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Genetic Approach on Descriptive Modeling of Data Mining

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Abstract: The fast developing computer science and engineering techniques has made the information easy to capture process and store in databases. Information or data are considered as elementary variable facts. Knowledge is considered as a set of instructions, which describes how these facts can be interpreted and use[1]. Data describes the actual state of the world; however knowledge describes the structure of the world and consists of principal and laws. How to gather, store and retrieve data is considered in database. Soft computing (SC) is an evolving collection of methodologies, which aims to exploit tolerance for imprecision, uncertainty, and partial truth to achieve robustness, tractability, and low cost. SC provides an attractive opportunity to represent the ambiguity in human thinking with real life uncertainty. Soft computing has recently been playing an important role in advanced knowledge processing. An advanced learning method using a combination of perception and motion has been introduced. Emergent, self-organizing, reflective, and interactive (among human beings, environment, and artificial intelligence) knowledge processing is considered by using soft computing and by borrowing ideas from bio-information processing [2].

Keywords: Soft Computing, Imprecision, Bio information, Emergent

I. INTRODAUCTION

Soft computing (SC)was proposed for construction of new generation artificial intelligence (high machine intelligence quotient (HMIQ), human-like information processing) and for solving nonlinear and mathematically unmodeled systems (tractability) (TR) [3].

Data mining is a field at the intersection of computer science and statistics, is the process that attempts to discover patterns in large data sets. It utilizes methods at the intersection of artificial intelligence, machine learning, statistics, and database systems. The overall goal of the data mining process is to extract information from a data set and transform it into an understandable structure for further use[4][5][6].

II. PROCESS OF KNOWLEDGE DISCOVERY

i. **Selection** : It involves identification or extraction of relevant data for analysis.
ii. **Processing** : It involves preparing the data set by resolving problems like missing data, skewed data, irrelevant fields, removal of outlying points etc[7][8]. This step consisting of two steps, like data cleaning and data integration. Data cleaning consists of some basic operations like normalization, noise removal etc. Data integration includes integrating multiple, heterogeneous data sets generated from different sources.
iii. **Data mining** : It involves application of , transformed data in order to extract meaningful patterns from the data.
iv. **Pattern Evaluation :** It involves evaluation of patterns for interestingness.
v. **Interpretation :** It involves representation of discovered knowledge in proper format.

III. METHODS OF DATA MINING:- Data mining, the extraction of hidden predictive information from large databases, is a powerful new technology with great potential to help companies focus on the most important information in their data warehouses. Data mining tools predict future trends and behaviors, allowing businesses to make proactive, knowledge-driven decisions[9]. The data is invariably present in substantial quantities.

1. **Classification:** Classification is the most commonly applied data mining technique, which employs a set of pre classified examples to develop a model that can classify the population of records at large. Fraud detection and credit risk applications are particularly well suited to this type of analysis[10]. This approach frequently employs decision tree or neural network-based classification algorithms.
2. **Clustering:** Clustering is a division of data into groups of similar objects. Representing the data by fewer clusters necessarily loses certain fine details, but achieves simplification[11]. It models data by its clusters. Data modeling puts clustering in a historical perspective rooted in mathematics , statistics, and numerical analysis[12].

3. **Association Rules** : Association analysis is the discovery of association rules showing attribute value conditions that occur frequently together in a given set of data. Association analysis is widely used in transaction analysis[13]. Association and correlation is usually to find frequent item set findings among large data sets. Association Rule algorithms need to be able to generate rules with confidence values less than one.
4. **Neural Network** : Artificial neural networks are composed of interconnecting artificial neurons (programming constructs that mimic the properties of biological neurons). Artificial neural networks may either be used to gain an understanding of biological neural networks, or for solving artificial intelligence problems without necessarily creating a model of a real biological system [14]. The real, biological nervous system is highly complex: artificial neural network algorithms attempt to abstract this complexity and focus on what may hypothetically matter most from an information processing point of view.
5. **Outlier Analysis:** The analysis is to identify and explain exceptions. Outliers are data elements that cannot be grouped in a given class or cluster. Also known as exceptions or surprises, they are often very important to identify.
6. **Visualization:** Visualization uses interactive graphs to demonstrate mathematically induced rules and scores, and is far more sophisticated than pie or bar charts. Visualization is used primarily to depict three dimensional geographic locations of mathematical coordinates.

