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Edgardo Bucciarelli · Shu-Heng Chen
Juan M. Corchado
Editors

Decision Economics

In the Tradition of Herbert A.
Simon's Heritage

Distributed Computing and Artificial
Intelligence, 14th International Conference

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Preface

To Vela and Nicola,

our continuous source of learning, knowledge, inspiration, creativity, wisdom, and understanding; our strength, refuge, and support throughout these years; on your wings only have we soared; without you both, many things would not be as they are.

(Edgardo Bucciarelli and Shu-Heng Chen)

Decision Economics, in the Tradition of Herbert A. Simon's Heritage

This book is dedicated to our mentors—Kumaraswamy Vela Velupillai and Nicola Mattoscio—who, more than anyone else, have led us to a deep understanding of Herbert A. Simon's immense body of work. Among their countless teachings, indeed, Vela and Nicola have had the merit to convey to us their great passion for Simon's lifelong research program on computational complexity theory, as classical behavioural economics, that has brought so many positive changes and challenges to the progress of economic studies. In remembering Herbert A. Simon, a pioneering scholar in the interlinked development of economics, cognitive psychology, and computer science, this book presents a collection of selected peer-reviewed papers presented at the special session on "Decision Economics" (DECON), a scientific forum held annually which works to share ideas, projects, research results, models, and experiences associated with the complexity of behavioural decision processes and socio-economic phenomena. DECON 2017 took place at the Polytechnic of Porto, ISEP, Portugal, as part of the 14th International Conference on Distributed Computing and Artificial Intelligence.

This year, in continuing to celebrate the centennial of Herbert A. Simon's birth, the Editors of this book decided to emphasize his quintessential vision and substance in framing decision problems to be solved by bounded rational agents, satisficing in the face of computationally complex search spaces. This vision and substance, as well as his thoughts, have endured through time and have proved to be seminal for generations of scholars. Not only that, but they also acquire new vitality in every age proving always to be relative and effective. Herbert Simon advanced great and beautiful ideas and was a genius of innovation who broke down the barriers between disciplines and opened up insights into seemingly distant fields: economics, psychology, epistemology, computer science, and business organization. What point do these disciplines have in common? The presence of human beings who, with their baggage of limited, imperfect, and incomplete cognitive ability, openly reject neoclassical economic theory. It is mainly in "The Sciences of the Artificial" (1969) that Simon gives us his broad and genial view of the future, a thoughtful synthesis of his conception of complexity and processes through which innovation is attained. A teaching that is a polar star for anyone who aims to engage in science and innovation.

In an effort to be in line with this teaching, the precepts that inform several of the peer-reviewed contributions selected in this book are based on notions of algorithms invoked by Simon. More specifically, each contribution has gradually moved away from the idea of being able to develop a general theory of decision-making, thus leaving open the question to see the extent to which the results achieved analytically can then be translated, given the different forms of rationality, into real progress in understanding complex phenomena. Therefore, this book discusses decision economics from a wide spectrum of methodological issues and applications. The content of each chapter is described briefly below.

Chapter 1. *"The Bayesian cost-effectiveness decision problem"* by Elías Moreno, Francisco-José Vázquez-Polo, Miguel A. Negrín, and María Martel-Escobar. In this chapter, the authors provide a decision theory approach for medical treatment comparison based on cost-effectiveness reasoning and illustrate the optimal decisions for two utility functions. The first utility function yields the optimal criterion of choosing the treatment having the maximum expected net benefit; the second one is motivated by the health objective of choosing the treatment having, in probability, the highest net benefit. In revising this decision problem, the authors assume Bayesian models for the cost and effectiveness of treatments. In order to briefly illustrate the performance of the two utility functions, an example with simulated data is presented. The authors' simulation study shows that the optimal Bayesian decision with respect to the second utility function beats the first one in the sense of choosing the optimal treatment more often, so minimizing the proportion of wrong decisions.

