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# What can Artificial Intelligence do for Peace Psychology?

ANDREAS HERGOVICH and ANDREAS OLBRICH

In the following paper we will present applications of Artificial Intelligence which can perform three different tasks in peace research. (1) Systems which enable conflict prediction, analyse political speeches or news from mass media, classify these and calculate probabilities of conflict. (2) Systems which influence or describe the course of a conflict, are usually based on system-theoretical or cybernetic considerations. Decision processes are modelled and conflicts simulated. (3) Systems which are designed to support peace negotiations between conflicting parties. Such systems are supposed to support negotiations. During such negotiations, arguments should be weighed, and basic conditions for successful negotiations identified.

The applications of Artificial Intelligence in peace psychology are manifold. Artificial Intelligence can be described as an interdisciplinary field of knowledge, the goal of which is to model human decision processes, develop new possibilities for information technology and alter the interaction between human and computer. According to Trappl: „Artificial Intelligence (AI) is the science and technique of making computers smart" (Trappl, 1986, p. 97).

Trappl (1986) defines three commercially successful areas of application of Artificial Intelligence, which are described in the following article for use in peace research:

1. Expert systems. An expert system or knowledge-based system is a computer program which models inferences of experts in a special area of knowledge. An expert is someone who possesses extraordinary knowledge in a certain area compared to other people (Krems, 1994). Expert systems provide support in making decisions to persons who do not possess detailed knowledge in a special area. An expert system consists of an inference motor, which represents the central problem-solving components and the various problem-solving mechanisms, a knowledge base and a database. The third component is the explanation component, which is usually closely connected with the inference motor and the database. The explanation component helps to visualise and verbalise the results which were calculated by the inference motor. The knowledge acquisition component regulates the import of new data into the database. The user interface is the interface through which the user contacts the expert system. In most expert systems this difference exists only schematically. That is, both the user interface and the explanation component are closely connected with each other. The rules used by the inference motor can either be explicitly set by the programmer or independently recognised (learned) by the expert system itself.

2. Language translation programs. Language translation programs enable faster communication between the parties in conflict. They provide some useful suggestions for culturally correct interpretations and behavioral reactions.

3. Robots (autonomous agents). Robots are finding more and more use in industry, but also in astronautics. Independent handling of dangerous substances is the most important goal. Robots only find limited use in peace work (one possible application is vehicles which remove landmines).

### *Current AI-research in the area of peace*

AI can design systems which perform three different kinds of tasks in peace research:

(1) Systems used to predict conflicts,

(2) Systems which influence or describe the course of a conflict, and

(3) Systems which are designed to support peace negotiations between the parties of the conflict.

This subdivision should only represent a rough classification of AI-applications and not a complete taxonomy of

Andreas Hergovich, University of Vienna, Institute of Psychology, Liebiggasse 5, A-1010 Vienna, Austria.
E-mail: andreas.hergovich@univie.ac.at. (Correspondence concerning this article should be sent to this address).

Andreas Olbrich, University of Vienna, Institute of Psychology, Liebiggasse 5, A-1010 Vienna, Austria.

the entire area of application. The applications differ both with respect to the methods of artificial intelligence and in the (inter-)disciplinary theories and data used.

*1. Systems for conflict prediction*

Systems for conflict prediction have already been developed in various disciplines, but they are still not very numerous. The first system which is to be presented in this area is from Schrodt and Gerner (1996) and is based on politological considerations. Schrodt and Gerner have tried to predict conflicts in the Near East. They analysed Reuters news reports concerning the States of Egypt, Israel, Jordan, Lebanon, Palestine, Syria, the USA and the former USSR (Russia). The headlines of the news reports were split up into 22 categories using a special software. These categories are standardised and are used primarily in creating historical or politological databases (World Events Interaction Survey, WEIS; McClelland, 1971). Table 1 provides the exact labels of the individual categories.

