

## Chapter 2.17

# Aspects of Intelligence in an “SP” Database System

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### **ABSTRACT**

This chapter describes some of the kinds of “intelligence” that may be exhibited by an intelligent database system based on the SP theory of computing and cognition. The chapter complements an earlier paper on the SP theory as the basis for an intelligent database system (Wolff, forthcoming b) but it does not depend on a reading of that earlier paper. The chapter introduces the SP theory and its main attractions as the basis for an intelligent database system: that it uses a simple but versatile format for diverse kinds of knowledge, that it integrates and simplifies a range of AI functions, and that it supports established database models when that is required. Then with examples and discussion, the chapter illustrates aspects of “intelligence” in the system: pattern recognition and information retrieval, several forms of probabilistic reasoning, the analysis and production of natural language, and the unsupervised learning of new knowledge.

### **INTRODUCTION**

Ordinary database management systems are not very “intelligent” but they are good at storing large amounts of data and they normally provide such things as concurrency control, error recovery, distributed processing, and security. By contrast, AI systems exhibit one or more features of human-like intelligence but often lack the ability to handle large amounts of data or other features needed for large-scale applications. Development of an intelligent database system means the integration of these two types of system, preserving the best features of both (Bertino, Catania, & Zarri, 2001).

It is, of course, possible to achieve a certain kind of integration by taking an established database management system and bolting an AI system on top of it. This kind of hybrid system may provide a short-term solution for some kinds of problem but it is not likely to be satisfactory in the long term because of underlying differences in the

way data is stored or knowledge is represented, with a consequent need for translations across the divide and the likelihood that there will be residual incompatibilities that limit the overall effectiveness of the hybrid system.

To move beyond that kind of short-term integration, we need to look at both kinds of systems to see what they may have in common and whether it may be possible to develop a unified model that accommodates them both.

This is precisely the same logic that was applied when database management systems were first developed: early databases were each hard coded from scratch but it was soon clear that, since all databases need a system for storing and retrieving knowledge and they all need a user interface, a lot of effort could be saved by providing those facilities within a generalized database management system and loading that system with different kinds of data according to need. In a similar way, early hard-coded expert systems gave way to expert system “shells”, each providing a means of storing if-then rules, generalized inference mechanisms and a user interface. This kind of expert-system shell can receive various sets of rules, depending on the area of application.

The purpose of this chapter is to introduce a unified model that may pave the way towards that “deeper” kind of integration between database management systems and AI systems that we may hope to see in an intelligent database management system. The unified model that is the main focus of this chapter is the SP theory of computing and cognition, which has been under development since 1987, and which aims to unify a range of concepts in computing, especially AI, and a range of observations and concepts in human perception and cognition. The theory is outlined later in this chapter but readers wishing to know more will find a relatively short overview of the theory in Wolff (2003a), an extended exposition of the theory and its range of potential applications in

Wolff (2006), and further information in earlier papers cited in those two sources.

In the present context, the main attraction of the SP system is that it uses a simple but versatile format for diverse kinds of knowledge, it integrates and simplifies a range of AI functions, and it supports established database models when that is required. An earlier paper (Wolff, forthcoming b) describes with examples how the SP system can imitate established database models (the relational model, the network and hierarchical models, and the object-oriented model), and it briefly reviews the kinds of intelligence that the system can demonstrate. This chapter complements that earlier paper by describing with examples some aspects of intelligence in the system including pattern recognition, information retrieval, several forms of probabilistic reasoning, the analysis and production of natural language, and the unsupervised learning of new knowledge.

The main focus in this chapter and the earlier paper is on the way diverse kinds of knowledge may be represented and integrated within the system and the way one relatively simple model supports several aspects of human-like intelligence. Despite the wide scope of the theory, it does not yet aspire to say anything sensible about things like those mentioned earlier: concurrency control, error recovery, distributed processing, and security.

## **OUTLINE OF THE SP THEORY**

The SP theory of computing and cognition is a theory of information processing in *any* kind of system, either natural or artificial. It is founded on principles of *minimum length encoding* pioneered by Solomonoff (1964) and others (see Li & Vitányi, 1997).<sup>1</sup>

The key idea in the SP theory is that all kinds of “computing”, “information retrieval”, “calculation”, “deduction”, “inference” or other forms

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