International Journal of Applied Engineering Research ISSN 0973-4562 Volume 14, Number 10, 2019 (Special Issue)

Study of Quantum Motivated Evolutionary Algorithms

Sanjay Singh
Department of Computer Science,
SHRI VENKATESHWARA UNIVERSITY,
Gajraula, UP, INDIA,

Sandeep Gupta
Department of Computer Science Engineering, JIMS Engineering Management Technical Campus,
Greater Noida, UP, INDIA

Abstract —This paper introduces a compact study of another class of metaheuristics, drawing their motivation from both: organic advancement and unitary development of quantum framework. In the initial segment of the paper, general ideas driving quantum-roused developmental calculations have been exhibited. In the second section, a best in class of this field has been talked about and a writing audit has been directed.

Keywords—evolutionary computing, quantum computing, entanglement, Image storage and retrieval. Quantum entanglement

I. INTRODUCTION

Quantum-enlivened developmental algorithm, one of the three principle look into territories identified with the mind boggling cooperation between quantum computing and developmental algorithm, are getting restored consideration. A quantum-roused transformative algorithm is another developmental algorithm for a traditional PC instead of for quantum mechanical equipment. This paper gives a unified structure and an extensive overview of recent work in this quickly developing field. In the wake of presenting of the primary ideas driving quantum-motivated transformative calculations, we introduce the key thoughts identified with the large number of quantum-enlivened developmental calculations, draw the contrasts between them, overview hypothetical improvements and applications that range from combinatorial improvements to numerical advancements, and analyze the preferences and restrictions of these different strategies. At last, a little similar review is directed to assess the exhibitions of various sorts of quantum-roused transformative algorithm and conclusions are drawn about some of the most encouraging future research advancements around there.

II. RELATED WORK

Quantum computing is a new method to computation that has the opportunity to revolutionize the sector of computer science. The late Nobel Prize winning physicist Richard Feynman, who becomes interested in the usage of a pc to simulate quantum systems, first investigated using quantum structures to do computation in 1982. He found out that the classical garage requirements for quantum systems develop exponentially inside the quantity of debris. So even as simulating twenty quantum debris simplest calls for storing a million values, doubling this to a forty particle simulation might require one trillion values. Interesting simulations, say using 100 or thousand debris, could no longer be feasible, and even the usage of every laptop on the earth. Consequently he counseled making computers that applied quantum particles as a computational aid that might simulate popular quantum systems on the way to do huge simulations and the idea of using quantum mechanical outcomes to do computation become born. The exponential storage ability, coupled with a few spooky results like quantum entanglement, has led researchers to probe deeper into the computing electricity of quantum systems. Quantum computing has blossomed over the last twenty years, demonstrating the ability to clear up some problems exponentially faster than any modern-day computer could ever do. The most famous algorithm, the integer-factoring algorithm of Peter Shor, might permit the most popular encryption methods in use nowadays to be cracked effortlessly, if large sufficient quantum computers can be built. Hence the race is on to broaden the concept and hardware that could allow quantum computing to turn out to be as sizeable as desktops are nowadays. Classical computers, which encompass all current mainstream computers, paintings on discrete pieces of facts, and manipulate them in step with rules laid out through John Von Neumann within the 1940's. In honor of his groundbreaking paintings, modern-day computer systems are said to run on a "Von Neumann architecture", that's modeled on an abstraction of discrete pieces of statistics.

But, in latest years, scientists have modified from this abstraction of computing, to figuring out that since a laptop should in the long run be a bodily device, the guidelines governing computation must be derived from physical law. Quantum mechanics is one of the maximum fundamental physical theories, and as a consequence become an excellent desire to take a look at what computational tasks could be physically achieved. This examine brought about the profound discovery that quantum mechanics allows much more powerful machines than the Von Neumann abstraction.

A. *Quantum Image Model*

The objective of classically inspired Quantum image processing (QIMP) or truly QIMP is to utilize the quantum computing technologies to capture, manipulate, and get better quantum images in extraordinary codecs and for different purposes [30]. based totally on the distinctive requirements to capture the content of an picture, we may want to divide the to be had Quantum image representation (QIP) into three fashions as discussed within the rest of this phase.

