

Expert System for International Crisis Management -CRISMAN

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Abstract

The prototype CRISMAN is part of an ambitious project which claims to introduce computer simulation as a part of investigation labour fulfilled by Spanish internationalists through the practicality of knowledge based systems and the establishment of multidisciplinary investigation groups.

Keywords Expert System, International Relations, Rule-based, Artificial Intelligence, Prediction, Conflict.

1 Computer simulation applied to international relations

In the field of social sciences the discipline of International Relations (IR) was included into degree studies in United Kingdom and United States in 1919. Nevertheless, its theoretical development and the use of quantitative techniques since the 1950s, allowed to incorporate mathematical models (game theory and probability theory) creating indicators which provided a more accurate description and explication of many phenomena of the International Society: arms race, armed conflicts, “guerrillas” and terrorism, underdevelopment and conflicts of structural nature, mass media and public opinion, international bipolarity and multi-polarity or regional political integration, among others.

Progresses made in computational technology, Artificial Intelligence (AI) and communicational and informational media have accomplished to deal with international happenings through simulation[1]. In fact we can find important contributions of Agent Based Simulations (ABS) in social science[2].

However, the main obstacles for applying computer simulation in the field of IR are two: a) the vagueness of multiple theoretical concepts, used in this science, making quantitative data collection and its evaluation (using indicators or probability calculation) more difficult, and b) the existing ignorance among internationalists concerning the possibilities of new, both informational and computational, technologies. A fact that leads, quite often, to underestimate and undervalue the work carried out in the area of simulation.

These two realities are more present among internationalists and investigators of the Spanish speaking world due to the crucial influence of disciplines like legal or historical sciences during their training, being neither of those sciences really permeable concerning quantification and new technologies.

CRISMAN is the first step taken to introduce AI as an effective technique in the investigation labour fulfilled by Spanish internationalists.

We point out three consecutive phases of this project:

1st Phase: Creation of a prototype of a Rule-Based Expert System (RBES) covering the analyse and foresight of international crises, with a direct application in different activities developed by investigators, intelligence analysts, political decision makers, high business executives, all of them guided in their international scope activity.

Prepare a Doctoral Thesis focusing on the utility of Expert Systems (ESS) teaching IR, including the development of a computer programme focusing on diagnostic, classification and training of international conflicts.

2nd.- Investigate about the applicability of fuzzy logic to ESS created for international crisis management[3].

3rd.- Develop a new ESS concerning evaluation and international political risk management as well as training in international aid programmes through simulation.

2 Prototype of expert system for international crisis management -CRISMAN

2.1 Problem Framing

The problem which is tried to be solved by using a RBEX consists in defining the evolution and existing relations between **two countries or group of countries A and B**, taking as a starting point an initial situation (conflict or crisis) between those countries, in order to anticipate the more likely decisions which will be taken by political leaders and to provide explanations of those decisions.

2.2 Technical Specifications

This ES is constructed upon a theoretical model or simplified description of reality, in order to facilitate the learning of Foreign Policy Analysis techniques. To achieve this goal, computer data and processing storage will be used with the aim of creating simulations of real-world cases through the use of rules or set of logical formulations which associate, in a conditional way, causal variables or attributes with consecutive variables or attributes.

The shell or computer programme used for this expert system is CLIPS, developed by NASA (<http://www.ghg.net/clips>) in its 6.23 version (2005). We also find an adapted version for Java called JESS (<http://www.herzberg.ca.sandia.gov/jess>), as well as an application suitable for fuzzy logic called FuzzyCLIPS, 6.10c version, developed by the National Research Council of Canada.

The Knowledge Base and the production rules have been carried out by Professor Rafael Calduch Cervera[4].

A forward chaining inference process allocated with certainty or trust coefficients will be applied to each of them.

The case data, used as examples, and the results, obtained by executing the programme, will be stored in a data base using XML language.

2.3 Theoretical Model

The theoretical model underpinning the knowledge base and the rules of the expert system are articulated on the existing relation between six basic attributes:

- 1) **Situations;**
- 2) **Aims;**
- 3) **Available means;**
- 4) **Previous case experience;**
- 5) **Future expectations;**

6) Relational strategy and
7) Conduct.

The user should define the variables choosing between the different options given by the ES concerning the first four attributes, while the programme will deduce the categories 5, 6 and 7; which, in turn, become the initial situation for the new realisation cycle of the ES.