Chapter 2. *"Evaluation of scientific production without using bibliometric indicators: decision-making on a priori criteria"* by Carmen Pagliari and Nicola Mattosio. In this chapter, the authors provide insights into the process of assigning

analytical scores to the scientific production of researchers who challenge in an open competitive exam for a socio-economic scientific sector. The authors describe the preliminary decisions made by the evaluation board subdividing them into six decision steps. The role of decision-making about a priori criteria is pointed out in relation both to the respect of researchers' identity and the evolution of science. In this contribution, moreover, an example of application is proposed, and some algebraic implications are highlighted. In particular, it is suggested to reflect on the usefulness of the rules of Boole's algebra for the calculation of total scores deriving from the simultaneous application of criteria having different logical characteristics. Although this contribution does not address behavioural issues, these are at the base of distorting and obsessive consequences on researchers' nature and may represent an original starting point for addressing future research lines in this emerging field as intended by the authors.

Chapter 3. *"Information aggregation in Big Data: Wisdom of crowds or stupidity of herds"* by Tongkui Yu, Shu-Heng Chen, and Connie Houning Wang. In this chapter, the authors explore the information aggregation behaviours of an interconnected population using an agent-based model and study how the connectedness among agents influences the checks and balances between the *"wisdom of crowds"* and the *"stupidity of herds"*, as well as the decision quality of the agents. The authors find that in a population of interconnected agents with limited fact-checking capacity, a quasi-equilibrium with a small portion of agents making decisions based on fact checking and a large portion of agents following the majority can be achieved in the process of reinforcement learning. The effects of agents' fact-checking capacity and search scope on herding behaviour, decision quality, and the possibility of systemic failure are also investigated. This contribution is interesting not only because it addresses big data and the effect of the information convenience on the quality of our decision-making, but mostly because the authors find that the decision accuracy first increases and then decreases as the agents' search scope goes up if the agents have a limited fact-checking capacity. This finding implies that a partially connected rather than a fully connected network is preferred from the viewpoint of information aggregation efficiency.

Chapter 4. *"Designing and programming a graphical interface to evaluate treatments in economics experiments"* by Edgardo Bucciarelli and Assia Liberatore. In this chapter, the authors develop a graphical interface that allows to calculate the efficacy of one or more *treatments* before adopting an experimental economics design. The graphical interface is built with Java according to a model-based *treatment* design. The originality of the contribution is twofold. The authors are first concerned with designing *treatments* in order to increase their efficacy, evaluating how experimental factors can affect the *treatment* process design. Second, they are interested in enhancing the internal and external validity of experiments to be run. Therefore, this research contributes to the economic literature focusing on the experimental economics design and providing a Graphical

Experimenter Interface (GEI) capable to support economists when deciding which experimental *treatment* design to adopt and, thus, which factors to include.

Chapter 5. “*A decision framework for understanding data-aware business process models*” by Raffaele Dell’Aversana. In this chapter, the author investigates the role played by data in Business Process Management as a discipline that enables organizations to analyse, design, and deploy business processes, providing tools to investigate the processes from an organizational point of view and transforming the design into a working software implementation. Based on Herbert A. Simon’s intuitions, the Business Process Modeling and Notation (BPMN) is the most widely adopted modelling language for designing and re-engineering business processes. As a matter of fact, one of best feature is that BPMN provides a graphical representation that is not only easy to understand by business people without technical expertise but also machine processable, with tasks assigned to software or human agents based on the workflow and rules defined within the process. The originality of this contribution, therefore, lies in the approach enabling the verification of the conformance to the business rules combining logic and mathematical expressions. Moreover, the new framework gives the possibility of separating the business requirements from the implementation, giving hints to the process designer and to the programmer.