B. *Quantum Inspired Evolutionary Algorithm*

The quantum-inspired evolutionary algorithms are located in the intersection of two subareas of computerScience”-Quantum computing and evolutionary computing, which has been presented in figure 1.The first notion of evolutionary algorithm primarily based on the concepts and ideas of quantum computing became offered in [22] and this location remains intensively studied in recent times. Other early examples of quantum-inspired genetic algorithms which rent binary quantum representation

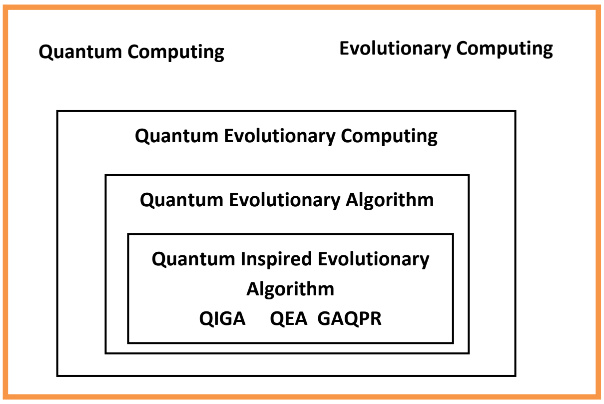

Fig.1.Quantum and evolutionary computing subfields

Primarily based on qubits are due to Han and Kim [21, 22, 23]. Within the past decade, several other editions [9, 8, 29, 25, 13] of quantum evolutionary algorithms had been additionally proposed.

In figure 2, the pseudo-code of well-known quantum inspired evolutionary set of rules has been offered. Within the figure, Q(t) denotes the t-th technology of a quantum populace.

```
procedure QIEA
begin
t ← 0
initialize Q(0)
...
while not termination-criterion do
   t ← t + 1
   ...
   evaluate Q(t)
   perform genetic operators on Q(t)
   ...
end while
end
```

Fig.2. Quantum-Inspired Evolutionary Algorithm pseudo-code

It is easy to see that the pseudo-code corresponds directlyto the general classical evolutionary algorithm scheme. However, the main stages of quantum-inspired evolutionary algorithm are modeled upon concepts and principles of quantum computing.

A variety of extended, widespread or modified genetic operators(e.g. [1, 2, 3, 8, 6]) were introduced in 42 papers for quantity individuals In 23 papers, different modifications of the representation(e.g. [23, 30, 12, 17, 11, 27, 14]) of quantum individuals were discussed. Most papers identified with double quantum coding (qubits rather than bits), and just a little portion of all papers [7, 8, 29, 2, 17, 12] identify with genuine - coded Algorithm.Not many papers [22, 28, 24, 25, and 15] are mainly centered on hypothetical examination inside and out. Only two complete overviews [16, 20] were conducted on this field. Two PhD theses [27, 30] and one book [28] have been devoted to quantum-inspired evolutionary algorithms entirely. In several dozen combinatorial and numerical optimization problems, many researchers reported efficacy of the quantum - inspired evolutionary algorithms. The previous decade has seen effective calculation applications in an assortment of regions, including image processing[13, 14, 15, 18, 34], network design issues[13, 14, 29, 22, 28], flow shop scheduling issues[11, 18, 19, 12, 29], power system optimization[8, 9, 1], thermal unit engagement, time series [5] and other structures discovery[20,15, 6, 16]. Quantum evolutionary algorithms with real numbers representation have been also successfully applied in various fields: engineering optimization problems [2, 3], option pricing modeling [12, 14], power system optimization [1], financial data analysis [10, 13, 14, and 12], training fuzzy neural networks [11] and ceramic grinding optimization [30]. Consequently, it has been demonstratedthat quantum evolutionary algorithms are capable to outperform classical metaheuristics for a wide range of problems. Though several successful attempts (e.g. [28, 25, and 15]) have been made for some specific algorithms, no strong theoretical foundations of general quantum evolutionary algorithms exist or the models are highly oversimplified. There has also been no systematic approach to algorithm tuning parameters yet. Therefore, no general rules are currently identified for setting parameters of quantum evolutionary algorithms, and usually the experience of the researcher in setting the parameters is required.

Input: *A set of predefined building blocks, the population size, the maximal generation number, the image dataset for classification*
Output: *the discover best Image (retrieval)*
1 P_0← Initialize a population with given population size ;
2 t ← 0;
While *t < the maximal generation number* ***do***
Evaluate the fitness of each individual in P_t ;
Q_t ← Generate offspring by genetic operator and Binary bat operator from the selected parent individual;
P_{t+1} ← Enviromental selection from Pt ∪ Qt;
t ← t +1;
end
Return *the individual which has the best fitness in P_t*