IV.SOFT COMPUTING TOOLS IN DATA MINING:

1. **Neural Network:** Artificial Neural Networks (ANN) are networks of artificial neurons, and hence constitute crude approximations to parts of real brains. They may be physical devices, or simulated on conventional computers. From a practical point of view, an ANN is just a parallel computational system consisting of many simple processing elements connected together in a specified way in order to perform a particular task. These are extremely powerful computational devices. They can learn and generalize from training data, so there is no need for enormous feats of programming. They are particularly fault tolerant; this is equivalent to the "graceful degradation" found in biological systems. They are also very noise tolerant, so they can cope with situations where normal symbolic systems would have difficulty[15].
2. **Fuzzy Set Theory** : Fuzzy sets theory as a paradigm to deal with some of the difficulties that are related to the concepts or numbers that have vague boundaries. Fuzzy sets theory defines such concepts and numbers as fuzzy sets[16]. Operations of fuzzy sets are the formal mechanism to operate on fuzzy sets to define new concepts[17].
3. **Genetic Algorithm :** Genetic algorithms a biologically inspired technology, are randomized search and optimization techniques guided by the principles of evolution and natural genetics. They are efficient, adaptive, and robust search processes, producing near optimal solutions, and have a large degree of implicit parallelism[18]. GAs are part of a broader class of evolution-inspired algorithms. Alternatively, one can classify them as one of a derivative-free optimization group of algorithms. Their applications in transportation go back to the early 1990s and since then have been growing steadily . In all applications, GAs were instrumental in solving problems that had been either difficult to solve, or the solutions had been of modest quality. GAs are one of the derivative-free stochastic optimization methods which have their foundation in the concepts of natural selection and evolutionary processes[19]. Genetic algorithm processing object not parameters itself, but the encoded individuals of parameters set, which directly operate to set, queue, matrices, charts, and other structure. In standard genetic algorithm, basically not use the knowledge of search space or other supporting information, but use fitness function to evaluate individuals. Genetic programming is used to automatically generate, evaluate, and select object-oriented queries[20]. GAs are also used for several other purposes like fusion of multiple data types in multimedia databases, and automated program generation for mining multimedia data.
4. **Rough Set Theory :** A rough set learning algorithm can be used to obtain a set of rules in IF-THEN form, from a decision table. The rough set method provides an effective tool for extracting knowledge from databases[21].

V. METHODOLOGY

Two steps of Methodology:-

a. **Pre Processing**
b. **Genetic Algorithm**

a. **Pre-processing:-** Pre-processing is combinations of 3 methods:-

Data Cleaning:- **DATA CLEANING** - a two step process including ***DETECTION*** and then ***CORRECTION*** of errors in a data set. Every dataset contains some errors, and every analyst experiences a rite of passage in wasting days drawing wrong conclusions because the errors have not been first rooted out. Up to half of the time needed for analysis is typically spent in "cleaning" the data. This time is also, typically, underestimated. Often, once a clean dataset is achieved, the analysis itself is quite straightforward.

i. Data Reduction:- Obtains reduced representation in volume but produces the same or similar analytical results.

ii. Data Integration:- It combines data from multiple sources into a coherent data store

as in data warehousing. These sources may include multiple databases, data cubes or flat files.

b. Genetic Algorithm:- After pre-processing I will use genetic algorithms as second step of my methodology. Genetic algorithms were formally introduced in the United States in the 1970s by John Holland at University of Michigan. The continuing price/performance improvements of computational systems has made them attractive for some types of optimization. In particular, genetic algorithms work very well on mixed (continuous *and* discrete), combinatorial problems. They are less susceptible to getting 'stuck' at local optima than gradient search methods. But they tend to be computationally expensive.

To use a genetic algorithm, you must represent a solution to your problem as a *genome* (or *chromosome*). The genetic algorithm then creates a population of solutions and applies genetic operators such as mutation and crossover to evolve the solutions in order to find the best one(s). The three most important aspects of using genetic algorithms are:

(1) Definition of the objective function.

