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The gap between Gromov-vague and Gromovâ€“Hausdorff-vague topology

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Abstract

In Athreya etÂ al. (2015) an invariance principle is stated for a class of strong Markov processes on tree-like metric measure spaces. It is shown that if the underlying spaces converge Gromov vaguely, then the processes converge in the sense of finite dimensional distributions. Further, if the underlying spaces converge Gromovâ€“Hausdorff vaguely, then the processes converge weakly in path space. In this paper we systematically introduce and study the Gromov-vague and the Gromovâ€“Hausdorff-vague topology on the space of equivalence classes of metric boundedly finite measure spaces. The latter topology is closely related to the Gromovâ€“Hausdorffâ€“Prohorov metric which is defined on different equivalence classes of metric measure spaces.

We explain the necessity of these two topologies via several examples, and close the gap between them. That is, we show that convergence in Gromov-vague topology implies convergence in Gromovâ€“Hausdorff-vague topology if and only if the so-called lower mass-bound property is satisfied. Furthermore, we prove and disprove Polishness of several spaces of metric measure spaces in the topologies mentioned above.

As an application, we consider the Galtonâ€“Watson tree with critical offspring distribution of finite variance conditioned to not get extinct, and construct the so-called Kallenbergâ€“Kesten tree as the weak limit in Gromovâ€“Hausdorff-vague topology when the edge length is scaled down to go to zero.

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MSC

primary, 60B05; 60B10; secondary, 05C80; 60B99

Keywords

Metric measure spaces; Gromov-vague topology; Gromovâ€“Hausdorff-vague; Gromov-weak; Gromovâ€“Hausdorff-weak; Gromovâ€“Prohorov metric; Lower mass-bound property; Full support assumption; Coding trees by excursions; Kallenberg tree

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