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ScienceDirect

Procedia - Social and Behavioral Sciences 195 (2015) 1477 – 1485

Procedia Social and Behavioral Sciences

World Conference on Technology, Innovation and Entrepreneurship

Artificial Neural Network and Agility

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Abstract

Data collection and analysis are now part and parcel of virtually all research carried out in economics, politics, technology and medicine. As operations and calculations improve in line with emerging technologies, it is now possible to carry out forward mathematical modelling based on basic criteria by utilizing such technologies. "Artificial Neural Networks and Agility" is a significant area of application making this modelling a viable reality. As artificial neural networks model the human brain, they are capable of providing reasonable solutions quickly for problems which cannot be solved by classical programming. Therefore, their use is widespread and has achieved successful results. This study examines artificial intelligence, artificial intelligence techniques, artificial neural networks, as well as their basic structure and agility.

Peer-review under responsibility of Istanbul Univeristy.

Keywords: Artificial Intelligence, Artificial Neural Networks, Agility

1. Artificial Intelligence

Artificial intelligence is a computer programme designed to acquire information in a way similar to the human brain. Artificial intelligence, a compound of neural networks, was developed as a result of research on cognitive talent and machinery design (Kutsurelis, 1998). The history of artificial intelligence dates back to Aristo. It is known that Aristo worked on the algorithm of thinking and also discussed its difficulties. In a modern sense, artificial intelligence was introduced to the scientific world when the first computer was invented in the 1940s and Alan Turing developed the first software (Bilge, 2007). Artificial neural networks, the most significant sub-segment of artificial intelligence, is a statistical approach created to develop prediction models. Artificial neural networks consist of processing devices similar to the design in the human brain and data processing (Blackkard & Dean, 1999). The first study on artificial intelligence was conducted by McCulloch and Pitts in 1956 through a calculation model based on logic modelling - which made use of artificial nerve cells, physiology and Turing's calculation notion. The studies by McCulloch and Pitts are logic-based and they are considered the pioneers of the connectionist movement.

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Peer-review under responsibility of Istanbul Univeristy.
doi:10.1016/j.sbspro.2015.06.448

They suggested that skills-learning may be assigned to the network structures by making logical processes through networks of nerve cells. The first initiative for creating artificial neural networks that could learn was made by Hebb (1949). In order to change the power of connection between nerve cells, Hebb made it possible to apply artificial neural networks to the system through a rule hypothesis. McCarthy, who continued his studies at Princeton University made SNARC, the first computer based on an artificial neural network, with Edmonds in 1951. At a workshop held at Dartmouth in 1956, the term artificial intelligence, suggested by McCarthy, was used for the first time. In 1969, programmes in certain areas of expertise in the books called *Perceptron* published by Minsky and Papert resulted in the rebirth of artificial intelligence. When professional systems were developed in the 1980s, they started to be used in a wide range of fields from engineering to business management to economics (Akın, 1997). Artificial intelligence experts estimate that by 2025, the sublimit for the total calculation capacity of a 100 billion-neuron-connection simultaneously working in the human body will have become 10 quadrillion. As for the memory capacity, total capacity becomes 10^18 if each of 100 trillion connection is assigned with a capacity of 10.000 bit information storage. It is estimated that the price of a computer with the functionality of human brain will be 1000USD by 2020. The memory capacity of a 1000-dollar computer will be equal to the memory of 1000 people in 2030, and it will be possible to purchase brain power greater than all people in the world for 1000 dollars in 2050.

1.2.Artificial Intelligence Techniques

Expert Systems

Expert systems, one of the most important areas of artificial intelligence implementation, search for solutions depending on people's area of expertise. The primary areas of application are in medicine and biomedical. Defining, conceptualization, formulation, testing and assessment stages are respectively applied to constitute expert systems (Serhatlioglu & Hardalac, 2009).

