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Integrating Soft Computing into Strategic Prospective Methods

Towards an Adaptive Learning Environment
Supported by Futures Studies

 Springer

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To Alejandro and Connie

Preface

Soft Computing is one of the fundamental areas in Artificial Intelligence, while prospective is a very important Future Studies approach. For several decades, many Soft Computing and Futures Studies books have been written, some of which contain hundreds of pages with pleasant discussions about uncertainty. This is the main topic of discussion in this book. The field of Soft Computing in Humanities and Social Sciences in recent years has changed. The proposal to include hybrid models of Soft Computing in the field of Futures Studies gave us the motivation to write this book, which is, however, not intended to replace others. Hence, this book introduces a new route that brings together two disciplines thus helping build a prospective reflection framework based on anticipation, learning, and adaptation.

There is increasing cooperation between sciences in a wide range of scientific projects between the so-called hard sciences and the so-called soft sciences.

The special feature of this book is to present an original model that, by integrating qualitative and quantitative approaches of Soft Computing in the field of Futures Studies, should help reducing uncertainty in the process of strategic decision-making. In other words, the approach used by the authors consists in reusing and combining Soft Computing with the field of Futures Studies, leading to promising results.

This book offers a guide to Soft Computing, with a special emphasis on the connections to the field of Futures Studies, and proposes a novel approach for strategic prospective, called Meta-Prospective. It builds and tests a framework that is able to reduce uncertainty in the processes of long-term strategic reflection.

In this book, the field of Soft Computing and the field of Futures Studies have reached a meeting point, by focusing on of the most relevant issues today, i.e., the future. This has been the main result of a fruitful exchange carried out on this subject in the last few years. Thus, the book focuses on pointing to a new path of integration, to which we can continue to add new pieces. An approach that can be understood as autonomous systems oriented to man, which could help to make decisions in the processes of strategic reflection in the long term.

It is time to address some special dates and events that happened during the time we worked with the manuscripts. At the end of 2017, thanks to the academic dialogue between José Luis Verdegay and Raúl Trujillo-Cabezas, it was agreed to make a visit of Raúl Trujillo-Cabezas to work with the Models of Decision and Optimization Research Group (MODO) led by José Luis Verdegay.

The MODO group is part of the Department of Computer Science and Artificial Intelligence of the Higher Technical School of Computer and Telecommunication Engineering at the University of Granada, Spain. Meanwhile, Raúl Trujillo-Cabezas is a member of the Strategic Thinking and Prospective Center of the Universidad Externado de Colombia.

The work, which made action research unique, was the collaboration of the Latin American organizations in conducting and interpreting the models to evaluate the new perspectives for the change in the corporate strategy methodologies.

It is appropriate to point out that the results achieved during the authors' work in Granada, and thanks to the valuable collaboration of David Pelta, during 2018, has given motivation and content for this book. We hope that the reading will inspire you to make your own contribution to the field of Futures Studies.

Authors want to present their gratitude to Springer and in particular to Dr. Leontina Di Cecco for giving them the opportunity of publishing this book. To finish they wish to express their special recognition to Prof. Janusz Kacprzyk, who accepted the book into the series Studies in Fuzziness and Soft Computing.

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Granada, Spain
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Raúl Trujillo-Cabezas
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Introduction

The contributions of this book are located in an intermediate point between Soft Computing and the field of Futures Studies to respond to the need to reduce the uncertainty that arises in visualizing the future. In this book, the reader will encounter notions of Futures Studies and basic concepts of Soft Computing and initial notions of fuzzy sets and dynamical systems. Several proposals have emerged during the last 50 years. Some of the most relevant are those made in the 1980s based on the model proposed by the Club of Rome and that have been consistently oriented toward building model-based alternatives. Of course, there are multiple works in the available literature. This book aims to contribute to the debate and helps to determine the possible roles of modeling and simulation in the field of Futures Studies and, particularly, in strategic prospective.

