Exploiting the Intelligent Bio-inspired Computing (IBioC) for e-Business

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Abstract: - Intelligent Bio-inspired Computing (IBioC) has emerged as a powerful paradigm in e-Science. BioC is a sub area of research of artificial intelligence technologies. IBioC provides both of software and knowledge engineers a robust methodologies and techniques to develop smart applications for e-government tasks. This paper explores the different IBioC paradigms used in developing smart e- business systems. Our analysis includes the following biological paradigms; artificial neural networks, genetic algorithms, support vector machines, and swarm intelligence. The results prove that, e-business systems based on the Bio-inspired computing approaches are characterized by smart behavior , such as high efficiency, reasoning and learning abilities, from the knowledge engineering and computing perspective.

Key-Words: -Bio-inspired Computing, artificial neural networks, genetic algorithms, support vector machines, and swarm intelligence, e- business, artificial intelligence, knowledge engineering.

1 Introduction

Intelligent Bio-inspired computing (IBioC) is related to the field of artificial intelligence (AI) and machine learning techniques [1, 2]. IBioC relies heavily on the fields of biological sciences, mathematics and informatics. Briefly put, it is the use of computers to model the living phenomena, and simultaneously the study of life to improve the usage of computers. Biologically inspired computing is a major subset of intelligent natural computation [1,28,29]. On the other side, knowledge and software engineers have pondered the significance of biology for their field. For example, computer scientists have explored the use of Deoxyribon Nucleic Acid(DNA) as a substrate for new computing hardware and the use of biological paradigms in solving hard computing problems.

E-business is a complex term encompassing deployment of innovative information and communication technologies (ICT) throughout an organization and beyond, through links to partners, suppliers, intermediaries, and customers. E-business includes many processes – not only buying and selling products and services, but also processing payments, servicing customers, interacting with business partners, etc. [6]. Researchers like Wallace[7] add to the participants in e-Business governments or nonprofits too. Summarizing the E-Business is buying, selling, delivering, marketing, servicing, and paying for products, services and information across networks linking an enterprise and its customers, partners, suppliers, agents, prospects, competitors, allie and complementors.

In this paper we focus our discussion around the Intelligent Bio-inspired computing(IBioC**)** methodologies and techniques for developing the intelligent e-business systems. Section 2 gives a brief overview of the field of e-business. Sections 3 presents four IBioC approaches, namely; artificial neural networks (ANN) , genetic algorithms(GA),Swarm intelligence (SI) , and Support vector machines(SVM) . Section 4 presents knowledge Computing Approaches versus IBioC Approaches. Section 5 discusses our analysis of intelligent Bio-inspired computing paradigms for e-Business tasks. Finally, section 6 presents the conclusions and future planes.

2 e-Business Technology

E-business covers all aspects of business, which relay on the use of IT and networks. Comparing e-business and e-commerce, most authors emphasize that E-business is a somewhat broader concept[3,4]. In addition to the buying and selling of goods and services, E-business refers to servicing customers, electronically communicating, discovering information, collaborating with business partners, delivering e-learning, performing electronic transactions within an organization, e-government, social networks, and far more[5,6].E-business links value chains across businesses, involves new technologies in the value chain, reduces costs, and improves business efficiency.

On the other hand, e-business technology is very complex and varied involving many activities, organizational units, and technologies [7]. It includes many E-business applications. To perform these applications, organizations and companies need an appropriate infrastructure and support areas. These support areas are the following: people, public policy, marketing and advertising, support services, business partnerships.The new developments, maturation and growth of E-business continue. One of the main prerequisites for this is the relentless evolution in technology and new commercial approaches, which exploit it[6]. The latest trends in recent years in E-business are related to the growth of social media phenomenon and especially of social networks Facebook, Twitter, Google+, etc. and the use of mobile technologies and conducting E-business via mobile devices[7,8].

