FLEXIBLE COMPUTER-BASED GAMES IN TRAINING AND RESEARCH

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ABSTRACT

Interactive programming languages make it possible to program games whose rules are variable rather than fixed. The game program requires initial human intervention to set parameters that define which set of rules, out of some potentially large finite number, will govern the game when next played. Programs can be written in such a way that persons untrained in the use of the programming language can nevertheless construct and implement a complex research design, design and execute a gaming experiment, with all the control and data-processing advantages of a computer base, without having to invest several weeks in learning a programming language. In the early stages of research training, the flexibility afforded by a substantial set of rule options is sufficient to test the student's understanding of the requirements of experimental design.

Almost any aspect of the rules of the game can be made optional. These include decision time limits, the size of rewards and penalties, the number of players, the level of consensus required to finish the game, the amount of interest conflict inherent in the payoff structure, the degree of co-operation or competition suggested by the instructions, the possibilities for communication among the players, the amount of information players receive about the results of previous iterations, and the identification of the opponent as another person or as a computer. Game packages, analogous to data analysis packages such as SPSS, can be developed as teaching tools.

Two computer-based games currently being developed and tested in West Germany and the United States are described as examples of this approach. One is a Prisoner's Dilemma Game, which allows several of the usual, and some unusual, parameters to be varied. The other game is a multi-person bargaining game called "Death at Sea". Versions of these games are geing tested in an American University and in a vocational rehabilitation institute in West Germany.

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Every game has a set of rules. Usually the rules of a game are fixed, and the value of the game derives from particular features of its rules. A game can be useful in training if its rules reward skills that need to be developed. It can be useful in research if its rules subject players to boundary conditions whose effect on human behavior is a topic of investigation.

We believe that this notion of the role played by the rules of games in training and research can be profitably extended. Rules can be still more useful for both purposes if they are variable rather than fixed. We shall explicate this assertion below and then illustrate our own ongoing attempt to implement it.

The traditional experimental or training game limits the range of options open to the subject or trainee (i.e. player). He cannot participate in the determination of the rules, which are fixed in advance by the experimenter or trainer. The player's alternatives are established and limited by the rules; his creativity can be exercised only insofar as the rules allow, as he seeks to attain his objectives in the game. The rules usually inform the player as to his desired objectives (the "object of the game") as well, although sometimes he is left to learn the purpose of the game by playing, and sometimes deception about game objectives may be necessary for experimental purposes.

The traditional game, with these limitations, is applicable to some training and research goals, but not all. In many situations, people need to be trained not only to follow rules, but also to devise them. Organization leaders, public and business administrators, teachers, recreation specialists, and many others are expected to have this kind of skill. Likewise, research on group behavior cannot possibly cover the range of its interesting aspects if rule-making behavior is excluded from consideration. Politics, especially, involves conflict over what the rules ought to be perhaps as much as conflict over the allocation of values under an existing and unchallenged set of procedural rules.

The extent to which a game allows players to exercise rule-creating options can be expressed roughly by a three-level classification. A "level-one game" shall be defined as a game whose rules are fixed and whose only options are those which the fixed rules offer to players. A "level-two game" is a game whose rules are variable along fixed dimensions, giving to the game initiator the opportunity to select values for particular parameters and thereby select one set of rules out of a larger (or even infinitely large) class. A "level-three game" will refer to one which offers variable dimensions as well as variable rules. The game initiator does not just answer a series of questions about what the rules should be, but first answers a series of questions about what questions ought to be asked about what the rules should be. A crude analogy to these three levels would be a political system requiring everyone to obey the existing laws (level one), one allowing them to change the laws in conformity with the constitution (level two), and one allowing them to change the constitution as well (level three).

A level-two or level-three game provides more training and research opportunities than a level-one game. First, a higher-level game provides training in training. This is so because each set of rules rewards, or places a premium on, a particular set of skills, whose relative importances are different under different sets of rules. Hence the task of determining the rules of the game implies the task of determining the skills in which training is to be given. It is an important but difficult task to devise an institution (e.g. a game) that will in practice place the desired emphases on a particular set of skills and succeed in enhancing them in the desired proportions and to the desired degrees. Secondly, how and how fast subjects learn to devise such institutions under various conditions is an interesting question as well. Thirdly, higher-level games offer an opportunity for practical training in research design.

Although many level-one games can be easily designed with conventional materials, such as boards, slips of paper, cards, pens, tables, and booths, the complexities of executing a level-two or level-three game are such as to make computerization worth considering. In fact, computer management, as we have argued elsewhere,[2] not only makes experimental games more efficient in several ways, but also makes some kinds of games possible which could not be played with conventional equipment.

Computer-based higher-level games can be programmed in such a way that naive trainees or subjects can make the necessary choices among rule alternatives to initiate a game without themselves knowing how to program at all. Likewise, research students with substantive interests who need to design and execute an experiment can proceed to and through this task without the lengthy delay that learning how to program, programming, debugging, and testing would entail, and also considerably faster than they could design and execute an experimental game with conventional materials. This, of course, assumes that the available higher-level game program includes options that let the student design a game/experiment appropriate to his theoretical purposes.

The range of alternatives that can be practicably programmed into a higher-level game is wide. Features that can be made subject to initiator determination include the number of players, the title of the game, the use of explicit outside-world interpretations for game parameters, the types and amounts of rewards and penalties, the time limits allowed for making decisions, the types of decisions that are to be made, the kind of consensus required to attain given rewards, the amount of interest conflict inherent in the payoff structure, the degree of cooperation or competition suggested by the game instructions, the possibilities for communication among the players, the amount of information the players receive about the results of previous iterations, the degree of physical isolation and anonymity among the players, and the degree of intervention or participation, as opposed to mere management, engaged in by the computer.

