Speaker: Carles Noguera

Title: Fagin's Theorem for Semiring Turing Machines

Abstract: In this talk we introduce a new machine model (Semiring Turing Machines) incorporating quantitative information in computations, distinct from so called weighted Turing machines. We improve on some earlier limitations in the model from Eiter & Kiesel (Semiring Reasoning Frameworks in AI and Their Computational Complexity, J. Artif. Intell. Res., 2023) thus providing a more natural machine model. In this way, we are able to recapture all the complexity results in Eiter & Kiesel (2023) in our new model, connecting a quantitative version of NP to various counting complexity classes. We discuss the shortcomings in Eiter & Kiesel (2023) and provide the exact relation between the old quantitative version of NP, called $NP_{\mathcal{R}}$ where $\mathcal{R}$ is a semiring, and the new one introduced here. More importantly, we solve an open problem posed in Eiter & Kiesel (2023) by providing a Fagin-style theorem (Theorem 19) for the quantitative complexity class that we call $NP_{\infty\mathcal{R}}$, using a version of weighted existential second-order logic that allows predicates to be interpreted as semiring-annotated relations. This result provides a precise logical characterization of the power series that form the class $NP_{\infty\mathcal{R}}$. Joint work with Guillermo Badia, Manfred Droste, Thomas Eiter, Rafael Kiesel, and Erik Paul.