Advances in Intelligent Systems and Computing 771

Manuel Graña · José Manuel López-Guede
Oier Etxaniz · Álvaro Herrero
José Antonio Sáez · Héctor Quintián
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International Joint Conference SOCO'18-CISIS'18-ICEUTE'18

San Sebastián, Spain, June 6–8, 2018, Proceedings

Springer

Advances in Intelligent Systems and Computing

Volume 771

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ISSN 2194-5357 ISSN 2194-5365 (electronic)
Advances in Intelligent Systems and Computing
ISBN 978-3-319-94119-6 ISBN 978-3-319-94120-2 (eBook)
https://doi.org/10.1007/978-3-319-94120-2

Library of Congress Control Number: 2018946625

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Preface

This volume of Advances in Intelligent and Soft Computing contains accepted papers presented at SOCO 2018, CISIS 2018, and ICEUTE 2018; all conferences held in the beautiful and historic city of San Sebastian (Spain), in June 2018.

Soft computing represents a collection or set of computational techniques in machine learning, computer science, and some engineering disciplines which investigate, simulate, and analyze very complex issues and phenomena.

After a thorough peer review process, the 13th SOCO 2018 International Program Committee selected 41 papers which are published in these conference proceedings and represent an acceptance rate of 45%. In this relevant edition, a special emphasis was put on the organization of special sessions. Two special sessions were organized related to relevant topics as: Optimization, Modeling and Control by Soft Computing Techniques and Soft Computing Applications in the Field of Industrial and Environmental Enterprises.

The aim of the 11th CISIS 2018 conference is to offer a meeting opportunity for academic- and industry-related researchers belonging to the various, vast communities of computational intelligence, information security, and data mining. The need for intelligent, flexible behavior by large, complex systems, especially in mission-critical domains, is intended to be the catalyst and the aggregation stimulus for the overall event.

After a thorough peer review process, the CISIS 2018 International Program Committee selected 8 papers which are published in these conference proceedings achieving an acceptance rate of 40%.

In the case of 9th ICEUTE 2018, the International Program Committee selected 11 papers, which are published in these conference proceedings.

The selection of papers was extremely rigorous in order to maintain the high quality of the conference, and we would like to thank the members of the Program Committees for their hard work in the reviewing process. This is a crucial process to the creation of a high standard conference, and the SOCO, CISIS, and ICEUTE conferences would not exist without their help.

SOCO'18, CISIS'18, and ICEUTE'18 enjoyed outstanding keynote speeches by distinguished guest speakers: Prof. Hujun Yin—The University of Manchester (UK), Prof. Maya Dimitrova—St. Petersburg University (Russia), Prof. Iván Macía Oliver—Director of the eHealth and Biomedical Applications Area of Vicomtech (Spain).

SOCO'18 has teamed up with Cybernetics and Systems: An International Journal (Taylor and Francis), Expert Systems (Whiley) and the J. Applied Logics—IfCoLog Journal (College Publications) for a suite of special issue including selected papers from SOCO'18.

For this CISIS'18 special edition, as a follow-up of the conference, we anticipate further publication of selected papers in one special issue in the prestigious Logic Journal of the IGPL (Oxford Academic).

Particular thanks go as well to the conference main sponsors: Startup Ole, and University of Salamanca, University of Basque Country who jointly contributed in an active and constructive manner to the success of this initiative.

We would like to thank all the special session organizers, contributing authors, as well as the members of the Program Committees and the Local Organizing Committee for their hard and highly valuable work. Their work has helped to contribute to the success of the SOCO 2018, CISIS 2018, and ICEUTE 2018 events.

June 2018

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Agents and Multi-agents Systems

An Investment Recommender Multi-agent System in Financial Technology

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Abstract. In this article is presented a review of the state of the art on Financial Technology (Fintech) for the design of a novel recommender system. A social computing platform is proposed, based on Virtual Organizations (VOs), that allows to improve user experience in actions that is associated with the process of investment recommendation. The work presents agents functionalities and an algorithm that will improve the accuracy of the Recommender_agent which is in charge of the Case-based reasoning (CBR) system. The data that will be collected and will feed the CBR corresponds to user's characteristics, the asset classes, profitability, interest rate, history stock market information and financial news published in the media.

