Simplifying Complex Problems

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ABSTRACT

The process of making complex and controversial decisions, that is, dealing with moral or ethical dilemmas, have intrigued people and inspired writers from time immemorial. Dilemmas give both color and depth to characters in good literary works. But beyond literary fiction, dilemmas occupy society in every day issues such as in introducing legislation or solving current political problems. One example of a current political dilemma is how to deal with Iran's quest for nuclear weapons.

If it were possible to assess and quantify each of the alternative solutions for a given problem, the process of decision making would be much easier. If a problem involves only two optional solutions, game theory techniques can be used. However, real life problems are usually multi-unit, multi-optional problems, as in Iran's nuclear quest.

Keywords: Decision Tree, Game Theory, Form, CAD, Interactive Methodology and Brain Storm.

1. SUGGESTED SOLUTION

The proposed herein computer system is a dynamic one ([1]-[4]), named **CAMD – Computed Aided Management Decision, based on so called** the ***dilemma-tree*** method. It establishes an on-line usage of the "***brain-storm"*** and ***game-theory*** methods for simulation and training purposes as well as for finding an optimal solution for real-world problems. There is a supervisory team which suggests the roles of other teams/players representing the sides in the conflict (namely, first iteration in the matching process between teams and the real players) The created tree can grow or shrink (traversed bottom up and top down) in accordance to the total solution propagation.

The suggested approach to solving these types of problems lies in transforming them into a "represented binary-tree form". In this approach, each pair of nodes that stem from a higher-level node stands for partnership or rivalry of two factors. This means that each node is a parametrical operator of the operation between its "children" - the operands. The result of that binary operation substitutes the current parent-node, which then becomes an operand. This bottom-up/top-down method is propagated upward until reaching the top - the root of the tree, which receives the final value for the whole tree and terminates the process.

The proposed interactive method will be accompanied by the proposed tool. It has two functions: pose the questions/-dilemmas (by one team) and, by using the collaboration or antagonism option, solve them automatically or manually by the other two teams, according to the game solution between the teams. The automatic component is referenced to a module which is initiated by the component (a tree node composed of a push-button) to a module which proposes an automatic solution of the problem, according the operands using the theoretical methods of the two-person's games. The games are played by randomly chosen expert teams. Their games are managed, registered and later analyzed in the background, using several pair solutions. The whole process is registered and analyzed statistically by the proposed tool. In the training mode, the time-dimension is governed by the system to measure and train the "player's" time-response. This method may be used to educate and evaluate managers, physicians, and military officers etc. – professionals who many times have to make under pressure, fast responsible decisions.

2. VARIOUS DOMAINS' APPLICATIONS - EXAMPLES

Political science

Decision tree: The Iran example can be used as an illustration of the above methodology [5]. The security and stability in the Middle East (see some security issues [6]) stands in conflict with Iran's aspirations of becoming a nuclear power. The main players are Iran and current world powers such as the United States and Israel. Their relationships can be represented in a hierarchical way using the Dilemma Tree (Fig. 1). When the "atomic club", the nations who have nuclear capabilities, consisted of only two members, the "Game Theory" method was used in analyzing their relationship [3]. Now that we have many members in the "atomic club" and the conflicts are much more complex, an alternative method such as the "Dilemma Tree" should be used.

Another advantage of breaking down a complex problem into smaller factors lies in the possibility that each team will consist of experts who can best deal with the specific problem. To facilitate this method of breaking down complex problems, an interactive tool is suggested (Fig. 1). Its role is to try various operational scenarios to solve the problem, such as making agreements or managing rivalries by using various combinations of probability-parameters. Simulations can be performed (see also [7], [8]) by using the game-theory's two-game (Fig. 2) strategies and adapting parameters to the different probabilities of the problem.

Fig. 1: Decision-tree tool board

(a) "Expand" creates the "son" node;
(b) "Evaluate" opens a separate window of Fig.2 and then substitutes the node by the evaluated/simulated value.

