

## THE APPLICATION OF COMPUTATIONAL INTELLIGENCE IN ACCOUNTING AND FINANCIAL ACTIVITIES

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**ABSTRACT:** During recent years, the ever-increasing use of computers has prepared the new fields of modern technology application in all human knowledge arena including accounting and financial subjects. Integration of accounting science and innovations in Information and Communication Technology (ICT) field has caused us to witness the growing speed and accuracy in financial and accounting systems by means of modern tools and techniques so that to reduce extremely operational costs and make giving of the financial services much more profitable. Similarly, employing of these systems may lead use to be able to cover wider spectrum of various fields by utilization of manpower and spending less time. Artificial Intelligence (AI) denotes producing of equipment and software application, which may imitate many of human specific behaviors rather its several uses in different fields, has also established its position in accounting and financial activities for some period of time. Today, computational intelligence is also one of the branches of artificial intelligence that has drawn attention by people in analysis process of economic and financial data more than ever. This issue is due to the ever-increasing quantity of the existing economic and financial information for analysis and multiple and growing number of various equipment and instruments for using in investment and rising amount of merchants' preferences. This problem has led to ineffectiveness of classic approaches and created essential challenge for emergence of computational techniques.

**KEYWORDS:** Artificial Intelligence (AI), Computational Intelligence, Accounting and Financial Activities, Swarm Intelligence, Artificial Neural Network (ANN), Evolutionary Computations, Fuzzy Logic Systems.

### INTRODUCTION

A short time after the end of World War II is the start point for creation of Artificial Intelligence (AI) when with respect to cybernetics issues; Norbert Wiener has prepared the ground for advancement of artificial intelligence. In 1950, Alan Mathison Turing introduced a test to determine whether a machine might compete with human's brain processes. In 1956 a meeting was held in college of Dartmouth where they encouraged for conducting wide studies on artificial intelligence. During 1960s is known as a decade for developing and advancement of researches in the field of artificial intelligence. The programs for chess game and robots served as human's fields for researches on artificial intelligence subject. Those techniques, which were employed for confining search strategies and design of shortcut methods in order to correct the given responses, played a prominent role in advancement of artificial intelligence application. Today, using of artificial intelligence and modeling tools are extremely going to increase in accounting field and financial activities. Within several past decades, Expert

System, Neural Network, Genetic Algorithm, and Fuzzy Logic were among the issues, which have drawn attention by many academic members. It is tried in this essay to express applications of computational intelligence in accounting and financial activities.

#### 1.1. Artificial Intelligence (AI)

Artificial intelligence is composed of the sciences including computer, physiology, philosophy, mathematics, statistics, and linguistics that it has been tried to simulate human's characteristics via computer systems. Artificial intelligence is to make equipments and software application that may imitate many of human's certain behaviors like reasoning, learning, problem solving, and recognition (Zarei, 2011).

#### 1.2. Computational Intelligence (CI)

It is one of the most important and applied subsections of artificial intelligence in which several tools are used to realize idea of artificial intelligence. The used tools in computational intelligence are often those mathematical tools that have been typically inspired from nature

and surrounding world. The most important tools used in computational intelligence that is purposed including as follows: Swarm Intelligence (SI), Artificial Neural Network (ANN), Evolutionary Computation, Fuzzy Logic Systems ([Anonymous, 2010a](#)).

### SWARM INTELLIGENCE

The techniques which are placed in this class may suggest another model to solve optimization problems. In these problems, a noticeable number of very simple and less intelligent agents may cooperate or compete to each other to form a type of swarm or collective intelligence. For instance, Ant Optimization Algorithm, which has been imitated from ants' collective behaviors, is one of the algorithms of swarm intelligence.

Swarm intelligence of collective intelligence is a type of artificial intelligence that has been interpreted based on collective behaviors in decentralized and self-organizing systems. These systems are usually composed of a population from simple agents that locally interact with each other and their environment. Despite of the fact that no focused control may impose way of behavior of agents to them, their local interactions will lead to emerging of a general behavior. One could see some examples from such systems in the nature including groups of ants, flock of birds, herd of animals, colony of bacteria and groups of fish ([Wikipedia, 2013](#)).

#### 2.1. Techniques of swarm intelligence

1. The method of Ant Colony Optimization (ACO)
2. Swallow Detection Algorithm with Particle Swarm Optimization (PSO)
3. Furnace Simulation Method
4. Tabu- Based Search Method
5. Evolutionary Computation Method

Two first above techniques are the most prosperous methods of swarm intelligence so far.