Fuzzy Logic

Fuzzy logic, first used by Zadeh, is based on the combination of the superiorities of artificial neural networks such as learning and decision-making (Canan & Yıldırım, 2008). Additionally, fuzzy logic-neural networks are also one of the best methods for time-sequence calculations. During this calculation, networks based on the back prop approach are used (Zimbra, Saidane & Ghiassi, 2004).

Artificial Neural Networks

Artificial neural networks are systems collecting information on samples by artificial neurons brought together in the same way as neurons in the human brain; they are capable of decision-making by using what they learn while encountering problems. Briefly, they are network structures created by connecting artificial neurons through various connection geometries (Emel & Taskın, 2002). After forming network structures, visual inputs are classified to reach a conclusion (Simard, Steinkraus, & Platt., 2003).

Multi-Layered Detectors and Learning Algorithms

As processors in a layer are connected to processors in another layer, multi-layered detector model consists of several layers including an input and one or more outputs. The reason why this model is widely used is that many teaching algorithms can be used while training this network (Emel & Taskın, 2002).

Genetic Algorthim

Using the information of purpose function and functioning by coding clusters of parameters, genetic algorithm is a probabilistic method based on natural genetics and the natural selection mechanism. Mechanical learning, economic and social system models, information systems are fields of its application (Emel & Taşkın, 2002).

1.3. A History of Artificial Neural Networks

The 1970s were a milestone for artificial neural networks. The first artificial neural network was created by McCulloch, a neurologist and Pitts, a mathematician. McCulloch and Pitts modelled a neural network with electric circuits, based on the calculation capacity of the human brain. When Rosenblatt developed Perceptron in 1957, studies on artificial neural networks accelerated (Etikan, Cumurcu & Celikel, 2009). With regards to artificial neural networks, the Self-Organizing Map was developed by Kohonen in 1982 (Dostal & Pokorni, 2009, p. 1). Broomhead and Lowe developed radial based functions in 1988. Other models developed later were used in computer systems and many other areas (Etikan , Cumurcu & Celikel, 2009).

1.4.Artificial Neural Networks

Artificial neural networks are developed by modelling the human brain, to which they are similar in two ways. First, information is acquired by networks in artificial neural networks. Secondly, connections between artificial neurons are used to store information. In artificial neural networks, the artificial network is a processor used to store information and to make it functional (Gelir, 1994). Artificial neural networks consist of the combination of constant non-linear functions (Chenoweth, Obradovic & Stephen, 1996) and the authority of neural networks express the capacity of neural networks (Krose & Smagt, 1996). Artificial neural networks, a simple copy of biological neural networks, have very impressive results despite the superficial connections between artificial neural networks. Artificial neural networks have been used in many areas (Gelir, 1994). Information technology units available in artificial neural networks might look like the neurons in the brain and neural networks consist of many information technology units which are inter-connected. Information processing units receive inputs from several different units and output is distributed to the other units as inputs (Emir, 2013).

Artificial neural networks include input layer, hidden layer and output layer.

Input Layer: It is the layer in which input data groups are introduced to the network. Parameters in input layers have to be selected before analysis (Blackkard & Dean, 1999). The number of neurons in an input layer is equal to the number of input data; every input neuron is transmitted to the next layer – which is the hidden layer.

Hidden Layer: The hidden layer is the basic function of the network. In this layer, data received from the input layer is processed properly and then transmitted to the output layer (Dag, 2012).

Output layer: Learning takes place in the output layer. Linear units are connected to the output consisting of hidden layers (Abdi, 2003). It is the final layer in the network and it processes the data received from the hidden layer and creates the output. The number of neurons is equal to the number of outputs received by the network. Values obtained are the output values for the problem in the artificial neural network (Dag, 2012).

1.5. Features of Artificial Neural Networks

1) Non-Linear: Artificial neural networks emerging from the combination of cells are nonlinear and this feature of theirs is spread throughout the network. Artificial neural networks are the most significant tool to solve complex non-linear problems.

