Referee's report on the Doctor Dissertation by György Vaszil

Referee:	Professor Alexander Meduna, PhD
Doctoral Dissertation:	*The Descriptional Complexity of Rewriting Systems – Some Classical and Non-Classical Models*
Author:	*György Vaszil*

Summary

This dissertation presents the author's work in the field of theoretical computer science—or, more specifically, in formal language theory. The main focus lies on the area of descriptional complexity, which studies various measures of complexity of formal models, such as the number of nonterminal symbols or rules in a grammar. It examines the trade-off between different limits and their effects on descriptive power of the system.

The studied models of computation fall into three basic categories. First, there are generative grammars with regulation, with tree-controlled grammars, simple semi-conditional grammars, and scattered context grammars as chosen representatives. Second, the author studies grammar systems, specifically parallel communicating (PC) grammar systems (with context-free components). The last, less traditional category entitled membrane systems includes P systems and P colonies, which are formal models inspired by biological observations of living cells and their interactions with the environment.

The document is organized as follows. The first chapter introduces the reader to the discussed models of computation in an informal or semi-formal way, and summarizes previously established results regarding their properties. It also briefly introduces the area of descriptional complexity.

In the second chapter, the author presents some of the general notions from formal language theory that are of key importance to the discussed topics. Formal definitions are provided.

The three subsequent chapters correspond to the three investigated types of formal models. Each of these chapters follows the same basic structure. First, the author introduces the discussed models and concepts in more detail, including precise formal definitions. He then shows how some of their parameters can be bounded and how such limits affect their properties. In particular, the main effort is to improve known bounds or introduce new bounds while maintaining the descriptive power of the system without these restrictions (in case of the investigated models, this usually means characterizing the class of recursively-enumerable languages).

Instead of an overall concluding chapter, the author chooses to include separate Remarks section for each of the discussed models of computation. These sections summarize the original results, place them in wider context, and offer directions in which further research might progress (or, in some cases, already has progressed, which is acknowledged by the author). They also state where the results were first published.

Remarks and observations

György Vaszil has authored and co-authored a large number of papers related to the presented work, published in international scientific journals (in particular I would like to point out six papers in *Theoretical Computer Science* and one in *Information Processing Letters*) and at conferences (such as the well-known *Descriptional Complexity of Formal Systems*).

The dissertation shows that the author has extensively studied previous work in the investigated areas, and relevant publications are properly cited. Based on this study, the author proceeded to establish new, original results, which form a substantial, important

contribution to the study of formal language theory.

From a theoretical point of view, the presented results—previously published in the aforementioned papers—hold and are demonstrated in detail. Most of the proofs also include semi-formal explanations, which greatly aid the reader in following the author's ideas.

Despite the overall high quality of the presented work, I do have several remarks and questions. First, there are certain inconsistencies throughout the text, for instance in the way definitions are presented. Also, throughout the text, certain pivotal terms are used interchangeably (e.g. *string* and *word* and related concepts such as *substring* and *subword*, or *rule* and *production*). As the author explicitly expects the reader's familiarity with the basic concepts of formal language theory, this is easily understandable, but I believe that higher consistency could further improve the readability and clarity of the text.

Further, I would welcome more examples illustrating the discussed models and concepts, as is done for tree-controlled grammars. In some cases, graphical representation might also be helpful for easier understanding (e.g. derivation trees in tree-controlled grammars).

As for formal and linguistic quality of the present document, there is only a negligible amount of typographical mistakes and typing errors (e.g. "priductions" instead of "productions"). While I am not a native English speaker myself, I believe that there are occasional minor grammatical errors (particularly with regards to punctuation), and some of the sentences and phrases seem somewhat unnatural or unnecessarily hard-to-follow. However, these issues are relatively rare, and the overall quality of the writing is very good.

Some specific observations:

- In proof of Theorem 3.2.1, I believe there should be $h(zuv)w$ instead of $h(zuv)$ on lines 10 and 12, p. 22.
- In the definition of direct derivation in semi-conditional grammar (p. 26), the function $sub(x)$ is not defined (it seems to denote the set of all symbols that appear in string x).
- On p. 106 (proof of Theorem 5.3.7), the deterministic `ADD` instruction should be `ADD` instead of `nADD` (again on p. 110 in proof of Theorem 5.3.8).
- On p. 108 (proof of Theorem 5.3.8), the resulting objects in C_1 should be $l_l l_l$ instead of $l_k l_k$.
- Could the definition of non-homogeneous query (part of Definition 4.2.1, p. 52) be simplified? It appears partially redundant and possibly even somewhat confusing.
- According to p. 14, the set of all finite multisets over the finite set V is to be denoted by V^*, which coincides with previously (p. 11) introduced notation for the set of all words over a given alphabet (as alphabets are by definition also finite sets). Is there a particular reason for this choice? (Perhaps connected with the string representation of a finite multiset?)
- Page 93 (Figure 5.1: Flowchart of the universal machine U_{32}) overflows.
- In Bibliography, first item on p. 115, A. K. should be Kelemenová, A.

Question

Could the author make a statement concerning all the specific observations sketched above?

Conclusion

Although there are occasional minor issues as mentioned above, which should be addressed during the dissertation defense, the presented work is of high overall quality and clearly demonstrates the author's scientific erudition. It brings a number of new, original results, which were published in well-known scientific journals and at major conferences. I find that György Vaszil has shown his scientific ability, as well as a great, lasting interest in the field. The presented results significantly contribute to the study of formal language theory.

The doctoral dissertation has achieved the defined objectives, used appropriate methods and bringed new knowledge, which is both significant in theory and applicable in practice. Therefore, this dissertation satisfies all the requirements, and it is ready for its final defence.

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