From that perspective, this book hopes to contribute to the application of Soft Computing to the field of Futures Studies. Especially in relation to the implications of the art of conjecture (De Jouvenel, 1967) and the heuristics that arise when using Soft Computing models to reduce uncertainty in the long-term strategic reflection process. Therefore, a way to develop these links in three key matters is proposed: The first has to do with Soft Computing approaches that can be used to improve understanding of opinions and value judgments, i. e., the ambiguity and vagueness of experts' decisions during the process of collective construction of the future using strategic prospective. The second is oriented toward recommending the most adequate Soft Computing method and logic to be used in the process of conjecturing during the elaboration of possible futures (futuribles). To allow for a better understanding of the systemic structure of the strategic design, therefore reducing uncertainty. The third is the incorporation of optimization methods for decision-making based on Soft Computing in order to reduce uncertainty in the process of formulating strategic actions that are more useful for attaining the scenario that is chosen as the most convenient one. It is during the process that links prospective with strategy.

De Jouvenel proposal on the art of conjecture is based on the need to determine an “art of political conjecturing” that rejects the idea of forecasting methods that imply a “prefabrication of the future.” Recognizing the application area of human

reflection to devise futuribles, or the array of possible futures that can occur according to diverse ways of acting. Here, conjecture is a pivotal idea in the French school of Futures Studies. It offers a non-positivistic way of reflection that widens the processes of visualizing the future not toward a single direction, by using a form of inductive reasoning that allows for the elaboration of general images of the future from particular premises.

According to Durance (2010), the “Futuribles Committee” was founded in 1961 at the initiative of De Jouvenel, and, with aid from Ford Foundation, it gathered a select group of specialists that by 1965 included among its members the names of Eugene V. Rostow of Yale University, Edward Shils of Chicago University, Waldemar A. Nielsen of the Africa-America Institute of New York, and Daniel Bell as a consultant. This encounter between the father of Futures Studies in the USA and the emerging French school of strategic prospective was not coincidental. In 1968, the first international conference on prospective and regional development was organized, sponsored by DATAR¹ with remarkable participation of American experts. The developments in the field made by Olaf Helmer and Herman Kahn of RAND Corporation regarding scenario building were acknowledged, and this originated a process of mutual collaboration. With Olivier Guichard and Jérôme Monod’s participation in the territorial planning delegation from DATAR was created the same year, a foster dialogue with the emerging futures think tanks focused on forecasting.

Those bonds, formed over five decades ago, became this book’s frame of reference. The benefits of Futures Studies are widely known, but the field’s limitations are also evidenced both in the French strategic prospective approach and in the model-based forecasting approach in centers for Futures Studies in the USA.

Concerning strategic prospective, the limitations outlined in this book have to do with the following matters: First, the growing inability to visualize the most convenient future, amid the increasing uncertainties of our time. They cast doubt on the application of the strategic prospective model proposed by *Laboratoire d’Investigation en Prospective, Stratégie et Organisation* (LIPSOR) in its methodological framework oriented toward proactivity, strategy, and the future, deemed capable of facing uncertainty in an efficient way. The occurrence of unstable futuribles that arise due to the difficulty to recognize the array of possible options limits the holistic understanding of decision-makers. When identifying future-bearing facts to later be used as sources in the inference process to build futuribles and make subsequent inferences, experts often underestimate the estimations of behavior related to the system’s own dynamics. Even though the literature shows several methods and techniques to explore, gather, systematize, and recognize future-bearing facts, which are an important source to attain future inferences.

¹Since in 1963 the French Government had created the DATAR agency, whose mission was to oversee regional development. The institution was responsible, between 1963 and 2014, to prepare the guidelines and implement the policy of national planning and development of the French territory. These missions are replaced in 2014 by the Commissioner General of the equality of the territories.

There is a lack of orientation toward understanding the characteristics of the system as a whole.