2) Fault Tolerance: In artificial networks, fault tolerance is quite high. The reason why artificial neural networks have fault tolerance is that information is scattered around the system in a regular way.

3) Training: Neural networks in artificial neural networks adjusted for a purpose modify their own values and are capable of adapting themselves for the exact solution of the problem.

4) Learning: In order to obtain the data required, algorithms are identified by adjusting the load of ANN (artificial neural networks). This process in which the load is adjusted is called “learning” (Gershenson, 2003). The process of learning is the process defining the relation between the system inputs and outputs. In order for artificial neural networks to learn a problem, input and output data must include sufficient samples as well as a clear definition of the learning cluster.

5) Generalization: Through generalization, artificial neural networks are capable of creating the desired response during the training process – with regard to samples it has never encountered, after studying and learning the problem.

6) Memory: In artificial neural networks, connection loads are the types of memory and memory is distributed by creating local memories. Load values of artificial neural networks represent the information available in the network right at that moment.

1.6. Artificial Neural Networks and Biological Nerve Cells

In order to analyse artificial neural networks well, it is essential to know the structure of biological neural networks constituting artificial neural networks as well as their functioning. The human brain is a mechanism controlling the activities in the human body through billions of nerve cells (neurons) that have a complex relation with one another. In a human brain, there are more than 10 billion nerve cells and each cell is interconnected with an average of 10,000 cells. Within nerve cells are neurons, by which signals are transmitted as vibrations up to 1000 per second which are formed by a chain of very complex electro-chemical events. A typical nerve cell in this mechanism collects signals from the neighbouring cells through capillary pathways called dendrites and transmit these signals to the brain via axons – a long and slender extension of a nerve cell with thousands of branches. At the end of each axonal branch, there is a knob called a synapse. These knobs transmit the signals they receive from the axons to the brain. Thanks to the signals (data) transmitted to the brain, learning takes place. The biological neural system is a control centre receiving and interpreting information and making decisions accordingly. This control unit consists of reception and reaction nerves. The neural systemis critical that ensuring that human being is capable of understanding all behaviour as well as his surroundings (Karahan, 2011).

In artificial neural networks, the artificial neuron is a model inspired by natural neurons.

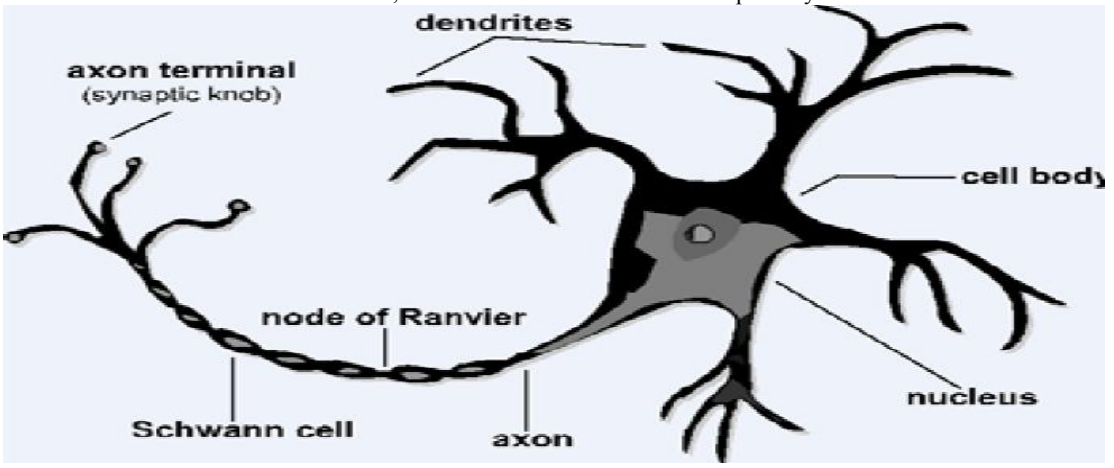

Figure 1.1 depicts a nerve cell consisted of synapse, axon, soma and dendrites.