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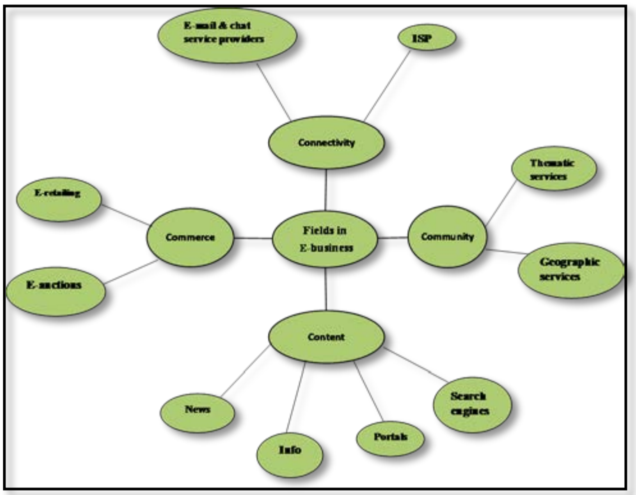

Fig.1 e-Business fields and applications

3 Overview of Intelligent Bio-inspired Computing Paradigms

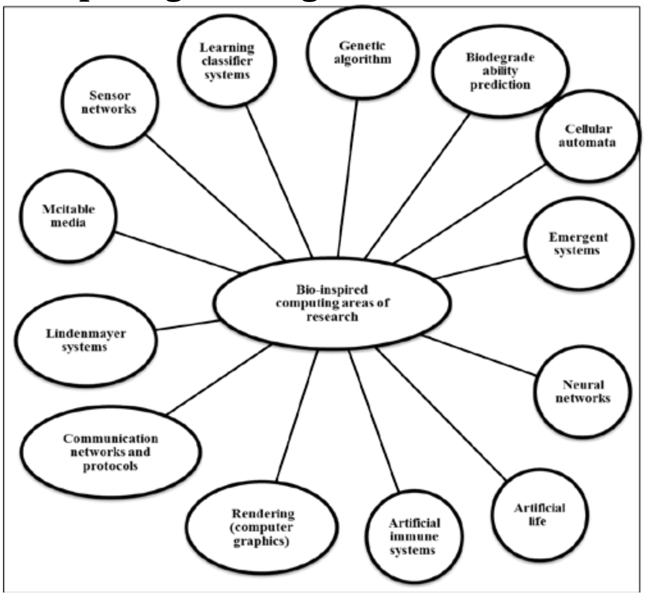

Fig.2 Research areas of intelligent bio-inspired computing.

3.1 Artificial neural network (ANN)

Natural Neural Network (NNN) is an interlinked collection of neurons inside an animal (your brain for instance). Artificial neural network ANN is a linked collection of simple processing units, inside a computer. Neuro-computing (or Connectionism) is the study of ANNs. Neuro-computing does borrow some ideas from the neurophysiology. Neuro-computing concerned with producing effective computing systems(30,31). ANNs are systems composed of processing nodes each of which performs a simple function but which together can be trained to perform quite complex input-output mappings. The processing's nodes are loosely modelled on real neurons and they can, at least in theory, operate in parallel.A biological neurons receives signals through synaptic regions at its dendrites; the input signal is carried by the incoming (afferent) dendrite to the body of the neuron, and the signal levels are combined at the axon hillock to transmit an output along the outgoing (efferent) axon to the dendrites of other neurons (see Fig 3).

