# Intelligent Techniques

There are quite a few ways organizations can capture knowledge using technology. **Knowledge discovery** tools and techniques help people find patterns, categories, and behaviors in massive amounts of data. A**rtificial intelligence (AI)** is not all about computers taking over the world and turning on their human inventors. Rather, many of the systems under the AI umbrella are useful tools for capturing, storing, and disseminating human knowledge and intelligence. Still over intelligent techniques help generate solutions to problems that can’t be solved by humans alone.

## Capturing Knowledge: Expert Systems

**Expert systems** are a common form of intelligent techniques. They are used to *assist* humans in the decision-making process, but they don’t *replace* humans. Many of the decisions we make are based on past experience, but we have the added benefit of reasoning and intuition. Expert systems ask questions, then give you advice and reasons why you should take a certain course of action based on hard data, not on hunches. Again, they don’t make the final decision.

Most of the problems an expert system helps resolve can, in fact, be solved by a human. But since the computer is faster or safer, businesses choose to use them instead of a person.

### How Expert Systems Work

Expert systems rely on a **knowledge base** built by humans based on their experiences and knowledge. The base requires rules and knowledge frames in which it can process data. When you think about it, humans work the same way. You look out the window to see if it’s raining. ***If*** it is, ***then*** you grab your umbrella. ***If*** it’s not raining, ***then*** you don’t. There you have it, a rule base.

Yes, we used a very simplified example. Most expert systems require thousands of rules and frames in which to operate in a rule-based expert system. The knowledge must be specific. In the example above, you wouldn’t take any action if the only information you had was “It rains 350 days a year in the Amazon rain forest.” Neither would an expert system.

The programming environment of an expert system uses rules, frames, and an **inference engine** to accomplish its tasks. The inference engine uses forward chaining or backward chaining to move through the rules and the frames.

In our example, using a **forward chaining** inference engine, you would start with the idea that it’s raining. You’d move through a series of decisions until you reached a conclusion and acted on it. You would determine that it’s raining, then you’d decide how much, then you’d decide how wet you don’t want to be, then you’d decide to take an umbrella. As long as the answer continues to be yes, you keep moving forward.

In a **backward chaining** inference engine, you’d start with a hypothesis and work backward until your hypothesis is proved or disproved. You got wet because it was raining; using an umbrella would prevent that.

You build an expert system in a similar fashion as other information systems in terms of hardware and software. However, it’s even more important to continually maintain and update an expert system: You never want to make decisions based on outdated or incorrect information. You can build a transaction processing system and perhaps not update it for six months to a year. With an expert system, you have to update the data and the processing software almost immediately and continually so that it’s never out of date.

### Examples of Successful Expert Systems

You measure the success of an expert system by the following criteria:

* Reduced errors
* Reduced cost, reduced training time
* Improved decisions
* Improved quality and services
* Happy users and happy customers

Most problems solved by expert systems are mundane situations. “If it’s raining, then take an umbrella.” But what happens if it’s cloudy and only “looks” like it will rain? Expert systems only do well in situations in which there are definitive outcomes. They aren’t good at making decisions based on guesses or hunches. The expert system might *advise* to take the umbrella along or to leave it home based on the input. The human makes the final decision to take or leave the umbrella.

If you understand that expert systems can only do so much, you’ll be just fine. If you understand that they aren’t people with the powers of reasoning and intuition, and therefore they can’t make every decision, you’ll know when to override the system and when to go with its output. Remember that everything in an expert system is based on IF this, THEN that. We know not everything is black and white and there are many gray areas.

Expert systems should not replace managers. They can aid managers in the decision-making process, but managers have to make the final call. For instance, you suggest to your boss that you should receive a pay raise. You have many subjective reasons why you should receive the raise; you arrive early and stay late, your work is always (well, almost always) turned in on time, you filled in for Sam while he was on vacation, and you’re a good worker. What happens if your boss relies on an expert system that uses only facts? You submitted the last two projects late (because the boss made last minute changes), you took an extra week’s vacation (when your child was in the hospital), and you were late to work three times in one month (because the subway broke down). You may or may not get the raise. Your boss still needs to use intuition, reasoning, and gut reaction to make the final decision.

## Organizational Intelligence: Case-Based Reasoning

So far, we’ve concentrated on capturing the individual knowledge in an expert system. Through practical experience, you’ve realized that “two heads are better than one.” Very seldom will only one individual work on a project. Or perhaps one individual works on the candy bar ad campaign while another works on the breakfast cereal campaign. They have different and yet similar experiences. What if you could tap into each person’s experience and knowledge on a collective basis? Take the best of the best from each one and apply it to your needs. Then you give your knowledge to someone else who will combine it with knowledge from others and continue building on “the best of the best.” That’s what a **case-based reasoning** (CBR)system does best.

The Help files you find in most desktop software applications are built on a case-based reasoning model. The technical support staff combines thousands of customer queries into a single database of problems and solutions and refines that information into a series of IF this is the problem, THEN try this. Access the Help files in your desktop software and try it.



***Figure 11-7: How Case-Based Reasoning Works***

Figure 11-7 gives you an excellent overview of how a case-based reasoning system works.