(2) Definition and implementation of the genetic representation.

(3) Definition and implementation of the genetic operators.

VI. CONCLUSION

The proposed model is more objective and reasonable in determining the object oriented queries with genetic algoritms and focuses in the most important linguistic term for reduced time complexity. With the help of this we can also perform the prediction of any given data sets. This is used to find optimal result.

VII. REFERENCES:

(i) Books

1. K. Das, K. Bhaduri. Parallel and Distributed Data Mining for Astronomy Applications. A chapter in *Data Mining and Machine Learning for Astronomical Applications*, K. Ali, A. Srivastava, J. Scargle and M. Way (editor), Chapman & Hall/CRC Press. (in communication). 2010.
2. K. Bhaduri, K. Das, K. Sivakumar, H. Kargupta, R. Wolff, R. Chen. Algorithms for Distributed Data Stream Mining. A chapter in *Data Streams: Models and Algorithms*, C. Aggarwal (editor), Springer. pp. 309-332. 2006.
3. **Data Mining: Concepts and Techniques** *Jiawei Han and Micheline Kamber,* **Publisher:** Morgan Kaufmann (6 Sep 2000).
4. Automating the Design of Data Mining Algorithms: An Evolutionary Computation Approach (Natural Computing Series) authors: Gisele L. Pappa, Alex Freitas Publisher: Springer; 2010 edition (November 5, 2009).
5. Data Mining Using Grammar Based Genetic Programming and (GENETIC PROGRAMMING Volume 3) Man Leung Wong , Kwong Sak Leung Publisher: Springer; 2000 edition (January 1, 2000).

(ii) Reference Papers

[1] Y. Dote, "Soft computing in computational intelligence and information/ intelligent system," in *Proc. IEEE Int. Workshop on Soft Computing in Industry*, Muroran, Japan, 1999, pp. 66–71.

[2] L. A. Zadeh, "Fuzzy logic, neural networks and soft computing," in *Proc. IIEEE Int. Workshop Neuro Fuzzy Control*, Muroran, Japan,1993, p. 1.

[4] FALOUTSOS, C. and LIN, K. 1995. Fastmap: A fast algorithm for indexing, data mining and visualization of traditional and multimedia. In Proceedings of the ACM SIGMOD Conference, 163-174, San Jose, CA.

[5] Dr. Gary Parker, vol 7, 2004, Data Mining: Modules in emerging fields, CD-ROM.

[6] HAN, J. and KAMBER, M. 2001. Data Mining. Morgan Kaufmann Publishers.

[7] BAEZA-YATES, R. 1992. Introduction to data structures and algorithms related to information retrieval. In Frakes, W.B. and Baeza-Yates, R. (Eds.) Information Retrieval, Data Structures and Algorithms, 13-27, Prentice-Hall.

[8] G. Piatetsky-Shapiro and W. J. Frawley. Knowledge Discovery in Databases. AAAI/MIT Press, 1991.

[9] W. J. Frawley, G. Piatetsky-Shapiro and C. J. Matheus, Knowledge Discovery in Databases: An Overview. In G. Piatetsky-Shapiro et al. (eds.), Knowledge Discovery in Databases. AAAI/MIT Press, 1991.

[10] DUDA, R. and HART, P. 1973. Pattern Classification and Scene Analysis. John Wiley & Sons, New York, NY.

[11] A.K. Jain, M.N. Murty, P.J.Flynn, "Data Clustering: A Review", ACM Computing Surveys ,vol. 31 , no.3, September 1999.

[12] BAKER, L.D. and MCCALLUM, A. K. 1998. Distributional clustering of words for text classification. In Proceedings of the 21st ACM SIGIR Conference, Melbourne, Australia.

[13] R. Agrawal, T. Imielinski, and A. Swami, "Mining association rules between sets of items in large databases," in Proc. 1993 ACMSIGMOD Int. Conf. Management Data, Washington, DC, May 1993, pp. 207–216.

[14] D. Shalvi and N. De Claris, "Unsupervised neural network approach to medical data mining techniques," Proc. IEEE Int. Joint Conf. Neural Networks, pp. 171– 176, May 1998.