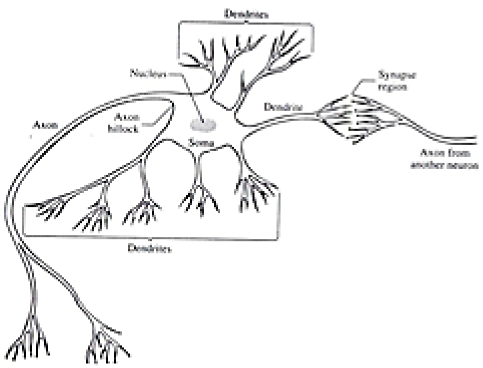

Fig.3 The concepts of Biological neurons

On the other side,ANNs consists of lots of artificial neurons. These neurons, or processing's nodes, compute a simple function of their inputs y =f(x) and pass it on as an activation signal to other neurons to which they are linked.This activation is typically a real number in the range 0 to 1 (

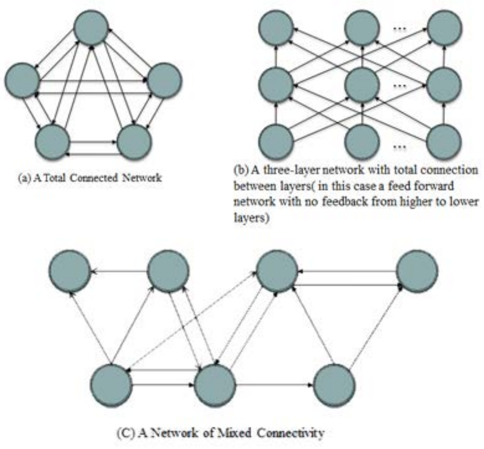

Fig. 4: Artificial neurons are modelled on biological neurons.

sometimes -1 to +1). Each node typically computes a weighted sum of its input vector (x) and applies a non-linear transfer function (e.g. a step- function, a ramp-function or a sigmoid) to that sum. The Significant point about ANNs is not so much the elements of which they are made up but the way in which those elements are interconnected. The idea is that the most important attributes of neural computing systems arise as emergent properties when many processing nodes work together. Nodes present their output signals, typically in the form of voltage levels, to other nodes. Many topologies are possible as shown in Fig. 4. In this figure, the arrows indicate the direction of the signal flow.A very large number of neural network types exist, and new ones are being added every week, but one architecture has become so common that it deserves to be called a connectionist cliché-the multi-layer perception.This extends Rosenblatt's original design in two main ways;

(1) It contains "hidden" neurons which are intermediate between a layer of input neurons and a layer of output neurons.

(2) The neurons apply a sigmoid or logistic function totheir summed input vector rather than a step function.

3.1.1 ANNs characteristics

ANNs are pattern associations. ANNs learns to associate inputs with outputs, by tuning ashallow model with many degrees of freedom to match the input-output relationships found in a training database. The inputs are usually vectors of numbers, interpreted as measurements on a single object or event; the outputs areusually vectors of numbers ranging from 0 to 1; interpretedas probabilities.

(1) They are strictly segregated into layers.

(2) As well as an input and an output layer, they also have 1 or more hidden layers.

(3) Neurons are fully connected between layers.

(4) Neurons are unconnected within layers.

(5) They operate in feed-forward mode only, i.e.activation signals only pass from a given layer tothe next nearer layer to the output.

(6) A sigmoid transfer function is used throughout.

(7) They are trained using back-propagation.

It should be noted that most of these features are in fact limitations which are imposed upon ANNs to make them suit the back- propagation training algorithm.

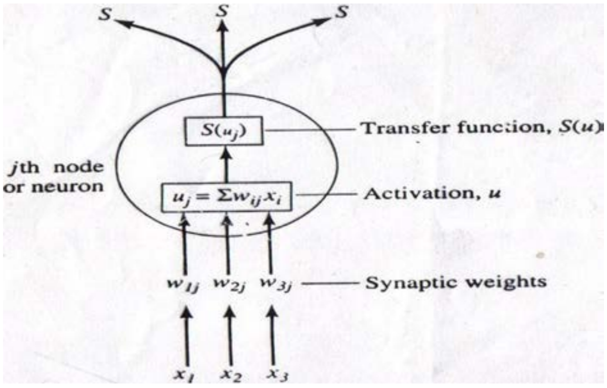

Fig. 5 The standard diagram of a generalized node in an artificial neural network

