Bayesian Inference for Uncertainty-aware Post-disaster Damage Assessment Using Artificial Intelligence

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ABSTRACT

Climate disasters cause significant loss of life and damage to properties and infrastructure. In a disaster aftermath, building inspectors conduct preliminary damage assessment (PDA) which, depending on the size and population of the affected areas, may be slow and resource-intensive. In this paper, we present an uncertainty-aware convolutional neural network (CNN) for PDA by incorporating a Bayesian framework and implementing Monte Carlo (MC) dropout sampling to efficiently approximate the Bayesian inferences. Using dropouts not only during training but also at the inference time allows the CNN model to represent softmax probabilities of the damage prediction as random variables, enabling a more rigorous and systematic characterization of uncertainty and confidence in model predictions. The model is trained and evaluated with non-deterministic ground-truth damage scores obtained through crowdsourcing from drone footage of a hurricane-affected area. Results indicate that the trained uncertainty-aware CNN model leads to more informed and reliable PDA outcomes.