

On Read-Once Threshold Formulae and their Randomized Decision Tree Complexity

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Abstract

TC^0 is the class of functions computable by polynomial-size, constant-depth formulae with threshold gates. Read-Once TC^0 ($RO-TC^0$) is the subclass of TC^0 which restricts every variable to occur exactly once in the formula.

Our main result is a (tight) linear lower bound on the randomized decision tree complexity of any function in $RO-TC^0$.

This relationship between threshold circuits and decision trees bears significance on both models of computation. Regarding decision trees, this is the first class of functions for which such a strong bound is known. Regarding threshold circuits, it may be considered as a possible first step towards proving $TC^0 \neq NC^1$; generalizing our lower bounds to all functions in TC^0 will establish this separation.

Another structural result we obtain is that a read-once threshold formula uniquely represents the function it computes.