

Fuzzy cognitive models in studying political dynamics: The case of the Cyprus problem

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Abstract

An attempt to model the dynamics of the Cyprus problem using a form of Fuzzy Cognitive Maps has been made. The main parameters involved in the interrelated dynamics are nationalism, religiousness, knowledge of history, level of educational development, tourism, oil, other natural resources, Anatolian settlers, and the general interests of the countries involved, as well as the interests of the two predominant communities. The political problem of Cyprus exists since the early 1960s, but has been amplified after the Turkish invasion of the island in July 1974. The population of the island is officially composed of Greek-Cypriots (78%) and of Turkish-Cypriots (18%). Geographically, the island is located in a region where many conquerors and civilizations spread their influence (Greek, Roman, Byzantine, Arabs, Franks, Venetians, Crusaders, Ottomans, Turks, and English). In recent years, there have been politico-economic dynamics related to the interests of both the Greek Cypriot community and the Turkish Cypriot community. Furthermore, there are antagonistic and cooperative interests among other countries involved in the problem and the region. These are primarily Greece, Turkey and the United Kingdom. Since the entry of Cyprus into the European Union, as well as the recent terrorist events in New York, Madrid and elsewhere, has made the involvement of Europe, USA, Russia and Israel important influential-dynamical factors. The system that has been developed can be used to study the effects of a change in any parameter, or a combination of parameters, on the stability and growth of the remaining parameters. Different scenarios may be implemented, observed and appraised. These can be used for systematic studies both as an instructional tool and as a research tool. In the present work, as an example, the effect of an increase of the involvement of European Union on the affairs of Cyprus is investigated. These effects are focused on the welfare of the two communities, their nationalism and religiousness, and on the interests of USA and Russia.

Keywords

Fuzzy cognitive map, neuro-fuzzy system, Cyprus politico-economic problem, European Union politics.

1. Introduction

Cyprus is a small island in the eastern Mediterranean Sea. It has about 660,000 inhabitants. The population consists of about 78% Greek-Cypriots, 18% Turkish-Cypriots and the remaining 4% of Armenian, Maronite and Latin-Cypriots. Turkish and Greek Cypriots lived together on the island for almost five centuries. The political problem of Cyprus exists since the early 1960s, but has been amplified after the Turkish invasion of the island on July 20th, 1974. Turkey launched a second offensive in August 1974 and as a result, she occupies about one third of the territory of the Republic of Cyprus. Since 1974 there has been a systematic, planned and steady inflow of Anatolian settlers in the occupied northern part of the Republic. This has been identified as a systematic process of changing the ethnographic characteristics of the country. Presently, these Turkish settlers are estimated at about 130,000. These people have changed the social fabric of the Turkish-Cypriot community, and introduced a new set of parameters and dynamics into the Cyprus problem.

The dynamics involved for the security and stability of the island, as well as the economic development, are related to the interests of both the Greek-Cypriot and the Turkish-Cypriot community. The dynamics have been governed largely by the strategic position of the island of Cyprus in the Eastern Mediterranean, where many conquerors and civilizations spread their influence (Greek, Roman, Byzantine, Arabs, Franks, Venetians, Crusaders, Ottomans, Turks, and English). The historical roots of the two communities forged them to be both antagonistic and cooperative. Also, the interests of other countries involved in the problem played a significant role in the politico-economic developments. These are primarily Greece, Turkey and the United Kingdom. The entry of Cyprus into the European Union, as well as the recent terrorist events (USA, Spain and elsewhere) has made the involvement of Europe, USA, Russia and Israel important influential-dynamical factors.

In this work, an attempt to model the dynamics of the problem, using a fuzzy cognitive map-like approach has been made. The main parameters involved in the interrelated dynamics are: Nationalism, religiousness, knowledge of history, level of educa-

tional development, tourism, Anatolian settlers, and the general interests of the countries mentioned previously, as well as the interests of the two communities.

In the last two years there have been intensive efforts to solve the problem based on a UN plan that has been prepared by an appointed Kofi Annan team. The plan provided for a federated system of two constituent states. It had strong mechanisms for cooperative advancement, but also deficiencies that made it unacceptable to the Greek-Cypriot community, as it has not been voted in a referendum done during April 2004. In the model we present we take into consideration the federal structure of the future governance of Cyprus.

A “cognitive map” is a set of cause-effect *relationships* that model the interrelationship among specific *concepts* (or factors, parameters, attributes, ...). By using an appropriate systematic process it is possible to estimate the effect of a change in the state of any concept (or set of concepts) on any other concept or on the entire system. The intensity of the interrelationships though are not clearly known and thus suitable membership functions may be used. Different fuzzy cognitive map (FCM) paradigms have been proposed [1, 3, 4, 5, 7] as well as different application areas [2, 6, 8]. In most of the applications each concept is related to the other concepts through appropriate degrees of effectiveness (causality, sensitivity). Then the system is simulated and allowed to grow. When the system settles, the researcher can observe the effects of a change of one factor on the intensity of another.