Chapter 6. “*Cluster analysis as a decision-making tool: A methodological review*” by Giulia Caruso, Stefano Antonio Gattone, Francesca Fortuna, and Tonio Di Battista. In this chapter, the authors provide emphasis on cluster analysis as an important tool in a broad variety of research fields, such as psychology, biology, computer sciences, and economics. It has established as a precious tool for marketing and business areas, thanks to its capability to support decision-making processes. Traditionally, clustering approaches concentrate on purely numerical or categorical data. A significant application of cluster analysis addresses the role of mixed data, composed by both numerical and categorical attributes. Clustering mixed data is not simple, because there is a strong gap between the similarity metrics for these two kind of data. In their review, the authors present some technical details about the kind of distances that could be used with mixed-data types. Finally, they stress the importance of cluster analysis in many practical applications focusing either on numeric or categorical variables, lessening the effectiveness of the method as a tool of decision-making.

Chapter 7. “*Similar patterns of cultural and creative industries. A preliminary analysis based on Self-Organized-Map to the Italian case*” by Donatella Furia, Alessandro Crociata, Fabiano Compagnucci, Vittorio Carlei. In this chapter, the authors deal with cultural and creative industries (CCI) with the aim to establish a better understanding of relevant industry relevance (RIR) of geographic samples with a relevant similarity in terms of industrial patterns. In this sense, the authors

move from a methodological approach, based on Self-Organizing Maps (SOM) by comparing patterns of local employment. The Italian case provides an interesting case study to analyse industrial patterns by offering new insights of occupational dynamics. This contribution represents a first explorative attempt to extend the previous literature to seize the overall productive structure of the local creative economy.

Chapter 8. *“Understanding Bruno de Finetti’s decision theory: A basic algorithm to support decision-making behaviour”* by Edgardo Bucciarelli, Nicola Mattosio, and Valentina Erasmo. In this chapter, the authors present an algorithm inspired to Bruno de Finetti’s decision theory, limited to the version proposed in the 1965 essay *“La probabilità: guida nel pensare e nell’agire”*. Therefore, this contribution is focused on decision theory within the subjective theory of probability conceived by de Finetti. It opens with a brief overview of his theory of probability, followed by a methodological analysis functional to introduce the renowned de Finetti’s example model given for the solution of decision problems. Starting from this example, the authors present a mathematical generalization of the decision algorithm. Afterwards, a real decisional algorithm written in mathematical-style pseudo code is developed: this novel algorithm represents the main aim and originality of this contribution.

Chapter 9. *“FOREX trading strategy optimization”* by Svitlana Galeshchuk and Sumitra Mukherjee. In this chapter, the authors address the challenge to stimulate the development of robust trading rules for forex trading. The idea behind this contribution is to employ a genetic algorithm to evolve a diverse set of profitable trading rules based on weighted moving average method. In this regard, the authors use the daily closing rates between four pairs of currencies—EUR/USD, GBP/USD, USD/JPY, and USD/CHF—in order to develop and evaluate their own method. Results are presented for all four currency pairs over sixteen years, from 2000 to 2015. The rules obtained using the genetic algorithm proposed by the authors result in significantly higher returns than those produced by rules identified through exhaustive search.

Chapter 10. *“Looking for regional convergence: evidence from the Italian case with multivariate adaptive regression splines”* by Iacopo Odoardi, Fabrizio Muratore, Edgardo Bucciarelli, and Shu-heng Chen. In this chapter, the authors propose a multivariate adaptive regression splines (MARS) analysis to investigate regional income difference in Italy and in order to help to detect relationships between variables that may not be very visible or even appear invisible to traditional econometric techniques. In Italy, as known for decades, the presence of a still unresolved North–South divide lends itself to being studied by multiple analytical perspectives. Recent studies prove that strong differences exist also in the regional human capital. Thus, the authors search for the causes of the local differences, also considering the entrepreneurial vitality and the international trade leverage. In

searching among several variables, MARS is useful in showing the actual determinants on which to intervene. This is possible by comparing regions grouped into clusters using huge amount of data. MARS results are used by the authors for providing policy suggestions as a contribution aiming at filling the income gap.