Keywords: Financial Technology · Virtual organization of agents
Recommender system · Hybrid A.I. algorithm · Investment decisions

1 Introduction

The emergence of Financial Technology (Fintech) is a result of the global economic-financial crisis that occurred in 2008. Companies known as Fintech distanced themselves from traditional banking in order to be able to offer the traditional services offered by banks, due to the cheapening of technology. In this way, small companies that grow in a technological environment have been able to use social networks to expand their market share [18]. Other aspects have also contributed to their expansion, such as the widespread use of smartphones, the bad reputation acquired by banks as well as the lack of transparency and the emergence of a new collaborative economy [2, 27].

In this paper, a research focuses on investment recommendation system for businesses is presented, in order to provide investment related suggestions. For this purpose, we identified different factors that could be extracted from the internet and from the information provided by the users. Perhaps, the biggest challenge is to gather relevant information to make through case-based reasoning (CBR), useful investment recommendations [3, 9, 21].

© Springer International Publishing AG, part of Springer Nature 2019
M. Graña et al. (Eds.): SOCO'18-CISIS'18-ICEUTE'18, AISC 771, pp. 3–10, 2019.
https://doi.org/10.1007/978-3-319-94120-2_1

The article is structured as follow: in Sect. 2 we analyzed the concept of Financial Technology, and the data oriented technology that this implies. We also describe Fintech's requirements, how it is being used to optimize business. The concept of Virtual Organizations is also described. VOs are our starting point in creating a recommendation system proposed in Sect. 3. Finally, conclusions and future work are presented in order to improve the recommender system in Sect. 4.

2 Financial Technology

Financial Technology (Fintech) can be considered as a consequence of the disruption of cloud computing, mobile devices, big data, cybersecurity and other Internet-related technologies, offering emerging business models that are more efficient, safer, innovative and more flexible than existing financial services [5, 11, 29]. IT Fintech companies present the following characteristics:

- Finance oriented
- Highly innovative companies
- New technologies are fundamental
- A challenging alternative to banking

Taking into account that it is necessary to handle large amounts of data, the starting point of many authors is data processing and its security [18]. Data-oriented techniques begin with the mining of operational data in the context of Big Data. This is the main technique for obtaining valuable information, it allows to analyze large volumes of data. In the field of banking, Big Data techniques have been considered an essential tool when dealing with financial data [23]. On the whole, the researchers developed on the handling of data in the field of Financial Technology are aimed at improving financial services or creating new ones. Obtaining datasets helps to distinguish processes, impacts and results and find solutions [15]. In this regard, some authors have used machine learning for large size datasets, in order to improve performance and guarantee privacy [34].

Due to the large amount of work, modern businesses use big data centers. For this reason, many businesses have been interested in the optimization of memory designs and energetic efficiency of the data centers [4, 14, 17, 27]. Researches intend to optimize computing performance with scalable and flexible systems. Data mining in a distributed environment is a tendency but at the same time it is a challenge (Lu *et al.* 2008). In [26] the authors propose a solution to the training problem in mining distributed data, a mechanism that could guarantee that different servers will process distributed data simultaneously, considering both the cost and efficiency. Yu *et al.*, 2015 added another variable: availability. Furthermore, they stressed the importance of integrating the Data Base Management System with storage, security and performance requirements. The result they obtained was that the input/output operation was 27 time faster than the traditional method [35].