The work reported here is mainly involved with an effort to apply an FCM variant to the dynamics of the Cyprus problem, aiming at getting some useful insight on the effectiveness and interactivity of the important contributing parameters, primarily the influence of European Union politics in the future events in Cyprus. Also, it may be used as a study tool for exploring complicated socio-political dynamics through the use of computing simulations.

2. Mathematical representation

Let a system of m interrelated. A change δC_i affects the change in an C_j . The concept update is done according to the relationship specified by equation 1.

$$C_j[\tau+1] = C_j[\tau] + \delta C_j = C_j[\tau] + \sum_i \frac{\partial C_j}{\partial C_i} \delta C_i \quad i = 1, \dots, m \quad (1)$$

The updating is done quasi-statically and interactively until the system evolves to settlement specified by desired boundaries. Any changes in the various parameters (concepts in the established FCM terminology) affect either directly or indirectly all other parameters of the system.

3. The FCM concepts

For the study presented in this paper, 29 influencing parameters (or states) have been used. These are presented in Table 1. It should be emphasized that these factors are difficult to quantify. Also, they are not agreed by every person involved in the analysis and decision. Some form of fuzzy approximation may be employed, using persons of good knowledge (experts) and extensive experience (politicians). Furthermore, each one of them embodies a general state (and associated trend), as it is commonly employed and understood. For instance by the term "*Welfare of the Federal State of Cyprus*" we mean a state that has characteristics of prosperity, political stability, social development, high quality of life, etc. The initial starting values of the concepts are also shown in Table 1.

4. The parameter sensitivities

A number of knowledgeable persons have been inquired to suggest the various sensitivities $\frac{\partial C_j}{\partial C_i}$ that are used to update the various concepts as per equation 1. The sensitivities used are as shown in Table 2.

Table 1. The concepts used in the FCM

CONCEPTS (Influencing parameters)	INITIAL VALUES OF THE CONCEPTS (Scale of 0-100%)
Welfare of the Federal State of Cyprus	50
Welfare of the Greek Cypriot State	60
Welfare of the Turkish Cypriot State	30
Greek Cypriot nationalism	40
Christian religiousness	10
Knowledge of Turkish language by the Greek Cypriots	5
Knowledge of Turkish history by the Greek Cypriots	10
Educational level of the Greek Cypriots	80
Turkish Cypriot nationalism	70
Islamic religiousness	70
Knowledge of Greek language by the Turkish Cypriots	20
Knowledge of Greek history by the Turkish Cypriots	10
Educational level of the Turkish Cypriots	50
Political interests of Europe	50
Political interests of USA	50
Political interests of Russia	40
Political interests of UK	50
Political interests of Israel	50
Political interests of Greece	60
Political interests of Turkey	60
Military interests of Israel	50
Military interests of Greece	50
Military interests of Turkey	50
Military interests of UK	50
Military interests of USA	50
Interests of Anatolian settlers	50
Level of tourism in the federated state	50
Quality of environment	30
General interest of Europe on the Cyprus problem	5

5. Results of simulations

Due to the constraint of having to maintain a reasonably short paper, only three major areas are presented. In all cases, a scenario in which the general involvement of the European Union in the Cypriot Affairs has been increased by 50%, 100%, 150% and 200%. The absolute values are vague, but what is important is not the true (values) – which in any case cannot be appraised – but the trends shown and the relative effects.

These changes have been investigated for the following areas of concern:

- 5.1 Effects on the general welfare of the federal as well as on the two constituent states.
- 5.2 Effects on the nationalism and religiousness of the two constituent states.
- 5.3 Effects on the political and military interests of USA and Russia.