Fig. 5 shows a diagram of a generalized node in an artificial neural network,where the jth node receives inputs (Xi) from other nodes. Each of these is multiplied by the corresponding synaptic weight, (Wij),and the resulting products are summed within the jth node to produce the activation, Uj The activation is transformed to produce the node's output Signal, S(uj). Various functions can be used to transform a neuron's internal activation, u into its output, S. Shown here are a step Function, a linear transfer function, and a family of sigmoid (S-shaped) curves. The equation shown in the figure is that of a logistic function, but there are also other functions that are used to generate sigmoid shapes. Whatever the function generates them, at the extremes the sigmoid can approximate step or linear functions. The sigmoid transformations belong to a class often called squashing functions, because they accept inputs over a theoretically infinite range.

3.1.2 ANN Training Procedures

Numerous learning algorithms have beenproposed for ANNs. Most of them, including the commonest namely back propagation, operate by adjusting the weights on the links between neurons. The trouble with back propagation is that (1)it is slow and prone to stick at what are called " local optima". (2) Hard problems often need tens of thousands ofdata presentations before this learning algorithm attains of tolerable level of performance. Back propagation requires that the network structure be fixed in advance : training alters weights on likes between neurons, but it leaves the topology of those links intact .the user must decide how many hidden layers to employ and how many neurons to have in each hidden layer.(No theory exists to guide this decision). Leading-edge research in the area of learningalgorithms is concerned with networks that candynamically re-arrange inter-neuron links during training.

3.1.3 ANN Applicationsin e-Business

In practice ANN have been applied to a wide range of e-business problems, e.g:(a)Finding currency/stock market trading strategies(b) Loan screening(c) Script/speech recognition and (d)Adaptive process control; and many others besides.

3.1.4 Neural Network learns from Experience

Numerous learning algorithms have been proposed for ANN. Fig. 6 shows that a neural network learns from experience.Each neuron multiplies a set of input values by a connection "weight", adds the products of these multiplications, and performs a mathematical operation on the sum. The resulting number is typically fed into another layer or two of neurons, which operate in a similar fashion and produce an output. Initially, the weighting factors are set randomly; during training, the network adjusts these weights. Most of ANN including the commonest namely back propagationoperates by adjusting the weights on the links between neurons.The trouble with back propagation is that it is slow and prone to stick at what called "Local optima".

3.2 Swarm Intelligence (SI)

SI is the collective behavior of decentralized, self-

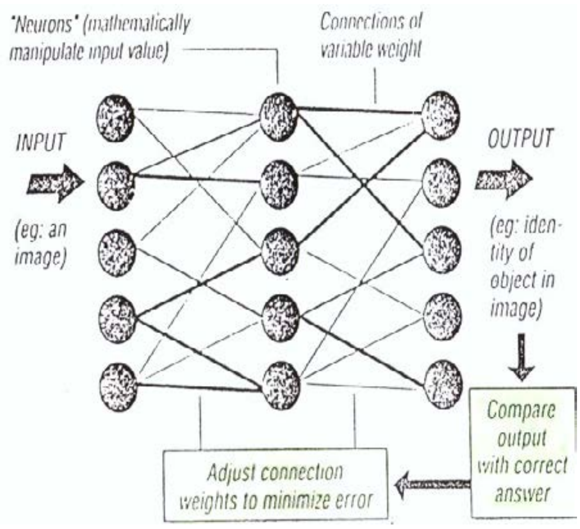

Fig. 6 Learning Mechanism of ANN

organized systems, natural or artificial. The concept is employed in work on artificial intelligence. The expression was introduced by Gerardo Beni and Jing Wang in 1989, in the context of cellular robotic systems.SI systems consist typically of a population of simple agents or boids interacting locally with one another and with their environment. The inspiration often comes from nature, especially biological systems. The agents follow very simple rules, and although there is no centralized control structure dictating how individual agents should behave, local, and to a certain degree random, interactions between such agents lead to the emergence of "intelligent" global behavior, unknown to the individual agents. Examples in natural systems of SI include ant colonies, bird flocking, animal herding, bacterial growth, fish schooling and microbial intelligence.

