

# Communication Complexity for Picture Languages

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21 novembre 2013

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Picture languages represent a two-dimensional generalisation of the classical unidimensional concept of regular (rational) languages, obtained by replacing words by rectangular pictures. They can be defined equivalently in various ways : by logical formulas, regular expressions or tiling systems. However none of them provide sufficient means to characterise regular languages, i.e. obtain a systematic method to prove whether some language is indeed regular. In fact, while problems about unidimensional regular languages can often be solved using automata or graph theory, the same questions on two-dimensional languages usually require tools from complexity (or computability) theory.

The purpose of the internship is to devise a new necessary condition for a language to be rational based on communication complexity. Informally, communication complexity studies how much information should be transferred between two peers Alice and Bob, each with a different fragment of the input, for them to compute some given function of the whole input. This particular complexity is well adapted to the study of two-dimensional languages. Indeed, we will be able to represent in this formalism the obvious remark that, tearing a picture in half, the information each fragment contains about the other half is encoded in the boundary.

It is expected from the intern to first acquire knowledge in two-dimensional languages and communication complexity, and then to use them to study how this tool may help in answering some open problems in two-dimensional language theory. In particular we will be interested in proving that some specific two-dimensional language (the reverse context free shift) is not regular.

A basic knowledge of and an interest in formal language theory is expected from the applicant.

## Références

- [1] Dora Giammarresi and Antonio Restivo. Two-dimensional languages. In *Handbook of Formal Languages*, volume 3. Beyond Words. Springer, 1997.
- [2] Dora Giammarresi and Antonio Restivo. Matrix-based complexity functions and recognizable picture languages. In *Logic and Automata - History and Perspectives*. Amsterdam University Press, 2008.
- [3] Eyal Kushilevitz and Noam Nisan. *Communication Complexity*. Cambridge University Press, 1996.