Resource: bilgisayarkavramlari.sadievrenseker.com

Natural neurons receive signals through a synapse on the dendrite or membrane. Neurons distribute these signals when the incoming signals are strong enough. Signals may also be sent to another synapse and activate the other neurons there (Gershenson, 2003). The nerve cells shown in Figure 1.1 above are called “neurons” in the medical literature. The neuron is a basic processor receiving stimuli from the biological system, interpreting and converting them into fine outputs. Neurons are very special cells equipped with cellular information as well as particular talents such as processing and transmitting this information. When neurons receive sufficient stimulation, they immediately react to an electrical stimuli coming from an axon (Karahan, 2011). Artificial neural networks (ANNs)consist of traditional network compounds such as feed forward connections and linear functions (Kramer, 1991). Neural networks have two basic disadvantages. These are local minimum convergence and slow learning speed (Castillo, Guijarro-Berdinas, Fontenla-Romero & Alonso-Betanzos, 2006). Based on their architectural structures, ANNs can be subjected to various classifications such as feed forward networks, feedback networks, memory based networks, radial based networks and module artificial neural networks. Of these network structures, the ones most commonly used in literature are feed forward networks and feedback networks: Perceptron and adaline (adaptive linear neuron). The most important feature of feed forward networks is that they are capable of detecting fake or missing data before the processing is concluded (Benell &Sutcliffe, 2003). Unlike feed forward networks, dynamic features of the network is significant in repetitive networks. In some cases, the activation values of the units go through a process of relaxation. In other applications, the change in the activation values of output neurons is important. Thus, dynamic behaviour creates the output in the network. In feed forward networks, data flows from input units to output units. Data processing might be expanded to the layers of the units; however, there are not any feed forward connections available –

that means, connections spread from the outputs of the units in the same layer or previous layer to the outputs of the units (Kurkcu, 2013).

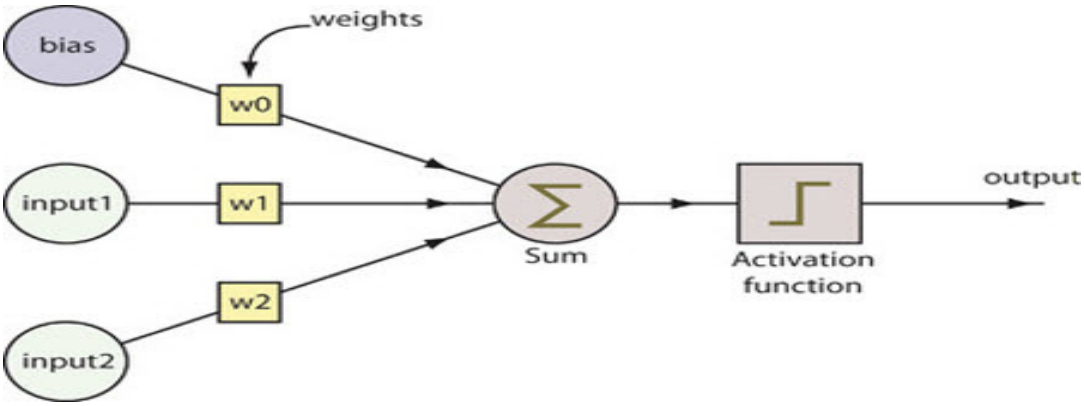

Figure 1.2: General Block Structure of ANN

Resource: chip.com

In figure 1.2 (x_i:i = 1……m) refers to the processor of input layer, ($w_{1;}$ 1……m) refers to the load of connection with hidden processor, ∑ refers to deviation function, y refers to the processor of output layer. V and φ (-) refers to the load of connection with the output processor.