Schrodt and Gerner's (1996) theory assumes a phase model of the conflict, described by Sherman and Neack (1993) as follows: "...conflict is seen as a sequence of phases". Movement from phase to phase in a conflict occurs as "the factors interact in such a way as to push the conflict ultimately across a series of thresholds toward or away from violence" (Bloomfield and Leiss, 1969). Characteristics of disputes can be visualized as the timing and sequencing of movement between and among phases. Processes of escalation of violence, resolution or amelioration of the seriousness (threat of violence-hostilities) and settlement are identifiable through the use of phrase structures (Sherman & Neack, 1993, p. 90).

*Table 1*

The two-digit categories of the WEIS of McClelland (1971)

| Code | Verb | Code | Verb |
|---|---|---|---|
| 01 | Yield | 12 | Accuse |
| 02 | Comment | 13 | Protest |
| 03 | Consult | 14 | Deny |
| 04 | Approve | 15 | Demand |
| 05 | Promise | 16 | Warn |
| 06 | Grant | 17 | Threaten |
| 07 | Reward | 18 | Demonstrate |
| 08 | Agree | 19 | Reduce Relationship |
| 09 | Request | 20 | Expel |
| 10 | Propose | 21 | Seize |
| 11 | Reject | 22 | Force |

According to Schrodt and Gerner, shortly before a conflict between two states a change in the cooperation between the two actors should become evident over time. As the WEIS categories still did not allow a clear division into cooperation and conflict, the data were transformed using a conflict-cooperation scale according to the method of Goldstein (1992). Before Israel's invasion of Lebanon in 1982 and the Palestinian Intifada, there was a significant change in the communication between the states. The time period during which this change can be seen varies from conflict to conflict; a change was observed half a year before the Israeli invasion, for example, while in the case of the Palestinian Intifada a change in communication was noticed only a month before the final outbreak of the conflict. This means that this method is very „imprecise" for a prediction of the conflict. Cultural differences in political contents and valences play also an important role (Hofstede, 1991).

Hergovich and Olbrich (1996) have designed an expert system for predicting wars and internal crises. For the database they chose 49 conflicts of three states (Great Britain, former USSR and USA), which were rated by historians in terms of how typical they are for the categories civil war, war, international conflict, religious war and peaceful actions. After this they analysed 189 newspaper and magazine articles, which had appeared one week before the beginning of the conflict, by means of scales derived from the theory of social identity (Wagner, 1994) and power theory (Winter, 1993). Winter (1993) postulated within the context of his power theory that a state which possesses a high score on the power motive and a low score on the affiliation motive will start war within a very short time. If the score on both the affiliation and the power motive is low, the probability that a state can peacefully resolve a disagreement is very high. With a high score on the affiliation motive and a low score on the power motive it is highly possible that the state will start a civil war or a religious war. The validation of the expert system according to the principles of the theory of fuzzy sets provided valid results. The criterion validity of the expert system was sufficiently high for the former USSR (70%) and for the USA (87.5%), but rather low for Great Britain (37.5%).

*2. Conflict simulations*

As early as 1971, Singer hoped for a gain in knowledge for peace research through computer simulations: "But in the same measure as our models improve and our data and correlation base expands, computer simulations become just as important. For the past 150 years our research has found 93 international wars, a majority of which were preceded by conflicts and crises. Under humanitarian viewpoints these may be 93 wars too many, from the point of view of science they were too few... The advantage of a computer simulation is that it enables us to re-construct such events and cases in a great variety of combinations; and if we know enough about the relationship between certain variables in certain combinations, we can use this knowledge to simulate what would have happened (or might have happened), the combination would have been sufficient" (Singer, 1971, p. 303f, translation from the authors).

Simulations are a frequently used method of testing hypotheses about world events. Probably the most famous simulation of world events comes from the Club of Rome (Meadows, Meadows, Randers & Behrens, 1972). This research group analysed global behaviour in the most important interdisciplinary areas (food, population growth, conflicts, economics, etc.). This type of simulation has been refined over the years and published, but has also come to be severely criticised, as the world model was too simply based on linear transformations and long-term predictions resulted in unrealistic values.