In the field of management, the most commonly used approaches are optimization and machine learning at the time of making investment recommendations or when creating businesses strategies. Li and Hoi [24] applied machine learning as online

decision support system. The study consisted in performing an online survey on investment portfolios. They presented selection as a sequential problem, obtaining five group categorization of solutions to the problem of online investment portfolio selection. However, they affirmed that precision continued being an unresolved problem. Wang in [32, 33] applied a different model to stock operations, it used fuzzy systems theory to transfer negotiation rules. Another approach to stock performance prediction was proposed by Hadavandi *et al.* in [20], they applied neural networks and integrated genetic fuzzy systems to predict performance on stock markets.

To sum up, many different data based techniques have been used in investment recommendation proposals: Machine learning, fuzzy logic algorithms, neural networks, etc. Nevertheless, it is necessary to include another approach to creating investment recommendations in the business sector. For this reason, the next section will overview the concept of Agent-based Virtual Organizations and the reasons for which they are a suitable recommendation model.

2.1 Virtual Organization of Agents

Agent technology is a branch of Distributed Artificial Intelligence (DAI). MAS (Multi-agent Systems) integrate different capabilities, such as: autonomy, reactivity, proactivity, learning, ubiquitous distributed communication and most importantly the intelligence of all their elements. These characteristics meet a large part of the requirements posed by Financial Technology, adapting to the needs of users in a ubiquitous, autonomous and dynamic manner [6, 16, 36].

In the field of computing, concretely in that of multi-agent systems, organizations are used to describe a group of agents who are coordinated through a series of behavioral patterns and roles aimed at achieving the system's objectives. A multi-agent system model has to be able to define organizations that can adapt dynamically to changes in the environment or to the specifics of the organization. Dynamic adaptation includes adapting to changes in the structure and behavior of the MAS, as well as the addition, deletion and substitution of components during system execution, without affecting its correct functioning [8, 12, 28].

Virtual Organizations (VOs) have a series of common characteristics:

- An organization of agents is made up of agents, roles, coordination and interaction rules.
- It pursues a common and global objective which is irrespective of the objectives of particular agents.
- Roles are assigned to the different agents. Thus, their tasks within the system are specialized in order to achieve the organization's global objectives.
- It divides the system in groups through departmentization, these groups are units of interaction between agents.
- It defines a series of limits for the agents belonging to the organization, their rules of interaction, its functionality and the services it offers.
- The input and output of agents of the organization determines their dynamics, therefore, their roles can change depending of the organization objective.

3 Investment Recommender System

Having described the characteristics of Agent-based Virtual Organizations, we propose a design based on VOs with new human-agent interaction modules which allow to improve user experience. This is associated with the process of investment recommendation [10, 13, 18, 20, 23, 26]. With this aim, the paper address the creation of a social computing platform which allows humans and machines to work collaboratively and transparently. Once functionalities are defined, this distributed design is going to facilitate subsequent development and allow for future modifications and extensions.

Our proposal is designed as a heterogeneous system in languages, applications and characteristics. Figure 1 illustrates the different elements of the platform together with the modules that make it up. Below, each of these modules is described, each of them will individually compose a Virtual Organization, with distinctive characteristics, rules and structures. This is described as follows:

- Identification (V.O.): User_agent is the interface that allows the user to Access recommendation functionalities. It is in charge of generating and updating a user profile.
- Information (V.O.): This organization is in charge of searching and processing information. In this case, we created different sub-organizations which are in charge of calculating the variables that are part of the recommendation system:
- User Risk Profile_Information_agent: This agent is responsible for collecting information on investment profiles, considering the level of risk that the investor is prepared to take (asset classes, profitability, interest rate, etc.).
- Share Price_Information_agent: It is in charge of obtaining the public process of shares.
- Financial news_Information_agent: This agent is responsible for obtaining financial news published in the media which list the transactions of businesses, both internal and external. Thy will be included in the Recommendation System in order to be able to extrapolate patterns and provide users with accurate recommendations.
- Recommendation (V.O.): It is responsible for making the different investment recommendations. The Recommender_agent is in charge of calculating factor and weight, and of managing the CBR System where the suggestions of the users are stored.
- Interface (V.O.): The Interface_agent is responsible for showing the user the investment recommendation when the access the system, this recommendation will be based on the user profile previously created by the User_agent for personalized investment recommendations.

