



## Preface

## Special issue “Applied soft computing for business analytics”



“Data is the new oil” is just one of the sayings that describe the importance of data for today's society. We have witnessed a rapid development of methods to analyze such data; starting with Statistics in the early 18th century, followed by Artificial Intelligence and Machine Learning, and finally leading to Data Science incorporating classical methodologies for data analysis, advanced data storage, visualization, and new programming paradigms.

In parallel, techniques for soft computing lately received increasing attention inspired by recent developments, such as Deep Learning, the recurrence of Artificial Intelligence, and new programming paradigms from Evolutionary Computation, among others.

This special issue aims to stimulate a scientific discussion on the potential of data-driven solutions showing how Soft Computing can be applied in Business Analytics. It covers a broad spectrum of applied as well as fundamental research. The following three papers present successful applications in various business sectors.

The work by Holý et al., “Clustering Retail Products Based on Customer Behaviour” presents a strategy for clustering products based on consumer behavior using basket analysis data. The clustering approach is presented as an integer programming model that minimizes the number of products of the same cluster that are bought together in the same transaction. It is assumed that customers buy at most one product from each cluster, and therefore the model penalizes violations of this behavior. The model is optimized using a genetic algorithm for simulated data and a real-world case from a Czech drugstore company, leading to important insights about the structure of the product categorization.

The paper by Valle et al., “Using Self-Organizing Maps to Model Turnover of Sales Agents in a Call Center”, proposes a supervised approach for modeling employee turnover in a Chilean call center. Self-Organizing Maps (SOMs) are used in a supervised fashion to predict turnovers at a given point in the trial period. Socio-demographic and psychometric information is combined to identify personality traits and other patterns that lead sales agents to not performing well, gaining insight into the call center industry, which suffers from high employee turnover rates.

van Calster et al. presented the paper “ProfARIMA: A Profit-Driven Order Identification Algorithm for ARIMA Models in Sales Forecasting”. It selects the lags of a seasonal ARIMA model taking into account a combination of forecast accuracy and expert knowledge. Three different search heuristics, i.e. Genetic Algorithms, Particle Swarm Optimization, and Simulated Annealing, were used for parameter optimization. The application on two publicly available data sets

and in one real-world case underlines the strength this approach has for business forecasting.

Two articles deal with the issue of Customer Relationship Management in the banking industry.

The paper by Kumar et al. “Fuzzy Formal Concept Analysis based Opinion Mining for CRM in Financial Services” proposes a descriptive analytics model that performs complaints/grievances analytics and summarizes the lengthy and verbose complaints concisely in a form that resembles association rules. The proposed hybrid model comprises fuzzy formal concept analysis and concept-level sentiment analysis in tandem, which in turn is compared against formal concept analysis and concept-level sentiment analysis. The proposed model also provides interactive visualization that enables business analysts and managers to access a specific set of complaints without having to go through the entire set thoroughly.

In their paper “A Data Mining Application to Deposit Pricing: Main Determinants and Prediction Models”, Batmaz et al. analyze the understudied problem of predicting deposit pricing behavior. This study uses customer-level data characterizing the relationship between them and the bank, and benchmark a series of models to predict the quoted rates given to the customers, and study which factors are the most determinant when making this decision. Their findings indicate that the strength of the relationship between the bank and the customer and some segmentations based on the customer location seem to be the most relevant variables. This study might be of interest to practitioners in the banking sector looking for more effective customer relationship management.

Two articles show how to model uncertainty in data mining applied to the financial sector.

The paper by Maciel et al. “An Evolving Possibilistic Fuzzy Modeling Approach for Value-at-Risk Estimation” suggests a Value-at-Risk (VaR) estimator based on uncertainty modeling. The approach is an extension of the possibilistic fuzzy c-means clustering and functional fuzzy rule-based modeling within the framework of incremental learning. Evolving possibilistic modeling employs memberships and typicalities to update the cluster structure and corresponding fuzzy rules using a statistical control distance-based criterion. A utility measure evaluates the quality of the current cluster structure and associated model.

Antunes et al. study in their paper “Probabilistic Modeling and Visualization for Financial Risk Data Analytics” the problem of bankruptcy prediction. They apply the Gaussian Processes (GP) classifier and compare it with Support Vector Machines, and Logistic Classification. Their experiments show that the GP classifier

outperforms the alternative approaches providing also models that are less sensitive to imbalanced data sets. Furthermore, they propose a visual representation that displays different metrics together with performance measures for various models as well as several data sets at the same time.

Analytics in social media is gaining a lot of attention lately. The paper by Shi et al. “*Understanding and Predicting Individual Retweeting Behavior: Receiver Perspectives*” presents an analysis of the components that lead users to forward a message (‘retweet’) to their followers in the micro-blogging platform Twitter. Their findings indicate that this behavior is a complex combination of factors such as the trustworthiness of the source, the topic affinity with the user, the richness of the communication, and the context of the document. This paper also shows that information-related variables do not seem to play a part in this decision, a fact that is relevant now given the role that such sites have had in the current political landscape.

A more fundamental approach is presented in “*RULEM: A Novel Heuristic Rule Learning Approach for Ordinal Classification with Monotonicity Constraints*”, where Verbeke et al. propose an approach to enforce monotonicity constraints in rule-based classifiers, such as decision trees. The solution proposed by the authors includes two justifiability measures, i.e., how well a proposed solution aligns with domain knowledge, and a post-processing step that induces new rules that ensure preserving monotonicity in future steps. Extensive experimentation validates their approach.

We hope that this Special Issue contributes to the scientific debate related to the use of soft computing in business analytics

and stimulates future research and applications in this fascinating area.

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Richard Weber  
*Universidad de Chile, Chile*

Cristián Bravo  
*University of Southampton, UK*

Rudolf Kruse  
*University of Magdeburg, Germany*

Sebastián Maldonado\*  
*Universidad de los Andes, Chile*

\* Corresponding author.  
E-mail addresses: [rweber@dii.uchile.cl](mailto:rweber@dii.uchile.cl) (R. Weber),  
[c.bravo@soton.ac.uk](mailto:c.bravo@soton.ac.uk) (C. Bravo),  
[rudolf.kruse@ovgu.de](mailto:rudolf.kruse@ovgu.de) (R. Kruse),  
[smaldonado@uandes.cl](mailto:smaldonado@uandes.cl) (S. Maldonado).