

The Third International Conference on Case-Based Reasoning (ICCBR'99)

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Case-based reasoning (CBR) is a problem-solving paradigm that uses exemplars or previous solutions to solve new problems (Aamodt and Plaza 1994; Kolodner 1993). Three characteristics of CBR account for its growing popularity. First, CBR can reduce search. Solution reuse is compatible with a wide range of problem-solving methods, so a CBR component can be used in many types of problem-solving system. When similar problems recur, CBR can significantly improve performance. This performance improvement can be particularly significant for problems with large search spaces, such as planning and design (Bergmann and Wilke 1996; Branting and Aha 1995; Veloso 1994; Koton 1988).

The second characteristic is that CBR permits problem solving even when the underlying domain theory is incomplete. This characteristic is beneficial in domains such as medicine (Porter et al. 1990) and law (Skalak and Rissland 1992; Ashley 1990) in which reasoning depends on vague or context-dependent concepts, such as reasonable care or probable cause. The ability to yield useful results in the absence of a complete domain theory also means that CBR systems can begin to provide useful performance while they are still under construction (Varma 1999; Acorn and Walden 1992).

Finally, CBR can facilitate knowledge acquisition. Although human experts can seldom articulate general problem-solving rules, they can often explain the solutions to particular problems. Thus, knowledge engineer-

ing tends to be easier for CBR systems. Moreover, many governmental and commercial institutions have vast repositories of reports on repairs, accidents, and other incidents. CBR provides a mechanism for converting these repositories into useful helpdesk, lessons-learned, or advisory systems much more quickly and inexpensively than alternative approaches (Aha and Weber 2000; Bergmann et al. 1999).

Current activity within the CBR community falls primarily within two broad strands. One area of activity emphasizes theoretical issues in repre-

The Third International Conference on Case-Based Reasoning was held at the Seeon Monastery, Bavaria, 27 to 30 July 1999. About 120 researchers from 21 countries attended. The conference included 4 workshops; 3 invited talks; 24 technical presentations; a poster session; and an Industry Day, where the focus was on mature technologies and applications in industry.

sentation, indexing and retrieval, and adaptation. Often, the target domains are characterized by complex representations, large search spaces, or incomplete domain theories. The second area of activity emphasizes the pragmatic issues of implementation, integration into business processes, and system maintenance. The target domains often involve help desks or sales.

Prior to 1995, there was relatively little interaction between the North

American and European CBR communities. The First International Conference on Case-Based Reasoning (ICCBR) (Veloso and Aamodt 1995), held in Sesimbra, Portugal, brought these communities together. The second ICCBR was held across the Atlantic in Providence, Rhode Island (Leake and Plaza 1997). The third ICCBR was held once again in Europe, at the Seeon Monastery, Bavaria, 27 to 30 July 1999. Continuing an ICCBR tradition of having chairs from both sides of the Atlantic, the ICCBR'99 conference chair was Ralph Bergmann (University of Kaiserslautern), and Klaus-Dieter Althoff (Fraunhofer Institute for Experimental Software Engineering) and L. Karl Branting (University of Wyoming) were program cochairs.

Industry Day

The conference began with an Industry Day, chaired by Brigitte Bartsch-Sporl (BSR Consulting Munich) and Wolfgang Wilke (tecunno GmbH, Kaiserslautern). The Industry Day presentations illustrated a number of successful commercial applications of CBR in the United States and Europe.

In his invited talk, Ian Watson (University of Auckland) reviewed several applications in the United States (Lockheed, Compaq, and Broderbund) and showed how CBR can successfully be commercialized. He concluded that the future of CBR is in online applications, such as product selection and self-service in electronic commerce.

Four successful commercial applications were then presented. The first presentation described the use of CBR for a service hotline at Mercedes Benz. The second talk illustrated the use of CBR for knowledge management by Nuon, a Dutch energy provider, which reengineered its entire customer-service process around a CBR model. The next two presentations dealt with the application of CBR to electronic commerce. Quoka uses CBR for the retrieval of advertisements and provides a natural language user interface. Finally, Let on the Net, a CBR-based online market for the rental of houses and apartments, made Hooke and Macdonald the market leaders in

the new-homes sector in Ireland.

In a concluding talk on the key factors for the success of CBR in practice, Brigitte Bartsch-Sporl stressed the importance of nontechnical issues in application projects, such as profitability calculations and social and psychological factors.

Industry Day was accompanied by an exhibition of commercial CBR tools and demonstrations of successful applications.