[15] Towell G., Shawlik J.W. (1994): Knowledge-based artificial neural networks. Artificial Intelligence, 70 (1- 2): 119-165 (October).

[16] Carpenter, G.A., Grossberg, S., and Rosen, D.B. 1991. Fuzzy art: Fast stable learning and Categorization of analog patterns by an adaptive resonance system. Neural Networks, 4, 759-771.

[17] L. A. Zadeh, "Fuzzy logic, neural networks, and soft computing," Commun. ACM, vol. 37, pp. 77–84, 1994.

[18] D. E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley,1989.

[19] E. Noda, A. A. Freitas, and H. S. Lopes, "Discovering interesting prediction rules with a genetic algorithm," Proc. IEEE Congr. Evolutionary Comput. CEC '99, pp. 1322–1329, July 1999.

[20] I.W. Flockhart and N. J. Radcliffe, "A genetic algorithm-based approach to data mining," in Proc. 2nd Int. Conf. Knowledge Discovery DataMining (KDD- 96). Portland, OR, Aug. 2–4, 1996, p. 299.

[21] Sushmita Mitra, Sankar K. Pal, Pabitra Mitra, "Data Mining in Soft Computing Framework: A Survey", IEEE Transactions On Neural Networks, Vol. 13, No. 1, January 2002.

[22] Adewole Philip, Akinwale Adio Taofiki, Otunbanowo Kehinde, "A Genetic Algorithm for Solving Travelling Salesman Problem", International Journal of Advanced Computer Sciences and Applications, Volume 2, No. 1, January 2011.

[23] Agustin-Blas, L.E.; Salcedo-Sanz, S.; Ortiz-Garcia, E.; Perez-Bellido, A.; Portilla-Figueras, A.; Dept. of Signal Theor. & Commun., Univ. de Alcala, Madrid, "Assignment of Students to Preferred Laboratory Groups Using a Hybrid Grouping Genetic Algorithm", Hybrid Intelligent Systems, 2008. HIS '08. Eighth International Conference.

[24] Christodoulopoulos, C.E.; Papanikolaou, K.A., "A Group Formation Tool in an E-Learning Context", Tools with Artificial Intelligence, 2007. ICTAI 2007. 19th IEEE International Conference.

[25] Hak Koon Yeoh, Mohamad Iskandr Mohamad Nor, "An algorithm to form balanced and diverse groups of students", 2009 Wiley Periodicals, Inc. Comput Application Engineering Education 19: 582–590, 2011.

[26] Kusum Deep, Hadush Mebrahtu, "Combined Mutation Operators of Genetic Algorithm for the Travelling Salesman problem", International Journal of Combinatorial Optimization Problems and Informatics, Vol. 2, No.3, Sep. - Dec. 2011, pp. 1-23.

[27] Li Liu, Murat Kantarcioglu, , Bhavani Thuraisingham, The applicability of the perturbation based privacy preserving data mining for real-world data, Data & Knowledge Engineering, Volume 65, Issue 1, April 2008, Pages 5-21.

[28] Seung-Woo Kim, Sanghyun Park, Jung-Im Won, Sang-Wook Kim, Privacy preserving data mining of sequential patterns for network traffic data**,** Information Sciences, Volume 178, Issue 3, 1 February 2008, Pages 694-713.

[29] Jose Zubcoff, Juan Trujillo, A UML 2.0 profile to design Association Rule mining models in the multidimensional conceptual modeling of data warehouses, Data & Knowledge Engineering, Volume 63, Issue 1, October 2007, Pages 44-62.

[30] George Gigli, Éloi Bossé, George A. Lampropoulos, An optimized architecture for classification combining data fusion and data mining, Information Fusion, Volume 8, Issue 4, October 2007, Pages 366-378.

[31] Michael Böhlen, Linas Bukauskas, Poul Svante Eriksen, Steffen Lilholt Lauritzen, Artūras Mažeika, Peter Musaeus, Peer Mylov, 3D visual Data Mining—goals and experiences, Computational Statistics & Data& Analysis, Volume 43,
Issue 4, 28 August 2003, Pages 445-469.