The world model GLOBUS (Bremer, 1987) was also developed in this research tradition. The world model GLOBUS is used to generate long-term alternatives through computer simulation. Zillner (1993) carried out a computer simulation using the world model GLOBUS, in order to test the economic and social effects of armaments reduction in developing countries. Zillner's simulation runs show that armaments reduction "cranks up" the economy. In the area of development aid, however, only slight positive effects are perceptible. The social situation improves in the desired direction, but areas of conflict still arise in developing countries. In order to achieve a positive effect, the entire system of development aid and international economic relationships would have to be changed. How the system can be changed so that fewer conflicts arise, Zillner does not say.

Many published simulations handle American foreign policy after World War II. The term of John F. Kennedy is simulated very often (Thorson & Sylvan, 1982; Sylvan & Majeski, 1983, Giers, 1986, Job & Johnson, 1986). Thorson and Sylvan (1982) simulated President Kennedy's knowledge level during the Cuban Missile Crisis. His knowledge was represented by 63 rules. The authors entered several hypothetical actions of the Russian opponent into their knowledge-based system and the system had to find an adequate reaction in its database.

Sylvan and Majeski (1983) simulated the behaviour of Kennedy-advisor Walter Rostow, who significantly influenced the decision to send even more advisors and troops to Vietnam. In this model, too, close attention was paid to the representation of the knowledge of President Kennedy. Giers (1986) criticised the ROSTOW-model as being too specific. Only one very particular situation in American foreign policy was simulated so that the consequences of the actions could not be generalised to other situations. Mallery (1988) and Majeski (1987) defended the model, as it reflected bureaucratic decision structures for the first time and thus a significant aspect of American diplomacy.

Job and Johnson (1986) developed the simulation UNCLESAM, which was based on the decision situation from 1961 to 1965 regarding the Dominican Republic. 250 to 300 reports from the New York Times were transformed by a specialist on Central America into a political action language. These rules aid the knowledge-based system in making decisions. When a result is achieved, it is issued in English. When an event has occurred, the system assesses the relevance for a political action. This assessment leads to a change in various values of the actors and their relationship to each other. If the relevance of the event is high, the system generates a report and describes the change in the attributes and relationships of the actors.

The CASCON project is used to identify similar conflicts and crises (Bloomfield, 1986). The database CASCON III consists of 50 conflicts and over 500 variables. New conflicts can be compared with this database and tested for statistical similarity. This project represents the attempt to assemble institutional knowledge which can be used by experts. This should make crises easier to recognise and solve effectively.

An especially interesting approach was proposed by Tanaka (1981, 1984). His simulation model CHINA_WATCHER takes into account elements of cognitive consistency theory, cognitive mapping and logic. Tanaka assumes that Chinese leaders divide the world into good and evil. As not all states fit into this dichotomous scheme, four categories are set up (friend, foe, ambivalent relationship, indifferent relationship). Six functions calculate the relationships of the individual states to China after entry of a specific course of action. If a Chinese action led to success, the system learned to use this action more often, but if the consequence was negative for China, the action was not stored in the database. In a validation study, 383 conflicts were simulated. 60 percent of the simulated actions of China corresponded to reality.

Artificial Life Research can also be used for conflict simulation. This new approach has developed greatly in the 1990's (Epstein & Axtell, 1996). In a simulated world, which is defined by very simple rules, there exist autonomous agents who possess only limited possibilities for action and information processing capacities. One behaviour pattern of an individual can for example be: look to all sides as far as you can see (the visual range of an individual is determined at the beginning of the simulation and remains constant), look for the location with the most food and go there. Life span, gender and „general health" (e.g. energy consumption, mating rhythm, etc.) of the individuals are determined at the beginning of the simulation and can remain constant during the simulation, as e.g. in the simulations of Epstein and Axtell (1996), but they do not have to. Social structures and group behaviour result from interaction with other individuals. The environment in which the individuals exist is usually a landscape which consists of renewable resources. But the renewal rhythm of the resources can be precisely determined by rules, so that bottlenecks may result in the supply of the autonomous agents if too many resources are used. The resources can also be unevenly distributed in the landscape. This usually leads to an accumulation of the autonomous agents around the most fruitful areas. As soon as the resources of these areas significantly decrease, the autonomous agents look for new fruitful areas. They often come upon other autonomous agents who are also pursuing this goal. The introduction of a competition rule ("Kill those agents who are weaker than you and are sitting on a resource") sets off battles. The introduction of a further rule, that only those agents can be battled which do not belong to one's own tribe, results in the development of complex behaviour with periodic attacks against enemy tribes.