The biggest methodological problem that had to be solved to make the theoretical model applicable was to reduce the semantic options of each attribute category to its minimum, avoiding the exponential growth of number of rules. This has not been easy, mainly because of the huge amount of diversity of conditions, objectives, means and type of existing experiences concerning relations between two countries.

Graphic Display of the Theoretical Model

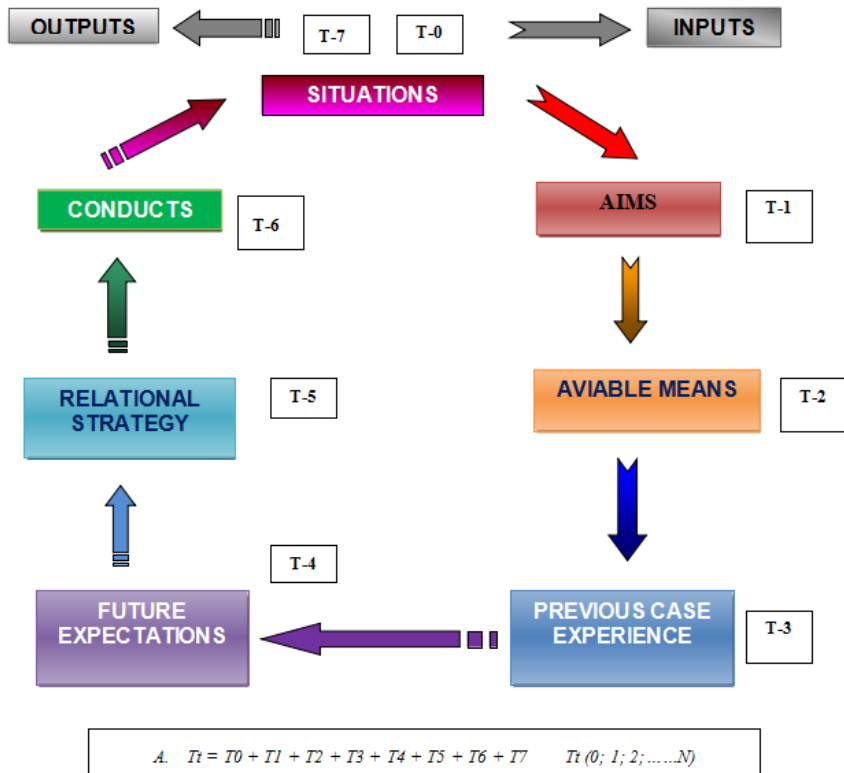


Fig.1 Graphic Display of the Theoretical Model

Attributes

1.- SITUATIONS:

- 1.1).- Normalised
 - 1.2).- Conflict
 - 1.3).- Deepening conflict
 - 1.4).- Crisis
 - 1.5).- Armed conflict
- 2.- AIMS:
- 2.1).- Compatible
 - 2.2).- Perception of compatibility
 - 2.3).- Incompatibility
 - 2.4).- Perception of incompatibility
- 3.- AVAILABLE MEANS
- 3.1).- Equivalence
 - 3.2).- Superiority
 - 3.3).- Inferiority
- 4.- PREVIOUS CASE EXPERIENCE
- 4.1).- Certainty of trust
 - 4.1.1).- Trust
 - 4.1.2).- Mistrust
 - 4.2).- Uncertainty
- 5.- FUTURE EXPECTATIONS
- 5.1).- Continuation of the situation
 - 5.2).- Escalating of disputes
 - 5.3).- De-escalate of disputes
 - 5.4).- Unpredictable
- 6.- RELATIONAL STRATEGY
- 6.1).- Cooperative
 - 6.2).- Negotiating
 - 6.3).- Competing
 - 6.4).- Deterrent
 - 6.5).- Aggressive
- 7.- CONDUCTS:
- 7.1).- Keep cooperation
 - 7.2).- Intensify diplomacy
 - 7.3).- Diplomacy with no military pressure measures
 - 7.4).- Diplomacy with deterrent military measures
 - 7.5).- Military deployment with limited use of force
 - 7.6).- Widespread use of force

3 Description of attributes

3.1 SITUATIONS

It is referred to the mutual relations between two countries in a limited period of time. We can choose between the following options:

1.1.- **Normalised**: the situation in which the relations between two countries (A and B) are mainly cooperative and respecting international legal standards.

