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Real Time Decision Support in Drilling Operations Using Bayesian Decision Networks

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Abstract

Today's decision makers in the petroleum industry have access to remarkable new technologies, huge amounts of information to help them make high-quality decisions, and the ability to share information at unprecedented speeds and quantities. A central hypothesis in the concept of digital oil field is that these tools and resources should lead to better decisions. Yet, the tools bring with them daunting new problems: the available data, though massive, are uncertain and often incomplete, unreliable, or distributed; interoperating/distributed decision makers and decision-making devices need to be coordinated; and many sources of data need to be fused to yield a good decision.

In this paper, we shall illustrate the use of *Influence Diagrams*, also known as *Bayesian Decision Networks*, to frame, analyze, and support real-time drilling decisions. Influence diagrams provide compact graphical representational and computational frameworks that are based on rigorous probability theory. They consist of a framing part, which encodes the decision basis elements along with their interrelationships, and a probabilistic part, which uses conditional probability distributions to quantify the strengths of the relationships.

Following a systematic decision analytic framework, particularly the *decision analysis cycle*, examples of influence diagrams are developed to provide insight to the decision situations. Also, an object-oriented influence diagram is built and tested for a real world casing setting decision situation. The influence diagram models are updated with the arrival of new data to reflect the current state of knowledge about the decision situation.

The study shows that influence diagrams are well-suited and efficient decision analysis tools for real-time support of the large and complex drilling decisions in which uncertainty is predominant.

Introduction

Drilling costs account for 50% of the upfront expenditures in oil & gas field development (Saputelli et al., 2003). As operators drill for oil and gas in increasingly complex and challenging environments, drilling operations become increasingly costly and risky. In the current economic environment, improving the drilling process is acknowledged to facilitate increased production and reserves while reducing costs. The industry has approached this challenge in two ways: (1) by improving the productive time of the *routine drilling process* itself; and (2) by eliminating the additional drilling expenses due to non-productive time related to *unexpected and undesired drilling events*.