Query<br>
↓<br>
language system (LS)<br>
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problem processing system (PPS)<br>
↓<br>
knowledge system (KS)<br>
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problem processing system (PPS)<br>
↓<br>
presentation system (PS)<br>
↓<br>
Answer.

*Figure 1.* The schematic representation of the functions of a negotiation support software system (NSS).

### 3. *Negotiation support software*

Negotiation support software (negotiation support system, NSS; Holsapple, Lay & Whinston, 1996) has the task of leading the negotiator to an optimal or least acceptable solution of the negotiation problem in negotiation situations (Bui & Strand, 1993; Fang, Hipel & Kilgour, 1989; Kersten, Michalowski, Szpakowicz & Koperczak, 1991). In the runs of the expert systems, the aims are an adequate representation of the problem and the restructuring of the problems during a negotiation situation (Kersten & Mallory, 1990; Kersten, Michalowski; Shakun, 1991; Sycara, 1991). As Holsapple, Lay and Whinston (1996) emphasise, negotiation support software can be designed to cover a very specific area (e.g. management in private businesses or political decision areas). Only then can this software system develop its full potential.

An NSS should consist of four sub-systems. The first sub-system is for recognising news reports sent by the users to the system (language system, LS). The presentation system (PS) is for issuing reports to the users. The problem processing system (PPS) resembles the inference motor of an expert system. It is used for deducing and selecting the best strategies. The knowledge system (KS) is the database of the NSS. Earlier cases are stored in the KS, which the PPS can access in order to carry out deductions. The way in which the NSS functions can be seen in Figure 1.

In order to program an NSS, one has to ask oneself for what areas of negotiation this system is to be used and what contents are to be discussed. In the software system NEGOPLAN the contents are depicted hierarchically by means of decision trees (Matwin, Szpakowicz, Koperczak, Kersten & Michalowski, 1989). An alternative possibility is the use of neural networks (Aiken, 1997; Bui & Strand, 1993).

The NSS should also have stored data on the individual negotiators. It is important to know the opponents willingness to negotiate, their strategies and opinions, their valences and social position, in order to make a prediction of behaviour. Kersten, Michalowski, Szpakowicz and Koperczak (1991) designed their NSS to be able to make predictions. In this context it is necessary to mention that the NSS should also be capable of learning, in order to retrieve behaviour displayed in this situation in later situations and determine possible changes and react to them adequately. The neural network developed by Bui and Strand (1993) also aims in this direction.

The identification of one's own and the opponents' willingness to negotiate is seen as one of the most important tasks of an NSS (Andriole, 1993; Holsapple, Lai & Whinston, 1996). "By tracking entities' acceptance regions, an NSS provides a foundation for forecasting entities' behavior such as selected strategies and movements. Certainly, this also depends on understanding the issue space and the involved entities. If an NSS is able to keep track of all entities' acceptance regions, it should also be able to compute the agreement region at any moment. A user of this NSS can understand the situation more clearly and completely a basis for contemplating an appropriate strategy." (Holsapple, Lai & Whinston, 1996, p. 264).

The determination of the position in the negotiation space becomes all the more difficult, the more negotiation dimensions need to be considered. Since the valences of the individual negotiation dimensions are set for the individual negotiation partners at the start of negotiations, and these valences are represented numerically, the NSS can determine the exact position in the negotiation space. Moreover, for a numerical (Euclidean) representation of the negotiation dimensions, it is possible to determine the distance between the individual negotiators. In complex negotiations, graphical illustrations were realised in the NSS of Hipel, Fang and Kilgour (1990) or in the NEGOTIATOR of Bui and Shakun (1996). They can ease understanding of the current situation and simplify the choice of the right strategy. They went on to show whether a selected strategy has decreased the distance between the negotiators or not.

