Evolved Bayesian Network Models of Rig Operations in the Gulf of Mexico: Preliminary Experiments

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Introduction

The operation of drilling rigs is highly expensive. It is therefore important to be able to identify and analyse factors affecting rig operations. Computational intelligence represents an opportunity to mine the data and develop models. We use a unique dataset derived from the commercial market intelligence databases assembled by ODS-Petrodata Ltd. We investigate the use of Bayesian Networks to model our dataset and approach a range of possible industry applications. Our research, in a broader scope, aims at providing business decision support based on Rig operation data modelling.

Offshore drilling

The oil and gas sector is an active industry constantly seeking to research and apply new technologies. Drilling rigs are operated by contractors who hire out their services to oil companies for both exploration and exploitation. The operation of drilling rigs is highly expensive. Typically a rig operating offshore in the Gulf of Mexico can cost from $400K to $600K per day.(ODS-Petrodata Ltd., 2010) With rig operations lasting weeks or even months at a time, variations in the efficiency with which rigs are operated can affect profitability by millions of dollars. It is therefore important to be able to identify and analyse variables affecting efficiency.

Rig owners contract rigs to drilling companies for specific pre-established needs in both exploration and production. The offshore drilling market is dynamic, highly competitive, and regionally-specific. Key differences across regions are legislative and geological variations, however, cultural differences and practices across regions and across companies often also impact on rig results. Oil is located using various survey methods. Once a site is selected, it is surveyed to find its boundaries. Then a drilling rig is brought on site and starts drilling. As drilling progresses, mud circulates through the pipe and out of the drill bit to float the rock cuttings out of the hole. When a pre-set depth is reached, the drill bits are removed from the hole and a steel-and-cement casing is installed. When reaching the final depth, various logs and tests are performed and samples are taken for analysis. The well is then secured and installed in order to let the oil flow in a controlled manner. Once the oil is flowing, the oil rig is removed from the site and production equipment is set up to extract the oil from the well. [1][2][3]

Figure 1 : An Oil rig

Bayesian Networks

Bayesian Networks are probabilistic models based on Bayesian Inference [4]. They are useful for representing knowledge under uncertainty. They can be represented using a Directed Acyclic Graph associated with a joint probability distribution [5]. To make use of the power of Bayesian Networks in knowledge representation and inference, the network has to be constructed for the given problem. The underlying Directed Acyclic Graph structure representing the network has to be learned and then the conditional probabilities calculated. Learning the underlying structure is a hard problem [6] because the number of possible structures grows super-exponentially with the number of variables [7].

Model

We use GA- and ACO-based algorithms exploring the space of node orderings to induce a Bayesian Network model for the real world problem of Rig Operations Management. The algorithms found credible network structures as evaluated by industry experts. Although most of the relationships discovered are obvious at this stage, this is a useful preliminary experiment. We will use a larger dataset in the near future for more precise modelling. Due to the size and complexity of the datasets being considered, irrespectively of which approach is used, further work will be required to improve the computation time and to meet the challenge of factor selection.

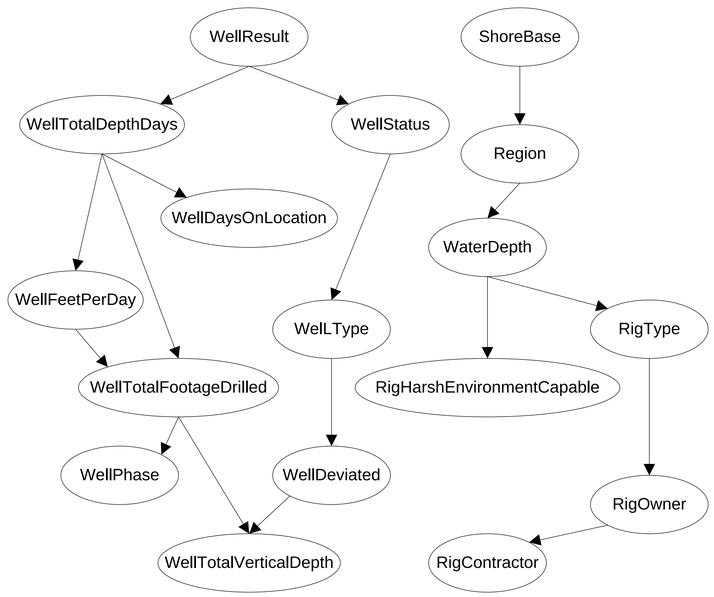

Figure 2 : Bayesian Network structure for our dataset

Future Research

This research is a step toward a model that could be used for various applications such as Drilling Rig Selection, Rig Performance forecasting or Rig Operation Scheduling. In future research, we aim to answer the following questions:

- How can Bayesian Networks be applied to a Recommender Systems taking into account user history but also the dynamic user preference changes through time, in the context of the Drilling Rig business problem and more generally for tool selection? Can tools such as various proximity measures be used across Bayesian Networks and Recommender Systems fields?
- How can Recommender Systems for Rig allocation and scheduling be introduced to commercial users? How can feedbacks be obtained and analysed? How can such system adapt itself for maintaining its accuracy through data and user preference change?

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This work was supported by ODS-Petrodata Ltd. (www.ods-petrodata.com) and the Technology Strategy Board under the Knowledge Transfer Partnership 006922