[32] Sirgo, J., Lopez, A., Janez, R., Blanco, R., Abajo, N., Tarrio, M., Perez, R., "A Data Mining Engine based on Internet, Emerging Technologies and Factory Automation," Proceedings ETFA '03, IEEEz Conference,16-19Sept.2003.WebSite:www.citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.11.8955

[33] Bianca V. D.,Philippe Boula de Mareüil and Martine Adda-Decker, "Identification of foreign-accented French using data mining techniques, Computer Sciences Laboratory for Mechanics and Engineering Sciences (LIMSI)".Website
www.limsi.fr/Individu/bianca/article/Vieru&Boula&Madda_ParaLing07.pdf

[34] Bianca V. D.,Philippe Boula de Mareüil and Martine Adda-Decker, "Identification of foreign-accented French using data mining techniques, Computer Sciences Laboratory for Mechanics and Engineering Sciences (LIMSI)".Website
www.limsi.fr/Individu/bianca/article/Vieru&Boula&Madda_ParaLing07.pdf

[35] Halteren, H. V., Oostdijk N., "Linguistic profiling of texts for the purpose of language verification, The ILK research group, Tilburg centre for Creative Computing and the Department of Communication and Information Sciences of the Faculty of Humanities, TilburgUniversity,TheNetherlands."Website:
www.ilk.uvt.nl/~antalb/textmining/LingProfColingDef.pdf

[36] Antonie, M. L., Zaiane, O. R.,Coman, A., "Application of Data Mining Techniques for Medical Image Classification", Proceedings of the Second International Workshop on Multimedia Data Mining MDM/KDD 2001) in conjunction with ACM SIGKDD conference, San Francisco, August 26, 2001.

[37]. Pei, M., Goodman, E.D., and Punch, W.F. "Pattern Discovery from Data Using Genetic Algorithms", *Proceeding of 1st Pacific-Asia Conference Knowledge Discovery & Data Mining (PAKDD-97)*. Feb. (1997).

[38]. Pei, M., Punch, W.F., and Goodman, E.D. "Feature Extraction Using Genetic Algorithms", *Proceeding of International Symposium on Intelligent Data Engineering and Learning'98 (IDEAL'98)*, Hong Kong, Oct. (1998).

[39]. Punch, W.F., Pei, M., Chia-Shun, L., Goodman, E.D., Hovland, P., and Enbody R. "Further research on Feature Selection and Classification Using Genetic Algorithms", In *5th International Conference on Genetic Algorithm* , Champaign IL, pp 557-564, (1993).

[40]. Siedlecki, W., Sklansky J., A note on genetic algorithms for large-scale feature selection, *Pattern Recognition Letters*, Vol. 10, Page 335-347, (1989).

[41]. Skalak D. B. (1994). Using a Genetic Algorithm to Learn Prototypes for Case Retrieval an Classification. *Proceeding of the AAAI-93 Case-Based Reasoning Workshop*, pp. 64-69. Washigton, D.C., American Association for Artificial Intelligence, Menlo Park, CA, 1994.

[42]. Vafaie H and De Jong K. "Robust feature Selection algorithms". *Proceeding 1993 IEEE Int. Conf on Tools with AI*, 356-363. Boston, Mass., USA. Nov. (1993).

[43] S. Brin, R. Motwani, J. Ulman, and S. Tsur, Dynamic itemset counting implication rules for market basket data. In Proc. Of ACM SIGMOD Intl. Conf. on Management of Data, May 1997.

[44] D. Cheung, T. Vincent, and W. Benjamin, "Maintenance of discovered knowledge: A case in multilevel association rules," in proc. of international conference on "Knowledge discovery and data mining (KDD)," August 1996.

[45] H. Toivonen. Sampling large databases for association rules. In Proc. Of Intl. Conf. on very Large Databases ((VLDB), 1996.

[46] J. Gennari, P. Langley, and D. Fisher, "Models of incremental concept formation," artificiall intelligence, 40: 11-61, 1989.

[47] Agrawal, R., Imielinski, T., and Swami, A. N. 1993. Mining association rules between sets of items in large databases. In Proceedings of the 1993 ACM SIGMOD International Conference on Management of Data, 207-211.

[48] Cai, W. and Li L., "Anomaly Detection using TCP Header Information, STAT753 Class Project Paper, May 2004.". Web Site:http://www.scs.gmu.edu/~wcai/stat753/stat753report.pdf.

