Information Systems Department
Faculty of Computer & Information Sciences
Ain Shams University

Intelligent System For Crude Oil Prediction

Thesis submitted as a partial fulfillment of the requirements for the degree of Doctor of Philosophy in Faculty of Computer and Information Sciences, Information System dept.
Ain shams University

By

Senan Abdullah Ali Ghallab

Under Supervision of

Prof. Dr. Mohamed Fahmi Tolba
Professor of Scientific Computing
Department of Scientific Computing
Faculty of Computer and Information Sciences
Ain Shams University

Prof. Dr. Abdel-Badeeh M. Salem
Professor of Computer Science
Faculty of Computer and Information Sciences
Department of Computer Science
Ain Shams University

Dr. Nagwa Lotfi Badr
Assistant Professor of Information Systems
Faculty of Computer and Information Sciences
Department of Information Systems
Ain Shams University

Cairo-December 2014

قال تعالى:

"وَلَا يُنَبِّئُكَ مِثْلُ خَبِيرٍ"

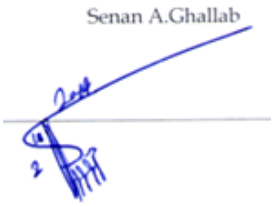
صدق الله العظيم

14-فاطر

I certify that this work has not been accepted in substance for any academic degree and is not being concurrently submitted in candidature for any other degree.

Any portions of this thesis for which I am indebted to other sources are mentioned and explicit references are given.

Senan Abdullah Ali Ghallab



ACKNOWLEDGMENT

To: **My *Mother*, My *Father soul***

To: **My *Wife*, My *Coming Son***

To: Sands of YEMEN

To: **All *Friends supporters***

I would like to express my deepest gratitude to Prof. Dr. Mohamed Fahmi Tolba , Prof. Dr. Abdel Badeeh Salem and Dr. Nagwa Lotfi Badr. It was only through their meticulous supervision, support, and constructive advice, that this work has been completed.

I am greatly indebted to them for valuable input and continue support and direction.

This list of persons could be extended much further, therefore I would like to thank all those not mentioned above, and who have supported me.

ABSTRACT

Since the earliest ages, petroleum belongs to the minerals that have been used by humanity, earlier than metals and coal, and for numerous different purposes. Petroleum is a mixture of naturally occurring hydrocarbons that may exist in the solid, rocks, liquid or gaseous states, depending upon the conditions of pressure and temperature to which it is subjected.

Petroleum Engineers combine technology, chemistry, mathematics, crude oil properties, physics and geology with engineering methods to enhanced petroleum industry. They are concerned with finding deposits of oil and gas in quantities suitable for commercial use and with the economic extraction of these materials from the ground.

In this thesis, an intelligent prediction system based on computational intelligence technique (fuzzy) has been designed as Intelligent Petroleum Prediction System (IPPS). Multiple processes are used to achieve an accurate result. The required data for evaluation has been chosen from distinct and specialized sources of oilfields.

The proposed system utilizes a huge amount of petroleum dataset using fuzzy technique to apply prediction function on Daqing oilfield and other oilfields in Yemen. Another goal of the proposed system is to share petroleum knowledge among Chief Executive Manager and engineers to make drilling decision on oil wells or nullity. More than one module applied on the prediction system; such as petroleum dataset acquisition, classification, data mining, prediction, knowledge validation and other processes.

Recently, using artificial intelligence techniques for prediction is highly usage in prediction domain, precision is the criterion. The proposed work reviewing engineering's experiences, analysis oil wells dataset, reordering memberships, forming an intelligent system to utilize crude oil knowledge and build an accurate predicted result.