#### 2.2. Ant Colony Optimization

ACO method is a type of metaheuristic methods that are appropriate for finding approximation solutions for composed optimization problems. ACO method in ACO method, the artificial ants through moving on graph of problem and laying tracks on the given graph, like the real ants which remain tracks on their moving path, cause the next artificial ants to be able to provide better solutions for the given problem ([Anonymous, 2010b](#)).

Of ACO applications in accounting and financial activities, one could refer to the following titles:

1. Optimization to credit risk assessment ([O'Neill and Brabazon, 2008](#))
2. Optimization for option pricing ([Kumar \*et al.\*, 2009b](#))
3. Financial classification problems ([Marinakis and Marinaki, 2009](#))
4. Solution for financial Road-show Documents ([Chuan \*et al.\*, 2011](#))
5. Price exotic options ([Kumar \*et al.\*, 2009a](#))

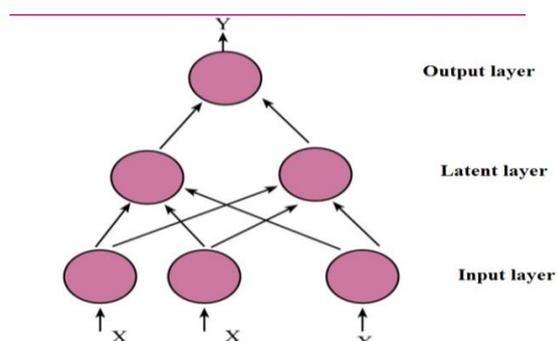
#### 2.3. Particle Swarm Optimization (PSO) Algorithm

PSO method is an overall minimization technique thereby one could treat the problems which their answer is located in one point or surface in n- dimensional space. In such a space, some hypotheses may be purposed while the initial speed is allocated to them. At the same time, connection channels are considered between particles. Then, in response to the space, these particles move and based on competence criterion the given results are computed for any time interval. Over the time, particles are accelerated toward other particles which possess higher criterion of competency and placed in an identical connection group. Compared to other minimization strategies, the major advantage of this method is in that great number of swarming particles will cause flexibility of this method against problem of local minimization response ([Anonymous, 2010b](#)).

### NEURAL NETWORKS

Artificial Neural Networks (ANNs) are a model for data processing, which have been made by imitation from biologic neural networks like human's brain. The new structure of information processing is the key element of this system and they are composed of a great number of elements (neuron) with internal strong connections that matched to work with this system to solve certain problems ([Mobasher, 2008](#)). Possessing noticeable ability in deduction of concepts from complicated or ambiguous data, the neural networks are employed to extract the models and to identify the methods that knowing them is very complicated and difficult for human and also other computerized techniques. A trained neural network may serve as an expert in information context in order to analyze the given data. This expert may be used for estimation of new arbitrary situations and giving answer to the questions "What if?" ([Hadi, 2012](#)). A neural network is a form of artificial intelligence that tends to follow up human's intelligence. This network is made up a group of subsequent modules (element processing), which separately react to a group of input signs toward which they have been transmitted. Figure (1) is a sample of a neural network that is

composed of an input layer, latent later, output layer.



**Figure 1:** A type of neural network

### 3.1. Application of neural network in accounting and financial activities

#### 3.1.1. Detection of fraud in financial statements

Neural networks may provide diagnosing the next behaviors unobserved by users in each of two approaches of anomaly and abuse diagnoses. These methods are implemented based on backlash of neural networks ([Hatami and Shahriari, 2005](#)).

#### 3.1.2. Prediction of stock price trend

Prediction of stock price or return is not an easy task for which many market factors are involved in its determination where all these factors may not be exclusively considered in technical analysis. Employing more complicated computational tools and algorithms like immune neural network, which derived from modeling non-linear processes that lead to stock price and trend, may result in better responses from statistical methods.

#### 3.1.3. Auditing

Detection of management's fraud as well as identifying the presence or absence of continued activity of customers' participation is one of the main applications of neural networks use in auditing regarding detection of important information rather than the fields of network use in auditing. Likewise, neural networks have been utilized in risk assessment in auditing, control risk, determination of audit commissioning and wage and also identifying of financial bottlenecks. Using ANN in auditing may contribute to process of analytical study, decisions for continuity of action and other cases.

#### 3.1.4. Prediction of credit value

Artificial Neural Network (ANN) may be trained in such a way that its input data to be the customers' related information and the output data serves as real decisions made by credit

analysts. This system is aimed at imitation from human decision maker in granting or rejection of credit and determination of credit levels. Compared to linear predicting models, ANN's advantage is in that it may employ wider group of financial data and it does not require using assumptions like linearity and normality. In his conducted studies, Kumar has explained the efficiency of non-linear models in prediction of solvency for payment of financial liabilities compared to linear models.

