One of the areas in AI that has witnessed the greatest popularity is knowledge-based systems, which we refer to here as knowledge application systems. **Knowledge application systems** are the topic of this chapter, and they basically apply knowledge to solve specific problems. Other areas of research within AI include natural language understanding, **classification**, diagnostics, design, **machine learning**, planning and scheduling, robotics, and computer vision. Next we describe the two most relevant intelligent technologies that underpin the development of knowledge application systems: rule-based expert systems and case-based reasoning.

RULE-BASED SYSTEMS

Traditionally, the development of knowledge-based systems had been based on the use of rules or models to represent the **domain knowledge**. The development of such systems requires the collaboration of a subject matter expert with a knowledge engineer, the latter being responsible for the elicitation and representation of the expert's knowledge. We will see two examples of **rule-based expert systems** when we present cases on Westinghouse Electric Corporation's GenAID and the SBIR/STTR Online Advisor later in this chapter.

The process of developing knowledge application systems requires eliciting the knowledge from the expert and representing it a form that is usable by computers. This process is called **knowledge engineering**. Knowledge engineers typically build knowledge application systems by first interviewing in detail the **domain expert** and representing the knowledge more commonly in a set of heuristics, or rules-of-thumb. Experts develop these rules-of-thumb over years of practical experience at solving problems. In order for the computer to understand these rules-of-thumb, we represent them as *production rules* or *IF-THEN* statements. For example: *IF* the number of employees is less than 500, *THEN* the firm is a small business is one of the rules that the SOS Advisor checks to ensure the firm is eligible for the SBIR/STTR program. Rules are the most commonly used knowledge representation paradigm, perhaps due to their intuitive implementation. The IF portion is the *condition* (also *premise* or *antecedent*), which tests the truth-value of a set of assertions. If the statement is true, the THEN part of the rule (also *action, conclusion,* or *consequence*) is also inferred as a fact.

In addition to rules, other paradigms to represent knowledge include **frames**, predicates, associative networks, and objects. Rule-based systems have posed some disadvantages. One is that in many circumstances, the number of rules that may be needed to properly represent the domain may be quite large. For example, the GenAID system that we describe in the first case study below consisted of about 10,000 rules when it was first deployed. Although later developments of GenAID may have condensed the number of rules by about 3,000, it was still considered a large system. Expert systems with such a large number of rules offer many disadvantages, namely (1) difficulty in coding, verifying, validating, and maintaining the rules; and (2) reduction in the efficiency of the inference engine executing the rules. As an alternative, we consider the use of cases as a method to represent knowledge. For more details on a rule-based systems refer to Chapter 8 of the book *Knowledge Management: Challenges, Solutions, and Technologies* (Becerra-Fernandez et al. 2004).