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The Wasserstein space of stochastic processes

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Researchers from different areas have independently defined extensions of the usual weak topology between laws of stochastic processes. This includes Aldous' extended weak convergence, Hellwig's information topology and convergence in adapted distribution in the sense of Hoover-Keisler. We show that on the set of continuous processes with canonical filtration these topologies coincide and are metrized by a suitable *adapted Wasserstein distance* $\mathcal{AW}$. Moreover, we show that the resulting topology is the weakest topology that guarantees continuity of optimal stopping.

While the set of processes with natural filtration is not complete, we establish that its completion is precisely the space processes with filtration FP. We also observe that $(\mathrm{FP}, \mathcal{AW})$ exhibts several desirable properties. Specifically, $(\mathrm{FP}, \mathcal{AW})$ is Polish, martingales form a closed subset and approximation results like Donsker's theorem extend to $\mathcal{AW}$.

This talk is based on joint work with Daniel Bartl, Mathias Beiglböck, Gudmund Pammer and Xin Zhang.

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