Games, walks and grammars: Problems I've worked on

Vervoort, M.R.

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Abstract

This dissertation consists of three disjunct parts.
The first part, titled 'Blackwell Games', is about the problem of determinacy of Blackwell games, a class of infinite games of imperfect information, where both players simultaneously select moves from a finite set, infinitely many rounds are played, and payoff is determined by a Borel measurable function f on the set of possible resulting sequences of moves. We give elementary proofs of determinacy for Blackwell games whose payoff function is an indicator function of a Borel set up to complexity $G_{\delta\sigma}$. For general Borel payoff functions, we give a reduction, found by D.A. Martin[16], to the known result of determinacy of Borel perfect information games. We also consider Blackwell games whose payoff function is not Borel measurable, and formulate an analogue of the Axiom of Determinacy for these games. Finally, we compare some of the consequences of this 'Axiom of Blackwell Determinacy' with those of the original Axiom of Determinacy.
In the second part, titled 'Random Walks', we consider recurrence in reinforced random walks, where edges in a graph are traversed with probabilities that may be different (reinforced) at second, third etc. traversals. We focus on the case where the probability for any edge only changes once, after its first traversal. As a special case, we show that the once-reinforced random walk on the infinite ladder is almost surely recurrent if reinforcement is small (extending a result by T. Sellke[31]), as well as when reinforcement is sufficiently large. For the last result, we use an application of nonstandard analysis to graph theory.
The third part, titled 'The EMILE Grammar Inducer', is about the EMILE program, a program that reads in a text, and without prior knowledge attempts to determine the grammatical structure of the language. The basic concepts and algorithms underlying the program are discussed, as well as the results of this approach, both in theory and in practice. It is argued that natural languages satisfy the condition of *shallowness*, and that this implies that the EMILE program will work well for natural languages. In a separate appendix, explicit pseudo-code for each of the sub-algorithms of EMILE is given.