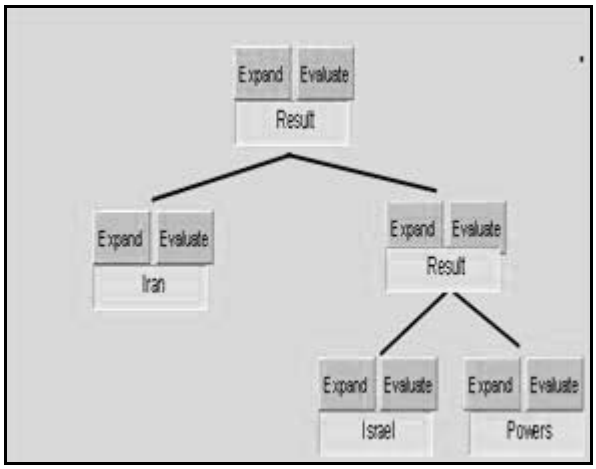


Fig. 2: Expanded tree represented in Fig.1.

(a) The node: "Israel;" has expanded into two 'sons" created:"Israel-Pro", Israel-Con"
(b)The node: "Powers" has expanded into two sons "Russia" and "USA"

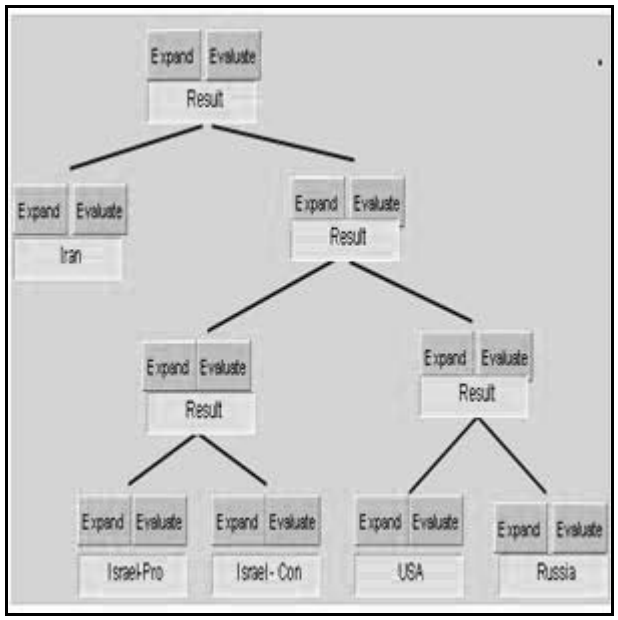
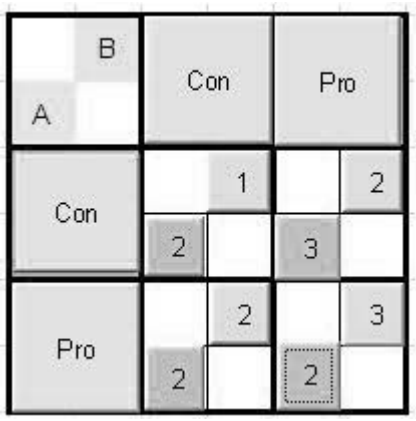


Fig. 3: Interactive Game Board.

An interactive board for setting parameters and playing two-person games. 'A' player uses the column's "pro" and "con" buttons where as the 'B' player can press the row respective buttons in his turn.



