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Digital twins for bias-free inference

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According to the standard cosmological model, about 95% of the Universe is dark. Recent large survey analyses reveal tensions with this model. For instance, the local measurement of the expansion rate and the estimate of the Universe homogeneity differ by more than three standard deviations from those inferred with the cosmic microwave background. The cosmological debate is to work out whether these tensions are a signature of new physics or of systematic biases in the analyses. Part of the studies relies on cosmological simulations to act as the missing ground truth for inference. However, the simulations reproduce only statistically the cosmic web. A new type of simulations, qualified as constrained, is gaining interest. Initial velocity and density fields of such simulations stem themselves from inference based on observational constraints. This talk will present such digital twins, that I named CLONES (Constrained LOcal & Nesting Environment Simulations) and give a few study examples. CLONES appear as a promising tool to increase our capacity to evade biases in future survey analyses in order to disentangle systematics from real tensions.

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