Abstract moves consist of changing the feature vectors, which we use to model the tactical and strategic aspects of the game. We use a hierarchy of boards and associated feature vectors that contain properties of the objects on the board at different levels of granularity. Such a hierarchy is needed to enhance decomposition by search and moreover, it can be used in a model of human reasoning about Go. We wanted to mimic human Go playing, since even amateur Go players are far superior to the best current computer Go programs.

This paper is organized as follows. Section 2 deals with the way humans reason effectively about Go. In section 3 we explain adversarial planning and explain our motivations for an adaptation of this approach. We discuss the board hierarchy and the feature vectors in section 4 and elucidate our choice for a graph representation. Our planning method is subject of section 5.

2 A model of human reasoning on Go

Human reasoning on Go is performed at roughly two levels of abstraction, a strategic and a tactical level. In reasoning on the strategic level one considers the whole board situation and focuses on the global interactions between different structures on the board. Tactical reasoning aims at finding locally good moves. We constructed a simple cognitive model of human reasoning on Go, consisting of the following steps. First (*abstraction*), the situation on the board is judged. Global structures called groups are recognized. Weak points in the groups and opportunities for both sides are investigated. Second (*goal formulation*), based on the relative strength of the groups, the most important areas to play in are determined. Goals are formulated to change the situation in this area. Third (*pursuing goals*), one tries to find locally a move that satisfies the goal, considering just a few good ways of resistance by the opponent. It sometimes happens in professional play that, even though some area is clearly the most important, the player moves attention to a different area because he cannot find a move that is locally good. This exception to the rule indicates that professional play indeed resembles this three step approach.

In order to mimic the effective way of human Go playing, it is also our approach to separate strategic and tactical reasoning. In order to do so, we will use different board representations with an appropriate level of granularity for each type of reasoning. On the tactical board we represent local objects and features, such as strings of adjacent stones and their number of liberties. On the strategic board we only use global objects and features, like groups and their degree of safety.

Besides mimicking human Go playing an advantage of using such a hierarchy of boards lies in the way of adding knowledge to your program. Abstract board representations by definition contain knowledge. This is either explict knowledge that has been used to make an abstraction step, or it is implicit in the form of some search that has been performed in order to deduce an inevitable outcome of some local situation, for example, stones have been shown to be connectable. Using abstract boards prevents that too much knowledge of the program is put in the evaluation function alone, making the program less manageable. Instead