The application of swarm principles to robots is called swarm robotics, while 'swarm intelligence' refers to the more general set of algorithms. 'Swarm prediction' has been used in the context of forecasting problems.

3.3 Genetic Algorithms (GA)

Many classifications models have been proposed in the literature, such as distributed algorithms, restricted search, data reduction algorithms, parallel algorithms, neural networks and decision trees, genetic algorithms. These approaches either cause loss of accuracy or cannot effectively uncover the data structure. Genetic Algorithms (GA) provide an approach to learning that based loosely on simulated evolution. The GA methodology hinges on a population of potential solutions, and as such exploits the mechanisms of natural selection well known in evolution. Rather than searching from general to specific hypothesis or from simple to complex GA generates successive hypotheses by repeatedly mutating and recombining parts of the best currently known hypotheses. The GA algorithm operates by iteratively updating a poll of hypotheses (population). One each iteration, old members of the population are evaluated according a fitness function. A new generation is then generated by probabilistically selecting the fittest individuals form the current population. Some of these selected individuals are carried forward into the next generation population others are used as the bases for creating new offspring individuals by applying genetic operations such as crossover and mutation.

4. Knowledge Computing (KC) Approaches Versus IBioC Approaches

Table 1 shows very important features and issues regarding the IBioC and the knowledge-based computing approaches which is known as "symbol-based artificial intelligence approaches ".

Table1 KC versus IBioC

Knowledge Computing Approaches	Intelligent Bio-inspired Computing Approaches
Intelligence can be achieved through formal operations on symbol structures	View intelligence as arising from collective behavior of large numbers of simple interacting components
Models emphasize the use of symbols to donate objects and relations in a domain of interpretation	Sub-symbolic models de-emphasize the use to denote objects and relations. (Sub-symbolic models are known as parallel Distributed processing, PDF).
Expert systems are typical examples	Neural networks cellular automata, genetic algorithms, and models based on the thermodynamic behavior of physics materials are typical examples.
Relying upon a single powerful processor	Relying upon large numbers of simple computational units
Computing is constrained to the sequential operations	Computation is not constrained to the sequential operations on data; the units of computations, like biological neurons, function independently.
Represent knowledge explicitly and manipulating it through an inference engine	Represent knowledge implicitly in patterns of interactions between components
Overlay sensitive to noise	Allow reasonable performance with incomplete or noisy data due to the distributed character of knowledge
Programs suffer from the “brittleness” problem, perform perfectly until it fails to perform at all	Programs tend to demonstrate graceful degradation when faced with unusual problems.
Programmed rather than trained	Trained rather than Programmed

From table 1, it can be seen the following important facts;

(1) Neural Architecture is appealing as mechanisms for implementing intelligence for a number of reasons:

- Have more potential for partially matching noisy and incomplete data. *WHY*?

Because the capture Knowledge in a large number offline-grained units

- More Robust. *WHY*?

Because knowledge is distributed somewhat uniformly around the Network

- Provide a natural model for parallelism *WHY*?

Because each neuron is an independent unit.

- Very well suited to solve complex problems. *WHY?*

Because its ability to learn complex and nonlinear relationships.

(2) Advantages of ANN over Knowledge-Based Systems

- Unlike RBS and CBS, the ANN networks; Learns from its mistakes, trained rather than programmed
  and very well suited to solve complex problems because of its ability to learn complex nonlinear relationships
- ANN allows reasonable performance with incomplete or noisy data due to the distributed character of knowledge
- If you don't have an algorithm and an expert system would be hard to build then you should think of using the ANN.