2. Agility

Companies in developing and developed countries are aware that agility is a must in order to meet the competitive factors and environmental pressures. Agility in global markets has been defined as a capacity to work in a profitable way with renewed changes in a global competition environment (Boehm & Turner, 2003, p.16). Agile entrepreneurship makes it possible to shift from one task to another and through unexpected variables; it offers short delivery times, high quality and low-cost. Therefore, in addition to several basic variables introduced by globalization, business enterprises in the market change more rapidly and variables such as innovation, flexibility and efficiency ease the advancement of enterprises (www.codecentric.com, 2010).

In the software industry, agile software emerged as an extension of plain approaches developed to boost manufacturing efficiency in the 1950s. Although it is possible to find various approaches on agility in the software world since the 1970s, the use of agile software methodologies accelerated in 1990s, and for nearly the last decade , it has proven its success and become popular all around the world. Currently, software companies the world over have developed agility approaches for many software projects (Evans, 2002). Agile manufacturing is the capacity of responding quickly to global markets with high quality and low cost. Agility aims at coping with uncontrollable terms emerging from constant changes in all areas where an enterprise exists such as all markets, manufacturing technologies, information technologies and enterprise relationships. The purpose of agility is to meet the demands within the time set by forming an organization to manage the uncertainty by using manpower and information. As for the companies themselves, the ones who are agile realize the largest profits by analysing the risks and opportunities in the global market.. By utilizing these methods, it is possible to achieve brand recognition, increased revenue and profitability. The e-commerce sector, in particular, is an important sector in terms of achieving the most efficient results for agile enterprises, thanks to its constant and rapidly growing dynamic structure. For the e-commerce sector, the essence of success is the dynamism, speed of change and innovation in the sector (Ustasuleyman, 2008). The establishment of self-managing teams capable of actualizing their ideas rapidly is the essence of agile methods, and it offers significant opportunities to the companies in managing the new generation, such as the feeling of possessiveness, increasing efficiency and decreasing turn-over. In Turkey and globally,, companies such as Groupon and Yemeksepeti have observed that they increased their efficiency and decreased their costs to a great extent as a result of agile transformations.

Moreover, in order to increase efficiency, the agile approach is not only being used for IT and software teams but also for non-technical departments.

- Google increased its productivity 180%.
- Yahoo increased its efficiency 35%.
- Ambysoft decreased its costs 72%.
- Salesforce.com increased its frequency to launch products 65%.
- 85% of Microsoft teams use the scrum method.[1]
- Version One increased its flexibility 87% (Akdag, 2014).

2.1.Principles of Agility

The basic principles of agility are individuals and the interaction between them, customer relationships, , and adapting to change (Pixton, 2013). Projects are developed gradually through iteration and thus it is capable of creating frequent outputs in very brief cycles. Agility focuses on channelling the source to the customer's needs and to the result. The description of quality aims at meeting the customer's demands for the product. Risk is kept at a minimum level due to iteration and maximum interactions (Erdil and Erbiyik, 2013).

When the managers and employees are asked to describe failure within enterprises, the five most common responses are:

- Having poor customer contact;
- Poor requirement analysis;
- Unrealistic schedules;
- Lack of change methodology;
- Insufficient assessment;
- Processes closed to change, or drawing more attention than the product.

Agile approaches try to overcome these problems. When it comes to failure, it is obvious that better and more varied methods are required. Agile methods respond to these issues. As such, the client is king. In order to strengthen client relations, the client has been transformed into a part of the team and this approach determines client requirements. Before the code is written, acceptance tests are written in a way which can be clearly understood by the client. This deeply impacts the process of collecting requirements and thus makes it difficult to make estimations as well as to plan. Schedules are not set by themselves; they are set by the team. In order to solve the problem, project estimations and schedules are prepared with the participation of the product and development teams. At the beginning of a project, the effort required to add a group feature to a product is measured by the product team and then it is submitted to the assessment development team, which in turn is asked to revise the product and to provide a feedback. Both teams work together until they reach an understanding and prepare a schedule. As the conclusion is received as a result of team work, it becomes easier to accept, resulting in greater motivation. Deadlines never change; In order to cope with the problem of change management, agile methods insist that everyone accepts the fact that "change will happen". That the delivery time requested by the client must also be accepted. In order to work around the absence of testing, assessments are written before writing codes and by doing so, codes are tested. For each code change, relevant automatic codes are run and problems can be realized earlier. Management is not an independent activity; A considerable number of management functions are undertaken by the development team. For instance, a team deals with setting schedules, making predictions, and determining the features to be added to the product (www.fdnsoft.com, 2014).