Fig. 1. structure of the Genetic Algorithm

III. CONCLUSION

Conclusions and future investigations, this paper briefly offers paths for quantum - inspired evolutionary algorithms. Extraordinary intrigue was set on quantum - stimulated genetic algorithms and the principal motivation of this algorithm was quickly reviewed.The evaluation of the literature was performed and its statistical summaries were provided. Additional randomness factors transmit a new size into evolutionary algorithms. What's more, research can be relied upon in nearness to fate on the best way to utilize the new conceivable outcomes productively.In quantum - inspired evolutionary algorithms, the new dimension of randomness allows the algorithms to be finely adjusted to numerous healthy optimization problems. Moreover, the extra components of haphazardness can convey the algorithm closer to obscure nature of numerous genuine world inconveniences. Thusly, it very well may be normal that quantum-stimulated evolutionary algorithms are explicitly valuable in fixing innately uncertain, obscure issues, i.e. evolving hard units or fuzzy regulations. Additionally, theoretical research of the set of rules nonetheless needs higher attention. Examples of such possible theoretical research paths encompass: generalization of Holland's schema theorem to quantum-inspired genetic algorithms or an evaluation in dynamic structures attitude. Gadget studying approach [6] and contemporary metaheuristics tuning techniques (like [26]) are additionally thrilling destiny studies paths. in the end, viable implementation of the quantum evolutionary algorithms on quantum computer systems is the most important project for the future. a few early promising but theoretical effects of this approach has been already performed [30, 22, 27].

ACKNOWLEDGEMNT

I express my sincere gratitude to my guide Dr. Sandeep Gupta, Associate Professor (CSE Department) for his constant help, worth full guidance and encouragement during the work. I would like to thanks to SVU, Uttar Pradesh for giving me such platform for taking my research work to some heights.

REFRENCES

[1] AK Al-Othman, FS Al-Fares, and KM EL-Nagger. Power System Security Constrained Economic Dispatch Using Real CodedQuantum Inspired Evolution Algorithm. International Journal ofElectrical, Computer, and Systems Engineering, 1:4, 2007.

[2] F.S. Alfares and I.I. Esat. Real-coded quantum inspired evolutionalgorithm applied to engineering optimization problems.In ISOLA '06: Proceedings of the Second International Symposiumon Leveraging Applications of Formal Methods, Verificationand Validation, pages 169–176, Washington, DC, USA,nov. 2006. IEEE Computer Society.

[3] C. Patvardhan Ashish Mani. An adaptive quantum evolutionaryalgorithm for engineering optimization problems. InternationalJournal of Computer Applications, 1(22):43–48, February 2010.Published By Foundation of Computer Science.

[4] P. Benioff. Quantum mechanical models of Turing machinesthat dissipate no energy. Physical Review Letters, 48(23):1581–1585, 1982.

[5] L. Bin, Y. Junan, and Z. Zhenquan. GAQPR and its application in discovering frequent structures in time series. In Proceedings of the 2003 IEEE International Conference on Neural Networks & Signal Processing, volume 1, pages 399–403. Citeseer, 2003.

[6] M. Birattari. Tuning metaheuristics: a machine learning perspective. Springer Verlag, 2009

[7] André V. Abs da Cruz, Carlos R. Hall Barbosa, Marco AurélioCavalcanti Pacheco, and Marley B. R. Vellasco. Quantum-inspired evolutionary algorithms and its application to numericaloptimization problems. In Nikhil R. Pal, Nikola Kasabov,Rajani K. Mudi, Srimanta Pal, and Swapan K. Parui, editors,ICONIP, volume 3316 of Lecture Notes in Computer Science,pages 212–217. Springer, 2004.

[8] André V. Abs da Cruz, Marco Aurélio Cavalcanti Pacheco, MarleyB. R. Vellasco, and Carlos R. Hall Barbosa. Cultural operatorsfor a quantum-inspired evolutionary algorithm applied tonumerical optimization problems. In José Mira and José R. Álvarez,editors, IWINAC (2), volume 3562 of Lecture Notes inComputer Science, pages 1–10. Springer, 2005.

[9] A.V.A. da Cruz, M.M.B. Vellasco, and M.A.C. Pacheco.Quantum-inspired evolutionary algorithm for numerical optimization.pages 2630 –2637, 0-0 2006.

[10] A.G. de Pinho, M. Vellasco, and A.V.A. da Cruz. A newmodel for credit approval problems: A quantum-inspired neuroevolutionaryalgorithm with binary-real representation. Pages445 –450, dec. 2009.

[11] M. Defoin-Platel, S. Schliebs, and N. Kasabov. A versatilequantum-inspired evolutionary algorithm. In Proceedings of theInternational Conference on Evolutionary Computation (Singapore,September 25–28, 2007). CEC, volume 7, 2007.

