



Industrial Uses for Rule Creation Systems

Introduction

An expert's abilities can sometimes be represented by groups of "if...then..." rules, such as "If the crackers are too brown, then turn down the heat by 5 degrees". An interesting new technology allows us to create groups of rules like this *automatically*, through interaction with databases or plant simulators. These rules created by a computer can equal or exceed the performance of an expert, if conditions are right.

This relatively new capability of rule creation involves computer systems that create groups of rules by interacting with simulations or databases, and it has a number of important applications.

Below are three ways in which the creation of rules can save money and improve operations when the rules are used to control plants.

1. Representing expert knowledge

Suppose our plant has an expert in plant control who is ready to retire, or who needs to train multiple new hires. Suppose also that our expert (like many experts) has difficulty in explaining how he or she makes decisions (it is a rare plant that has a Standard Operations Manual capturing what is inside its experts' heads.)

One way for the expert to train new controllers is to let them watch what happens when the expert handles emergencies, but emergencies are generally rare, and this is not an efficient way to transmit the expertise from the expert to the people being trained.

If the expert's past actions have been captured in a database together with data representing the state of the plant when the expert took action, then a rule creation system can be used to create a set of rules that will generate the actions that the expert took under the same conditions. These rules can be read and reviewed by the expert, and so they can be expanded to handle other situations, modified in cases when the expert feels that an incorrect action was taken, and so forth. The resulting set of rules can replicate what the expert did, even if the expert would not have represented his or her reasoning in the form of rules. A benefit of creating such rules is that new hires can often learn them more easily than learning from an expert who is unable clearly to explain why he or she takes action.

The central point to note here is that, without any long and costly process of interviewing the expert, a computerized rule creation system can be used to look at past data in order to provide a very good initial set of rules that can be edited and that capture the expert's actual or desired behavior when actions are required to bring the plant under control.



2. Improving on expert practice

Let's suppose we have a set of rules created and edited as described in section 1 above. Is it possible to improve on those rules? This might be desirable—experts are always learning and looking for new best practices. A rule creation system can be used to improve on rules that reflect an expert's practice, as long as we have a software system available that simulates the operations of our plant.

The rule creation system would proceed as follows. It would start with the set of rules that our expert has validated. It would then be exposed to a variety of conditions in our simulated plant. It would experiment with modified versions of the rules, and with new rules, in order to attempt to continually improve its performance in handling simulated problems in the plant. At worst, the initial set of rules would pass through this process unmodified, and we would have learned that the expert's current procedures are very good. More likely, the system will find changes to the group of rules that will better handle the range of conditions it has experienced under simulation. In this case, once the expert has reviewed the new rules, validated them, and edited them, we may have found a way to control the plant even better than before—a useful outcome.

3. Creating expert practice

What if we have a new plant with no existing expert, or we have a plant with an expert that has already retired before his or her expertise was documented in some way? In that case, a rule creation system can be used to create a good starting point for representing what an expert could do in the plant. We would proceed as follows in order to create expert rules where none existed before (note that this procedure requires a plant simulator in order to work quickly and effectively.)

First, our rule creation system would create an initial group of simple rules for controlling the simulated plant. This initial set would be very general, and it would have very bad performance—this is why we want it to interact with a simulated plant rather than a real plant.

Next, we would have the system interact with the plant simulation, periodically modifying its rules, deleting rules, and creating new ones. After a great deal of interaction with the plant simulator, the rule creation system would contain a group of rules that handled the situations it had seen under simulation.

Finally, human controllers would review these rules, modify them, and validate them, as before. The reviewed, modified, and validated rules would be the outcome of this process, and would serve as a representation of what an expert would do to control this plant.

The only difference between this procedure and the procedure in section 2 above is that in this case the rule creation system begins with a very bad set of initial rules, since no good rules are known. It will probably take more computer time for a rule creation system to find a good set of rules under these conditions. In section 2, the rule creation system began with a set of expert rules, and so it would typically need to work less hard in order to find an even better set of rules.



Conclusions

We have discussed three different cases in which a rule creation system can be used to make life easier for plant controllers. There are many other ways in which rule creation can be useful in industry, but these examples demonstrate some of their general capabilities. The points to take away from this discussion are the following:

- Rule creation can help create a set of rules that replicate an expert's past behavior
- Rule creation can help improve rules that reflect current expert behavior
- Rule creation can help create rules where expertise does not already exist

The new technology of rule creation can improve our industrial practices without extensive interactions with our experts, whose time is precious. They are an improvement on older approaches such as expert systems, because they do not require the same level of human interaction as expert systems, and because they can improve on expert practice as well as capture it. They are an improvement on techniques such as neural networks because they produce results—groups of rules—that humans can read, edit, and validate.

The use of a rule creation system can capture best practices, create standard operating procedures that are easily taught to new hires, and even improve on current practice.