5. Analysis of Bio-inspired computing paradigms for e-Business tasks

During the last five years, there are a growing number of specialized publications and research projects that pay greater attention to the e-activities and technologies(32,33).Based on our scientific analysis of the published results during the last five years, Table 2,3,4,5 how the different roles of the CI paradigms in e-activities for different applications. Our analysis includes the following techniques; artificial neural networks, genetic algorithm, support vector machines, and swarm intelligence

Table 2 ArtificialNeural Networks (ANN)

Author(s)	Application and Tasks
Bhavani, M et al.2003[8]	Classification, clustering, early warning and proactive control Systems.
Pengyu, et al, 2012[9]	Classification early warning and proactive control systems
Ching-Tung, et al. 2005 [10]	Clustering of large database using the exemplar. Power system measurements.
Giorgio, et.al. 2006 [11]	Analysis of web mining applications.
Hailing, et.al, 2008 [12]	Mining the data over the www through-government systems

Table 3 Genetic algorithm (GA)

Author(s)	Application and tasks
Cordón et.al 2001[13]	Search of the optimal translation as a minimization process.
Herrera et.al. 1997[14]	A stabilizing compensator.
Hong et.al. 2006[15]	Automatically extract numerical control rules from the sensor data.
Hou et.al. 1997[16]	Give information pheromone to distribute Quick convergence.
Hong et al. 1999[17]	Analyses the shortcomings of simple GA, simulated annealing GA and immune algorithm.

Table4 Support vector machines paradigm

Author(s)	Application and tasks
Cardoso, et al. 2005[18]	large-scale datasets and classifying accuracy
Vapnik 1999[19]	Classification tasks as bio- or non-bio aerosol
Stitson et.al. 1999[20]	Innovative services to cope with customers' evolving demands and to create customers' value
Weston et.al. 1999[21]	For the general workflow of E-governmentdocument.
Vapnik 1999[22]	Efficient classification tasks.
Yisong et.al. 2003[23]	Detection malware with strong resilience and high accuracy

Table 5 Swarm intelligence paradigm

Author(s)	Application and tasks
Drucker et.al. 1999[24]	Hierarchical task network
Boddy et.al. 2006[25]	To reduce time and cost of testing.
Brueckner et. al. 2000[26]	Hierarchical task network descriptions of constraints
Chen and Decker 2005[27]	Identifying suspicious behaviours in e-government procurement systems

6. Conclusion and Future Work

Intelligent Bio-inspired Computing (IBioC) approaches have been proposed by the knowledge engineers in the context of e- Business applications and technologies. IBioC paradigms view intelligence as arising from collective behavior of large numbers of simple interacting components**.**These paradigms have two very important strengths: (a) they are eminently suited to parallel implementation and (b)they adapt automatically. Exploration of biological computation suggests a potential for insight into the nature of and alternative processes for intelligent computing, and it also gives rise to questions about hybrid systems that achieve some kind of synergy of biological and computational systems. And there is also the fact that biological systems exhibit characteristics such as adaptability, self-healing, evolution, and learning that would be desirable in the ICT that humans use. Moreover, these approaches offer intelligent methodologies, techniques, and algorithms that can help solving problems in a variety of e-business tasks and domains (e-commerce, e-health, e-learning, e-government. e-business,...). These techniques have been successfully used in solving many of the e-business problems. Using such paradigms is well-motivated and has many business benefits .e.g.; (a)the ability to represent, manage and structure the knowledge in specific domain,(b) the ability to optimize resources,(c) the ability to perform efficient performance , and (d) the ability to conduct scheduling, forecasting ,planning, and budgeting. The variety of computational intelligence paradigms/techniques/algorithms enabling the design of a robust e-government applications and systems. On the other side, the convergence of artificial intelligence (AI) theories, e-business sciences and web science is enabling the creation of web-based intelligent e-business technology. As a future work, we have plans to investigate the contribution of other bio-inspired computing paradigms, e.g. ant colony, artificialimmune systems, cellular automata, on different e-business tasks.

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