Economics

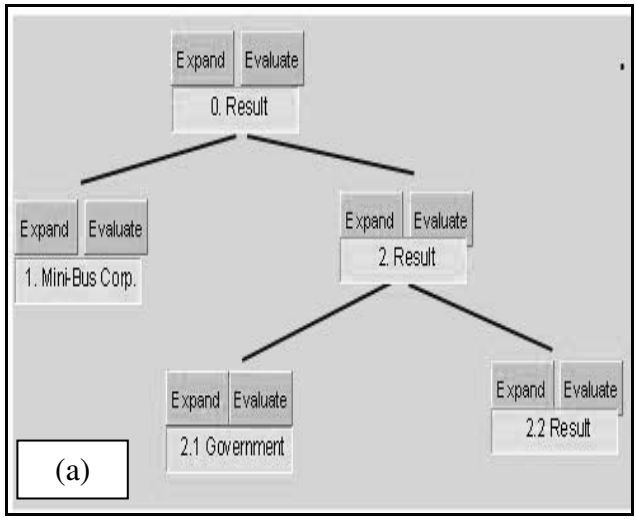
Decision tree: The simple market-competition example can be used as an illustration of the above methodology. The stability of the bus-transportation system [9] (see some economic issues [10] and [11]) is threatened by the mini-bus company entering the market. Their relationships can be represented in a hierarchical way using the dilemma-tree (Fig. 1(a)). When the "bus-club" i.e. the companies that used normal-sized buses, consisted of only two members, the "Game Theory" method was used to analyze their relationship [8]. A probable outcome would be increased collaboration. Having more members in the "bus-club" creates conflicts that are much more complex and an alternative method such as the "dilemma-tree" should be used.

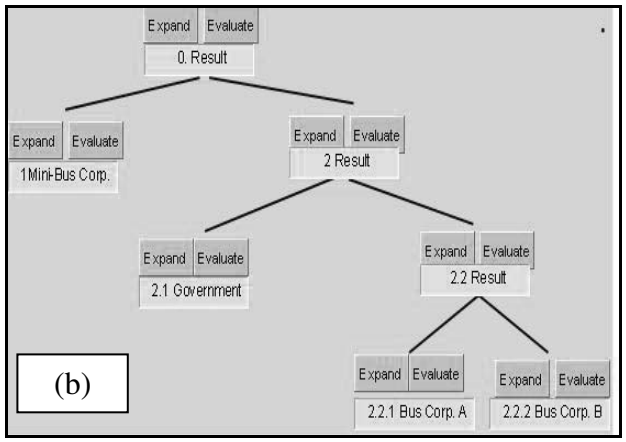
Game board: To facilitate this method of breaking down compound problems, an interactive tool is suggested (Fig. 1). Its role is to try various operational scenarios to solve the problem, such as making agreements or managing rivalries by using various combinations of probability-parameters. Simulations can be performed (see also [2], [7]) by using the game-theory's two-game (Fig. 2) strategies and adapting parameters to the different probabilities of the problem.

Fig. 4: Simulating-tree tool

(a) Simulating-tree tool board: ***"Expand"*** creates the "child" node; ***"Evaluate"*** opens a separate window of Fig.4(b) and then substitutes the node by the evaluated/simulated value.

(b) The expanded tree represented in Fig.4(a). The 2.2 node is expanded into two nodes 2.2.1 and 2.2.2, representing the bus corporations as partners.





A similar interactive method as in the previous example (Political science) is shown. The extending/evaluating of some sub-trees of the decision tree is used (Fig.4)

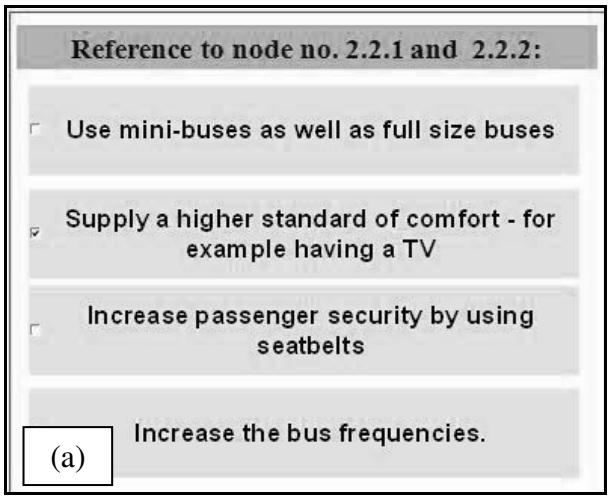
Decision node: In the current example it will be emphasized how to perform the node analysis with the help of the module posing and checking several alternatives of the analyzed node (see Fig. 5).