2.2. Artificial Neural Networks and Agility

In today's business world, with an ever-increasing need for profitability and efficiency, the terms of competition terms and market dynamics change rapidly and naturally Accordingly, it is now needed more than ever to have all business processes keep up with this dynamism. Within the framework of adjusting to this dynamism, agile management methods will perfectly meet the changing business demands since they reveal practical and profitable products and/or results in a rapid and constant way. In agile methodology, all short-term and product-focused project processes for the operational profitability and efficiency of the organizations include all the functional managers, experts, project team members and mid-level managers. Agile management manages

[1] Scrum is a way for teams to work together to develop a product. Scrum methodology is most commonly used in software development. The Scrum process is suited for projects with rapidly changing or highly emergent requirements. Scrum software development progresses via a series of iterations called sprints, which last from one to four weeks.

the changes emerging in project processes harmoniously and ensures that rapid, profitable products and results are created. So as to meet the current business demand, it is a requirement to release products (and/or results) in a constant and rapid way, within short cycles. Agile management ensures that active, agile, profitable and product-focused management has an interactive format via applications, workshops and best-management practices (projeegitimmerkezi, 2014). It is a must for institutions and enterprises to adopt a more flexible approach in their projects and to become more agile in a constantly changing world. Nevertheless, flexible agile approaches might be perceived as daunting or risky for certain institutions which base their projects and programmes on a specific system. Mature agile approaches (agility within the concept of delivery) are required for these project-focused institutions. In addition, agility also offers rapid improvement, change and authorization skills for the team.

For the managers, the advantages of the agile approach to ensure managing successful agile projects are as such:

- In comparison to traditional projects, it teaches different management styles and how to adopt them to different projects;
- It ensures that there is active trust and cooperation between business executives and developers in the corporation and it creates transparency in the work done;
- By combining agility and traditional management methods, it provides a better adaptation to the business environment;
- By encouraging feedback and efficient control, it accelerates results and thus brings frequent success to management.

Advantages for companies include:

- It provides a less risky and rapid change with a low-cost;
- It increases visibility and elaboration in the company management;
- Instead of developing agile management processes tailored for the company, it ensures that a tested approach is used;
- Project budget offers adaptation to control, and project plans on the projects as well as better communication; without ignoring the period and scope (makronorm, 2014).

The primary purpose of artificial neural networks and agility provides rapid, flexible and integrated design, production and service for complex products in expanded and globalized supply chains. They also help develop mechanisms which will ensure the sustainability of the enterprise organizations in uncertain conditions and which will restructure their activities in accordance with the unexpected market conditions and increasing market uncertainties. In addition to the changing technological innovations, it is considered critical to use artificial neural network technologies so as to offer rapid product design, product and process development simultaneously. It is also t is important to use and to develop reorganized agile entrepreneurship application systems in order to boost aesthetic, as well as to have performance optimization and to improve the adjustment skill of artificial neural networks and agility systems in uncertain conditions. It is being applied to several areas such as optimization of product systems, product analysis and design, quality analysis of products (integrate, paper, resource etc.) and control, planning and management analysis (Karahan, 2011).

There are a number of areas of application for artificial neural networks. Such as:

- Statistics and Economics: ANNs have been used in statistics and economics since estimations on time series are frequently used in classification (Vriend, 1994). Corporate investors making transactions in the world's stock markets and especially in Wall Street have recently focused on implementing artificial intelligence (AI) and AI techniques for their own portfolios and for the estimations on the general tendency of economics as well as basic indicators. AI-based software used in investment planning is kept classified by the relevant institutions mostly. These financial corporations have their own IT experts who prepare a software tailored for their company and they never leak any information outside the company (Seker, Yildirim, & Berkay, 2004).