Second, there are many sources of uncertainty linked to the vague opinions expressed by experts during discussion sessions that occur in the process of reflection related to the collective construction of the future. The reason being that, during this process, a wide variety of the tools are used gather evidence from diverse sources, in different conditions and with different instruments; which they are generally expressed as intuitions and expert knowledge.

Third, there is the recurrent simplification in the elaboration of interfaces between prospective and strategy, with strong implications on the consistency and coherency of the strategic formulation. The outcome is a loss of confidence in the results attained through long-term strategic reflection since there is not a clear road map to reach the chosen future scenario, whose implications are significant in regard to the decision-making process. Strategic actions are the preferred means to build the interfaces, demanding the use of methods to look for the consensus of experts based on their subjective judgments.

Concerning forecast-based models, Miller (2007) argues that these are centered on the reliance upon predictive approaches that are stimulated through trend analysis, the development of forecasting models or the use of multifactor estimations. These are some of the reasons that support this approach to the future: the deep human desire to know what can occur. Thus, many organizations, sectors, or territorial entities desire predictions as a means to understand the future. Also, arise the need to develop a systemic understanding that offers a way to achieve stability in terms of the behavior of complex systems, since it is relevant to understand the system's attributes, concepts, and evolution (von Reibnitz, 1988). Finally, there is a need to manage risks in the decision-making process, and it fosters the development of a plethora of heterogeneous proposals that offer homogeneity in long-term planning processes, turning discontinuities in time into a challenge (Van Notten, 2005). Despite the apparent sophistication, the impossibility to assign significant probabilities to the way a system could work years ahead is currently recognized (Slaughter, 1995, 2004). Notwithstanding the formal agreement on the insufficiency and failure of predictive efforts in the strategic field, little progress has been made in the development of practical alternatives.

In the application of Futures Studies on multiple contexts (such as the business, sectorial, technological, or territorial spheres), it is difficult for social actors to recognize and deal with emerging dynamics that arise in their surroundings of interest, and this translates into a gradual increase in uncertainty in the face of the need to make decisions of the strategic type. These circumstances become more apparent inasmuch as reflection reaches the level of decision-making in business, in territories and in different sectors. Such is the case of instances such as boards of directors or presidential committees, where dialogue oftentimes reflects reflections with a high degree of uncertainty concerning the proposed results for Futures Studies. These processes include, among other key matters, conceptualization processes that drive the emphasis of strategic interests and collaboration processes where network-based work dynamics easily emerge.

The literature on Futures Studies highlights the need to improve the inference process to better face turbulences and acquire the necessary abilities to detect potentially harmful events (Mendonça, Cunha, Kaivo-Oja, & Ruff, 2004). From that perspective, the need to delve increase the knowledge regarding the elaboration of futuribles is referenced (Vacum & Melo, 2010). Also, there is a trend in the literature emphasizing the link between building the future and innovation, which requires new approaches (Rohrbeck & Gemünden, 2011). Finally, there are reflections on the methodological dispersion in the application of methods and techniques to future-building processes (Son, 2015). These are some of the available references that offer contributions reflections related to the diverse application areas of Futures Studies.

Given the variety and amount of methods and techniques that are available in the aforementioned approaches, there are multiple paths that have been developed to build scenarios for different application contexts. These are determined by the wide spectrum of objectives that can be attained, and the choice of approaches to be used, which have an impact on the way of dealing with long-term strategic reflection. However, this wide array of options can be synthesized for now, as mentioned by Kosow and Gaßner (2008), in two perspectives that are apparently in conflict. The “exploratory” versus the “normative,” and the “qualitative” versus the “quantitative,” or even from the perspective of possible future actions, there is a dilemma between “reference scenarios” and “policy scenarios.” The matter that settles the confrontation is nothing but the need to deal with uncertainty. Thus, the high vagueness introduced by the approaches, the complex and critical interactions that take place between social actors linked to the process of reflection, and the acknowledgment of the difficulty of inference processes increases the multiple sources of uncertainty.

