Qualitative

Qualitative is a model property that can be set to describe the method used by the model-builder while choosing how to model uncertainties. If the model-builder has arbitrarily broken the total system into individual uncertainties, the appropriate setting is "Arbitrary." With this setting, the model attempts to minimize the total information in the system (equivalent to maximizing entropy when only discrete outcomes are present). If the model-builder has reason to believe that there should be a minimum of connections between the uncertainties, then the appropriate setting is "Minimize Interactions."

By default, the Qualitative setting is set to "Maximize Information", which is a balance between these two extremes. The "Maximize Information" setting realizes that a model-builder chooses uncertainties in a way to maximize the relevant information going into the model. Generally, a model-builder should seek to balance accuracy and simplicity. Individual uncertainties should be carefully chosen to increase the relevant information in the model by both increasing the total information in the model and decreasing the amount of complex relationships. That is, when possible, a model-builder should attempt to break complex total systems into simpler, individual uncertainties.

There are also settings for "Almost Arbitrary" and "Reduce Interactions."

Here's an illustrative example. Suppose there are two scenarios, "test A" and "test B". Each has two possibilities, up or down. To demonstrate the differences between Qualitative settings, we'll enter two pieces of information:
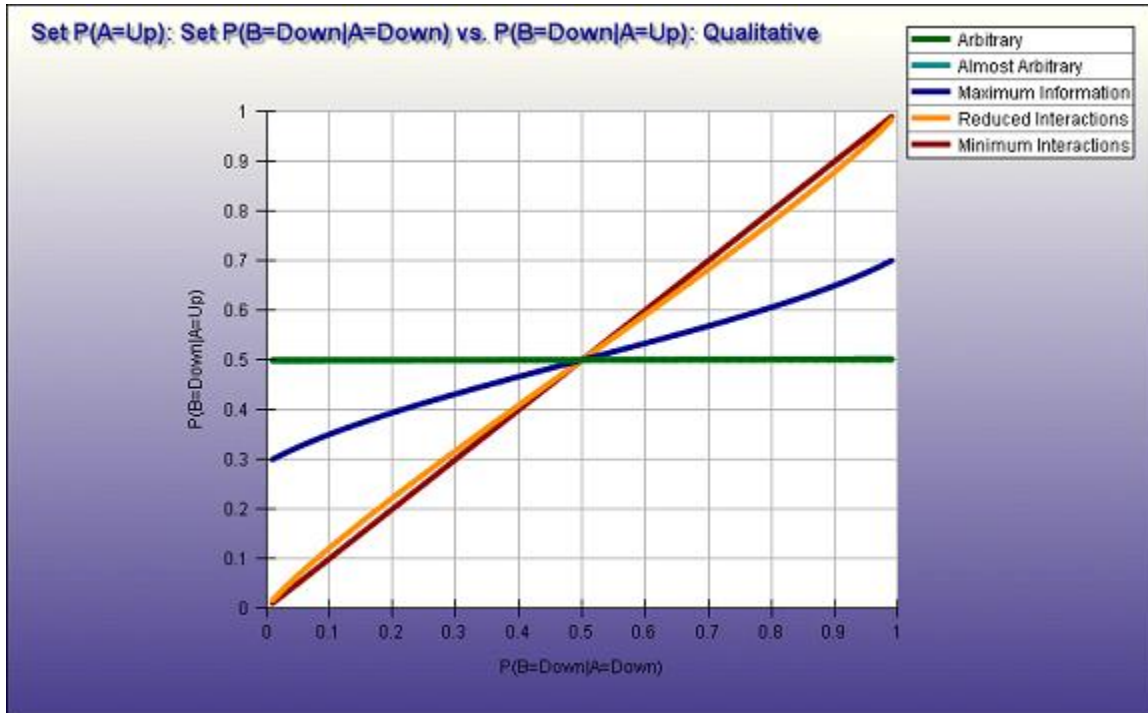
1. Probability of test A Being Up
2. Probability of test B Being Down if test A is Down

With this information, the remaining probabilities depend on the qualitative nature of how test A and test B were chosen as the unknowns. Two examples will illustrate this point. First consider that test A is similar to a coin flip and that test B is the weather. We would suppose that these two uncertainties would have no interactions. Next consider a test D that has four possible outcomes: D1, D2, D3, and D4. Test D could also be thought of as consisting of 2 tests, A and B, with 2 outcomes each. For example, A1 = (D1 or D2), A2 = (D3 or D4), B1 = (D1 or D3), and B2 = (D2 or D4). We could say that this selection of uncertainties was made arbitrarily.

If we have selected the two tests that should have a minimum of interaction and the probability of B being Down is 90% when test A is Down, then we'd like to think that the probability of test B being Down when test A is Up would also be 90%. And that is what we find when we set the *Qualitative* property to *Minimum Interactions*.

If we have selected the two tests arbitrarily, then knowing that the probability of test B being Down is 90% when test A is Down, tells us nothing about the probability of test B being Down when test A is Up. Therefore, the probability is 50% when we set the Qualitative property to *Arbitrary*.

In almost all cases, the qualitative selection process of relevant uncertainties lies somewhere between these two extreme cases. The middle point between the two is what we call *Maximum Information* and is our default setting and used 99+% of the time. We have also defined *Reduced Interactions*, which is close to Minimum Interactions but more robust, and *Almost Arbitrary*, which is very close to Arbitrary but more robust. A graph of the probability of test B being Down when test A is Up for each of five different qualitative values is shown below. The probability of test A being Up is set to 50%.

The Almost Arbitrary line is nearly completely hidden behind the Arbitrary line. Notice how when we minimize interactions, the probability of test B being Down is the same whether test A is Up or not. When we choose the unknowns arbitrarily, the probability of test B being Down when test A is Up is always 50% because the probability of test B being Down when test A is Down provides no information about what happens when test A is Up. Maximum Information lies between the two extremes and provides a balance.