Characterizing computational complexity classes with ordinary differential equations

Daniel Graça,

Universidade do Algarve and Instituto de Telecomunicações

In this talk we will show how classical complexity classes such as P, EXPTIME, or PSPACE can be characterized with ordinary differential equations. Although it is known that continuous-time models of computation can simulate Turing machines, defining proper notions of complexity for such models has been challenging, since time can be "stretched" or "compressed" in an arbitrary manner, making it very hard to establish a meaningful notion of time complexity for such models (this is the so-called Zeno phenomenon). In [1] it was shown that one can characterize the complexity class P with ordinary differential equations, by using the length of the solution curve as the complexity measure. This analysis depended heavily on properties of polynomials. Here we show how such characterization can be extended to other time complexity classes such as EXPTIME or the Grzegorczyk hierarchy. We also consider space complexity and show how PSPACE can be characterized with ordinary differential equations. This is joint work with O. Bournez, R. Gozzi, and A. Pouly.

References

[1] O. Bournez, D. S. Graça, and A. Pouly, *Polynomial time corresponds to solutions of polynomial ordinary differential equations of polynomial length*, Journal of the ACM, 64(6):38:1–38:76, 2017.