- Insurance and Finance: In the banking sector, they can be used for developing credit applications, for customer analysis, for credit application assessments, and for the estimations on budget investment. Additionally, they are also used for product optimization, development of application policy, valuation, analysis of market performance, budget estimates, targeting, and estimation methods (Karaatli, 2003).

- Space, Automotive and Correspondence: As a system to analyse and to detect failure, ANNs are capable of learning the regular and proper way of functioning for a system, a device, or a component. Thus, they are capable of detecting any possible breakdowns in a system. As a result, ANNs are used in the failure analysis of electrical machinery, planes or their compounds as well as integrated circuits. They are being implemented in the automation of the defence industry, weapons and target monitoring, detecting and differentiating objects/visuals, new detector designs and noise prevention (Duji-ene, 2004).

- Medicine: Professional medical systems have been developed to provide an answer for the structural problems in medical areas. Professional medical systems are developed upon the recommendations of one or more medical experts. The purpose of professional medical systems is not to replace physicians, rather to make suggestions and provide advice based on patient data. They have several areas of application, such as the analysis of medical signals like EEG and ECG, analysis of cancer cells, prosthesis design, optimization of transplantation timing and optimization of hospital costs (Demirhan, Kilic, & Guler, 2010). Chemical engineering, construction and structural engineering, electrics and electronics engineering, manufacturing and machinery engineering, systems and control engineering are additional fields of use.

3.Conclusion

Due to the dynamic structures of the global economy, developing information technologies, the complexity of data in decision-making mechanisms and their interrelationships, new techniques are needed to be far more efficient in problem-solving than traditional decision-making processes. In order to meet the need, parallel processing mechanisms mimicking the human brain, eliminating uncertainties, and maximizing efficiency have been developed gradually. Agility can meet expectations by constituting an organization that will manage uncertainty by using manpower and information. As for companies, the ones who have the largest profit by analysing the risks and opportunities in the global market are considered agile. The establishment of self-managing teams capable of actualizing their ideas rapidly is the essence of agile methods, and it offers significant opportunities to companies in managing the next generation through such feelings as possessiveness, increased efficiency, etc.

Artificial neural networks are created by mimicking biological neural networks in a computer environment. ANN is an algorithm capable of processing and learning like a brain, accepting constant data input, and seeking conclusions by using current information in case of insufficient data, . Since they are computer systems that can derive new information through learning, constituting new information and discovering without assistance, they both lead the way for new developments and contribute to research on how the human brain functions, which remains to be fully understood. In addition to solving various problems including information classification and information interpretation, they are also successfully applied instead of current available methods in medicine, finance, manufacturing, training and engineering. When the key features of agility and artificial neural networks are considered, it is seen that they are structures offering creative and talented employees, coordination skill for concurrent activities, proactive approaches, existence of technological information, a rapid adaptation skill to the information obtained by the enterprise, diversification and personalization approach, a structure with a developing authorization and cooperation feature, an approach to realize opportunities and constant learning. The common ground for artificial neural networks and agility is that they encourage feedback and efficient control; they provide rapid results and they offer success for management. They offer lower risk, less cost and more rapid change. In order to keep up with change, globalized supply chains require enterprises to be free from their bulky organizational structures. They should switch to flexible organizational structures with a faster and more efficient decision-making mechanism so that they can provide rapid, flexible and integrated design, manufacturing, and service of complex products.

The fact that academic research focuses on artificial neural networks and agility in our country and on developing solutions via these methods such as classification, estimation, data conceptualization and solving control problems is certainly going to make a great contribution to the field in our country. Thus, it can be ensured that our country is represented in the world literature with a sufficient number of studies and that it is equipped with the new technologies of the new millennium.

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