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The IO- and OI-hierarchies

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Abstract

An analysis of recursive procedures in *ALGOL 68 with finite modes* shows, that a denotational semantics of this language can be described on the level of program schemes using a *typed \hat{I} -calculus with fixed-point operators*. In the first part of this paper, we derive classical schematological theorems for the resulting class of *level- n schemes*. In part two, we investigate the language families obtained by *call-by-value* and *call-by-name* interpretation of level- n schemes over the algebra of formal languages. It is proved, that differentiating according to the functional level of recursion leads to two infinite hierarchies of recursive languages, the *IO-* and *OI-hierarchies*, which can be characterized as canonical extensions of the regular, context-free, and IO- and OI-macro languages, respectively. Sufficient conditions are derived to establish strictness of *IO-like hierarchies*. Finally we derive, that *recursion on higher types* induces an infinite hierarchy of control structures by proving that level- n schemes are strictly less powerful than level- $n+1$ schemes.



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