#### 3.1.5. Estimation of final cost

upon estimation of final cost, many factors should be taken into consideration including constant variation in nature of technology, the presence of materials, direct wage, and value of monetary currency etc. thus, with respect to this point, the input data are numerous and often incomplete so that neural network may be an appropriate choice for estimation of final cost ([Kalateh and Chehardah Cheriki, 2006](#)).

## EVOLUTIONARY COMPUTATIONS

Evolutionary computations include a group of methods, which are known under title of evolutionary algorithms. The most well-known of these algorithms is Genetic Algorithm (GA), which have been derived from theory of evolution and genetic science. In this algorithm, evolution process, which has taken place over millions of years, is simulated. The most major case of using the evolutionary algorithms is solving the problems of optimization and mathematical planning.

Four samples of well-known evolutionary algorithms are as follows: Genetic Algorithm (GA), Evolutionary Strategies (ES), Genetic Planning (GP), and Evolutionary Planning (EP) ([Anonymous, 2010a](#)).

#### 4.1. Genetic Algorithm

Genetic algorithm is a non classic optimization and direct searching technique that is involved in the given function and not its derivatives and it has been founded based on mechanism of survival of the best choice and natural genetic science, derived from Darwin's Theory of Evolution. Genetic Algorithms were invented by John Holland in 1960s and it was developed by him and his students and some of his colleagues in University of Michigan during 1960s and 1975.

Genetic algorithm is based on iteration and its primary principle has been excerpted from genetics. This algorithm is utilized in various subjects like system optimization, identification and control, image processing and composition related issues, determining topology and

training of artificial neural networks, decision making and rule- based systems.

Genetic algorithms are simple and useful tools by which a machine could simulate mechanism of natural choice while this task is done in searching for problem space to find the superior answer but not necessarily optimal alternative. Genetic algorithm may essentially differ from the common search and optimization techniques that can be mentioned as follows.

*I:* Genetic algorithm operates with the relevant codes of answers not only with them.

*II:* It searches the choice within a population of responses not an individual answer.

*III:* It employs data from target function not derivative or other auxiliary information.

*IV:* It adapts possible transfer rules not definite rules ([Rayati Shovazi and Abzari, 2013](#)).

## 4.2. Application of genetic algorithm in accounting financial activities

### 4.2.1. Detection of fraud in financial statements

Fraud in financial statements is considered as a great risk for beneficiaries in an enterprise including investors and loan borrowers. Fraud detection techniques should suffer from the lowest error percentage. Fraud detection process in financial statements is exposed to some problems for several reasons. First, fraud is a rare phenomenon and it occurs in enterprises at 2% level and for this reason, sample size for the study on this subject is very small. In many models of fraud detection, logistic regression models and neural networks are utilized. Under some conditions when work dimensions is too wide and number of members is low in sample size, these models are not feasible since many of existing information will be ignored. Hugs conducted a study under title of "Application of genetic algorithm in finding of models that reveal fraud in financial statements" in order to take genetic algorithm approach in detection of fraud in financial statements. For this purpose, a sample including 51 enterprises, which had been accused by SEC to inappropriately determination of income, was used as target group along with a sample composed of 339 enterprises, which fitted to the former group in terms industry and income level, was considered as control group. Research variables are 79 comparative criteria, which have been extracted from financial statements, and also they represented corporative historical performance and its performance in the given industry as well as 9 other variables that denote specifications of the enterprise. Time- based models, discovered by genetic algorithms, may properly classify 63% of target enterprises and 95% of control enterprises.

### 4.2.2. Prediction of bankruptcy

One of the main subjects in classification of bankruptcy in enterprises is prediction of bankruptcy. Investors, owners, directors, creditors, and public institutions tend to evaluate corporative financial status for which they should incur a lot of cost in the case of bankruptcy ([Najmeddin and Nematizdeh, 2012](#)). The existing appropriate tools and models for evaluation of financial situations and status of organizations is one of the subjects that may contribute to way of decision made by investors. One of the tools used for decision making for investment in an enterprise is bankruptcy prediction models. Solving the problem of bankruptcy prediction by means of genetic algorithm is aimed at a genetic model that may extract automatically classification smart rules for prediction of bankrupt and non- bankrupt enterprises groups in a sample by means of values of financial certain ratios. These financial ratios are so-called known as predictor variables. Arthur in a survey under title of "Genetic algorithm applications in bankruptcy risk analysis", used genetic algorithm for prediction of bankruptcy. His sample was composed of 500 enterprises including 236 bankrupt enterprises and 264 non- bankrupt firms. Results of this study may denote 93% prediction accuracy rate one year before bankruptcy and 91.6% for two years before occurrence of bankruptcy. Mien in a research called as "Composed Genetic Algorithm and Support Vector Machine in prediction of bankruptcy", have adapted simultaneously GA and SVM and christened that GA-SVM model. The results of their study suggested 86.53% prediction accuracy rate in training group and 80.30% in tested sample for one year before bankruptcy.

