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Mapping the Geography of Extreme Events with Optimal Sampling ANTOINE BLANCHARD, THEMISTOKLIS SAPSIS, MIT — We introduce a smart sampling algorithm for prediction and quantification of extreme events in dynamical systems. The algorithm iteratively probes the phase space, judging the dangerousness of each state visited by advancing the "black-box" dynamics over a prescribed prediction horizon. To keep the number of black-box evaluations at a minimum, the algorithm chooses its next move meticulously by minimizing a criterion that accounts for the importance of the output relative to the input. The criterion and its gradients can be computed analytically, which allows for the possibility of the phase space being high-dimensional. We show that no more than a few dozen samples are necessary for the algorithm to learn the complete geography of extreme events in the phase space. The resulting "danger map" can be used to a) compute precursors for the dangerous regions; b) predict, assess the severity of, and control the extreme events in real time; and c) quantify the statistics for the observable of interest.

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