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Descriptive complexity for hard counting problems with easy decision version.
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The class #P is the class of functions that count the number of solutions to problems in NP. Since very few counting problems can be exactly computed in polynomial time (e.g. counting spanning trees), the interest of the community has turned to the complexity of approximating them. The class #PE of problems in #P with decision version in P is of great significance.

We focus on a subclass of #PE, namely TotP, the class of functions that count the total number of paths of NPTMs. TotP contains all self-reducible #PE functions and it is *robust*, in the sense that it has natural complete problems and it is closed under addition, multiplication and subtraction by one.

We present logical characterizations of TotP and two other *robust* subclasses of this class, building upon two seminal works about descriptive complexity for classes of counting problems [1, 2]. Specifically, to capture TotP, we use recursion on functions over second-order variables which, we believe, is of independent interest.

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[1] S. Saluja and K.V. Subrahmanyam and M.N. Thakur, *Descriptive Complexity of #P Functions*, ***Journal of Computer and System Sciences***, vol. 50, no. 3, pp. 493–505.

[2] M. Arenas and M. Muñoz and C. Riveros, *Descriptive Complexity for Counting Complexity Classes*, ***Logical Methods in Computer Science***, vol. 16, no. 1.