## Fuzzy Logic Systems

Okay, one more time, back to our umbrella. If it’s only cloudy outside, how do you know whether to take the umbrella? “It depends on how cloudy it is,” you say. If it looks like rain, you know to take the umbrella; there is a strong possibility that it will pour buckets. If it’s only a little cloudy and doesn’t look like rain, you’ll take the chance that you won’t get wet and leave the umbrella at home. That’s fuzzy logic!

**Fuzzy logic** is based on approximate values and ambiguous data. A fuzzy logic system will combine various data into a range of possibilities and then help solve problems that we couldn’t solve before with computers.

## Machine Learning

If you’ve made a purchase on Amazon.com or a clothing Web site like JC Penney, you’ve probably seen a feature displaying suggestions about what other people purchased when they purchased your item. How does the Web site know that? Because as people make purchases and view similar items, the computer running the Web site captures all that data and feeds it into an algorithm. The machine running the Web site “learns” about the preferences. As thousands and millions of people make purchases and view other items the **machine learning** capabilities of the knowledge management system used by Amazon.com and Penney’s are altered for future use.

Machine learning allows computer systems to recognize patterns in data and change their behavior based on their recognition of patterns, experience or prior knowledge. The use of machine learning has greatly expanded over the past few years because of improvements in algorithm design, growth of databases including “Big Data,” and the increase in raw computing power available in today’s computer systems.

## Neural Networks

This type of knowledge system is as close to emulating the human ability to learn as we’ve been able to come. Let’s return to our umbrella example. How do you know to take an umbrella when it’s raining? You probably got wet a few times without one. Then you tried using one when it rained and discovered that you didn’t get wet. You *learned* that when it rains, an umbrella will keep you dry. That’s basically how **neural networks** work.

You give a neural network data for which you already know the output, so that it has a base of correct information upon which it can build. When you give it new, different data, the computer will compare it with the previous data to determine what the correct outcome of the situation should be. If the data don’t fit, it figures out why. It adds that information to its current database of knowledge and then keeps taking in more data. It eventually *learns* the right outcome. The more data it takes in, and the more situations it gets right, the better it becomes at knowing the right answer to the next set of decisions.

If you want an excellent online demonstration of neural networks, <A HREF=“http://www.emsl.pnl.gov:2080/proj/neuron/neural/demos.html” target=”new”>Pacific Northwest National Laboratory’s Web site</a>.

**The Difference between Neural Networks and Expert Systems**

* Expert systems *emulate* human decision making.
* Neural networks *learn* human thought processes and reasoning patterns.
* Expert systems use rules and frames in which to make their decisions.
* Neural networks adjust to inputs and outputs.
* Expert systems provide explanations for solutions.
* Neural networks cannot explain why they arrived at a particular solution.
* Expert systems require humans to update their database of information.
* Neural networks continue to expand their own base of information.

## Genetic Algorithms

We’ve evolved as a human race through genetics. We are made up of many combinations of generations of humans. That’s how **genetic algorithms** work. Solutions to problems are examined by the system. The best solution is retained for future use, while the worst solutions are discarded. The solutions that are retained are used to help provide better solutions to future problems. They are combined and changed the next time they are used.

Businesses often need to solve problems that are dynamic, complex, and have many variables. Very few problems are clear-cut, black-and-white. Genetic algorithms are good systems for businesses to use because it’s almost like having millions of people coming at a problem from all directions.

## Hybrid AI Systems

We’ve mentioned before about taking the best of the best and that’s just what **hybrid AI systems** do. They take the best parts of expert systems and the best parts of fuzzy logic, and the best parts of neural networks, and combine them into one system that solves a problem. You can look forward to more of this hybridization as we continue to expand our knowledge of technology and of human behavior.

## Intelligent Agents

Jump on the Web and find the best price for computer printer supplies. Simply typing the words “computer printer supplies” into your favorite search engine will result in thousands of pages with more than just price information. You can find specific information on prices much faster using an **intelligent agent.** These software programs learn your personal preferences for accomplishing simple tasks and can take the drudgery out of repetitive, specific work. Figure 11-11 in the text demonstrates intelligent agent technology at work.

Businesses can use intelligent agents to help train users on new systems, schedule appointments, or monitor work in progress. By far though, the most popular use of this nifty little software program is as a “shopping agent” that surfs the Web for you looking for specific items to purchase or the lowest prices on a particular item.

If you’d like to try a shopping bot yourself, try www.mysimon.com . The Web site explains its service this way “Our secret is a team of helpers built with patent-pending software. The Virtual Learning Agent™ technology creates ‘intelligent agents’ trained by our own team of shopping experts to collect information from any online store.” It’s fun and fast.

Another way companies are using intelligent agent technology is by developing agents that mimic real entities—customers, supply chains, and stock markets. **Agent-based modeling** uses the agents to model behavior and help managers make decisions. For example, it seems reasonable to assume that it’s better to wait until you have a full truckload of supplies before you dispatch the truck. But P&G discovered through agent-based modeling that the amount of lost sales because of out-of-stock conditions actually cost the company more than the transportation expenses associated with partial truckloads of supplies.