

Report on the outcomes of a Short-Term Scientific Mission¹

Action number: CA20111

Grantee name: Franziska Alber

Details of the STSM

Title: String Solving with Parametrized Automata

Start and end date: 25/05/2025 to 01/06/2025

Description of the work carried out during the STSM

Description of the activities carried out during the STSM. Any deviations from the initial working plan shall also be described in this section.

(max. 500 words)

On the first day of the STSM, Franziska Alber received a warm welcome, a key and a desk in one of the TU Wien working group's shared offices. The day was then spent outlining a few promising open research questions and then choosing one problem on which Clemens Eisenhofer (TU Wien) and Franziska Alber worked for the following days: computing and deciding emptiness of the intersection of a regular expression and a string term with powers. This point was reached faster than expected in the initial working plan, mostly due to preparations before the start of the STSM.

Over the following days, significant progress was made on the chosen problem. While we had initially planned to utilize parametrized automata in our research, it quickly turned out that other classes of automata are more suitable to model the problem. The intersection of a regular expression and a string term with powers can be obtained by computing the product of a finite-state automaton and a finite-state automaton that has been equipped with counters (the latter is a much weaker model than counter automata, which are Turing complete). While this is a straightforward transformation, unforeseen interactions between counters complicate important decision properties. Our task was therefore to investigate the decidability and complexity of the emptiness problem for such automata with counters, and come up with efficient algorithms for the implementation.

Most breakthroughs occurred outside of formal meetings while discussing ideas in front of a whiteboard, and we posit that the observed amount of progress would not have been possible had we not met and worked together in person. By the third day, formalization and implementation of the developed approach

¹ This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

began. There were two formal meetings, one kick-off meeting on the first day and one meeting summarizing the findings on the third day.

Description of the STSM main achievements and planned follow-up activities

Description and assessment of whether the STSM achieved its planned goals and expected outcomes, including specific contribution to Action objective and deliverables, or publications resulting from the STSM. Agreed plans for future follow-up collaborations shall also be described in this section.

(max. 500 words)

We have shown that, using very simple transformations, the problem above can be reduced to computing the Parikh image of a unary regular language (which itself can be computed in polynomial time, see [1]). This result was obtained by combining the knowledge of both working groups. We are now continuing our work on two fronts: efficient implementation of the method, and solving related, open problems that will close significant gaps regarding solving string equations with powers. Clemens Eisenhofer will visit the University of Regensburg for a week in early July, and we are planning to submit a paper on the subject later this year.

In conclusion, this STSM has achieved all goals outlined in the final section of the application form.

[1] Anthony Widjaja To. "Parikh Images of Regular Languages: Complexity and Applications." CoRR abs/1002.1464, 2010.

Hosting scientist: Laura Kovács, TU Wien