[49] Nandi, T., Rao, C. B. and Ramchandran, S., "Comparative genomics using data mining tools, Journal of Bio-Science, Indian Academy of Sciences, Vol. 27,No. 1, Suppl. 1, page No. 15-25, February 2002".

[50] Khreisat, L., "Arabic Text Classification Using N-Gram Frequency Statistics A Comparative Study". proceedings of The 2006 International Conference on Data Mining, DMIN'06, pp 78-82, Las Vegas, Nevada, USA, June 26-29, 2006

[51] Onkamo, P. and Toivonen, H., "A survey of data mining methods for linkage disequilibrium mapping", Henry Stewart Publications 1473 - 9542. Human Genomics. VOL 2, NO 5, Page No. 336- 340, MARCH 2006.

[52] Smith, L., Lipscomb, B., and Simkins, A., "Data Mining in Sports: Predicting Cy Young Award Winners". Journal of Computer Science, Vol. 22, Page No. 115-121,April 2007.

[53] Deng, B., Liu, X., "Data Mining in Quality Improvement". USA.ISBN1-59047-061-3.WebSite http://www2.sas.com/proceedings/sugi27/Proceed27.pdf

[54] Cohen, J. J., Olivia, C., Rud, P., "Data Mining of Market Knowledge in The Pharmaceutical Industry". Proceeding of 13th Annual Conference of North-East SAS Users Group Inc., NESUG2000, Philadelphia Pennsylvania, September 24-26 2000.

[55] Elovici, Y., Kandel, A., Last, M., Shapira, B., Zaafrany, O., "Using Data Mining Techniques for Detecting Terror-Related Activities on the Web".WebSite: www.ise.bgu.ac.il/faculty/mlast/papers/JIW_Paper.pdf

[56] Solieman, O. K., "Data Mining in Sports: A Research Overview, A Technical Report, MIS Masters Project, August 2006". Web Site: http://ai.arizona.edu/hchen/chencourse/Osama-DM_in_Sports.pdf

[57] Maciag, T., Hepting, D. H., Slezak, D., Hilderman, R. J., "Mining Associations for Interface Design". Lecture Notes in Computer Science, Springer Berlin / Heidelberg, Volume 4481, pp.109-117, June 26, 2007

[58]Silva1, S., Almeida, J.: Dynamic Maximum Tree Depth A Simple Technique for avoiding Bloat in Tree-Based GP.Biomathematics Group, Instituto de Tecnologia Qu′ımica e Biol′ogica Universidad Nova de Lisboa, PO Box 127, 2780-156 Oeiras, Portugal (2002)

[59]Stoffel, K., Spector, L.: High-Performance, Parallel, Stack-Based Genetic Programming. In: Proceeding of the First Annual Conference, pp. 224–229 (1996)

[60]Luke, S., Panait, L.: Fighting Bloat with Nonparametric Parsimony Pressure. In: Proceeding of the First Annual Conference (2000)

[61]Koza, J.R.: Genetic Programming. Encyclopedia of Computer Science and Technology (8.18), 2–4 (1997)

[62]Aguilar-Ruiz JS, Riquelme JC, Toro M (2003) Evolutionary learning of hierarchical decision rules. IEEE Trans Syst Man Cybern B 33(2): 324–331 CrossRef

[63]Araujo DLA, Lopes HS, Freitas AA (1999) A parallel genetic algorithm for rule discovery in large databases. In: Proceedings of IEEE systems, man and cybernetics conference, vol 3, Tokyo, pp 940–945

[64]Bacardit J (2004) Pittsburgh genetics-based machine learning in the data mining era: representations, generalization, and run-time. PhD thesis, Ramon Llull University, Barcelona

[65]Bacardit J, Krasnogor N (2006a) Empirical evaluation of ensemble techniques for a Pittsburgh learning classifier system. In: 9th International workshop on learning classifier systems (IWLCS 2006), Lecture Notes in Artificial Intelligence. Springer

[66]Bacardit J, Krasnogor N (2006b) Biohel: Bioinformatics-oriented hierarchical evolutionary learning. Nottingham eprints, University of Nottingham