LOGIC SESSION (FRI 9/1/26)

ROOM S303 (12.45-15.35)

Kerkko Luosto (Tampere University)
Regular Representations of Uniform TC^0 **(12.45-13.05)**

This is joint work with Lauri Hella and Juha Kontinen. In descriptive complexity theory, complexity classes are studied by using various logics. A lot of progress in this field has concerned complexity classes below PTIME during the last two decades. In particular, we considered the circuit complexity classes DLOGTIME-uniform AC^0 and DLOGTIME-uniform TC^0 and, in short, just AC^0 and TC^0. Both of these have well-known characterizations in terms of logics and so-called built-in relations.

We formulate what it means that a logic is regular in the context of built-in relations. It is known that AC^0 is not closed under restricting AC^0-computable queries into simple subsequences of the input. This implies that the characterizations of AC^0 as a logic are not regular. It is not transparent from the known characterizations of TC^0 either, that the logics of TC^0 are regular, but we present logics with (generalized) quantifiers and built-in linear order that make this apparent. Actually, TC^0 is the regular closure (where the closure is defined in the natural way) of AC^0.

We discuss these concepts, results, and techniques behind the results.

Matias Selin (Tampere University)
Characterizing Graph Neural Networks with Random Initialization **(13.15-13.35)**

State-of-the-art methods of processing data in the form of graphs revolve around the use of graph neural networks (GNNs), an application of deep learning that has received considerable interest during the past decade. However, theoretical work has lagged behind, and even the basic expressive power of many of these models has long remained ambiguous. Recent years have seen considerable interest in filling this gap by giving logical characterizations of these models and of how architectural adjustments affect them, one of which is random node initialization. The talk presents recent results in this research program, including a novel characterization developed in my master's thesis based on the work of Ahvonen et al. (2024).

Veeti Ahvonen (Tampere University)
Logical characterizations of graph transformers **(13.45-14.05)**

Transformers form the foundation of modern large language models (LLMs), such as ChatGPT and Copilot, and have proven highly effective for addressing a wide range of problems. Recently, graph transformers—that is, transformers tailored for graph data—have gained significant attention in the field of graph learning, which has traditionally been dominated by graph neural networks and related frameworks. Nevertheless, little is known about the precise expressive power of graph transformers. In this talk, we will explore a recently published joint work that introduces logical characterizations of graph transformers.

Joni Puljujärvi (University College London)
A new Ehrenfeucht-Fraïssé game for dependence logic **(14.15-14.35)**

We define a new Ehrenfeucht-Fraïssé game for dependence logic. A version of the EF game for dependence logic was already introduced by Väänänen almost two decades ago; however, that game was essentially the EF game of existential second-order logic, i.e. the moves of the game are sets instead of elements, making the game rather cumbersome to actually play. Our new game is, on the other hand, a variant of the ordinary EF game for first-order logic where the moves are elements. It differs from the first-order game in that the first player makes certain commitments during a play: he is allowed to declare that a move he makes is determined by a given number of previous moves.

Of course, trying to see any kind of dependences between moves in a single play of the game is a fool's errand, but if the players proceed to play several different plays and the first player declares the same dependences in each one, then it is possible to investigate whether the first player truly has played according to his commitments.

The existence of a so-called uniform winning strategy for the second player in this newly defined game captures equivalence in dependence logic the same way the existence of a winning strategy for the second player in the previous game of Väänänen does, but this one, we claim, appeals more to the intuition of playing the Ehrenfeucht-Fraïssé game than the old game of second-order flavour.

This is joint-work with Jouko Väänänen.

Miguel Moreno (University of Helsinki)
Borel sets and the generalized Baire spaces **(14.45-15.05)**

One of the main motivations to develop Generalized Descriptive Set Theory was the connection with Model Theory (in particular Stability Theory and Shelah's Main Gap). The development was done under the assumptions $\kappa^{<\kappa} = \kappa$. One of the main objectives in the Generalized Descriptive Set Theory program has been its development without this assumption, and the definition of κ-Borel sets in a way that the theory is meaningful and the connections with other fields are not lost (in particular the connection with Model Theory).

In a joint work with Tapani Hyttinen and Jouko Väänänen, we develop Descriptive Set Theory in Generalized Baire Spaces without assuming $\kappa^{<\kappa} = \kappa$. Our notion of κ-Borel coincides with the established one when the assumption $\kappa^{<\kappa} = \kappa$ is made. We found that our generalized notion has connections with Model Theory in a similar way to when the assumption $\kappa^{<\kappa} = \kappa$ is made.

Otto Rajala (University of Helsinki)
Singular cardinals in choiceless models **(15.15-15.35)**

The study of choiceless models of set theory, that is, models satisfying the ZF axioms but not the Axiom of Choice, has been a centrally important theme in set theory during the past half-century. The research on such models is motivated, on the one hand, by the enormously powerful implications of determinacy principles on the properties of cardinals and the structure of sets of real numbers. On the other hand, many natural strengthenings of large cardinal axioms are incompatible with the Axiom of Choice. There are many intriguing phenomena related to cardinals in choiceless models, especially in models satisfying the Axiom of Determinacy. I will discuss some of these phenomena, and I will also talk about ongoing research on forcings that singularize cardinals in choiceless models.

This work is joint with Rahman Mohammadpour and Sebastiano Thei.