Editorial

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Bio-inspired computing, and its second ego nature-inspired computing, has been a growing area in both industry and research in recent years. The fascination in imitating natural systems comes from their magical capability of solving complex systems at relatively limited computational requirements. This fascination is not new. One can observe this in AI-life research which has been in existence for years with varying amount of interest, success and failures. This can be seen as the traditional basis of bio-inspired computation (BIC). However, the new field of BIC goes beyond of its traditional basis to formulate a new field of algorithmic solutions to engineering problems. In this special issue, we can see a wide range of techniques and approaches developed from traditional algorithms as well as new algorithms utilising new analogies from natural sciences.

One of the most active new areas in nature-inspired computing is swarm intelligence (SI). The fact that it often presented as a population-based algorithm contributes to the confusion surrounding SI algorithms, which explains why they are often coupled with evolutionary computation algorithms. On the other hand, SI algorithms are true nature-inspired algorithms with analogies from physical particles, insects such as ants and bees, animal herds and even humans. They are also true representatives of complex systems mechanics that are often beyond formalised rational and/or discrete explanation.

The stochastic and distributed nature of SI algorithms made them prime candidates for optimisation problems leading to the metamorphosis of two distinct classes of SI optimisation algorithms, namely ant colony optimisation (ACO) and particle swarm optimisation (PSO). PSO is used by Sheta, Ayesh and Rine in their paper entitled ‘Evaluating software cost estimation models using particle swarm optimisation and fuzzy logic for NASA projects: a comparative study’ to estimate the cost of software projects. Whilst ACO is used by Ghnemat, Bertelle and Duchamp in their paper entitled ‘Modelling spatial organisation with swarm intelligence processes’ to model urban planning processes and services. ACO was also used by Laalaoui and Drias in their paper entitled ‘ACO approach with learning for preemptive scheduling of real-time tasks’ to deal with real-time scheduling, whilst Upendar, Gupta and Singh in their paper entitled ‘Modified PSO and wavelet transform-based fault classification on transmission systems’ provide another example of PSO application to transmission systems within the context of power systems.

Upendar, Gupta and Singh’s paper complements Panda, Swain and Baliarsingh’s paper that is entitled ‘Differential evolution algorithm for simultaneous tuning of excitation and FACTS-based controller’ into showing the application of BIC in the more traditional electrical and control engineering field. They use differential evolution algorithms in tuning a flexible AC transmission system (FACTS) controllers in power systems. Genetic algorithms melted in the pot of evolutionary computation. The description of evolutionary computation may be simplified in a reductionistic fashion to include all stochastic population-based algorithms. Whilst more traditional versions of GA algorithms are still in use with a wider range of applications even in their traditional clustering problem such as the biclustering presented in Sheta, Hany and Mahdi’s paper entitled ‘An evolutionary approach for biclustering of gene expression data’.

In the same spirit of applying the new BIC approaches to traditional applications, Bonyadi and Shah-Hosseini apply ACO to the very traditional salesman problem, one of AI beloved demonstrative problems. Their paper entitled ‘A dynamic max-min ant system for solving the travelling salesman problem’ where the simple functions of max-min are used in controlling the selection processes within the algorithm.

Neural networks built on a rich computational literature on graph theory and graph-based representations, such as semantic nets, cognitive maps, to mention but two. In fact, neural networks approach to cognition led to the connectionism as a very distinctive subfield of artificial intelligence. Returning to the graph-based approaches, Lakel and Djellal in their paper 'Resolving the pursuit evasion problem in known environment using graph theory' use graphs to deal with the traditional evasion problem in robotics. To one surprise, they did not consider cognitive maps that were bio-inspired from extermination on rats and their ability to model spatial information into cognitive maps during maze navigation.

One may say BIC is the nature-imitated solution to complex systems. These complex systems may be ad hoc networks, robotic formations, electrical grids controller, to mention but few. Complex systems are often associated with engineering applications regardless of whether these applications are in manufacturing and dealing with hardware configuration or enterprise systems dealing with software implementation. In addition, engineering solutions are often practical with less attention paid to the philosophical underlying of the solutions or its scientific explanation. Bio-inspired algorithms by their nature are compatible with such endeavour attempted by engineering solutions.

Data mining over large-scale datasets is a good example of knowledge engineering problem where complete solutions are computationally expensive if they are ever possible. When the dataset is large on both dimensions, the number of records and attributes within each record, the complexity of performing a complete search, which is the first step in a simple pattern matching algorithm, is computationally demanding that outstrip most of available computers. If there is a third dimension to the data like in biological data, this processing becomes far too complex for complete search solutions and a stochastic approach is a must. Similarly, when the data provided is rapidly changing and/or has real-time constraints on its validity powerful search algorithms will significantly helps in finding the significant patterns compared to traditional search algorithms. The increased uncertainty factor in addition of the stream of data fed into the system makes it impossible to deal with this data except in a stochastic and dynamic manner.

In this special issue, the papers are representatives of some important areas of BIC and its engineering applications. One may struggle to find two papers covering the exact same area of the BIC field in testament to its extensive reach and wider scope. The innovative algorithms, such as SI algorithms, are giving BIC a progressive dimension needed for sustainability. Furthermore, subfields of development are emerging in the process of defining the field of BIC in a similar manner to that observed in the development of the now larger field of artificial intelligence. Meanwhile, this special issue contributes to this development through a gallery of exemplary papers of the different emerging sub-areas and applications of BIC.