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THESIS ABSTRACTS

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KRISTINA BRANTLEY, ***Monadic Intuitionistic and Modal Logics Admitting Provability Interpretations***, New Mexico State University, USA, 2019. Supervised by Guram Bezhanishvili. MSC: O3B45, 03B55, 03F45. Keywords: modal logic, intuitionistic modal logic, monadic modal logic, Gödel translation, Solovay's theorem.

Abstract

The Gödel translation T provides an embedding of the intuitionistic logic IPC into the modal logic Grz, which then embeds into the modal logic GL via the splitting translation S. Combined with Solovay's theorem that GL is the modal logic of the provability predicate of Peano Arithmetic PA, both IPC and Grz have arithmetical interpretations. When attempting to 'lift' these results to the monadic extensions MIPC, MGrz, and MGL of these logics, the same techniques no longer work. Following a conjecture made by Esakia, we add an appropriate version of Casari's formula to these monadic extensions (denoted by a '$+$'), obtaining that the Gödel translation T embeds $\mathsf{M^+IPC}$ into $\mathsf{M^+Grz}$ and the splitting translation S embeds $\mathsf{M^+Grz}$ into MGL. As proven by Japaridze, Solovay's result extends to the monadic system MGL, which leads us to an arithmetical interpretation of both $\mathsf{M^+IPC}$ and $\mathsf{M^+Grz}$.

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ROSARIO MENNUNI, ***Invariant Types in Model Theory***, The University of Leeds, UK, 2020. Supervised by Dugald Macpherson and Vincenzo Mantova. MSC: 03C45 (primary), 03C64, 03C65. Keywords: domination, model theory, neostability theory, invariant types, small-type semi-isolation.

Abstract

To a saturated first-order structure $\mathfrak{U}$ it is possible to associate the semigroup $(S^{\mathrm{inv}}(\mathfrak{U}), \otimes)$ of global invariant types. This can be endowed with the *domination* preorder, the semi-isolation analogue of Shelah's $\mathrm{F}^{\mathrm{s}}_{\kappa}$-isolation: $p \geq_{\mathrm{D}} q$ holds iff p together with a small set of formulas entails q. Its kernel $\sim_{\mathrm{D}}$ is called *domination-equivalence*, and this dissertation studies the quotient $S^{\mathrm{inv}}(\mathfrak{U})/\sim_{\mathrm{D}}$. We give sufficient conditions for $\otimes$ to induce a well-defined operation on it, yielding the *domination monoid* $\widetilde{\mathrm{Inv}}(\mathfrak{U})$, develop the general theory of the latter, provide tools to compute it, and do so in various cases of interest.

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In [3], where $\widetilde{\mathrm{Inv}}(\mathfrak{U})$ was introduced to prove an Ax–Kochen–Eršov-type result, it was claimed that this semigroup is always well-defined and commutative. We disprove both statements, provide $\sim_{\mathrm{D}}$-invariants, and show independence of $S^{\mathrm{inv}}(\mathfrak{U})/\sim_{\mathrm{D}}$ from the choice of $\mathfrak{U}$ to contradict the Independence Property.

Theorem A. *There is a supersimple theory of SU-rank* 2 *in which* $\sim_D$ *is not a congruence with respect to* $\otimes$, *and where* $\geq_D$ *differs from nonforking-domination. Moreover, in the Random Graph* $\widetilde{\mathrm{Inv}}(\mathfrak{U})$ *is not commutative.*

Theorem B. *If* $p_0 \geq_D p_1$ *and* p_0 *is definable, finitely satisfiable in some small model, generically stable, or weakly orthogonal to* q, *then so is* p_1.

Theorem C. *If there are only boundedly many* $\sim_D$*-classes, then* T *is* NIP.

Beyond the above results from [4], we reduce the study of $\widetilde{\mathrm{Inv}}(\mathfrak{U})$ in o-minimal context to proving that every invariant type is equivalent to a product of 1-types, and show this to hold in Real Closed Fields. This yields a complete characterisation both in this theory and, using results from [1], in that of Real Closed Valued Fields. We also survey the stable case, compute $\widetilde{\mathrm{Inv}}(\mathfrak{U})$ in several other theories, including that of dense meet-trees, and show its well-definedness in certain expansions of the latter studied in [2].

Theorem D. *In Real Closed Fields,* $(\widetilde{\mathrm{Inv}}(\mathfrak{U}), \otimes)$ *is well-defined and isomorphic to the semilattice of finite subsets* $(\mathscr{P}_{fin}(X), \cup)$, *where* X *is the set of convex subrings of* $\mathfrak{U}$ *which, for some small* A, *are fixed by the stabiliser* $\mathrm{Aut}(\mathfrak{U}/A)$.

Theorem E. *In dense meet-trees,* $\widetilde{\mathrm{Inv}}(\mathfrak{U})$ *has the form* $\mathscr{P}_{fin}(X) \oplus \bigoplus_{|\mathfrak{U}|} \mathbb{N}$.

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[4] R. Mennuni, Product of invariant types modulo domination–equivalence. *Archive for Mathematical Logic*, vol. 59 (2020), pp. 1–29. https://doi.org/10.1007/s00153-019-00676-9

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José Miguel Blanco, ***An Implicative Expansion of Belnap's Four-Valued Matrix: A Modal Four-Valued Logic Without Strong Modal Lukasiewicz-Type Paradoxes*** (in Spanish), University of Salamanca, Spain, 2018. Supervised by Gemma Robles and José M. Méndez. MSC: 03B47, 03B45, 03B50, 03B53. Keywords: substructural logics, relevance logics, modal logics, many-valued logics.

Abstract

Towards the end of his life, the great Polish logician J. Łukasiewicz developed the four-valued modal system known as Ł. This system validated theses as $(MA \wedge MB) \rightarrow M(A \wedge B)$