A Bayesian Framework For Human-Ai Partnership In Disaster Damage Classification

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Advancements in remote sensing technology, computer vision techniques, and social network platforms provide transformative opportunities for more rapid, efficient, and effective disaster damage assessment practices. However, AI-assisted post-disaster damage assessment is subjected to uncertainty and lack of reliability due to the high complexity of post-disaster scenes, making the refined classification of damage states challenging. In such scenarios, humans usually perform more reliably since humans often have background knowledge and a certain understanding of the complicated scenes in disaster-affected areas. On the other hand, the fully human-based damage assessment is resource-intensive and costly due to the large number of information required to be processed during disaster events. We present an uncertainty-aware crowd-AI teaming system that reinforces the power of AI with human intelligence to improve accuracy and reduce the uncertainty in rapid and automated damage assessment using aerial imagery. Our proposed hybrid crowd-AI framework consists of two modules: (i) an AI-assisted building damage classification model based on computer vision and convolutional neural network, and (ii) a crowdsourcing-based module for participatory damage assessment. The first module uses a Bayesian deep learning model to predict the probabilistic descriptions of building damage severity. The quantified uncertainty will then be used to measure the value of information and identify the tasks that go into the crowdsourcing module for improved assessment with reduced uncertainty. Moreover, to achieve a more reliable inference of crowd assessment, the crowdsourcing module uses a maximum posterior estimation where the AI predictions are utilized as the prior in a Bayesian setting. The outcome of this study will enable leveraging the collective strength of both machine and human intelligence to achieve a more accurate disaster damage assessment, which is instrumental in post-disaster response and management.