Uncertainty can arise for multiple reasons. Some of them are the lack of expert knowledge, as well as the ignorance (given the nature of the future) that sometimes causes situations in which the real world must be ignored outside the laboratory (Lamata, Pelta, & Verdegay, 2018).

The art of conjecture is a complex process, with a high variability owing to the complex interactions that take place in the identification of futuribles, making long-term reflection a process that faces several challenges. Some of those challenges can be defined briefly as:

- (1) The difficulty decision-makers, experts, and other related social actors have in recognizing the systemic structure of the strategic design. Then, the recognition of futuribles turns out to be, in many cases, a leap in the dark that occurs because of the apparent lack of knowledge about the system’s behavior dynamics as a whole. Thus, this is a form of ignorance about the decision-making process, since the conjecturing process to identify futuribles is a challenge that must be faced, but it is insufficient in terms of the feasibility of said futuribles.
- (2) The difficulties surrounding the identification of experts’ opinions. It is a fundamental issue in the process of collective construction of the future, given the vagueness with which decision-makers, experts, and other related social

actors voice their opinions. Here, it becomes evident that decision-makers have trouble expressing their value judgments using nominal or ordinal scales (depending on the method that is used to gather their opinions). This creates mistrust in agreement processes, which can affect decision-making in the context of the phases of strategic prospective that guide the process of reflection for the collective construction of the future.

- (3) The difficulties that surround the process of strategic formulation, i. e., the link between prospective and strategy that orients the way to connect the envisioned future with the current situation of the system. Hence, its solution is highly important, given its implications concerning the process of setting in motion and deploying the strategic actions, that must take place to attain the futurible that was chosen as the most convenient by decision-makers. In the face of this challenge, the most relevant aspect has to do with the way of making decisions are the methods that are used to prioritize the most convenient actions and, the potential inability to recognize their relevance using validity criteria. All of this can lead to the unwilling omission of relevant courses of action.

Given the nature of those difficulties, Smithson's (1985) taxonomy provides a variety of approaches to the problem of decision-making in human thought and behavior in the face of uncertainty. Particularly concerning its fuzzy nature. Therefore, it is possible to recognize naturally the need to propose ambiguous and vague information concepts in relation to the construction process of the future and, more specifically, in strategic prospective.

The use of fuzzy logic, fuzzy sets, fuzzy cognitive maps, and multi-criteria decision-making (MCDM) methods, commonly linked to Soft Computing, provides a way to reduce the uncertainty that pertains to processes of long-term strategic reflection. The use of fuzzy logic favors the combination of qualitative and quantitative methods when facing complex processes in order to understand the interactions between key factors that make part of the strategic design. The subjectivist approach can include human imagination, local, and unique knowledge based on the use of inductive logic. The objectivist approach tends to have a concrete structure, emphasizing a positivistic idea of the future, where knowledge is accumulated through the use of deductive logic.

The present book introduces the development and proof of a proposal that comprises logic and a set of methods aimed at improving the inference process and reducing uncertainty in the context of the process of visualizing the future. Therefore, as a development on the approach of De Jouvenel (1967) in his book on the art of conjecture. From the strategic point of view, the model proposed here delves into the use of a systemic and complex perspective to understand the system's behavior dynamics. Since, even though complex and systemic thinking is commonly recognized as an important ability in Futures Studies, its use and discussion in the literature are relatively low, and its discussion is somewhat recent.

The proposed model (called here Meta-Prospective) is oriented toward strengthening the inference process in light of the validity criteria used in the practice of strategic prospective. The validity criteria are namely pertinence,

coherence, likelihood, importance, and transparency (Godet, 1995a, 1995b). Therefore, the development of the Meta-Prospective proposal arises from a combination of systemic and complex thought with the use of Soft Computing in order to help to reduce the ambiguity and vagueness that appear in the inference process. They are adapted to the uncertainty of long-term futures, devising a less linear path compared to the regular way of proposing futuribles. Thanks to the choice of a more rugged method of understanding the complexities of studying the future.

