Modeling Prospect Dependencies with Bayesian Networks

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In recent years, great interest has been devoted to the evaluation of prospect dependencies. Here, we look at the use of Bayesian networks based on trap, source and reservoir probabilities as a tool for analyzing a set of prospects. With such networks in place, we can easily run what-if drilling scenarios to determine drilling sequences. We exemplify this by finding the minimum number of dry wells to drill before abandoning an area.

In oil exploration, the probability of success for a prospect is often split into three independent factors: reservoir, trap and source. These represent the presence of reservoir rock, a closed trap, and oil migrating into the reservoir, respectively. We model dependencies between prospects by using one Bayesian network for each of these factors.

A Bayesian network is a powerful, yet simple tool for representing dependencies. With one network representing the geological dependencies for reservoir rock, another traps and a third one sources and possible flow paths, it is evident that the networks mirror physical dependencies and that the nodes have physical interpretation. The two first networks use binary success/failure nodes, whereas the source nodes may have four states if both oil and gas are modeled (dry, oil, gas, oil and gas). This discrete state situation fits nicely into the Bayesian network framework.

With the help of a team of experts, we have created such networks. With these networks established, it is easy to evaluate the changes in probability and economic viability for different prospects given new well data. The main strength of this is to feed the model with hypothetical well data, and use it to compute values of information and plan drilling sequences.

Using networks based on a real case, we show how a drilling plan can be created. The setting is that we want to drill as few dry wells as possible before abandoning the area. With a full model for dependencies, it is easy to evaluate the economic viability of the remaining prospects given a set of dry wells, and by running through all small subsets, we find the optimal solution.

We show that Bayesian networks are a powerful tool, both for analyzing and modeling the dependencies between prospects in an area. With such a model in place, it is easy and fast to update probabilities and expected value of prospects as new data become available. This is useful for well planning.