

The discovery of the Turing Completeness of the Chemical Reaction Networks (CRN) language was only the beginning of a long journey. Our team works hard to optimize a compiler that takes as input an elementary mathematical function and return a CRN that compute this function. We also propose a more robust framework to compute with CRN in a way that is robust to internal perturbation and adapt on the fly to external ones. Interestingly, these pragmatic works offered us two interesting theoretical results about PODE. Namely, the NP completeness of the quadratization for PODE and a strong relation between algebraic functions and PODE.

The initial compiler was known to generate CRN using more species than needed. This inoptimality was in part due to the quadratization step : this operation reduces the order of the polynomial ordinary differential equation to 2 in order to be able to compile the function to an elementary CRN. To optimize the compiler, we found that while the existence of a quadratization was a well known fact in the mathematical community, the optimization of this operation had never been investigated. We will show that it is a NP complete problem.

Using our proposed framework in a biological setting, we realized that it was highly sensitive to noise and found this inadequate. We thus propose a new one called absolute functional robustness, and found that this framework is only able to express the algebraic functions, a relation that I will explain in details.