning stages of tremendous growth with more and more applications being offered on the horizon. [1]

(3)Increasing the authenticity level of the simulation. Students, receiving C grades and less for the interacting business game, are always kindly informing me that when they played the game the class was unfair to them in some respect and that their grade is not indicative of their ability. Well, the professor could say that (1) life isn't fair, (2) the real world will be worse, (3) they couldn't pass if their competitors were illiterate chipmunks, (4) things will balance out in life, (5) the game is fair or (6) some combination of #1-5. Seriously, it is possible for four or more teams to all make large errors in the same direction for all their products during the simulation. This would indeed negatively or positively influence the results for a particular team. Unfortunately, when playing an interactive game, there is a slight probability that this situation will occur. The Monte-Carlo approach completely eliminates this problem because the simulation designer determines the upper and the lower limits for the industry averages. Therefore, the Monte-Carlo approach compared to interacting gaming offers a more authentic environment for the business student.

In conclusion, this paper's ultimate purpose has been the offering of insights on an alternative simulation methodology to game designers and practitioners in the ever changing field of computer business games.

The final observation of this paper is really a recommendation/challenge for game designers. During the literature review, it was noticed that there were many fixed format games (decision-making on a quarter of a year basis) available for main-frames and micros. [11] In real life (reliability, validity, verisimilitude) decision-making is not in a discrete mode through time (4 times a year, quarterly.) It is continuous. A manager can modify variables whenever the need or desire warrants, not just quarterly. The results of these decisions, P & L's can also be monitored for variable lengths of time. So please game designer, think not discrete but continuous distributions and functions.

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