1.2.- **Conflict**: the situation in which the relation between two countries (A and B) is of conflict, although there exists no explicit threat of violence or the use of force.

1.3.- **Deepening conflict**: the situation of conflict between two countries (A and B) in which one or both countries turn to military measures of pressure or with deterrent character, although there exist no direct nor express threat of violence or use of force.

1.4.- **Crisis**: the conflict situation in which, one or both countries (A and B), threaten with the use of force or make a limited use of it to condition the behaviour of the other country.

1.5.- **Armed conflict**: the situation in which the general use of force is the main tool concerning the relation of both countries (A and B).

3.2 AIMS

We understand this topic as those interests or purposes which are being tried to achieve by each of the countries according to their capacities and available means in a particular situation. According to the relation between purposes and targets of the countries we can find the following possibilities:

2.1.- **Compatible**: it takes place when the purposes and targets of both countries (A and B) can be achieved simultaneously and, as well, this possibility is sensed as part of reality.

2.2.- **Perception of compatibility**: it takes place when the subjective perception of achieving interests or targets from one of the countries (A) can be achieved simultaneously with the satisfaction of others interests or targets of the other country (B), even though elements which prevent this compatibility exist.

2.3.- **Incompatibility**: it takes place when the accomplishment of interests or targets of one or both countries (A and B) cannot be achieved simultaneously and, also, this possibility is clearly sensed as part of reality.

2.4.- **Perception of incompatibility**: it takes place when the subjective perception makes believe that the achievement of interests or targets of one of the countries (A) cannot be achieved simultaneously with the satisfaction of the interests or targets of the other country (B), even though there do not exist any elements for this incompatibility in reality.

3.3 AVAILABLE MEANS

This topic includes all kind of capacities a country is willing to use in the relations with any other country to ensure the consecution of its targets.

e can find the following possibilities:

3.1.- **Equivalence**: it exists when the means used by one country (A) in its relation with another country (B), whatever its nature, hold or at least are valued with the same level of effectiveness in the same manner, to ensure the achievement of their respective targets.

3.2.- **Superiority**: it exists when the means used by one country (A) in its relation with another country (B), are in fact, or at least are valued with a higher grade of effectiveness than those of the other country to ensure the attainment of their particular targets.

3.3.- **Inferiority**: it exists when the means used by one country (A) in relation with the other country (B) are in fact, or at least are valued with a lower grade of effectiveness than those of the other country to ensure the attainment of their particular targets.

3.4 PREVIOUS CASE EXPERIENCE

It is formed by the evolution of the political relations between two countries (A and B), during the period of time in which a generation exercises leadership in both countries (25 to 30 years) in the way it is perceived by their leaders.

We have to work with the following options:

4.1.- **Certainty of trust**: When the leaders of one country (A), based on former identical or analogous experiences, are convinced that the leaders of the other country (B) will adopt the necessary decisions and actions to fulfil their compromises to execute their threats assuming the consequences associated to it.

4.1.1.- **Trust**: When the leaders of a country (A), based on former identical or analogous experiences, are convinced that the leaders of the other country (B) will fulfil the compromises reached with them, although they may imply losses of interests or additional winnings in case of infringement, and in case of escalation, they would formulate a clear and explicit threat.

4.1.1.- **Mistrust**: When the leaders of a country (A), based on former identical or analogous experiences, are convinced that the leaders of the other country (B) will not fulfil the compromises reached with them, because of putting the unilateral satisfaction of their targets or the achievement of additional winnings through infringement, and in case of escalation, they would not formulate a clear and explicit threat.

4.2.- **Uncertainty**: When the leaders of a country (A) have a lack of former identical or analogous experiences or the ones existing are contradictory and, in consequence, they have no deep-seated conviction concerning the degree of compliance or infringement of the other country (B) will make in relation with the achieved compromises or, in case of escalation, they do not know if a previous, clear and explicit threat will be formulated.

3.5 FUTURE EXPECTATIONS

We consider future expectations as the evolution expected by political leaders of every country concerning the present situation with the other country.

We have to choose between four possibilities:

5.1.-**Continuation of the situation**: no significant changes between the two countries (A and B) are expected.

5.2.- **Escalating of disputes**: a new, more conflictive, situation between countries (A and B) is expected due to changes in their relation.

5.3.- **De-escalating of disputes**: a new, less conflictive, situation between countries (A and B) is expected due to changes in their relation.