The compilation of ideas and concepts rooted in systemic and complexity sciences as well as in Futures Studies, and, particularly, in strategic prospective, gives to this proposal an interdisciplinary spirit since it also uses different methodologies.

The integration of concepts and proposed ideas into a new model that links strategic prospective to modeling and hybrid simulation based on Soft Computing methods, results in a novel proposal that uses tools and contents already available in the scientific literature, though with a new interpretation.

The effort and dedication to the new proposal include the use of logic and a set of methods based on approaches that have been developed from new perspectives which allow for an improvement of the process of inferring futuribles, and it can make use of the traditional toolbox of strategic prospective and, more generally, of tools that are available in the field of Futures Studies.

The Meta-Prospective approach, therefore, does not constitute a mere sum of methods. Since it is aimed at following closely the arguments that Godet proposed concerning the interaction between the normative and the explorative approaches to scenarios, when he argued, “This does not mean that we are abandoning the normative for the explanatory; in our view, this distinction is only of operative interest. In fact, once the evolution and the situation are described, in one direction or the other, the corresponding course of events is both explanatory and normative.” (Godet, 1995a, p. 44).

The logic and the concepts taken from the systemic and the complex, together with the methods of Soft Computing, serve the purpose of reducing uncertainty, or better. Rather dealing with uncertainties in a better way (Godet, 1995a, 1995b; Bourse, 2016) in order to help decision-makers face “growing interdependence, the quickening pace of change in certain areas (...) and the noticeable lack of action in others” (Godet, 1995a, 1995b), so that their use in the practice of strategic prospective is subordinated to the processes of decision-making by social actors. Favoring three key purposes: (a) the use of more robust methods and logics to determine the trend-oriented behavior of the system, recognizing a priori the range of trend-oriented future situations as points of reference; (b) identifying a set of scenarios contrasted from the exploration of extreme situations, concerning the a priori situation of the system’s future behavior, so that it is possible to recognize a trajectory of the future that is “anticipatory, imaginative and normative” (Godet, 1995a, 1995b) to adapt to its environment as well as transform it; and (c) strengthening the process of strategic reflection in light of prospective thinking, since, once the futuribles have been identified, it is necessary to identify the possible actions.

Therefore, from the point of view of the collective construction of the future, the use of optimization models for decision-making in Soft Computing is a means to

improve the logic of inference and reduce uncertainty. This is a better way to make decisions to reduce the reverse order effect, by prioritizing the most convenient strategic actions faced by decision makers, experts and other social actors who are responsible for materializing the envisioned futurable.

The literature on Futures Studies mentions a wide range of methods and techniques to explore, gather, and recognize facts, together with various methods for developing the inference process. In the process of visualizing the future by using strategic prospective have had a notoriously limited development in the literature, the topics concerning the approach based on the understanding of the systemic structure of strategic design, the fuzzy nature of the value judgments made by decision-makers, experts and other related social actors, and the link between prospective and strategy based on a limited available information. In other words, there is a lack of literature focused on the use of Soft Computing methods in strategic prospective; even though there is a wide array of Soft Computing applications in other areas, there is not enough application to approaches related to Futures Studies.

The implications expected from the Meta-Prospective model are oriented toward contributing to the field of Futures Studies in three key areas:

First, the complex understanding of the real world is a must for the success of Futures Studies, from the perspective of complex thinking (Morin, 1995) linked to complexity sciences (Prigogine & Stengers, 1979, 1980, 1984; Nicolis & Prigogine, 1989) and the application of causal logic (Forrest, 2009) to Futures Studies. The proposal of Forrest (2009, p. 2) emphasizes “examining and understanding complex issues,” and argues that Futures Studies “needed more robust logic that would suggest implications and inferences adequate for cross-comparisons.” They help transcend the idea that “the structure of a system leads to its behavior” (Sterman, 2000, p. 28) in order to recognize “laws of the system” as pointed out by Checkland (1999).