The proposed system results evaluation applied through compared system predicted result with measured or empirical values of different oilfields and other intelligent technique results. IPPS achieved approximated results; verified and give the oil engineers a range of prediction process before the drilling operation. More than one module approved in this thesis, from dataset collection within distinct sources until validation prediction result test by multiple evaluation functions, the proposed system modules are:

- Dataset acquisition, analysis, classification, clustering and mining using Weka utility.
- Interesting of analysis, classifying, data mining, prediction, test cases, and regression through applying time series statistics of vagueness petroleum data.
- Integrate crude oil ontology into chemical knowledge. The development of crude oil ontology architecture approved by PROLOG and Protégé-OWL utilities, respectively.
- Knowledge validation by expert's and scientific methods.
- Test a novel application for Oil and Gas ratio prediction using ANFIS technique.
- Building an intelligent prediction system based on fuzzy system called Intelligent Petroleum Prediction System (IPPS).
- Retest both historical and test cases statues of predicted results through validation processes. The computational intelligence technique (Fuzzy), test case and clustering functions are used to achieve overlap Strictness.
- Confirm predicted results through logistic regression model which terminates the controversial and system efficiency.
- Using Time series forecasting Model to retest predicted results for more efficiency and minimize error range.

Published papers

1- Senan A.Ghallab, N.L. Badr, Abdel-Badeeh Salem, M. F. Tolba "***Modeling an Application for Oil and Gas Ratio Prediction Using ANFIS***". In the Egyptian Computer Science Journal, **Egypt**, Vol. 38. pp. 1-6, Sep-2012.

2- Senan A.Ghallab, N.L. Badr, Abdel-Badeeh Salem , M. F. Tolba "***Integration Web-Based Crude Oil Ontology***". In the proceeding of International Conference on Computing and Informatics (ICCI), **Egypt**, Vol. 1, pp. 91-96, 2012.

3- Senan A.Ghallab, N.L. Badr, Abdel-Badeeh Salem , M. F. Tolba "***A Fuzzy Expert System For Petroleum Prediction***". In the proceeding of World scientific and engineering Academy Society (WSEAS), **Croatia**, Vol. 3 , pp. 70-75, 2013.

4- Senan A.Ghallab, N.L. Badr, Abdel-Badeeh Salem , M. F. Tolba "***Computational Intelligence Approaches For Manipulating Vagueness Petroleum Data***", In the International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), **India**, Vol. 3, pp. 284-289, 2014.

5- Senan A.Ghallab, N.L. Badr, Abdel-Badeeh Salem, M. F. Tolba "***Effectiveness Ontology-Based for Crude Oil Deduction Model***". In the International Journal of Applications of Fuzzy Sets and Artificial Intelligence, **Greece**, Vol. 4, pp.127-139, 2014.

6- Senan A.Ghallab, N.L. Badr, Abdel-Badeeh Salem , M. F. Tolba " ***Intelligence Test Case Based-Approach for Crude Oil Prediction System***". In the proceeding of Intelligent Sytems(IS'14), **Poland**, IEEE Press, Vol. 323, pp. 893-903 June- 2015.

7- Senan A.Ghallab, N.L. Badr, Abdel-Badeeh Salem , M. F. Tolba "***An Intelligent Prediction System for Crude Oil Presence Using Fuzzy Model*** ". In the proceeding of Advanced Machine Learning Technologies and Applications (AMLTA14).Egypt, Vol. 488, pp.289-295 , **Egypt**, Springer, Nov-2014.

8- Senan A.Ghallab, N.L. Badr, Abdel-Badeeh Salem , M. F. Tolba "***Logistic Test Case Regression Model of Petroleum Availability Prediction System***". In the proceeding of Advanced Machine Learning Technologies and Applications (AMLTA14).Vol. 488, pp. 248-257, **Egypt**, Springer, Sep-2014.

9- Senan A.Ghallab, N.L. Badr, Abdel-Badeeh Salem, M. F. Tolba, "**Strictness Petroleum Prediction System Based on Fuzzy Model**". Paper submitted in the International Journal of Service Science, Management, Engineering, and Technology (IJSSMET), **USA**, 2014.

10- Senan A.Ghallab, N.L. Badr, Abdel-Badeeh Salem, M. F. Tolba, "**Intelligent Systems Utilization For Petroleum Prediction**", Accepted as book chapter, Paper accepted in the proceeding of Advanced Machine Learning Technologies and Applications (AMLTA14), **Egypt**, Nov-2014.

11- Senan A.Ghallab, N.L. Badr, Abdel-Badeeh Salem, M. F. Tolba, "**Fuzziness Petroleum Data Consolidation Using A Time Series Forecasting Model**". Paper submitted in the 7th International Conference on Information Technology (ICIT), **Jordan,** June-2015.

Table of Contents

List of Figures

List of Tables