Habilitation Thesis Reviewer's Report

Masaryk University

Faculty	Faculty of Informatics
Procedure field	Informatics
Applicant	Dr. rer.nat. RNDr. Mgr. Bc. Jan Křetínský, Ph.D.
Applicant's home unit, institution	Technical University of Munich, Germany
Habilitation thesis	*Modern Probabilistic Verification*
Reviewer	Prof. Slawek Lasota
Reviewer's home unit, institution	Faculty of Mathematics, Informatics and Mechanics, University of Warsaw, Poland

SUMMARY

The topic of the habilitation thesis is formal verification, with the main emphasis on verification of probabilistic systems (modeled as finite Markov chains and Markov decision processes). The thesis itself consists of a brief overview of the results, together with attached 10 selected papers co-authored by the habilitant, Jan Křetínský.

The overview, except for a short introduction, presents briefly state of the art of the three groups of topics: applications of simulation and machine learning techniques to probabilistic verification (Chapter 2), applications of automata on infinite words to LTL model-checking (Chapter 3), and probabilistic verification with respect to complex correctness criteria (Chapter 4). Each of the three chapters contains also a brief overview of the contributions of the habilitant to the respective fields (the list is far from being exhaustive):

- in Chapter 2: the first stopping criterion for value iteration for simple stochastic games; applications of stochastic simulation and learning techniques for fast approximate verification of black-box probabilisitic systems and for compact representation of strategies produced by probabilistic verification.

- in Chapter 3: new translations from LTL (and its extensions) to omega-automata avoiding the complexity of the seminal Safra's construction; their running implementations (Rabinizer 3 and Rabinizer 4 tools); and integration with the PRISM tool for probabilistic verification.

- in Chapter 4: new notion of probabilistic bisimulation equivalence based on distributions on states rather than on individual states; progress in the satisfiability problem for PCTL and model-checking of an extension of LTL (frequency LTL); new methods of risk estimation in probabilistic systems.

EVALUATION

These results (even without the ones not mentioned above) are impressive, both qualitatively and quantitatively. On one side, the habilitant did not hesitate to attack difficult problems, and has proved capable of providing highly-nontrivial solutions. On the other side, the number of different contributions is far beyond the customary requirements for habilitation. This is confirmed by a number of publications in best venues. For instance, among the 10 articles listed in the thesis (or rather 12 articles, if counting separately the initial conference versions and the final journal ones) there are 3 LICS publications, 3 CAV publications, and 2 top journal articles (Logical Methods in Computer Science, ACM Transactions on Computational Logic). Among other papers co-authored by Jan Křetínský (whose total number according to the DBLP database is 61 (impressively high!), with 37 out of them published in 2014 or later, i.e., after PhD) there is one further LICS article, six further CAV articles, eight CONCUR articles, to list only the best venues, and six further journal articles, among the others.

Another positive aspect of the research record in the good balance between theory and practice: several results seem to be pretty applicable and some of them are implemented in tools (especially the translations of LTL to omega-automata). The applicability of the results are confirmed by multiple publications in application-oriented conferences such as TACAS and ATVA (3 of them belonging to the 10 articles listed in the thesis).

The research topics, even if mostly concentrated on verification of probabilistic systems, are quite diverse, ranging from automata to logic.

Other aspect of the scientific activity of Jan Křetínský are also impressive: he has been invited to program committees of several good international conferences, has given a number of invited talks at good international venues, has been involved in organization of several workshops (including a Dagstuhl seminar) and has already started supervision of several PhD students.

The only negative factor of the research record of Jan Křetínský that I can notice is the fact that his publications, in vast majority, are multi-authored and that the number of co-authors tends to be relatively high. In his total research record I found only two single-authored pa-

pers, seemingly both being surveys. In particular, focusing on the 10 articles selected for the thesis, all of them are multi-authored and the average number of co-authors equals 4.

RECOMMENDATION

Jan Křetínský shows himself as a very effective degree collector: up to now he has been granted three Bachelor's degree, two Master's degree, one advanced Master's degree (according to his CV), and two PhD degrees! And without any doubts he deserves granting one more - the habilitation degree. On the basis of the presented habilitation thesis, I declare that the research record of the habilitant meets, with huge excess, the most demanding requirements for the habilitation degree. In may opinion the overall publication and research activity record is pretty comparable to one required at the level of professor degree.

Summing up, I strongly support granting Jan Křetínský habilitation degree. In case there exists a custom of formal distinctions of best habilitation theses, I wholeheartedly recommend this thesis for such distinction.

Reviewer's questions for the habilitation thesis defence (number of questions up to the reviewer)

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Conclusion

The habilitation thesis entitled "*Modern Probabilistic Verification*" by Jan Křetínský *fulfills* requirements expected of a habilitation thesis in the field of Informatics.

In Warsaw on 2019.03.24