Real Time Bayesian Inference and Prediction of Hazards and Threats

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Abstract: We have recently developed methods for real-time solution of massive scale Bayesian linear inverse problems governed by autonomous dynamical systems. Our focus has been on tsunami hazard early warning: real-time inference of earthquake-induced seafloor motion from seafloor pressure sensors and a coupled acoustic—gravity wave propagation system, followed by forward propagation of the inferred seafloor motion to predict gravity wave (i.e., tsunami) height at critical coastal locations, all under uncertainty. We are able to compute the solution to this Bayesian inversion and posterior prediction problem in real time by exploiting the time shift invariance of both the forward wave propagation and the parameter-to-observable (p2o) map. Our framework is in theory applicable to a much broader set of problems with similar mathematical structure. The goal of the proposed work is to extend and elaborate our framework to problems involving wave propagation source inversion problems of critical importance to threat and hazard detection and situational awareness.