The NSS should also be able to suggest strategies in negotiation situations. Successful strategies should be stored in the database for this purpose. In addition, the Problem Processing System (PPS) should possess rules which simplify the selection of strategies and learn new strategies and store them in the database. The NSS should also have the ability to document and classify the use of the individual strategies. This means that the opponent's preferred strategies should be recognised by the NSS, and counter-strategies developed. One NSS which already exists according to these specifications is the program NEGOTIATION EDGE, which was presented by Jelassi and Foroughi (1989). Holsapple, Lai and Whinston (1996) emphasise that NSS should also recognise coalitions and possibilities for these. Coalitions have the advantage that they enable one to appear more credible and stronger to an opponent and make more demands. The software system NEGO is already capable of this (Kersten, 1985).

NSS should also remind the negotiators of the negotiation rules that have been agreed upon. These rules are already taken into account in the knowledge base (KS) of the systems.

Bui and Shakun (1996) use their system NEGOTIATOR to demonstrate the best procedure for programming an NSS. First, the most important aims for the negotiations should be determined. This is accomplished when every negotiating partner decides their aims and enters them into the system. The next step is deciding the valences of these aims. The negotiation space is then determined. Each partner determines their negotiation space by means of simple functions, which are very easy to generate graphically using the computer system and are transformed into numerical values by the system itself. The negotiation space is determined based on these functions, as are the intersections of the negotiation positions (for every negotiator is shown the maximum, the average and the relative result). After these calculations, the negotiators have the option of changing the valences of their aims and thus effecting an adjustment to the negotiation space, which can lead to an agreement between the negotiators.

Trappl and collagues (Fürnkranz, Petrak, Trappl & Bercovitch, 1994; Fürnkranz, Petrak & Trappl, 1997; Petrak, Trappl & Fürnkranz, 1994; Trappl, Fürnkranz & Petrak, 1996; Trappl, Fürnkranz, Petrak & Bercovitch, 1997) analysed the CONFMAN-database. This database should be used to find empirical answers to questions such as "How can international intercession (especially mediation) be applied effectively?"

Fürnkranz et al. (1994) analysed this database by means of the "Top-Down-Induction-Decision Trees C4.5" of Quinlan (1993). A total of 60 attributes of every conflict were considered in the analysis.

In an initial analysis, Fürnkranz et al. (1994) had the algorithm generate a decision tree which used all independent variables to create branches so that a branch could only contain one element. The data record was thus divided up into over 100 categories. This approach was used to gain an initial overview of the data structure. The authors looked into this "unpruned tree" to search for clusters containing more than ten elements. During this process a total of 12 rules were discovered which fulfilled this criterion. Five rules describe successful international mediation attempts and seven rules failures in mediation. These twelve rules describe approximately 25.77% (185 attempts) of the data record. One of these rules is: "If there have been less than 400 fatalities and party B's raw power index is 33 and the conflict management type was mediation and the conflict lasted between 1 and 3 months then the conflict management was always successful in 15 mediation attempts in 8 different conflicts" (Fürnkranz et al., 1994, p. 11). As can be seen from this rule, the result is very complex. Fürnkranz et al. (1994) also admit that these rules are very hard to find: "Some of the rules are rather complicated, and it is unlikely that these regularities could have been detected by a human analyst" (Fürnkranz et al., 1994, p. 11).

The next step was to prune the resulting decision tree. That is, branches which only separate very few elements were removed and added to the next main trunk. This resulted in a considerably simpler decision tree. This approach had three advantages: (1) the complexity of the tree (the rules) is reduced, (2) the validity is increased and (3) "random branches", which resulted from the division of the data and are meaningless, are found. The "pruned" decision tree of Fürnkranz, Petrak, Trappl & Bercovitch (1994) consisted of only 9 rules which divided the data record.

The authors also wanted to know under what conditions mediation can be successfully applied. In generating the decision tree, only those 548 data records were used which contained an instance of mediation. There were three types of mediation: (1) Communicative mediation was defined as: "The mediator is in a fairly passive role, acting largely as a channel of communication or go-between for the conflict parties" (Fürnkranz, Petrak, Trappl & Bercovitch, 1994, p. 19); (2) procedural mediation is determined by the situation control of the mediator, i.e., the mediator determines the type and the environment of the meeting between the conflict parties; (3) in directive mediation the negotiator can influence the content and the process of negotiation, in which they make allowances to a conflict party or put the conflict parties under pressure.