5.1 Effects on the general welfare of the federal as well as on the two constituent states.

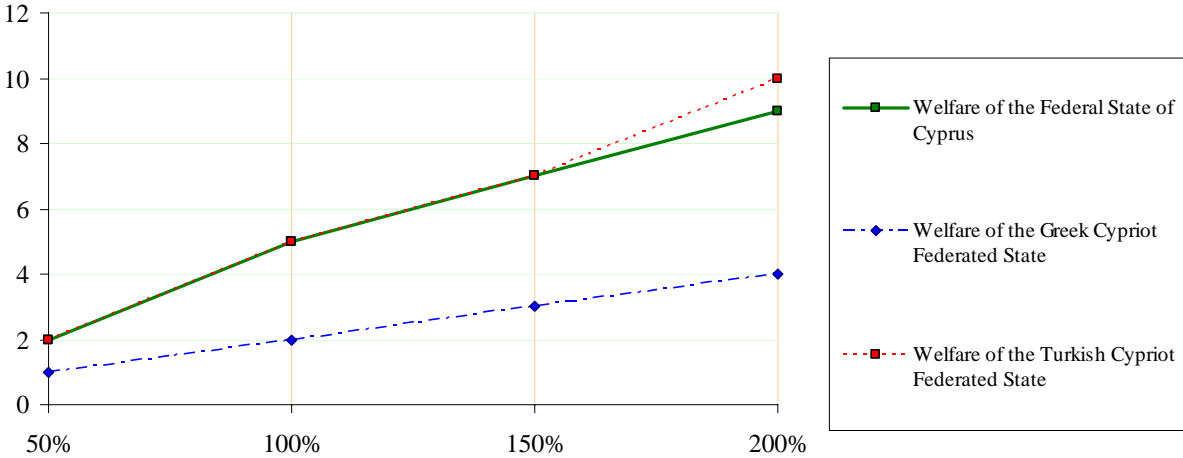


Figure 1. Changes in the general welfare of the federal as well as on the two constituent states when the European involvement is increased by 50, 100, 150 and 200 percent.

5.2 Effects on the nationalism and religiousness of the two constituent states.

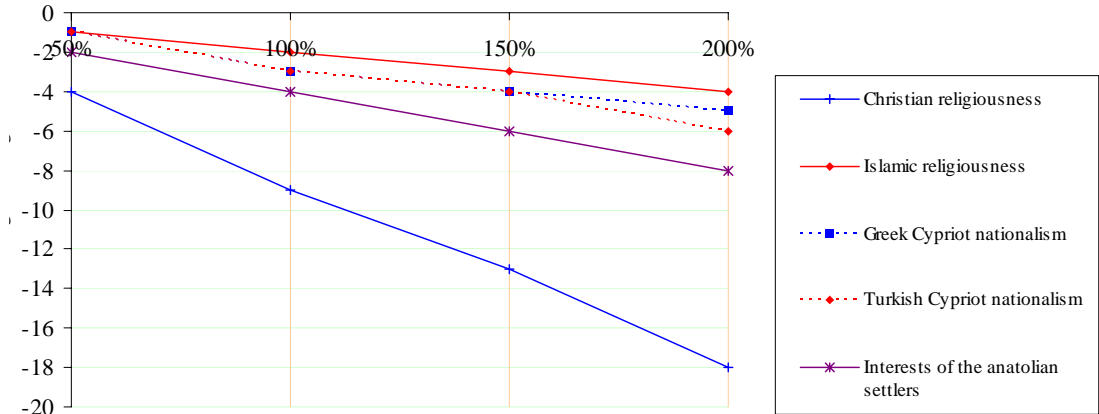


Figure 2. Effects on the nationalism and religiousness of the two constituent states when the European involvement is increased by 50, 100, 150 and 200 per cent.

5.3 Effects on the political and military interests of USA and Russia.

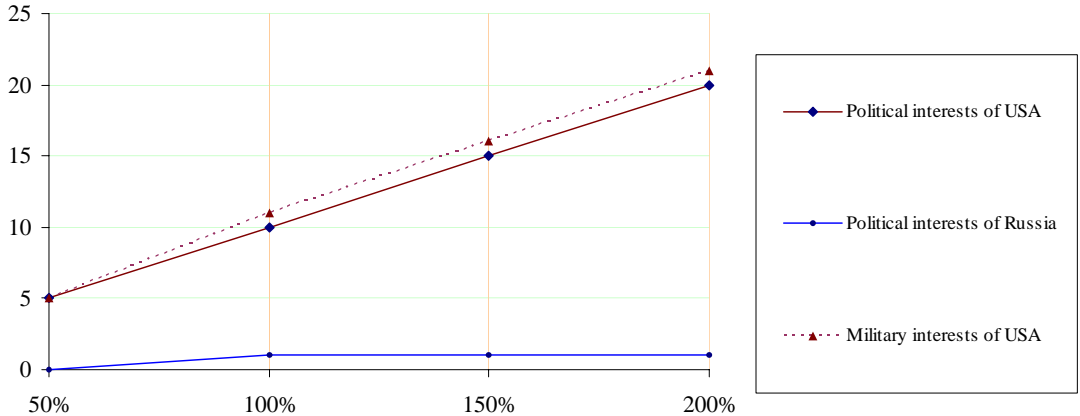


Figure 3. Changes in the political and military interests of USA and Russia when the European involvement is increased by 50, 100, 150 and 200 percent.

6. **Concluding remarks**

The FCM has shown reasonable trends and effects in relation to the scenarios studied. It has been observed though that the model predicts a higher benefit for the Turkish Cypriot community if the European involvement is significantly increased. This is shown in Figure 1 for the case of the welfare of this community.

It is also interesting to note that as the involvement of European Union is increased, the Christian religiousness is significantly decreased, while the Islamic religiousness is also decreased but less prominently.

As expected, the USA political and military interest increase as the European involvement is increased. The interests of Russia though are unaffected.

It should be pointed that this is a model with much vagueness, and can be more credible as more authoritative opinions from politicians and political scientists are embedded. It is, however, a useful tool for quick explorations, for better understanding of the dynamics involved and for building a basis for more complicated scenarios. Further explorations are needed to verify its credibility and to fine-tune the various parameters and processes.

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