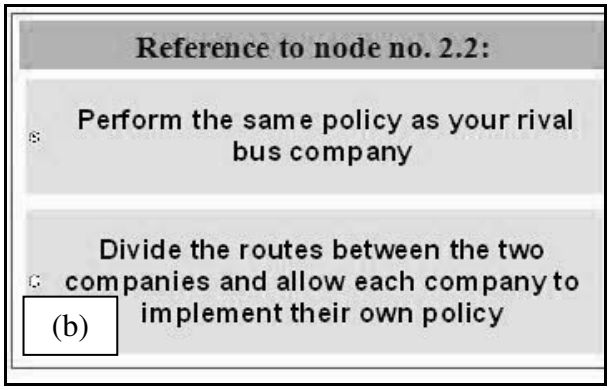
Fig. 5: Examples of corresponding questionnaires

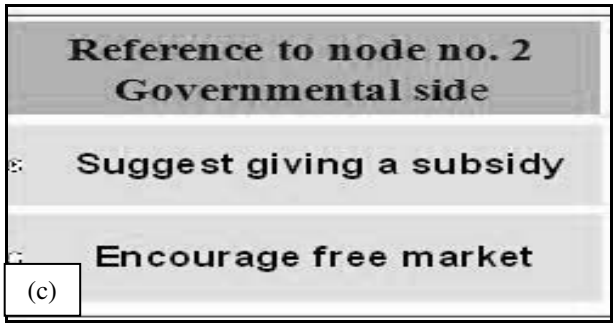
(a) Check-boxes the expansion of the nodes 2.2.1 and 2.2.2. in the dilemma tree (Fig. 4 (b));

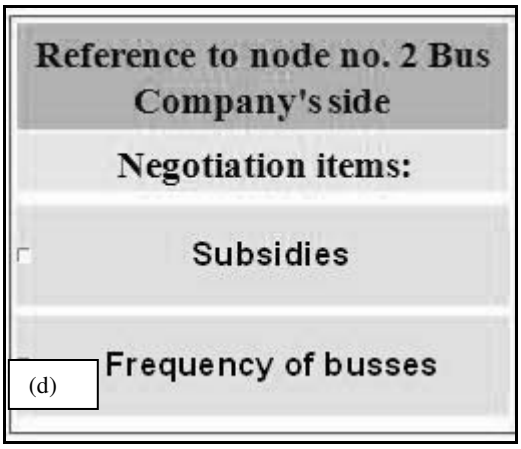
(b) Radio-boxes to choose- the expansion of the node no. 2.2 in the dilemma-tree (Fig. 4 (a));

(c) and (d) boxes treating the relationship between the govermnet and the representat of the bus-companies: (c) gevernement perspective (d) bus-companies options.









(d)

The expert teams create, with the help of the proposed module the possible alternatives (Fig. 5). The other teams supply the parameters of the probable policies generated by the previous team. The policies are inserted into the system separately, and the game module aids in performing the fine-tuning of the parameters or even cancelation of the whole policy. After using several simulations by several different groups, an average and standard deviation are computed and this outcome is used as the parameter for the higher level nodes.

3. CONCLUSIONS

The above methodology using defined modules can be implemented as a software package, analogous to a computer aided tools such as CAD – Computed Aided Design (CAM, CAE) [10] system, giving a methodology and computer tool. The system introduced here, **CAMD – Computed Aided Management Decision, justifies its name, it** enables interactive/distributed man/machine operations, or one user simulations to solve especially controversial problems concerning various aspects of various domains requiring human intervention.

Various other heuristic aspects (see [11] and [12]) can be added in updated versions of this CAMD.

4. REFERENCES

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