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ON BEHAVIOUR EQUIVALENCE FOR PROBABILISTIC I/O AUTOMATA AND ITS RELATIONSHIP TO PROBABILISTIC BISIMULATION [1]

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ABSTRACT

Previous work of the author has developed *probabilistic input/output automata* (PIOA) as a formalism for modelling systems that exhibit concurrent and probabilistic behaviour. Central to that work was the notion of the "behaviour map" associated with a state of a PIOA. The present paper presents a new, simpler definition for PIOA behaviour maps, investigates the induced "same behaviour map" equivalence relation, and compares it with the standard notion of probabilistic bisimulation equivalence. *Weighted finite automata* are used as a unifying formalism to facilitate the comparison. A general notion of congruence for weighted automata is defined, which relates *signed measures* on states, rather than just individual states. PIOA are defined as a class of weighted automata, as are the class of *probabilistic weighted automata* for which the standard definition of probabilistic bisimulation makes sense. A characterization is obtained of probabilistic bisimulation as the largest congruence that is in a sense generated by its restriction to a relation on states. This characterization is then used as the definition of *weighted bisimulation*, which generalizes probabilistic bisimulation to the full class of weighted automata. PIOA behaviour equivalence is also shown to define a weighted automata congruence, which is strictly refined by weighted bisimulation equivalence. The relationship between these congruences and a notion of *composition* for weighted automata is also examined.

Keywords: Probabilistic I/O automata, weighted automata, continuous-time Markov chains, probabilistic bisimulation, lumpability

1. Introduction

In previous work [22] we introduced *probabilistic I/O automata* (PIOA) as a formal model for systems that exhibit concurrent and probabilistic behaviour. An important

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