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**JOSEE DESHARNAIS**, Université Laval

*Almost Sure Bisimulation in Labelled Markov Processes*

In this talk we propose a notion of bisimulation for labelled Markov processes parameterised by negligible sets (LMPns). The point is to allow us to say things like two LMPs are “almost surely” bisimilar when they are bisimilar everywhere except on a negligible set. Usually negligible sets are sets of measure 0, but we work with abstract ideals of negligible sets and so do not introduce an ad-hoc measure. The construction is given in two steps. First a refined version of the category of measurable spaces is set up, where objects incorporate ideals of negligible subsets, and arrows are identified when they induce the same homomorphisms from their target to their source  $\sigma$ -algebras up to negligible sets. Epis are characterised as arrows reflecting negligible subsets. Second, LMPns are obtained as coalgebras of a refined version of Giry’s probabilistic monad. This gives us the machinery to remove certain counterintuitive examples where systems were bisimilar except for a negligible set. Our new notion of bisimilarity is then defined using cospans of epis in the associated category of coalgebras, and is found to coincide with a suitable logical equivalence given by the LMP modal logic. This notion of bisimulation is given in full generality - not restricted to analytic spaces. The original theory is recovered by taking the empty set to be the only negligible set.