Chapter 11. *“Information manipulation and web credibility”* by Te-Cheng Lu, Tongkui Yu, and Shu-Heng Chen. In this chapter, the authors deal with fake information, news, and reviews in the era of big data, using an agent-based model to simulate social interaction between information producers and consumers. Whether the information producers manipulate true or fake information depends on individual consumers attitude to truth or presentation of information. Consumers adapt themselves to accept or reject information and may evolve or learn socially from the others. Honest and dishonest producers select production strategies and also evolve from the same type of producers. The authors unexpectedly find that dishonest producers may produce true information because consumers co-evolve with producers by raising their standard on truth of information. To prevent fake information diffusion, the authors let consumers take social responsibility by raising standard on truth of information improving social welfare and web credibility in the era of information overload.

Chapter 12. *“A data mining analysis of the Chinese inland-coastal inequality”* by Shu-Heng Chen, Hung-Wen Lin, Edgardo Bucciarelli, Fabrizio Muratore, and Iacopo Odoardi. In this chapter, the authors study the inland/coastal income inequality differences in China which is a different phenomenon than the well-known Chinese rural/urban inequality. As in many countries, even the Chinese socio-economic changes have affected income inequality in recent decades. The various economic opportunities have led to different paths of development causing severe disparities in GDP per capita level. Among the many known causes of inequality, the authors aim to discover the actual determinants of the local GDP and, therefore, of income in a period that includes the international economic crisis started in 2007. With this aim, the authors use different variables to obtain clusters of the Chinese provinces in the period 2004–2015 and, subsequently, they investigate the determinants of income with a multivariate adaptive regression splines (MARS). There is an extensive economic literature on the Chinese case: MARS allows the authors to integrate this literature enabling them to find which GDP determinants are the most relevant in the certain areas of China.

Chapter 13. *“The cognitive determinants of social capital. Does culture matter?”* by Alessandro Crociata, Donatella Furia, and Massimiliano Agovino. In this chapter, the authors address the relationship between social capital and cultural access. In doing that, the authors provide a conceptual framework by moving from a cultural economics standpoint and by applying a simultaneous equation model (SEM). Some linkages and relationships emerge through the analysis of cultural participation as a proxy of cultural capital and the accumulation of two selected

dimensions of social capital. More specifically, anchoring this contribution within the literature of cultural economics, the output of the analysis is as follows: (i) the share capital and the capital generated by informal volunteering stimulate each other and are thus connected by a virtuous circular process; (ii) the capital generated from volunteering is positively stimulated by more introspective and niche cultural consumption; (iii) the informal social capital is stimulated by cultural consumption related to recreation and the stimulation of relationships whose goal is entertainment and fun.

Chapter 14. *“A unified framework for multicriteria evaluation of intangible capital assets inside organizations”* by Raffaele Dell’Aversana. In this chapter, the author addresses the importance of the capability concerning the internal metrics used to evaluate intangible assets within modern organizations. The author presents a novel unified framework to measure, assess, and develop intangible capital assets within organizations giving the possibility of enhancing decision-making within the operational and strategic governance. Once identified the assets under investigation, the author’s idea is to focus on a method based on a data model approach, giving directions for open research challenges in order to develop more efficient and effective organizations.

Chapter 15. *“Processing and analysing experimental data using a tensor-based method: evidence from an ultimatum game study”* by Edgardo Bucciarelli and Tony E. Persico. In this chapter, the authors address a multidimensional approach proposing a tensor-based method to analyse the experimental data obtained through an ultimatum game conducted by them in the context of an extra-laboratory-based experiment in 2015. The authors find a significant role both for different structures of preferences and meta-ranking. More specifically, the authors prove that subjects do not behave as standard game theory would predict, but rather they basically prefer fair divisions of gains. This evidence confirms significant implications for theories addressing the evolution of, and the mechanisms underpinning, human group behaviour in economics, cognitive, and organizational studies.