5.4.- **Unpredictable:** the political leaders of countries (A and B) lack the knowledge or enough former experiences not being able to make future expectations concerning the evolution of their relations.

3.6 RELATIONAL STRATEGY

These kinds of strategies are formed by the planning and organization of the relations of one country with another through the exclusive, or clearly dominating, remit of specific types of behaviour in the relation.

We can find the following categories:

6.1.- **Cooperative:** the strategy which resorts to collaborative relations between two countries (A and B) to achieve the established targets together.

6.2.- **Negotiating:** the strategy which uses communication or political and diplomatic negotiation to achieve some kind of agreement or understanding between two countries (A and B) to satisfy their targets.

6.3.- **Competing:** it is the kind of strategy that combines communication or political and diplomatic negotiation with pressure builds or conflictive, but no military, behaviours, trying that country (A), the one making them, achieves unilateral advantages in relation with country (B) or achieves the exclusive satisfactions of its targets.

6.4.- **Deterrent:** this kind of strategy combines communication or political and diplomatic negotiation, deployment and/or increase of the military capacity of country (A), with the explicit intention of using this military capacity to defend its vital interests and targets or to avoid an armed aggression fulfilled by the other country (B).

6.5.- **Aggressive:** this strategy implies the unilateral and extensive use of force by one country (A) to achieve specific targets or exclusive advantages at the expense of the other country (B).

3.7 CONDUCTS

Conducts are the dominating actions which characterize the relations between two countries in a specific situation. There are the following possibilities:

7.1.- **Keep cooperation:** it means that the behaviour of one country (A) concerning the other country (B) keep the same so that the mutual interests or joint targets can be satisfied.

7.2.- **Intensify diplomacy:** it means that there is an increase of communication or political and diplomatic negotiation between one country (A) regarding the other country (B) in order to facilitate or achieve any type of understanding or agreement to achieve their interests or targets.

7.3.- **Diplomacy with deterrent military measures:** this conduct creates the use of a combination of communication or political and diplomatic negotiation with the use of behaviours, excluding the use of force, that are intended to provoke direct damage to the other country (B) or to hinder the accomplishment of its targets.

7.4.- **Diplomacy with deterrent military measures:** this conduct means the use of different communicational or political and diplomatic conducts with the use of demonstrations measures, display or increase of its military capacity by one country (A) but only with a defensive character concerning the other country (B).

7.5.- **Military deployment with limited use of force:** this kind of conduct means the use of a combination of measures from one country (A) that entails a direct threat for the other country (B) through the display of its military capacity or the use of these

military capacities in a limited period of time and space.

7.6.- **Widespread use of force:** this conduct involves developing of all kind of s-trategic, tactical and logistical conducts needed to warlike use of military capacities of one country (A) against another country (B) in order to achieve its defeat.

4 Priority of conditioning of attributes to draw up rules

The order of priority concerning the application of causal attributes to determine consistent attributes is the following:

1.- **Initial situation**

2.- **Aims**

3.- **Available means/previous case experience**

The main conditioning resides in the Initial situation of the relations between two countries because of two main reasons: Firstly, because this situation will also be the final situation, product of former relations between those countries and this, of course, affects the Previous case experience and also because the initial situation conditions the category of Aims which are tried to be fulfilled by each country.

The second most important conditioning is set-up by the Aims every country tries to achieve through its relation with another country. Concerning this topic we have to bear in mind the different strategies and conducts that can be developed in their relation.

The third level of conditioning considers the effectiveness concerning the Means every country uses compared to the ones used by another country, because this relation of effectiveness will condition possible strategies to be followed by every country as well as the effectiveness of conducts adopted by each of them concerning the other.

Nevertheless, this third conditioning can also match with Previous case experience because this experience is decisive to determine Future expectations made by the leaders of every country and this will, as well, condition the election of the judged to be more effective or probable strategies and conducts to achieve the targets set.

The priority of conditionals concerning every single attribute will determine, in case of conflict, the effects that should prevail in the rule formulation, considering the following criteria:

a).- When the conditionals of different levels are complementary they cause a strengthening or intensification of the resultant effects.

b).- When there is a conflict or opposition between conditions of different levels, the effects of the hierarchical higher level will be chosen.

c).- If the conflict is between two conditionals of the same level their result concerning the effects will be neutralized, using those effects derived from higher hierarchical level.

