1.0. Abstract.

In this paper we compare the descriptive power of three programming logics by studying the elementary equivalence relations which the logics induce on nondeterministic state-transition systems. In addition, we compare these relations with other natural state-equivalence relations for nondeterministic systems. We find that the notions of *bisimilarity* (Park [P], Ogden [O]) and *observation equivalence* (Milner [M]) are very strong equivalences compared with those induced by the logics. These three comprise *regular trace logic* (RTL), *propositional dynamic logic* (PDL), and *Hennessy-Milner logic* (HML). Regular trace logic is a new logic which can be used to give behavioral specifications for concurrent systems (e.g. Wolper [W], but with significant differences). It is a way of formalising those properties of programs which have been given informally in terms of path expressions [CH]. The model theory and axiomatics of this logic are interesting in their own right. Propositional dynamic logic is well-known; our treatment differs from the standard one only in that we regard the modalities as specifying intended behavior instead of being programs. Hennessy-Milner logic is a simplified modal logic which those authors used as a characterisation of their notion of observation equivalence, which we call weak observation equivalence in this paper. We also include a brief treatment in this context of two other natural equivalences for nondeterministic systems: *failure equivalence* [HBR] and *trace equivalence* [H], both of which are weaker than the relations induced by the logics but can be characterised using appropriate logical subsets.

1.1. Introduction.

In this paper we generalise the notion of state-equivalence, familiar from the theory of sequential machines, to the case of nondeterministic transition systems, and use it to investigate some issues in the semantics of parallel processes. We are motivated by several recent studies of parallelism and concurrency. In particular we are interested in modelling systems which can be controlled through interactions with a surrounding environment, but which are also capable of making internal or hidden moves, in a way which cannot be influenced by an outside agent. This sort of behavior naturally demands a nondeterministic model, especially when no probabilities can reasonably be attached to the internal actions.