### 4.2.3. Selection of portfolio

Bond market is a financial institution for collection and guiding small capitals and the needed financial provision for manufacturing units in the course of economic development. Investors in stocks purchase and sale market participate in this economic activity exclusively for benefit acquisition goals and profitability objectives. Selection of stock is one of the complicated issues in financial field and investment. There are several stocks in this problem and it is stipulated to invest in this market through purchase of a stock with maximum value-added and minimum rate of riskability. With respect to uncertainty that governs over Security and Exchange Organization (SEO) and also given that the

existing various interest and preferences of investors, it seems necessary to find a method for selection of an appropriate group of bonds and securities thereby one could overcome on uncertainty and individuals' various preferences. On the other hand, with respect to successful performance of genetic algorithm in optimization problems, this algorithm may put a suitable method at investors' disposal in order to choose optimal stocks basket. With respect to efficiency of the algorithm, investor may form efficient stocks basket at different levels of risk and efficiency by identifying quantity of his/ her own given stocks. It is clear that this may reduce investment costs by lowering transactions cost noticeably. Concerning to employing of GA, there are many studies on selection of stocks basket. Arenon purposed a genetic algorithm for problem of unbounded portfolio, but their risk criterion that they used was a half of variance. The calculation results were computed for 15 assets. To select unbounded stocks basket, Lurashi employed isle models (i.e. models bases on genetic algorithm to be used in isolated communities from each other in which the more fitted responses migrate among the communities) and solved this model by means of fitting responses. The results in two problems were compared with 530 and 35 properties ([Masihabadi and Abdollahi, 2009](#)).

### FUZZY LOGIC

Fuzzy logic is a very important logic that was purposed by an Iranian professor called Dr. Lotfalizadeh in 1965 and it seriously confronted with Aristotle's binary logic. Initially, Fuzzy logic was introduced as a method for data processing in which members of a set might also define the intermediate state rather than definite states of membership and non- membership in this logic. Instead of dealing with zero and one, fuzzy logic examines and analyzes the values from zero to unit. In other words, the set that contains two members (0,1) in Aristotle's logic, will be converted into a set of infinite members with values from zero to one in Fuzzy logic and as a result fuzzy logic may approach more to human's state of mind and thinking.

Fuzzy logic may be utilized in software, hardware, and or a composition of both.

Fuzzy logic is aimed at preparation of a basis for conducting approximated and accurate deductions. This is done with considering a certain rate of competency and contingency ranged from zero to unit for the members inside a fuzzy system in such a way that enables the elements in a fuzzy set to be relatively black or white. With expressing qualitative and quantitative data as well as lingual arguments in

scientific and quantitative form, fuzzy sets may reduce the possible personal judgments and cause making more logical decision ([Mahdian and Nadaf, 2007](#)).

#### 5.1. Application of fuzzy logic in accounting and financial activities

##### 5.1.1. Accounting management

In accounting management, the fuzzy logic is mainly used for decision making and performance evaluation so that more than 31% of fuzzy studies in management accounting concerns with decision making, particularly capital budgeting and development of new product and about 24% of them relate to evaluation of performance, especially by means of a balanced evaluation system and also only 18% of the conducted studies is about cost analysis. Other fuzzy studies in management accounting are also related to planning, control, and strategic management accounting with respectively 15% and 10% levels. The foremost known applications of fuzzy logic in management accounting are as follows:

1. Increase in accuracy and veracity of cost budgeting systems based on activity by reduction in ambiguity and uncertainty regarding input data for system
2. Making it possible to review and determine final cost of product in modern technologies and before manufacturing of product with respect to environmental unclear conditions
3. Improving balanced performance evaluation system through removal of ambiguity regarding determination of appropriate evaluation parameters in each of balanced performance evaluation structures and order preference of these indicators and disambiguation of relations and impact of these structures on each other
4. Creation of possibility for more accurate analysis on cost relationships, size of activity and profit under ambiguous and uncertain conditions

##### 5.1.2. Auditing

The second use of fuzzy logic in accounting is related to auditing. The paramount known applications for fuzzy logic in auditing are as follows:

- Improvement in evaluation process of internal controls and omission of the effect of human and personal judgments through design of expert system for evaluation of internal controls and interpretation of its result within the framework of lingual variables and in accordance with procedure of human's processing