Examples of Rules Used in CRISMAN

RULES

1)NORMALIZED INITIAL SITUATION

R 1).- If INITIAL SITUATION = **Normalised**
and AIMS A) and B) = **Compatible**

and AVAILABLE MEANS A) and B) = **Equivalence**
 and PREVIOUS CASE EXPERIENCE A) and B) = **Certainty of trust**
 then FUTURE EXPECTATIONS A) and B) = **Continuation of the situation**
 then RELATIONAL STRATEGY A) and B) = **Cooperative**
 then CONDUCTS A) and B) = **Keep cooperation**
 so FINAL SITUATION = **Normalised**

R 2).- If INITIAL SITUATION = **Normalised**
 and AIMS A) and B) = **Incompatibility**
 and AVAILABLE MEANS A) and B) = **Equivalence**
 and PREVIOUS CASE EXPERIENCE A) and B) = **Certainty of trust**
 then FUTURE EXPECTATIONS A) and B) = **Escalating of disputes**
 then RELATIONAL STRATEGY A) and B) = **Negotiating**
 then CONDUCTS A) and B) = **Intensify diplomacy**
 so FINAL SITUATION = **Conflict**

R 3). If INITIAL SITUATION = **Normalised**
 and AIMS A) = **Perception of compatibility**
 and AIMS B) = **Perception of incompatibility**
 and AVAILABLE MEANS A) and B) = **Equivalence**
 and PREVIOUS CASE EXPERIENCE A) and B) = **Certainty of trust**
 then FUTURE EXPECTATIONS A) = **Continuation of the situation**
 then FUTURE EXPECTATIONS B) = **Escalating of disputes**
 then RELATIONAL STRATEGY A) = **Cooperative**
 then RELATIONAL STRATEGY B) = **Negotiating**
 then CONDUCTS A) = **Keep cooperation**
 then CONDUCTS B) = **Intensify diplomacy**
 so FINAL SITUATION = **Normalised**

5 Theoretical operating model of the ES

a).- The initial situation between the countries A and B at the moment (T-0) is the starting point.

b).- The aims of each country (A and B) to identify the possibility/probability of simultaneous and joint or unilateral success of those aims by each of the countries are analyzed.

c).- The relation of existing effectiveness of each country (A and B) to achieve their targets is assigned.

d).- Historical precedents that have existed in the relations between both countries (A and B) in identical or analogous situations are evaluated to define their influence concerning the perception of the leaders.

Taking the options chosen by the user for former attributes into account, the ES will deduce:

1).- Expectations that the political leaders of each country (A and B) set on the future development of relations between the two countries.

2).- The most likely strategies political leaders will develop in each country (A and B) in their relation with the other country.

3).- The behaviour that will prevail in each country's relations with the other based on the established relations strategy.

4).-The type of situation that will result at the end of reciprocal behaviour made by both countries. This final situation concludes the cycle and it is established as the initial situation of the next cycle in the operation of the expert system.

6 User profile

CRISMAN can be used in the teaching of graduate students in the universities and research centres, as well as by international analysts who may carry out an evaluation of political risk assessment.

*** Carlos E. Calduch Cervera developed the prototype of the computer program to perform the Expert System CRISMAN.**

References

- [1] Taber, Ch. S. (1992), "POLI: An expert system model of U.S. foreign policy belief systems", *American Political Science Review*, Vol.86, No.4, pp.888-904.
GOLDSPINK, Ch. (2002), "Methodological Implications Of Complex Systems Approaches to Sociality: Simulation as a foundation for knowledge", *Journal of Artificial Societies and Social Simulation*, Vol.5, No.1.
see <http://jasss.soc.surrey.ac.uk/5/1/3.html>.
- [2] Davisson, P. (2002), "Agent based social simulation: A computer science view", *Journal of Artificial Societies and Social Simulation*, Vol.5, No.1, see <http://jasss.soc.surrey.ac.uk/5/1/7.html>.
- [3] Cioffi-Revilla, C. A. (1981), "Fuzzy sets and models of international relations", *American Journal of Political Science*, Vol. 25, No.1, pp.129-159.
- [4] CALDUCH, Rafael. (1991), *International Relations* , Ediciones de Ciencias Sociales, Madrid.
- [5] CALDUCH, Rafael. (1993), *Dynamics of International Society*, Ediciones CEURA, Madrid.

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