In order to find the rules which influence the mediation strategy, the following independent variables which turned out to be relevant in a statistical analysis, were used: frequency of incidents, mediation environment, mediation strategy, earlier relationships of the mediator, contents of mediation and rank of the mediators. The resulting decision tree consisted of eight rules, which correctly described the data to 63.1%. Communicative mediation was successful when the amount of incidents were few. Mediators who come from a small country – relative to the conflict parties – or are members of an organisation, used the procedural strategy. The results of the directive strategy are determined by the mediation environment and the earlier relationship of the mediator to the conflict parties.

## DISCUSSION

These areas of application of Artificial Intelligence in peace psychology are manifold and the initial results indicate that on the one hand decision-making in conflict situations can be made easier and on the other, hypothesis testing „in safety" made possible. Various personality structures of the decision makers can thus be simulated and the outcome of negotiation situations predicted. However it should be mentioned that it is precisely this modern personality research which points out that situational factors play a more important role than personality-related variables (Mischel, 1968). A further factor influencing the behavior in extensive ways are emotions. Designing a model of decision making Carver's and Scheier's (1990) model of self-regulation should be taken into account. Carver (2001) points out that past and future action influence our present action. Goals serve as reference values for feedback processes. Furthermore due to improvements in hardware and software it has become possible to simulate very complex decision structures and thus the situations realistically (Mosler, 2000).

The systems for conflict prediction can also be expanded to allow information from the internet to be evaluated according to the analysis methods of peace psychology. Updated databases for existing expert systems can be downloaded already today (for example for the CASCON project at http://web.mit.edu/cascon/).

The results of the negotiation support systems are disillusioning in practice. Negotiations in international conflict areas only seem to succeed after several rounds of negotiation (Fisher, 1997). These circumstances must especially be taken into account in validating these systems (Fürnkranz et al., 1994). The validity of the AI systems depends mostly on the used databases. In a recent study from Kovar et al. (2000) the problems of the KEDS database are discussed extensively. They found no pattern to predict crisis, although they used the latest data-mining techniques from Mannila and Toivonen (1996).

If one follows the classification of the AI-applications used here, one can use the following psychological theories, which have already proven to be valid in the individual areas of peace research, and thus create AI-based systems. Psychological theories which should be classified for conflict prediction systems are power theory (Winter, 1993), the theory of social identity (Brown, 2000; Wagner, 1994), the theory of subjective well-being (Diener, Diener & Diener, 1995) and the theory of cognitive complexity (Tetlock, 1985; Tetlock, Peterson, McGuire, Chang & Feld, 1992). Qualitative analyses can be used to determine whether the power motive is rising and the affiliation motive falling. These changes in motivation indicate that a military conflict, or a conflict involving violence may follow in the near future (Winter, 1993). Before military conflicts it has also been observed that cognitive complexity falls, i.e. argumentation in political speeches becomes simpler and the various points of view of the conflict parties are no longer differentiated by the decision-makers and integrated into solution or reduction of the conflict. It has also been shown that before an armed conflict, the emphasis on group membership increases, the group's own leader rises in esteem and the members of the other conflict parties are degraded.

Negotiation support systems should take into account theories for decision-making and especially the results of groupthink research (Fuller & Aldag, 2001; Tetlock, Peterson, McGuire, Chang & Feld, 1992).The ability and motivation of precise and thoughtful information processing have great impact on the decision making process. Mosler (2000) simulated decisions and actions of an artificial society based on the elaboration likelihood model (Petty & Cacioppo, 1986). The best strategy for decision makers to get ideas into collective action is the persuasion of subjects who have great impact on others.

Finally, it should be pointed out that most AI-initiatives in the field of peace psychology are only discussed in an academic setting and politics hardly utilises the possibilities of AI-applications. Here there is a need for action on the part of science. Especially in the area of peace research it is important not just to linger in an ivory tower, but also venture a discussion with non-academics (politicians and lobbyists). The AI-applications should be designed so that the software is very easy to use and rules of behaviour and instructions for action can be suggested by the program (Norman, 1988).

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