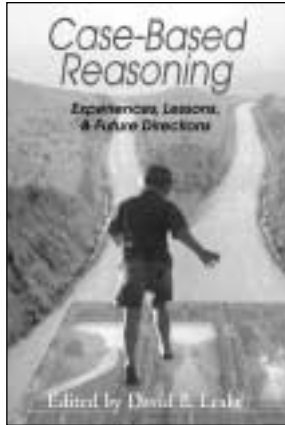
Workshops

Four concurrent workshops were held on the morning of the second day of the conference. Two focused on business applications: "Integration of CBR in Business Processes" and "Practical CBR Strategies for Building and Maintaining Corporate Memories." The other two workshops focused on theoretical issues: "Formalization of Adaptation in CBR" and "Hybrid CBR Systems."

"Integration of CBR in Business Processes" addressed the organizational processes involved in the development and maintenance of CBR systems. Discussion focused on the life cycle of cases and the impact of CBR systems on organizations. "Practical CBR Strategies for Building and Maintaining Corporate Memories" was also concerned with the business environment but focused instead on methodologies for knowledge management.

"Formalization of Adaptation in CBR" addressed the most complex aspect of CBR: adaptation of prior solutions to solve new problems that differ in some significant respect. Adaptation is typically required for synthesis tasks, such as planning, design, or configuration, because solutions have a complex structure that must be modified to apply to new problems. This workshop addressed the elusive goal of developing a domain-independent model of adaptation.

As mentioned earlier, CBR is compatible with a wide range of problem-solving methods. A variety of CBR hybrids are therefore possible. "Hybrid CBR Systems" focused on the synergies that can be obtained from integrating CBR with other problem-solving paradigms.



Case-Based Reasoning: Experiences, Lessons, and Future Directions

Edited by David B. Leake

This book provides a vision of the present and a challenge for the future of case-based reasoning research and applications. It includes chapters addressing fundamental issues and approaches in indexing and retrieval, situation assessment and similarity assessment, and case adaptation. These chapters provide a "case-based" view of key problems and solutions in context of the tasks for which they were developed. It also presents lessons learned about how to design CBR systems and how to apply them to real-world problems. The final chapters include a perspective on the state of the field and the most important directions for future impact.

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Invited Talks

CBR is an increasingly popular technique for electronic commerce. The first invited talk, "Intelligent Systems in Electronic Commerce" by Pdraig Cunningham (Trinity College Dublin), discussed the relationship between CBR and alternative approaches to product selection, such as collaborative filtering or constraint-based retrieval. Several promising applications were discussed.

Boi Faltings (Ecole Polytechnique Fédérale de Lausanne) gave the second invited talk, entitled "Case Adaptation—New Perspectives for CBR." Faltings stressed the centrality of adaptation to CBR, arguing that without adaptation, CBR is no different from information retrieval. This view generated some controversy because many commercial systems perform no adaptation. This controversy mirrored the underlying division between motives for using CBR: reduction of search in complex domains versus fast knowledge acquisition in commercial domains.

The final invited talk, by Kevin Ashley (University of Pittsburgh), was entitled "Text-Based CBR." CBR involves reuse of prior experiences, and

prior experiences are recorded in textual form by many commercial and governmental institutions. Constructing CBR systems for domains with textual cases can therefore be automated using some combination of information extraction, machine learning, and natural language-processing techniques. However, the precise combination of techniques that yields the best results for a given domain is frequently unclear. Research in text-based CBR is still in its early stages (Lenz and Ashley 1998), but the long-term benefits of this line of research are likely to be great.

Paper Presentations

The 24 technical paper presentations and 20 posters covered topics ranging from the sublime (expressive musical performance) to the mundane (locomotive diagnosis). Themes that seemed more popular in ICCBR'99 than in previous conferences included maintenance and integration. CBR system maintenance includes such issues as updating case libraries to remove cases that have become outdated, editing case libraries to select the most predictive cases, and select-

ing new cases for inclusion. Integration, mentioned previously, consists of techniques for combining CBR with other, complementary problem-solving paradigms so that each technique compensates for the weaknesses of the other.

As in past ICCBRs, numerous papers addressed theoretical issues concerning retrieval (probability-based metrics, annotated case summaries, footprint-based retrieval) and adaptation (evolutionary approaches, a knowledge-level task model of adaptation). Further topics covered included planning (coordination of search-and-rescue operations, flexibly interleaving processes, interactive case-based hierarchical task network planning), design (engineering design support, footwear design, reusability in system design), diagnosis (case-oriented tutoring, locomotive diagnostics, welding robot diagnosis), and vision (image segmentation architecture, reuse of image processing knowledge).

The numerous successful applications described in ICCBR'99 papers illustrate that CBR has matured into a technology well suited for a wide range of practical problems. The broader lesson for AI is that the effectiveness of CBR demonstrates the power of a tight integration of machine learning with problem solving.