Second, the details of interest regarding the future cannot be predicted with a reliable degree of accuracy (Ostrowski, 1959), so this limits the usefulness of quantitative models in obtaining long-term predictions (Miles, 1975; Ajzen, 1977). Therefore, a combination of quantitative and qualitative models can be used to refine the understanding of issues that can provide a basis for inferring a system’s behavior patterns.

Third, the more precise it is, the better it can get ready for (and shape) the future (Neumann, 1974). Hence, the modeling process must be as flexible as possible, thanks to the use of simple modeling and simulation methods that are still potent enough to take advantage of the knowledge related to the system’s structural design (Koulouriotis, Diakoulakis, & Emiris, 2001; Narayanan, 2005).

The Meta-Prospective model aims to materialize the goal of building better images of the future (Godet, 1995a, 1995b) by proposing the following guidelines: (a) Contribute to deal with the vagueness that occurs in the decision-making process, given the fuzzy nature of the value judgments made by decision-makers, experts, and other related social actors during the conjecture process to visualize the future; (b) go deeper, both in the quantitative and the qualitative, to build a systemic

structure of strategic design that gathers the evidence of past trends and future-bearing facts; and (c) improve the ability to link the most convenient future (the product of the prospective process) to the strategy, by using methods that amplify and increase the flexibility of the prioritization criteria of the most convenient strategic actions to build, from the present, the desired future.

The book is divided into three parts. The first part comprises three chapters. In Chap. 1, the contextual frameworks are addressed via a brief historical review in order to provide a state of the art of Futures Studies and, more specifically, of strategic prospective. Therefore, Chap. 1 provides the reader with an overview focused on the paradigms and schools that have dominated long-term strategic reflection. In Chap. 2, the conceptual frameworks are addressed, emphasizing the art of conjecturing, which is the nucleus of long-term strategic reflection. In Chap. 3, an outlook of the conceptual frameworks of Soft Computing is given, developing the ideas of uncertainty and the links between Futures Studies and Soft Computing. Thus, it will be possible to recognize and characterize the contributions from diverse Soft Computing methods in order to deal with the vagueness and ambiguity that arise during the inference process of prospective reflection, contributing to reduce uncertainty.

The second part comprises three chapters. In Chap. 4, in the context of strategic prospective, several concepts are introduced to shape a proposal of a widened design called Meta-Prospective, which allows for the modeling and simulation of the future. In Chap. 5, the proposal of the Meta-Prospective model is developed. Including the process called Futures Lighthouse Trend Scenarios (FLighTS) and process of categorization of strategic actions and the development of a creative and adaptive learning environment. It is thanks to the newly proposed approach that combines strategic prospective and multiple Soft Computing methods. In Chap. 6, two experimental applications are developed, namely: A Cooperative Bank Association and A Traditional Security Company, providing a means to compare traditional strategic planning practices with strategic prospective and the Meta-Prospective proposal.

The third part comprises two chapters. In Chap. 7, a fuzzy proposal from the strategic prospective toolbox is introduced. It offers a context to integrate the methods used in the experimental applications, both in the traditional and in the newly proposed approaches. Finally, in Chap. 8, a guide for using the proposed tools (which can be found in a Cloud Environment) is presented using RStudio and R programming.

The book is aimed at two types of audiences interested in linking Future Studies with Artificial Intelligence (AI). A first type of readers from the social sciences to explore new proposals for the implementation of the strategic prospective based on methods of Soft Computing. These can read the book in its natural order. A second type of interested in exploring the application of Soft Computing methods, which in this case are oriented toward the social sciences and in particular with the processes of strategic reflection of long term. These can read the book from the end to the beginning.

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