[12] Kai Fan, Anthony Brabazon, Conall O'Sullivan, and Michael O'Neill. Option pricing model calibration using a real-valued quantum-inspired evolutionary algorithm. In GECCO '07: Proceedings of the 9th annual conference on Genetic and evolutionary computation, pages 1983–1990, New York, NY, USA, 2007. ACM

[13] Kai Fan, Anthony Brabazon, Conall O'Sullivan, and MichaelO'Neill. Quantum-Inspired Evolutionary Algorithms for FinancialData Analysis. In EvoWorkshops, pages 133–143, 2008.

[14] Kai Fan, Conall O'Sullivan, Anthony Brabazon, Michael O'Neill,and Sean McGarraghy. Calibration of the vgssd option pricingmodel using a quantum-inspired evolutionary algorithm, 2008.

[15] X. Fu, M. Ding, C. Zhou, and Y. Sun. Multi-threshold image segmentationwith improved quantum-inspired genetic algorithm. InProceedings of SPIE, volume 7495, page 749518, 2009.

[16] G.A. Giraldi, R. Portugal, and R.N. Thess. Genetic algorithms and quantum computation. Arxiv preprint cs/0403003, 2004.

[17] Lov K. Grover. A fast quantum mechanical algorithm fordatabase search. In STOC '96: Proceedings of the twentyeighthannual ACM symposium on Theory of computing, pages212–219, New York, NY, USA, 1996. ACM Press.

[18] J. Gu, M. Gu, C. Cao, and X. Gu. A novel competitive coevolutionaryquantum genetic algorithm for stochastic job shopscheduling problem. Computers and Operations Research,2009.

[19] J. Gu, X. Gu, and M. Gu. A novel parallel quantum geneticalgorithm for stochastic job shop scheduling. Journal of MathematicalAnalysis and Applications, 355(1):63–81, 2009.

[20] X. Guo, T. Wang, Z. Chen, L. Wang, and W. Zhao. Fast FPGAplacement algorithm using Quantum Genetic Algorithm withSimulated Annealing. In IEEE 8th International Conference onASIC, 2009. ASICON'09, pages 730–733, 2009.

[21] K.H. Han and J.H. Kim. Genetic quantum algorithm and its applicationto combinatorial optimization problem. In Proceedingsof the 2000 Congress on Evolutionary computation, volume 2,pages 1354–1360. Citeseer, 2000.

[22] K.H. Han and J.H. Kim. Analysis of Quantum-Inspired Evolutionary Algorithm. In Proceedings of the 2001 International Conference on Artificial Intelligence, pages 727–730, 2001

[23] K.H. Han and J.H. Kim. Quantum-inspired evolutionary algorithmfor a class of combinatorial optimization. IEEE transactionson evolutionary computation, 6(6):580–593, 2002.

[24] K.H. Han and J.H. Kim. On setting the parameters of quantuminspiredevolutionary algorithm for practical applications. In Proceedingsof IEEE Congress on Evolutionary Computing, pages178–184. Citeseer, 2003.

[25] K.H. Han and J.H. Kim. On the analysis of the quantuminspiredevolutionary algorithm with a single individual. In IEEECongress on Evolutionary Computation, pages 16–21, 2006.

[26] K.H. Han, K.H. Park, C.H. Lee, and J.H. Kim. Parallel quantuminspiredgenetic algorithm for combinatorial optimization problem.In Proceedings of the 2001 Congress on EvolutionaryComputation, volume 2, pages 1422–1429. Citeseer, 2001.

[27] Kuk-Hyun Han. Quantum-inspired Evolutionary Algorithm. PhDthesis, Korea Advanced Institute of Science and Technology(KAIST), 2003.

[28] Md. Amjad Hossain, Md. Kowsar Hossain, and M. M. AHashem. A generalized hybrid real-coded quantum evolutionaryalgorithm based on particle swarm theory with arithmeticcrossover, 2005.

[29] C. Hui, Z. Jiashu, and Z. Chao. Chaos updating rotated gatesquantum-inspired genetic algorithm. In Communications, Circuitsand Systems, 2004. ICCCAS 2004. 2004 InternationalConference on, volume 2, 2004.

[30] H. Huo, Q. Xie, X. Shen, and V. Stojkovic. A Probabilistic CodingBased Quantum Genetic Algorithm for Multiple SequenceAlignment. In Computational systems bioinformatics/Life Sciences Society. Computational Systems Bioinformatics Conference,volume 7, page 15, 2008.