Further Information

For additional information on ICCBR'99, see www.iccbr.org/iccbr99. The conference proceedings of ICCBR'99 was published by Springer Verlag. On the occasion of ICCBR, the *Engineering Applications of Artificial Intelligence* journal (Elsevier) published a special issue, guest edited by Ralph Bergmann, that contains extended versions of the best ICCBR papers that describe engineering applications of CBR. ICCBR'01 will be held in Vancouver, Canada, immediately prior to the Seventeenth International Joint Conference on Artificial Intelligence. The conference chair is Qiang Yang, and the program chairs are David Aha and Ian Watson. For further information, see www.iccbr.org/iccbr01.

References

- Aamodt, A., and Plaza, E. 1994. Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches. *AI Communications* 7(1): 39–59.
- Acorn, T., and Walden, S. 1992. SMART: Support Management Automated Reasoning Technology for Compaq Customer Service. In *Innovative Applications of Artificial Intelligence 4*, eds. A. Scott and P. Klahr, 3–18. Menlo Park, Calif.: AAAI Press.
- Aha, D., and Weber, R., eds. 2000. *Intelligent Lessons Learned Systems: Papers from the AAAI Workshop*. Technical Report WS-00-03. Menlo Park, Calif.: AAAI Press.
- Ashley, K. 1990. *Modeling Legal Argument: Reasoning with Cases and Hypotheticals*. Cambridge, Mass.: MIT Press.
- Bergmann, R., and Wilke, W. 1996. On the Role of Abstraction in Case-Based Reasoning. Paper presented at the Third European Workshop on Case-Based Reasoning (EWCBR-96), 14–16 November, Lausanne, Switzerland.
- Bergmann, R.; Breen, S.; Goker, M.; Manago, M.; and Wess, S. 1999. *Developing Industrial Case-Based Reasoning Applications*. Lecture Notes in Artificial Intelligence 1612. New York: Springer-Verlag.
- Branting, K., and Aha, D. 1995. Stratified Case-Based Reasoning: Reusing Hierarchical Problem-Solving Episodes. In Proceedings of the Fourteenth International Joint Conference on Artificial Intelligence (IJCAI-95), 384–390. Menlo Park, Calif.: International Joint Conferences on Artificial Intelligence.
- Kolodner, J. 1993. *Case-Based Reasoning*. San Francisco, Calif.: Morgan Kaufmann.
- Koton, P. 1988. Using Experience in Learning and Problem Solving. Ph.D. dissertation, Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology.
- Leake, D., and Plaza, E., eds. 1997. *Case-Based Reasoning Research and Development: First International Conference on Case-Based Reasoning (ICCB-97)*. Lecture Notes in Artificial Intelligence 1266. New York: Springer Verlag.
- Lenz, M., and Ashley, K., eds. 1998. *Textual Case-Based Reasoning: Papers from the 1998 AAAI Workshop*. AAAI Technical Report WS-98-12. Menlo Park, Calif.: AAAI Press.
- Porter, B. W.; Bareiss, E. R.; and Holte, R. C. 1990. Concept Learning and Heuristic Classification in Weak-Theory Domains. *Artificial Intelligence* 45(1–2): 229–263.
- Skalak, D., and Rissland, E. 1992. Arguments and Cases: An Inevitable Intertwining. *Law and Artificial Intelligence* 1(1): 3–48.
- Varma, A. 1999. ICARUS: Design and Deployment of a Case-Based Reasoning System for Locomotive Diagnostics. In *Case-Based Reasoning Research and Development: Third International Conference on Case-Based Reasoning (ICCB-99)*, 501–596. Lecture Notes in Artificial Intelligence 1650. New York: Springer Verlag.
- Veloso, M. 1994. *Planning and Learning by Analogical Reasoning*. New York: Springer-Verlag.
- Veloso, M., and Aamodt, A., eds. 1995. *Case-Based Reasoning Research and Development: First International Conference on Case-Based Reasoning (ICCB-95)*. Lecture Notes in Artificial Intelligence 1010. New York: Springer Verlag.

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Ralph Bergmann finished his doctoral dissertation on case-based planning at the University of Kaiserslautern in 1996. Since 1995, he has been project leader at the University of Kaiserslautern for several large research and development projects on case-based reasoning and knowledge-based systems funded by German and European organizations. His current research focuses on knowledge management and knowledge processing applied to virtual assistants for electronic commerce and electronic service. He is author or coauthor of more than 90 scientific papers, and he organized several case-based reasoning workshops and conferences. His e-mail address is bergmann@informatik.uni-kl.de.

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