

Substructural Logics with Modal Operators

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About the research project

We aim to investigate cut-free dual context sequent calculus for substructural modal logics.

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2. It allows us to construct rules for each group separately, establishing how they relate with each other.
3. In particular, we have two cut rules, one for the box context, and other for ordinary assumptions.
4. This concept was first introduced by Jean-Yves Girard in 1993 [4].

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2. Contraction

Example

See modal logic K by Pfenning (Slides)

Bibliography

-  G. A. Kavvos. Dual-Context Calculi for Modal Logic. Logical Methods in Computer Science Volume 16, Issue 3, 2020, pp. 10:1–10:66
-  G. M. Bierman and V. C. D. de Paiva. On an Intuitionistic Modal Logic. Studia Logica 65, 383–416 (2000).
<https://doi.org/10.1023/A:1005291931660>
-  F. E. Miranda-Perea, L. C. González Huesca and P. S. Linares Arévalo. A dual-context sequent calculus for the constructive modal logic S4. Mathematical Structures in Computer Science. 2022;32(9):1205-1233. doi:10.1017/S0960129522000378
-  Girard, J. -Y. On the unity of logic. Annals of Pure and Applied Logic, 59(3):201217, feb 1993.
-  Pfenning, F. Decomposing Modalities. Logical Frameworks and Meta-Languages: Theory and Practice (LFMTP'15), 59(3):201217, Berlin, Germany, August 1, 2015 (Slides).