- Providing the possibility for detection of fraud and manipulation in financial reporting through enforcing the accuracy at appropriate level within the initial stages of auditing operation and via general information and without need to secret data
- Developing of audit risk assessment system and lack of detection for computation of risk level and value for non- detection and reduction due to human judgments
- Making it possible for conducting more accurately evaluation of principle of significance in financial reporting by designing significance evaluation expert system based on quantitative and qualitative criteria

### 5.1.3. Financial accounting

The financial accounting is the third application for fuzzy logic in accounting. Some of the foremost applications for fuzzy logic based on studied fuzzy researches in financial accounting are as follows:

- More accurately evaluation from assets and liabilities based on current value through removal of existing ambiguities in traditional models of discounted cash flows regarding the amount of cash flows and used discount rate
- Determining the best mechanism for preparation of financial accounting standards to increase the quality of financial reports
- Paying attention to uncertainty and lowering of information acquisition costs through implementation of fuzzy logic in expert systems at enterprises
- Creation of possibility for more precise comparison from similarity facets and difference in accounting standards among various countries and providing opportunities to improve financial accounting standards ([Namazi and Karimi, 2013](#))

### CONCLUSION

Utilization of artificial intelligence has created dramatic enormous development in domain of accounting and financial activities and this trend will continue. Human's brain is the most complicated existing and known structure throughout the universe. Inspired from neurologists' findings, artificial neural networks and using knowledge and awareness from financial experts and compositing that factor with modern technology, it is possible to purpose a group of experts' knowledge and experience to non- expert investors within software formats and to play noticeable role in enhancement of investors' decisions.

Due to high capability and unique flexibility, genetic algorithm is capable to cover wide range from accounting and financial activities related issues and subjects and it has justified typically taking of the extra-disciplinary title for itself in detection of fraud within financial statements and prediction of bankruptcy and selection of portfolio.

Today, this technology is utilized more than ever as a tool for decision making by successful managers and organizations so that of course the resultant findings from their application (e.g. proper decisions, time savings, flexibility, improved quality, efficient training) have added to its popularity. If this technology is appropriately merged with other smart technologies then it is possible to add daily to cases of their application in various files and to be benefitted from their advantages.

### REFERENCES

- Anonymous. Acquaintance with computational intelligence. Mihan SEO, Computer Applied Essays, 2010a.
- Anonymous. What is swarm intelligence. Robotic Expert Website 2010b.
- Chuan CH, Lin W, Huang H. Swarm Intelligence Solution for Financial Roadshow Documents. *Advances in Swarm Intelligence Volume 2011*;6728:616-625.
- Hadi M. Neural Networks. Portal for management scientific essays 2012.
- Hatami Rad A, Shahriari HR. Techniques and strategies for fraud detection in E-banking. *Economic News* 2005.
- Kalateh RF, Chehardah Cheriki M. Artificial intelligence and its use in accounting and financial activities. *Kankash* 2006.
- Kumar S, Thulasiram RK, Thulasiraman P. Ant Colony Optimization to price exotic options. *IEEE Xplore* 2009a;pp:2366-2373.
- Kumar S, Ruppa K, Thulasiraman P. Ant Colony Optimization for Option Pricing. *Natural Computing in Computational Finance* 2009b;185:51-73.
- Mahdian SH, Nadaf L. Accounting and statics in Fuzzy Systems. Aftab Press 2007.
- Marinakakis Y, Marinaki M. Ant colony and particle swarm optimization for financial classification problems. *Expert Systems with Applications* 2009;36(7):10604-10611.
- Masihabadi A, Abdollahi A. Concepts and applications of genetic algorithm in accounting. *Economy, accounting knowledge and research* 2009;(17-24):64.
- Mobasher MA. What is neural network. Persian blog 2008.
- Najmeddin N, Nematizdeh S. Genetic algorithm application in prediction of bankruptcy.

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- Accounting, Financial Activities, and Investment National Conference, 2012.
- Namazi M, Karimi M. The review on applications of Fuzzy Logic in accounting. Alborz Professors Scientific and Cultural Center 2013.
- ONeill M, Brabazon A. financial credit-risk assessment. IEEE Xplore 2008;pp:3087-3093.
- Rayati Shovazi A, Abzari M. The position of AI technologies in the field of financial management and investment. 2<sup>nd</sup> International Conference of Financial Advisors and Directors, 2013.
- Wikipedia. Swarm Intelligence 2013.
- Zarei MA. Artificial Intelligence AI and AI application in accounting and financial activities, accounting world, 2011.