Abstract

We present two applications for interactive instruction in the geological aspects of petroleum reservoir characterization, both tightly woven through the Kansas Geological Survey’s web site. The first application, the Oz Machine, is a Java applet that provides a simple exercise in the interpretation of lithologies from petrophysical well logs. Each time the applet is run, a Markov chain simulation procedure generates a new sequence of lithologies from which a corresponding suite of logs is computed. The student’s task is then to identify the lithological sequence based on the logs, with the applet optionally providing feedback on the accuracy of the student’s interpretation. Despite the simplicity of the applet, it provides a compellingly realistic exercise in geological log interpretation. The second application, Small County, expands the basic concepts Oz Machine to three dimensions and adds identification of fluid contents to the interpretive problem, employing a virtual subsurface closely reflecting the geology of the US mid-continent, in the fictional setting of Small County, Kansas. Stochastic simulation techniques are used to generate the subsurface characterization, inductively incorporating the observed well control. The student explores this subsurface by siting exploratory wells and interpreting the well logs. The primary intention of the advanced undergraduate version of Small County is to provide students with experience in interpreting petrophysical well logs, using those logs to identify interval tops, lithologies, and zones of significant oil saturation (pay) in each well they drill. The student is first presented with an overview map of the county (Figure 2). From here, the student can view contour plots of either the elevations or thicknesses of the major intervals, initially interpreted from a set of pre-existing wells. These maps are updated to reflect the information obtained from each well that the student drills. The student may also view data associated with an existing well. Clicking on a well’s icon populates the Well Summary View with elevations and relative thicknesses of the intervals for the selected well’s location. In addition, the student can view cross sections of the horizons at the elevations (Figure 3) by ctrl-clicking on a sequence of wells and then selecting the Cross Section tab.

Oz Machine

The applet version of the Oz Machine provides two options, one to generate and display a new sequence of logs without displaying the true (simulated) lithologies from which the logs are computed, and the other to generate and display a new sequence with the true lithologies revealed. After clicking the New (without lithology) option, the student then fills in the depth track with interpreted lithologies, selected from the palette on the right. If the Cheese Lithology option is turned on, the code flags incorrect picks with red circles, providing a self-directed tutorial. After filling in the depth track with interpreted lithologies, the student is then presented with the Well Log View (Figure 4). Here the student’s task is to interpret the presented data and determine the correct lithology at each depth as well as mark the tops of the major intervals. Additionally, the student may select pomping ("pump") cones to perform for production upon completion of the well. After labeling lithologies and picking the interval tops, the student indicates that he or she has finished by selecting a toolbar button. An interpretation “score card” is presented summarizing the student’s performance (Figure 5). A table depicting the difference between the actual interval tops and the student’s picks is shown at the top of the window. This is followed by a summary of the picked and missed pay zones.

Advanced Undergraduate Version

The primary intention of the advanced undergraduate version of Small County is to provide students with experience in interpreting petrophysical well logs, using those logs to identify interval tops, lithologies, and zones of significant oil saturation (pay) in each well they drill. The student is first presented with an overview map of the county (Figure 2). From here, the student can view contour plots of either the elevations or thicknesses of the major intervals, initially interpreted from a set of pre-existing wells. These maps are updated to reflect the information obtained from each well that the student drills. The student may also view data associated with an existing well. Clicking on a well’s icon populates the Well Summary View with elevations and relative thicknesses of the intervals for the selected well’s location. In addition, the student can view cross sections of the horizons at the elevations (Figure 3) by ctrl-clicking on a sequence of wells and then selecting the Cross Section tab.

Introductory Geology Version

In the introductory version, the student’s task is to find the peak of an anticlinal structure in a single horizon, on the presumption that the best prospects for oil production would be in the vicinity of this peak. This version does not involve well log interpretation. Instead, the contour map of the horizon elevation immediately updates to reflect the "served" elevation in any new well that the student drills. Thus, the student’s task is to interpret the contour map and cross-sectional display to locate the anticlinal peak. After drilling five wells (in addition to ten pre-existing wells), the student is presented with a dialog box indicating how close he or she has gotten to the actual peak (Figure 6).

Development Platform

The Small County application is based on the Eclipse Rich Client Platform (RCP) (http://www.eclipse.org/eclipse). This enables rapid development of an application that runs on multiple operating platforms (Win32, OSX, Linux/GTK) while retaining the feel of the native operating environment. The RCP provides a framework of applications, UI, and modeling tools that allow developers to focus on the applications domain without much concern for low-level implementation details. Another benefit of the RCP is that the application is reusable.

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