Automating Prover Development for Non-Classical Logics

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Our interest in this talk is automation of prover development and other related tasks for non-classical logics, focussing on modal, description and intuitionistic logics. Developing and implementing a theorem prover from scratch is not straightforward and very time-consuming. There are however general principles for implementing theorem provers and many techniques and optimisations in provers are logic-independent. For automated prover generation it is therefore important to try and distil such general principles and techniques while at the same time exploiting as best as possible logic-specific properties. In an ongoing research project we have developed a tableau prover generator, called Mettel [1, 14, 15]. It takes as input the specification of the syntax of a logic and a set of inference rules defining a deduction calculus for the logic. The output is Java code of a prover that performs inferences in accordance with the specified calculus. Mettel is designed to make it very easy to obtain provers for various logics, including not previously studied logics. In this talk we demonstrate the use of Mettel, we discuss some of its internal workings, and highlight some practical experiences so far from various case studies [2, 4, 5, 6, 7]. Issues and results related to ensuring completeness, blocking to ensure termination [9, 10, 12], automatic rule refinements [13], automatic rule generation [11], and automating correspondence theory [3, 8] will be touched upon.

References

[1] MetTeL website. `http://www.mettel-prover.org`.

[2] C. Dixon, B. Konev, R. A. Schmidt, and D. Tishkovsky. Labelled tableaux for temporal logic with cardinality constraints. In *Proceedings of the 14th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing (SYNASC 2012)*, pages 111–118. IEEE Computer Society, 2012.

[3] D. M. Gabbay, R. A. Schmidt, and A. Szałas. *Second-Order Quantifier Elimination: Foundations, Computational Aspects and Applications*, volume 12 of *Studies in Logic: Mathematical Logic and Foundations*. College Publications, 2008.

[4] M. Khodadadi, R. A. Schmidt, and D. Tishkovsky. An abstract tableau calculus for the description logic SHOI using unrestricted blocking and rewriting. In Y. Kazakov, D. Lembo, and F. Wolter, editors, *Proceedings of the 2012 International Workshop on Description Logics (DL-2012)*, volume 846 of *CEUR Workshop Proceedings*. CEUR-WS.org, 2012.

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[5] M. Khodadadi, R. A. Schmidt, and D. Tishkovsky. A refined tableau calculus with controlled blocking for the description logic SHOI. In D. Galmiche and D. Larchey-Wendling, editors, *Automated Reasoning with Analytic Tableaux and Related Methods (TABLEAUX 2013)*, volume 8123 of *Lecture Notes in Computer Science*. Springer, 2013. To appear.

[6] M. Khodadadi, R. A. Schmidt, D. Tishkovsky, and M. Zawidzki. Terminating tableau calculi for modal logic K with global counting operators. Manuscript, 2012.

[7] S. Minica, M. Khodadadi, D. Tishkovsky, and R. A. Schmidt. Synthesising and implementing tableau calculi for interrogative epistemic logics. In P. Fontaine, R. A. Schmidt, and S. Schulz, editors, *PAAR-2012: Proceedings of the Third Workshop on Practical Aspects of Automated Reasoning*, volume 21 of *EPiC Series*. EasyChair, 2012.

[8] R. A. Schmidt. The Ackermann approach for modal logic, correspondence theory and second-order reduction. *Journal of Applied Logic*, 10(1):52–74, 2012.

[9] R. A. Schmidt and D. Tishkovsky. Using tableau to decide expressive description logics with role negation. In Aberer et al, editor, *The Semantic Web*, volume 4825 of *Lecture Notes in Computer Science*, pages 438–451. Springer, 2007.

[10] R. A. Schmidt and D. Tishkovsky. A general tableau method for deciding description logics, modal logics and related first-order fragments. In A. Armando, P. Baumgartner, and G. Dowek, editors, *Automated Reasoning (IJCAR 2008)*, volume 5195 of *Lecture Notes in Computer Science*, pages 194–209. Springer, 2008.

[11] R. A. Schmidt and D. Tishkovsky. Automated synthesis of tableau calculi. *Logical Methods in Computer Science*, 7(2):1–32, 2011. Short version published in *Proc. TABLEAUX 2009*.

[12] R. A. Schmidt and D. Tishkovsky. Using tableau to decide description logics with full role negation and identity, 2013. To appear in *ACM Transactions on Computational Logic*.

[13] D. Tishkovsky and R. A. Schmidt. Refinement in the tableau synthesis framework, 2013. arXiv e-Print 1305.3131v1 [cs.LO].

[14] D. Tishkovsky, R. A. Schmidt, and M. Khodadadi. MetTeL2: Towards a tableau prover generation platform. In P. Fontaine, R. A. Schmidt, and S. Schulz, editors, *PAAR-2012: Proceedings of the Third Workshop on Practical Aspects of Automated Reasoning*, volume 21 of *EPiC Series*. EasyChair, 2012.

[15] D. Tishkovsky, R. A. Schmidt, and M. Khodadadi. The tableau prover generator MetTeL2. In L. F. del Cerro, A. Herzig, and J. Mengin, editors, *Proceedings of the 13th European Conference on Logics in Artificial Intelligence (JELIA 2012)*, volume 7519 of *Lecture Notes in Computer Science*, pages 492–495. Springer, 2012.