The Reuse of Knowledge in Ripple Down Rule Knowledge Based Systems

Deborah Christina Richards

THE UNIVERSITY OF
NEW SOUTH WALES

A Thesis submitted in the fulfilment
of the requirements for the degree of
Doctor of Philosophy

Department of Artificial Intelligence
School of Computer Science and Engineering
The University of New South Waltes
Sydney, NSW, 2052
Australia

December 1998

Abstract

The work reported in this thesis is motivated by the belief that knowledge-based systems (KBS) research needs to focus more on users' needs and cater for the various decision situations in which users will find themselves. To build individual systems that cater for all the activities that may be needed is not feasible or desirable. The problems associated with capturing knowledge are well known and the ability to capture knowledge once and access and manipulate the knowledge in multiple ways is highly desirable. It adds value to the original knowledge and offers all the benefits associated with the reuse of resources. Thus, the problem becomes one of knowledge reuse. The research question pursued in this thesis is "can knowledge captured for one purpose, such as consultation, be reused to support a wide range of alternative purposes, such as critquing or tutoring, allowing the user to answer different types of questions according to their current circumstances"? Further, this question was to be answered in a situated cognition, dynamic knowledge framework.

The system developed in this thesis is based on the Multiple Classification Ripple Down Rule (MCRDR) knowledge acquisition and representation technique. MCRDR is a form of cased-based reasoning which uses rules to index cases. The cases and the exception structure provide a situated cognition based approach. It was found that MCRDR already supported the activities of knowledge acquisition (KA), maintenance, inferencing and validation within the one system. However, a range of activities, which are referred to as reflective activities, were not well supported by the performance knowledge being captured using MCRDR. These activities include explanation, tutoring, causal modelling, 'what-if' analysis, hypothesis testing and student modelling. These reflective activities required uncovering the concepts, both primitive and more abstract, in the knowledge base. In addition these concepts needed to be ordered and structured. It was found that Formal Concept Analysis (FCA) provided a way of retrospectively uncovering an abstraction hierarchy which could be used to support the reflective activities.

A tool was developed which allowed FCA to be used with MCRDR. The approach was evaluated by consulting experts about the discovered concepts and carrying out a student survey comparing a number of different rule representations. Although these evaluations are not definitive, they clearly suggest that an integrated MCRDR-FCA system provides the types of KA and reuse required.

A number of related issues were addressed in this thesis. One is the removal of repetition from RDR KBS and experiments performed using Induct and Rough Set Theory are reported and discussed in this thesis. Another issue is how to support the KA activity when multiple sources of expertise are involved. A requirments engineering (RE) framework has been developed as a solution to this problem and is an extension of the FCA modelling work.

Perhaps the most significant contribution of this thesis is the demonstration that we can start with assertional knowledge that is simply acquired and automatically derive terminological knowledge. Such an approach may be an answer to the KA bottleneck problem and the diffulties associated with building models such as unreliability and variation between users and the articulation, maintenance and validation of such models.

Acknowledgements

There are many people I must thank. Without their assistance the pages that follow would be blank. Firstly, I thank my supervisor Paul Compton for his various contributions which include: encouragement, knowledge, advice, understanding, flexibility, RDR and even babysitting. I thank Tim Menzies for his enthusiasm and support and for pushing me to look further at the area of RE and conflict resolution. I also thank Tim for his valuable comments on an earlier draft of this thesis. I thank the academic and administration staff in the School of Computer Science and Engineering. I thank the Australian Federal Government and the School of Computer Science and Engineering at UNSW for their financial support which made pursing my dream possible. I thank my friends in the AI lab at UNSW just for being there. Phil Preston deserves a special mention as I could always rely on him to help me out whether the problem concerned software or arranging a piece of equipment for a seminar. I apologise to those who have had a quite weekend in the lab disturbed by my three noisy children. I wish you all success.

Beyond Kensington campus, I have many others to thank. Bob Colomb has answered many an email message and provided me with a range of software and files each time I have asked. And his response time is truly remarkable. I thank the four experts that gave me their time to provide evaluations: Glenn Edwards, Zvi Hochman, Geoff Taylor and Mary Mulholland. Others who have kindly assisted me include Jacek Sienkiewicz, Klaus Biedermann, Frank Vogt and Peter Burmeister. I have taken much inspiration, and encouragment, from Bob Colomb, Brian Gaines, Zdzislaw Pawlak, Mildred Shaw and Rudolf Wille.

On a more personal level, I thank my mother for giving me the confidence to begin and complete such a journey. I thank my children Sally, William and James for your unquestioning love and hope that you will follow your dreams as I have done. You have been my reality. I always have and always will put you first. A very special thanks goes to my girlfriends: Deidre Vaill, Helen Terry, Susan Campbell, Pauline Holmwood, Anne Green and Brigit ten Bruggencate. I thank Deidre for driving my kids to and from school for the last three years. You gave me time, which is such a precious gift. Helen had the privilege, or misfortune, of being my only friend who lived near UNSW and often minded my kids while I was at Uni during the school holidays. I am indebted to all of you for your support and very real assistance in caring for my children when I had paper deadlines or was away at conferences. This thesis is a tribute to the sisterhood of women.

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