Higher-level game programs embodying large numbers of such options could be called game packages, analogously to statistical program packages like SPSS, DATA-TEXT, or Biomed. Along with the obvious common problems of inter-installation transferability and a limited range of invokable procedures, both kinds of packages also offer the advantage of pretested, quickly implementable procedures which hopefully satisfy the most common needs of many users.

Two game packages currently under development[3] at the State University of New York at Stony Brook and at the Stiftung Rehabilitation in Heidelberg, Federal Republic of Germany, illustrate what has been said above. The first game is a generalized, two-person, 2-by-2 game. The present program allows the initiator to vary the game title and the identification and description of the opponent, who however is in fact always played by the computer itself. The payoff schedule and actual payoffs displayed to the human player can be limited to his own or can also include the opponent's, can be in terms of points or monetary units (cents or pfennigs), and can be set as desired by the initiator. The computer's strategy can be fixed as any class 1 (homogeneous Markov) decision rule (probabilistic or deterministic), and the player can be given various levels of information about the computer's strategy. In addition to or instead of making binary choices, the player can be asked to predict the opponent's choices, and the payoff schedule can be based on predictive accuracy as well as on each round's pair of choices. The game can be set to end on demand of either player or after a particular number of rounds, chosen by the initiator. He can also determine the frequency with which total and summary feedback about all prior rounds' results is displayed to the player. The initiator can also have the program request from the player at the end of the game subjective descriptions of his and the opponent's strategies.

The second game program, unlike the first, allows several human players to interact. The computer makes no decisions, but only manages the game. The game is called "Death at Sea". Players are told they are in a sinking lifeboat that can only hold a bare majority of them and will sink if a bare majority does not agree within a certain time on what bare minority shall be dumped overboard. The players vote in secret for as many rounds as necessary to reach the required unanimity among a bare majority or until the time limit is reached. The initiator can set the game to provide a monetary reward to the survivors, if he chooses. He can select from three levels of feedback that players should receive at the end of each round regarding the results of the voting. Votes can be required to be cast within any desired number of seconds, and votes against oneself can be allowed or prohibited. Furthermore, passengers may be allowed to send messages to each other before each round of voting. If so, these messages may be limited to suggestions on voting, or to promises of side-payments, or may be selectable by each player from these two types. The number of messages a player can send per round may be limited, as may be the set of potential receiving players: the initiator can completely define the network of (directed) communication channels. Players, who are identified to each other only by number, may however also be described as having certain characteristics. The options in "Death at Sea" can be exercised differently for different players; e.g. one player might be able to send only two promises per round and only to players 5, 7, and 8, while another player may send only one message per round, but unlimited as to type or addressee.

Both games described above have instruction and practice subroutines, which can be skipped with experienced players. All moves and messages are stored by the program for later analysis, which can be carried out at any of the same terminals used by players during the game.

Since such decisions as to whether players should make moves, predict their opponents' moves, or both, and as to whether there should be any communication among players, are decisions as to whether particular dimensions should be invoked for more detailed specifications of game rule characteristics, the two game programs just described fulfill the requirements of level-three games. Even so, they illustrate only a fraction of the potential variation that game packages can be programmed to provide.

Footnotes

1. The senior author is currently on leave as a postdoctoral fellow at the University of Mannheim.

2. "Computer Programs as a Means of Efficiency and Control in Cross-Cultural Experimental Games", delivered at the 70th Annual Meeting of the American Political Science Association, Chicago, Aug. 29-Sept. 2, 1974.

3. This development has been supported by the SUNY Research Foundation, the SUNY at Stony Brook Instructional Resources Center, the University of Mannheim, the Stiftung Rehabilitation, the DAAD, the Council for European Studies, and the Alexander von Humboldt-Stiftung.

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The utility of computer-based games whose rules are flexible is discussed. Games can be programmed in such a way that relatively untrained individuals can make choices among alternative rules and subsequently execute the thus modified games with themselves and/or others as players. They can in this way be given training either in the skills the game requires or in experimental design and procedure. Two games currently being developed according to this model are described for illustration.

SUMMARY

Interactive programming languages make it possible to program games whose rules are variable rather than fixed. The game program must require initial human intervention to set parameters that define which set of rules, out of some potentially large finite number, will govern the game when next played. Such programs can be written in such a way that persons untrained in the use of the programming language can nevertheless initiate the game and make the choices necessary to do so. These persons can then participate in the game as players, or can administer it as others play.

In a non-research training situation, trainees can use such a game to learn the skills the game requires, and, in addition, to select certain skills for emphasis by modifying the rules to place these skills at a premium. This permits trainees to have a role in deciding what to be trained to do. In a research training situation, such a game allows students to design and execute a gaming experiment, with all the control and data-processing advantages of a computer base, without having to invest several weeks in learning a programming language. In the early stages of research training, the flexibility afforded by a substantial set of rule options is sufficient to test the student's understanding of the requirements of experimental design.

Almost any aspect of the rules of the game can be made optional. These include decision time limits, the size of rewards and penalties, the number of players, the level of

consensus required to finish the game, the amount of interest conflict inherent in the payoff structure, the degree of co-operation or competition suggested by the instructions, the possibilities for communication among the players, the amount of information players receive about the results of previous iterations, and the identification of the opponent as another person or as a computer.

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