3.1 Hybrid A.I. Algorithm for Investment Recommendation System

In [30] the authors refer to Machine learning algorithms like effective in fitting parameters automatically, avoiding over-fitting, and being capable of combining multiple inputs. Also mentioned that ranking investors' sentiment hence provides a natural way to select stocks based on the "portrayed performance" in news media.

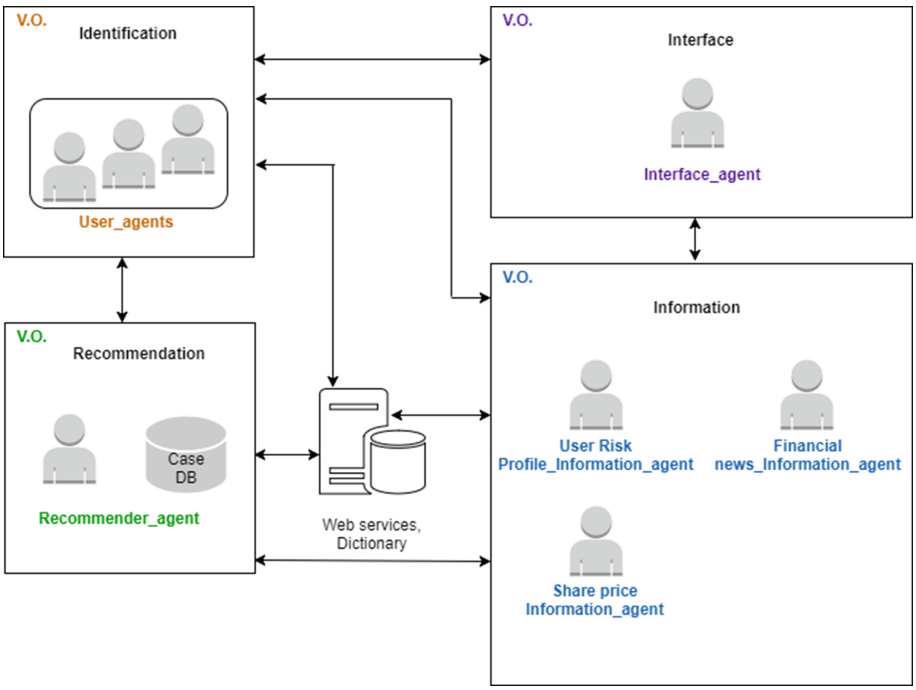

Fig. 1. Stock Investment recommender platform

Reviewing the literature, it is possible to find three kinds of machine learning algorithms for financial market prediction and trading strategies: price prediction, movement directions predictions and algorithms for rule-based optimization to determine optimal combinations. In our study, we will focus on those oriented to price prediction. Regression algorithms [10] and neural networks are able to perform approximations of the future performance of assets.

The concept of Support vector regression (SVR) is addressed in [25], the authors shown a typical regression problem to illustrate the SVR concept:

Consider a set of data $G = \{(x_i,q_i)\}_i^n$, *where* x_i *is a vector of the model inputs,* q_i *is actual value and represents the corresponding scalar output, and n is total number of data patterns. The objective of the regression analysis is to determine a function f(x), so as to predict accurately the desired (target) outputs (q). Thus, the typical regression function can be formulated as* $q_i = f(x_i) + \delta$, *where* δ *is the random error with distribution of* $N(0, \sigma^2)$. *The regression problem can be classified as linear and nonlinear regression problems. As the nonlinear regression problem is more difficult to deal with, SVR was mainly developed for tackling the nonlinear regression problem.* On the other hand, regarding neural networks, the definition given is that comprehensive system that considers numeric inputs, performs computations on these inputs, and creates outputs for one or more numeric values [1]. Neural networks improve the traditional statistical methods such as linear regressions, using function approximations, discriminant analysis, and logistic regression [22, 31].