Chapter 16. *“The mediating effect of the absorptive capacity in the international entrepreneurial orientation of family firms”* by Felipe Hernández-Perlines. In this chapter, the author analyses the mediating effect of absorptive capacities on the impact of international entrepreneurial orientation on the international performance of family firms. The author focuses on family businesses using a structural equation model PLS-SEM. The main conclusion of this contribution is that the international performance of family firms can be explained both by the influence of the international entrepreneurial orientation and the absorptive capacity having a mediating role in previous relationships.

Last but not least, this year’s Special Session on Decision Economics would not have been possible without the enthusiastic help of its Program Committee. Special thanks are due to Sara Rodríguez González, Fernando De la Pietra, Jeyashree Kumar, and Renzo D’Agnillo for their support, encouragement, and advice. The

Program Committee members and English language mentors have helped ensure the quality of the contributions with their extensive and continuous feedback to most of the authors.

Edgardo Bucciarelli
Shu-Heng Chen
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Contents

The Bayesian Cost–Effectiveness Decision Problem	1
Eliás Moreno, Francisco-José Vázquez–Polo, Miguel A. Negrín, and María Martel–Escobar	
Evaluation of Scientific Production Without Using Bibliometric Indicators: Decision-Making on <i>a Priori</i> Criteria	9
Carmen Pagliari and Nicola Mattoscio	
Information Aggregation in Big Data: Wisdom of Crowds or Stupidity of Herds	16
Tongkui Yu, Shu-Heng Chen, and Connie Houning Wang	
Designing and Programming a Graphical Interface to Evaluate <i>Treatments</i> in Economics Experiments.	28
Edgardo Bucciarelli and Assia Liberatore	
A Decision Framework for Understanding Data-Aware Business Process Models	39
Raffaele Dell’Aversana	
Cluster Analysis as a Decision-Making Tool: A Methodological Review	48
Giulia Caruso, Stefano Antonio Gattone, Francesca Fortuna, and Tonio Di Battista	
Similar Patterns of Cultural and Creative Industries. A Preliminary Analysis Based on Self-Organized-Map to the Italian Case	56
Donatella Furia, Alessandro Crociata, Fabiano Compagnucci, and Vittorio Carlei	
Understanding Bruno de Finetti’s Decision Theory: A Basic Algorithm to Support Decision-Making Behaviour.	62
Edgardo Bucciarelli, Nicola Mattoscio, and Valentina Erasmo	

FOREX Trading Strategy Optimization	69
Svitlana Galeshchuk and Sumitra Mukherjee	
Looking for Regional Convergence: Evidence from the Italian Case with Multivariate Adaptive Regression Splines.	77
Iacopo Odoardi, Fabrizio Muratore, Edgardo Bucciarelli, and Shu-Heng Chen	
Information Manipulation and Web Credibility	86
Te-Cheng Lu, Tongkui Yu, and Shu-Heng Chen	
A Data Mining Analysis of the Chinese Inland-Coastal Inequality	96
Shu-Heng Chen, Hung-Wen Lin, Edgardo Bucciarelli, Fabrizio Muratore, and Iacopo Odoardi	
The Cognitive Determinants of Social Capital. Does Culture Matter?	105
Alessandro Crociata, Donatella Furia, and Massimiliano Agovino	
A Unified Framework for Multicriteria Evaluation of Intangible Capital Assets Inside Organizations.	114
Raffaele Dell'Aversana	
Processing and Analysing Experimental Data Using a Tensor-Based Method: Evidence from an Ultimatum Game Study	122
Edgardo Bucciarelli and Tony E. Persico	
The Mediating Effect of the Absorptive Capacity in the International Entrepreneurial Orientation of Family Firms.	135
Felipe Hernández-Perlines	
Author Index.	143

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programming in the socio-economic studies. His work as a scholar is interdisciplinary and focused since the beginning on methodologies related to the bounded rationality and Herbert A. Simon's contributions. Shu-Heng Chen holds the position of Editor of prestigious international economic journals and is author of more than 150 publications including scientific articles, monographs, and book chapters.

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